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Carpals and tarsals of mule deer, black bear and human: an osteology guide for the archaeologist

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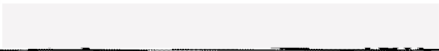
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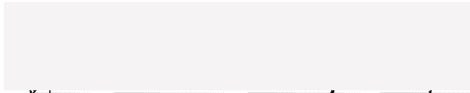
**CARPALS AND TARSALS OF MULE DEER, BLACK BEAR
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THE ARCHAEOLOGIST**

By
Tamela S. Smart

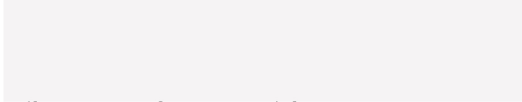
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MASTER'S THESIS

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A Thesis
Presented to
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May 2009

ABSTRACT

Existing osteological literature often lacks descriptions and illustrations of the smaller elements, such as hand and foot bones, of animals commonly found in the archaeological record. Black bear (*Ursus americanus*) and mule deer (*Odocoileus hemionus*) are both cosmopolitan species and important resources for indigenous peoples, resulting in their widespread presence in faunal assemblages. Additionally, the carpal and tarsal elements of these two mammalian taxa can be difficult to distinguish from human elements because of their similarities in size and shape. Proper identification of faunal and human remains is paramount to responsible cultural resource management (CRM). This thesis presents a textual and photographic osteological guide of black bear and mule deer carpals and tarsals and provides the means for distinguishing these elements from their human counterparts.

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CHAPTER I: INTRODUCTION

The ability to distinguish human skeletal remains from bones of other animals is becoming increasingly important for professional archaeologists in North America because of their ethical and legal responsibilities when human remains are discovered. Archaeologists conducting shovel testing, permitted excavation, or monitoring of construction excavation must often make quick decisions about whether to stop or continue work in order to comply with procedures mandated by law, contract, or permit. Most protocols for handling inadvertent discovery of human remains require leaving them in place and causing no further disturbance while the appropriate authorities are contacted. While many archaeologists have some training in human osteology or comparative mammalian osteology, few have extensive experience, and even those elements that are generally recognizable may present challenges if they are fragmented or only partially exposed. Thus archaeologists commonly rely on illustrated osteological guides to confirm field identifications, and to recognize less common or less distinctive elements. Despite the number of available osteological guides, there are still gaps in coverage. Human bone anatomy texts and virtual guides assist in identifications (Bass 1995; Kappelman 2008; Schwartz 1995; White 2000; White and Folkens 2005); however most of these sources provide little comparison of human and faunal anatomy. Most animal osteological guides (eg., Brown and Gustafson 1990; Digital Morphology Group and UTCT 2002; Gilbert 1990; Kasper 1980; Schmid 1972) focus on crania or larger skeletal elements and ignore smaller ones, such as the bones of the hands and feet. This is unfortunate as these bones tend to preserve well and be relatively well represented in archaeological sites. Carpals and tarsals are morphologically distinct yet less familiar than long bones to the non-specialist and can be readily misidentified between animals of comparable size.

This thesis helps to fill this gap by providing a guide for identifying and distinguishing human elements from the carpals and tarsals of *Ursus americanus* (black bear) and *Odocoileus hemionus* (mule deer), mammals which are commonly represented in North American archaeological sites (Ubelaker 2006). These elements are similar enough in size and morphology to commonly be confused with human bones by untrained observers.

Given the pace of development in the United States, and increasing legislative protection for burials, archaeologists frequently find themselves working in situations where discovery of human remains requires specific procedural responses, and where failure to comply can have significant negative consequences for individuals, companies, and the professional community.

Recent federal legislation provides more explicit protection for burials, and many states have followed suit. Federal law mandates that human remains, funerary objects, sacred objects or objects of cultural patrimony that are in the possession of the federal government, or a federally funded institution or agency, must be repatriated to tribes that can show genetic or cultural affiliation (See Native American Graves Protection and Repatriation Act – NAGPRA, 1990). NAGPRA also regulates the inadvertent discovery and intentional archaeological excavation of human remains on Federal land (43 CFR 10). Before the late 1980s most states had legislation protecting graves in clearly established cemeteries which, however, did not apply to unmarked Native American burials (Hutt 1998). A 1989 National Geographic article brought public attention to the destruction of more than 800 burial sites on a Kentucky farm and the lack of government response. Within a couple of years of this publication most states had amended their laws to include Native American burials (Arden 1989; Hutt 1998). Washington State reflects this nationwide trend. Here, a number of recent cases involving ancient burials have brought this issue to the forefront. The most well known case concerns the dispute over the disposition of Kennewick Man’s remains (Boxberger 2009; Bruning 2006; Chatters 2000). Also, within the last ten years two large scale construction projects, the Hood Canal Bridge Graving Dock in Port Angeles and the Blaine Waste Water Treatment Plant on the Semiahmoo Spit, were stopped due to the discovery of unmarked burials and disagreements over management of the unearthed human remains (Davila 1999; WSDOT 2004).

State laws concerning burials vary a great deal; Washington state law is discussed here as an example. Three statutes pertain to the discovery of human remains in Washington State. The first is the Notice to Coroner (Revised Code of Washington [RCW] 68.50) (1987) which states that “...it shall be the duty of every person who knows of the existence and location of a dead body coming under the jurisdiction of the coroner...to notify the coroner thereof in the most expeditious manner possible...”. Those that do not follow this action are guilty of a misdemeanor. The second applicable statute is the Indian Graves and Records Act (RCW 27.44) (1989) which requires that

Any person who knowingly removes, mutilates, defaces, injures, or destroys any cairn or grave of any native Indian or any glyptic or painted record of any tribe or peoples is guilty of a class C felony punishable under chapter 9A.20RCW. Persons disturbing Native American graves through inadvertence...shall reinter the human remains under the supervision of the appropriate Indian tribe.

The third statute is the Abandoned and Historic Cemeteries and Historic Graves Act (RCW 68.60) (1989) which makes it is a class C felony to knowingly remove, mutilate, deface, injure or destroy an historic grave. The three statutes described above have recently (in 2008) been strengthened with the passing of Washington State House Bill 2624-S2.E which adds new sections to the existing grave protection legislation. Further, it has resulted in the creation of a State Physical Anthropologist position under the Department of Archaeology and Historic Preservation (DAHP) and has made this person responsible for determining whether non-forensic remains are Indian or non-Indian and for reporting their findings to the affected tribes (DAHP n.d.).

When human remains are inadvertently discovered during an initial investigation, monitoring project, permitted excavation or during lab work the applicable laws should be followed. How laws governing human remains are implemented is dependent upon the policy of the agency with jurisdiction (Hutt 1988; King 2008). Generally, when human remains are encountered the archaeologist should notify the property owner or on-site superintendent. All work in the immediate area should stop and the area should be secured, with all equipment moved to a safe distance. The local law enforcement and medical examiner should be contacted in order to determine if the remains are forensic in nature. If they are non-forensic the State Physical Anthropologist determines if they are Indian or Non-Indian and reports the findings to the affected tribes (DAHP n.d.). If a federal agency is not involved the DAHP conducts all consultation with the affected parties regarding future preservation, excavation and the remains disposition (DAHP n.d.).

The task of differentiating human remains from faunal remains is complicated by numerous taphonomic processes (Aslan and Behrensmeyer 1996; Behrensmeyer 1978; Behrensmeyer et al. 2000; Haglund and Sorg 1997; Lyman 1994; Whyte 2001). First, the way in which a skeleton enters the archaeological record greatly affects its appearance and preservation. Human remains that are intentionally buried are easily identified by most people because of their anatomical positioning and completeness (Whyte 2001). However, certain mortuary practices such as secondary burials and cremations can greatly change the positioning and appearance of elements (Whyte 2001). In comparison, animal carcasses are rarely buried intentionally and are often processed by humans for a wide variety of reasons. Processing results in bone fragmentation and incomplete and disarticulated skeletons; all of which make identification more difficult (Davis 1987; Lyman 1994; Reitz and Wing 2008). For example, if a carcass is being

processed in the field with the intention of reducing it to transportable parts then it would likely exhibit cut marks associated with skinning and disarticulation. It would then be brought back to camp in its entirety minus the bone fragments related to its division (Lyman 1978 and 1994; Nokes 2004).

Finally, post depositional disturbances can greatly impact skeletal remains and their identification. These disturbances can be divided into two groups, abiotic and biotic. Abiotic disturbances include inanimate forces such as rain, earthquakes, floods, waves, wind, sun, freezing and thawing, as well as soil properties (Ceci 1984; Gordon and Buikstra 1981; Reitz and Wing 2008). For example, forests soils are generally highly acidic, which accelerates the rate of decomposition of organics such as bone (Gordon and Buikstra 1981). Bones that are naturally decomposing may no longer exhibit key identifying landmarks. In contrast, shell midden deposits increase the alkalinity of the soil and result in a slower rate of bone decomposition. Biotic disturbances are associated with plants and animals. Bioturbation, the movement of soil by plants and animals, is a common biotic disturbance (Ceci 1984). Others include scavenging, trampling and gnawing (Lyman 1994; Reitz and Wing 2008). Humans should also be considered one of the main causes of post depositional disturbance. Agricultural activities, land clearing, damming of rivers, road construction and maintenance, installation of utilities and construction of buildings are just a few of the land modifications that can impact archaeological remains (Ceci 1984; Reitz and Wing 2008).

Regardless of the condition of skeletal remains archaeologists need to be able to identify whether they are human or faunal. In the laboratory the most effective way to make a positive identification is with the use of a comparative collection. As this resource is not feasible for use in the field, osteological guidebooks are essential. A number of human skeletal guides provide detailed descriptions and illustrations of adult elements (Bass 1995; Flower 1885; Schwartz 1995; White 2000; White and Folkens 2005). In addition, a few guides emphasize human juvenile osteology and the development of the skeletal system (Baker et al. 2005; Scheuer and Black 2000; Scheuer et al. 2008). Compared to human osteological guides, faunal guides generally do not provide the same level of detail, especially in regards to smaller elements such as wrist and ankle bones. For example, Brown and Gustafson (1990) is a guide to the postcranial skeletal elements of cattle/bison, elk and horse, yet there are no carpal illustrations and only three tarsals are included (the calcaneus, the astragalus and the naviculo-cuboid). In addition, Schmid's (1972) comparative guide illustrates only the calcaneus and astragalus of selected mammalian taxa. This unfortunate bias is not new in the field of archaeology. Cornwall (1964), one of the

more in-depth human and faunal skeletal guides (geared towards archaeologists), exemplifies this bias in stating:

For the archaeologist the carpal bones are generally of no great importance. Owing to their usually small size and irregular shape, they are frequently but poorly preserved and may easily be overlooked by excavators since, in the earth; they are not readily recognizable as bones [146].

The major exceptions to this trend are Flower (1885), Gilbert 1990, Post (2004a and 2004b), and Sandefur (1977), which do emphasize carpal and tarsal elements. Of these works, Sandefur (1977), Post (2004a) and Gilbert (1990) were the most helpful in the creation of this guide. Sandefur (1977) provides in depth descriptions of mule deer carpals, however, the illustrations are lacking in detail. Gilbert (1990) also provides illustrations of mule deer carpals, as well as drawings of the calcaneus, astragalus, and naviculo-cuboid for a number of selected taxa, but lacks labels and descriptions of key landmarks. Post (2004a) provides detailed illustrations of black bear wrist and ankle elements from a number of different views, unfortunately the views are not labeled and a description of key landmarks is not provided.

