Waking the Dead:

The Human Remains from Mainistir Chiaráin, Inis Mór, Ireland

A THESIS SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL OF THE UNIVERSITY OF MINNESOTA

BY

Danika Ceilidh Lerwick

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS

Kieran McNulty, John Soderberg, and Kathleen Blue advisors

June 2010

Images from or modified after Ní Ghabhláin 1997, 1998 and 2010 were used with permission.

Acknowledgements

The work of this thesis could not have been completed without the following people:

Kieran McNulty, who put up with my rather jumbled, haphazard style and let me be his first graduate student, even though he'd rather have been discussing things a little less human and a little further in the past (say several million years before today).

John Soderberg, who gave access to the *Mainistir Chiaráin* skeletal assemblage, helped with tips on research directions, and was his usual "super lab guru" self.

Kathleen Blue, who gave me time outside her normal workday, including extra travel, and helped with the bioarchaeology above and beyond the call of duty.

Sinéad Ní Ghabhláin, who also spent time outside her normal workday searching through old excavation notes and helping me figure out the site reports; also going beyond the call of duty.

And, the Anthropology department at the University of Minnesota who gave both financial support and flexibility in engineering a degree program geared towards bioarchaeology.

Many, many thanks to all. This thesis would never have come to fruition without you.

To my father,
who would be havering about what I was going to do next with my life.

Dr. Lowell P. Lerwick, EdD (21 September 1934-14 March, 2007)

Abstract

For the last several decades there has been a growing increse in the archaeological research in Ireland. Much of this new research has been focused on the Gaelic western half of the country which had been mainly neglected in previous research. Researchers in Ireland are now making an attempt to understand what was happening in the Gaelic portion of the country during the medieval period. In the late 1990s, an excavation at *Mainistir Chiaráin*, a medieval monestary site on the island of *Inis Mór,* was undertaken in the hopes of shedding more light on this topic. Revealed in the excavation was an assemblage of disarticulated human remains, later understood to be a minimum of 12 people. A systematic study of this osteology was undertaken in the hopes of learning more about the lives of people living on *Inis Mór.* A date of the late 13th century CE was determined from a tooth by AMS dating. The bones were curated and assessed for age, sex, stature, health, work load and pathologies. Several unexpected findings came to light during the analysis, including a potential case of tuberculosis and another potential case of scurvy, as well as premolar and molar hypoplasia, mandibular torus, and shovel-shaped incisors. Speculation was made as to whether the nature of the assemblage was indiciative of the population as a whole, or if it was representitive of some sort of liminal burial of outsiders to the community. Future research is needed to answer this question.

Table of Contents

List of Tables

List of Figures

Introduction

Ireland has been a relatively neglected area of the world when it comes to archaeology, especially in the western part of the country. It has been even more so neglected in the study of Irish human osteology. Excavations in the late 1990s at *Mainistir Chiaráin* on the island of *Inis Mór* uncovered a modest assemblage of human skeletal remains. These remains were radiocarbon dated to the late 13th century. The work of this thesis is an analysis and examination of those human remains, in an attempt to learn more about western Ireland and life in the late-medieval period.

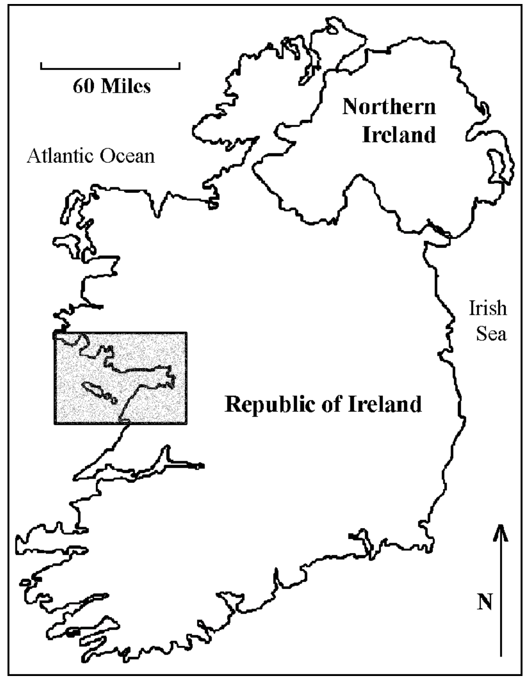


Figure 1: Map of Ireland. Galway Bay Highlighted

Mainistir Chiaráin lies on the northeast side of the island of *Inis Mór,* off the west coast of Ireland in Galway Bay (Figures 1 and 2).Also known as Inishmore or *Árainn Mhór*, *Inis Mór* is the biggest of the Aran Islands that were once high spots on the land and a part of the Irish mainland (Williams 2004, Feehan 1994, Roden 1994). Even today, the depth of the sea between the Arans and the Burren mainland is less than 30m (98.43ft). Both the Aran Islands and the corresponding mainland known as the Bur-

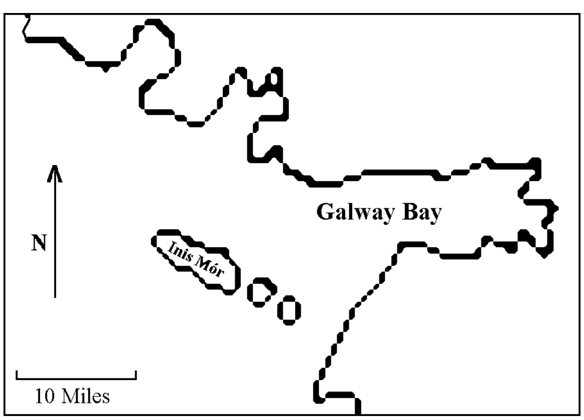


Figure 2: Highlighted Area from Figure 1. Detail of Galway Bay with ***Inis Mór*** Indicated

ren are made of Lower Carboniferous limestone, formed from the muddy lime-rich sediment which, 325 to 350 million years ago, was sitting at the bottom of the sea collecting the remains of brachiopods, corals and other life forms (Williams 2004, Feehan 1994, O'Connell and Roden 1994).

The Arans have actually formed as a long low ridge with a steep escarpment on one side and a gentle southerly dip on the other, i. e. a *cuesta* (Williams 2004, Feehan 1994). The side facing southwest is the high, with cliffs upwards of 200m (656.17ft) high. This steps down in a terrace like formation until it reaches sea level on the northwest side of the island (*ibid.*). Through the limestone are pronounced and pervasive joint systems, one set striking approximately N–S and the other approximately NE–SW (Williams 2004, Feehan 1994, Robinson 1986). The joints are subject to erosion. Certain joints became grikes, or fissures that often fill with mud or muddy water (*ibid.*) Some of the joints have eroded to the point of becoming valleys. *Inis Mór* actually has two valleys that run through the island, one of which is sometimes easily hidden by high seas and has earned the name *An Sunda Caoch,* or Blind Sound, with the number of ships that have crashed into the shore (Williams 2004, Feehan 1994, Roden 1994, de Courcy Ireland 1994).

Mainistir Chiaráin is on the northeast side of the island overlooking a small pebble beach (Figures 3 and 4, Ní Ghabhláin 1997 and 1998, Robinson 1986). When people first came to the islands more than 4000 years ago, the land surface was mostly the rock pavement-like limestone. The readily

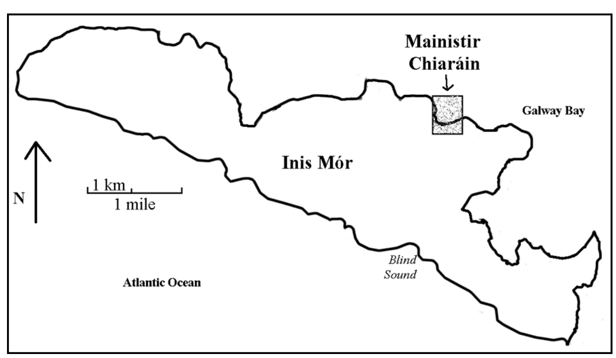


Figure 3: ***Mainistir Chiaráin's*** Location on ***Inis Mór***

available loose limestone was used to enclose off areas of land and to dam up the grikes and gain control of the erosion and water flow. Then the cordoned off areas were filled with seaweed and sand to produce arable soil (Feehan 1994, Robinson 1986). But, this soil had to be well watched and cared for. High winds and waves could easily destroy any top soil which is why enclosure walls could easily top 2m (6.56ft) high, and why there is no remaining housing on the windward (SW) side of the island. It is the NW side that the best protected from erosion (Feehan 1994, Waddell 1994). This would seem to be the main reason *Mainistir Chiaráin* was placed where it was.

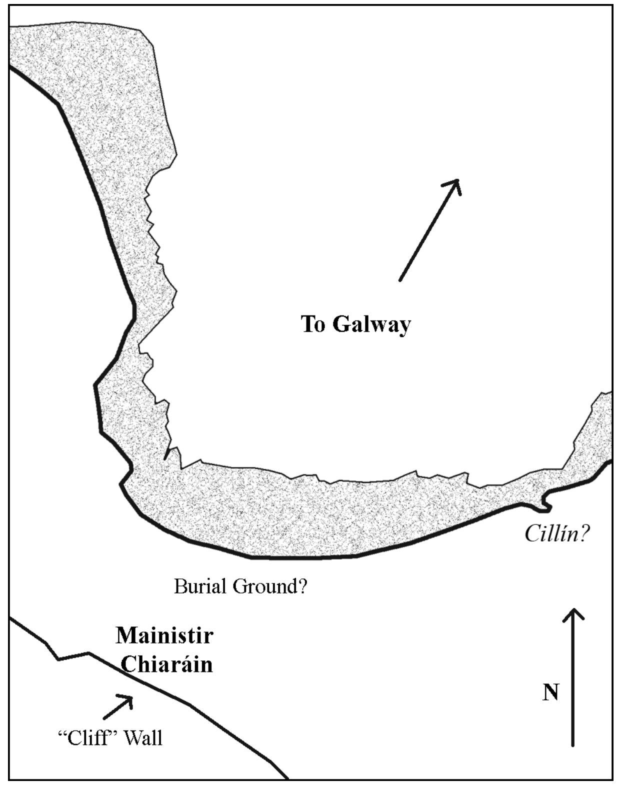


Figure 4: ***Mainistir Chiaráin's*** Location by the Beach

There is little known history of the monastery complex. Custom attributes the creation of *Mainistir Chiaráin* to *Naomh Ciarán*, or Saint Kieran, who founded the more well known monastery of *Clonmacnoise* sometime during the sixth century CE (Waddell 1994, Ní Ghabhláin 1997, Robinson 1986, Gosling 1993). While there is no evidence to prove this claim, it is certainly possible. Saint Kieran was a known follower of *Naomh Éinne*, Saint Enda, who was the earliest known saint to come to *Inis Mór* sometime during the fifth century CE (Waddell 1994, Robinson 1986, Gosling 1993). It would make sense that Saint Kieran travel a similar path as his master.

Possibly the most famous icons from *Mainistir Chiaráin* are the standing cross-slab stones; however, what remains of the actual monastery is four buildings in varying degrees of ruin (Figure 5). There is *Teampall Chiaráin,* which is a single celled church with a trabeate doorway on the west and a finely-wrought Transitional style east window which dates to the 12th century. (Ní Ghabhláin 1997). The foundation of a small, single cell chapel lies just north and adjacent to the *Teampall*, possibly part of the original 7th century buildings. The foundations of two more buildings lie to the south: one about six meters from the southeast corner, and one at just over a meter directly to the south from the western half of the *Teampall*.

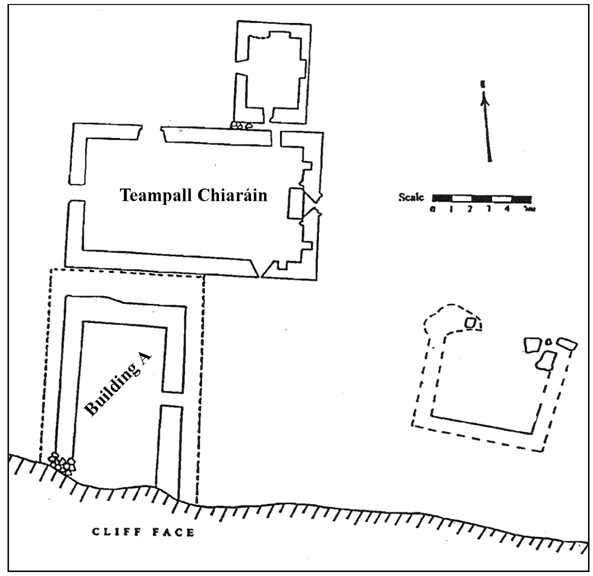


Figure 5: ***Mainistir Chiaráin*** Modified from Ní Ghabhláin 1997

The excavated area was on the south side of the *Teampall* and began with the fourth building mentioned above, labeled Building A by the excavation team (*ibid*.). Building A, was deemed domestic in nature based on the artifactual evidence: pottery, grind stones, nails, and clay pipe fragments. These artifacts produced dates ranging from the 14th to the 18th Centuries, with the bulk being in the 16th to 17th Century. A layer of rubble began slowly accumulating in the late 16th, eventually leading to its disuse (Ní Ghabhláin 1997).

Once several stratification layers were removed, it became obvious that there had been a previous building upon which Building A was constructed. Given the designation Building B, this previous building's foundation was shifted to the east.

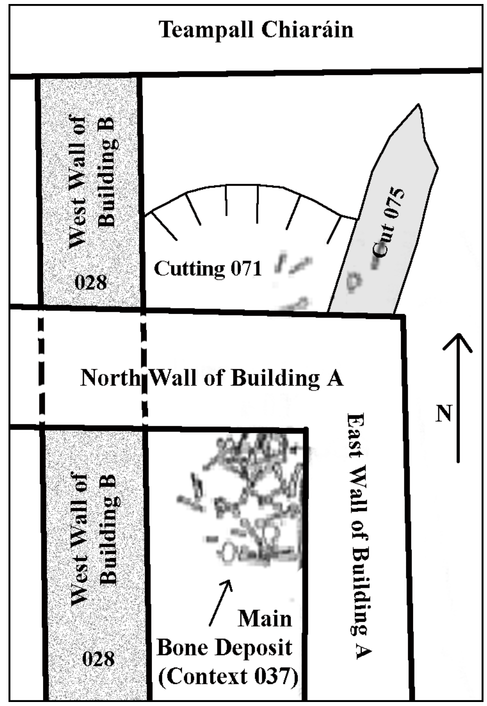


Figure 6: The Main Deposit Location Modified from Ní Ghabhláin 1997

such that the two foundations were overlapped Building A over Building B. The main deposit of human remains was located between the east wall of Building A and the west wall of Building B and labeled Cut 037 (Figure 6).

As can be seen in a cross-section of the excavation looking to the north at the north wall of Building A (Context 073), the stratigraphy of the site is not exceptionally deep, about 40cm (15.75in) from the surface to the bedrock, and less than 20cm (7.87in) from the surface to the main bone deposit (Figure 7). One hundred and one, or 28.5%, of the total human remain fragments were found in Cut 037.

Further excavation and analysis revealed that Cut 037 was actually part of a larger hole that was eventually labelled Cut 084. "A hole was cut through the floor of the building when it was no longer in use to rebury the bones of at least two individuals" (Ní Ghabhláin 1997:25). The excavation was able to identify the north end of Hole 084 (Ní Ghabhláin 1997 and 1998). A reasonable assumption was made that the west side truncated at Wall 028, the west wall of Building B. The eastern edge of Hole 084 was also a bit unclear, but it appeared to be located just east of the eastern wall of Building

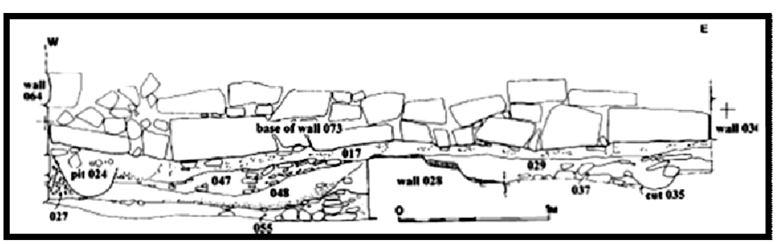


Figure 7: Stratigraphy of Main Deposit facing North

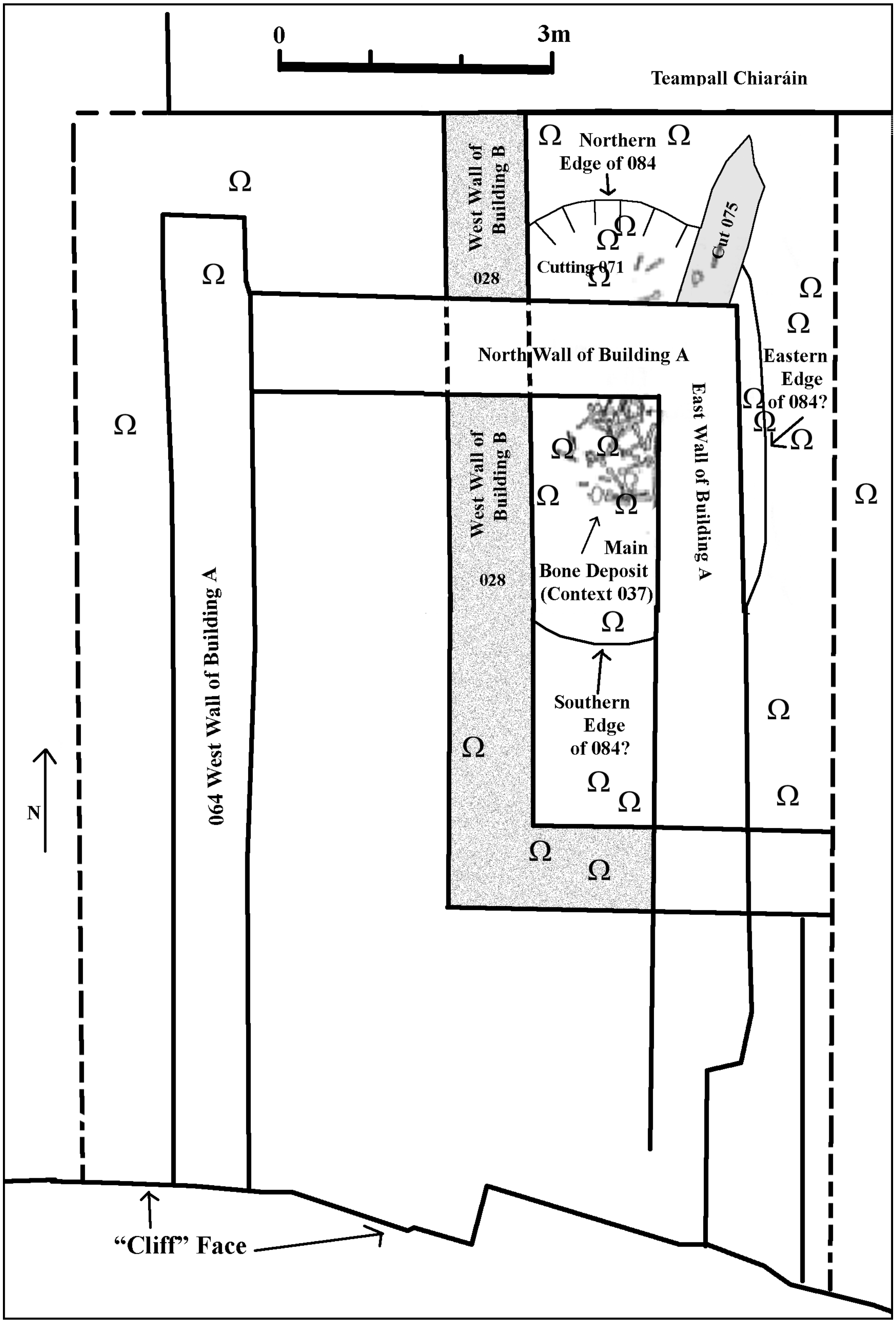


Figure 8: ***Mainistir Chiaráin*** excavaiton site. Ω represents locations where human remains were discovered in addition to Context 037. Redrawn after Ní Ghabhláin 1997.

A, or Wall 030. The excavation was unable to discover the exact southern end of the hole. Based on the site reports (*ibid.*) and personal communication with Sinéad Ní Ghabhláin (2010), it would seem that Hole 084 would have been about 4m (13.12ft) north to south, 2m (6.56ft) east to west, and about 20cm (7.87in) deep (Figure 8). Hole 084 appeared to have been dug after Building B had fallen into disuse, and before Building A was constructed.

As the excavation progressed, more bone was discovered. Most of this bone was not identified as human by the excavation crew. However, on further examination in the lab, it became clear that there were many more human remains in the assemblage than were recognized at the site. An additional 109 identifiable human bone fragments came out of either the fill from Hole 084, or the stratigraphy directly above this hole. Adding this 30.7% to the 28.5% actually found in Context 037 and a total of 210 of the 355 fragments in this assemblage, 59.2%, can be directly associated with Hole 084. In addition to this, 36 more fragments were discovered within 1m (3.28ft) of the suspected edges of this hole, several of these pieces being mates to the fragments found in those directly associated with Hole 084, adding another 10.1% to the amount relating to the deposit of Hole 084. As this was considered the main deposit, I sent one tooth from this context to Beta Analytic for radiocarbon dating. Beta returned a date in the late 13th century which will be discussed later in this work.

Sixty-six more fragments came from the excavation area centered around Building A, most from the area to the north near the *Teampall.* These pieces do not have any definitive connection to those found in Hole 084; however, there is at least a suggestion of connection to season three's excavation finds and as they were discovered nearer the *Teampall* than the cliff, which is also the relative situation of Hole 084, a definite separation between the remains of 084 and the rest of these 66 bones cannot be made.

The third season of the excavation moved to the east (Figure 9, Ní Ghabhláin 1998). Unfortunately, in this 6m x 6m area (118.11ft^2), the only context given was the first three stratigraphic layers until further into the soil was reached. The 20cm (7.87in) topsoil revealed six pieces of human remains. Under this layer, with no indication of depth, was a shell midden that not only covered the entire excavation block, but was also identified with a shell layer found in the excavation block from seasons one and two (Ní Ghabhláin 1998). The contexts given for the previous season's shell midden corresponds with two contexts in direct correspondence with the 084 deposit, Context 017 and 063, as well as one context of the assumed correspondence category, Context 023 (Ní Ghabhláin 1997, Ní Ghabhláin 1998) . In addition, two teeth from the season three shell midden have probable mates as well as consistent maxillary crypts that were discovered in 084 associated cuts: 061 and 015. Thus, the eight human remains from this stratigraphic layer were grouped with the previously discussed population.

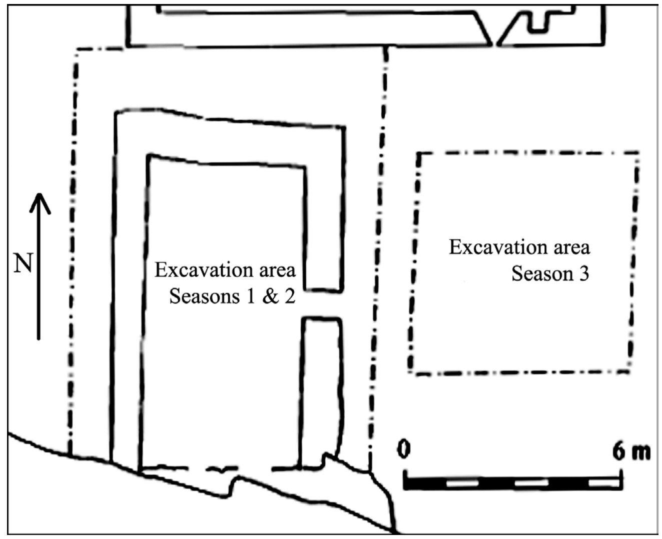


Figure 9: Excavation Areas. Modified from Ní Ghabhláin 1998

Beneath the shell midden was an 18-25cm (7.09-9.84in) thick layer of sandy loam. There was difficulty in determining where the shell midden ended and this particular layer began (Ní Ghabhláin 1998). There was also the suggestion that this layer "most likely represents cultivation to the east of Building B contemporary with its construction and use" (Ní Ghabhláin 1998:58). Because of this, coupled with the exact location where each human bone piece was discovered, it is difficult to determine whether the 17 human fragments from this loamy layer should be considered as a separate entity from the previous 318. In addition to this there are 20 from the 4th season from which the site reports were lost due to circumstances beyond anyone's control (Ní Ghabhláin 2010). The preliminary summary for season four was available (Ní Ghabhláin 1999). This did not include context numbers, but it did give an overview of the excavation that confirmed an immediate connection to the three previous seasons. Thus it is unclear what to make of these last 37 bone pieces except to say that there is a likely connection to the skeletal assemblage as a whole.

As these bones are mostly fragmentary and do not detract or significantly alter analysis of the *Mainistir Chiaráin* assemblage, I have chosen to include them in the population statistics as a whole. However, if future excavation or research should reveal the excavation layers from which these bones were found were not affiliated with the associated layers of the other 318 bones, some of the analysis in this work may need reevaluation.

The following pages detail the work completed in the analysis of these human remains from *Mainistir Chiaráin*. The first section outlines the materials and methods used in the analysis. This section is followed by a section labelled The Human Remains, which details a fairly extensive report of the findings in the analysis; including a skeletal inventory, a demography, a discussion on the markers of physiological stress and markers of pathological conditions, diet, and non-metric traits observed in the skeletal assemblage. The following section is a discussion of the findings with potential meaning and possible future direction of investigation.

The last sections are the concluding comments and an appendix with raw data tables and the AMS information.

Materials and Methods

Excavations at *Mainistir Chiaráin* yielded an unsuspected quantity of human remains. Under the direction of Sinéad Ní Ghabhláin and Jo Moran, volunteers from University Research Expeditions Program Berkley excavated the south side of the monastery over four seasons from 1996 to 1999 (Ní Ghabhláin 1997, 1998, and 1999). Funding for this excavation was conferred by Heritage Services, Department of Arts, Culture and the Gaeltacht as well as University Research Expeditions Program Berkley.

