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Analysis of the talus and calcaneus bones from the Poole-Rose Ossuary: a Late Woodland burial site in Ontario, Canada

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ANALYSIS OF THE TALUS AND CALCANEUS BONES FROM THE POOLE-ROSE OSSUARY: A LATE WOODLAND BURIAL SITE IN ONTARIO, CANADA

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Arts in The Department of Geography and Anthropology

by

Adrienne Elizabeth Penney

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# TABLE OF CONTENTS

AKNOWLEDGMENTS ........................................................................................................ ii 

LIST OF TABLES ................................................................................................................ v 

LIST OF FIGURES ............................................................................................................. vi 

ABSTRACT ............................................................................................................................ vii 

CHAPTER 1
INTRODUCTION ....................................................................................................................... 1 

CHAPTER 2
THE HURON PEOPLE ........................................................................................................... 3 

CHAPTER 3
FEAST OF THE DEAD AND OSSUARY BURIALS .................................................................. 8 

CHAPTER 4
THE TALUS AND CALCANEUS AND THE PATHOLOGY OF THE FOOT ........................................ 16
  Talus and Calcaneus ........................................................................................................... 16
  Pathology of the Foot ........................................................................................................ 19
    Arthritis .......................................................................................................................... 19
    Congenital Diseases ........................................................................................................ 23
    Occupational Diseases .................................................................................................. 24
    Infectious Diseases ........................................................................................................ 24
  Other Studies of the Talus and Calcaneus ....................................................................... 26 

CHAPTER 5
MATERIALS AND METHODS .............................................................................................. 29 

CHAPTER 6
RESULTS ................................................................................................................................ 34
  Minimum Number of Individuals in the Poole-Rose Ossuary ......................................... 34
  Males and Females in the Ossuary .................................................................................... 34
  Measurements ................................................................................................................... 35
  An Examination of Sub-adults in the Pool-Rose Ossuary ................................................. 36
  Cut Marks in the Ossuary ................................................................................................ 40
  Cremation in the Ossuary ................................................................................................. 41
  Population Health ............................................................................................................ 42 

CHAPTER 7
DISCUSSION AND CONCLUSION ..................................................................................... 46
LIST OF TABLES

5.1 Elements Previously Studied in the Poole-Rose Ossuary.......................................................................29

6.1 MNI of Calcanei and Tali in the Poole-Rose Ossuary........34
6.2 Mean Measurements of Individual Elements.................................35
6.3 Comparison of Maximum Length Means........................................36
6.4 Sub-adult Percentages in the Poole-Rose Ossuary.........................37
LIST OF FIGURES

2.1 Map of Poole-Rose Ossuary in Canada.........................................................4
5.1 Calcaneus Measurements........................................................................31
5.2 Talus Measurement................................................................................32
6.1 Sample of Sub-adult Left Calcanei.........................................................37
6.2 Sample of Sub-adult Right Calcanei.......................................................38
6.3 Smallest Calcaneus Bone......................................................................38
6.4 Sample of Left Sub-adult Tali.................................................................39
6.5 Sample of Right Sub-adult Tali...............................................................40
6.6 Cut Marks on Calcaneus......................................................................41
6.7 Burned Right Talus...............................................................................42
6.8 Resorption Pit on Calcaneus, Posterior View........................................43
6.9 Resorption Pit on Calcaneus, Posterior View........................................43
6.10 Superior Aspect of Talus with Rheumatoid
    Deformation..............................................................................................44
6.11 Medial Aspect of Talus with Rheumatoid
    Deformation..............................................................................................45
6.12 Lateral Aspect of Talus with Rheumatoid
    Deformation..............................................................................................45
ABSTRACT

This study reports on the demography and osteological profile of the Poole-Rose Ossuary. Excavated in 1990 under the direction of Heather McKillop and at the request of the Alderville First Nation, the Poole-Rose Ossuary is a Late Woodland burial site in southern Ontario, Canada. Lack of European artifacts in the burial suggests that this site predates European contact. The Poole-Rose Ossuary is radiocarbon dated to A.D. 1550 ± 50 years. The skeletal remains were commingled. This ossuary likely represents the mass re-burial known as the “Feast of the Dead” or the “Kettle.” For the most part, closely related individuals were involved in such re-burials, which occurred every eight to 12 years.

The talus and calcaneus were used in this study. The left talus shows a minimum number of individuals (MNI) of 212; approximately 15% of the individuals are subadults. The MNI is within the range reported in previous studies on the Poole-Rose Ossuary (range of MNI is 161 to 337). The incidence of degenerative joint disease is low, which is consistent with the clinical literature. This study also reports on issues of concordance and discordance of the Poole-Rose Ossuary with an ethnohistoric account and other
studies of Late Woodland ossuaries (e.g., burial of infants, de-fleshing, and cremation).
CHAPTER 1: INTRODUCTION

The rites practiced at the death of an individual are often among the most integral elements of a society. Caring for and interring the dead are practices common to the human species that vary from culture to culture.

According to accounts given after the arrival of Europeans, the Huron believed that a person had two souls. The first soul would be reborn later in a child. This belief explained, to the Huron, why many children looked and acted like their ancestors. The second soul remained with the body until the Feast of the Dead was performed (Trigger 1976).

The Feast of the Dead was practiced every eight to 12 years when the village was moved to a new location as the surrounding fields went fallow. Previously buried bodies were taken from their graves and placed in a large pit, or ossuary, where the bones were co-mingled in an elaborate ceremony. Any bodies not completely skeletonized were disarticulated by the women of the village; the recently dead were cremated in the ceremonies (Trigger 1976).

Over 200 ossuaries are found in the Great Lakes’ area. The Poole-Rose Ossuary is one such mass burial of the Late Woodland. The Ossuary was discovered accidentally during the renovation of a house on the site in 1990.
Dr. Heather McKillop was asked by chief Nora Bothwell of the Alderville First Nation to excavate the ossuary archaeologically and study the remains; my study is part of that research. Located in southern Ontario, the Poole-Rose site is radiocarbon dated to A.D. 1550 ± 50. The human remains in the collection represent several hundred individuals including three complete, articulated skeletons (McKillop and Jackson 1991).