Guides that illustrate ankle and wrist bones are important because these elements commonly preserve in the archaeological record. This is due in large part to their small spherical shape and relatively high structural density (Darwent and Lyman 2001; Sobolik 2003). In addition, carpals and tarsals (especially those of artiodactyls) exhibit minimal interstitial space, thus contain limited grease and marrow and are not likely to be fragmented by humans during processing (Binford 1978; Darwent and Lyman 2001). The common preservation of these elements makes them ideal for quantifying the minimum number of individuals (MNI) of a given taxa in an assemblage. MNI is defined as the fewest number of individuals necessary to account for all of the elements present in an assemblage (Lyman 1994; White 2000). White (2000) states that this method of quantifying individuals should take into consideration the following: element, side, age, sex, occlusion, articulation and antimeric partners (White 2000). Carpal and tarsal counts are ideal for estimating MNI because these elements preserve well and each individual has only one left and one right. Alyson M. Rollins, the Lummi Indian Nation Physical Anthropologist who works on repatriation issues including unanticipated discoveries of human remains, often uses carpal and tarsal elements to assist in determining MNI (personal communication 2009). In addition, carpals and tarsals of human can also be used for stature,

age and sex determinations (Bidmos 2006; Bidmos and Asala 2003; Bidmos and Asala 2004; Cameriere and Ferrante 2008; Cameriere et al. 2007; Hsieh et al. 2007; Sulzmann et al. 2008)

There are no comprehensive osteological guidebooks that emphasize comparative carpal and tarsal morphology. The goal of this thesis is to fill this gap by providing information needed to identify these elements for two mammals commonly found at archaeological sites: the black bear (*Ursus americanus*) and the mule deer (*Odocoileus hemionus*) (Ubelaker 2006). In addition, this work will highlight the characteristics of these elements that distinguish them from human. Black bear and mule deer were selected for three primary reasons: 1) potential for misidentification due to size and morphological similarity to human wrist and ankle bones, 2) their importance in the local economies of prehistoric peoples, and 3) overall ubiquity at archaeological sites. Many black bear and mule deer skeletal elements are similar in both size and morphology to their human counterparts and thus are commonly misidentified by non-specialists. Carcasses of mule deer and less frequently black bear are routinely discovered on roadways or trails after predation by other animals and humans, and after collisions with motor vehicles. In Michigan State alone there are approximately 65,000 deer-vehicle collisions each year (Riley and Marcoux 2006). Disarticulated animal remains can easily be mistaken for human. In these cases, local law enforcement, coroners, medical examiners and physical anthropologists are often contacted for identification (Klepinger 2006; Orcholl and Hudson 2001; Owsley and Mann 1990; Stewart 1959; Sims 2007). Owsley and Mann (1990) estimate that about 15% to 25% of the medicolegal cases involving forensic anthropologists are misidentified animal remains, most commonly deer, pig, dog and bear.

Robert Bishop, Coroner for Island County in Washington State is often brought skeletal remains by the public and stated “I have had a bear paw mistaken for a human hand once, but it still had soft tissue attached. I was interested in how similar it appeared, but of course it did not have an opposable thumb...In the past 14 years I would suggest that deer make up the majority of the bones presented to this office” (personal communication 2009). Alyson M. Rollins and Guy Tasa the Washington State Physical Anthropologist for DAHP have had similar experiences with archaeological skeletal remains. Rollins says that she has worked on a number of repatriations in which deer, bear and dog elements were identified as human and human elements were identified as faunal (personal communication 2009). Guy Tasa believes that deer skeletal elements and to a lesser extent bear, cow, sheep, wapiti, seal, sea lion and pig bones are commonly misidentified as human (personal communication 2009).

Identification of mule deer and black bear bones is important not just as an aid to recognizing human remains correctly, but for their value in contributing to analysis of human life ways and their use of animal resources. Both mule deer and black bear had great importance as resources for indigenous peoples of North America, which is evidenced by both the archaeological record and ethnographic literature (Ubelaker 2006). Both of these taxa have a wide geographic range (Mackie et al. 1982; Nowak and Paradiso 1983; Pelton 1982), and were hunted throughout their range.

In this osteological guide emphasis is placed on descriptions and photographs of *Odocoileus hemionus* and *Ursus americanus* wrist and ankle elements. First, an overview of the focal species is provided in Chapter II. Discussed in this chapter are the animals' taxonomy, distribution, ecology, social behavior, morphology and their importance for prehistoric peoples. Chapter III describes the methods used in creating this guide. Chapters IV and V provide an overview of mammalian hand and foot morphology, as well as a detailed discussion of *Odocoileus hemionus* and *Ursus americanus* carpals and tarsals. Further, these chapters highlight the key characteristics that distinguish mule deer and black bear wrist and ankle bones from their human counterparts. The final chapter discusses the importance of osteological guides to archaeologists and suggests where additional work is needed.

CHAPTER II: NATURAL HISTORY AND THE CULTURAL IMPORTANCE OF MULE DEER AND BLACK BEAR

Mule deer and black bear are two of the most widely dispersed and recognizable terrestrial mammals in North America. Further, these species play an important role in both the local ecology and in the cultures of the indigenous peoples. Due to the importance of mule deer and black bear as a resource to the indigenous peoples and their common presence in the archaeological record these animals are often encountered by archaeologists in the field. In this chapter an overview of the natural history of mule deer and black bear is discussed including their taxonomy, geographic range, social behavior, and physical attributes. A discussion of the importance of these animals to prehistoric peoples in the Pacific Northwest follows.

Natural History of the Mule Deer

The mule deer (*Odocoileus hemionus*) is an extant species of the taxonomic Order Artiodactyla, which includes a group of mammals whose weight is positioned on their third and fourth toes. Deer are commonly referred to as cervids, due to their inclusion in the family Cervidae. The other members of this family that inhabit North America include white-tailed deer (*Odocoileus virginianus*), wapiti (*Cervus elaphus*), moose (*Alces alces*) and caribou (*Rangifer tarandus*). The species *Odocoileus hemionus* consists of seven generally agreed upon subspecies, including both mule deer and black tailed deer (Mackie et al 1982). The specimens utilized in this project were identified only to the species level.

The geographic range of this species covers most of temperate North America from the Pacific coast eastward to the 100th meridian. They are found as far north as the southern Yukon in the west and Manitoba in the east. Their southern limits extend into Baja California and northern Mexico (Mackie et al 1982; Nowak and Paradiso 1983).

Within this geographic range mule deer are found in habitats that vary widely in terms of climatic and vegetation zones as well as elevation. They frequently endure temperatures averaging -15° C in the winter and 30° C in the summer. This species commonly inhabits open forests, brushy areas, and shrub-lands associated with rough terrain. They are highly adapted to high elevation mountainous regions, foothills and will also frequent prairies along river drainages (Mackie et al 1982; Nowak and Paradiso 1983).

The social behavior of *Odocoileus hemionus* varies greatly depending on the following factors: subspecies, sex, and season. For the majority of the year they are widely dispersed with

the basic social unit consisting of an adult female, her female yearling, and two fawns. Males are usually alone or in small groups. In certain cases however, this species will aggregate around resources and groups as large as several hundred individuals will form. Mule deer are polygamous and during mating season males compete with each other for females in estrus (Mackie et al 1982; Nowak and Paradiso 1983).

The physical appearance of this species is quite distinctive. Adult individuals molt twice each year. In the winter their upper body is brownish gray and their under belly is lighter in color. In the summer they exhibit a reddish brown coat. The tail is somewhat small and is either white or black on the proximal end and black on the distal end. *Odocoileus hemionus* exhibits sexual dimorphism with males weighing on average 74 kg and females weighing 59 kg. In addition, males are longer, averaging 152 cm, while females average 142 cm. Also, males grow deciduous antlers, which females do not (Mackie et al 1982; Nowak and Paradiso 1983).

As previously mentioned, all members of the family Artiodactyla exhibit highly adapted morphology. The third and fourth toes bear all of the body weight and this adaptation is manifested not only in the morphology and orientation of the animal's digits but in the entire morphology of the manus and pes. The individual bones of the hands and feet will be discussed at length in the succeeding chapters.

Natural History of the Black Bear

The black bear (*Ursus americanus*) is an extant species of the taxonomic Family Ursidae. Two additional members of this Family inhabit North America, the Grizzly bear (*Ursus arctos*) and the Polar bear (*Ursus maritimus*). Of these three species, black bears are by far the most common.

Black bears have a substantial geographic range. They inhabit the forested areas across much of North America. To the north, they are found in Alaska and Northern Canada, while their southern boundary extends into Mexico. It should be noted that their density varies greatly within this range due to limited suitable habitat and human population size (Nowak and Paradiso 1983; Pelton 1982). Black bears are primarily found in forested areas with a thick under-story and mountainous terrain. Along the Pacific coast they inhabit forests where the dominant over-story includes Douglas fir (*Pseudotsuga taxifolia*), Ponderosa Pine (*Pinus ponderosa*), Lodgepole pine (*Pinus contorta*), Redwood (*Sequoia sempervierns*), Sitka spruce (*Picea sitchensis*), and Hemlock

(*Tsuga* sp.). In addition to forested areas, black bears also live in meadows, riparian zones, brushlands and tidelands (Pelton 1982).

Black bears are largely solitary animals. Breeding occurs in the summer and females give birth during their dormancy period in the winter. A litter usually consists of two cubs, however females have been observed with as many as four. The cubs generally stay with their mother until they are yearlings when they disperse during the spring or summer months (Pelton 1982).

The outward appearance of *Ursus americanus* is quite impressive. Body lengths range from one to two meters and weight ranges from 40 to 70 kg in females and 60 to 140 kg in males. These animals are most commonly black, chocolate brown or cinnamon brown. In the Pacific Northwest white and blue phases do occur, but are rare. Black bears can also be differentiated from other bears by their small, round ears, short tail and brown muzzle (Nowak and Paradiso 1983; Pelton 1982).

The hand and foot morphology of the black bear is similar to many mammals in that they exhibit five digits (pentadactyl) and have a plantigrade stance (Pelton 1982). The anatomy of their carpals and tarsals will be discussed at length in the succeeding chapters.

Cultural Importance of Mule Deer and Black Bear to Prehistoric Peoples

Mule deer inhabit most of the western half of North America, while their close cousin, the white tailed deer, is found throughout the continental United States, southern Canada, Mexico, Central America and northern portions of South America. Black bear are also very widespread, ranging from the Pacific to the Atlantic Ocean and from Northern Alaska down into Mexico (Mackie et al. 1982; Nowak and Paradiso 1983; Pelton 1982). These animals were hunted to varying degrees throughout these geographic ranges (Ubelaker 2006). It is beyond the scope of this project to provide a detailed discussion of traditional use of these two animals across North America, therefore, archaeological and ethnographic evidence from the Pacific Northwest is provided as an example of the importance of these animals to indigenous peoples.