Throughout the excavation, disarticulated bones from many different animals were unearthed, such as: cattle, sheep, dogs, and fish. Of special note was an unorganized assemblage of human remains discovered in the northeast corner of Building A (see Introduction). The bone from this particular context was wrapped in toilet and news paper and packed in a cardboard box. All other bone found during the excavation was collected on site in plastic, ziplock bags which were labelled with context and cutting. These bags of bones were then packed into 15 more—12" x 15" x 15" cardboard boxes and all 16 boxes were shipped from Ireland to John Soderberg at the University of Minnesota for analysis.

In the fall of 2008, I began systematically sorting through these 16 boxes of skeletal elements, separating out the human remains from the animal. If a bone was identified as human, it was carefully put into a new plastic bag, which was labeled with the context and cutting. Once completed, I then proceeded to clean and curate the remains. Cleaning involved mostly brushing off any attached soil with a soft tooth brush, as well as carefully dislodging any soil from cracks and crevasses using a dental pick. So as to avoid contamination that might hamper future analyses (e.g., genetic or isotopic research) only minimal cleaning was undertaken. Water and solvents were avoided if at all possible. In only a few instances was water used in the cleaning, and this done in areas where the presence of soil hindered proper evaluation and the residue would not be removed by any other method.

After cleaning, each piece was carefully marked with an accession number and catalogued, if possible, by element and side in a spreadsheet. As mentioned previously, in the field the bones were placed in plastic bags and labeled with the context and cutting. This method is based on the matrix system developed by Edward Harris (Ní Ghabhláin 2010, Paice 1991, Chippindale *et. al.* 2000). A cutting is the actual open area excavated. A context is a single deposit or cut. As may be noticed, the difference between a cutting and a context is minimal, a context being a single cut and therefore essentially just a small version of a cutting, and for archaeologists not accustomed to this system it can be a bit confusing. For the purposes of this work, the cutting number is used mainly for curation purposes and need not be understood beyond that role. The accession number was created using the context number as the first portion, the cutting number became the second, and the third portion was determined by the order the bone was removed from the bag. Thus, the third bone removed from the bag labeled with context 999 and cutting 90 would result in an accession number of 999.090.3 (see Appendix, Table 1 for an inventory of items labeled with corresponding accession numbers).

The final step in the curation process was the reassembling of any possible elements. Pieces that could be positively matched were recombined and glued together with water soluble glue. This glue was deemed the least caustic and easiest to unbind if the need arose. Once that was completed, the elements were recorded and scored using the protocols set in *Standards for Data Collection from Human*

Skeletal Remains (Buikstra & Ubelaker 1994). As none of the skeletal elements were *in situ*, few were complete or could be positively identified as belonging one with another, each element was evaluated independently for age at death, sex, stature, and any pathologies. *Standards* and *Human Osteology* (White 2000) were also used as initial references in the examination.

Age at death was estimated for the appropriate elements using tooth formation and eruption (Moorees et. al. 1963a & 1963b, Ubelaker 1989) epiphysis closure and long bone length (Gray 2000, Baker *et. al.* 2005, Bass 2005) , morphology of the coxal auricular surface (Lovejoy et. al. 1985, Buckberry & Chamberlain 2002) and the pubic symphysis (Todd 1921a & 1921b, Brooks & Suchey 1990, Stewart 1979). Sex was evaluated using pelvic and cranial morphology as well as quantitative measurements entered and analyzed in Fordisc 3.0 (Ousley & Janz 2005) where applicable. Stature was estimated using long bones and Fordisc 3.0, also where applicable. Skeletal pathologies were assessed and recorded according to a variety of sources (Capasso 1998, Mann and Hunt 2005, Ortner and Putschar 1985, Aufderheide and Rodríguez-Martín 1998, Živanovic 1983, Roberts and Cox 2003) and pathologies specific to dental and oral health were evaluated using additional sources (Alt *et. al.* 1998, Scott and Turner 1997, Brothwell 1963).

The complete inventory of human remains amounted to 355 separate pieces of bone, which combined to make 144 elements, not including the dentition; most of which could not be positively identified as coming from the same individual. Using element size, morphology, and development stage, it was possible to ascertain a minimum number of individuals of 12: one infant near birth, one child aged 2-4 years, one child aged 4-10 years, two juveniles aged 10-17 years, and seven adults; however, this does not preclude a larger number of individuals.

Tables detailing the relevant scoring for the appraisable elements can be found in the appendix. Scores were recorded if present. Etiologies not present were not recorded. A key to the relevant table abbreviations and inventory listing is also available as Table 1 in the appendix.

The Human Remains

Skeletal Inventory

The total amount of identifiable human bone in the *Mainistir Chiaráin* assemblage was 355 individual pieces representing at least 144 elements, plus dentition. Crania and long bones were found in the highest percentage.

The crania were difficult to reassemble. The cranial remains were highly fragmented, the smallest identifiable piece being just 21mm x 20mm (0.83in x 0.79in). Some of these cranial pieces could be matched, but many had so much taphonomic activity that positive association, let alone reconstruction, was impossible. Of the 115 cranial pieces, ten maxillae could be identified out of eleven pieces; three right, five left, and two undetermined; none which could be positively identified as a matched set. One right maxilla also revealed an attached lateral pterygoid plate and one left maxilla was accompanied by the greater palatine foramen; adding both a sphenoid and a palatine bone to the list of identifiable elements.

Although not specifically cranial, there were three mandibles in the assemblage as well. One consisted of only the area surrounding and including the third right molar. The other two mandibles were intact, missing only a portion of the dentition; and it was possible to identify one mandible as female and the other as a probable male (Acsádi and Nemeskéri 1970, Ousley and Janz 2005). None of the mandibles could be matched with any of the cranial pieces.

Six temporal bones were identified. The one right temporal was from a probable male, as well as three of the lefts (Acsádi and Nemeskéri 1970). One left was from a probable female and one was indeterminate (*ibid.*).

Five occiputs were identified out of six pieces. 16 parietal bones were identified out of 21 of the cranial pieces; only two could be sided--right--and the rest were indeterminate. There were also four frontal bones, one right and three left, out of seven of the cranial pieces; again no positive correlation could be made between these pieces. The rest of the 70 cranial pieces were only identifiable as coming from somewhere on the vault and were given that designation.

Of the long bones, few were found complete. Several could be reconstructed to a complete or near complete status and several pieces could be matched to form only portion of a given long bone. The rest were not reconstructible and were left as individual pieces.

There were 11 humeri: two probable pairs from adults plus one right and three left that are also from adults. There is also one left humerus from a juvenile under 16 years of age (Baker *et al.* 2005, Gray 2000, Bass 2005). One of the adult left and one of the right humeri, as well as the left juvenile humerus, were in complete or near complete condition; although the epiphyses were missing in the case of the juvenile. Three right humeri and one left humerus were in pieces, but easily reassembled into a complete or near complete condition. One right and two left humeri consisted of only the distal portion of the shaft, and one right humerus was a probable composite consisting of a distal shaft and the distal condyles.

There were also four left and two right ulnae One right was complete after matching two pieces together, one right needed no repairs but was missing the distal portion, and all four lefts were completely missing the distal half of the element.

Of the six radii, all three of the rights were made whole with relatively easy repairs. One left radius was complete while another consisted of only the proximal two thirds of the shaft, and one left raidus consisted of only 4.5cm (1.77in) of the proximal end.

The tibiae were all in mostly complete condition and revealed one probable pair in the 14-18 year age range (*ibid.*) and one right, smaller tibia in the same age range; all missing the epiphyses. There were also three adult probable tibial pairs and one non-paired right tibia. All of the fibulae were in need of repair. There was one right juvenile and one undetermined juvenile fibula, both aged 13-18 years (*ibid.*) with missing epiphyses. There were also six left and three right fibulae of adult age.

After careful consideration of the assemblage, it appeared that the femora revealed the most information about the minimum number of individuals. There were a total of 43 elements that could be assembled into 14 femora. There were three left juvenile femora, from individuals aged 7-17 years (Baker *et al.* 2005), and one right femur which was an acceptable size and shape to be considered a mate to one of the left femora. There were also four left adult femora and two probable femoral pairs. The remaining two femora are actually multiple fragments that are a likely fit; however, there is not enough evidence to suggest siding, nor enough to suggest a positive match. This puts the total number of individuals represented by the femora at nine; an MNI larger than that represented by any other one element.

In addition to long bones and crania, there were two cervical, five thoracic, and three lumbar vertebrae identified, plus one cervical vertebra from a child, aged 2 to 4 years (Gray 2000, Baker *et. al.* 2005) . There was also one upper and one lower sternebra from a child aged 4-10 yrs. (*ibid.*) and a left clavicle from a perinate, which was broken at the acromial end and a more specific age could not be established (Gray 2000, Baker *et. al.* 2005, Fazekas 1978)

There were also four right sternal ribs; two which were unfused, coming from an individual aged 16-25 (Gray 2000, Baker *et. al.* 2005); and one second rib, also unfused and in the age range of 16-25. All of the adult ribs were broken at the sternal end, but were otherwise in complete condition. There were five scapulae: one right from a juvenile of 8 to 15 years of age (*ibid.*), and four adult left scapulae. None of the scapulae were whole. Three scapulae were able to be made more complete by matching fragments; however, none possess the vertebral border and many have most of the blade completely missing.

Present from the extremities were a right calcaneus and a left talus, a left second metatarsal and a proximal pedal phalanx. There is also a right capitate and lunate, and seven intermediate manual phalanges; four from an adult and three from a sub-adult of roughly 10 to 20 years of age (Gray 2000, Baker *et. al.* 2005, Bass 2005).

There were two superior portions of adult sacra, both missing portions of the alae. Both of these are probable males (Bass 2005, Stewart 1979). Once the pieces were reassembled, there were also five complete (or near complete) os coxae, three left and two right. Two of the os coxae were an extremely good match, enough to deem them from the same individual. This pair comes from a female, as do two others, and one of the left os coxae is male (Stewart 1979, Bass 2005, White 2000, Klepinger 2006). Only one of these os coxae was received in a mostly complete condition. The rest were reassembled from multiple fragments. In addition, there was one right ilium from a probable female and one right ischial piece of undetermined sex, along with one right probable female and one left probable male portion of pubic symphysis (Todd 1921a and 1921b, Brooks and Suchey 1990).

Thirty-three skeletal elements are represented if the two sternebrae are counted as one element, and the manual intermediate phalanges are also counted as one (not distinguishing one phalanx from another). As the vault pieces are ambiguous it can be assumed for the sake of this thesis that they do actually correspond with other cranial pieces in the assemblage. Thus, there are 144 distinguishable bones present: 43 cranial, 14 femora, 11 fibulae, 11 humeri, 10 tibiae, 9 manual bones, 7 pelves, 7 vertebrae, 6 radii, 6 ulnae, 5 scapulae, 4 ribs, 4 pedal bones, 3 mandibles, 2 sacra, 1 clavicle, and 1 sternum. 24.3% were in complete or near complete condition and another 19.4% were in the same condition after repair, making a grand total of 43.8% of the elements that were at a complete to near complete status by the end of the curation process. Interestingly, all but one of the tibiae fits in this category, as do the ribs. None of the other elements fared quite so well taphonomically.

Of the 101 bones present that orient to a particular side, (ribs, long bones, etc.), 53.4% were lefts, 41.6% were rights, and the rest were indeterminate. 11.8% of the skeletal elements were from juveniles in the 13 to 25 age range, 1.4% were from the 4-10 child age range and 0.7% were from the perinate category. As only a few elements could be sexed (see page 19 for more on this topic), there is a minimum of four males and five females in the assemblage with any others being indeterminate. As this correlates to the nine individuals represented by the femora, it would seem to be a valid estimate of the minimum number of individuals. Taking into account the sternebra aged 4-10, the vertebra aged 2-4, and the clavicle aged at a perinate stage--none of which can be accounted for by any other skeletal element, there would seem to be a need to add another three people, making the final MNI, minimum number of individuals, equal to 12: three adult males, four adult females, two juveniles--one male, one female--aged 10-17, one child aged 4-10, one child aged 2-4, and one infant near birth.

Inventory of the dentition did not alter the MNI. There were 23 incisors: 15 left and 8 right; 15 canines: 9 left and 6 right; 35 premolars: 17 left and 18 right; and 31 molars: 15 left and 17 right. All previous teeth are adult, of which 41 were lower and 63 upper. There was also one upper left deciduous molar in the assemblage.

Demography

While it does exist, sexual dimorphism is a not always an easy item to ascertain. Population as well as individual variation often cause difficulties in the separation of males from females, and often there is considerable overlap between the two (Todd 1921a and 1921b, Oschinski 1964, Oettlé *et. al.* 2009, Novotný *et. al.* 1993, White 2000, Ayoub *et. al.* 2008). To date, the pelvis is still the best method for determining sex (White 2000, Bass 2005, Burns 2006, Stewart 1979). While methods have been explored to sex the skeleton from many other parts of the body (Cowal and Pastor 2008, Kalmey and Rathbun 2005, Pomeroy and Zakrzewski 2009, Holland 1991, Sacragi and Ikeda 1995), none have proven reliable enough in the broad spectrum of human variation to be used with any accuracy. Even the commonly used cranial anthroposcopic traits developed by Acsádi and Nemeskéri (1970) are today in question (Konigsberg *et. al.* 2009, Brasili *et. al.* 1990, Molleson and Hodgson 2003, Novotný *et. al.* 1993). In addition, there has been no accurate and reliable method developed for sexing skeletons of individuals who have not gone through puberty (Baker *et. al.* 2005, Vlak *et. al.* 2008, Hoppa 1992).

Thus, sex for most of the human remains in the *Mainistir Chiaráin* assemblage could not be determined. If the traits of an element fit within the confines of the male or female sexing variables, that particular sex was assigned to that element. If the element fit marginally in the confines of the sexing variables of male or female, the element was listed as a probable male or female. If no sex could be determined, no mention is made of sex at all. Of the 12 individuals in the sample, two were female, three were probable female, one was male, three were probable males, and three indeterminate (Figure 10).

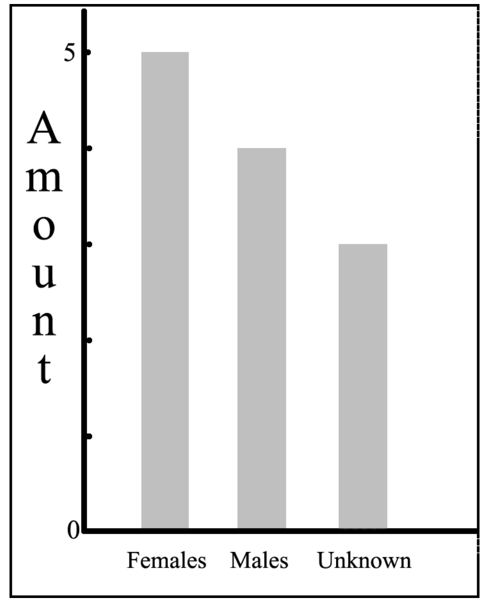


Figure 10: Histogram of Sex Determination in the Mainistir Chiaráin Assemblage

Age is also a difficult criterion to assess. In this assessment, it tends to be the younger individuals who receive the more accurate assessment, rather than the older individuals as with assessing sex. There is considerable information on developmental assessment of prenatal, perinatal and newborn children (Fazekas 1978, Weaver 1998) as well as children from birth to adulthood (Baker *et. al.* 2005, Stewart 1979, White 2000, Ubelaker 1989, Bass 2005, Klepinger 2006, Burns 2006, Gray 2000). Because human development has a tendency to follow a predictable pattern, aging an individual while he or she is still evolving into an adult is relatively accurate. If there is an actual population with known skeletal development patterns associated with that individual, aging can become even more accurate.

In terms of adults, the aging methods lose accuracy (Stewart 1979, White 2000, Bass 2005, Klepinger 2006, Burns 2006). Skeletal aging patterns in adulthood vary widely and are affected by genetics, lifestyle, diet, occupation, health, environment and even personal hygiene (Sofaer 2006, Jurmain 1999, Roberts and Manchester 2007, Ortner and Putschar 1985, Mann and Hunt 2005, Aufderheide and Rodríguez-Martín 1998). As there is little to no data for the area surrounding the Aran Islands, let alone *Inis Mór* itself, there is nothing which can be compared to the skeletal information from *Mainistir Chiaráin*. Thus the aging done in this work is more of a preliminary assessment than one would hope.

The aging for the adults was done using the analyzable portions of the os coxae: the pubic symphysis (Todd 1921a & 1921b, Brooks & Suchey 1990) and the auricular surface (Lovejoy *et. al.* 1985, Buckberry & Chamberlain 2002). These methods can produce quite a range of ages, thus for graphing purposes the mean for each element was used. Aging for other adult skeletal elements was not able to be assessed--although the comment should be made that the degenerative changes that often come with age were not in abundance (see Markers of Physiological Stress). Thus, only five of the seven adults could be assessed for age. Aging for sub-adults was based on epiphyseal closure and element fusion. Means were also used here for any given age ranges (Figure 11).

Figure 11: Graph of the aged individuals from ***Mainistir Chiaráin.***.

A normal population curve shows a high number of deaths in infants and the elderly (Larsen 1997, Paine 1989, Konigsberg and Frankenberg 1992). This is marginally the case in the *Mainistir Chiaráin* assemblage, and the small sample size, only 10 individuals able to be aged, makes an accuate assessment of mortailty rate quite improbable. There are many instances of variation among populations (Howell 1982, Alesan *et. al.* 1999, Larsen 1997, Paine 2000) and there is always the unresolved issue of the osteological paradox: what is seen in the osteology is actually all that survived taphonomically, not necessarily a complete record of past events (Konigsberg and Frankenberg 2002, Storey 2007, Wood *et. al.* 1992). .

Long bones are correlated with stature, especially the lower long bones that make up the leg (Stewart 1979, White 2000, Bass 2005, Ousley and Janz 2005). Assessing stature from a single long bone will produce an estimated stature that usually ranges about 12-13cm (5in). In dealing with an individual, as with forensic identification, this is a bit of a drawback. The difference between 168 and 180cm (5'6" and 5'11") is quite great after all. This range is much more acceptable, however, in dealing with analysis of a population, when the analysis usually involves quantitative means rather than individual identification (Feldesman and Fountain 1996, Vercellotti *et. al.* 2009, Maijanen and Niskanen 2010).

In the case of the *Mainistir Chiaráin* sample, there is neither a complete population, nor a complete individual. With a MNI of only 12 people, it is difficult to say much statistically about this group as a population; and with no means of assembling even a partial skeleton, there is no individual to identify. For the purposes of gleaning at least some information about stature from these remains, stature was computed for the adult specimens that were complete in length once curation was finished. There are methods for estimating stature from partial long bones (Steele and McKern 1969, Prasad *et. al.* 1996). However, as previously mentioned, stature calculations from whole bones commonly result in an error spread of about 13cm (5in). Since the remains from *Mainistir Chiaráin* lack a comparative sample, keeping the probable error rate low was thought the best course of action in these preliminary studies of western Ireland.

Unfortunately, this left few lower long bones available for stature estimation. These total three left fibulae, four left tibiae and one right tibia--a probable match to one of the left tibiae--and two left femora. Even more unfortunate is that it is not known whether any of these elements are from the same individual or even from the same limb. And, as there is no known sample from which to compare, there is no method to estimate sex for these elements. Because of these factors, stature was calculated and given for each element independently. The 19th century statistics in Fordisc 3.0 (Ousley and Janz 2005) were used in analysis. Again, as the comparative sample is limited for *Mainistir Chiaráin*, the 19th century population was chosen because it is an older sample and taken from individuals of European descent.

Stature calculations for these 10 long bones, provide a mean stature of 157.78cm (5’2”) (Figure 12). Roberts and Cox (2003) report a stature mean of 159cm (5’2.5”) for females and 171cm (5’7”) for males in the late-medieval period (*c.* 1050-1550 CE). This study surveyed 60 sites from all over the British Isles, including Ireland. Unfortunately, no specification is given to which particular sites. This would seem to put

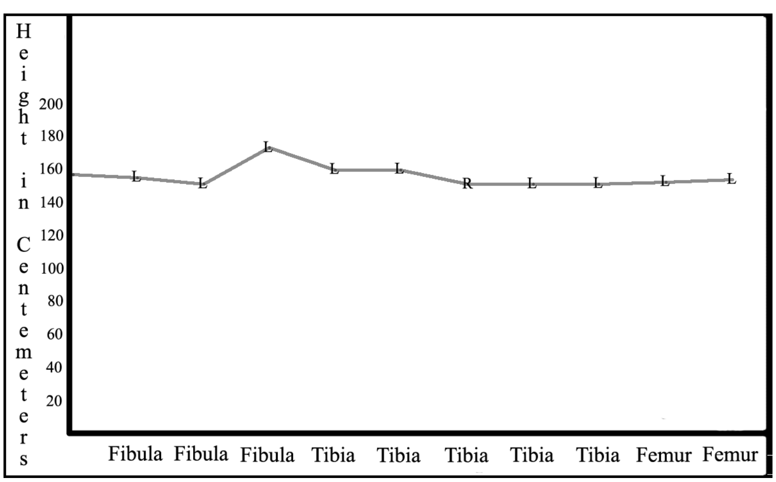


Figure 12: Stature from ***Mainistir Chiaráin*** Long Bones. L=Left, R=Right.

the *Mainistir Chiaráin* sample slightly shorter than the overall populace at the time; however, as the study is not specific to Ireland, small islands in the North Sea, County Galway, or some other geographically or otherwise directly comparable population--in addition to the already mentioned problems with stature estimation of the *Mainistir Chiaráin* assemblage itself--it is difficult to ascertain if the short stature is significant or not.

Markers of Physiological Stress

“Physical activity is a defining characteristic of human adaptive regimes” and “(w)orkload and activity have enormous implications for the demographic history of a population” (Larsen 1997:161). This is mainly because life leaves its traces on our corporeal body. Ever since the western world’s love affair with forensics--commonly referred to as “the CSI effect”--it is hard to find someone who isn’t aware of Edmond Locard’s Exchange Principle (Locard 2010, Nickell and Fischer 1999, Mann 2006, Cole and Dioso-Villa 2007); although, he may not know that is what it is called.

Locard’s Principle is simply that for every contact that is made, something is left and something is taken away. Criminalists use this concept in analyzing trace evidence at crime scenes. The basic principle, however, can easily be applied to the human body. For everything we touch we leave behind the dirt on our skin, our fingerprints, and even sometimes our DNA (Blackledge 2007, Nickell and Fischer 1999). We also take with us the dirt and bacteria on the surface we touch--one of the main ways viruses such as the common cold are spread (Rollinger and Schmidtke 2010, Lukashevich *et. al.* 1999).

But life can leave many more permanent traces on our bodies than a cold.

Some marks are left so deeply that they remain in the skeleton long after the soft tissue has gone. One such life marker is robusticity, a feature which has quite a broad range in the *Mainistir Chiaráin* sample. As with most changes in the body, the manifestation of robusticity is complex, resulting from climate and environments as well as heredity and chronic or habitual behavior (Jurmain 1999, Stock 2006, Bridges 1996, Stock and Pfeiffer 2001). The best way to understand this manifestation is with interpopulation comparison. As that is not possible with this assemblage, some generalities will have to be allowed for until further research is available.

Figure 13: Mandible A with Coronoid and Gonial Flaring

"Adults who exercise tend to have higher bone mass and size than adults who are relatively sedentary" (Larsen 1997:196). Overall bone size and cortical thickness tends to be greater in individuals with a high level of activity. Some of the skeletal elements from *Mainistir Chiaráin* show a high level of robusticity, suggesting these individuals had a very physically active life.

The two intact mandibles, for example, are noticeably robust compared to many mandibles found in the average collection. Mandible A (Figure 13) is surprisingly robust even in comparison to Mandible B. The mandibular cortex is considerably dense with a significant gonial and coronoid eversion. Mandible B (Figure 14) also has dense cortical bone and thickened rami, but lacks the coronoid and gonial eversion seen in

Figure 14: Mandible B with Bulbous Horizontal Ramus

Mandible A. The body of this mandible has the added peculiarity of being bulbous and rounded like a barrel along its transverse axis.

Several of the femora also show this noticeable robusticity. For instance, Femur A (Figure 15) has cortical bone with a thickness of 8.1mm (0.32in) at mid shaft; 10.4mm (0.41in) at the *linea aspera*. The proximal half of this femur is missing, so it is unknown the lenght of the element; however, the shaft itself measures 33.6mm (1.32in) transversely at the nutrient foramen and 34.8mm (1.37in) in the antero-posterior direction.

Figure 15: Femur A with Noticable Robusticity

Robusticity is not the only life marker that suggests a high level of activity in this sample. Large muscle attachment sites, often referred to as rugosity or entheses, are another sign of heavy activity in the life of an individual, and are also highly correlated with robusticity (Larsen 1997, Hawkey & Merbs 1995, Kennedy 1989, Kennedy 1998, Wilczak & Kennedy 1998, Hoyte and Enlow 1966, Capasso *et. al.* 1998, Weiss 2007, Lieverse *et. al.* 2009). Bone remodelling theory holds that when muscle insertion sites are subjected to stress, blood flow is increased, stimulating osteoblasts to form new bone in the stimulated area. Entheses, or bone proliferation at muscle attachment sites, is the result. “Anthropologists have concluded using bone remodelling theory that large muscle markers are due to continued muscle use in daily and repetitive tasks (especially when started at a young age and continued through adulthood), which has made muscle markers ideal for reconstructing past lifestyles” (Weiss 2007:931).   This may be so, but there is still not much known about the exact relationship between robusticity and ontological development (Cowgill and Hager 2007, Knusel 2007, Ruff *et al* 1994, Shaw and Stock 2009, Pearson and Lieberman 2004, Mays *et. al.* 2009). Thus, for the sake of this work, no investigation has been made in to the robusticity, or lack thereof, in the subadult elements.