The current study focuses on the tali and calcanei associated with the Poole-Rose Ossuary, including a complete analysis of the bones (minimum number of individuals, health status, and population demographics).
CHAPTER 2: THE HURON PEOPLE

North of the Five Nations were the Hurons, a populous confederacy made up of four aristocratic tribes, richest in tradition and ceremony of all the Iroquoian people (Brandon 1985 p.180).

The name ‘Huron’ is not the word that these northern people called themselves. They called themselves Wendot, or ‘dwellers of the peninsula,’ referring to their location between two of the Great Lakes. The word Huron comes from the French word Huron, which was a slang term of the time for ruffians or rustic peoples (Trigger 1976).

The Huron were located in modern day Canada between the Georgian Bay and Lake Simcoe on the peninsula between Lake Huron and Lake Ontario. In the south they were bordered by the Wasaga River, which, in the Huron’s time, was a large, swampy area which cut them off from their southern neighbors (Figure 1). The Huron lived in approximately 18 to 25 villages in this area. Each village consisted of about 40 or more multi-family dwellings surrounded by palisades. The average village covered four to six acres. Some of the largest villages were 15 acres in size (Donnelly 1975, Trigger 1976).
In historic times, as studied by Trigger (1976) and others, a Huron longhouse was about 27.44 to 30.48 meters long and 7.62 to 9.15 meters wide. The house was constructed by inserting long poles into the ground which were tied together at the top to form an arch-like shape. This bare framework was then covered with bark. At either one or both ends of the house was a covered porch where
firewood and corn were stored. Inside the house, along the outer walls, were platforms raised about five feet off the ground. Along the center was a row of hearths used to heat the house. Smaller fires were placed on either side of the large fires for cooking purposes. A single family (mother, father and unmarried children) lived on each side of these central fires. Based on the construction and the materials used, scholars assume that most of these houses only lasted about the lifetime of the village, eight to 12 years. The men in the tribe helped to rebuild a house if a new one was needed (Donnelly 1975, Trigger 1976).

Each long house contained an average of six families, all linked through the female line. The average household included a woman and her daughters and their husbands and families or a group of sisters together with their husbands and children. Through matrilineal decent, family property was owned by the women and passed down through the women of the family. The average family consisted of three children. Births were spaced two or three years apart and high infant mortality occurred (Donnelly 1975, Trigger 1976).

Huron villages, typically, were located on hills near water, streams or rivers. This location was convenient for travel in canoes. The sandy, well-drained soil on the
sides of the hills was good for growing their crops. Huron villages were connected by a network of trails. Trails connected the Huron people and their allies and trading partners (Donnelly 1975, Trigger 1976).

Farming was the main method of subsistence practiced by the Huron. The fields used by the Huron were cleared by the men. The vegetation was burned to add more nutrients to the soil. If a field was carefully tended and weeded, the fertility of the field lasted four to six years. The periodic addition of burned leaves and branches extended the lifetime of the fields eight to 12 years (Donnelly 1975, Trigger 1976).

The women of the tribe had the task of tending, planting, and harvesting the fields. In historic times, the French often commented on how hard the women worked to weed and care for their fields. Each woman tended her own field for her family alone. If one woman’s field had any problem that compromised food production, her family did not go hungry as reciprocity was commonly practiced (Donnelly 1975, Trigger 1976).

Corn was a major plant food of the Huron diet. Two known types of corn were harvested by the people in the Huron area. The first and oldest corn in the Huron area was called flint corn. Later, dent corn was grown. This corn
was called dent because of the dent that each kernel had on the top. Dent corn was used mainly as flour for making unleavened bread and various types of cakes. Along with corn, the Huron grew sunflowers, artichokes, lima beans, kidney beans, tobacco (tended by the men for their own use), pumpkins, and gourds (Driver 1961).

In addition to the tended crops that were used for food, the women also gathered wild roots, berries, acorns and other nuts. The men hunted and fished. Fish were a staple in the Huron diet, but deer were their favorite animals to hunt and eat. The only domesticated animals that the Huron had were dogs. Many of the dogs were deemed special by their owners, which prevented them from being killed and eaten (Donnelly 1975, Trigger 1976).

These data, collected archeologically and through historical accounts, provide information about the lifeways of the Huron, who along with the Iroquois, were the Late Woodland people of northeastern North America encountered by the Europeans.
CHAPTER 3: FEAST OF THE DEAD AND OSSUARY BURIALS

Notably the Huron, north and east of Lake Ontario, practiced elaborate mass-burial ceremonies, when collected bones of the dead of ten or twelve years were formally interred together with mountains of rich funeral gifts, from furs to beautifully worked tools and arms (Brandon 1985 p.152).

The ceremonial feast was one of the most important and complex attributes of the Huron people. Feasts held by the Huron were both public and private. The largest feast was associated with the annual meeting of the confederacy council and the installation of new chiefs. Each person invited to a feast was expected to wear his or her best clothing and to bring utensils and dishes with which to eat. Feasts lasted all day, and food was served in the morning and in the afternoon. Strangers were given the best portions of each dish served. Guests were expected to eat enthusiastically while hosts ate little. The hosts spent all their time doting upon guests (Brandon 1985).

The most important event to the Huron was the Feast of the Dead, known historically as ‘The Kettle.’ Jean de Brébeuf, a French Jesuit missionary who traveled among the Huron, provides the only known European eye-witness account of the Feast of the Dead. Father Brébeuf reported that the Huron believed that the body had two souls, the first of which would be reborn in a village infant. This belief
explained to the Huron why children often looked and acted like a dead relative. The second soul remained with the body until the Feast of the Dead was celebrated (Donnelly 1975, Kidd 1953, Sutton 1988, Trigger 1976).