The Pacific Northwest includes both the Northwest Coast culture area and the interior Plateaus. The former is defined by Suttles (1990) as extending approximately 1,500 miles from the Copper River Delta on the Gulf of Georgia south to the Winchuck River near Oregon's southern border. West to east it spans from the coastal islands to the Chugach and St. Elias Ranges in Alaska, the Coast Mountain Ranges in British Columbia and the Cascade Range in

Washington and Oregon. East of the Cascade Range are the Columbia and Fraser Plateaus, which have generally been treated as a distinct culture area (Walker 1989). Ames and Maschner (1999) argue for treating these areas together, and term the combined area Cascadia. The hunter-fisher-gatherer peoples that inhabited both sides of mountain were connected by ties of linguistics, trade, kinship, and the exploitation of anadromous salmon, although the coastal areas were distinguished by more complex social organization (Ames 1994; Ames and Maschner 1999).

Researchers have placed great emphasis on the role of salmon to explain the cultural complexity and population density of the Pacific Northwest (Ames 1994; Butler and Campbell 2006; Driver 1993; Hodgetts and Rahemtulla 2001). More recently, archaeologists are paying greater attention to the importance of non-marine resources. Butler and Campbell (2006) analyzed faunal data from 65 Plateau and Northwest Coast archaeological sites that date from the last 10,000 years and confirmed that over time there was a gradual change from broad spectrum foraging to organized collecting strategies and intensified exploitation of salmon. However, this intensification did not result in an increased use of salmon relative to other resources. Rather, some terrestrial mammals such as deer (*Odocoileus spp.*) and wapiti (*Cervus elaphus*) were utilized to a greater extent over time (Butler and Campbell 2006). Further, artiodactyls (especially deer and wapiti) are the most ubiquitous terrestrial mammals found in sites throughout this region. Black bear do not comprise a large component of faunal assemblages like deer, but they are found at numerous Pacific Northwest sites (Butler and Campbell 2006; Cannon 1991; Imamoto 1976; Lyman 1995; Hodgett and Rahemtulla 2001; Huelsbeck 1994; Montgomery 1979; Nokes 2004).

An examination of selected archaeological sites from both the coastal region and the plateau clearly reflects this trend (Butler and Campbell 2006; Nokes 2004; Livingston 1985). *Odocoileus hemionus* (number of identified specimens [NISP] 239) is the most abundant mammal with *Castor canadensis* (beaver) (NISP 193) as the second and *Cervus elaphus* (elk) (NISP 169) as the third at 45WH34 (Ferndale), a site located in the Gulf of Georgia. Black bear are also present at this site but comprise only a small portion of the assemblage (NISP 24, MNI 1). Interestingly, the bear elements present at the site are primarily hand and foot bones and include one calcaneus, three metapodials, two metacarpals, four first phalanges, six second phalanges, and one third phalanx (Nokes 2004). Deer and wapiti elements at the Ferndale site also follow this trend with distal leg and manus and pes elements being the most common (Nokes 2004). In the plateau region, artiodactyls are again the predominant terrestrial taxa in the faunal assemblage

(Butler and Campbell 2006). For example, artiodactyls comprise 90% of the identified elements at 45OK258 (a site located along the right bank of the Columbia River). *Odocoileus spp.* (3,452 elements) including mule deer and white tailed deer were the most abundant of the artiodactyls and *Ovis canadensis* (mountain sheep) (511 elements), *Cervus elaphus* (14 elements), and *Antilocapra americana* (pronghorn antelope) (42 elements) were also present but in much smaller numbers. An examination of the distribution of the elements indicates that all parts of the artiodactyls were brought back to the site and utilized. A total of four *Ursus spp.* (grizzly bear and black bear) elements were identified at this site and all were from the paw region and include two metatarsal fragments, one metacarpal and one metapodial (Livingston 1985).

The ethnographic literature also indicates that mule deer and black bear were important sources of food and raw material for Pacific Northwest peoples. “Deer and elk meat were considered the best varieties and dried with special care, the meat was cut in pieces and hung on a frame. Fires were built on three sides and the meat was thoroughly roasted” (Haeberlin and Gunther 1930: 21). Deer were also valued for their bone, antlers, hooves and hides which were used to make tools, clothes and ceremonial and decorative items (Ruby and Brown 1976; Underhill 1945). In May of 1792, George Vancouver during his exploration of Port Discovery writes the following in his journal “Their native woollen garment was most in fashion, next to it the skins of deer, bear, etc.; a few wore dresses manufactured from bark, which, like their woollen ones, were very neatly wrought” (Meany 1942:122).

Bears were utilized as a food source, for their hide, and to make regalia for ceremonies (Haeberlin and Gunther 1930; Ruby and Brown 1976; Suttles 1990; Underhill 1945). They were hunted by bow and arrow, trapped and chased out of caves with smoke and killed (Suttles 1990). Haeberlin and Gunther (1930) provide a detailed description of a bear trap.

A trap for bears consisted of two poles about ten feet high erected over some bear tracks. These carried a heavy horizontal pole to which a rope was attached. This rope was also tied to brush that covered up a four to five foot hole dug underneath the horizontal pole. When the bear stepped on the brush and fell into the hole, he pulled down the horizontal pole which fell on him [25].

CHAPTER III: METHODS

The differentiation between human skeletal elements and those of other mammalian taxa is complicated by many factors, the most notable of which is similarity in body size. Second, humans exhibit a generalized mammal form resulting in elements that are morphologically similar to other generalized taxa, such as bear. Third, ubiquity is an important factor. Black bear and mule deer were important resources for North American indigenous peoples resulting in their widespread presence in archaeological sites (Ubelaker 2006). Based on these factors, mule deer and black bear were chosen for this osteological study.

Specimen selection was based on age of the individual, completeness of the forelimbs and hind-limbs and the overall condition of individual elements. Age determination was based on epiphyseal fusion and preference was given to mature individuals. All of the specimens photographed in this work were adult except for #UA1, an adolescent bear. Additionally, elements that were highly fragmented, exhibited injury or severe degenerative disease were excluded.

The faunal specimens used for photographing and comparison were borrowed from the Burke Museum of Natural History and Culture at the University of Washington, the Western Washington University Geology Lab, the Western Washington University Archaeology lab, and the Equinox Research and Consulting International, Inc. laboratory. Additional specimens were donated by private individuals and added to the author's personal collection. Seven *Ursus americanus* specimens were used in this thesis: three of the specimens were complete individuals; one specimen was partially complete with an articulated lower limb and ankle; one specimen was an articulated foot; and two of the specimens were disarticulated hand and foot bones. In addition, 26 *Odocoileus hemionus* specimens were examined: two of the specimens were complete individuals; one specimen was largely complete minus the head; two specimens were articulated lower limbs and feet; and 21 of the specimens were represented by single carpal or tarsal elements. A complete list of the faunal specimens is presented in Appendix 1. The six human specimens used in this guide are teaching specimens housed at the Western Washington University Biological Anthropology Lab. All of the human specimens were either largely complete or complete skeletons and they are listed in Appendix 2.

In addition to comparative collections, guide books were a key resource in the construction of this guide. The following sources provided valuable illustrations/photographs and textual descriptions that were consulted throughout this work: Cornwall (1964), Flower (1885),

Gilbert (1990), Post (2004a), Sandefur (1977), White (2000) and White and Folkens (2005). Further, the organization of this guide is patterned largely after White (2000) and White and Folkens (2005).

In order to provide a comprehensive guide to bear and deer carpals and tarsals, both written descriptions and black and white photographs are provided. The written descriptions detail the general morphology of each element, their location within the hand or foot and the key identifying landmarks. These landmarks are labeled with an alphabetical delineation and are identified in the corresponding photographs. Photographed specimens were selected based on their completeness and lack of any soft tissue that might obscure landmarks. All specimens are photographed in anatomical position, which results in differences in element orientation. Specimens that were not photographed were used for comparative purposes. Multiple views of each element are presented in order to show all of the key landmarks and to enhance the reader's ability to identify both complete elements and fragments.

Many bear and deer carpals and tarsals exhibit a morphological resemblance to human elements. In cases where possible confusion may arise, a discussion outlining how to make a positive determination between the species is included. Comparisons are not limited to homologous (the same bones in different animals) elements, rather elements that are similar in size and morphology are compared. For example the deer medial cuneiform is compared to the human pisiform. Most of the discussions do highlight human carpals and tarsals; however the bear pisiform is compared to the human first metacarpal, as they are similar in appearance. Photographs of the necessary views of the human elements are provided, as well. Key landmarks on the human elements were given numerical delineations that correspond to the descriptions in the text.

The osteological terminology utilized by human and faunal specialists often varies. To assist the reader a list of important directional and anatomical terms are listed in Table 1. The terms are compiled from the following sources: Clemente (1985), Cornwall (1964), Flower (1885), Scheuer and Black (2000), and White (2000).

Table 1. Directional and Anatomical Terms

Term	Definition
Anterior	Towards the front of the body
Articular surface	A Place where a bone comes into contact with an adjacent bone
Distal	Furthest from the axial skeleton
Dorsal	Towards the back or upper surface
Foramen	An opening in the bone, usually for blood vessels and nerves
Fossa	A broad shallow depressed area
Head	A large round end of a bone, often an articular surface
Inferior	Below
Lateral	Away from the midline of the body
Medial	Towards the midline of the body
Neck	The area between the head and the shaft
Palmar	The palm side of the hand
Plantar	The sole of the foot
Posterior	Towards the back of the body
Proximal	Nearest to the axial skeleton
Radial	Towards the radius
Shaft	The main section between the ends of a long bone
Superior	Above
Tubercle	A small rounded bony projection
Ulnar	Towards to ulna
Ventral	Towards the front or under surface
Volar	Underside of the hand or foot

The photographs presented in this work were taken with a Sony Cybershot DSC-H5, which has high quality macro shot capabilities. A tripod was utilized to stabilize the camera and to ensure that each picture was taken from a consistent distance. The background was removed from each picture using Microsoft PowerPoint in order to enhance clarity and a scale bar is included for size determination. All photographs represent elements from the right side of the body in order to ensure consistency.

Photographing the fine details on bones can be difficult with inadequate lighting, thus a light box was constructed to sufficiently illuminate the specimens during photographing sessions. Instructions for light box construction were found at the Our Media: Channels of Creativity (n.d.) website. The materials used in its assembly included five pieces of white foam board, strips of 2” wide masking tape, one straight edge knife, one ruler, three metal clip-on shop lights and three 60Hz full spectrum light bulbs.

CHAPTER IV: THE MORPHOLOGY OF THE WRIST

The bones of the mammalian hand (manus) are divided into three groups: carpals, metacarpals and phalanges. Carpals are small wrist bones, largely cubical in shape, which form from single primary ossification centers. They articulate through synovial joints which allow for limited mobility (Flower 1885). Proximal to the carpals are the ulna and radius (the forearm bones) and distal to the carpals are five tubular shaped bones called metacarpals.

Metacarpals (MC) are numbered one through five (from medial to lateral). They form from two centers of ossification with the epiphysis at the distal end (in all but the first) (Flower 1885). The proximal ends of the metacarpals articulate with the carpals at largely immobile joints and their distal ends articulate through hinge joints with the phalanges. Deer are an exception to this pattern, as they exhibit two small vestigial metacarpals (second and fifth) and one large metacarpal formed from the fused third and fourth elements (Cornwall 1964; Flower 1885).

