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Frostbite and the Skeletal Remains of Native Alaskans

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Disciplines

Anthropology

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Abstract

A collection of Native Alaskan remains from Point Barrow, Alaska is currently housed at the University of Pennsylvania Museum of Archaeology and Anthropology. The collection was examined for evidence of frostbite to the bones of the hands and feet based on radiographic frostbite damage that has been found in present populations and paleopathologically. Bones of the hands and feet were present for a total of four individuals. However, the collection is incomplete. There was one possible finding of frostbite, which is thought to be an underepresentation of the frostbite injuries that most likely occurred in the living population. A number of possible reasons for the lack of frostbite findings are explored.

ethnographic items can be seen in the University of Pennsylvania Museum of Archaeology and Anthropology's gallery on Alaska's Native People (University of Pennsylvania Museum, 2002). The skeletal collection includes approximately twenty-five crania and postcranial as well. The majority of the materials are skeletonized. However, some contain partially mummified matter, such as skin, cartilage, hair, and even brain matter. The focus of this research was on the bones of the hands and feet for signs of frostbite, and those that were present were completely skeletonized. Studies of frostbite in European populations, have shown that the hands and feet are the most vulnerable to frostbite injury (Murphy et al., 2000). In addition, other paleopathologic instances of frostbite have been found in these areas, particularly in the feet (Post and Donner, 1972; Murphy et al., 2003).

The degree of frostbite injury depends on the degree of cold exposure that an individual is subjected to, which is the result of the temperature and the amount of time that the tissue is frozen (Murphy et al., 2000). As the temperature of the tissue begins to decrease, the flow of blood decreases as well until the cool blood from the cooling tissue threatens the core body temperature (Rabold, 2004). Frostbite develops when the temperature of tissues falls below zero degrees centigrade (Danzl, 2005). The damage is due to the formation of ice crystals in the extracellular space which distort and destroy the cellular architecture by puncturing the cell membranes (Bednar, 2003). An osmotic gradient is produced, which results in cell dehydration. During this time the body alternates between constriction and dilation of the blood vessels in the affected area in response to the injury, but this leads to a partial thawing and refreezing which causes a great deal of damage to the tissue (Murphy et al., 2000; Littell, 1952). At this point,

Point Barrow, Alaska, the northernmost point of the United States located on the Arctic Ocean, was named in the 1800s for Sir John Barrow, the second Secretary of the British Admiralty and a supporter of exploration of the Arctic (State of Alaska, 2006; Point Barrow, 2006). However, the area is known as Ukpeagvik, meaning "Place Where Owls Are Hunted", to the Inupiat who continue to make up the majority of the inhabitants. The area has a long and rich history, with archaeological sites suggesting habitation dating back to the time between 500 and 900 A.C.E. Due to the climatic conditions and extensive historical habitation, the skeletal remains of Native Alaskans from Point Barrow which are currently housed at the University of Pennsylvania Museum of Archaeology and Anthropology were analyzed for evidence of frostbite injuries.

Point Barrow is located approximately ten miles north of Barrow, Alaska, which takes its name from Point Barrow (State of Alaska, 2006). Figure 1 in the appendix shows the location of Barrow, Alaska. This area is located on the coast of the Chukchi Sea, which is free of ice from mid-June through October with light precipitation. However, due to the arctic climate, the weather is frigid with the daily minimum temperature falling below the freezing point for 324 days of the year. The cold season of Alaska is not unchanging, but goes through a number of stages that each affect the ecosystem differently (Olsson et al., 2003).

The collection currently at the University Museum includes the skeletal remains of Native Alaskans from Point Barrow. The collection includes both ethnographic items and skeletal remains. It was accumulated by Edward Avery McIlhenny in 1897 and 1898 with additional findings by William Blair Van Valen in 1917 and Arthur Hopson in 1929 (Hawkes, 1916; University of Pennsylvania Museum, 2004). A number of the blood flow to the coldest area is terminated to maintain the core body temperature. Vascular complications will arise once the vascular endothelium is damaged, often by the formation of a clot (Danzl, 2005). When the tissues thaw there usually is a decrease in the blood supply to the area along with arteriovenous shunting. The result of this is an increase in tissue pressure and swelling of the area. Necrosis can appear and mummification may develop over time.