The Feast of the Dead was held whenever a large village shifted location, about every eight to 12 years. This interval has been suggested by historical accounts. However, at the present historians and archaeologists do not have enough archaeological evidence to confirm this. In fact, from some archaeological excavations we now know that certain of the largest Huron villages lasted upwards of thirty years (Kidd 1953, Sutton 1988, Trigger 1976).

Once the village was abandoned, the dead could no longer be meticulously cared for. The Huron believed that the soul would remain in the cemetery until the feast was completed and then the person’s soul would travel westward until it reached the Huron village in the spirit world (Kidd 1953, Trigger 1976).

The Huron ossuary was well protected from fire and other natural disasters because it was thought that the dead could be angered easily. Champlain was the first European to mention the Feast of the Dead in his writings. The French missionary, Jean de Brébeuf, was the only European to record, in full, a firsthand observation of the
Feast of the Dead. Brébeuf claimed that almost everybody was buried in the cemetery with only a few exceptions. Infants were buried in paths that were often traveled by women and in house doorways. The path burial ensured that the soul of the baby would be reborn. Infant burials have been found in excavations of Late Woodland houses, lending support to the historic accounts (McKillop personal communication 2005). The bones of captives and people who died violent deaths were not included in the feast either. Instead, they were burned and buried immediately after death in a small mound with a bark roof erected over the top (Donnelly 1975, Kidd 1953, Sutton 1988, Trigger 1976).

People from nearby villages were invited to participate in the Feast of the Dead. Neighbors and friends were asked to bring their dead to co-mingle their bones with the bones of the former residents of the village. In this way, the Feast of the Dead brought all of the Huron together, and the belief was held, that since dead relatives could be co-mingled, the living should cooperate and be friends with one another (Donnelly 1975, Kidd 1953, Sutton 1988, Trigger 1976).

Arrangements for the feast were made months and even years in advance. Invitations were sent throughout the Huron population. The feast lasted ten days, eight of
which were spent in preparation of the bodies and in assembling people. Unless the bodies were among the recently dead, they were taken from their original place of burial. The female relatives stripped the bodies of any remaining flesh using their knives or teeth. The flesh was burned along with the mats and robes in which they had been wrapped at the first burial. After the bones had been exposed, they were wrapped in decorated beaver bags. The bodies of the newly unburied dead were wrapped in new skins and carried on litters to the village (Donnelly 1975, Johnston 1979, Kidd 1953, Sutton 1988, Trigger 1976).

In historic times offerings were given in honor of the dead. In the village, guests were assigned by the leader to a host long house where they placed their dead and the associated gifts. In general, the hosts and guests belonged to the same clan segments named after the same animal. After all the attendants had eaten their fill, the dead and their presents were carried to the village where the rest of the feast was celebrated. While the feasting and games were going on, a large pit, about ten feet deep and fifteen feet or more in diameter, was dug in an open field outside the village. Around this pit, a scaffold was erected about fifty feet across and ten feet high with ladders on all sides. Cross-poles were erected on top of
the platform. On the seventh day of feasting the undecomposed bodies were brought to the edge of the pit and placed beneath the scaffold on slabs of bark several feet high (Donnelly 1975, Kidd 1953, Trigger 1976).

The next day the dead were taken to the burial pit to be mourned for the last time. Once there, all the mourners arranged themselves in groups according to village and clan segments. The gifts given to the dead were hung on the scaffold and remained on show for several hours. This process gave the visitors and hosts a chance to show their prosperity and devout feeling toward the dead. Some of the undecomposed bodies were burned in a show of respect for them. The bundled bodies were tied to the cross poles and arranged according to clan segments. In the evening, 50 beaver robes were used to line the burial pit, and old kettles (in historic times) were put in the pit for the use of the dead. Finally, the undecomposed bodies were lowered into the pit. Fires were lit and all of the people camped for the night. At dawn, a signal was given and the bags of bones were emptied into the pit by the crowd of people. A number of men stationed around the pit had the job of mingling the bones with large poles. When all the bags had been emptied, the dead were covered with mats and bark. Logs from the platform were piled over the mouth of the pit.
to prevent animals from burrowing into it, and sand was used to create a mound. Cornmeal was then added to the top to give the dead a final meal. Lastly, the bundles of gifts were slashed open and distributed to the mourners. This ceremony held the Huron together and gave them a sense of unity. The feast must have had an enormous economic impact on the village; despite the financial burden created by the feast, the Huron enthusiastically gave their relatives proper second burial (Donnelly 1975, Kidd 1953, Trigger 1976).

The Feast of the Dead ceremony is described in detail by Father Brébeuf and so is used as an analogue for prehistoric ossuaries. As the Huron’s trading network expanded, the Feast of the Dead expanded. The Neutral also engaged in the same practice on a much smaller scale. The Grimsby site in Ontario is a good example of a Neutral ossuary type burial (Kenyon 1982). The Ontario Huron had the unique phenomenon of elaborate burials, which appears to have reached its peak in the Late Woodland period. After the destruction of the Huron Confederacy in A.D. 1649, the Feast of the Dead practice diminished among the northern neighbors and disappeared by the end of the seventeenth century (Johnston 1979, Sutton 1988).
The Poole-Rose Ossuary is typical of prehistoric Late Woodland ossuaries in that there were no grave offerings. This Ossuary does not include any grave goods that would point to European contact or trade in the area. The Grimsby site is located west of the Poole-Rose Ossuary. Grimsby is a historic site dated between 1640 and 1650. The graves at this site contain a large amount of artifacts (Kenyon 1982), a striking contrast to the Poole-Rose Ossuary.

Interestingly, ossuary samples have recently come under study by researchers. In the past, many researchers thought that ossuaries were the best way to learn about pre-historic and even historic peoples because of their large size and closed population. However, neighbors and friends were invited to participate in the Feast of the Dead. The commingling process included in ossuary burials means there were bones from the village and perhaps elsewhere, so that an ossuary cannot be assumed to represent a village population.