Entheses do not have a broadly accepted method of quantification and none that have been suggested are used with any great frequency (Mariotti *et. al.* 2004, Hawkey and Merbs 1995, Villotte *et. al.* 2010, Bridges 1996). Although, not included in Buikstra and Ubelaker's *Standards* (1994), which again was used to collate and score the data from this assemblage, the Hawkey and Merbs (1995) scale seems to be the most useful and is used in this work. A score of 0 is given to attachment sites with no enthesophic expression, a score of R1 is given to a faint expression, R2 is given to a moderate expression, and an R3 is given to an enthesopathy with a strong expression.

In addition to the overall robust nature of Mandible A, there is a considerable amount of rugosity at several muscle attachment sites. In the case of the masseteric attachment at the gonial angle, it is understood that the force caused by the use of the masseter pulls on the gonial angle causing the mandible to flare outwardly (Lai and Lovell 1992, Hannam and Wood 1989, Goto *et. al.* 1995). This flaring is accompanied by increased rugosity at the attachment point to offset the force that would otherwise rip the tendon from the bone (Lieverse *et. al.* 2009, Larsen 1997, Hoyte and Enlow 1966). Mandible A scores an R3 for the gonial angle entheses. There is also an increased rugosity at the attachment for the platysma, which scores an R2. "Dissection of seven cadavers showed that the platysma muscle may cover large parts of the masseter muscle. . . .The platysma may, therefore, in some individuals, have a functional role during the opening phase of chewing cycles when this has a marked lateral component" (Widmalm *et. al.* 1985:17). Andrew (1963:17) also found in his study of primates that the "platysma contraction may give some needed support to the neck (perhaps to major blood vessels) during intense vocalisation."

There has been some indication of extramasticatory use in the development of mandibular entheses (Merbs 1983, Molnar 2008, Larsen 1997). Accompanying this rugosity, then, should be some sign of tooth wear. Although Mandible A's incisors are missing, there is no sign of significant wear, nor much wear of any kind in the remaining dentition. It would appear that whatever activities caused this increase in muscle attachment size on Mandible A, extramasticatory use did not play a part.

The femora as well show rugged muscle attachments along with the robusticity. Out of the 14 femoral shafts acceptable for analysis, five can be given scores of R3 for the linea aspera, and three score in the R2 range. The remainder score and R0 or the beginnings of an R1 and will be discussed later in this section. These eight robust femora also show large attachments for the vastus intermedius and lateralis muscles, especially in the articular area between these muscles. These two muscles, along with the vastus medialis, form the powerful quadriceps muscle group that contributes to the movement of the knee (Nordin and Frankel 2001, Buckwalter *et. al.* 2000, Gray 2000). The greater trochanter also exhibits a good amount of rugosity where the glutaeus medius and glutaeus minimus would attach, both muscles highly involved in abduction of the hip and usually worked heavily in climbing rough terrain (Buckwalter *et al.* 2000, Kumagai *et. al.* 1997, Snell and Donhuysen 1968). Observing large muscle attachments for these muscles, along with the adductor muscles that attach to the linea aspera previously mentioned, provide an image of a heavy work load involving squatting and lifting or climbing.

The ulnae also show heavy upper limb usage. Entheses manifest at the attachment site for the brachialis, the flexor digitorum sublimis and the supinator crest. The brachialis is the primary flexor of the elbow (Nordin and Frankel 2001, Gray 2000, Pauley *et. al.* 1967). The flexor digitorum sublimis is a superficial flexor of the fingers at the proximal interphalangeal joints (Buckwalter *et. al.* 2000, Kursa *et. al.* 2006, Gray 2000). The supinator crest is the ulnar attachment for the supinator muscle which, as its name suggests, aids in supination of the arm (Nordin and Frankel 2001, Gray 2000, Hawkey and Merbs 1995).

The very interesting thing to note about these particular muscles is that none of them work in tandem with the other, or at least none of the other two are required for any given one to function. Unlike the previously mentioned adductor muscles of the femur that work as a group, the brachialis, flexor digitorum sublimis, and the supinator can all work relatively independent one from the other (Pauley *et. al.* 1967, Kursa 2006, Nordin and Frankel 2001, Buckwalter *et al.* 2000). This is highly suggestive of a wide range of upper limb movement in common activity at *Mainistir Chiaráin*.

In addition to the above entheses, two of the ulnae (or 1/3), show signs of what is loosely known as “Woodcutter’s Elbow” (Capasso *et. al.* 1998), also known as an olecranon spur (Figure 16). This lesion results from “[s]tress on the insertion of the triceps brachii during flexion-extension. Maximum stress occurs when the triceps brachii is completely extended” (Capasso *et. al*. 1999:78) as is seen in woodcutting, pitching, handball, even vigorous net casting (Capasso

Figure 16: Ulna with Woodcutter’s Lesion

et. al. 1999, Tyrdal and Finnanger 1999, Orava and Leppilahti 1999). Enthesophytic lipping of this nature is thought to ossify due to the body's need to stabilize and protect an overused area. The exact correlation is as yet unknown, and it is wise to bear this in mind with any evaluation involving health or activity patterns; however, the existence of any of these conditions can still be used to make tentative assumptions about the life of any given individual. (Jurmain 1999, Cardoso and Henderson 2010, Villotte *et. al.* 2010)

As formerly alluded to, the range of overall robusticity in the *Mainistir Chiaráin* sample is quite broad. It was stated that Femur A (Figure 15) has cortical bone with a minimum thickness of 8.1mm (0.32in) at mid shaft and the shaft itself is 33.6mm (1.32in) by 34.8mm (1.37in). In contrast, one of the adult femora scoring an R1 on the enthesis at the linea aspera, and an R0 on all other attachment sites, has a shaft that measures 21.7mm (0.85in) transversely and 18.7mm (0.74in) antero-posteriorly and cortical bone that is only 3mm (0.12in) thick. This makes the shaft size of the R1 femur 34.7% the size of Femur A and cortical bone that is only 37% of that of Femur A.

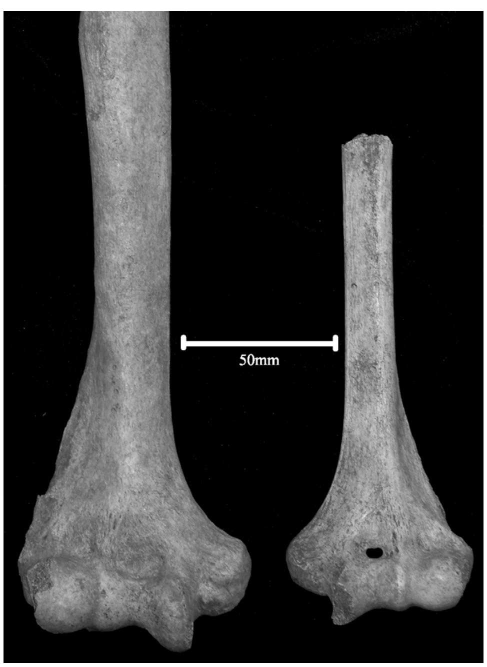


Figure 17: Range of Robusticity Example. Humerus A, left. Humerus B, right.

This type of variation is also seen in the humeri. Humerus A (Figure 17) the cortical bone is dense and thick, measuring at about 5mm at mid shaft; 8.4mm at the deltoid tuberosity, which scores an R3 on the Hawkey-Merbs scale. Also the lateral supracondylar ridge has developed a flange-like nature where the brachioradialis and extensor carpi radialis longus attach. The deltoid is the primary abductor muscle of the upper limb (Buckwalter *et al.* 2000, Gray 2000, Potau *et. al.* 2009). The brachioradialis is a rather versatile muscle. Its main function is to aid in flexion of the forearm at the elbow, but it is also capable of both pronation and supination in certain arm positions, and it is used to stabilize the elbow during rapid flexion and extension in a midposition (Nordin and Frankel 2001, Staudenmann *et. al.* 2009, Søgaard *et. al.* 2006). The extensor carpi radialis longus is used to dorsiflex and abduct the wrist (Buckwalter *et al.* 2000, Nordin and Frankel 2001, Gray 2000). This are all suggestive of activities such as chopping wood , hammering, hauling rope line on a ship or in fishing; any activity that involves strength coupled with wrist and elbow movements.

Humerus B (Figure 17) is missing the portion with the deltoid tuberosity, so no score can be given for this enthesis. With or without the deltoid tuberosity, the contrast to Humerus A is visibly striking. It does, however, have a similarity in a dense cortical bone; although not quite as thick as Humerus A measuring 3.4mm (0.13in) or 68% the thickness of Humerus A. There is also a bit of the flange-like nature in the supracondylar ridge seen in Humerus A.

At the current time it is unclear why there is such a broad range of rugosity and robusticity in the *Mainistir Chiaráin* assemblage. These traits are associated not only with the stresses of activity, but also with climate, environment, diet, health and heritability (Jurmain 1999, Stock 2006, Bridges 1996, Stock and Pfeiffer 2001). *Inis Mór* was a pilgrimage stop in the medieval period (Ní Ghabhláin 1997, Gosling 1993, Robinson 1986). It is possible that some of the individuals in the assemblage were not originally from *Inis Mór* or even from Ireland. As there were no isotopic or genetic tests done on the sample, there is no current resolution for this issue.

Labor divisions do often show this kind of robusticity contrast (Larsen 1997, Frayer 1980, Ruff 1987, Feik *et. al.* 2000, Pomeroy and Zakrzewski 2009, Bridges 1996). Division of labor between the sexes tends to produce high levels of robusticity in the heavily worked sex--often, but not always, male. In addition to this, times of stress, including famine and war, often produce a division in robusticity regardless of the workload: the female biologically constructed to put resources towards parturition and nursing in difficult times (Stock 2006, Stini 1969, Scrimshaw and Behar 1965, Ellison 1990, Ellison 2001, Wood 1994). If the people at *Mainistir Chiaráin* were experiencing some sort of environmental stress, it may result in this wide range in skeletal robusticity. The broad variation could also be a division of labor along lines other than sex: monks doing one sort of prescribed activity, local island dwellers doing another. Hopefully future research can shed light on this subject.

Signs of physiological stress, or life markers, do not just leave traces in robusticity and entheses. Arthritis is another, very commonly observed mark left indelibly on the skeleton. Arthritis is one of the most researched life markers and it is still mainly an obfuscation (Jurmain 1999, Aufderheide and Rodríguez-Martín 1998, Ortner and Putschar 1985, Roberts and Manchester 2007, Roberts and Cox 2003, White 2000, Živanović 1983, Rogers *et. al.* 1987). The word arthritis tends to be used as an all-encompassing term that covers arthropathy, arthrosis, osteoarthritis, septic arthritis, rheumatoid arthritis, osteophytosis, and so forth. For the sake of simplicity in this work, the term arthritis will continue to be use in this same inclusive manner.

Arthritis is a multi-factorial disorder which is dependent on things such as:

genetics, sex, climate, health and weight, metabolism, and trauma; just to name a few. (Weiss and Jurmain 2007, Larsen 1997, Jurmain 1991, Jurmain 1999). Essentially, arthritis is "the result of a physiological imbalance between the mechanical stress in the joint tissue and the ability of the joint tissues to withstand. . . stress." (Radin 1982:20) In essence, it is the body's response to overuse of a joint. Even more so, it is the destruction of the joint tissue itself, leading to porous proliferation, osteophytes, eburnation, etc. Thus arthritis can be a strong indicator of activity patterns, especially those chronically performed.

The four adult scapulae show indications of heavy upper limb usage (Figure 18). Two exhibit arthritis on and around the glenoid fossa along with entheses on the acromion and around the glenoid. One scapula is extremely robust over all and exhibits pronounced ridges on the subscapular fossa.

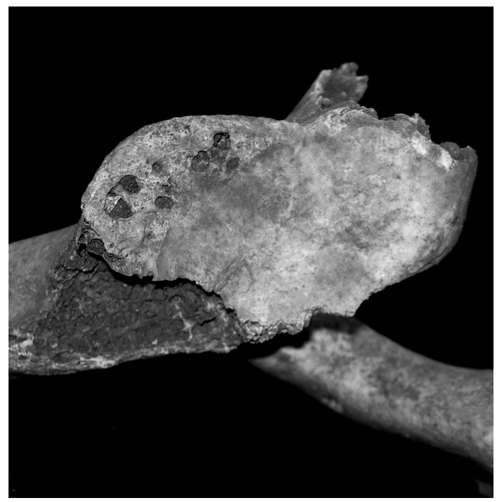


Figure 18: Glenoid with Degenerative Changes

The cartilage in a ligament and the manner in which it attaches to bone is very different than the articular connection between bones; especially in a ball and socket joint such as the shoulder (White 2000, Carter and Beaupré 2001, Buckwalter *et. al.* 2000, Nordin and Frankel 2001). To gain the mobility available in the glenohumeral joint, a sacrifice in stability must be made as well. The upper limb bones from *Mainistir Chiaráin* evidence of a wide range of motions preformed. These motions have been done chronically, but not overtaxing the body's ability to strengthen the bone and ligaments connected to the muscles in use. This is also seen in the robusticity and rugosity of the scapulae.

The appearance of gleno-humeral arthritis is highly suggestive of chronic activity or activities that *are* overtaxing the synovial shoulder joint (Jurmain 1999, Aufderheide and Rodríguez-Martín 1998, Ortner and Putschar 1985, Roberts and Manchester 2007, Roberts and Cox 2003, White 2000, Živanović 1983, Rogers *et. al.* 1987). Again, this is not unusual considering the nature of the feature in question.

Arthritis is also highly correlated with age (Carter and Beaupré 2001, Roberts and Manchester 2007, Živanović 1983, Weiss and Jurmain 2007). Not surprising considering that the body tends toward conservation of resources the further away from peak reproduction one goes (Nordin and Frankel 2001, Buckwalter *et. al.* 2000, White 2000). Joints that are unstable to begin with, such as the ball and socket joint of the shoulder, will become even more unstable as lack of resources are sent its way for maintenance and repair. This is one reason why arthritis is actually a suitable indicator of activities. In theory at least, the joints used the most, obviously off-set by the stability factor, will be the first to show arthritic changes. When arthritic changes occur in a younger individual, it can be even more indicative of overuse and activity.

Thus, what makes this sample a bit unusual, is that this arthritic nature is not also seen in the acetabulum of the pelves. That is not to say that some arthritis was not observed in the acetabula. There were some arthritic changes; however, these changes were rather mild--especially in comparison to the gleno-humeral joints. As previously stated, ball and socket joins are some of the most unstable; a trade-off for mobility. The hip joint has an added point of stress that the shoulder tends not to have. The hip is a weight bearing joint, holding the pressure of the weight of the upper body (Carter and Beaupré 2001, Buckwalter *et. al.* 2000, Nordin and

Frankel 2001). Because of this nature, the hip joint is one of the most common places to find arthritis, especially in individuals of advanced age. Three of the pelves from *Mainistir Chiaráin* aged to over 45 years (see Demography), one with a mean age of 48.5years, one pair scored a mean age of 56.75 years and one pelvis scored a mean of 60 years of age; and yet the arthritic changes in the acetabulum were mild. The exact meaning of this is unclear; however, it is suggestive of extreme upper limb usage over that of the lower limb. Further study is needed to shed light on this information.

The spine is another common place to find arthritis (Capasso *et. al.* 1998, Rogers *et. al.* 1987, Buckwalter *et. al.* 2000, White 2000, Ortner and Putschar 1985, Aufderheide and Rodríguez-Martín 1998). Like the hip, the joints between the vertebrae are weight bearing. Stability, in this case, is better; however, the hip receives the bulk of its pressure when the body is in a complete upright position: standing, walking, running, and so forth. The spine, on the other hand, receives pressure whenever the back is in use: standing, walking and running; but also sitting, bending, pulling, and lifting (Carter and Beaupré 2001, Buckwalter *et. al.* 2000, Nordin and Frankel 2001). Thus, while the hip joint is less stable than those in the spine, the hip receives fewer moments of stress overall.

Arthritis in the spine most commonly appears as osteophytic lipping. "The majority of articular osteophytes are covered with apparently normal hyaline cartilage. This has been thought of as a biologic way to resurface the diseased joint" (Buckwalter *et. al.* 2000:479). There was a minimum to moderate level of osteophytic lipping observed on all but one of the adult *Mainistir Chiaráin* vertebrae.

In addition to the osteophytes, Schmorl's nodes are present on four of the ten adult vertebrae. "Schmorl's nodes are typically described as 'cartilaginous nodes'

(Schmorl and Junghanns, 1971) which represent 'intervertebral herniation of disk material' (Resnik and Niwayama, 1978). [The nodes appear as indentations on the articular body surface of a vertebra] The most common sites are lower thoracic/upper lumbar vertebrae" (Jurmain 1999). Of the four presentations of Schmorl's nodes in the *Mainistir Chiaráin* assemblage, one is a 12th thoracic, one is a 2nd or 3rd lumbar, and there is one in each of the two lowest lumbar vertebrae (Figure 19).

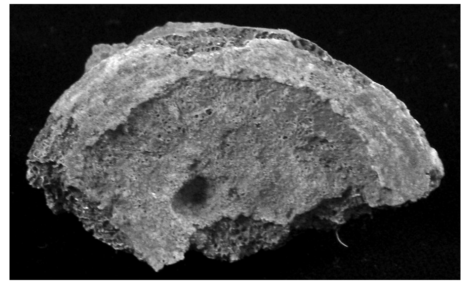


Figure 19: Lumbar with Schmorl's Node

There is some debate over the exact etiology of Schmorl's nodes. Schmorl and Junghanns (1971) suggest childhood trauma or infection that weakens the cartilaginous plate. More recent explanations, and more commonly accepted, as that the intervertebral disc herniates, pushing into and causing a void in the body of the vertebra; although, in order for the node to present, there must be an underlying genetic disposition to the condition in the first place. (Resnik and Niwayama 1978, Jurmain 1999, Williams *et. al.* 2007)

Faccia and Williams found in a clinical study that "Schmorl's nodes located in the central portion of the vertebral body are significantly associated with patient reporting of pain, and that the presence of osteophytes, in the affected vertebral region, may increase the likelihood that an individual will report pain" (Faccia and Williams 2008:28). This suggests that the individuals from which the affected vertebrae come would probably have experienced a certain level of back pain for some time prior to death.

Although usually treated as a separate entity, Schmorl's nodes generally fall into the category of a lytic cortical defect. A lytic cortical defect is essentially a cavity in the cortical surface of bone. This type of lesion is often referred to as a cortical defect in anthropology and osteology, but is also known as a lytic lesion or a surface defect (Larsen 1997, Hawkey and Merbs 1995, Lukacs and Martín 2002, Regan *et. al.* 1999). There is actually some debate as to the etiology of this lesion, but for the sake of this discussion the origin will be defined as arising from over, unnatural, or especially stressful use of an area of bone. To the list of lytic cortical defects in the *Mainistir Chiaráin* assemblage, we can add preauricular sulci, dorsal pitting and septal apertures.

The first two mentioned, the preauricular sulci and the dorsal pitting, involve the os coxae. A preauricular sulcus is a pit formed just anterior to the auricular surface of the ilium. Dorsal pitting, as its name suggests, also involves the formation of a pit (or pits) on the interior, or dorsal, surface of the pubis, just lateral to the pubic symphysis. It has commonly been accepted that both a preauricular sulcus and dorsal pitting were signs of parturition (Capasso *et. al.* 1999, Stewart 1979, Acsádi and Nemeskéri 1970, Ullrich 1975). Several studies have shown, however, that both pelvic changes may have little to do with parity. For example, Suchey *et. al.* found a "statistical association was found between the number of full term pregnancies and the degree of dorsal pitting. . . it is found that age and number of pregnancies are most important in predicting the degree of pitting and the effect of interval on pitting is not significant. Age is found to be an important variable independent of the number of full term pregnancies. In nulliparas, an absence of dorsal pitting is far more frequently found in females younger than 30 than in those over 30" (Suchey *et. al.* 1979:517). And Kelly showed that pits and grooves acquired through: "1). pregnancy and parturition appear to become obliterated in old age, 2.) the preauricular groove is the most sensitive indicator of pregnancy and parturition, 3.) moderate-large pitting in the dorsal pubic region rarely occurs in nulliparous females, and 4). it is doubtful that more precise statements than 'no children' and 'one or more children' can be made on the basis of skeletal remains alone" (Kelly 1979:541).

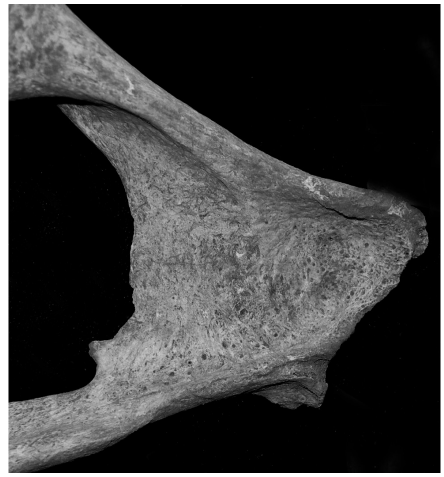


Figure 20: Portion of Ossified Obturator and Thinned Ramus

Two of the older os coxae, aged at 56.75 years (see Demography), are most likely two halves of a whole. These pelves were also sexed as female. The pubic rami have thinned almost beyond recognition; being only 2.8mm (0.11in) thick (Figure 20). The medial portion of the obturator foramen has ossified. The symphysis has also thinned and has become curved convexly toward the anterior. In addition, there is dorsal pitting and a rather deep preauricular sulcus, 8.2mm (0.32in) wide. These appear on two more pelves, sexed as probable females, as well; although, one has only a trace of a preauricular sulcus.

The thirdly mentioned lytic cortical defect is the septal aperture. A septal aperture is a thinning of the wall in the olecranon fossa. There are classes of apertures that range from a thinning, a partial or fibrous perforation, to a true septal aperture in which the olecranon fossa is fully perforated (Buikstra and Ubelaker 1994, Bass 2005, Mays 2008). A septal aperture "generally arises from impingement on the humeral septum by the coronoid and olecranon processes, chiefly the former. It is tentatively suggested that frequency of septal aperture may be an index of joint hypermobility in earlier populations" (Mays 2008:432). Other studies have shown that this aperture does increase joint mobility, but whether the condition is a physiological life marker or a biological adaptation is still undetermined

(Benfer and McKern 1966, Glanville 1967, Corruccini 1974). Several studies have shown that they occur in smaller humeri, thus more women than men, and more often on the left than the right side (Hrdlicka 1932, Benfer and McKern 1966, Mays 2008). Two of the *Mainistir Chiaráin* humeri, a probable pair, show this feature. Both humeri are smaller in comparable size and well within the realm of being from a female.

No specific significance can be attributed to these lytic cortical defects at this time. Perhaps future research will change that status.

Markers of Pathological Conditions and Disease

As stated in the previous section "life can leave many more permanent traces on our bodies than a cold. Some marks are left so deeply that they remain in the skeleton long after the soft tissue has gone." The common cold does not leave such skeletal traces, but many other types of infection do. Any bacteria that reach the bone can leave its traces in bone proliferation and resorption. This activity when seen on the surface of the cortical bone is known as periostitis; when seen internally into the trabeculae is known as osteomyelitis (Larsen 1997, Aufderheide & Rodríguez-Martín 1998, Ortner & Putschar 1985, Roberts and Cox 2003, Roberts and Manchester 2007).

In general, manifestations of bone infection in the *Mainistir Chiaráin assemblage* were low, which in and of itself is interesting. Roberts and Cox (2003) report a total CPR of 14.08% for periostitis in all of late medieval Britain; although, driving that are places like St. Mary Spital, London with a CPR of 44.12%. Tintern Abby in Wexford Ireland held a crude prevalence of only 4.55% in comparison. Osteomyelitis showed a CPR considerably lower than periostitis; 0.78% overall.

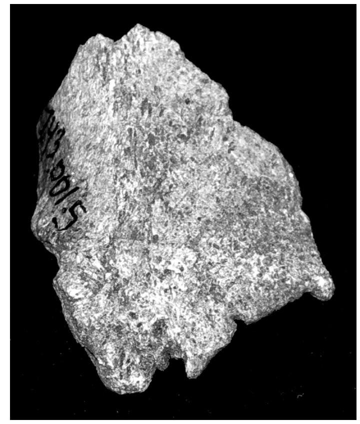


Figure 21: Frontal A with Nonspecific Infection

This suggests that periostitis, especially, should have been an expected pathology in the human remains from *Mainistir Chiaráin*, and yet excluding the conditions discussed immediately hereafter, the manifestations of infection were relatively absent.

Frontal Bone A (Figure 21) has a large quantity of active bone on the external cortex from the zygomatic process to mid-orbit, residing just above the supra-orbital ridge. This active bone appears to have begun as a periostitic infection; however, it does reach the diploe in various places, with a deeper internal reach towards the zygomatic process. The pathology is similar to that seen with early development rickets (Ortner & Mays 1998); however, the individual represented by Frontal A is a probable adult, and the effects of rickets tend to produce a more spongy appearance in adult crania (Ortner & Putschar 1985).

Another probable candidate is a hematoma, caused by blunt force trauma or scurvy related hemorrhage (Aufderheide & Rodríguez-Martín 1998, Ortner & Putschar 1985). Ectocranial hematomas occur with scurvy once the tissues in the body can no longer hold cohesion. Blood vessels burst and cracks form in the skull, through which the blood leaks into the subdural area. This irritates the bone, effectively causing periostitis or osteomyelitis. The same essential physiology can occur with blunt force trauma; the difference being that the soft tissue bursts and the bone cracks from the force of the blow and not from a structural depletion.