Frostbite injuries are graded as either superficial or deep (Bednar, 2003). Only the skin is involved in superficial frostbite and the injury often heals. Swelling, blistering, and discoloration are often seen in these cases (Edwards and Leeper, 1952). Deep frostbite, on the other hand, involves damage to both the skin and the subcutaneous structures, like bone. However, the damage cannot be assessed until after rewarming of the tissue has occurred (Murphy et al., 2000). In addition, the full extent of the damage caused by frostbite may not initially appear, but can take weeks or months to develop (Rabold, 2004). The most severe damage is usually distal (Rabold, 2004; Murphy et al., 2000; Tishler, 1972). Infection can be a likely complication. In addition, gangrene can occur which may require amputation or result in autoamputation (Littell, 1952).

For evidence of frostbite in the Native Alaskan collection, bone damage, and therefore deep frostbite injuries, would have had to occur. Radiographic studies of modern populations and paleopathologic cases demonstrate the bone changes that can occur. The majority of the bone damage involves the distal phalanges and rarely involves the metacarpals or metatarsals (Selke, 1969; Murphy et al., 2000). The damage seen in the radiographs depends on a number of factors. First of all, it depends on the degree of the cold exposure (Bednar, 2003). Secondly, it depends on the age of the individual at the time of the frostbite injury, as adult and children's bones respond differently due to the different stages of development. Finally, the amount of time that has elapsed since the injury occurred has an effect, as bone and joint changes can take time to develop (Tishler, 1972).

No evidence of bone damage is seen immediately after a frostbite injury, even if the injury is extremely severe (Tishler, 1972). Intermediate changes are seen a number of weeks to a number of months after the initial frostbite injury. This is characterized by demineralization of the affected bones, especially in the areas where the soft tissue damage is the most severe (Dreyfuss and Glimcher, 1955). Long-term changes can take months to years to develop and vary from person to person, but often involve areas of increased density of bone (Tishler, 1972; Carrera et al., 1979).

The characteristic damage seen when frostbite occurs during childhood is due to these individuals being skeletally immature, in which case the epiphyses of the phalanges, metacarpals, and metatarsals have not yet fused (Bednar, 2003). For this reason, fragmentation and destruction of the epiphyses are common late bone changes and some cases show complete absence of epiphyses (Murphy et al., 2000; Selke, 1969). In addition, epiphyses can prematurely fuse (Carrera et al., 1979). Both damaging results can lead to arrested growth and shortened or deformed digits. Furthermore, these bone damages can lead to deformities of the articular surfaces (Thelander, 1950; Tishler, 1972). Arthritis can often be seen as a result of injury to the developing subchondral bone, usually between the distal and intermediate phalanges (Carrera et al., 1979; Solomon, 1980). Roughened diaphyses and clinodactyly have been noted as well (Thelander, 1950; Carrera et al., 1979). The majority of the injuries seen in case studies involves the distal phalanges and is usually asymmetric with the damage not being equally extensive for all digits of the frostbitten area due to differences in the severity of the cold exposure. Furthermore, the epiphyseal bone changes are specific to children because the bones are immature. However, additional bone changes are seen in both adults and children.

A variety of bone changes can be seen in frostbite injuries and are associated with arthritis due to the damage (Dreyfuss and Glimcher, 1955). Punch-out areas of bone are often found at the phalangeal joint surfaces. In addition, joint-space narrowing, bony fusions, and marginal spurs have been noted in case reports (Ellis et al., 1969; Tishler, 1972). Finally, bone damage can occur as a result of infection and gangrene (Post and Donner, 1972). The result is often seen as destruction and reabsorption of the distal phalanges, which can appear pointed. More extensive destruction of phalanges can develop as well.