We can also no longer assume that eight to 12 year intervals between ossuary burials were the norm. Upwards of thirty years between village shifts is more logical from the archaeological evidence. Since men who died in war were not buried in the ossuary, females should be more prevalent in the ossuary. However, many of the ossuaries studied
have a ratio of about 1:1, giving less weight to the ethnohistoric account (Jackes 1986, Sutton 1988).

Yet, analyzing the skeletal remains from a pre-contact period ossuary, such as Poole-Rose, does offer the opportunity to expand our scientific knowledge about a group of Native Americans that lived in a particular region prior to European contact. Since the analysis of human remains found in an ossuary burial typically requires the researcher to focus on only one or two skeletal elements at a time, an understanding of the form and function of those bones being studied is necessary in order to evaluate their role in the population demographics and overall health.
CHAPTER 4: TALUS AND CALCANEUS AND PATHOLOGY OF THE FOOT

Talus and Calcaneus

The human foot contains twenty-six bones. The bones of the foot include seven tarsal bones. Moving distally in the foot, there are five metatarsals, followed by two rows of five phalanges and one row of four phalanges. The second largest tarsal bone is the talus. The talus is located between the fibula, superiorly, and the calcaneus, inferiorly; no muscle attaches to the talus (Vesalius 1998, White 2000).

The calcaneus is the largest bone in the foot; this bone is colloquially known as ‘the heel bone.’ The calcaneus is located inferior to the talus and articulates distally with the cuboid bone. The Achilles’ tendon attaches anteriorly. The calcaneus is also the only tarsal bone that has two ossification sites; therefore, the calcaneus is the only foot bone that you can use to identify juvenile individuals. The rest of the tarsals in the foot have a single ossification site and one cannot distinguish adult from juvenile confidently (Vesalius 1998, White 2000).

Bone growth takes place at the epiphyseal growth plate in most bones. This growth is accomplished through a cycle
of cartilage growth, matrix formation, and calcification of cartilage that act as a scaffold for bone formation. A second part of bone growth is modeling, in which the bone is continually being resorbed and replaced by new bone. This process is most abundant during childhood and adolescence and permits the long bones to increase in diameter, to change shape, and to develop a marrow cavity. Remodeling is a similar process in adults which keeps the bone healthy and balanced (White 2000).

The early development of both the hand and the foot is similar because of the pentadactyl nature of the limbs. However due to the proximodistal organization of the embryo, the development of the foot lags about five to six days behind that of the hand. Around day 37 of fetal development the footplate becomes visible on the lower end of the embryo. By day 41 the tarsal region becomes visible and, by week seven, chondrification begins. Chondrification is first apparent in the region of the metatarsals two through four, followed by the cuboid, metatarsal five, calcaneus, talus, medial cuneiform, intermediate cuneiform, lateral cuneiform, metatarsal one, navicular, proximal phalanges, middle phalanges, and finally the distal phalanges (Scheure et al. 2000).
The calcaneus chondrifies from two separate centers, with the distal nucleus appearing before the more proximal one. The separate chondrification sites ultimately fuse into a single mass by about day 48. The talus has three separate locations from which it begins to chondrify. The largest site appears first; this center forms the head and body of the talus. The second, smaller center forms the lateral process, and the third forms the posterior process (Scheure et al. 2000).

The foot has potentially 46 separate centers of ossification; about 26 are primary and about 20 are secondary. The calcaneus is the first of the tarsals to ossify and frequently commences from two separate centers at about five to six fetal months. By around birth or within the first month, the calcaneus is identified as pyriform in shape with a shallow indentation just distal to the center of the dorsal surface. The classical perinatal appearance wanes within the first few months of birth. The bone then begins to elongate and develops the recognizable morphology (Scheure et al. 2000).

The talus, in comparison, is the first bone to show evidence of vascular invasion. Ossification of the talus originates in the sixth fetal month in females and the seventh fetal month for males. Cases have been reported of
the talar center being absent at birth, although it did appear shortly afterwards. The perinatal talus is oval in shape, and its radiographic image is said to resemble a ‘stubby peanut.’ The bone becomes recognizable as the talus about two years of age (Scheure et al. 2000).

Pathology of the Foot

The diagnosis of diseases in ancient populations will always present a challenge to those who attempt the task. Bone has a limited number of ways that it can respond to stress from external and internal forces, which can create discouraging situations for the individual who attempts a study. One must not only consider the pathology of the bones, but also the biocultural and archaeological context of the specimens studied (Buikstra and Cook 1980).

Arthritis

Arthritis has been noted in early American populations for over one hundred years but has often been ignored, mostly because of its commonality among all populations. The definition of arthritis is simply an inflammation of the joints (Aufderheide and Rodriguez-Martin 1998). The American Arthritis Foundation identifies eight separate types of arthritis in modern populations: osteoarthritis, rheumatoid arthritis, gout, ankylosing spondylitis,
juvenile arthritis, systemic lupus erythematosus (lupus), scleroderma, and fibromyalgia (Arthritis Foundation 2004).

The current study focuses on osteoarthritis and rheumatoid arthritis, as these are the only forms of arthritis that show obvious evidence in the tarsal bones. Osteoarthritis is a disease of ‘wear and tear’ which makes it an indicator of an individual’s activity level, injury, or general age. This disease involves the destruction of articular cartilage of synovial joints which leads to noticeable changes in the bone. These changes include peripheral osteophytes or bony lipping, porosity of the joint surface, and eburnation, the development of dense, smooth areas where cartilage has been destroyed, exposing the underlying bone (Aufderheide and Rodriguez-Martin 1998, Bridges 1992, Janssens 1970).

Almost all osteoarthritis appears asymmetrically in the body, and, since most humans are right handed, this stress is usually seen on the right side of the body. Ankle or foot arthritis is usually less common than that of the wrists and hands. Not much data have been published on the foot and ankle joints, but in the case studies available, the ankle shows more asymmetry than any of the other major appendicular joints (Bridges 1992, Rathbun and Buikstra 1984).
Osteoarthritis can also be indicative of the type of work done by the people. An example that has been studied extensively is what C.F. Merbs termed ‘Atlatl Elbow.’ The name comes from the action that causes the arthritis, repeated use of an atlatl in males, and other such strenuous activities in females (Bridges 1992).