Phalanges comprise the fingers or digits of the hand. The generalized mammalian form is comprised of five digits, as represented in both human and bear. The digits are referred to as follows: I (thumb or pollex), II (index finger), III (middle finger), IV (ring finger), V (little finger). Each of the digits has three phalanges including the proximal, intermediate and distal (ungual) with the exception of the pollex which is comprised of only two phalanges (Cornwall 1964; Flower 1885; Scheuer and Black 2000; White 2000). It is important to emphasize that in some of the more specialized mammal species digits may be reduced in size or absent. For example, in deer the pollex is absent (Flower 1885).

Proximal to the carpals are the bones of the forearm, which include the radius and ulna. The radius and ulna are long bones positioned side by side in the lower arm. In humans these elements are relatively similar in overall size and robusticity, however in most non-human mammals the radius is generally the more robust of the two (Flower 1885). In deer and horses, for example, the ulna exhibits a substantial proximal end and a reduced sliver-like distal end. The degree of movement between these two elements also varies greatly. In some mammals, including deer, the ulna and radius are fused, resulting in a limited range of motion. Whereas in humans, they remain unfused, resulting in a greater range of motion that allows for the palm to be oriented up or down (Flower 1885; White 2000).

The Carpals

The full complement of carpals in mammals includes eight bones, which are generally arranged in two transverse rows, a proximal and a distal, with one additional bone occupying a centered position among them, the central (Cornwall 1964). Interestingly, the central is often absent, as is the case with the species included in this guide. The proximal row of carpals (from radial to ulnar) is comprised of the scaphoid, the lunate, and the triquetral. The distal row (from radial to ulnar) includes the trapezium, the trapezoid, the capitate and the hamate. Two sesamoid bones, located on either side of the carpals within the tendons of the flexor muscles, are also common within the wrist. The first is the pisiform which is common and often highly developed. The second is the radial sesamoid, which is frequently absent (Cornwall 1964; Flower 1885) (Figure 1).

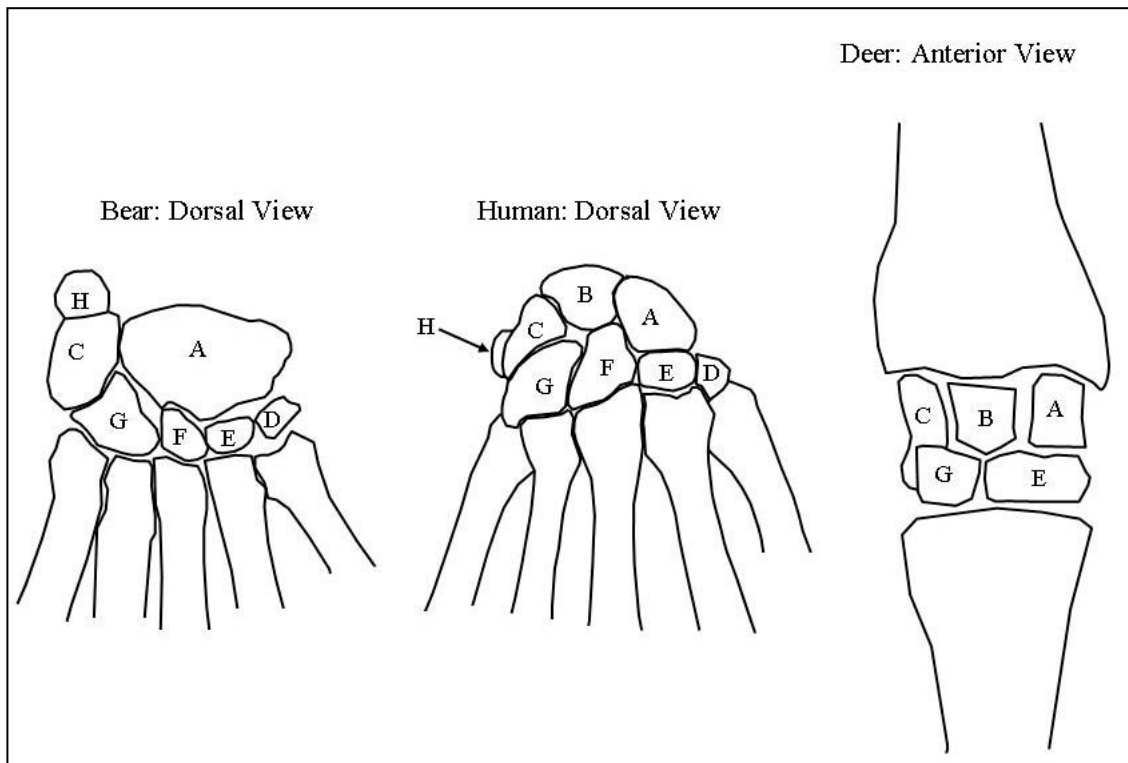


Figure 1. Schematic drawing of bear, human and deer right carpals.
Key: A, scaphoid/scapho-lunar; B, lunate; C, triquetral/cuneiform; D, trapezium; E, trapezoid/
trapezoid-magnum; F, capitate; G, hamate/unciform; H, pisiform.

There are several systems for carpal bone nomenclature; synonyms are presented in Table 2 (Bass 1995; Cornwall 1964; Flower 1885; White 2000).

Table 2. Carpal Name Synonyms

Carpal Names	Synonyms
Scaphoid	Radial, Navicular, Scapho-lunar (when fused with the lunate)
Lunate	Lunar, Intermedium, Semilunar, Lunatum, Scapho-lunar (when fused with the scaphoid)
Triquetral	Ulnare, Cuneiform, Triquetrum, Pyramidale
Central	Centrale, Intermedium
Trapezium	Greater Multangular, Multangulum majus, Carpal 1
Trapezoid	Lesser Multangular, Multangulum minus, Carpal 2, Trapezoid-magnum (when fused with the capitate)
Capitate	Capitol, Magnum, Carpal 3, Trapezoid-magnum (when fused with the trapezoid)
Hamate	Hamate, Uncinatum, Unciform, Carpal 4 & 5
Pisiform	Ulnar sesamoid bone
Radial Sesamoid	Sesamoid

Each carpal is morphologically distinctive. An understanding of their characteristic landmarks can help distinguish both within and between species. The following pages provide detailed descriptions and photographs of each of the deer and bear carpals. Key landmarks are noted using alphabetical notation and are described in detail. Human elements that share a common morphology with deer and bear carpals are discussed in order to identify their distinguishing features. These comparisons are not limited to homologous (the same bones in different animals) elements. Also, the views presented for each of the compared elements may differ, resulting from either differences in anatomical positioning or because different views were more similar in appearance.

Scaphoid

The scaphoid is one of the larger carpal bones and its name stems from the Greek word *skaphidion* meaning “a small ship” (Sanderfur 1977). Due to its boat like shape it is commonly referred to as the navicular of the hand. This element is located in the proximal row of the carpal

block on the radial side. In some mammals, including bear, the scaphoid and lunate are fused, forming the scapho-lunar. The overall shape of this element varies greatly between mammals.

Deer Scaphoid

The deer scaphoid is an irregular shaped bone that is located on the superior-medial side of the carpal block (Figure 2 and Figure 3). It articulates with three other bones including the radius (superiorly), the trapezoid-magnum (inferiorly) and the lunate (laterally).

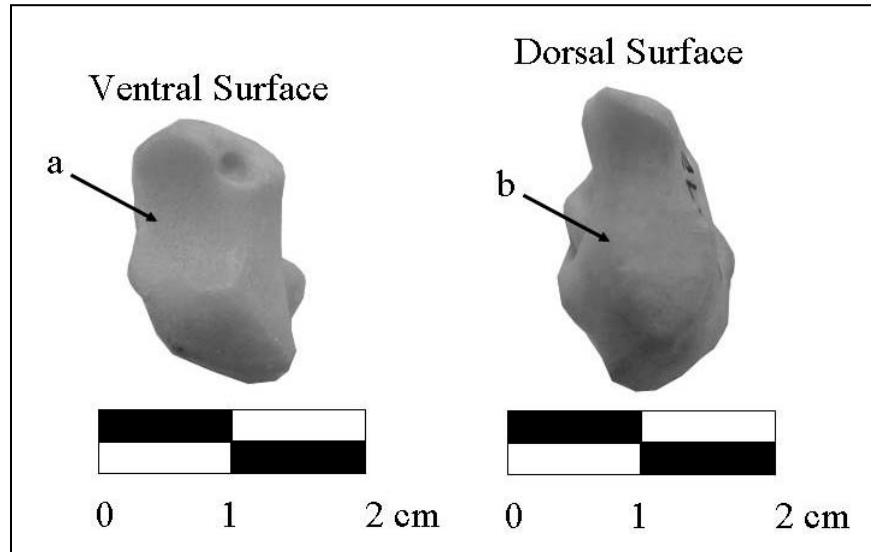


Figure 2. Right deer scaphoid ventral and dorsal surfaces.

Key: a, trapezoid magnum articular surface; b, distal radial articular surface.

- a. The **trapezoid magnum articular surface** is a large landmark that covers most of the elements ventral surface. It exhibits four non-distinct facets.
- b. The **distal radial articular surface** covers the entire dorsal surface of the element and exhibits a saddle-like appearance.

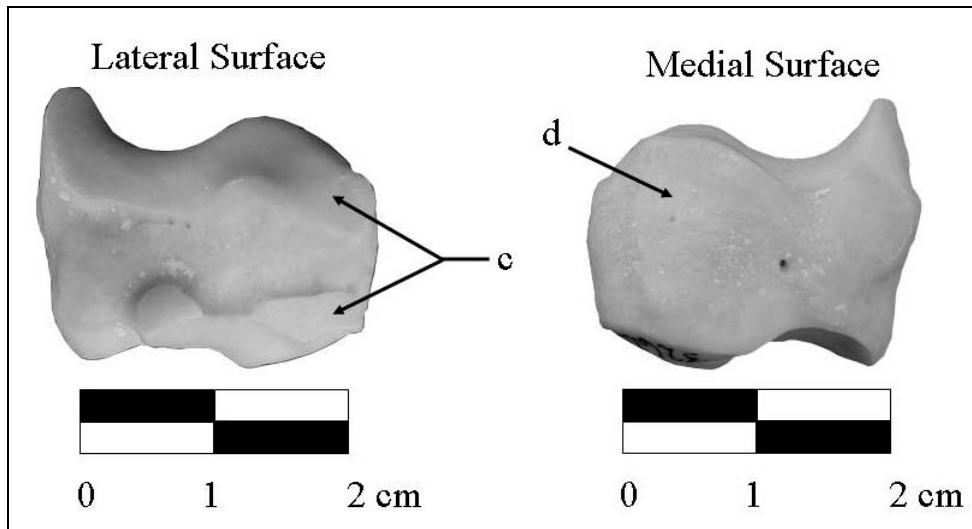


Figure 3. Right deer scaphoid lateral and medial surfaces.
Key: c, lunate articular facets; d, medial side.

- c. There are two **articular facets for the lunate** located on the lateral side of the scaphoid. They run horizontally and are separated by a deep groove.
- d. The **medial side** of the scaphoid is a semi rough rectangular surface with no articular facets. It exhibits a distinctive rectangular shape with a pinched-in midline.

Bear Scapho-lunar

The scapho-lunar is the largest carpal found in the bear and also one of the most distinctive (Figure 4). Its overall shape is rectangular with a large inferior projection extending from its medial corner. The scapho-lunar articulates with six elements, including the trapezium, trapezoid, capitate, hamate, triquetral (anteriorly), and radius (posteriorly).