Roberts and Cox (2003) report a 0.22% CPR (crude prevalence rate) of rickets at the late-medieval (c. 1050-1550 CE) site of St. Francis' Abbey, Limerick; a 1.74% crude prevalence for St. Peter's Church, Waterford; and a 1.69% rate for Temple Lane, Dublin. Scurvy seems to be even more rare: only two known cases in all the British Isles in the entire 500 year period. Unfortunately, there is no known study detailing prevalence rates for cranial periostitis induced by blunt force trauma. Roberts and Cox do list the CPR for trauma wounds in the late-medieval British Isles. Total CPR for cranium trauma from 21 sites is 2.12%; although this includes blunt force as well as sharp force trauma.

All three possibilities, rickets, scurvy, and blunt force induced hematoma, are relatively rare; blunt force hematoma being the most likely, when comparing the raw probability to all of the British Isles. It is, however, very interesting that the two cases of scurvy for all sites listed in Roberts and Cox (2003), both were from St. Francis' Abbey, Limerick, in the west of Ireland. As this is one of the very few studied sites from western Ireland, it is possible further research in this area will reveal a completely different situation for the west of Ireland during the late-medieval period.

Tuberculosis is another disease that has a low prevalence rate for this time period in the British Isles.: 0.88% CPR of confirmed tuberculosis for all of late medieval Britain, 1.89% more possible cases (Roberts and Cox 2003). Of these, all the cases in Ireland were potential in nature, not confirmed: 0.75% in Solar, Antrim and 3.39% in Temple Lane, Dublin. And yet again, there is evidence of this infection at *Mainistir Chiaráin* in both an os coxa and its probable accompanying femur.

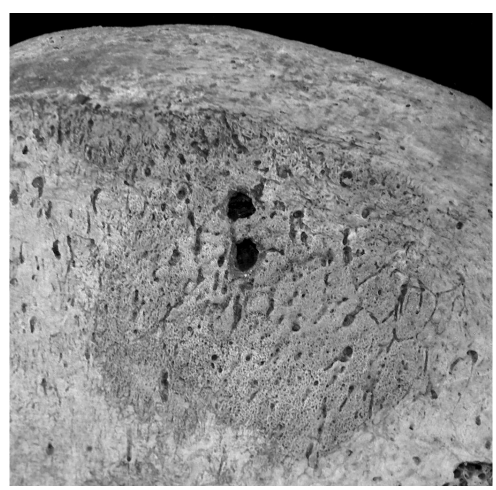


Figure 22: Possible Tubercular Lesion on Ilium

The most obvious lesion presents on the exterior lateral surface of the ilium towards the superior aspect, directly under the gluteus medius. The lesion is roughly circular with a 29.2mm (1.15in) diameter and has changed the color of the bone from tan to light grey (Figure 22). This lesion appears to have breached the cortical bone, gone through the trabeculae, and appears on the interior ilial surface as a rough circle with a 10mm (0.39in) diameter. The nature of the lesion is fibrous on the surface, with accompanying cloacae, or holes in the bone for drainage. On further examination, it becomes apparent that further lesions appear at odd intervals over the entire os coxa; although the change in color is not so obvious. The accompanying femoral lesion is on the anterior aspect of the greater trochanter. What remains of the femur is the proximal portion and much of the trochanter has been destroyed taphonomically, so the full extent of this pathology is not certain. What is present is a similar greyish color and relative fibrous texture to that of the lesions seen on the pelvis. None of the lesions other than the first mentioned is as rounded as the first mentioned lesion. These lesions do make it apparent that the course of this condition is the destruction of the underlying trabeculae. Several of these lesions also have cloacae and it is clear upon inspection that the trabecular area from which the cloacae originate is hollow.

The os coxa is a common bone affected by tuberculosis, so presentation here is not improbable (Aufderheide & Rodríguez-Martín 1998, Ortner and Putschar 1985, Mays *et. al.* 2001). Tuberculosis acts to destroy the bone from the inside out with little periosteal reaction. In some cases, the bone appears to have melted away, and there is some of this quality evident in the lesions on this innominate. (Aufderheide & Rodríguez-Martín 1998, Ortner and Putschar 1985, Roberts and Cox 2003) Holes, similar to cloacae in appearance, appear as the bacterium eats away at the cortex (*ibid*.).

Hip variant tuberculosis does tend to affect the acetabulum the most severely, and while the acetabulum in this case does show some sort of fibrous bone activity, it is certainly not the worst area affected (Figure 23). In addition, hip tuberculosis tends to present in the early years of life. Presentation after age 25 is rare; only 4.3% in a study of 995 tubercular individuals (Ortner and Putschar 1985). Unfortunately, the cortical surface of the pubic symphysis was mostly lost taphonomically. What little remains is on the anterior portion and does show billowing. The youngest age using the Todd method (1921a and 1921b) is 30 and oldest 35. The youngest using Suchey-Brooks (1990) is 21 and the oldest is 53. The auricular surface is more complete. The Lovejoy method (1985) gives and age of 39, while the Buckberry-Chamberlain (2002) method puts the age at 29-81. Even with the youthful billowing, it seems that the likelihood of being under the 25 year marker Ortner and Puschar (1985) give is low. However, many of the pathologies appearing in the *Mainistir Chiaráin* remains have a low probability rate; and at this point it seems wise to take such probabilities with a healthy bit of skepticism.

Figure 23: Possible Tuberculosis in Acetabulum

A less surprising pathological manifestation in the *Mainistir Chiaráin* sample was periodontal disease. A total crude prevalence rate of 37.53% was reported for sites surveyed throughout the British Isles during the late-medieval period; with Wexford showing 74.19%, Dublin showing 44.83%, and Limerick at 11.98% (Roberts and Cox 2003). Periodontitis, periostitis and osteomyelitis of the alveolus, appeared in most of the oral osteology of the assemblage (White 2000, Buikstra and Ubelaker 1994, Aufderheide & Rodríguez-Martín 1998, Ortner and Putschar 1985). Mandible A previously mentioned (Figure 13) shows active bone in the crypts of all four of the incisors and the two canines. This active bone was evident in the maxillary crypts of five teeth as well, in addition to two more crypts exhibiting active crypt bone with alveolar attrition. Mandible B exhibited minor reactive resorption around the alveolus of two premolars and one molar, as well as the alveolus around 10 maxillary crypts. There was also one mandibular piece which suggested an impacted 3rd molar, not only exhibiting the signs of osteomyelitis, but also a cloaca, or a hole created by the bone for drainage of infected fluid.

Periodontitis wasn't the only oral condition of note. Individuals in past societies tended toward well occluded teeth (Mills 1963, O'Connor *et. al.* 2005). This is not meant to imply that malocclusion never occurred. Malocclusion is influenced by many factors, both genetic and environmental. However, the overall tougher diets of past societies stimulated bone growth. This allowed for greater alveolar space in which teeth could erupt, and therefore produced a low prevalence of dental crowding. Perhaps it is telling that Roberts and Cox (2003) did not include even a mention of malocclusion or supernumerary teeth in their rather all inclusive work.

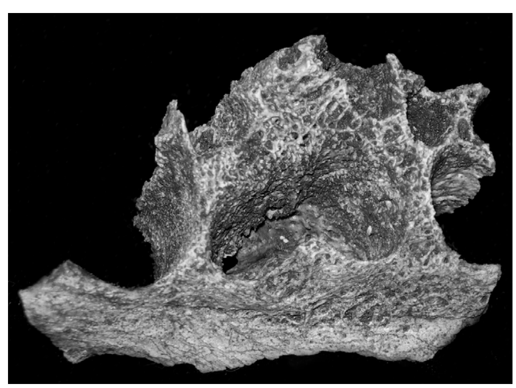


Figure 24: Inferior View of Maxilla A with Supernumerary Crypts

Of the pieces that were whole enough for analysis, Maxilla A revealed an interesting anomaly (Figure 24). Behind the normal dentition line, medially into the palate, was a line of relatively large holes that had been constructed with active woven bone. These appear to be tooth crypts. Too much taphonomic breakage made aging improbable; however, by size and bone development, it seems reasonable to assess the age as older juvenile to young adult. From the position and size of the crypts, one appearing to be a double crypt, it would seem that the adult teeth developed here to at least stage six under the Moorees system (Moorees *et. al.* 1963), or in other words the crowns had fully formed. These adult teeth would either have been heterotopic supernumerary teeth or teeth in severe malocclusion (Ortner and Putschar 1985, Buikstra and Ubelaker 1994, Alt *et. al.* 1999, Brothwell 1963). While not a large sample, the two complete mandibles in the *Mainistir Chiaráin* assemblage are well occluded, which would presuppose that the accompanying maxillae (not present in the assemblage) match that occlusion. Of the other maxillae, two are complete: one right, one left; not from the same individual. Three more are partial; however, there is quite a bit extant of the dental arcade and analysis of occlusion is possible. Of these five extant maxillae, all are well occluded and show no signs of supernumerary teeth. Although a small sampling, this is further suggestion that Maxilla A is more of a rarity than the norm.

Accompanying the expected periodontitis and the unsuspected heterotropy is another unsurprising oral pathology with a surprising twist. Of the 69 analyzable teeth, 20 showed signs of hypoplasia. Hypoplasia is the failure of development in an organ (Ortner and Putschar 1985, Buikstra and Ubelaker 1994, Alt *et. al.* 1999, Brothwell 1963, White 2000, Lukacs 1989). In teeth, this is usually seen in enamel formation. Unlike bone, tooth enamel cannot remodel. Once the enamel formation process is complete, no further enamel will be formed, no healing will take place. If there is stress during the formation of a tooth, the body will often halt production of enamel in order to deal with that stress. The body does not, however, halt development of the tooth itself. Once the stress has been dealt with, the body will resume enamel formation at the point in which the tooth is in development—not at the point where it left off, leaving gaps in the enamel of the tooth. "Enamel hypoplasias are useful indicators of systemic growth disturbances during childhood, and are routinely used to investigate patterns of morbidity and mortality in past populations." (King *et. al* 2005:547)

Dental enamel hypoplasia is most common in the anterior teeth. This pattern has been attributed to weaning stress, which occurs in most societies between the ages of six months to three years; which is the crucial time period for the development of the anterior permanent teeth. (Larsen 1997, Katzenberg *et. al.* 1996, Goodman and Rose 1990, Goodman and Armelagos 1985a). However, of the 20 teeth presenting with enamel hypoplasia in the *Mainistir Chiaráin* sample, 15 were cheek teeth and one of those was a deciduous molar. Most of this was linear with one grooved line encircling the crown, but a few instances of pits did appear. It seems pertinent to note here that many of the incisors were broken, missing or worn—a not unusual situation in an archaeological assemblage—however, this still seems like a high number of cheek teeth to display hypoplasia.

Although populations and individuals vary, permanent cheek teeth begin development between birth and six months of age. Full crown formation occurs at about eight years of age, with the third molars sporadically finishing crown formation about 15. The deciduous dentition can begin formation in utero, and the molar crowns are usually formed by the end of the first year. (Ubelaker 1989, Harris and McKee 1990) Molar hypoplasia does appear in a few populations and there is research being done as to the etiology of this manifestation (Aarow 2009, Ogden *et. al.* 2007, Li *et. al.* 1995). One survey of the literature showed an 11.2% expression in the maxillary first permanent molar, and a 5.2% expression in the second (Goodman and Armelagos 1985b). In the mandible, this same survey showed a 10.8% expression in the first permanent molar and a 4.6% expression in the second. Manifestation of hypoplasia in the cheek teeth suggests that the individuals from *Mainistir Chiaráin* had instances of stress in their lives unrelated to weaning; whether from famine, health, or warfare it cannot currently be known.

Diet

Without isotopic analyses, the discussion of diet is limited to a few pathologies; many of which are currently under suspicion as to how much they really reveal about diet and how much they reveal about disease and other life adaptations.

Porotic hyperostosis and cribra orbitalia, for instance, are commonly linked to iron deficiency anemia (Larsen 1997, Ortner and Putschar 1985, Aufderheide & Rodríguez-Martín 1998). The conclusion has been that lack of proper iron quantities in the diet leads to bone resorption in the skull. Two of the frontal bone fragments exhibit pinpoint porosity around the superciliary arch and cribra orbitalia in the orbit. Both pathologies in both individuals appear healed; however, most of the orbit is missing due to taphonomic loss, and the extent of the cribra orbitalia is unknown. The lack of presentation consistency with these porotic forms has produced criticism; sometimes appearing in the orbits, sometimes near the sutural areas of the vault, sometimes only in the central region of a vault element (Jurmain 1999, Stuart-Macadam 2006, Roberts and Cox 2003, Blom *et. al.* 2005, Walker *et. al.* 2009). New studies are strongly suggestive that the cause of these pathologies is not iron deficiency anemia, at least not due to a dietary lack. Current findings point to stress and infection, especially of a parasitic nature, and the body's inability to absorb iron while fighting illness and stress (Jurmain 1999, Stuart-Macadam 2006, Roberts and Cox 2003). If this is so, the manifestation of porotic hyperostosis and cribra orbitalia would tell us less about the diet and more about the overall health of these two individuals.

The crude prevalence rate for the late-medieval British Isles is 10.82% (Roberts and Cox 2003). The two Irish sites included in this total were Tintern Abbey, Wexford and Temple Lane in Dublin. Wexford's CPR was 13.64% and Dublin's was 13.56%, both only slightly more than the mean for 33 sites. This suggests that the appearance of both cribra orbitalia and porotic hyperostosis in the *Mainistir Chiaráin* sample is not to be unexpected; although a 50% CPR--two out of four frontal bones--is rather high.

Not including extramasticatory wear, which is mainly caused by using teeth as tools, an additional pathological marker traditionally associated with diet is dental attrition. A relatively flat wear pattern is commonly seen in hunter-gatherer societies, while an uneven or cup-shaped wear pattern is associated with agricultural societies (Larsen 1997, Lukacs 1989, Živanovic 1983, Alt *et. al.* 1998, Brothwell 1963). Dietary based attrition is normally seen in the cheek teeth, as that is where the greatest amount of mastication is done in the mouth.

There were 68 teeth in the *Mainistir Chiaráin* assemblage complete enough to analyze. Forty of these teeth were loose, and while there were cases of possible mates, none of these teeth could be identified as coming from the same dental arcade. Ten teeth came from Mandible A (Figure 13), 13 teeth were from Mandible B (Figure 14), and five teeth came from one maxillary arcade.

Out of the total 68 teeth, 29, or 42.65% , exhibited moderate to severe wear. The remaining 39, 57.35%, exhibited minor wear to no wear at all (see Materials and Methods). Both the 10 teeth from Mandible A and the five teeth in the single maxillary arcade exhibited little to no wear. The maxilla was fragmented and incomplete to establish a fit with Mandible A; however, the tooth morphology is similar enough that this maxillary portion could be a mate to Mandible A.

In addition, the attrition to the 13 teeth from Mandible B are highly suspect as to the amount of wear that can be attributed to diet and the amount that can be attributed to extramasticatory use. All of these 13 teeth do show moderate to severe wear; however, there is a considerable amount of attrition in the anterior dentition. This wear pattern suggests that this particular wear is from extramasticatory use and not dietary. How much attrition in Mandible B is from diet and how much from extramastication is, at this point, unclear.

Also unclear is how to organize the dentition for analysis. The two mandibles and one maxilla comprise two or three individuals, depending on the origins of Mandible A and the maxillary arcade. The remaining 40 teeth lack connection to any one individual or even to each other, lending to the potential of highly skewed results. There is also no known study concerning the prevalence rate of dental attrition for this geographic area or in the larger area in the late-medieval time frame. Currently published studies focus on other dental patterns such as hypoplasia and periodontitis, with minimal or no attention made to attrition frequency and patterning (Roberts and Cox 2003, Murphy and McNeill 1993, Power *et. al.* 1997). Thus I leave the discussion of attrition in the *Mainistir Chiaráin* dentition open ended in lieu of future information.

Dental caries and calculus are also indicators of diet, along with being an indication of oral health care. Caries is a process caused by microorganisms which destroy the hydroxyapatite based structures in the body: mainly bone, enamel, and dentin (Larsen 1997, White 2000, Živanovic 1983, Alt *et. al.* 1998, Brothwell 1963). More specifically, in the case of dental caries, it is the digestive waste of bacteria produced in the bacterial processing of carbohydrates in the mouth. Sweet sugars tend to be more destructive than grains and starches. A diet high in meat or seeds and nuts will contribute very little to the carious process. This fact, coupled with a low incidence in dental hygiene, mainly brushing and flossing, will tend to produce a high incidence of carious lesions in the dentition in populations with a carbohydrate laden diet (*ibid*.). In general, hunter-gatherer societies have diets low in carbohydrates, while the diet of agriculturalists tends to be high in carbohydrates. Hunter-gatherers also tend towards diets that are high in abrasive foods and have a greater tendency towards extramasticatory usage, while agri-culturalists have a softer diet and tend not to use their teeth as tools. These are, of course, merely tendencies and exceptions can and do occur (see Larsen 1997, Bernal *et. al.* 2007, Lanfranco and Eggers 2010, Gil *et. al.* 2009).

Of the 68 teeth from *Mainistir Chiaráin* complete enought for analysis, 33 showed signs of the carious process, or 58.53%. Again, 28 of these teeth came from Mandible A, Mandible B, and the maxillary portion, with the remaining 40 teeth having an unknown affiliation. Thus, a similar problem of analysis exists here as it did with attrition.

Also, data collected on the carious process is generally recorded as presence or absence, with no indication of severity. It seems pertinent to mention that the majority of the carious lesions at *Mainistir Chiaráin* were no bigger than a pin hole. Only one tooth exhibited what can only be described as a very large cavity; 5mm x 3mm (0.2in x 0.12in) at the cemento-enamel junction. Roberts and Cox (2003) listed prevalence data for both individual dental arcades and individual teeth affected by caries. From 41 sites all over the British Isles in the late-medieval period, individuals affected by the carious process were reported at 52.64%. This appears not too far from the *Mainistir Chiaráin* prevalence rate of 58.53%; however, as a goodly portion of the *Mainistir Chiaráin* dentition was not in occlusion, it seems more accurate to compare the prevalance rate to the reported data on individual teeth. For the same previously indicated sites across the British Isles, there was only a 5.55% prevalence rate (*ibid.*)--a rather large gap between that and the 58.53% seen in the *Mainistir Chiaráin* sample.

Calculus is the accumulation of food residue on the teeth that has hardened over time (Larsen 1997, White 2000, Živanovic 1983, Alt *et. al.* 1998, Brothwell 1963). This tends to gather in between teeth and at the gingival sulcus. Like caries, build-up of calculus can usually be avoided with good dental hygiene. Although there is a bit of variation in the kind of foods that lead to calculus versus the kind that will form caries: sticky foods such as breads and puddings will adhere to gaps in the dentition and lead to food buildup, while foods such as an apple or a carrot will not. Keeping in mind the repeated problem of analyzing the *Mainistir Chiaráin* dentition in occlusion with the loose dentition, the *Mainistir Chiaráin* teeth exhibited calculus at a 75% expression rate: 51 out of the 68 teeth. Roberts and Cox (2003) reported a 53.99% prevalence rate for 26 sites across the British Isles, again putting the *Mainistir Chiaráin* dentition on the high side for dental pathology.

Non-Metric Traits of Distinction

Non-metric traits, discrete traits, epigenetic variants, biomarkers; these are all terms for the same essential thing: skeletal variations that are outside the norm of human development, but cannot be considered a disease, negative condition, and in many cases cannot be explained as a positive condition either (White 2000, Larsen 1997, Saunders 1989). These are traits such as having an supraorbital foramen rather than a notch, having extra bones in the cranium (ossicles or wormian bones), or having a third trochanter on the femora. The septal aperture mentioned previously is sometimes placed in this category. Theories about these traits range from occupational adaptation to genetic heritability.

Mandible B holds one very good example of non-metric variation: a mandibular torus beginning on the lingual surface at the second incisors, coming to a nodule like apex at the first premolars and then tapering off to blend with the normal lingual surface about the middle of the second molars (Figure 25).

Figure 25: Mandible B Showing Lingual Torus

As with most of these discrete traits, theories abound as to the etiology of oral tori. Ossenberg proposed that the primary cause is masticatory stress (Ossenberg 1978-1980). What Hassett found in her study of 498 archaeological skeletons was that heritability seemed to play the most important part (Hassett 2006). Alvesalo *et. al.* suggested that "the sex chromosomes may have an influence on the occurrence, expression, and timing of development of the mandibular torus. Sexual dimorphism in the manifestation of torus mandibularis may result particularly from the effect of the Y chromosome on growth" (Alvesalo *et. al.* 1996:145). There is a higher prevalence rate of oral tori in those populations originating from the North Atlantic: Greenland, Iceland and Canadian Eskimo (Oschinsky 1964, Halffman 1992, Ossenberg 1978-1980). One study collated data from several sources to show the Canadian Eskimo having a 85.3% male and 80.0% female rate of expression, and Lapps having an expression rate of 26.8% male and 38.8% female (Hauser and DeStefano 1989). With the obvious cold climate that these populations live in, there seems the possibility of some sort of biomechanical adaptation to cold: thickening of the cortical bone to protect internal tissues that would otherwise be harmed by cold exposure. In modern populations, tori have been known to reappear after surgical removal (Brunsvold *et. al.* 1997). This is highly suggestive of a physiological response to a stress. However, in their familial study of Japanese families, Suzuki and Sakai found that "[w]hen the children have torus palatinus or torus mandibularis, 85.7 or 89.7% of either or both of their parents likewise have these tori" (Suzuki and Sakai 1960:267). It would therefore seem that, like many other manifestations in the skeleton, there are both intrinsic and extrinsic factors at play.

The other non-metric trait that proved even more surprising was the shovel shape of the incisors. Incisor shovelling is exactly as the name suggests: the blade-like incisors exhibit ridging on either edge of the lingual surface making the incisors appear to be like a shovel (White 2000, Buikstra and Ubelaker 1994, Ubelaker 1989, Bass 2005, Alt *et. al.* 1998, Brothwell 1963). There are varying degrees of expression, from barely noticeable to almost folded in on itself. In some cases there is even double shovelling with the ridging appearing on both the lingual and labial surfaces. Incisor shovelling is a commonly accepted mongoloid trait (Hrdlicka 1920, Scott and Dahlberg 1982, Turner 1987, Scott and Turner 1997). As there is not enough evidence or research to do the topic justice, for the sake of this discussion, the very large problem of racial classification will be ignored; although, future research on the topic of shovel-shaped incisors will most likely have to rework these outmoded classifications. With that in mind, one survey of several studies showed a 92.7% expression in Japanese, Chinese and Tibetan and a 100% expression in East Greenland Eskimo (Carbonell 1963). Another survey showed similar results for East Asians with American Indian populations ranging from 85% expression in a mixed group to 100% in the Pueblo and Indian Knoll (Bass 2005).

Of the 12 incisors complete enough to allow for analysis, ten from *Mainistir Chiaráin* have a shovel shaped morphology. Nine of these incisors have mild to moderate shoveling, and Incisor A has lingual protrusions that are not only large but also appear folded in on itself (Figure 26). Surprising as this appearance may be, further research has shown that shovel shaping may not be as much of a mongoloid trait as it is professed to be. One of the previously mentioned surveys reported Swedes with a 36% expression rate, Danes with 30.3%, Anglo-Saxons with 31.3%, and Romano-British expressing a 12% rate of incisoral shoveling (Carbonell 1963). Another showed a 17.3% expression for Black American males, 14.9% for Black American females, 10.2% for White American males, and a 8.4% expression rate for White American females (Bass 2005). Although no percentages are currently available, shovel-shaped incisors were also observed in the juvenile Anglo-Saxon skeletons at Church End Cemetery, Cherry Hinton, a Late Medieval Christian cemetery in Cambridgeshire, UK (Blue 2010). Clearly the manifestation of shovel-shaped incisors is not unheard of outside the so-called mongoloid classification. The *Mainistir Chiaráin* dentition shows a 83.33% expression rate. Although, this is based on individual teeth, not expression per individual, this rate

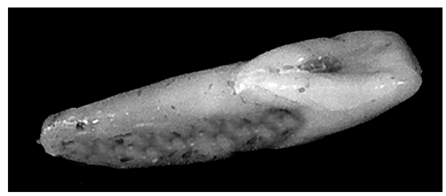


Figure 26: Shovel-Shaped Incisor A

is still provocative in light of the previously mentioned expression rates. Future research will hopefully shed more light on this topic.

Discussion

There have been fewer than a handful of mortuary sites in late-medieval (1200-1600 CE) Ireland that have been excavated For those that have been excavated, excavations have focused on the standing architecture; and sampling of human remains was not normal practice until very recently (Brosnan 1993, Fry 1999, Scott 2007). Add to this the very limited exploration into western Ireland, and one is given very little comparative data for the interpretation of the human remains from *Mainistir Chiaráin*.

Curation and analysis revealed a minimum number of individuals of 12, which is a small sample to come to any definite conclusion about the population at *Mainistir Chiaráin*. The disaggregation and fragmentation of the remains made definitive population statistics like stature, age and sex demographics tentative at best. Use of Roberts and Cox's survey, *Health and Disease in Britain* (2003), was helpful to give some general perspective to the *Mainistir Chiaráin* assemblage. For example, the mean stature estimations place the individuals from *Mainistir Chiaráin* a little short in comparison to Roberts and Cox's (2003) report for all the late-medieval sites surveyed in the British Isles (see Demography); and periodontal disease was high in the *Mainistir Chiaráin* sample when compared to sites in a similar survey (*ibid.*, see Markers of Pathological Conditions and Disease). Unfortunately, the data available in the Roberts and Cox survey (2003) includes too few sites from Ireland, none with a comparable situation to *Mainistir Chiaráin*, to do this particular evaluation justice; and unfortunately, as previously stated, analyses that would be comparable to *Mainistir Chiaráin* are relatively nonexistent.