In recent years, more comprehensive studies of osteoarthritis in the Native American population have been completed. Patterning of osteoarthritis in prehistoric American populations is different than in modern populations; the ancient populations have a much larger prevalence of lesions in the elbow than that of modern populations. Prehistoric males often show more arthritis than females; yet, historic skeletons display more arthritis in females. This might suggest that the sex roles were much more rigidly defined in ancient populations. While this explanation might be sensible for groups such as the Eskimos, this theory is not quite so sensible for other settled agriculturalists (Bridges 1992).

Rheumatoid arthritis is a chronic inflammatory disease of the synovial joints and connective tissue producing both articular and extra-articular symptoms and signs. This disease has three distinct stages, but joint signs do not appear until the second stage. The first stage consists of
synovitis showing lymphocytic infiltration and proliferation of the synovial membrane. Fingers and wrists are involved first. Later, the synovitis moves to the elbow, shoulder, knee, ankle, and foot. Stage two starts with the inflammatory lesion, resulting in a necrosis of the synovium with an extreme local inflammation. Destruction of the cartilage exposes the underlying bone. Articular movement becomes limited and tendons may rupture. The third stage produces responsive measures to the destruction of stage two. This includes joint deformity with capsular distention and more tendon rupture. Muscular atrophy and fibrous ankylosis occurs, and this can progress to bony ankylosis (Aufderheide and Rodriguez-Martin 1998, Bridges 1992, Rathbun and Buikstra 1984).

Rheumatoid arthritis occurs symmetrically in the body and usually involves many joints. This may be helpful in studying prehistoric populations when a full skeleton is available to distinguish between osteo- and rheumatoid arthritis (Aufderheide and Rodriguez-Martin 1998). Victims of rheumatoid arthritis typically go through periods of remission and recurrence. The etiology of rheumatoid arthritis is unknown, although many factors have been implicated. Females are more prone to rheumatoid arthritis than males (Bridges 1992).
In both the Old and the New World, rheumatoid arthritis is rare in prehistoric times; as a result, many researchers have suggested that it is a relatively new disease. A candidate for a forerunner disease has been suggested by Rothschild et al. (1988), but it differs from rheumatoid arthritis in a number of ways. In their 1988 study Rothschild et al. found that polyarticular resorptive arthritis resembles rheumatoid arthritis in its penchant for secondary joints, as well as in the lesion appearance, both visually and radiographically. This particular disease first appeared during the Archaic period in the regions of Alabama and western Kentucky. Later polyarticular resorptive arthritis is found in the Mississippian cultures of the same area (Bridges 1992).

**Congenital Diseases**

Congenital diseases are not seen as commonly in the bones as osteoarthritis but should not be ruled out in examination. *Talipes equinovarus*, or club foot, is most evident in the talus, which is the only foot bone that always shows abnormalities for this disease. These abnormalities include a shortened neck that is sometimes completely absent, producing the appearance that the head is fused to the talar body. There are also minor changes in the shape of the body of the talus in a club foot.
Another congenital ailment is *talus verticalis congenitus*, which is uncommon in the general population. It can occur as an isolated condition or in association with other neurological disorders. This disease is shown by an underdeveloped talus and a heel valgus. Fundamentally, this condition is a congenital dislocation of the talonavicular joint that can be both unilateral and bilateral (Aufderheide and Rodriguez-Martin 1998).

**Occupational Diseases**

Occupational diseases are those diseases that come about because of the work that a person does on a daily basis. In the talus, wear can be seen when a person has been squatting for most of his or her life. In such cases, the talus becomes prolonged on the external trochlear articular surface that encroaches on the superior surface of the neck. The calcanei show evidence of long distance running by exostosis on the insertion of the Achilles’ tendon and the adductor hallucis on one or both sides. If a person spends much of his life walking on hard surfaces, bursitis and calcaneal bony spurs at several loci can be found (İşcan and Kennedy 1989).

**Infectious Diseases**

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis*, which is curable in the modern world in
vitre. Tuberculosis is unique among mycobacteria because it possesses no environmental saprophytic strains; instead, the bacterium is an obligate pathogen. The bacterium has two modes of contraction. The sister strain, *M. bovis*, from cattle, can be ingested with the consumption of cattle meat or milk. The primary lesion then appears in the gut, and, therefore, is not apparent in the skeletal remains. Transmission of *M. tuberculosis* is from the inhalation of droplets exhaled by a person with open, infectious, pulmonary tuberculosis. The incubation period for the disease can be anywhere from two years to several decades (Janssens 1970).

Tuberculosis affects the tibiotalar joint and is most commonly found in the talus of children and the tarsal bones of an adult. Abscesses and fistula are signs of the early stages. In later stages of the disease, lesions are commonplace on the talus and calcaneus and, if the disease progresses far enough, can extend as far as the metatarsals.

Paul A. Jannsens states “Pre-Columbian material almost never shows lesions which might indicate tuberculosis” (1970, p. 143). Many post-Columbian cases have tuberculosis lesions, leading many experts to believe that tuberculosis
does not appear before the Europeans arrived in the Americas (Jannsens 1970).

Leprosy, also called Hanson’s disease, is not as common as tuberculosis. Hanson’s disease can be seen in the foot bones through resorption, mostly of the tarsals and metatarsals. If the disease goes untreated for a long period of time, the talus and calcaneus will also be completely or partially resorped (Jannsens 1970).

Osteomyelitis was the last infectious disease that I looked for in this study; this is most commonly seen in the femur, tibia, and fibula, but can extend into the foot. Osteomyelitis is caused by a staphylococci infection which invades the bone via the nutrient artery and spreads to the epiphysis of the bone. From there the disease perforates the periosteum and moves to the Volkmann’s and Haversian canals to enlarge them. Then, large parts of the bone suffer ischemic necrosis, forming a sequestrum that may separate from the rest of the bone. This separation creates bone deformation that is almost impossible to heal in a lifetime, which makes osteomyelitis easy to identify in the skeleton (Aufderheide and Rodriguez-Martin 1998).