The previous bone damages associated with frostbite were all determined in radiographs of living individuals in present populations. However, paleopathology has revealed similar bone changes which have been associated with frostbite. The first case involves a pre-Columbian mummy discovered in Chile (Post and Donner, 1972). Radiographic studies showed loss of the distal and intermediate phalanges of the feet with further phalangeal destruction, as well as bony fusion of the fifth metatarsal and proximal phalanx due to gangrene, infection, and arthritis from the frostbite injury. In addition, bone changes due to frostbite were seen in an approximately 5,000 year old frozen mummy found in the Tyrolean Alps, and commonly known as Ötzi or the iceman (Murphy et al., 2003). A punched out area and formation of a spur on the fifth intermediate phalanx were indications of osteoarthritis due to a frostbite injury because only one digit was affected.

The aforementioned cases of frostbite were limited to the more distal bones of the hands and feet without the presence of any bone damage to the carpals or the tarsals. For this reason, in the examination of the Native Alaskan skeletal remains, the focus was on the phalanges, metacarpals, and metatarsals. In the collection, the bones of the hands and feet were present for four individuals, identified as numbers 29-80-144, 5429, 5863, and 17340. The collection did not include the complete skeleton for any of these individuals. In addition, all of the bones of the digits were not present, with the majority of the missing bones being those that are more distal. Therefore, the research could only be based on the bones that were present in the collection.

The estimated age and sex of each individual was determined. The main reasoning behind the collection of this information is based on findings from current cases of frostbite. However, these findings may be comparable to older populations. First of all, it has been found that the majority of frostbite cases in the present occur in individuals who are between 30 and 49 years of age (Murphy et al., 2000). Secondly, males tend to outnumber females in sustaining frostbite injuries (Murphy et al., 2000; Conway and Husberg, 1999). It is not believed that these differences are due to physiological differences in susceptibility to cold injury. Instead, it is most likely due to differences in activities performed based on both age-related ability and gender-related roles. It is probable that these activity-related differences were present in Native Alaskan populations as well.

The age and sex estimates of the individuals were based on analysis of the os coxae, as these were the only available bones for these analyses due to the absence of the crania of these individuals. The right and left os coxae were not both present for all of the individuals. A chart summarizing the age and sex estimates can be found in Figure 2 of the appendix.

The morphology of the os coxae can be the most reliable for the estimation of the sex of human skeletal remains (Buikstra et al., 1994). This is due to the differing functions of the males and females pelvises, with its use for both locomotion and birthing for females. The sex of each of the individuals was determined based on the morphology of the ventral arc, the subpubic concavity, the ischiopubic ramus ridge, the greater sciatic notch, and the preauricular sulcus with each feature scored based on whether it exhibited more female-like or more male-like characteristics. The results indicate that individual 29-80-144 was male, while individuals 5429, 5863, and 17340 were all female.

The age-related changes of the os coxae were used to estimate the age at the time of death for the individuals (Buikstra et al., 1994). The morphological changes of the pubic symphyseal faces were examined and scored using the Todd standards with a score of 1 through 10 and the Suchey-Brooks standards with a score of 1 through 6 based on the amount of deterioration. In addition, the auricular surfaces were examined and scored on a scale of 1 through 8 for age-related changes. A general age class was determined, as a more precise age is difficult to determine after the dentition has fully emerged. The classes are divided into young adult, being approximately 20 to 35 years of age, middle adult, being approximately 35 to 50 years of age, and an old adult, being 50+ years of age. Individuals 29-80-144 and 5429 were estimated to be old adults, individual 5863 was estimated to be a middle adult, and individual 17340 was estimated to be a young adult based on the amount of age-related changes to the os coxae.