A high range of robusticity and rugosity suggests either a definite division of labor or a period of stress in the population. Entheses and arthritis in the upper body of the *Mainistir Chiaráin* remains that was not paralleled in the lower, an uncommon finding in the medieval period, suggests daily activities with a great deal of upper limb usage. Findings of tuberculosis, potential scurvy, molar hypoplasia, shovel-shaped incisors, and mandibular tori suggest that the people in the *Mainistir Chiaráin* assemblage may be unique among the greater population of the British Isles at the time. Also a possible unique manifestation is the way in which these people were deposited..

The human remains from *Mainistir Chiaráin* were examined and evidence was found in the way of postmortem dry-fractures, bone surface erosion, an some animal gnawing (see Data Tables in Appendix). These taphonomic factors were not consistent from one piece to the next as would be expected from skeletal elements which were left together in the same environment for a long period of time. These taphonomic indicators suggest that the remains were disturbed, spent an indeterminate amount of time exposed to the elements, and then redeposited in a secondary burial.

Secondary burial is a common phenomenon worldwide (Chapman 2000, Fry 1999, Larsen 1997, Miccozzi 1991, Parker Pearson 1999). Therefore, in and of itself the reburial is not unusual. However, ritually based secondary burials are archaeologically prone to reveal certain patterns in the positioning of the bones or in the specific elements preserved. For example, a noticeable clustering of certain elements, such as the mandibles appearing to be located in the same general area, while all the pedal bones are located in an entirely different area. There may also be a complete absence of a particular element, such as all the halluces being missing (Orschiedt and Haidle 2006, Parker Pearson 1999). Small bones such as the

Figure 27: Context 037 from Above. Ní Ghabhláin 2010.

bones in the hands and feet and delicate bones like the ethmoid tend to decompose quicker than the larger bones such as the femora or the humeri. These bones also are easily lost in the transfer of a secondary burial. Finding a high quantity of hand and foot bones and finding relatively complete skulls can often mean that great care was taken in the reinternment of the skeletal remains (Orschiedt and Haidle 2006, Parker Pearson 1999, Thomas 1988). In the *Mainistir Chiaráin* remains, the high percentage of lower limb bones and very low percentage of torso, manual and pedal bones suggests that there was little selectivity or care in the deposition of the remains (Figure 27). More likely, these bones were unintentionally disinterred at some point and then reburied.

The prevalence rate of this type of reinternment in Ireland is unknown; however, it is certainly not uncommon to find graves which encroach upon each other as well as seemingly random assemblages of obviously reinterred human remains (Soderberg 2010, Scott 2010, Scott 2007, Ní Ghabhláin 2010, Deevy and Murphy 2009). In a study of the burial ground on Omey Island, which lies to the northwest of the Aran Islands and a bit closer to the Galway coast, it was found that bones from the burials occasionally come to the surface from the erosion caused by the Atlantic Ocean. When that occurs, the locals simply gather up the exposed pieces and rebury them within the confines of the Christian burial ground. (Scott 2007 and O'Keeffe 1994). The location of Mainistir Chiaráin on the leeward side of the island negates a high probability of erosion (Ní Ghabhláin 1997, Soderberg 2010); however, the soil on *Inis Mór* is not deep overall and common daily activities could easily uncover a shallow grave.

Disinternment-reinternment also became something of importance during the late-medieval period in Ireland. "[R]ecorded instances of the disinterment of bodies (or parts of them), or the translation of bones clearly see related to ideas of conquest and territoriality and the desire to possess the remains of people who were regarded as significant within the culture. . . . The remains of powerful people were believed to retain their power after death, and it was thought wise to show them proper honor and keep them where they could offer the greatest benefit to the kin-group. Conversely, bodies were sometimes disinterred and stolen in order to humiliate or intimidate opponents" (Fry 1999:120-121)

To benefit the *Tuath*, or kinship-group, a body was often placed under the doorway or entrance of an important building or area (Fry 1999). If there is more than one place desired to be blessed by the power of the dead, the body may be buried in portions: the head here, the foot there. If the bones of an enemy have been stolen, his remains may be buried in pieces to help hide the body from his *Tuath* (*ibid*.). The enemy's body may also be placed in the same location as someone from the local *Tuath*, for the same reason of gaining the power of the dead; however, the enemy's corpse would be buried in some humiliating manner; such as face down, in a jumble, or with his head at his feet. While there is some evidence for this kind of activity as early as the sixth century, the bulk seems to occur from the 12th to the 17th centuries (*ibid*.).

This dating is provocative with the *Mainistir Chiaráin* assemblage in mind. One premolar from the main deposit, Context 037, was sent to Beta Analytic for AMS dating (see Appendix). The sigma calibrated results put the date at 1270 to 1290 CE with an intercept at 1280 CE; essentially dating the remains to the late 13th century. Building A, which was the extant building foundation originally under excavation (see Introduction), was given date in use of the 16th to 17th century. Both of these dates fit perfectly within the same time frame as this reburial "frenzy". This dating link to the reburial frenzy, however, does not explain the disaggregated nature of the deposit. Again, with secondary burials there is usually some sort of identifiable pattern (Orschiedt and Haidle 2006, Parker Pearson 1999, Thomas 1988), which is not the case at *Mainistir Chiaráin*.

Neither accidental disinterment with subsequent reburial, nor the late-medieval burial-reburial custom accounts for the high number of uncommon skeletal factors in the *Mainistir Chiaráin* remains: the shovelled incisors, the variety of dental attrition, the tuberculosis and scurvy, the mandibular torus. These are all unexpected things to observe in a medieval population from the British Isles, let alone northern Europe (Roberts and Cox 2003, Bass 2005, Ortner and Putschar 1985, Aufderheide and Rodríguez-Martín 1998, Capasso *et. al.* 1998). Also unexplained is the lack of organization, the "dumped" nature, of the deposit (see Introduction).

The *Mainistir Chiaráin* remains are suggestive of outsiders or "others" who do not fit the confines of the accepted society and were therefore treated with less ceremony and cultural deference than would someone who was an accepted member of the *Inis Mór* populace. In Ireland during the medieval period and into modern times, there were special cemeteries for unbaptized children. This type of cemetery was known as a *cillín,* Killeen, *ceallúnach*, or *cealltrach* (Finlay 2000, Donnelly et. al. 1999, Scott 2007) . Sometimes outsiders such as strangers or known non-Christians would also be buried in a *cillín* with the children. Although *ceallúnach* have been neglected in academic research, what is known is that the essential layout of a *cillín* is the same as any graveyard, and the bulk of the *cillín* population is infants and children (*ibid.*).

While there are three children in the *Mainistir Chiaráin* remains, one aged 4-10 years, one aged 2-4 years, and one perinate, there are nine more individuals who are beyond the age of childhood (seven who are well into adulthood). Three children at *Mainistir Chiaráin* does not put them in the highest demographic, and being the highest demographic is a main component in a *cillín*.

Again, *Mainistir Chiaráin* does not fit a given paradigm. In fact, local tradition holds that there is a *cillín* just to the north east of the monastery grounds (Figure 4); although, no actual investigations have taken place to confirm this (Ní Ghabhláin 1997, Gosling 1993). If the human remains were unbaptized outsiders of the sort that would be associated with the *ceallúnach*, shouldn't the 12 people found at *Mainistir Chiaráin* have been buried there? Additionally, there is a Christian cemetery immediately to the north of and associated with *Mainistir Chiaráin* itself (Figure 4); and again, there has been no investigation to confirm this information (Ní Ghabhláin 1997, Gosling 1993). Even though these remains were being reburied, if these people were not outsiders to be deposited in a *cillín*, should they not have been deposited in the actual cemetery--a cemetery not 25m (82.02ft) away?

As research into medieval western Ireland is minimal and published research is even harder to come by, there is little to shed light on this mystery. There is one possible comparison to the situation at *Mainistir Chiaráin* in the human remains found at Doonbought Fort. During the Doonbought Fort excavation,what the authors referred to as "the 13th century dump" was discovered (Murphy and McNeill 1993). In this "dump" were located 22 individuals in two identifiable groups; most in an incomplete and disarticulated form with a mixed variety of taphonomic factors. Both groups a mixture of the very young to the very old. Pathological conditions were observed that were reportedly rare in the late medieval period. There was also a cemetery close but not utilized (*ibid.*).

Doonbought was originally a military or at least a secular fortification located in Antrim, Northern Ireland. *Mainistir Chiaráin* was a monastery, a religious installation, off the western coast. Despite these differences, there are too many provocative similarities to ignore the potential connection between the two sites. As neither site fits a known pattern for burial deposition, there is only speculation as to the meaning of these "dump" sites. As research into burial sites in Ireland is a relatively young field of study, it is possible that more of this type of secondary deposit will come to light. In light of the Doonbought excavation, is it possible that researchers are happening upon a "new" type of burial ground specifically for a certain category of outsider? Only further research into the burial archaeology and human osteology of Ireland will tell us that answer. For now, there is merely the knowledge that, at *Mainistir Chiaráin*, a minimum of 12 people from infant aged to elderly, presenting with a variety of skeletal anomalies, were buried in a hole dug in a disused building which was on sacred ground, but away from any of the consecrated burial sites.

Conclusion

For the last several decades there has been a growing increase in the much neglected archaeological research in Ireland. This research has been focused on the Gaelic western portion of the country, and the excavation at *Mainistir Chiaráin* was an attempt at furthering that research. A medieval monestary on the island of *Inis Mór, Mainistir Chiaráin* revealed an assemblage of disarticulated and dumped human remains including at least 12 people with a wide range of ages. A systematic study was undertaken of these remains to learn more about the lives of people living at this time and place. A date of the late 13th century CE was determined. The materials and methods were detailed and an extensive report of the skeletal analysis was given. Several findings were unexpected, a potential case of tuberculosis and another of scurvy, premolar and molar hypoplasia, mandibular torus, and shovel-shaped incisors. It is uncertain whether the assemblage is indiciative of the population for that given time and place, or if it is representitive of an outsider group. It is also unclear if there is a correlation of this kind of burial to other sites, such as Doonbought Fort. As this area of research is relatively new in Ireland, there is great potential for future findings and further study to reveal the unanswered questions about *Mainistir Chiaráin.*

Bibliography

Acsádi, G. and J. Nemeskéri. History of Human Life Span and Mortality. Budapest: Akadémiai Kiadó, 1970.

Alesan, A., M. Assumpcio, and C, Simó. "Looking Into the Demography of an Iron Age Population in the Western Mediterranean. I. Mortality." American Journal of Physical Anthropology (1999): 110:285-301.

Alt, K. W., F. W. Rösing, and M. Teschler-Nicola. Dental Anthropology: Fundamentals, Limits, and Prospects. New York: Springer Wien, 1998.

Alvesalo, L., J. T. Mayhall, and J. Varrela. "Torus Mandibularis in 45,X Females (Turner Syndrome)." American Journal of Physical Anthropology (1996): 101:145-149.

Andrew, R. J. "The Origin and Evolution of the Calls and Facial Expressions of the Primates." Behaviour (1963): 20:1-109.

Arrow, P. "Risk Factors in the Occurrence of Enamel Defects of the First Permanent Molars among Schoolchildren in Western Australia." Community Oral Dental Epidemiology (2009): 37:405–415.

Aufderheide, A. C., and C. Rodríguez-Martín. The Cambridge Encyclopedia of Human Paleopathology. Cambridge University Press, 1998.

Ayoub, F., M. Yehia, A. Rizk, M. Al-Tannir, A. Abi- Farah, and G. Hamadeh. "Forensic Norms of Female and Male Lebanese Adults." Journal of Forensic Odontolstomatology (2008): 27:1:18-23.

Baker, B. J., T. L. Dupras, and M. W. Tocheri. The Osteology of Infants and Children. Bryan, TX: Texas A&M University, 2005.

Bass, W. M. Human Osteology: a Laboratory and Field Manual. Missouri Archaeological Society, 2005.

Benfer, R. A., and T. W. McKern. "The Correlation of Bone Robusticity with the Perf oration of the Coronoid-olecranon Septum in the Humerus of Man." American Journal of Physical Anthropology (1966): 24:247-252.

Behrensmeyer, A. K. "Taphonomic and Ecologic Information from Bone Weathering." Paleobiology (1978): 4:150-162.

Bernal, V., P. Novellino, P. N. Gonzales, and S. I. Perez. "Role of Wild Plant Foods Among Late Holocene Hunter-Gatherers from Central and North Patagonia (South America): An Approach from Dental Evidence." American Journal of Physical Anthropology (2007): 133:1047–1059.

Blackledge, R. D. Forensic Analysis on the Cutting Edge: New Methods for Trace Evidence Analysis. Hoboken: John Wiley & Sons, Inc., 2007.

Blom, D. E., J. E. Buikstra, L. Keng, P. D. Tomczak, E. Shoreman, and D. Stevens-Tuttle. “Anemia and Childhood Mortality: Lattitudinal Patterning Along the Coast of Pre-Columbian Peru.” American Journal of Physical Anthropology (2005): 127:152–169.

Blue, K. Personal Communication May 2010.

Brasili, P., L. Zaccagni and E. Gualdi-Russo. “Scoring of Nonmetric Cranial Traits: a Population Study.” Journal of Anatomy (1990): 195:551-562.

Bridges, P. S. “Skeletal Biology and Behavior in Ancient Humans.” Evolutionary Anthropology (1996): 5:112-120.

Brooks, S. and J.M. Suchey. “Skeletal Age Determination Based on the Os Pubis: a Comparison of the Acsfidi-Nemesk6ri and Suchey-Brooks Methods.” Human Evolution (1990): 5:3:227-238.

Brosnan, Á. Mortuary Practices in the Cathedral Cemetery, Ardfert, Co. Kerry: a Preliminary Assessment. Cork: Unpublished MA thesis, 1993.

Brothwell, D. R. Dental Anthropology. New York: The Macmillan Company, 1963.

Brunsvold, M. A., D. A. Kaiser, and R. M. Faner. “Recurrence of Mandibular Tori After Surgical Removal: Two Case Reports.” Journal of Prosthodontics (1995): 4:164-167.

Buckberry, J., and A. Chamberlain. “Age Estimation From the Auricular Surface of the Ilium: A Revised Method.” American Journal of Physical Anthropology (2002): 119:231–239.

Buckwalter, J. A., T. A. Einhorn, and S. R. Simon. Orthopaedic Basic Science: Biology and Biomechanics of the Musculoskeletal System. Rosemont, IL: American Academy of Orthopaedic Surgeons, 2000.

Buikstra, J. and D. Ubelaker. Standards for Data Collection from Human Skeletal Remains. Fayetteville: Arkansas Archeological Society, 1994.

Burns, K. R. The Forensic Anthropology Training Manual. New York: Prentice Hall, 2006.

Capasso, L., K. A. R. Kennedy and C. A. Wilczak. Atlas of Occupational Markers on Human Remains. Chieti, Italy: Associazione Antropologica Abruzzese - Journal of Paleopathology, 1998.

Carbonell, T. “Variations in the Frequency of Shovel-Shaped Incisors in Different Populations.” Brothwell. Dental Anthropology. London: Pergamon Press, 1963.

Cardoso, F. A. and C. Y. Henderson. "Enthesopathy Formation in the Humerus: Data from Known Age-at-Death and Known Occupation Skeletal Collections." American Journal of Physical Anthropology (2010): 141:550–560.

Carter, D. R., and G. S. Beaupré. Skeletal Function and Form: Mechanobiology of Skeletal Development, Aging, and Regeneration. New York: Cambridge University Press, 2001.

Chapman, J. Fragmentation in Archaeology: People, Places, and Broken Objects in the Prehistory of South Eastern Europe . New York: Routledge, 2000.

Chippindale, C., J. de Jongh, and J. Flood. "Stratigraphy, Harris Matrices and Relative dating of Australian Rock-Art." Antiquitity (2000): 74:285-286.

Cole, S., and R. Dioso-Villa. " CSI and its Effects: Media, Juries and the Burden of Proof." New England Law Review (2007): 41:435-470.

Corruccini, R. S. "An Examination of the Meaning of Cranial Discrete Traits for Human Skeletal Biological Studies." American Journal of Physical Anthropology (1974): 40:425-445.

Cowal, L. S. and R. F. Pastor. "Dimensional Variation in the Proximal Ulna: Evaluation of a Metric Method for Sex Assessment." American Journal of Physical Anthropology (2008): 135:469–478.

Cowgill, L. W., and L. D. Hager. "Variation in the Development of Postcranial Robusticity: An Example from Çatalhöyük, Turkey." International Journal of Osteoarchaeology (2007): 17:235–252.

de Courcy Ireland, J. "The Maritime History of the Aran Islands." Waddell, J., J. W. O'Connell, and A. Korff. The Book of Aran. Newtownlynch, Kinvara, Galway: Tír Eolas, 1994. 159-182.

Deevy, M. B., and D. Murphy. Places Along the Way: First Findings on the M3. Dublin: National Roads Authority, 2009.

Donnelly, S., C. Donnelly and E. Murphy. "The Forgotten Dead: the Cillini and Disused burial Grounds of Ballintoy, County Antrim." Ulster Journal of Archaeology (1999): 58:109-113.

Ellison, P. T. "Human Ovarian Function and Reproductive Ecology: New Hypotheses." American Anthropologist (1990): 92:933-952.

—. On Fertile Ground: A Natural History of Human Reproduction. Cambridge: Harvard University Press, 2001.

Faccia, K. J. and R. C. Williams. "Schmorl's Nodes: Clinical Significance and Implications for the Bioarchaeological Record." International Journal of Osteoarchaeology (2008): 18:28–44.

Fazekas, I. G. Forensic Fetal Osteology. Trans. F. Koza. Budapest: Akademiai Kiado, 1978.

Feehan, J. "The Geology of the Aran Islands." Waddell, J., J. W. O'Connell, and A. Korff. The Book of Aran. Newtownlynch, Kinvara, Galway: Tír Eolas, 1994. 16-34.

Feik, S. A., C.D.L. Thomas, R. Bruns, and J.G. Clemeny. "Regional Variations in Cortical Modeling in the Femoral Mid-Shaft: Sex and Age Differences." American Journal of Physical Anthropology (2000): 112:191–205.

Feldesman, M. R. and R. L. Fountain. ""Race" Specificity and the Femur Stature Ratio." American Journal of Physical Anthropology (1996): 100:207-224.

Frayer, D. W. "Sexual Dimorphism and Cultural Evolution in the Late Pleistocene and Holocene of Europe." Journal of Human Evolution (1980): 9:399-415.

Fry, S. L. Burial in Medieval Ireland, 900-1500: A Review of the Written Sources. Dublin: Four Courts Press, 1999.

Gil, A. F., G. A. Neme, R. H. Tykot, P. Novellino, V. Cortegoso, V. Durán. "Stable Isotopes and Maize Consumption in Central Western Argentina." International Journal of Osteoarchaeology (2009): 19:215-236.

Glanville, E. V. "Perforation of the Coronoid-Olecranon Septum Humero-Ulnar Relationships in Netherlands and African Populations." American Journal of Physical Anthropology (1967): 26:85-92.

Goodman, A. H., and G. J. Armelagos. "Factors Affecting the Distribution of Enamel Hypoplasias within the Human Permanent Dentition." American Journal of Physical Anthropology (1985b): 68:479-493.

—. "The Chronological Distribution of Enamel Hypoplasia in Human Permanent Incisor and Canine Teeth." Archives of Oral Biology (1985a): 30:503-507.

Goodman, A. H., and J. C. Rose. "Assessment of Systemic Physiological Perturbations From Dental Enamel Hypoplasias and Associated Histological Structures." Yearbook of Physical Anthropology (1990): 33:59-110.

Gosling, Paul. Archaeological Inverntory of County Galway, Volume 1: West Galway. Dublin: The Stationary Office, 1993.

Goto, T. K., G. E.J. Langenbach, T. W. P. Korioth, M. Hagiwara, M. L. Tonndorf, and A. G. Hannam. "Functional Movements of Putative Jaw Muscle Insertions." The Anatomical Record (1995): 242:278-288.

Gray, Henry. Gray's Anatomy. Ed. Warren H. Lewis. New York: Bartelby, 2000.

Halffman, C. M., G. R. Scott, and P. O. Pedersen. "Palatine Torus in the Greenlandic Norse." American Journal of Physical Anthropology (1992): 88:145-161.

Hannam, A. G., and W. W. Wood. "Relationships Between the Size and Spatial Morphology of Human Masseter and Medial Pterygoid Muscles, the Craniofacial Skeleton, and Jaw Biomechanics." American Journal of Physical Anthropology (1989): 80:429-445.

Harris E. F., J. H. McKee. "Tooth Mineralization Standards for Blacks and Whites from the Middle Southern United States." Journal of Forensic Science (1990): 35:859–872.

Hassett, B. "Torus Mandibularis: Etiology and Bioarcheological Utility." Dental Anthropology (2006): 19:1-14.

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

Hawkey, D. E., and C. F. Merbs. "Activity-induced Musculoskeletal Stress Markers (MSM) and Subsistence Strategy Changes among Ancient Hudson Bay Eskimos." International Journal of Osteoarchaeology (1995): 5:324-33 8.

Holland, T. D. "Sex Assessment Using the Proximal Tibia." American Journal of Physical Anthropology (1991): 85:221-227.

Hoppa, R. D. "Evaluating Human Skeletal Growth: an Anglo-Saxon Example." International Journal of Osteoarchaeology (1992): 2:275-288.

Howell, H. "Village composition implied by a paleodemographic life table: The Libben Site." The American Journal of Physical Anthropology (1982): 59:263-269.

Hoyte, D. A. N. and D. H. Enlow. "Wolff's Law and the Problem of Muscle Attachment on Resorptive Surfaces of Bone." American Journal of Physical Anthropology (1966): 24:205-214.

Hrdlicka, A. "Shovel-Shaped Teeth." American Journal of Physical Anthropology (1920): 3:429-465.

—. "The Humerus: Septal Apertures." Anthropologie (1932): 10:31-96.

Jurmain, R. D. "Degenerative Changes in Peripheral Joints as Iindicators of Mechanical Stress: Opportunities and Limitations." International Journal of Osteoarchaeology (1991): 1:247–252.

Jurmain, R. Stories from the Skeleton: Interpreting the Remains of the Past. Gordon & Breach, 1999.

Kalmey, J. K and T. A Rathbun. “Sex Determination by Discriminant Function Analysis of the Petrous Portion of the Temporal Bone.” Journal of Comparative Human Biology (2005): 55:213-28.

Katzenberg, M. A., D. A. Herring, and S. A. Saunders. “Weaning and Infant Mortality: Evaluating the Skeletal Evidence.” Yearbook of Physical Anthropology (1996): 39:177-199.

Kelly, M. A. “Parturition and Pelvic Changes.” American Journal of Physical Anthropology (1979): 51:541-546.

Kennedy, K. A. R. “Markers of Occupational Stress: Conspectus and Prognosis of Research.” International Journal of Osteoarchaeology (1998): 8:305-310.

Kennedy, K. A. R. “Skeletal Markers of Occupational Stress.” Ýþcan, M. Y. and K. A. R. Kennedy. Reconstruction of Life from the Skeleton. New York: Alan R. Liss, Inc., 1989. 129-160.

King, T., L.T. Humphrey, and S. Hillson. “Linear Enamel Hypoplasias as Indicators of Systemic Physiological Stress: Evidence From Two Known Age-at-Death and Sex Populations From Postmedieval London.” American Journal of Physical Anthropology (2005): 128:547–559.

Klepinger, L. L. Fundamentals of Forensic Anthropology. Hoboken: Wiley-Liss, 2006.

Knusel, C. “Activity-Related Skeletal Change.” Fiorato, V., A. Boylston and C. Knusel. Blood Red Roses: The Archaeology of a Mass Grave from the Battle of Towton AD 1461. Oxford: Oxbow Books, 2007. 103-118.

Konigsberg, L. W., and S. R. Frankenberg. “Deconstructing Death in Paleodemography.” American Journal of Physical Anthropology (2002): 117:297-309.

—. “Estimation of Age Structure in Anthropological Demography.” American Journal of Physical Anthropology (1992): 89:235-256.

Konigsberg, L. W., B. F. B. Algee-Hewitt, and D. W. Steadman. “Estimation and Evidence in Forensic Anthropology: Sex and Race.” American Journal of Physical Anthropology (2009): 139:77–90.

Kumagai, M., N. Shiba, F. Higuchi, H. Nishimura, A. Inoue. “Functional Evaluation of Hip Abductor Muscles with use of Magnetic Resonance Imaging.” Journal of Orthopaedic Research (1997): 15:888-893.

Kursa, K., L. Lattanza, E. Diao, and D. Rempel. “In Vivo Flexor Tendon Forces Increase with Finger and Wrist Flexion During Active Finger Flexion and Extension.” Journal of Orthopaedic Research (2006): 24:763-769.

Lai, P. and N. C. Lovell. "Skeletal Markers of Occupational Stress in the Fur Trade: a Case Study from a Hudson's Bay Company Fur Trade Post." International Journal of Osteoarchaeology (1992): 2:221-234.

Lanfranco, L. P. and S Eggers. "The Usefulness of Caries Frequency, Depth, and Location in Determining Cariogenicity and Past Subsistence: A Test on Early and Later Agriculturalists from the Peruvian Coast." American Journal of Physical Anthropology (2010): In Print.

Larsen, C. S. Bioarchaeology: Interpreting Behavior from the Human Skeleton. New York: Cambridge University Press, 1997.

Li, Y., J, M. Navia, and J. Bian. "Prevalence and Distribution of Developmental Enamel Defects in Primary Dentition of Chinese Children 3–5 Years Old." Community Dentistry and Oral Epidemiology (1995): 23:72-79.

Lieverse, A. R., V. I. Bazaliiskii, O. I. Goriunova, and A. W. Weber. "Upper Limb Musculoskeletal Stress Markers Among Middle Holocene Foragers of Siberia's Cis-Baikal Region." American Journal of Physical Anthropology (2009): 138:458-472.