**Other Studies of the Talus and Calcaneus**

Information on the tarsal bones is limited. At least four other studies have been done on either the talus
and/or the calcaneus. Bidmos and Asala (2003) used the Raymond A. Dart collection of the University of Whitwatersrand and the Pretoria Bone Collection, University of Pretoria, to determine a discriminant function for sexing the calcaneus. Steele (1976) studied the Terry Skeletal Collection at the Smithsonian Institution in Washington, D.C., and two Pueblo populations, the Larson Site and Pueblo Bonito. Steele used these collections to estimate sex on the basis of both the talus and calcaneus, using the mean of the samples. Riepert et al. (1996) extended the study completed by Steele (1976) of dry bone to radiographs and found that his estimated means could be used for radiographic analysis. Riepert et al. (1996) studied the radiographs of 800 male and female individuals of Central European ancestry from the clinic for Radiology of the University of Mainz, Germany, to assess sex of an individual. Holland (1995) studied the Hamann-Todd Collection at the Cleveland Museum of Natural History to determine stature of an individual. He found that a discriminant function could be calculated. Mongoloids were not included in the study and, therefore, a stature equation is unknown for that population. The four studies listed above allow us to compare the Poole-Rose population
with other populations. Comparisons to other studies allow a greater understanding of the current study.
CHAPTER 5: MATERIALS AND METHODS

Several other studies have been carried out on various bones in the Poole-Rose Ossuary. The minimum number of individuals (MNI) has been calculated for most of these studies. Prior to cataloguing the calcanei and the tali for the current study, I compiled a summary table of previous studies. Table 5.1 outlines these studies and the MNI in each of the studies. I used these tables for various elements as a preliminary guide for the MNI I might expect.

<table>
<thead>
<tr>
<th>Study</th>
<th>Element Used</th>
<th>Minimum Number of Individuals</th>
<th>Number of Sub-adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodin (2002)</td>
<td>Ulna</td>
<td>221</td>
<td>-</td>
</tr>
<tr>
<td>Schiess (2002)</td>
<td>Femur</td>
<td>300</td>
<td>58</td>
</tr>
<tr>
<td>Parks (2002)</td>
<td>Radius</td>
<td>205</td>
<td>-</td>
</tr>
<tr>
<td>Lundin (2000)</td>
<td>Humerus</td>
<td>249</td>
<td>52</td>
</tr>
<tr>
<td>Seidemann (1999)</td>
<td>Crania</td>
<td>337</td>
<td>-</td>
</tr>
<tr>
<td>Dunne (1999)</td>
<td>Vertebra</td>
<td>204</td>
<td>26</td>
</tr>
<tr>
<td>Tague et al. (1998)</td>
<td>Innominates</td>
<td>242</td>
<td>-*</td>
</tr>
<tr>
<td>Smith (1997)</td>
<td>Skull</td>
<td>161</td>
<td>-</td>
</tr>
<tr>
<td>Bordelon (1997)</td>
<td>Tibia</td>
<td>193</td>
<td>-</td>
</tr>
<tr>
<td>Listi (1997)</td>
<td>Tibia</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Sub-adult 24%, no actual number given.

The specimens for this study had been cleaned previously and identified by number as to the location in the ossuary site. They had also been sorted into adult and sub-adult, and left and right. Some of the bones needed to
be resided or re-evaluated for age, as adult or sub-adult. Sub-adult was classified as any bone that had an unfused epiphysis. This form of identification could only be used for the calcaneus, as this is the only tarsal bone that has an epiphysis. Both whole and partial bones were evaluated and included in the study.

Each calcaneus was measured according to the Standards of Data Collection From Human Skeletal Remains (Buikstra and Ubelaker 1997). These measurements include maximum length (MAXL) and middle breadth (MIDB) (Figure 5.1). The dorsal articular facet breadth (DAFB) was measured according to Bidmos and Asala (2003).

Although both Steele (1976) and Holland (1995) studied the talus, no standard methods exist for measuring this bone. Following the given measurements for the other bones in the human body in Buikstra and Ubelaker (1997), I created my own measurement. Steele (1976) and Holland (1995) do use a similar measurement in their studies. The maximum length measurement was taken from the most prominent point on the head to the most prominent point on the dorsal portion of the trochlea (MAXL) (Figure 5.2).
Figure 5.1 Calcaneus Measurements
Drawn by Mary Lee Eggart
The MNI, sex, any osteological peculiarity, and disease markers were recorded in a Microsoft Excel 2003 database. MNI was recorded based on the presence of the trochlea and head on the talus and the sustentaculum tali on the calcaneus. All bones were examined under a microscope for cut marks, unusual nodules, and fissures.

To approximate the sex of an adult bone, the bones were seriated by sorting them into ascending size order. All bones that fell in the top quarter were assumed to be male and those that fell in the lowest quarter were assumed to be female. The middle half were assumed to be unknown. This was done for each bone and each side.

Recently, other assessments have become available to evaluate the sex of bones in the postcranial skeleton. I
used the function presented by Bidmos and Asala (2003) for assessing the sex of a calcaneus. The equation given by
Bidmos and Asala in the discriminant function is $y = (DAFB \times 0.314) + (MAXL \times 0.081) + (MIDB \times 0.159) + (-19.932)$, where $y$ is
the discriminant function score. The $y$-value given was then compared with the sectioning point, -0.042; a $y$-value
greater than the sectioning point indicates a male, and a $y$-value less than the sectioning point indicates a female.
The tested accuracy of this formula in African whites is approximately 90.6%. This researcher felt confident that
this equation would give a similar accuracy in the Poole-Rose population because of a similar study done by Steele
(1976). Steele found that there is little or no difference in the size of a talus or calcaneus in separate races.