The bones of the hands and feet for the four individuals were identified, sided, and an inventory of those present in the collection was taken. Figures 3 and 4 in the appendix indicate which bones of the hand and feet were present in the Native Alaskan collection. The collection was not complete for any of the hands and feet of the four individuals. The metacarpals and metatarsals were the most represented in the collection, followed by the proximal phalanges and the intermediate phalanges respectively. The vast majority of the distal phalanges were absent. This could be due to a number of reasons, one of which is that the more distally located bones are smaller in size and may have been harder to locate and retrieve when the collection was accumulated.

Based on the radiographic bone changes associated with known cases of frostbite in present populations, the skeletal hand and foot remains of the Native Alaskan collection were examined for any evidence of frostbite. The majority of the bones appeared normal without signs of trauma, arthritis, or any pathologic changes. However, there were two bones with abnormalities worth noting.

The first distal phalanx of the left foot of individual 5429 (the female, old adult) showed abnormalities that could possibly be due to frostbite, though this is not conclusive. This can be seen in Figure 5 of the appendix. Partial destruction of the phalanx can be seen. In addition, there appears to be damage to the articular surface and evidence of a punch-out lesion. The first proximal phalanx shows no signs of these bone changes. In addition, three of the terminal phalanges of the left foot are not present in the collection and there are no other signs of bone changes. Therefore, frostbite as the cause for this damage cannot be ruled out.

An abnormality has also been noted for the third metatarsal of the left foot of individual 17340 (the female, young adult) and can be seen in Figure 6 of the appendix. The metatarsal exhibits a shortened diaphysis and a broad, flattened epiphysis. Frostbite has been ruled out as the cause due to the presence of a callus. This is most likely an indication of a fracture of the third metatarsal which was in the process of healing at the time of death.

The collection did not reveal any strong indications of frostbite. Individual 5429 demonstrated possible evidence of a frostbite injury. However, widespread frostbite injuries were not found, although they were expected due to the conditions of Point Barrow, Alaska. There are a number of possible explanations for the rarity of frostbite injuries in this collection.

First of all, the lack of frostbite injury could be due to the sample. The sample size was small, with only four individuals represented. It is possible that frostbite was a problem for Native Alaskans, but these four individuals were unaffected. Furthermore, as mentioned for current populations, males tend to suffer from frostbite at higher rates than females (Murphy et al., 2000; Conway and Husberg, 1999). The bones of the hand and foot were present for only one male in this collection. Had there been additional males, there may have been an increase in frostbite findings.

A major factor is probably the incompleteness of the collection. A majority of the distal phalanges were not present and many of the intermediate phalanges were missing as well. The frostbite induced bone damage that has been detected in a number of radiographic studies indicate that the areas affected are most commonly the distal and intermediate phalanges and only rarely are the metacarpals and metatarsals affected (Rabold, 2004; Murphy et al., 2000; Tishler, 1972). Most of the metacarpals and metatarsals were present and these showed no indication of frostbite injury, which was not unexpected. The first distal phalanx of the left foot of individual 5429 showed evidence of a possible frostbite injury. Had the collection included more of the distal phalanges, it is possible that additional frostbite injuries may have been encountered indicating an increased prevalence of the problem. Additionally, the absence of the distal phalanges could be the result of their complete destruction due to frostbite. However, it is impossible to make this claim for skeletal remains. The paleopathologic examples were mummified remains, in which case the absence of distal phalanges due to insufficient retrieval of remains is not an issue, as the bones remain enclosed within the mummified individual if they were present at the time of death.

Furthermore, cold exposure could have caused frostbite in other areas, such as the nose, which was not taken into consideration in the examination of this collection. Vilhjálmur Stefánsson (1913), who explored Point Barrow, Alaska in the early 1900s, noted that frostbite to the cheeks and nose were quite common. Frostbite was dealt with quite simply. He explained that "…there is perhaps on one cheek a hard spot the size of a quarter of a dollar, you press the palm on it a minute or so till it is as soft as the rest of your cheek…. Then, a few days later, a bit of skin comes off…." This description indicates that frostbite to the face was common. However, it also appears as though these were only superficial frostbite injuries.