Locard, E. Les Crimes De Sang Et Les Crimes D'amour Au Xviie Siècle. Paris: Nabu Press, 2010.

Lovejoy, C. O., R. S. Meindl, T. R. Pryzbeck, and R. P. Mensforth. "Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Age at Death." American Journal of Physical Anthropology (1985): 68:15-28.

Lukacs, J. R. and C. R. Martín. "Lingual Cortical Mandibular Defects (Stafne's Defect): An Anthropological Approach based on Prehistoric Skeletons from the Canary Islands." International Journal of Osteoarchaeology (2002): 12: 112–126.

Lukashevich, I. S., R. Maryankova, A. S. Vladyko, N. Nashkevich, S. Koleda, M. Djavani,D. Horejsh, N. N. Voitenok, and M. S. Salvato. "Lassa and Mopeia Virus Replication in Human Monocytes/Macrophages and in Endothelial Cells: Different Effects on IL-8 and TNF-a Gene Expression." Journal of Medical Virology (1999): 59:552–560.

Maijanen, H., and M. Niskanen. "New Regression Equasions for Stature Estimation for Medieval Scandinavians." International Journal of Osteoarchaeology (2010): In Press.

Mann, M. D. "The "CSI Effect": Better Jurors through Television and Science?" Buffalo Public Interest Law Journal (2006): 157-183.

Mann, R.W, and D.R.Hunt. Photographic Regional Atlas Of Bone Disease: A Guide To Pathologic And Normal Variation In The Human Skeleton. Springfield, IL: Charles C. Thomas, 2005.

Mariotti, V., F. Facchini and M. G. Belcastro. “Enthesopathies–Proposal of a Standardized Scoring Method and Applications.” Collegium Antropologicum (2004): 28:145–159.

Mays, S. “Septal Aperture of the Humerus in a Mediaeval Human Skeletal Population.” American Journal of Physical Anthropology (2008): 136:432–440.

—. “Taphonomic Factors in a Human Skeletal Assemblage.” Circaea (1992): 9:54-59.

Mays, S., G.M. Taylor, A.J. Legge, D.B. Young, and G. Turner-Walker. “Paleopathological and Biomolecular Study of Tuberculosis in a Medieval Skeletal Collection from England.” American Journal of Physical Anthropology (2001): 114:298–311.

Mays, S., R. Ives, and M. Brickley. “The Effects of Socioeconomic Status on Endochondral and Appositional Bone Growth, and Acquisition of Cortical Bone in Children From 19th Century Birmingham, England.” American Journal of Physical Anthropology (2009): 140:410-416.

Merbs, C. Patterns of Activity-Induced Pathology in a Canadian Inuit Population. Ottawa: National Museums of Canada, 1983.

Micozzi, M. S. Postmortem Change in Human and Animal Remains. Springfield, IL: C. C. Thomas, 1991.

Mills, J. R. E. “Occlusion and Malocclusion of the Teeth of Primates.” Brothwell, D. R. Dental Anthropology. New York: The Macmillan Company, 1963. 29-52.

Molleson, T. and D. Hodgson. “The Human Remains from Woolley’s Excavations at Ur.” Iraq (2003): 65:91-129.

Molnar, P. “Dental Wear and Oral Pathology: Possible Evidence and Consequences of Habitual Use of Teeth in a Swedish Neolithic Sample.” American Journal of Physical Anthropology (2008): 136:423-431.

Moorees, C. F. A., E. A. Fanning, and E. E. Hunt. “Age Formation by Stages for Ten Permanent Teeth.” Journal of Dental Research (1963b): 42:1490-1502.

—. “Formation and Resorption if Three Deciduous Teeth in Children.” American Journal of Physical Anthropology (1963a): 21:205-213.

Murphey, E. M. and T. E. McNeill. “Human Remains Excavated at Doonbought Fort, C. Antrim, 19969.” Ulster Journal of Archaeology (1993): 120-138.

Ní Ghabhláin, S. “Excavations at Mainistir Chiaráin, Inis Mór.” Preliminary Excavation. 1999.

—. Excavations at Mainistir Chiaráin, Inis Mór 1996-1997. Ní Ghabhláin, 1997.

—. Excavations at Mainistir Chiaraín, Inis Mór 1998. Ní Ghabhláin, 1998.

Ní Ghabhláin, S. Personal Communication January-May 2010.

Nickell, J., and J. F. Fischer. Crime Science: Methods of Forensic Detection. Lexington: University Press of Kentucky, 1999.

Nordin, M., and V. H. Frankel. Basic Biomechanics of the Musculoskeletal System. Baltimore: Lippincott Williams & Wilkins, 2001.

Novotný, V., M, Y. Ýþcan and S. R. Loth. “Morphologic and Osteometric Assessment of Age, Sex, and Race from the Skull.” Ýþcan, M. Y and R. P. Helmer. Forensic Analysis of the Skull. New York: Wiley-Liss, 1993. 71-88.

O’Connell, M. and C. Roden. “The Natural History of the Sea.” Waddell, J., J. W. O’Connell, and A. Korff. The Book of Aran. Newtownlynch, Kinvara, Galway: Tír Eolas, 1994. 47-56.

O’Connor, C., R. G. Franciscus, and N. E. Holton. “Bite Force Production Capability and Efficiency in Neandertals and Modern Humans.” American Journal of Physical Anthropology (2004): 2:129-151.

Oettlé, A. C., Pretorius, E., Steyn, M. “Geometric Morphometric Analysis of the Use of Mandibular Gonial Eversion in Sex Determination.” Journal of Comparative Human Biology (2009): 60:29-43.

Ogden, A. R., R. Pinhasi, and W.J. White. “Gross Enamel Hypoplasia in Molars from Subadults in a 16th-18th Century London Graveyard.” American Journal of Physical Anthropology (2007): 133:957-966.

O’Keeffe, T. “Omey and the Sands of Time.” Archaeology Ireland (1994): 8:14-17.

Orava, S. and J. Leppilahti. “Overuse Injuries of Tendons in Athletes.” European. London: The British Editorial Society of Bone and Joint Surgery, 1999.

Orschiedt, J. and M. N. Haidle. “The LBK Enclosure at Herxheim Theatre of War or Ritual Centre? References from Osteoarchaeological Investigations.” Journal of Conflict Archaeology (2006): 153-167.

Ortner, D. and S. Mays. “Dry-bone Manifestations of Rickets in Infancy and Early Childhood.” international Journal of Osteoarchaeology (1998): 8:45–55.

Ortner, D. J., and W. G. J. Putschar. Identification of Pathological Conditions in Human Skeletal Remains. Washington DC: Smithsonian Institution Press, 1985.

Oschinski, L. The Most Ancient Eskimos. Ottawa: The Canadian Research Centre for Anthropology, 1964.

Ossenberg, N. S. "Mandibular Torus: A Synthesis of New and Previously Reported Data and a Discussion of its Cause." Contributions to Physical Anthropology (1978-1980): 1-52.

Ousley, S. D. and R. L. Jantz. FORDISC 3.0 Personal Computer Forensic Discriminant Functions. University of Tennessee. 2005. Knoxville, 2005.

Paice, P. "Extensions to the Harris Matrix System to Illustrate Stratigraphic Discussion of an Archaeological Site." Journal of Field Archaeology (1991): 18:17-28.

Paine, R. R. "If a Population Crashes in Prehistory, and There Is No Paleodemographer to Hear it, Does it Make a Sound?" American Journal of Physical Anthropology (2000): 112:181–190.

—. "Model Life Table Fitting by Maximum Likelihood Estimation: A Procedure to Reconstruct Paleodemographic Characteristics from Skeletal Age Distributions." American Journal of Physical Anthropology (1989): 79:51-61.

Parker Pearson, M. The Archaeology of Death and Burial. Texas A&M University Press, 1999.

Pauley, J. E., J. L. Rushing, and L. E. Sheving. "An Electromyographic Study of Some Muscles Crossing the Elbow Joint." The Anatomical Record (1967): 159:47-53.

Pearson, O. M., and D. E. Lieberman. "The Aging of Wolff's "Law": Ontogeny and Responses to Mechanical Loading in Cortical Bone." American journal of Physical Anthropology (2004): 47:63–99.

Pomeroy, E. and S. R. Zakrzewski. "Sexual Dimorphism in Diaphyseal Cross-sectional Shape in the Medieval Muslim Population of Écija, Spain, and Anglo-Saxon Great Chesterford, UK." International Journal of Osteoarchaeology (2009): 19:50–65.

Potau, J. M., X. Bardina, N. Ciurana, D. Camprubí, J. F. Pastor, F. de Paz and M. Barbosa. "Quantitative Analysis of the Deltoid and Rotator Cuff Muscles in Humans and Great Apes." International Journal of Primatology (2009): 30:697-708.

Power, C., R. A. Housley, and J. Lanting. "Human Skeletal Remains." M. F. Hurley, O. M. B. Scully, R. M. Cleary, M. F. Hurley & S. W. J. McCutcheon. Late Viking Age and Medieval Waterford: Excavations 1986–1992. Waterford Corporation, 1997. 762-817.

Prasad, R., S. Vettivel, L. Jeyaseelan, B. Isaac, and G. Chandi. "Reconstruction of Femur Length From Markers of Its Proximal End." Clinical Anatomy (1996): 9:28-33.

Radin, E. L. "Mechanical Factors in the Causation of Osteoarthriris." Rheumatology (1982): 7:46-52.

Regan, M. H., D. T. Case, and J. C. Brundige. "Articular Surface Defects in the Third Metatarsal and Third Cuneiform: Nonosseous Tarsal Coalition." American Journal of Physical Anthropology (1999): 109:53-65.

Resnik, D., and G. Niwayama. "Intervertebral Herniation: Cartilagenous (Schmorl's) Nodes." Radiology (1978): 126:57-65.

Roberts, C. and K. Manchester. The Archaeology of Disease. New York: Cornell University Press, 2007.

Roberts, C., and M. Cox. Health & Disease in Britain: From Prehistory to the Present Day. Thrupp, Stroud, Gloucestershire: Sutton Publishing Limited, 2003.

Robinson, T. Stones of Aran: Pilgrimage. New York: Viking, 1986.

Roden, C. "The Aran Flora." Waddell, J., J. W. O'Connell, and A. Korff. The Book of Aran. Newtownlynch, Kinvara, Galway: Tír Eolas, 1994. 35-46.

Rogers, J., T. Waldron, P. Dieppe, and I. Watt. "Arthropathies in Palaeopathology: The Basis of Classification According to Most Probable Cause." Journal of Archaeological Science (1987): 14:179-1 93.

Rollinger, J. M., and M. Schmidtke. "The Human Rhinovirus: Human-Pathological Impact, Mechanisms of Antirhinoviral agents, and Strategies for their Discovery." Medicinal Research (2010): In Press.

Ruff, C. B., A. Walker and E. Trinkaus. "Postcranial Robusticity in Homo III: Ontogeny." American Journal of Physical Anthropology (1994): 93:35-54.

Ruff, C. "Sexual Dimorphism in Human Lower Limb Bone Structure: Relationship to Subsistence Strategy and Sexual Division of Labor." Journal of Human Evolution (1987): 16:391-416.

Sacragi, A. and T. Ikeda. "Sex Identification from the Distal Fibula." International Journal of Osteoarchaeology (1995): 5:139-1 43.

Saunders, S. R. "Nonmetric Skeletal Variation." Ýþcan, M. Y. and K. A. R. Kennedy. Reconstruction of Life from the Skeleton. New York: Alan R. Liss, Inc., 1989. 95-108.

Schmorl, G. and H. Junghanns. The Spine in Health and Disease. New York: Grune and Stratton, 1971.

Scott, G. R., and C. G. Turner II. The Anthropology of Modern Human Teeth. Cambridge University Press, 1997.

Scott, G. R., and Dahlberg, A. A. "Microdifferentiation in Tooth Crown Morphology among Indians of the American Southwest." Kurtén, B. Teeth: Form, Function, and

Evolution. New York: Columbia University Press, 1982. 259-291.

Scott, R. E. Personal Communication Spring 2010.

—. Social Identity in Early Medieval Ireland: A Bioarchaeology of the Early Christian Cemetery on Omey Island, Co. Galway. Ann Arbor: Proquest: University of Pennsylvania, 2007.

Scrimshaw, N. S., and M. Behar. "Malnutrition in Undeveloped Countries." New England Journal of Medicine (1965): 272:137-144.

Shaw, C. N. and J. T. Stock. "Intensity, Repetitiveness, and Directionality of Habitual Adolescent Mobility Patterns Influence the Tibial Diaphysis Morphology of Athletes." American Journal of Physical Anthropology (2009): 140:149–159.

Snell, C. A. R. D., and H. W. A. Donhuysen. "The Pelvis in the Bipedalism of Primates." American Journal of Physical Anthropology (1968): 28: 239-246.

Soafer, J. The Body as Material Culture. New York: Cambridge University Press, 2006.

Soderberg, J. Personal Communication Spring 2010.

Søgaard, K., S. C. Gandevia, G. Todd, N. T. Petersen, and J. L. Taylor. "The Effect of Sustained Low-Intensity Contractions on Supraspinal Fatigue in Human Elbow Flexor Muscles." Journal of Physiology (2006): 573:511–523.

Staudenmann, D., T. Rudroff and R. M. Enoka. "Pronation–Supination Torque and Associated Electromyographic Activity Varies During a Sustained Elbow Flexor Contraction but does not Influence the Time to Task Failure." Muscle and Nerve (2009): 40:231–239.

Steele, G. D., and T. W. McKern. "A Method for Assessment of Maximum Long Bone Length and Living Stature from Fragmentary Long Bones." American Journal of Physical Anthropology (1969): 31:215-227.

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

Stini, W. A. "Nutritional Stress and Growth: Sex Difference in Adaptive Response." American Journal of Physical Anthropology (1969): 31:417-426.

Stock, J. T. "Hunter-Gatherer Postcranial Robusticity Relative to Patterns of Mobility, Climatic Adaptation, and Selection for Tissue Economy." American Journal of Physical Anthropology (2006): 131:194-204.

Stock, J. T., and S. Pfeiffer. "Linking Structural Variability in Long Bone Diaphyses to Habitual Behaviors: Foragers from the SAfrican Later Stone Age and the Andaman

Islands." American Journal of Physical Anthropology (2001): 115:337–348.

Storey, R. "An Elusive Paleodemography? A Comparison of Two Methods for Estimating the Adult Age Distribution of Deaths at Late Classic Copan, Honduras." American Journal of Physical Anthropology (2007): 132:40-47.

Stuart-Macadam, P. "Integrative Anthropology: A Focus on Iron-Deficiency Anemia." Archeological Papers of the American Anthropological Association (2006): 16:129–137.

Suchey, J. M., D. V. Wiseley, R. F. Green. "Analysis of Dorsal Pitting in the 0s Pubis in an Extensive Sample of Modern American Females." American Journal of Physical Anthropology (1979): 51:517-540.

Suzuki, M., and T. Sakai. "A Familial Study of Torus Palatinus and Torus Mandibularis." American Journal of Physical Anthropology (1960): 18:263-272.

Thomas, J. "The Social Significance of Cotswold-Severn Burial Practices." Man (1988): 23:540-59.

Todd, T. W. "Age Changes in the Pubic Bone. I: The Male White Pubis." The American Journal of Physical Anthropology (1921a): 3:285-334.

—. "Age Changes in the Pubic Bone. III: The Pubis of the White Female." American Journal of Physical Anthropology (1921b): 4:1-70.

Turner, C. G. "Late Pleistocene and Holocene Population History of East Asia Based on Dental Variation." American Journal of Physical Anthropology (1987): 73:305-321.

Tyrdal, S., and A-M. S Finnager. "Osseous Manifestations of 'Handball Goalie's Elbow'." Scanidinavian Journal of Medicine & Science in Sports (1999): 9:92-97.

Ubelaker, D. H. Human Skeletal Remains. Washington D. C.: Taraxacum Press, 1989.

Ullrich, H. "Estimation of Fertility by Means of Pregnancy and Childbirth Alterations at the Pubis, the Ilium and the Sacrum." OSSA (1975): 2:23-39.

Vercellotti, G., A. M. Agnew, H. M. Justus, and P. W. Sciulli. "Stature Estimation in Early Medieval (XI-XII c.) Polish Population: Testing the Accuracy of Regression Equations in a Bioarcheological Sample." American Journal of Physical Anthropology (2009): 140:135–142.

Villotte, S., D. Castex, V. Couallier, O. Dutour, C. J. Knusel, and D. Henry-Gambier. "Enthesopathies as Occupational Stress Markers: Evidence from the Upper limb." American Journal of Physical Anthropology (2010): In Press.

Vlak, D., M. Roksandic, and M. A. Schillaci. "Greater Sciatic Notch as a Sex Indicator in Juveniles." American Journal of Physical Anthropology (2008): 137:309–315.

Waddell, J. “The Archaeology of Ireland.” Waddell, J., J. W. O’Connell, A. Korff. The Book of Aran. Newtownlynch, Kinvara, Galway: Tír Eolas, 1994. 75-136.

Walker, P. L., R. R. Bathurst, R. Richman, T. Gjerdrum, and V. A. Andrushko. “The Causes of Porotic Hyperostosis and Cribra Orbitalia: A Reappraisal of the Iron-Deficiency-Anemia Hypothesis.” American Journal of Physical Anthropolgy (2009): 139:109–125.

Weaver, D. S. “Forensic Aspects of Fetal and Neonatal Skeletons.” Reichs, K. S., and W. Bass. Forensic Osteology: Advances in the Identification of Human Remains. Springfield: Charles C. Thomas, 1998. 187-203.

Weiss, E. “Muscle Markers Revisited: Activity Pattern Reconstruction With Controls in a Central California Amerind Population.” American Journal of Physical Anthropology (2007): 133:931–940.

Weiss, E. and R. Jurmain. “Osteoarthritis Revisited: A Contemporary Review of Aetiology.” International Journal of Osteoarchaeology (2007): 17:437–450.

White, T. Human Osteology. San Diego: Elsevier, 2000.

Widmalm, S. E., P. A. Nemeth, M. M. Ash, Jr. and J.H. Lillie. “The Anatomy and Electrical Activity of the Platysma Muscle.” Journal of Oral Rehabilitation (1985): 12:17-22.

Wilczak, C.A. and K. A. R. Kennedy. “Mostly MOS: Aspects of Identification of Skeletal Markers.” Forensic Osteology. Ed. ed. Kathy J. Reichs. 2nd. Springfield: Charles C. Thomas, 1998. 461–490.

Williams, D. M. “Short Contribution: Marine Erosion and Archaeological Landscapes: A Case Study of Stone Forts at Cliff-Top Locations in the Aran Islands, Ireland.” Geoarchaeology: A International Journal (2004): 19:2:167-165.

Williams, F. M. K., N. J. Manek, P. N. Sambrook, T. D. Spector, and A. J. MacGregor. “Schmorl’s Nodes: Common, Highly Heritable, and Related to Lumbar Disc Disease.” Arthritis & Rheumatism (2007): 57:855–860.

Wood, J. W. Dynamics of Human Reproduction: Biology, Biometry, Demography. New York: Aldine de Gruyter, 1994.

Wood, J. W., G. R. Milner, H. C. Harpending, and K. M. Weiss. “The Osteological Paradox: Problems of Inferring Health from Skeletal Samples.” Current Anthropology (1992): 33:343–370.

Živanovic, S. Ancient Diseases: Elements of Palaeopathology. Trans. L. F. Edwards. New York: Pica Press, 1983.

Appendix

SD Side	2.1.0 Nasal	Metrics Measurements in Millimeters	3.1.1 Located in External Table
SN Section Present	2.1.1 Hyoid	BLN Bicondylar Length	3.1.2 Located in Internal Cortex
1 Proximal Epiph/Articular Surface	3.1.3 Cervical 3-6	CBR Middle Breadth	3.1.4 Mixed 1.1 & 1.2
2 Proximal 1/3 of Diaphysis	3.2.1 Thoracic 1-9	CDL Bicondylar Breadth	3.2.1 Extent < 1/3
3 Middle 1/3 of Diaphysis	3.2.4 Thoracic 12	CIR Circum at Nutrient Foramen	3.2.2 Extent 1/3-2/3
4 Distal 1/3 of Diaphysis	3.3.0 Lumbar Vertebra	EBR Epicondylar Breadth	Organization BONE LOSS
5 Distal Epiph/Articular Surface	3.4.0 Sacrum	GOG Bigonial Breadth	3.3.1 Unifocal
6 Proximal 2/3 Diaphysis	3.6.2 2nd Rib	GNI Gnathion to Infradentale	3.3.3 Multifocal: 3-5 foci
7 Distal 2/3 Diaphysis	3.6.3 Rib 3-10	HDD Max Head Diameter	3.3.5 Multifocal: 10+ foci
8 Total Diaphysis	3.7.2 Sternal Body	HMF Height at Mental Foramen	3.4.1 Size <1 cm
9 Both Articular Surfaces	4.0.1 Clavicle	MAP Midshaft Ant-Post Diameter	3.5.1 Sclerotic Reaction
ASP Aspect of Bone Present	4.1.1 Humerus	MDM Max. Midshaft Diameter	3.5.2 Boundaries def-no sclerosis
1 Superior Surface	4.1.2 Radius	MTV Midshaft Trans Diameter	3.5.4 Mixed 5.1 & 5.2
2 Inferior Surface	4.1.3 Ulna	MWD Min. Midshaft Diameter	3.6.1 Diffuse with Cortical Thinning
4 Medial	4.1.4 Carpal	PEB Max Prox Epiph Breadth	3.6.2 Diffuse w/out Cort. Thinning
5 Lateral	4.2.0 Os Coxa	SAP Ant-Post Subtroch Diameter	3.7.1 Structural Collapse
7 Posterior	4.2.1 Ilium	STV Trans Subtroch Diameter	Abnormal BONE FORMATION
Bone Codes	4.2.2 Ischium	TMF Thickness at Mental Foramen	4.1.1 Reactive Woven Bone Present
2.0.1 Frontal	4.2.3 Pubis	WRB Minimum Ramus Breadth	4.1.3 Woven and Sclerotic Reaction
2.0.2 Parietal	4.3.1 Femur	XLN Greatest Length	4.2.1 Sunburst Spicule Effect
2.0.3 Occipital	4.3.3 Tibia	Abnormality of SHAPE	4.3.2 Cloacae in Cortex
2.0.4 Temporal	4.3.4 Fibula	1.1.0 Long Bone Bowing	4.5.1 Dep of Imm Woven Bone
2.0.5 Zygoma	4.3.5 Tarsal	1.3.1 Flaring Metaphyses	4.6.1 <1/3 Involvement
2.0.6 Maxilla	4.3.6 Metatarsal	1.3.4 Other	4.6.2 1/3-2/3 Involvement
2.0.7 Mandible	4.3.7 Pedal Phalanges	1.4.1 Degree Barely Discernible	4.7.2 Enthesopathy
2.0.8 Palatine	AG Age	1.4.2 Degree Clearly Discernible	Fractures and Dislocations
2.0.9 Sphenoid	Piece # Accession Number(s)	Abnormal BONE LOSS	5.1.2 Partial or Greenstick

Table 1: Key to Abreviations and Codes(Continued Next

5.1.3 Simple	8.4.1 Porosity Extent < 1/3	Stage 14 Apex formation closed	1 Faint
5.1.7 Depressed, Outer Table Only	8.4.2 Porosity Extent 1/3-2/3	WR = Wear Morrees *et. al.* 1963b	2 Trace
5.4.3 Healing Present	8.4.3 Porosity Extent > 2/3	C = Caries	3 Semishovel 1
5.5.3 Dislocation Type Ambiguous	8.7.1 Surface Osteophytes Minimal	1 On Occlusal Surface	5 Shovel
Porotic Hyperostosis	8.7.2 Surface Osteophytes Clear	2 On Interproximal Surface	1UPRT = Upper 1st Premolar Root #
6.1.1 Barely Discernable	8.8.1 Periartic. Resorption Minimal	5 Below the CEJ	UMHC = Upper Molar Hypocone
6.1.2 Porosity Only	8.8.2 Periartic. Resorption Obvious	AB = Abscess	3.5 Moderate size cusp
6.2.1 Orbital Location	8.9.1 Periarticular Extent < 1/3	1 Buccal or Labial Channel	4 Large cusp present
6.2.2 Located Adjacent to Sutures	8.9.2 Periarticular Extent 1/3-2/3	Calc = Calculus (with location)	UMEE = Upr Molar Enam Extension
6.3.1 Active at Death	8.9.3 Periarticular Extent > 2/3	1 Small Amount	2 About 2mm long
6.3.2 Healed	**Taphonomy**	2 Moderate Amount	1LPRT = Lower Premolar Root #
Vertebral Pathology	W = Weathering Behrensmeyer 1978	3 Large Amount	1 Groove, shallow v-shape
7.1.1 Schmorl's Nodes Minimal	D = Discoloration	9 Unobservable	2 Groove, moderate v-shape
7.1.2 Schmorl's Nodes Moderate	C = Cutmarks	HY = Hypoplasia	4 Deep invagination
7.2.1 Osteophytes Minimal	G = Gnawing	1 Linear Horizontal Grooves	LMGP = Lower Molar Cusp Pattern
7.2.2 Osteophytes Elevated Ring	RE = Root Etching	2 Linear Vertical Grooves	Y Cusp 2 & 3 in contact
7.3.1 Enthesophytes Minimal	DF = Deformation	3 Linear Horizontal Pits	+ All cusps in contact
7.3.1 Enthesophytes Elevated Ring	B = Breakage	4 Non-linear Arrays of Pits	X Cusps 1 & 4 in contact
Arthritis	**Dentition**	5 Single Pits	LMCN = Lwr Molar Cusp Number
8.1.1 Lipping Minimal	T = Side, Tooth, Number	**Dental Measurements**	4 Only cusps 1-4 are present

Table 1 Continued: Key to Abreviations and Codes

Table 2: Osteological Inventory

001.002.1	Humerus	
001.002.2	Cranium	
002.002.1	Femur	Left
002.002.2	Femur	Left
002.002.3	Humerus	Right
003.001.2	Parietal	
004.002.1	Femur	Right
004.002.2	Cranium	
004.002.3	Cranium	
004.002.4	Humerus	
004.002.5	Lunate	Right
004.002.6	Fibula	Left
004.002.7	Vert	Cerv
005.002.1	Vert	Cerv
005.002.2	Femur	
005.002.3	Cranium	
005.002.4	Cranium	
005.002.5	Cranium	
007.002.1	Cranium	
007.016.1	P4	Right
011.002.1	Radius	Left
011.002.2	Frontal	Left
011.002.3	Parietal	
015.002.1	Cranium	
015.002.2	Cranium	
015.013.1	Maxilla	Right
015.013.2	Maxilla	Left
015.013.3	Cranium	
015.013.4	Cranium	
017.002.1	Cranium	
017.002.2	Cranium	
018.002.1	Cranium	
018.002.2	Femur	Right
018.002.3	Sternum?	
019.002.1	Radius?	
019.002.2	Clavicle	Right
019.002.3	Vert	Thor
019.002.4	M1	Right
019.002.5	Cranium	
019.002.6	Cranium	

021.001.1	Vert	Thor
021.001.2	Vert	Thor?
022.002.1	Vert	Cerv
022.002.10	Humerus?	
022.002.11	Phalanx	Right?
022.002.12	I1	Left
022.002.13	Maxilla	Right
022.002.2	Vert	Lumb
022.002.3	Sacrum	
022.002.4	Humerus	Left
022.002.5	Cranium	
022.002.6	Cranium	
022.002.7	Parietal	
022.002.8	Maxilla	Left
022.002.9	Ulna	Right
023.002.1	Parietal	Right?
023.002.2	C1	Left
023.002.3	C1	Right
023.002.4	Maxilla	Left
023.002.5	Vert	Lumbar
023.002.6	I1	Left
023.002.7	Cranium	
023.003.1	M1	Left
023.003.2	Parietal	
023.003.3	Parietal	
023.003.4	Parietal	Right
029.001.1	Femur	Left
029.001.10	Humerus	
029.001.11	Humerus	
029.001.2	Femur	
029.001.3	Femur	
029.001.6	Scapula	Right
029.001.7	Scapula	Right
029.001.8	Ulna	Left
029.001.9	Humerus	
033.002.1	Femur	Left
037.001.1	Humerus	Right
037.001.10	Scapula	Left
037.001.11	Scapula	Left
037.001.13	Radius	

037.001.14	Radius	
037.001.15	Radius	
037.001.16	Radius	
037.001.17	Maxilla	Right
037.001.18	Ilium	
037.001.19	Fibula	Right
037.001.2	Fibula	Right
037.001.20	Fibula	Right
037.001.21	Femur	
037.001.22	Femur	
037.001.23	Femur	
037.001.24	Radius	Right
037.001.25	Fibula	
037.001.26	Fibula	
037.001.27	Humerus	
037.001.3	Tibia	Left
037.001.8	Scapula	Left
037.001.9	Scapula	Left
037.002.1	P4	Left
037.002.10	Humerus	Right
037.002.11	Tibia	Left
037.002.12	Fibula	Left
037.002.13	Fibula	Left
037.002.14	Ilium	
037.002.15	Ilium	
037.002.16	Ilium	
037.002.17	Ilium	
037.002.18	Ilium	
037.002.19	Radius	Right
037.002.2	P3	Left
037.002.20	Tibia	Left
037.002.21	Tibia	Right
037.002.22	Radius	Right
037.002.23	Humerus	Right
037.002.24	Femur	Left
037.002.25	Femur	Left
037.002.26	Innom	Right
037.002.27	Mandible	
037.002.28	Innom	
037.002.29	Humerus	Right

Table 2: Osteological Inventory, cont.