SPSS® 12.0 was used for the statistical analysis of the calcanei as compared to other populations. A binocular
microscope was also used to investigate the cut marks and evidence of arthritis.
CHAPTER 6: RESULTS

Minimum Number of Individuals in the Poole-Rose Ossuary

Table 6.1 outlines the numerical findings of the current study. The MNI, 212, was determined using the left talus.

Table 6.1 MNI of Calcanei and Tali in the Poole-Rose Ossuary

<table>
<thead>
<tr>
<th></th>
<th>Adult</th>
<th>Sub-adult</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Calcaneus</td>
<td>180</td>
<td>17</td>
<td>197</td>
</tr>
<tr>
<td>Left Calcaneus</td>
<td>158</td>
<td>13</td>
<td>171</td>
</tr>
<tr>
<td>Right Talus</td>
<td>-</td>
<td>_</td>
<td>211*</td>
</tr>
<tr>
<td>Left Talus</td>
<td>-</td>
<td>_</td>
<td>212*</td>
</tr>
</tbody>
</table>

*Sub-adults are not distinguished from adults in analysis.

Males and Females in the Ossuary

When the equation given by Bidmos and Asala was used to determine sex, the results were less satisfying. The left calcanei yielded 51 bones that could not be assigned a sex due to the lack of available measurements. When the undetermined are eliminated from the count, 107 assignable bones remained. The equation yielded about 15 females, with the remaining 92 bones assigned male. For the right calcanei, there were 37 undeterminable. Of the remaining 143 bones, only 18 were determined to be female, leaving 125 of the bones assigned to male.
Measurements

Table 6.2 illustrates the mean of all measurements in the studied sample.

<table>
<thead>
<tr>
<th>Element</th>
<th>Measurement</th>
<th>Mean (mm)</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Calcaneus</td>
<td>MAXL</td>
<td>78.44</td>
<td>147</td>
</tr>
<tr>
<td>Left Calcaneus</td>
<td>MAXL</td>
<td>79.03</td>
<td>117</td>
</tr>
<tr>
<td>Right Calcaneus</td>
<td>MIDB</td>
<td>41.53</td>
<td>161</td>
</tr>
<tr>
<td>Left Calcaneus</td>
<td>MIDB</td>
<td>41.90</td>
<td>123</td>
</tr>
<tr>
<td>Right Calcaneus</td>
<td>DAFB</td>
<td>28.60</td>
<td>169</td>
</tr>
<tr>
<td>Left Calcaneus</td>
<td>DAFB</td>
<td>21.18</td>
<td>141</td>
</tr>
<tr>
<td>Right Talus</td>
<td>MAXL</td>
<td>48.12</td>
<td>172</td>
</tr>
<tr>
<td>Left Talus</td>
<td>MAXL</td>
<td>50.96</td>
<td>165</td>
</tr>
</tbody>
</table>

The Poole-Rose population was compared to other populations where the calcaneus was studied. The only measurement that all populations had in common was the maximum length measurement. Therefore, this was the only measurement used in the evaluation of the calcanei. The mean maximum length of the Poole-Rose calcaneus falls in the middle of the previous studies undertaken (Table 6.3).
### Table 6.3 Comparison of Maximum Length Means

<table>
<thead>
<tr>
<th>Population</th>
<th>Mean (mm)</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>German (Riepert et al. 1996)</td>
<td>85.90</td>
<td>800</td>
</tr>
<tr>
<td>White (Bidmos and Asala 2003)</td>
<td>80.33</td>
<td>106</td>
</tr>
<tr>
<td>Black (Holland 1995)</td>
<td>79.35</td>
<td>50</td>
</tr>
<tr>
<td>Black (Steele 1976)</td>
<td>79.25</td>
<td>60</td>
</tr>
<tr>
<td>Poole-Rose Left</td>
<td>78.73</td>
<td>264</td>
</tr>
<tr>
<td>White (Holland 1995)</td>
<td>78.52</td>
<td>50</td>
</tr>
<tr>
<td>White (Steele 1976)</td>
<td>78.30</td>
<td>59</td>
</tr>
<tr>
<td>Larson Site (Steele 1976)</td>
<td>51.60</td>
<td>40</td>
</tr>
<tr>
<td>Pueblo Bonito (Steele 1976)</td>
<td>47.00</td>
<td>49</td>
</tr>
</tbody>
</table>

### An Examination of Sub-adults in Poole-Rose Ossuary

Approximately 15% of the calcanei are juveniles in this study; the percentage of juveniles is as much as 24% in studies of other skeletal elements in the Ossuary (Table 6.4).
### Table 6.4 Sub-adult Percentages in the Poole-Rose Ossuary

<table>
<thead>
<tr>
<th>Study</th>
<th>MNI</th>
<th>Number of Sub-Adult</th>
<th>Percent Sub-Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penney (present study)</td>
<td>212</td>
<td>17</td>
<td>15%</td>
</tr>
<tr>
<td>Schiess (2002)</td>
<td>300</td>
<td>52</td>
<td>21%</td>
</tr>
<tr>
<td>Lundin (2000)</td>
<td>249</td>
<td>52</td>
<td>21%</td>
</tr>
<tr>
<td>Dunne (1999)</td>
<td>204</td>
<td>26</td>
<td>13%</td>
</tr>
<tr>
<td>Tague et al. (1998)</td>
<td>242</td>
<td>-</td>
<td>24%</td>
</tr>
</tbody>
</table>

Figures 6.1 and 6.2 illustrate some of the juvenile calcaneus bones in the study.

**Figure 6.1 Sample of Sub-adult Left Calcanei**
Catalogue numbers from left to right
11-24-1603, 2-24-1831, 6-9-1326, 3-13-1256-1, 11-19-410
Figure 6.2 Sample of Sub-adult Right Calcanei
Catalogue numbers from left to right
10-16-119, 2-24-2790, 6-24-1891, 7-23-1031, 11-19-1181

Figure 6.3 shows the smallest calcaneus bone in the study (approximately 2cm long), which is possibly a prenatal or early postnatal bone (Scheure et al. 2000).