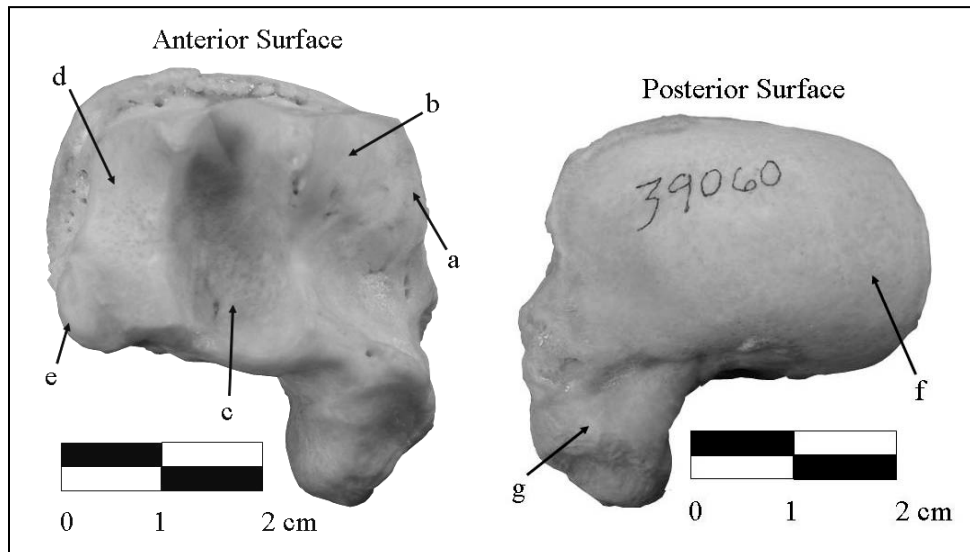


Figure 4. Right bear scapho-lunar anterior and posterior surfaces.

Key: a, trapezium articular surface; b, trapezoid articular surface; c, capitate articular facet; d, hamate articular surface; e, triquetral articular surface; f, articular surface for radius; g, scapho-lunar process.

- a. The **trapezium articular surface** is a small triangular facet located on the medial side of the anterior surface.
- b. The **trapezoid articular surface** is located just lateral to the trapezium articular surface and it is the larger of the two facets.
- c. The **capitate articular facet** is a long concave rectangular facet located along the midline of the anterior surface.
- d. The **hamate articular surface** is located along the lateral side of the anterior surface of the scapho-lunar. It is an elongated concave facet.
- e. The **triquetral articular surface** is located just inferior to the hamate articular surface on the lateral side of the anterior surface. It is small and semi-circular in shape.
- f. The **articular surface for the radius** is a large rectangular convex facet that comprises 2/3 of the elements posterior surface.

- g. The **scapho-lunar process** extends from the medio-inferior quadrant of the element and serves as an attachment site for soft tissue.

Possible confusion with human elements:

The bear scapho-lunar is similar in morphology to the human navicular (Figure 5 and Figure 6). Both have a large flattened body with a process or tubercle extending from their medial sides. In addition, the posterior side of the bear scapho-lunar and the anterior side of the human navicular both exhibit a large convex articular surface.

To distinguish between these two elements look for the following distinctive characteristics.

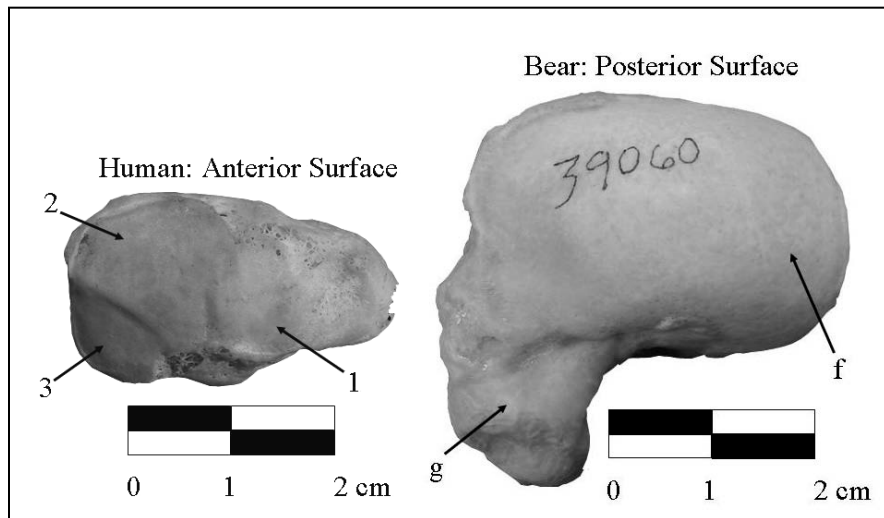


Figure 5. Right human navicular anterior surface and right bear scapho-lunar posterior surface. Key: 1, medial cuneiform articular surface; 2, intermediate cuneiform articular surface; 3, lateral cuneiform articular surface; f, articular surface for the radius; g, scapho-lunar process.

- The human navicular is generally smaller than the bear scapho-lunar.
- The anterior side of the human navicular is oval in shape and its articular surface can be divided into three, sometimes four sections, where it articulates with the medial cuneiform (1), the intermediate cuneiform (2), the lateral cuneiform (3) and sometimes the cuboid. In contrast the articular surface on the posterior side of the bear scapho-lunar is rectangular in shape and exhibits a single facet where it articulates with the radius (f).

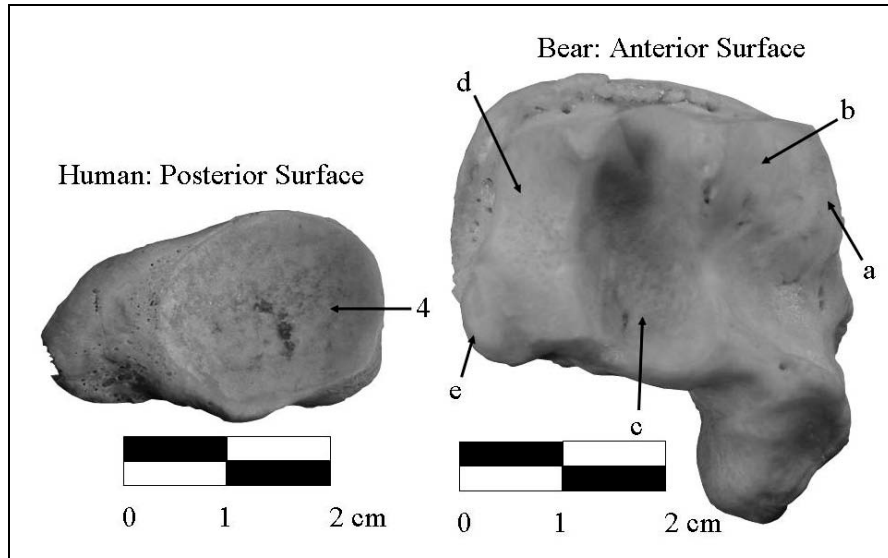


Figure 6. Right human navicular posterior surface and right bear scapho-lunar anterior surface. Key: 4, talar facet; a, trapezium articular surface; b, trapezoid articular surface; c, capitate articular facet; d, hamate articular surface; e, triquetral articular surface.

- The opposing sides of the elements are very different. The anterior side of the bear scapho-lunar has three deep depressions separated by two ridges, while the posterior side of the human navicular has a single large rounded facet for the head of the talus (talar facet) (4).

Lunate

The lunate is named for its distinctive crescent shape, which is clearly exhibited in the human form. This characteristic however, is absent in many taxa, including deer and bear. The lunate is generally positioned along the midline of the carpal block between the scaphoid and the triquetral. As previously mentioned, the scaphoid and lunate are fused in many mammals, such as bear, and in these cases it is referred to as the scapho-lunar.

Deer Lunate

Though the lunate was named for its resemblance to the moon, it exhibits a cuboidal shape in the deer (Figure 7 and Figure 8). The lunate is located in the middle of the proximal carpal row and it articulates with the following five elements: radius (superiorly), scaphoid (medially), cuneiform (laterally), trapezoid-magnum (inferio-medially) and unciform (inferio-laterally). The deer lunate can be identified by its twisted appearance and its very distinct angular surfaces. It is also the largest carpal in the deer (Sandefur 1977).

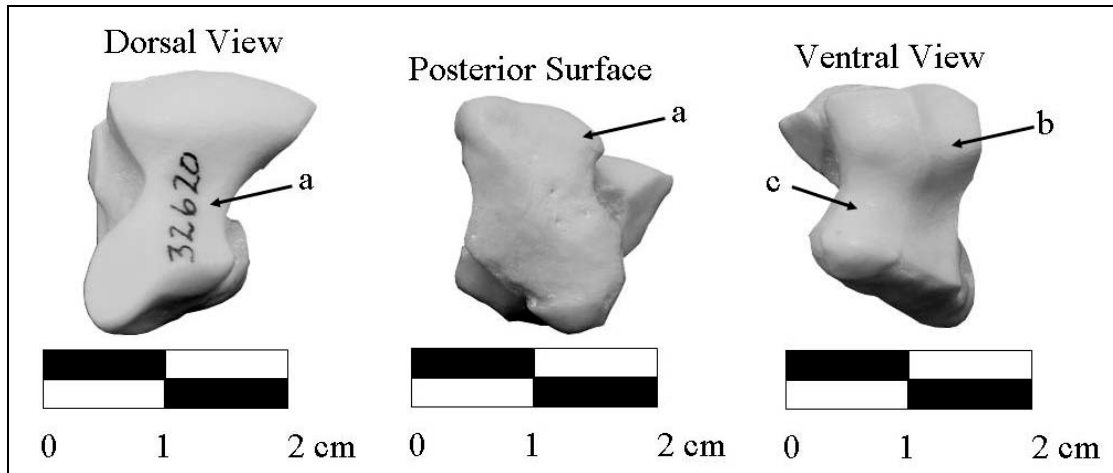


Figure 7. Right deer lunate dorsal, posterior and ventral surfaces.

Key: a, articular facets for the radius; b, trapezoid magnum articular facet; c, unciform articular facet.

- a. There are two **articular facets for the radius**. The larger of the two covers the entire dorsal surface of the element. Its overall shape is irregular but it does bare some resemblance to the letter “J”. The smaller articular facet for the radius is located on the posterior surface, in the postero-lateral corner.
- b. The **trapezoid magnum articular facet** is located on the medial side of the ventral surface adjacent to the articular facet for the unciform. This landmark is rectangular in shape, has a twisted appearance and exhibits a convex anterior portion and a concave posterior portion.
- c. The **unciform articular facet** is located on the lateral side of the ventral surface and is shaped like the adjacent trapezoid magnum articular facet. It is the larger of the two facets on this surface.