037.002.3	Ulna	Left
037.002.30	Humerus	Left
037.002.31	Femur	Right
037.002.32	Tibia	Right
037.002.33	Fibula	
037.002.34	Fibula	
037.002.35	Femur	Right
037.002.36	Femur	
037.002.37	Femur	
037.002.38	Femur	
037.002.39	Fibula	
037.002.4	Fibula	Right
037.002.41	Ilium	Left
037.002.42	Ilium	Left
037.002.43	Scapula	Right
037.002.44	Ilium	Left
037.002.45	Radius	Right
037.002.46	Humerus	Left
037.002.47	Femur	Left
037.002.48	Fibula	Right
037.002.49	Mandible	
037.002.5	Fibula	Right
037.002.50	Fibula	Right
037.002.51	Ischium	Right
037.002.52	Humerus	Left
037.002.53	Rib	Right
037.002.54	Ilium	Right
037.002.55	Tibia	Left
037.002.56	Ilium	Right
037.002.57	Fibula	
037.002.58	Fibula	
037.002.59	Fibula	
037.002.6	Tibia	Right
037.002.60	Scapula	Left
037.002.61	Scapula	Left
037.002.62	Scapula	Left
037.002.63	Pubis	Left
037.002.64	Humerus	Right
037.002.65	Femur	Right
037.002.66	Femur	Left

037.002.67	Innom	Left
037.002.68	Ilium	Right
037.002.69	Tibia	Right
037.002.7	Humerus	Right
037.002.70	Femur	Right
037.002.71	Tibia	Right
037.002.72	Radius	Left
037.002.73	Femur	Left
037.002.74	Tibia	Left
037.002.75	Tibia	Left
037.002.76	Femur	Left
037.002.77	Humerus	Right
037.002.78	Tibia	Left
037.002.79	Tibia	Right
037.002.8	Humerus	Right
037.002.80	Humerus	Right
037.002.9	Humerus	Right
038.002.1	Femur	Left
044.002.1	Ulna	Left
047.002.1	2MT	Left
047.002.2	Vert	
047.002.3	Parietal	Right
048.002.1	Cranium	
049.002.1	Femur	
051.002.1	Maxilla	Left
051.002.1	Humerus	Right
051.002.2	Temporal	Left
051.002.3	Cranium	
051.002.4	Scapula	Left
052.002.1	Temporal	Right
052.002.2	Temporal	Left
052.002.3	Frontal	Right
052.002.4	Femur	Left
052.002.5	I1	Left
052.002.6	C1	Left
052.002.7	Cranium	
058.002.10	Femur	
058.002.11	Femur	
058.002.12	Ilium	Right
058.002.13	Femur	

058.002.14	Femur	
058.002.15	Femur	
058.002.16	Radius?	
058.002.17	Rib	
058.002.18	Vert	Thor
058.002.19	Humerus?	
058.002.2	Innom	Right
058.002.20	P4	Right
058.002.3	Vert	Thor
058.002.4	Vert	Thor?
058.002.5	Rib	
058.002.6	Humerus?	
058.002.7	Mandible	Left
058.002.8	Fibula?Ulna?	Right
058.002.9	Femur	Left?
059.002.1	Radius	Left
061.002.1	Parietal	Left
061.002.2	Cranium	
061.002.3	Cranium	
061.002.4	P3	Left
061.002.5	C1	Left
061.002.6	Humerus?	
061.007.1	Mandible	Right
061.007.2	M2	Right
061.007.3	M3	Right
061.007.4	I2	Right
063.002.1	Fibula	Right
063.002.2	Manubrium	
063.002.3	Cranium	
063.002.4	Cranium	
063.002.5	Cranium	
063.002.6	Cranium	
063.002.7	Cranium	
063.002.8	Cranium	
065.002.1	Femur	Left
065.002.2	Femur	
069.002.1	Calcaneus	Right
069.002.10	Humerus	
069.002.11	Fibula	Left
069.002.12	Rib	Left

Table 2: Osteological Inventory, cont.

069.002.13	P3	Left
069.002.14	M1	Right
069.002.15	Phalanx	
069.002.16	Ischium	Right
069.002.17	Fibula	
069.002.2	Humerus	Left
069.002.3	Fibula	
069.002.4	Rib	Left
069.002.5	Tibia	Left
069.002.6	Fibula	Left
069.002.7	Ulna	Left
069.002.8	Ulna	Left
069.002.9	Cranium	
071.002.1	Rib	Right
071.002.2	Rib	Right
071.002.3	Pubis	Right
071.005.1	P4	Left
072.002.1	Femur	Left
085.002.1	Talus	Left
086.002.1	C1	Right
086.002.2	I1	Left
086.002.3	P4	Left
094.002.1	M1	Left
094.002.2	Phalanx	
098.002.1	Radius	Right
098.002.10	Frontal	Left
098.002.11	Frontal	Left
098.002.12	Sphenoid	Left
098.002.13	Scapula	Right
098.002.14	Innom	Left
098.002.15	Innom	Left
098.002.16	Innom	Left
098.002.17	Radius	Right
098.002.18	Phalanx	Left?
098.002.19	Phalanx	Left?
098.002.2	Radius	Right
098.002.20	C1	Left
098.002.21	Ulna	Right
098.002.22	Cranium	
098.002.3	Radius	Right

098.002.4	Temporal	Left
098.002.5	Temporal	Left
098.002.6	Temporal	Left
098.002.7	Temporal	Left
098.002.8	Frontal	Left
098.002.9	Frontal	Left
110.002.1	Ulna	Left
110.002.10	P4	Right
110.002.11	Rib	
110.002.13	Scapula	Right
110.002.15	Scapula	
110.002.2	Femur	
110.002.3	Femur	
110.002.4	Femur	Right
110.002.5	Femur	Right
110.002.6	Temporal	Left
110.002.7	Vert	Lumbar
110.002.8	Rib	Right
110.002.9	Parietal	Right
112.002.1	Humerus	Right
112.002.2	Cranium	
112.002.3	m1	Left
128.002.1	Vert	Thor
130.005.1	Phalanx	
130.005.2	P3	Right
146.009.1	Vert	Thor
176.006.1	Frontal	Left
176.006.10	Crainum	
176.006.2	Cranium	
176.006.3	Cranium	
176.006.7	Palate	
177.002.1	P4	Right
180.013.1	I1	Left
180.013.1	Femur	
180.013.2	Cranium	
180.013.3	Cranium	
180.013.4	Cranium	
180.013.5	M3	Left
180.013.6	C1	Left
180.013.7	P3	Right

186.013.1	Maxilla	Right
186.013.10	Cranium	
186.013.11	Cranium	
186.013.12	Cranium	
186.013.13	Cranium	
186.013.14	Mandible	Right?
186.013.15	Mandible	
186.013.18	Phalanx	
186.013.19	Shaft	
186.013.2	P3	Left
186.013.3	Capitate	Right
186.013.4	Cranium	
186.013.5	Cranium	
186.013.7	M1	Right
186.013.8	P3	Right
186.013.9	P3	Right
188.004.1	Fibula	Left
239.001.1	Cranium	
239.001.2	Cranium	
239.001.3	Cranium	
243.001.1	Temporal	Left
243.001.3	P3	Right
243.001.4	Pubis	
243.001.5	Frontal	Left
244.001.1	Humerus	Left
245.001.1	Cranium	
252.001.1	Maxilla	Left
260.001.1	I2	Left
265.001.1	Phalanx	
282.001.1	Fibula	Left
282.001.2	Occip	
282.001.3	Occip	Right
282.001.5	Sacrum	
282.001.6	Sacrum	Left
319.003.1	Femur	Left

Table 3: Cranial Pieces

SD	BONE	Piece #	3.1	3.2	3.3	3.4	3.5	4.1	4.6	4.7	6.1	6.2	6.3	T	W	D	G	RE	B	Size
	2.0.2 Parietal	063.002.6	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	43x26
	2.0.2 Parietal	063.002.3	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	N	Y	15X21
	2.0.2 Parietal	186.013.11	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	36x34
	2.0.2 Parietal	186.013.12	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	24X31
	2.0.2 Parietal	180.003.2	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	25X18
	2.0.2 Parietal	239.001.2	0	0	0	0	0	0	0	0	0	0	0	N	N	Y	N	Y	Y	33x19
L	2.0.4 Temp	051.002.2	1	1	5	1	1	0	0	0	0	0	0	N	2	N	N	N	Y	
L	2.0.4 Temp	110.002.6	1	1	5	1	1	0	0	0	0	0	0	N	2	N	N	N	Y	
	2.0.3 Occip	061.002.1	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	56x35
	2.0.3 Occip	186.013.4	1	1	5	1	1	0	0	0	0	0	0	N	1	Y	N	N	Y	31x20
	2.0.3 Occip	282.002.2 282.002.3	2	1	3	1	4	0	0	2	0	0	0	N	3	N	N	N	Y	110x96 49x32 (116x96)
L	2.0.1 Frontal	176.006.1	2	1	1	1	1	3	1	0	2	1	1	N	2	Y	N	N	Y	52x35
L	2.0.1 Frontal	243.001.5	0	0	0	0	0	3	2	0	0	0	0	U	1	N	Y	N	Y	35x25
L	2.0.1 Frontal	098.002.11 098.002.10 098.002.9 098.002.8	0	0	0	0	0	0	0	0	1	1	2	N	N	N	N	Y	Y	57x74 69x42 53x51 35x17 (81x115)
R	2.0.1 Frontal	051.002.3	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	89x56
R	2.0.2 Parietal	047.002.3 022.002.5 002.002.6 023.003.2 023.003.3	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	72x68 52x36 66x41 28x32 60x49 (138x115)
R	2.0.2 Parietal	007.002.1	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	35x25

Table 3: Cranial Pieces, cont.

SD	BONE	Piece #	3.1	3.2	3.3	3.4	3.5	4.1	4.6	4.7	6.1	6.2	6.3	T	W	D	G	RE	B	Metrics
R	2.0.3 Occip	063.002.7	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	41X34
	2.0.3 Occip	112.002.2	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	40X27
	2.0.2 Parietal	019.007.5	0	0	0	0	0	0	0	0	0	0	0	N	3	N	N	N	Y	26X32
	2.0.2 Parietal	003.001.2	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	31X42
	2.0.2 Parietal	023.002.1 023.003.4	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	N	Y	51x36 39x38 (72x51)
	2.0.2 Parietal	069.002.9	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	51x31
	2.0.2 Parietal	048.002.1	0	0	0	0	0	0	0	0	0	0	0	N	N	Y	N	Y	Y	32x32
	2.0.2 Parietal	063.002.8	0	0	0	0	0	0	0	0	0	0	0	N	2	Y	N	Y	Y	33
	2.0.2 Parietal	110.002.9	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	39x60
	2.0.2 Parietal	022.002.7	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	50x36
L	2.0.4 Temp	243.001.1	1	1	5	1	1	0	0	0	0	0	0	N	2	N	N	N	Y	
L	2.0.4 Temp	052.002.2	1	2	5	1	1	0	0	0	0	0	0	N	1	Y	N	Y	Y	
L	2.0.4 Temp	098.002.12 098.002.5 098.002.6 098.002.4 098.002.7	1	1	5	1	1	0	0	0	0	0	0	N	1	Y	N	Y	Y	
R	2.0.4 Temp	052.002.1	1	1	5	1	1	0	0	0	0	0	0	N	2	Y	N	N	Y	
	Vault	052.002.7	0	0	0	0	0	0	0	0	0	0	0	N	2	Y	N	N	Y	31x24
	Vault	018.002.1	0	0	0	0	0	0	0	0	0	0	0	N	3	Y	N	N	Y	52x59
	Vault	011.002.2	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	60x49
	Vault	061.002.2	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	16X10
	Vault	011.002.3	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	25x34
	Vault	180.013.3	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	25x26
	Vault	023.003.5	0	0	0	0	0	0	0	0	0	0	0	N	2	N	Y	N	Y	21x20
	Vault	239.001.1	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	N	Y	33X29
	Vault	004.002.2	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	31X25
	Vault	063.002.4	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	20X31

Table 3: Cranial Pieces, cont.

SD	BONE	Piece #	3.1	3.2	3.3	3.4	3.5	4.1	4.6	4.7	6.1	6.2	6.3	T	W	D	G	RE	B	Size
	Vault	065.002.4	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	24x23
	Vault	005.002.3	0	0	0	0	0	0	0	0	0	0	0	N	2	Y	N	N	Y	23x38
	Vault	004.002.3	0	0	0	0	0	0	0	0	0	0	0	N	2	Y	N	N	Y	28x18
	Vault	180.013.4	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	N	Y	39x40
	Vault	186.013.10	0	0	0	0	0	0	0	0	0	0	0	N	3	Y	N	N	Y	72x42
	Vault	015.013.4 015.013.3	1	1	5	1	1	0	0	0	0	0	0	N	2	N	N	N	Y	32x42 25x10 (32x43)
	Vault	239.001.3	0	0	0	0	0	0	0	0	0	0	0	N	N	Y	N	Y	Y	23x27
	Vault	019.002.6	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	26x18
	Vault	015.002.2	0	0	0	0	0	0	0	0	0	0	0	N	N	N	N	Y	Y	16x15
	Vault	023.002.7	0	0	0	0	0	0	0	0	0	0	0	N	2	N	N	Y	Y	33X43
	Vault	001.002.2	0	0	0	0	0	0	1	0	0	0	0	N	2	N	N	Y	Y	35x27
	Vault	176.006.2	2	1	3	1	4	0	0	0	0	0	0	N	3	N	N	Y	Y	49x35
	Vault	186.013.13	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	27X21
	Vault	061.002.3	0	0	0	0	0	0	0	0	0	0	0	N	3	N	N	Y	Y	23X31
	Vault	017.002.1	0	0	0	0	0	0	0	0	0	0	0	N	2	Y	N	N	Y	24x28
	Vault	005.002.5	0	0	0	0	0	0	0	0	0	0	0	N	1	Y	N	Y	Y	23x20
	Vault	017.002.2	0	0	0	0	0	0	0	0	0	0	0	N	1	N	N	Y	Y	33X39
	Vault	098.002.22	0	0	0	0	0	0	0	0	1	2	2	N	1	Y	N	N	Y	19x25
	Vault	015.002.1	0	0	0	0	0	0	0	0	1	2	2	N	3	N	N	N	Y	24x29

Table 4: Maxillae

SD	ASP	BONE	AG	Piece #	W	D	RE	B
R	2,8	2.0.6 Maxilla 2.0.9 Lateral Pter Pl	A	186.013.1	3	Y	N	Y
L	2,8	2.0.6 Maxilla 2.0.8 Great Pal For	A	022.002.8	N	N	N	Y
R	2,8	2.0.6 Maxilla		037.001.17	1	N	N	Y
L	2,8	2.0.6 Maxilla	A	051.002.1	N	N	N	Y
L	2,8	2.0.6 Maxilla	A	023.002.4	3	Y	N	Y
R	2,5	2.0.6 Maxilla	A	022.002.13	2	N	N	Y
L	2,5	2.0.6 Maxilla	A	252.001.1	1	Y	N	Y

Table 5: Dentition in Maxillae

T	BONE	PS	Calc	NOTE
LI1	023.002.4	5	9	
LI2	023.002.4	5	9	
LC1	023.002.4		9	
LP3	023.002.4	7	9	
LP4	023.002.4	7	9	
RP3	022.002.13	7	9	Active alveolus
RP4	022.002.13	5	9	Active alveolus
RM1	022.002.13	5	9	Active alveolus
RM2	022.002.13	5	9	Active alveolus
LI1	022.002.8	5	9	Active crypt
LI2	022.002.8	5	9	
LC1	022.002.8	5	9	
LP3	022.002.8	7	9	Active crypt
LP4	022.002.8	7	9	Active crypt
LM1	022.002.8	4-5	9	Active crypt
LM2	022.002.8	4-5	9	Active crpt w/ attrit @ M2 & M3
LM3	022.002.8	4-5	9	Active crpt w/ attrit @ M2 & M3

Table 5: Dentition in Maxillae, cont.

T	BONE	PS	WR	CS	Calc	NOTE	MDD	BLD	CH	IS	1UP RT#	UM HYC
RI1	186.013.1	5	0	0	9							
RI2	186.013.1	5	0	0	9							
RC1	186.013.1	7	0	0	9							
RP3	186.013.1	5	0	0	9							
RP4	186.013.1	7	0	0	9							
RM1	186.013.1	2	22	1	9		10	12	NA	N	N	4
RM2	186.013.1	5	0	0	9							
RM3	186.013.1	7	0	0	9							
LP4	252.001.1	5	0	0	9							
LM1	252.001.1	2	31	1	1, Intrprx		10	11	NA	N	N	4
	252.001.1	4 or 5	0	0	0	Active crypt						
LI1	015.013.2	5	0	0	9	Active alveolus						
LI2	015.013.2	2	1	1	1, Intrprx	Active alveolus	7	6	10	1	N	N
LC1	015.013.2	2	1	1	1, Intrprx	Active alveolus	8	8	10	N	N	N
LP3	015.013.1	2	2	0	2, Intrprx		7	9	9	N	N	N
LP4	015.013.1	2	2	1	2, Intrprx		7	9	7	N	1	N
LM1	015.013.1	2	8	1	1, Buccal		11	10	7	N	N	4

Table 6: Mandibles

SD	ASP	SX	AG	Piece #	Metrics	Fordisc Sex	1.0	3.1	3.2	3.3	3.4	4.1	4.3	4.6	4.7	8.1	8.2	8.7	8.8	8.9	W	D	RE	B
			A	037.002.27	GNI30, HMF28, TMF13, GOG116, CDL112, WRB33	Ambig	3.1 4.2	0	0	0	0	0	0	0	2	1	1	1	0	0	1	N	Y	Y
		F	A	037.002.49	GNI28, HMF29, TMF14, GOG98, CDL112, WRB31	JF58.2 WM20.3 WF15.8 JM5.7	3.1 4.2	1	2	1	1	0	0	0	2	0	0	0	1	1	2	N	Y	N
R	1,7	U	>15	067.007.1		U	0	1	1	1	1	1	2	1	0	0	0	0	0	0	1	Y	Y	Y

Table 7: Dentition in Mandible 037.002.27

T	PS	WR	CS	AB	Calc	HY	NOTE	MDD	BLD	CH	1LP RT	LM GP	LM CS	LM C5
LM3	2	1	1	0	0	0		11	10	7	N	X	4	N
LM2	2	2	0	0	1, Intrprx	0		11	10	7	N	X	4	N
LM1	2	16	0	0	1, Circum	0		11	10	6	N	X	5	3
LP4	2	2	0	0	0	0		7	9	8	N	N	N	N
LP3	2	2	0	0	1, Lingual	3		7	8	9	4	N	N	N
LC1	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
LI2	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
LI1	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
RI1	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
RI2	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
RC1	5	0	0	0	9	0	Active bone in crypt.	N	N	N	N	N	N	N
RP3	2	2	0	0	2, Buccal	1		7	8	9	4	N	N	N
RP4	2	2	0	0	1, Circum	0		7	9	8	N	N	N	N
RM1	2	13	0	0	1, Circum	0		11	10	7	N	X	5	3
RM2	2	1	0	0	1, Circum	0		11	10	7	N	X	4	N
RM3	2	1	1	0	1, Circum	0		11	10	7	N	X	4	N

Table 8: Dentition in Mandible 037.002.45

T	PS	WR	CS	Calc	NOTE	MDD	BLD	CH	IW	IS	IPS	1LP	LM	LM	LM
LM3	2	13	0	2, Intrprx		9	8	6	N	N	N	N	Y	5	3
LM2	2	18	0	2, Intrprx		10	9	5	N	N	N	N	X	4	0
LM1	2	20	1	1, Lab & Intrprx	Active alveolus	10	9	5	N	N	N	N	X	5	5
LP4	5	0	0	9	Active alveolus	N	N	N	N	N	N	N	N	N	N
LP3	5	0	0	9		N	N	N	N	N	N	N	N	N	N
LC1	2	4	0	2, Lab & Intrprx		6	6	N	N	N	N	N	N	N	N
LI2	2	6	0	2, Lab & Interprox		5	6	N	N	1	N	N	N	N	N
LI1	2	6	0	2, Intrprx 1, Labial		4	5	N	3	1	1	N	N	N	N
RI1	2	6	0	3, Labial		4	5	N	3	1	1	N	N	N	N
RI2	2	4	0	2, Intrprx		5	6	N	N	1	N	N	N	N	N
RC1	2	4	0	3, Inter & Lab-1,		6	7	N	N	N	N	N	N	N	N
RP3	2	2	0	3, Inter & Lab		7	6	7	N	N	N	0	N	N	N
RP4	5	0	0	9	Active alveolus	N	N	N	N	N	N	N	N	N	N
RM1	2	15	1	1, Intrprx		9	9	5	N	N	N	N	X	5	5
RM2	2	24	0	2, Labial		10	9	5	N	N	N	N	+	5	3
RM3	2	29	1	1, Labial		9	9	6	N	N	N	N	N	N	0

Table 9: Loose Dentition

T	BONE	PS	WR	CS	AB	Calc	HY	NOTE	MDD	BLD	CH	IS	1UP	UM	UM	1LP	LM	LM	LM	LM
RP3	180.013.7	2	2	0	0	1, Ling	1		8	8	9	N	N	N	N	2	N	N	N	N
Lm1	112.002.3	2	2	1	0	0	3													
RP4	071.005.1	2	2	1	0	2, Ling-1, Buc & Occlus	0		8	8	7	N	N	N	N	N	N	N	N	N
RP4	058.002.20	2	3	1	0	1, Ling	0	Fits 037.002.49	6	7	6	N	N	N	N	1	N	N	N	N
LP3	037.002.2	2	2	0	0	2, Ling-1, Bucc & Occlus	5	Fits 037.002.49	6	6	7	N	N	N	N	1	N	N	N	N
LP4	037.002.1	2	2	0	0	1, Ling & Intrprx	0	Fits 037.002.49	6	7	6	N	N	N	N	1	N	N	N	N
RC1	023.002.3	7	5	5	0	0	4													
RP3	243.001.3	7	1	1	0	0	1		NA	6	8	N	2	N	N	N	N	N	N	N
RI2	061.007.4	Stg 6	0	0	0	0	0		7	7	10	3	N	N	N	N	N	N	N	N
LC1	180.013.6	2	2	0	0	1, Buccal	0		7	8	10	N	N	N	N	N	N	N	N	N
RC1	086.002.1	2	3	1	0	0	1,2		7	8	U	N	N	N	N	N	N	N	N	N
LC1	098.002.20	2	2	1	0	1, Ling	5		7	7	11	N	N	N	N	N	N	N	N	N
RC1	023.002.2	2	2	0	0	1, Ling	1,5		7	8	11	N	N	N	N	N	N	N	N	N
LC1	061.002.5	2	6	0	0	0	1		7	7	U	N	N	N	N	N	N	N	N	N
LC1	052.002.6	2	1	0	0	2, Total	0		7	8	11	N	N	N	N	N	N	N	N	N
LI1	022.002.12	2	3	0	0	0	0		8	7	11	1	N	N	N	N	N	N	N	N
RI1	086.002.2	2	3	1	0	1, Intrprx	0		9	7	10	2	N	N	N	N	N	N	N	N
LI1	180.013.1	2	6	0	0	0	1		8	7	U	1	N	N	N	N	N	N	N	N
LI2	260.001.1	2	1	0	0	0	0		6	6	10	N	N	N	N	N	N	N	N	N
LI1	052.002.5	2	2	0	0	0	0		5	6	9	N	N	N	N	N	N	N	N	N
LI1	023.002.6	2	2	0	0	1, shovel apex	0		6	6	10	5	N	N	N	N	N	N	N	N
RP3	186.013.8	2	1	1	0	1, Labial	1		6	9	8	N	1	N	N	N	N	N	N	N
LP3	186.013.2	2	2	1	0	1, Intrprx	4		7	9	9	N	2	N	N	N	N	N	N	N
LM3	180.013.5	2	11	1	0	1, Buccal	1	Enm bud apex dist rts	11	9	7	N	N	N	N	N	N	N	N	N
LP4	086.002.3	2	4	1	0	0	0		9	9	U	N	N	N	N	N	N	N	N	N
RP4	007.016.1	2	2	1	0	1, Intrprx	1		7	10	8	N	N	N	N	N	N	N	N	N

Table 9: Loose Dentition, cont.