In addition, there is the possibility that frostbite affected the hands and feet of these four individuals, but the damage was not severe enough to leave any osteological evidence of its presence. As stated earlier, superficial frostbite involves only the skin and will often heal (Bednar, 2003). Any of these four individuals could have been affected by superficial frostbite. During life this would have left them with sensory loss, cold sensitivity, or changes in the color of the skin in the affected areas (Murphy et al., 2000; Rabold, 2004). However, in death, no evidence would have been left behind. The use of radiographic studies may reveal bone changes that cannot be seen by the naked eye.

Lastly, the Native Alaskans may have had methods to combat the cold and the damaging effects that it can cause. This could include both cultural and biological adaptations to the climate (Moran, 1981). In this way, this population may have been able to guard itself by innovation for suitable clothing and by physiological changes, both allowing for at least some prevention of frostbite injury or at least a reduction in frostbite injury in comparison to other populations.

Clothing is of extreme importance for battling the cold and preventing cold-related injuries. The cultural practices involved with adequate clothing in the cold, Alaskan climate include knowledge of the proper materials to use, preparation, stitching, and design techniques, and care of the clothing (Stefánsson, 1913; Moran, 1981; Kaplan, 1986). Coats, for example, are often made from young deer in the summer months, as this is when the hair is short (Stefánsson, 1913). In addition, the hood of a coat from the Native Alaskan collection at the University of Pennsylvania Museum of Archaeology and Anthropology displays a wolverine hair trim, which will not freeze when subjected to the breath of the individual wearing it (Kaplan, 1986). Grass is utilized as well, as grass socks are often worn inside boots to absorb either water that leaks in or perspiration.

Garments are often designed with ventilation in mind by taking advantage of drawstring openings which allow for the flow of air (Moran, 1981). This is an important aspect because hard labor can result in perspiration and sweat-soaked clothing which will not protect against the cold. The construction of the clothing involves care in the preparation and stitching of the materials. The stitching must be done in a way in which needle holes do not allow water to enter. When clothing does become wet it must be dried to prevent rotting (Stefánsson, 1913). These techniques are all crucial and important barriers between the individual and the climate. In fact, there has been a great deal of continuity in the construction of Native Alaskan clothing, as archaeological findings from the sixteenth century indicate, due to the superiority of the clothing (Issenman, 1997).

Biological protection from the cold has been suggested as well. Although biological adaptations to the cold are controversial, there are examples of morphological adaptation to cold climates that have been noted (Murphy et al., 2000; Hall et al., 2004; So, 1980). In addition, a number of studies have been conducted with recent populations of Native Alaskans which indicate possible physiological adaptations to the cold, with a reduction in the risk of frostbite (Brown and Page, 1952; Coffey, 1955).

Morphological adaptations to cold climates include body proportions and nasal morphology. A minimization of surface area exposure can conserve energy in cold regions (Hall et al., 2004). Studies have shown that relatively high trunk to limb proportions have been found in populations that reside in cold climates. Additionally, Native Alaskan cranial morphology has been investigated for cold-related adaptations. Small frontal sinus surface areas of an Alaskan skeletal population have been correlated with colder climates (Koertvelyessy, 1972; So, 1980). Koertvelyessy (1972) concluded that the small frontal sinuses were an adaptation for thermoregulation. Shea (1977) studied Alaskan craniofacial morphology as well, and found a decrease in maxillary sinus size with decreasing temperatures.

Studies of current Alaskan native populations indicate additional adaptation to the cold, and adaptations against frostbite in particular. A study by Brown and Page (1952) compared the hand blood flow and temperature of males from a Native Alaskan population from the Arctic and a Caucasian population living in a temperate climate. The findings indicated that the hand blood flow of the Native Alaskan population was greater at all of the temperatures tested. The temperature of the Native Alaskan's hands was greater at lower temperatures as well. Furthermore, Coffey (1955) performed a comparative study which suggests Native Alaskan adaptation specifically, rather than acclimatization to the cold. In this study, young Native Alaskan males who were living in a cold climate, but under more European-like conditions, including diet and customs, were compared to white males in the military who had been living in the cold climate. The Native Alaskan males maintained manual dexterity in the lower temperatures and demonstrated an overall increased ability to tolerate the cold. In addition, the white males suffered from more cases of frostbite and other cold injuries.