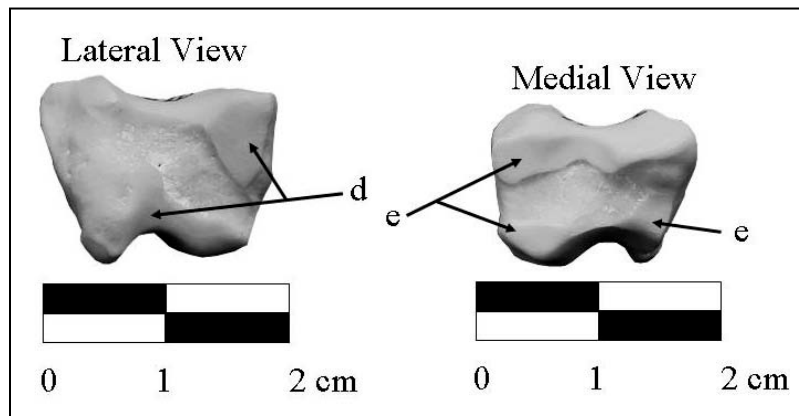


Figure 8. Right deer lunate lateral and medial surfaces.

Key: d, articular facets for the cuneiform; e, scaphoid articular facets.

- d. There **are two articular facets for the cuneiform** on the lateral surface. The first is positioned along the inferior margin and runs the length of the element. The second is triangular in shape and is located on the antero-superior corner. These two landmarks are separated by a large groove.
- e. There are **three scaphoid articular facets** located on the medial surface. The first is positioned along the superior border and forms a long narrow strip that extends the length of the element. The two remaining facets are located on the anterior and posterior corners of the inferior border.

Bear Scapho-lunar

The bear scaphoid and lunate are fused forming the scapho-lunar. See the above scaphoid section for photographs and descriptions of this element.

Triquetral

The triquetral is named for its pyramidal or triangular form (Clemente 1985). It is positioned within the proximal row of the carpal block on the ulnar side and it articulates with the ulna (proximally), the lunate (medially), and the hamate (distally).

Deer Triquetral (Cuneiform)

The deer cuneiform is a long and narrow bone located on the superior-lateral portion of the carpal block (Figure 9 and Figure 10). It articulates with four elements including the unciform (inferiorly), lunate (medially), pisiform (posteriorly) and the fused radius and ulna (superiorly).

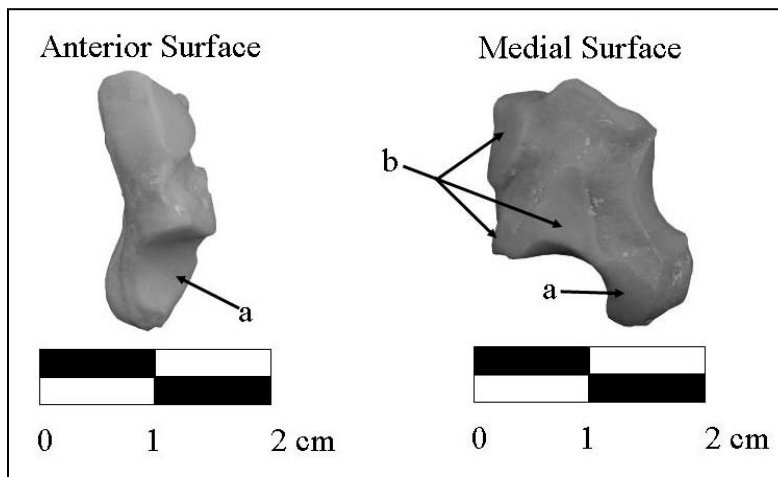


Figure 9. Right deer cuneiform anterior and medial surfaces.
Key: a, unciform articular surfaces; b, lunate articular facets.

- a. There are two **unciform articular surfaces** on the cuneiform. The first is visible on both the anterior and ventral surfaces of the triquetral and exhibits a crescent shape. The second is located on the medial surface.
- b. There are three **articular facets for the lunate**, all of which are located on the medial side of the element.

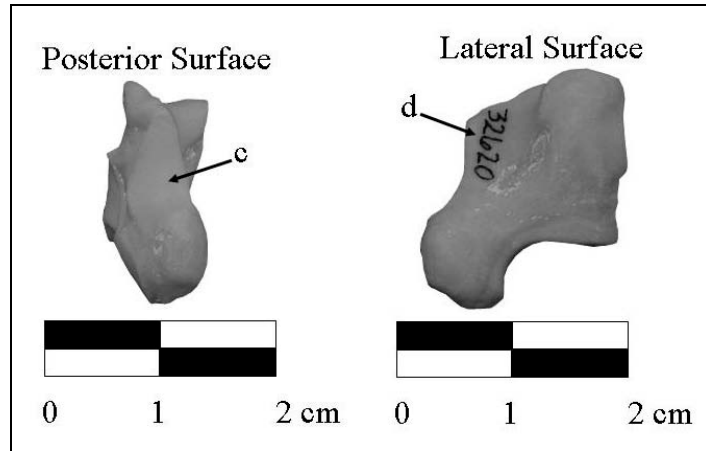


Figure 10. Right deer cuneiform posterior and lateral surfaces.
Key: c, pisiform articular surface; d, articular surface for the fused ulna and radius.

- c. The **pisiform articular surface** is located on the posterior surface and exhibits a crescent shape.
- d. The **articular surface for the fused ulna and radius** is a large facet that can be seen on both the dorsal and lateral surfaces.

Possible confusion with human elements:

The deer cuneiform shares a minor resemblance to the human hamate (Figure 11). Both elements exhibit an irregular body and a large hook-like process. The process on the human hamate is referred to as the hamulus (1). Though similar these elements can be easily distinguished due to the cuboidal shape of the human hamate versus the flatted appearance of the deer cuneiform. In addition, their articular surfaces vary greatly in shape and size.

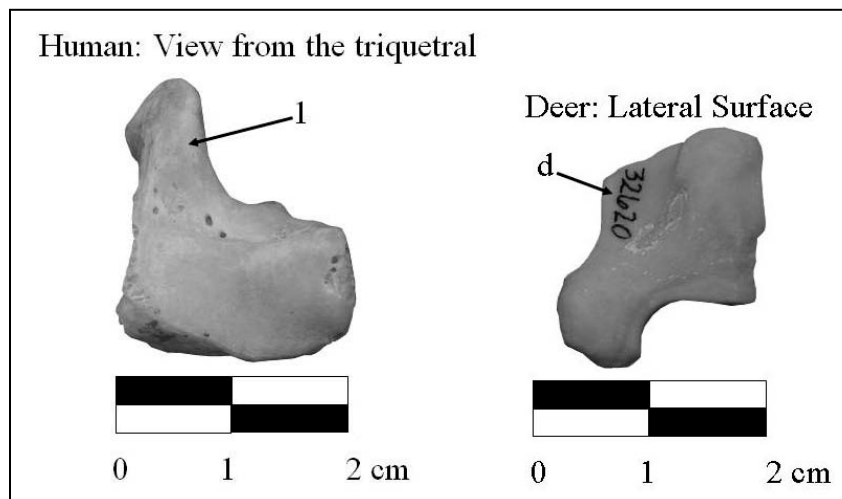


Figure 11. Right human hamate view from the triquetral and right bear cuneiform lateral surface.
Key: 1, hamulus; d, articular surface for the fused ulna and radius.

Bear Triquetral

The bear triquetral is a flattened, irregularly shaped bone (Figure 12 and Figure 13). It is positioned on the lateral side of the manus and articulates with the hamate (anteriorly), the pisiform (posteriorly) and the scapho-lunar (medially).

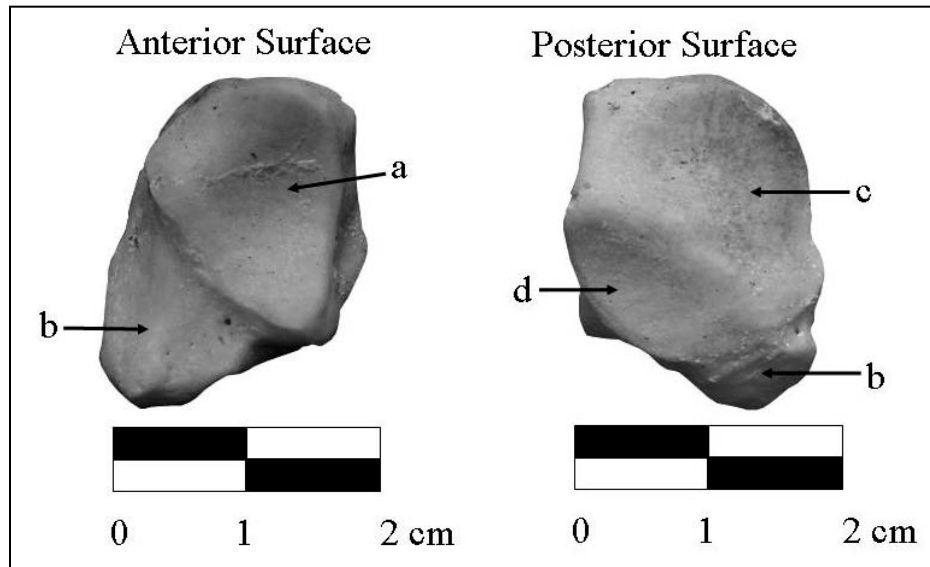


Figure 12. Right bear triquetral anterior and posterior surfaces.

Key: a, hamate articular facet; b, triquetral process; c, ulnar articular facet; d, pisiform articular facet.

- a. The **hamate articular facet** is located on the anterior surface. This landmark is concave and triangular in shape.
- b. The **triquetral process** is a roughened non-articular projection that extends laterally. It serves as an attachment site for soft tissue.
- c. The **ulnar articular facet** is located on the posterior surface of the element just superior to the articular facet for the pisiform. This landmark is concave and has a semicircular shape.
- d. The **pisiform articular facet** is located on the posterior surface and exhibits a kidney bean shape. This landmark is smaller than the superiorly placed ulnar articular facet.

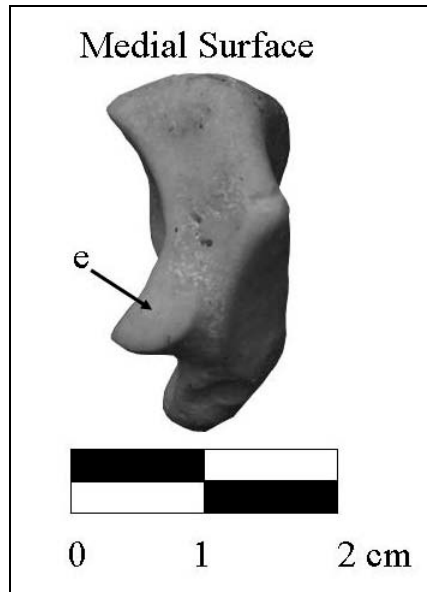


Figure 13. Right bear triquetral medial surface.
Key: e, scapho-lunar articular surface.

- e. The **scapho-lunar articular surface** is a small semicircular facet located on the inferior portion of the medial surface.

Possible confusion with human elements:

The bear triquetral is morphologically similar to the human scaphoid (Figure 14 and Figure 15). Both exhibit a rounded main portion and a large process/tubercle.

To distinguish between these two elements look for the following distinctive characteristics.