T	BONE	PS	WR	CS	AB	Calc	HY	NOTE	MDD	BLD	CH	IS	1UP RT	UM HC	UM EE	1LP RT	LM GP	LM CP	LM C5	LM RT
RM3	067.007.1	1	Stg 14	1	1	9	0		11	10	7	N	N	N	N	N	+	4	N	2
RM1	023.003.1	2	8	1,2	0	1, Buccal & Intrprx	0	Fits 022.002.8	11	10	7	N	N	4	2	N	N	N	N	N
RP4	177.002.1	2	7	0	0	1, Intrprx	0		6	9	UNK	N	N	N	N	N	N	N	N	N
RP3	130.005.2	2	7	0	0	0	0													
RP3	186.013.8	2	5	1	0	0	4		7	10	8	N	2	N	N	N	N	N	N	N
RM1	186.013.7	2	6	0	0	1, Buccal	0		12	10	7	N	N	4	N	N	N	N	N	N
RM1	069.002.14	2	10	1	0	1, Ling & Intrprx	0		11	12	6	N	N	N	N	N	Y	5	3	2
LM1	094.002.1	2	34	1	0	1, Circ	0		12	10	UNK	N	N	4	N	N	N	N	N	N
RP4	110.002.10	2	1	1	0	1, Buccal & Ling	1		8	9	8	N	N	N	N	N	N	N	N	N
LP3	069.002.13	2	1	0	0	3, Ling & Occl-2,	1		7	8	9	N	N	N	N	0	N	N	N	N
LP3	061.002.4	2	2	0	0	2, Occlus 1, Circ	1		7	8	8	N	N	N	N	1	N	N	N	N
RM3	061.007.1	2	6	1	0	0	1		9	11	7	N	N	N	N	N	N	N	N	N
LM1	061.007.2	2	9	1	0	1, Lingual	0		10	12	7	N	N	N	N	N	+	5	1	2
RM1	019.002.4	2	19	1	0	1, Intrprx	0		10	12	UNK	N	N	N	N	N	NA	4	N	2

Table 10: Scapulae

SD	ASP	Bone	SX	AG	Piece #	3.1	3.2	3.3	3.4	3.5	4.1	4.6	4.7	5.1	5.5	8.1	8.2	8.3	8.4	8.7	8.8	8.9	D	RE	B
L	5	4.0.2 Scapula	U	A	037.002.43	1	1	5	1	1	0	0	2	7	3	1	2	2	1	0	1	0	N	N	Y
L	5	4.0.2 Scapula	U	A	051.002.4	1	1	5	1	1	1	0	0	0	0	2	2	3	3	1	2	3	N	N	Y
L	2,5	4.0.2 Scapula	U	A	037.002.60, 037.002.61, 037.002.62	1	2	0	0	0	1	3	2	0	0	0	0	0	0	0	0	0	N	Y	Y
R	2,5	4.0.2 Scapula	U	Juv 8-15	037.001.11, 037.001.10, 037.001.9, 037.001.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	N	Y
L	2,5	4.0.2 Scapula	U	A	029.001.6, 029.001.7	0	0	0	0	0	1	0	0	0	0	1	2	0	0	1	0	0	N	N	Y

Table 11: Vertebrae and Sterna

SX	AG	BONE	Piece #	3.1	3.2	3.3	3.4	3.5	3.7	4.1	4.3	4.6	4.7	7.1	7.2	7.3	8.1	8.2	8.3	8.4	8.7	8.8	8.9	D	B
U	Ch 2-4	3.1.3 C3-6	005.002.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	Y
U	Ch 4-10	3.7.2 Up Strn	063.002.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	N
U	Ch 4-10	3.7.2 Lw Strn	018.002.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	N
U	Perinate	4.0.1 Clavicle	019.002.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	Y
U	A	3.1.3 C3-6	004.002.7	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	1	3	0	0	0	Y	Y
U	A	3.1.3 C3-6	022.002.1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	1	2	0	0	N	Y
U	A	3.2.1 T1	146.009.1	2	1	5	1	4	2	0	0	0	2	0	1	0	2	3	1	3	0	2	2	N	Y
U	A	3.2.1 T1-2	047.002.2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	1	0	0	N	Y
U	A	3.2.1 T4-5	128.002.1	4	1	4	1	1	0	0	0	0	0	0	1	1	2	3	1	3	1	2	1	Y	Y
U	A	3.2.1 T7-9	019.002.3	4	2	5	1	1	0	1	0	0	0	0	2	0	2	3	3	3	2	2	3	N	Y
U	A	3.2.4 T12	110.002.7	0	0	0	0	0	0	1	0	1	0	1	2	2	2	3	0	0	1	0	0	N	Y
U	A	3.3.0 L2-3	022.002.2	0	0	0	0	0	0	1	0	1	0	1	2	0	2	3	0	0	0	0	0	N	Y
U	A	3.3.0 L4-5	058.002.18	4	2	5	1	1	0	2	2	2	0	1	0	0	2	1	3	2	0	0	0	N	Y
U	A	3.3.0 L4-5	023.002.5	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	1	0	0	Y	Y

Table 12: 4.1.1 Humeri

SD	ST	AG	Piece #	Metrics	FdscSX	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.6	4.7	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	W	D	C	GN	RE	DF	B
L	8,9	A	037.002.64 069.002.10	XLN324, EBR58, HDD48, MXD24,	WM59.6 BM21.6	1	2	5	1	1	3	0	0	0	1	1	0	0	2	1	1	0	0	N	N	N	N	N	N	Y
R	1,7	A	037.002.80	XLN(NA), EBR68, HDD(NA), MXD26,	WM53.9 BM45.8	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	N	N	N	N	Y	N	Y
R	8,9	A	037.002.77	XLN315, EBR64, HDD47, MXD26,	BM55 WM44	2	1	5	1	2	0	0	0	2	1	1	0	0	0	0	1	2	1	N	N	N	N	y	N	y
R	8,9	A	037.002.29 037.002.46	XLN320, EBR55, HDD43, MXD20,	WF63 BF36.4	1	2	5	1	1	1	1	1	2	1	1	1	2	0	0	0	0	0	N	N	N	N	y	N	Y
L	8,9	A	037.002.30	XLN295, EBR54, HDD43, MXD20,	WF76.1 BF23.6	0	0	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	N	N	N	N	Y	Y	Y
R	8	<16	037.002.23			0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	N	Y	N	N	Y	N	N
R	7	A	037.002.10 037.002.9 037.002.8	XLN(NA), EBR(es54), HDD(NA), MXD21, MWD16	BF52.1 WF46.5	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	N	N	N	N	Y	N	Y
R	4	U	051.002.1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	N	Y	N	Y	N	Y
L	4,5	U	037.002.52	XLN(NA), EBR55, HDD(NA), MXD17,	WF56.3 BF43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	N	N	N	Y	Y	Y
L	4	U	022.002.4			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	N	N	Y	Y	N	Y
L	4	U	069.002.2			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	Y	N	Y	Y	N	Y
R	1	A	037.001.1			0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	N	N	N	N	N	N	Y
L	1	A	112.002.1			0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	N	N	N	N	N	N	Y
R	1	A	244.001.1			0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	N	N	N	N	N	N	Y
L	1	A	029.001.9 029.001.11			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N	N	N	N	N	N	Y

Table 13: 4.1.3 Ulnae

SD	SD	Metrics	FdscSX	AG	Piece #	4.1	4.5	4.6	4.7	8.1	8.2	8.8	8.9	D	RE	DF	B
L	1,2	DVD16, TVD12, CIR(NA), PHL(NA), XLN(NA)	BF46.2 WF24.4 WM15.5 BM 13.8	A	037.002.3	0	0	0	2	1	1	0	0	N	Y	N	Y
R	1,2	DVD20, TVD15, CIR(NA), PHL(NA), XLN(NA)	BM63.7 WM35.8	A	110.002.1	0	1	1	2	0	0	0	0	N	N	N	Y
L	1,2	NA	NA	A	044.002.1	0	0	0	2	1	1	0	0	Y	N	Y	Y
R	1,2	DVD18, TVD14, CIR(NA), PHL(NA), XLN(NA)	BM52.8 WM41.1 BF4.9	A	029.001.8	0	0	0	2	0	0	0	0	N	N	N	Y
L	1,6	DVD18, TVD16, CIR41, PHL(NA), XLN(NA)	BM56.8 WM42.6	A	069.002.7 069.002.8	1	0	1	0	1	1	2	1	N	N	Y	Y
L	1,8	DVD19, TVD17, CIR41, PHL240, XLN275	WM51.2 BM48.7	A	098.002.21 022.002.9	1	0	1	4	2	1	0	0	N	Y	N	Y

Table 14: 4.1.2 Radii

SD	SN	AG	Piece #	Metrics	FdscSX	3.6	4.1	4.7	8.7	W	D	RE	B
R	8,9	A	037.002.19 037.002.22 037.002.24	XLN215 DVD11 TVD17	WF60.8 BF32.1 WM7	1	1	2	2	N	N	y	Y
L	1,2	A	059.002.1			0	0	0	0	N	N	Y	Y
R	8,9	A	037.001.13 037.001.14 037.001.15 037.001.16 037.002.45	XLN232 DVD9 TVD14	WF71.5 BF27.8	0	0	0	0	N	N	N	Y
R	1,6	A	098.002.3 098.002.2 098.002.1	XLN(NA) DVD13 TVD18	WM56.2 BM40.4	0	0	0	0	1	Y	N	Y
L	8,9	A	037.002.72	XLN222 DVD10 TVD16	WF68.5 BF28.7 WM2.7	0	0	0	0	N	N	Y	Y
R	5	A	098.002.17			0	0	0	0	N	N	N	Y
L	3	A	011.002.1	XLN(NA) DVD13 TVD17	WM50 BM43.2	0	0	0	0	2	N	N	Y

Table 15: 4.3.3 Tibiae

SD	SD	AG	Piece #	Metrics	FdscSX	Fordisc Stature	1.0	3.1	3.2	3.3	3.4	4.6	4.7	8.1	8.2	8.7	W	D	G	RE	DF	B
L	8	<18	037.002.55				0	0	0	0	0	0	0	0	0	0	N	N	N	Y	N	N
L	8,9	A	037.001.21 037.002.32 037.002.71	XLN344 PEB70 DEB49 NFX28 NFT21 CIR79	WF75.7 BF22.9	19th Cen 63.1” (90% 60.3-66.0)	0	0	0	0	0	1	2	0	0	1	N	N	N	Y	N	Y
L	8,9	A	037.002.11 037.002.74	XLN344 PEB70 DEB51 NFX30 NFT20 CIR81	WF84.8 BF11.5	19th Cen 63.1” (90% 60.3-66.0)	0	0	0	0	0	1	2	0	0	1	N	N	N	Y	N	Y
R	8,9	A	037.002.80	XLN326 PEB70 DEB45 NFX33 NFT26 CIR94	BF51.0 WF48.2	19th Cen 60.2” (90% 57.5-62.9)	0	0	0	0	0	1	2	1	1	0	N	Y	N	Y	N	Y
L	8,9	A	037.002.75	XLN327 PEB69 DEB45 NFX31 NFT25 CIR89	BF51.4 WF48.2	19th Cen 60.3” (90% 57.6-63.0)	0	0	0	0	0	1	2	0	0	1	N	Y	N	Y	N	Y
R	8	<18	037.002.69				3	0	0	0	0	0	0	0	0	0	N	N	N	Y	N	Y
L	8	<18	037.002.21				3	0	0	0	0	0	0	0	0	0	1	Y	N	Y	N	Y
R	1,8	A	037.002.79	XLN(NA) PEB65 DEB(NA) NFX30 NFT23 CIR86	BF71.5 WF28.1	NA	0	0	0	0	0	1	2	0	0	0	N	N	Y	Y	Y	Y
L	8,9	A	037.002.78 037.001.3	XLN330 PEB67 DEB48 NFX30 NFT21 CIR84	WF75.4 BF 24.2	19th Cen 61.5” (90% 58.7-64.4)	1	1	1	5	1	1	2	0	0	0	N	N	N	Y	N	Y
L	5	A	069.002.4				0	0	0	0	0	0	0	1	1	0	N	N	N	Y	N	Y

Table 16: Podials and Digits

SD	SN	BN	SX	AG	Piece #	Metrics	FdscSX	4.7	8.1	8.2	D	RE	DF	B
R		4.3.5 Calcaneus	U	A	069.002.1	CXL85 CBR43	WM42.2, BM41.5, WF16.3	2	1	1	Y	Y	Y	Y
L		4.3.5 Talus	U	A	085.002.1			0	0	0	0	Y	N	N	Y
L	8,9	4.3.6 2nd MT	U	A	067.002.1			0	0	1	1	N	Y	N	Y
U	5,8	4.3.7 Prox	U	A	094.002.2			0	2	0	0	N	Y	N	Y

Table 17: 4.3.1 Femora

SD	SN	ASP	AG	Piece #	Metrics	FdscSX	Fordisc Stature	1.0	4.1	4.6	4.7	W	D	C	G	RE	DF	B
R	5		A	110.002.4				0	0	0	0	N	N	N	N	N	N	Y
L	5,7		A	037.002.66 037.002.36 037.002.73 037.002.37				0	0	0	2	N	Y	Y	N	Y	N	Y
R	8		13-18	037.002.31				0	0	0	2	N	N	N	N	Y	N	Y
L	6		13-18	037.002.76				0	0	0	2	N	N	N	N	Y	N	Y
R	1		<18	018.002.2				0	0	0	2	N	Y	Y	N	N	Y	Y
R	1		A	072.002.1				0	0	0	0	N	N	Y	N	N	N	Y
L	1,6		A	037.002.24 037.002.25 037.001.4	XLN(NA), BLN(NA), EBR(NA), HDD42, SAP23, STV30, MAP25, MTV22, CIR71	WF56.3 BF41.8	NA	0	1	1	2	N	Y	N	N	N	N	Y
L	6		13-18	037.002.47				0	0	0	0	1	N	N	Y	Y	N	Y
U	1		A	022.002.10				0	0	0	0	N	N	Y	N	Y	N	Y
U	1		A	033.002.1				0	0	0	0	N	N	N	Y	N	N	Y
U	3		A	058.002.13				0	0	0	2	2	N	N	N	Y	N	Y
U	3		U	004.002.1				0	0	0	0	3	Y	N	N	Y	N	Y
L	8		Juv?	052.002.4				0	0	0	0	N	N	N	N	Y	N	Y
L	8,9		A	037.002.21	XLN402, BLN397, EBR73, HDD41, SAP25, STV31, MAP25, MTV25, CIR80	WF68.4 BF31.5	19th Cen 61.3” (90% 58.7-63.8)	0	1	1	2	N	Y	N	N	Y	N	Y
L	1		<18	049.002.1				3	0	0	0	N	Y	Y	N	N	N	N
R	1	8	A	319.003.1				3	0	0	2	1	Y	N	Y	Y	N	Y
L	8,9		A	029.001.1 029.001.2 029.001.3	XLN424, BLN400, EBR(NA), HDD42, SAP21, STV34, MAP23, MTV24, CIR77	WF60.5 BF38.3	19th Cen. 61.5” (90% 58.8-64.2)	0	0	0	2	1	N	N	N	Y	N	Y
L	1		A	038.002.1				0	0	0	0	N	N	N	N	Y	N	Y
L	5		A	037.001.21				0	0	0	0	N	N	N	N	Y	N	Y
L	5		A	002.002.2				0	1	1	0	N	N	Y	N	Y	N	Y
L	1		A	002.002.1				0	0	0	2	1	N	Y	N	Y	N	Y
L	5	4	A	065.002.1				0	0	0	0	1	Y	N	N	Y	N	Y
	3		A	065.002.2				0	0	0	2	1	N	N	N	N	N	Y
R	2		A	110.002.5				0	0	0	0	1	N	N	N	N	N	Y
U	1		<18	005.002.2				0	0	0	0	N	Y	Y	N	N	N	Y
U	1		<18	180.013.1				3	0	0	0	N	N	Y	N	N	N	Y
R	7		A	110.002.2 110.002.3				0	0	0	2	1	Y	N	N	Y	N	Y

Table 18: Pelves

SD	ST	BN	SX	AG	Todd Suchey-Brooks	Lovejoy Chamberlain	Piece #	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.6	4.7	8.1	8.2	8.3	8.4	8.7	W	D	RE	DF	B
L		4.3.0 Os Cox	M	A	T:8 (40-45) S-B:4 (Mean 35, 23-57)	L:I (Age 50) C:VI (Mean 66, 39-91)	098.002.14 098.002.15 098.002.16	0	0	0	0	0	0	0	0	2	2	3	1	1	0	3	Y	Y	N	Y
R		4.3.0 Os Cox	F	A	T:9 (45-49) S-B:6 (Mean 60, 42-87)	L:J (Age 51) C:VI (Mean 66, 39-91)	037.002.26	1	1	5	1	1	0	0	0	2	1	2	2	1	0	N	N	Y	N	Y
L		4.3.0 Os Cox	F	A	T:10 (50+) S-B:6 (Mean 60, 42-87)	L:K (Age 54) C:VI (Mean 66, 39-91)	037.001.18 037.002.28 037.002.44 037.002.54 037.002.63	1	1	5	1	1	1	1	0	2	0	0	1	1	0	1	Y	Y	Y	Y
R		4.3.0 Os Cox	F	A	NA	L:K (Age 54) C:VI (Mean 66, 39-91)	037.002.16 037.002.17 037.002.18 037.002.51 037.002.56 037.002.68	2	1	3	1	4	3	0	1	2	0	0	0	0	0	N	N	Y	N	Y
L		4.3.0	F	A	NA but 17x7 dorsal	L:F (Age 39)	037.002.14 037.002.15	2	1	3	1	4	3	0	0	2	0	0	0	0	0	N	N	Y	N	Y
R		4.2.2	U	A			069.002.16	2	1	1	1	1	0	0	1	2	2	1	0	0	0					
R		4.2.1	F	A			058.002.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	Y	Y	N	Y
L		4.2.3 Pubis	M		T:1 (18-19) S-B:1 (Mean 18, 15-23)	NA	071.002.3																			
R		4.2.3 Pubis	F		T:1 (18-19) S-B:1 (Mean 19, 15-24)	NA	243.001.4																			
	1	3.4.0 Sacrum	M	A			022.002.1	0	0	0	0	0	1	0	1	0	2	3	1	3	1	3	N	N	N	Y
	1	3.4.0 Sacrum	M	A			282.002.5 282.002.6	0	0	0	0	0	1	0	1	0	2	3	3	3	1	0	N	N	N	Y

Table 19: 4.3.1 Fibulae

SD	ST	ASP	AG	Piece #	1.0	Metrics	FdscSX	Fordisc Stature	4.7	8.1	8.2	W	D	RE	DF	B
L	8,9		A	037.001.2 037.002.12 037.002.13	0	XLN332 MDM15	WF60.4 BF35.6	19th Cen 61.9” (90% 59.1-64.7)	0	0	0	N	N	Y	N	Y
L	1,2		A	282.001.1	1, 4.1				2	0	0	3	Y	N	N	Y
L	8,9		A	037.002.58 037.002.57 037.001.20 037.002.50 037.001.19	1, 4.2	XLN317 MDM15	WF69.2 BF29.3	19th Cen 60.1 (90% 57.3-62.9)	2	1	1	1	Y	N	N	Y
R	8		<18	037.002.39 037.002.34 037.002.33	1, 4.1				0	0	0	1	N	Y	N	Y
U	2		<18	058.002.16	0				2	0	0	N	N	Y	N	Y
R	2		A	019.002.1	0				0	0	0	1	N	Y	Y	Y
L	7		A	069.002.3	0				0	0	0	1	Y	Y	N	Y
R	8,9		A	037.002.5 037.002.4 037.002.48	1,4.2	XLN371 MDM19	BF32.7 WM29.7 WF23.6 BM14		2	2	2	N	N	Y	N	Y
L	8,9		A	037.002.59 069.002.11 069.002.6	0	XLN376 MDM16	WM34.5 BF29 WF18.3 BM18.2	19th Cen 68.2” (90% 65.4-71)	2	1	1	N	N	Y	N	Y
R	1	8	A	069.002.17	0				0	0	0	N	N	N	N	Y
L	5		A	063.002.1	0				0	0	0	N	N	Y	N	Y

Table 20: Ribs

SD	SN	BN	SX	AG	Piece #	4.7	5.1	5.4	T	D	RE	B
L	6	3.6.2 2nd Rib	U	16-25	069.002.4	0	0	0	N	N	Y	Y
R	8	3.6.3 Rib 9-10	U	16-25	071.002.1 071.002.2	0	0	0	N	Y	N	Y
R	1,2	6.6.3 6th Rib	U	A	110.002.8	0	0	0	N	N	N	Y
R	1,6	6.6.3 Rib 5-8	U	A	037.002.53	2	2,3	3	Y	N	Y	Y
R	2	6.6.3 Rib 3-10	U	16-25	069.002.12	0	0	0	N	N	Y	Y

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.5:lab. mult=1)

Laboratory number: **Beta-277162**

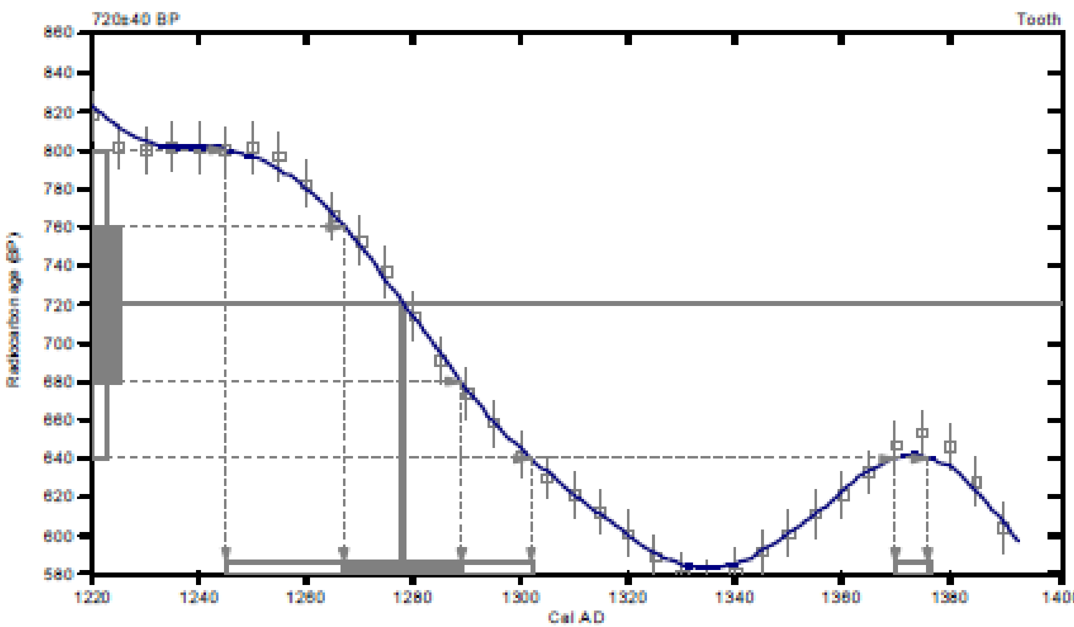
Conventional radiocarbon age: **720±40 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 1240 to 1300 (Cal BP 700 to 650) and Cal AD 1370 to 1380 (Cal BP 580 to 570)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1280 (Cal BP 670)

1 Sigma calibrated result: (68% probability) Cal AD 1270 to 1290 (Cal BP 680 to 660)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory
4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com