Evidence from the recent past is indicative of frostbite injuries. As mentioned earlier, Stefánsson (1913) described the frequent patches of superficial frostbite to the face that were often experienced by the Native Alaskans. In addition, Mills and

Kettelkamp (1961) conducted an interview with a Native Alaskan, Maggie Lind, who knew a great deal about traditional medical practices. The interview included a description of the treatment of frostbite in which an injured area was "…put in cold water… and [you] change the water until there is no more ice on the skin". Although the number of individuals affected by frostbite was unknown, knowledge of a treatment for frostbite injury would not be necessary if the injuries did not occur.

Frostbite continues to be a problem for Alaskan populations, for both Native and more recently established inhabitants (Conway and Husberg, 1999). Two hundred and thirteen hospitalizations were the result of frostbite in Alaska between the years 1991 and 1995. For those injured while working, 50% were in the military. Surprisingly, Native Alaskans account for 51% of all cold-related injuries that were contracted during non-work related activities, yet they only make up 16% of Alaska's residents. However, this can be explained by changes in the economy, which have affected the availability of materials for making clothes and the amount of time that is necessary for making traditional Alaskan clothing (Issenman, 1997; Buijs and Oosten, 1997).

Frostbite-related information is not extremely extensive and most of the information is on the pathophysiology and treatment (Conway and Husberg, 1999). The majority of frostbite studies have focused on individuals in the military, especially during World War II and the Korean War, when a number of cold-related injuries were sustained (Murphy et al., 2000). Interest in frostbite injuries in the general population has increased in the past few decades. However, additional research could be of great importance, especially among Alaskan populations where this is an issue. In addition, a better understanding of the traditional ways in which they combated the cold culturally, with clothing, could be extremely beneficial, especially when compared to the clothing worn by military servicemen who experience a high prevalence of frostbite (Edwards and Leeper, 1952). In fact, during Alaskan expeditions in the early twentieth century, European style clothing was often rejected and replaced by the traditional Alaskan clothing (Stefánsson, 1913). However, acceptance of the benefits of the Native Alaskan garb was not initially accepted by Westerners (Buijs and Oosten, 1997).

Despite the cultural and biological mechanisms that could aid in the prevention of frostbite injuries and the scanty evidence of frostbite injuries in the Native Alaskan skeletal collection from Point Barrow, it is doubtful that this population did not endure cold-related injuries to some extent. This is because the climatic conditions were harsh and frostbite is highly prevalent in the area today. For this reason, additional research of larger collections of skeletal remains of Native Alaskan populations could provide a great deal of information on the affects of the climate on populations in the past.