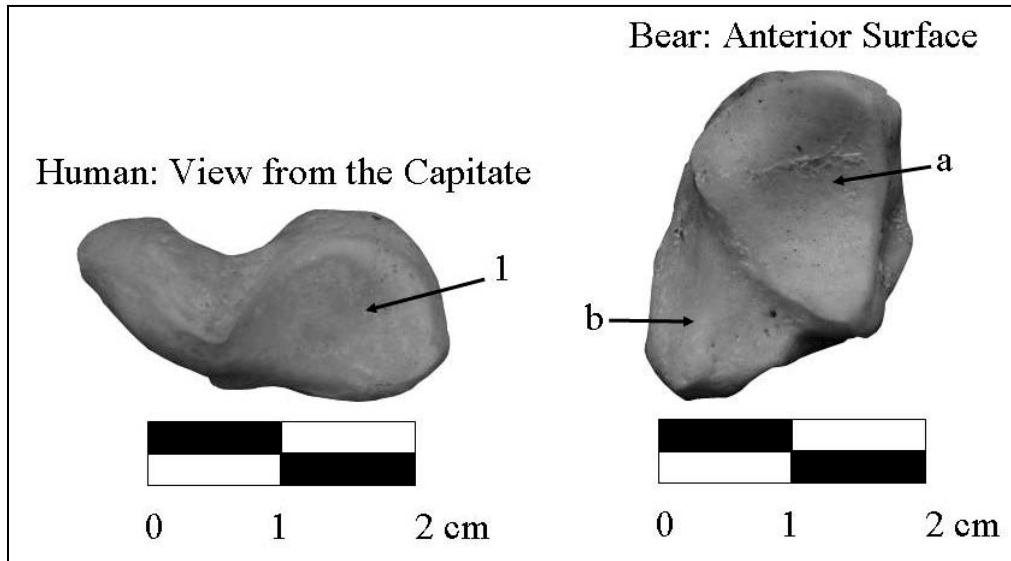


Figure 14. Right human scaphoid view from the capitate and right bear triquetral anterior surface. Key: a, hamate articular surface; b triquetral process; 1, capitate articular surface.

- The bear triquetral is approximately twice as large as the human scaphoid.
- The distal side of the human scaphoid (view from the capitate) and the anterior side of the bear triquetral both have a single concave facet. The facet on the human element is round (1) whereas the facet on the bear element is triangular (a).

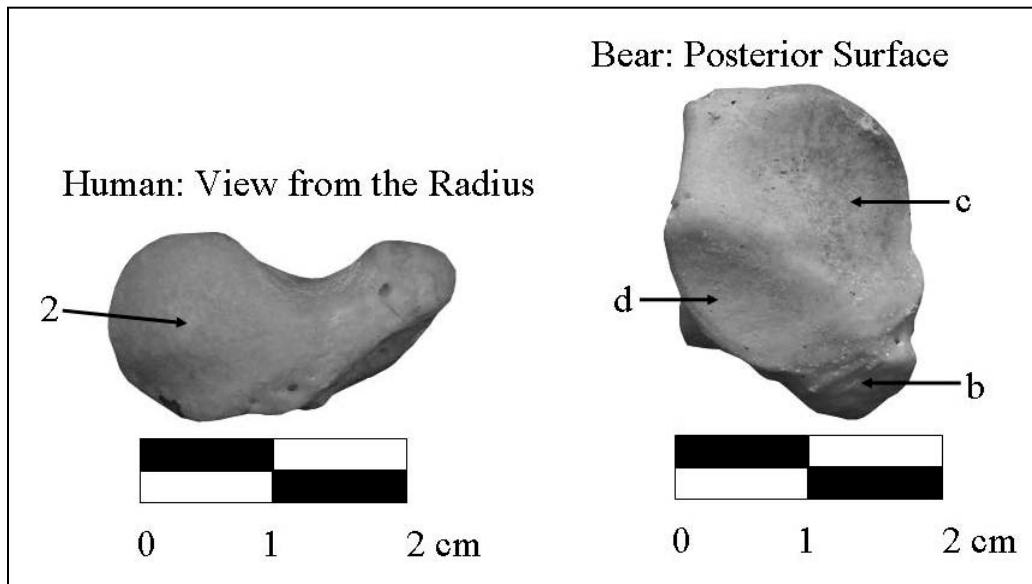


Figure 15. Right human scaphoid view from the radius and right bear triquetral posterior surface. Key: b, triquetral process; c, ulnar articular facet; d, pisiform articular facet; 2, radial facet.

- The proximal side of the human scaphoid (view from the radius) and the posterior surface of the bear triquetral look similar with both exhibiting a large articular surface. However, the proximal surface on the human scaphoid has a single facet for the radius (2), which is convex. Whereas the posterior surface of the bear element has two facets (c and d) and both are concave.

Trapezium

The term trapezium stems from the Greek word *trapezion* which literally means “small table” (Sandefur 1977). In the generalized mammal form this element is located on the radial side within the distal row of the carpal block, and is therefore situated between metacarpal I and the scaphoid. As previously mentioned, this element is not present in the deer.

Bear Trapezium

The bear trapezium is a wedge-shaped bone, located on the medial side of the manus (Figure 16 and Figure 17). It articulates with the scapho-lunar (posteriorly), the trapezoid (laterally) and the first metacarpal (anteriorly).

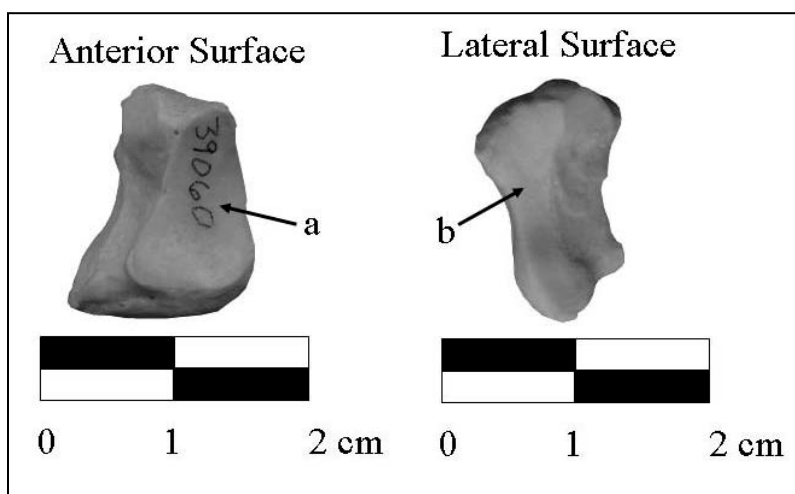


Figure 16. Right bear trapezium anterior and lateral surfaces.
Key: a, MC 1 articular surface; b, trapezoid articular surface.

- a. The **articular surface for MC 1** comprises the entire anterior surface of the element. It is a large vertical facet that exhibits a slightly concave appearance.
- b. The **trapezoid articular surface** is shaped like a lower case “r” and is located on the lateral surface of the trapezium.

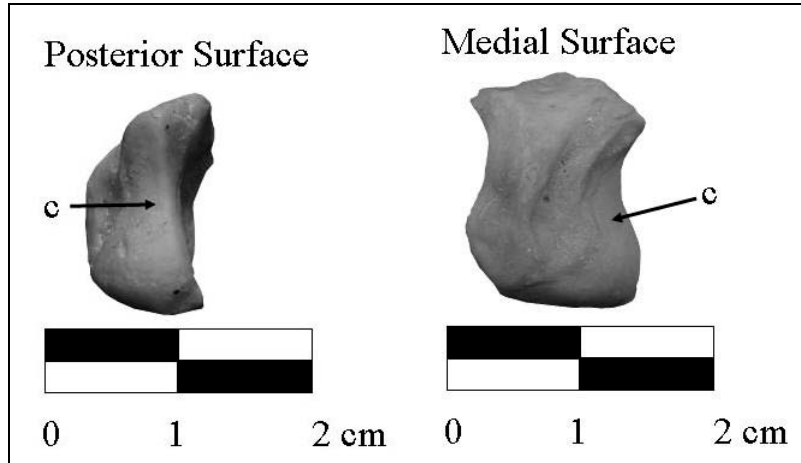


Figure 17. Right bear trapezium posterior and medial surfaces.
Key: c, scapho-lunar articular surface.

- c. The **scapho-lunar articular surface** is located on the posterior and medial surfaces. It is slightly concave and has an elliptical shape.

Possible confusion with human elements:

The bear trapezium is very similar in size and morphology to a human lunate (Figure 18). Morphologically, they both exhibit a crescent shape with concave articular facets.

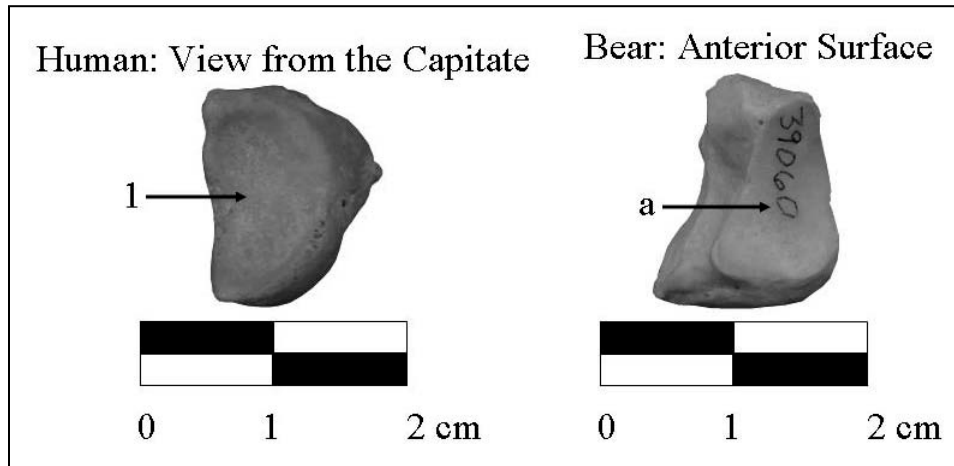


Figure 18. Right human lunate view from the capitata and right bear trapezium anterior view. Key: 1. capitata articular facet; a. MC 1 articular facet.

Despite these similarities the two species can easily be distinguished.

- The human lunate is cuboidal in shape while the bear trapezium has a more flattened and slightly twisted appearance.
- The human lunate exhibits a large concave articular facet where it comes into contact with the capitata (1). This landmark resembles the bear trapezium articular surface for MC 1 (a). To distinguish between these landmarks note that the facet on the human element is more concave and exhibits a less distinct border.

Trapezoid

Like the trapezium, the term trapezoid also stems from the Greek word *trapezion* which literally means “small table” (Sandefur 1977). In some mammal forms, such as the mule deer, the trapezoid is fused with the capitate forming an element called the trapezoid-magnum. The term magnum comes from the Latin word *magnus* meaning “great” (Sandefur 1977). In the generalized mammal form the trapezoid is positioned towards the radial side of the distal row of the carpal block.

Deer Trapezoid-magnum

The deer trapezoid-magnum is positioned on the medial side of the carpal block in the distal row and is one of the primary weight bearing carpals in the deer (Sandefur 1977) (Figure 19 and Figure 20). It articulates on the dorsal and posterior surfaces with the scaphoid and lunate, laterally with the unciform, and ventrally with the metacarpal.