Figure 6.3 Smallest Calcaneus Bone
Catalogue number 2-6-1698-10
The talus does not have an epiphysis such as the calcaneus, but the size and shape can indicate the general age of a bone. Bones can have a juvenile appearance, characterized by a porous surface with smooth curves, as opposed to the angles that define the articular surfaces in adults. Figures 6.4 and 6.5 show tali bones that are most likely sub-adult because of their size and shape.

Figure 6.4 Sample of Left Sub-adult Tali
Catalogue numbers from left to right
3-5-194-8, 2-23-213, 3-6-953-4, 2-24-2439
Figure 6.5 Sample of Right Sub-adult Tali
Catalogue numbers from left to right
2-22-423, 3-6-938-8, 2-24-2554, 2-24-1861

Cut Marks in the Ossuary

Six of the calcanei have cuts in them, three on the right and three on the left (Figure 6.6). Two of the left calcanei have one cut mark on the inferior medial aspect. One left calcaneus has one cut mark on the superior medial side. The three right calcanei have cut marks on several different locations. One right bone has a cut mark located on the inferior medial aspect; a second bone has one cut mark on the superior medial aspect. The last bone has one cut mark on the dorsal aspect.
Seven of the tali have cut marks on them, three on the right and four on the left. Each of the left tali has only one mark; two have the cut mark on the head; one bone has a cut mark on the neck; and the final bone has its cut mark on the superior medial aspect. The right tali that have cut marks on them seem to be more prolific. The first bone has about two cut marks on the superior aspect; the second bone has one cut mark on the superior medial aspect of the bone. Finally, the last right talus has five marks on the neck of the bone.

Figure 6.6 Cut Marks on Calcaneus
Catalogue number 1-24-119

Cremation in the Ossuary

Only one talus showed evidence of burning, with scorch marks on the medal aspect of the head (Figure 6.7).
Population Health

The arthritis in the Poole-Rose calcanei and tali is minimal. Lipping and resorption pits are the only signs on the bones. Approximately 1% of the calcanei and approximately 4% of the tali in the Poole-Rose Ossuary show evidence of arthritis. This is about one in every 50 individuals that shows arthritic tendencies.

Besides arthritic changes, three bones show marked alteration from disease. Two left calcanei have large portions of resorption in the calcaneal tuber in which the Achilles’ tendon inserts (Figures 6.8 and 6.9).
Figure 6.8 Resorption Pit in Calcaneus, Posterior View
Catalogue number 6-23-464

Figure 6.9 Resorption Pit Calcaneus, Posterior View
Catalogue number 3-10-1149-5
One left talus has acute deformation from rheumatoid arthritis (Figures 6.10 to 6.12). No other bone shows such extreme deformation or advanced disease. A complementary bone does not exist. The right talus must have been lost, as rheumatoid arthritis develops symmetrically in the body.

**Figure 6.10** Superior Aspect of Talus with Rheumatoid Deformation
Catalogue number 10-16-194
Figure 6.11 Medial Aspect of Talus with Rheumatoid Deformation
Catalogue number 10-16-194

Figure 6.12 Lateral Aspect Talus with Rheumatoid Deformation
Catalogue number 10-16-194
CHAPTER 7: DISCUSSION AND CONCLUSION

The previous chapters have shown that the MNI in the Poole-Rose Ossuary ranges from 161 to 337. The MNI of the current study is 212. The differences in MNI can be explained in many ways. For example, the burial and then reburial of the bones can result in loss through transportation.

The historic account noted that infant bodies are not included in the Feast of the Dead. According to Trigger, the Huron believed that the soul of a child was too weak to travel to the afterlife. Therefore, the child’s soul stayed in the village (1969). “Because of these difficulties (in the journey), the souls of very young and of the very old remained in the Huron country, where they planted their corn in the fields that the living had abandoned” (Trigger 1976, p.87). Only three bones from infants were found in this study, which lend support to the historic accounts.

Although an ossuary can provide a wealth of information about the overall health of a population, the study of foot bones can be a misleading measure of health. Arthritis is mostly found in the spine and in the major appendicular joints of the elbow, shoulder, hip, and knee. The disease may not be as prevalent or obvious in the ankle and foot joints, creating a misleading view of the
population’s health. Many other diseases that affect pre-
industrial society do not affect the feet until the more
advanced stages.

This population had little osteoarthritis and, in
general, gives the impression of healthy individuals. The
lack of osteoarthritis could be explained by suggesting
that the very old were not included in the ossuary burial,
as stated in the historic account. In contrast, Bordelon
(1997) found that in the right distal tibia, 18 of the 145
bones showed lipping, and the left distal tibia had lipping
in 10 of the 146 bones. She found eburnation in four of
the 159 right bones and one of the 155 left bones. These
numbers for osteoarthritis are slightly elevated from the
numbers found in the current study sample of tali, though
the MNI is about the same for both studies.

The resorption pits on the two calcanei are
unexplained. Current research on tarsal bones does not
include discussion of such pathology, though it surely
exists in the archaeological record.

Generally speaking, the lack of disease in the
calcaneus and talus of the Poole-Rose skeletal remains
suggests a healthy population. However, as previously
noted, these specific elements may not mirror the health
status of this pre-European contact group.
Any human remains that are found in an archaeological setting are keys to the life of the persons who lived and died. Stresses from every day activity leave markers on the skeleton to help later generations understand what that person’s life was like. Overall, a thorough investigation of the Poole-Rose population will further our understanding of indigenous Canadians at the cusp of European contact.


VITA

Adrienne Elizabeth Penney was born in Rochester Hills, Michigan, on May 1, 1981. She was graduated from the University of Evansville in Evansville, Indiana, in 2003 with a Bachelor of Arts degree in classical archaeology and a minor in anthropology. She presented a poster on the thesis research at the 2005 American Association of Physical Anthropologists meeting. She will to continue her studies in physical anthropology with an emphasis on comparative anatomy.