Appendix

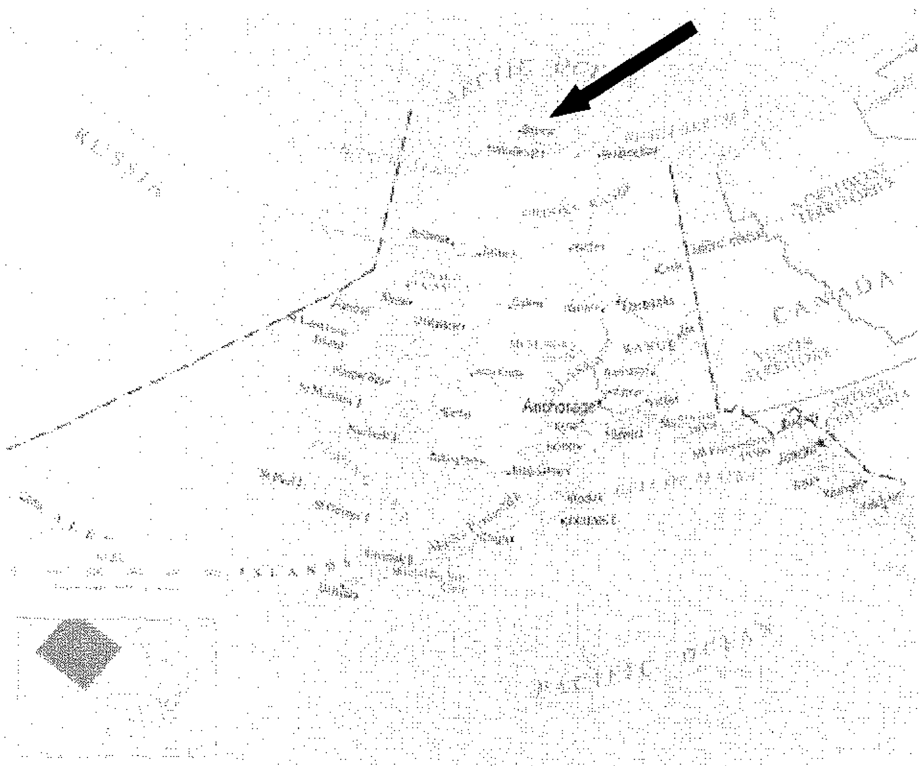

Figure 1. The arrow indicates the location of Barrow, Alaska.

The map is from the national atlas (United States Department of the Interior, 2006).

Identification Number	Os Coxae	Sex	Age
29-80-144	Right & Left	Male	Old Adult
5429	Right	Female	Old Adult
5863	Left	Female	Middle Adult
17340	Right & Left	Female	Young Adult

Figure 2. Summary of os coxae inventory and subsequent sex and age results.

Bone	Identification Number			
Right Hand	29-80-144	5429	5863	17340
R-Scaphoid			√	√
R-Lunate			√	√
R-Triquetral			√	
R-Pisiform			√	
R-Trapezium			√	√
R-Trapezoid			√	√
R-Capitate			√	√
R-Hamate			√	√
R-1st Metacarpal			√	√
R-2nd Metacarpal			√	√
R-3rd Metacarpal			√	√
R-4th Metacarpal			√	√
R-5th Metacarpal			√	√
R-1st Proximal Phalanx			√	√
R-2nd Proximal Phalanx			√	√
R-3rd Proximal Phalanx			√	√
R-4th Proximal Phalanx			√	√
R-5th Proximal Phalanx			√	√
R-2nd Intermediate Phalanx			√	
R-3rd Intermediate Phalanx			√	
R-4th Intermediate Phalanx			√	
R-5th Intermediate Phalanx			√	
R-1st Distal Phalanx			√	√
R-2nd Distal Phalanx			√	
R-3rd Distal Phalanx			√	
R-4th Distal Phalanx				
R-5th Distal Phalanx				
Left Hand	29-80-144	5429	5863	17340
L-Scaphoid				√
L-Lunate				
L-Triquetral				
L-Pisiform				
L-Trapezium				√
L-Trapezoid				
L-Capitate				
L-Hamate				
L-1st Metacarpal				
L-2nd Metacarpal	√			√
L-3rd Metacarpal				√
L-4th Metacarpal	√			√
L-5th Metacarpal				√
L-1st Proximal Phalanx				√
L-2nd Proximal Phalanx				√
L-3rd Proximal Phalanx				√
L-4th Proximal Phalanx				√
L-5th Proximal Phalanx				√
L-2nd Intermediate Phalanx				√
L-3rd Intermediate Phalanx				√
L-4th Intermediate Phalanx				√
L-5th Intermediate Phalanx				√
L-1st Distal Phalanx				
L-2nd Distal Phalanx				
L-3rd Distal Phalanx				
L-4th Distal Phalanx				
L-5th Distal Phalanx				

Figure 3. An inventory of the bones of the right and left hand for the Native Alaskan collection.

Right Foot	29-80-144	5429	5863	17340
R-Talus				√
R-Calcaneus				√
R-Cuboid				√
R-Navicular				
R-Medial Cuneiform				
R-Intermediate Cuneiform				
R-Lateral Cuneiform				√
R-1st Metatarsal				√
R-2nd Metatarsal				√
R-3rd Metatarsal				√
R-4th Metatarsal				√
R-5th Metatarsal				√
R-1st Proximal Phalanx				
R-2nd Proximal Phalanx				
R-3rd Proximal Phalanx				
R-4th Proximal Phalanx				
R-5th Proximal Phalanx				
R-2nd Intermediate Phalanx				
R-3rd Intermediate Phalanx				
R-4th Intermediate Phalanx				
R-5th Intermediate Phalanx				
R-1st Distal Phalanx				
R-2nd Distal Phalanx				
R-3rd Distal Phalanx				
R-4th Distal Phalanx				
R-5th Distal Phalanx				
Left Foot	29-80-144	5429	5863	17340
L-Talus	√	√		√
L-Calcaneus	√	√		√
L-Cuboid	√	√		√
L-Navicular	√	√		√
L-Medial Cuneiform	√	√		√
L-Intermediate Cuneiform	√			√
L-Lateral Cuneiform	√	√		√
L-1st Metatarsal	√	√		√
L-2nd Metatarsal	√	√		√
L-3rd Metatarsal	√	√		√
L-4th Metatarsal	√	√		√
L-5th Metatarsal	√	√		√
L-1st Proximal Phalanx		√		
L-2nd Proximal Phalanx	√			√
L-3rd Proximal Phalanx	√	√		√
L-4th Proximal Phalanx				
L-5th Proximal Phalanx				
L-2nd Intermediate Phalanx		√		
L-3rd Intermediate Phalanx		√		
L-4th Intermediate Phalanx				
L-5th Intermediate Phalanx				
L-1st Distal Phalanx		√		
L-2nd Distal Phalanx				
L-3rd Distal Phalanx		√		
L-4th Distal Phalanx				
L-5th Distal Phalanx				

Figure 4. An inventory of the bones of the right and left foot for the Native Alaskan collection.

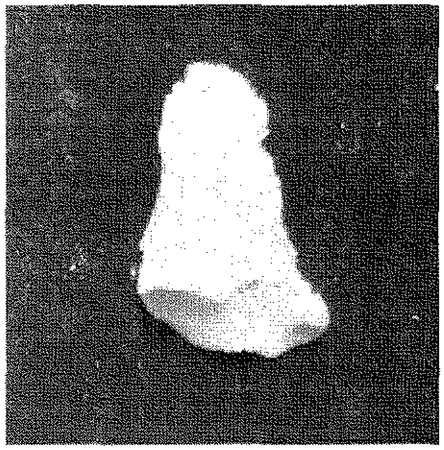

Figure 5. The first distal phalanx of the left foot of individual 5429.

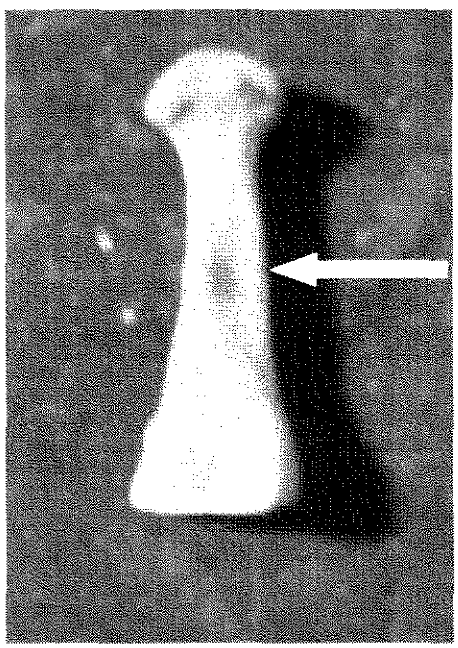

Figure 6. The third metatarsal of the left foot of individual 17340. The arrow indicates the location of a callus.

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