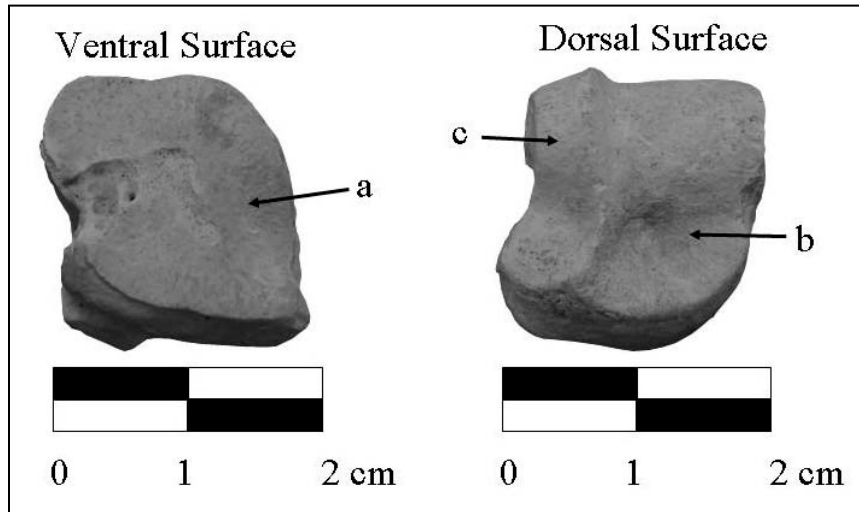


Figure 19. Right deer trapezoid-magnum ventral and dorsal surfaces.
 Key: a, MC articular surface; b, scaphoid articular surface; c, lunate articular surface.

- a. The **MC articular surface** comprises most of the ventral surface of the trapezoid magnum and its shape resembles a backwards “C.”
- b. The **scaphoid articular surface** is located on the medial side of the dorsal surface, adjacent to the lunate articular surface. It exhibits an “S” shape with a concave anterior portion and a convex posterior portion.
- c. The **lunate articular surface** is located on the lateral side of the dorsal surface. It is adjacent to and smaller than the scaphoid articular surface. This landmark is long and narrow and exhibits a concave anterior portion and a convex posterior portion.

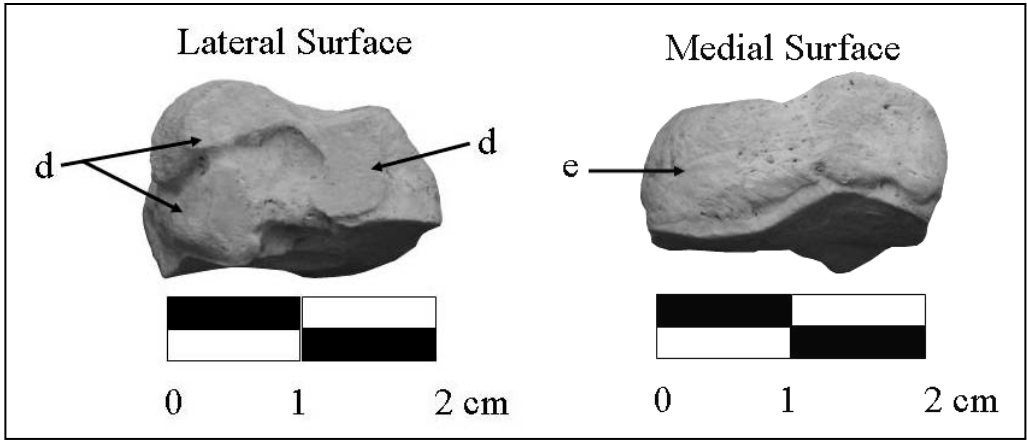


Figure 20. Right deer trapezoid-magnum lateral and medial surfaces.
Key: d, unciform articular facets; e, medial surface.

- d. There are **three articular facets for the unciform** and they are located on the lateral surface of the element. All three exhibit a semicircular appearance and they are separated by a concave roughened area.
- e. The **medial surface** of the trapezoid-magnum is rough with no articular facets; however, it can be easily identified by its “S” shape.

Bear Trapezoid

The trapezoid is the smallest of the bear carpals and is triangular in shape (Figure 21 and Figure 22). It is positioned in the distal row of the carpal block on the radial side. This element articulates with the capitate (laterally), the scapho-lunar (posteriorly), the trapezium (medially) and the second metacarpal (anteriorly).

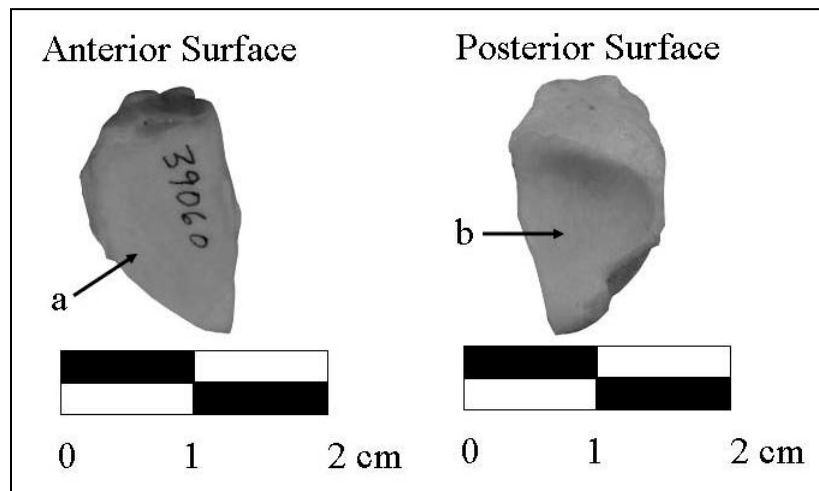


Figure 21. Right bear trapezoid anterior and posterior surfaces.
Key: a, MC 4 articular surface; b, scapho-lunar articular facet.

- a. The **MC 4 articular surface** comprises the entire anterior surface of the trapezoid. This landmark is triangular in shape and slightly convex.
- b. The **scapho-lunar articular facet** is located on the posterior surface, is angular in shape and concave.

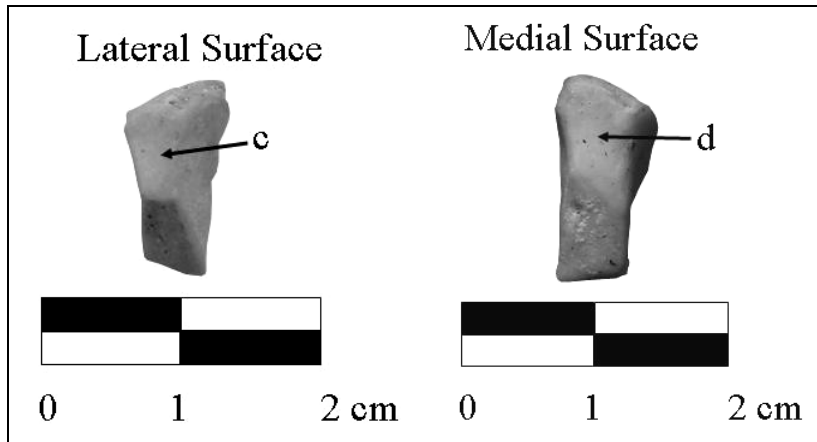


Figure 22. Right bear trapezoid lateral and medial surfaces.
Key: c, capitae articular facet; d, trapezium articular surface.

- c. The **capitate articular facet** is located on the superior portion of the lateral surface. It is small and rectangular in shape.
- d. The **trapezium articular surface** is located on the superior portion of the medial surface, and is small and narrow.

Possible confusion with human elements:

The bear trapezoid is similar in size to the human triquetral and both exhibit an angular shape (Figure 23). However, the two elements can be easily distinguished as the human triquetral has a pyramidal shape where as the bear trapezoid has an overall flattened appearance.

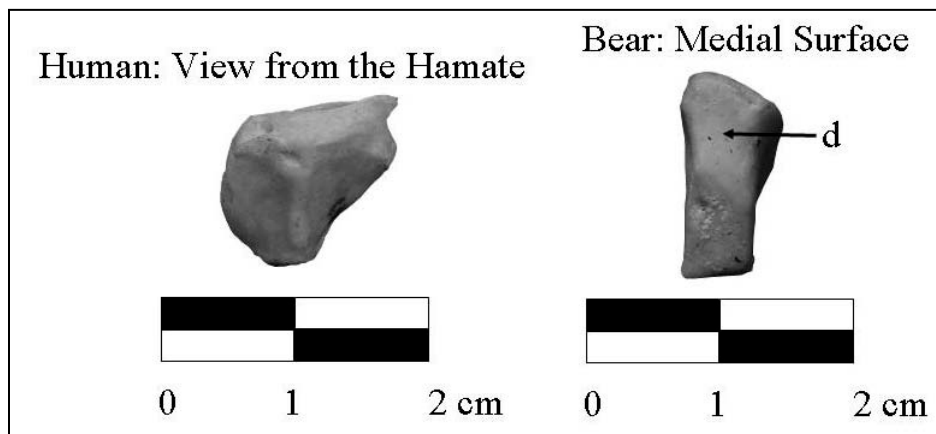


Figure 23. Right human triquetral view from the hamate and right bear trapezoid medial surface.
Key: d, trapezium articular surface.

Capitate

The name of this element stems from the Latin word *capitatus* which means “having a head.” This descriptive name refers to the element’s large rounded portion or head where it articulates with the scaphoid and lunate. The base of the capitate is square, morphology dictated by its articulation with the third metatarsal. The capitate is located in the distal row of the carpal block towards the midline of the hand.

Deer Trapezoid-magnum

As previously mentioned the deer capitate is fused with the trapezoid and is commonly referred to as the trapezoid-magnum. For further discussion see the above trapezoid section.

Bear Capitate

The bear capitate lives up to its name, as it possesses a distinctive large rounded head (Figure 24 and Figure 25). This element articulates with the scapho-lunar (posteriorly), the hamate (laterally) the trapezoid and fourth metacarpal (medially) and the third metacarpal (anteriorly). It is located in the distal row of the carpal block, along the midline.

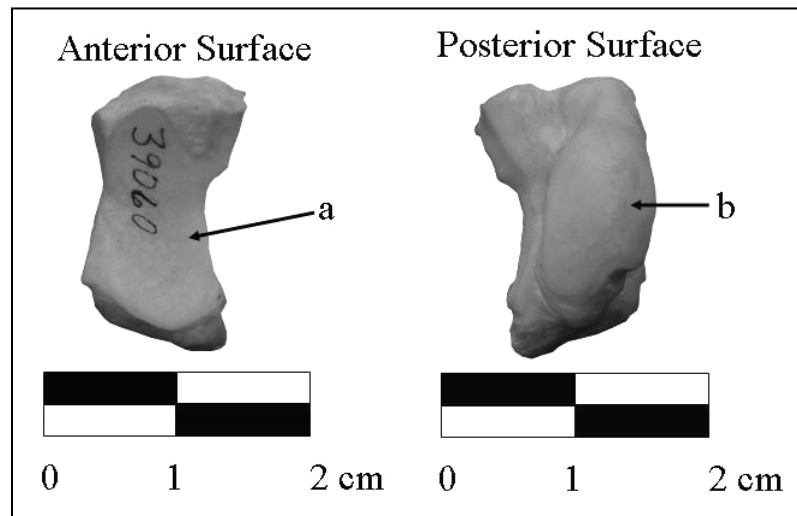


Figure 24. Right bear capitate anterior and posterior surfaces.

Key: a, MC 3 articular surface; b, head.

- a. The **articular surface for the proximal end of MC 3** is a rectangular concave facet that comprises the entire anterior surface of the capitate. Both its medial and lateral sides pinch in towards the midline.
- b. The **head** of the capitate articulates with the scapho-lunar (posteriorly). This landmark is a long and narrow vertically oriented feature with a smooth convex surface.

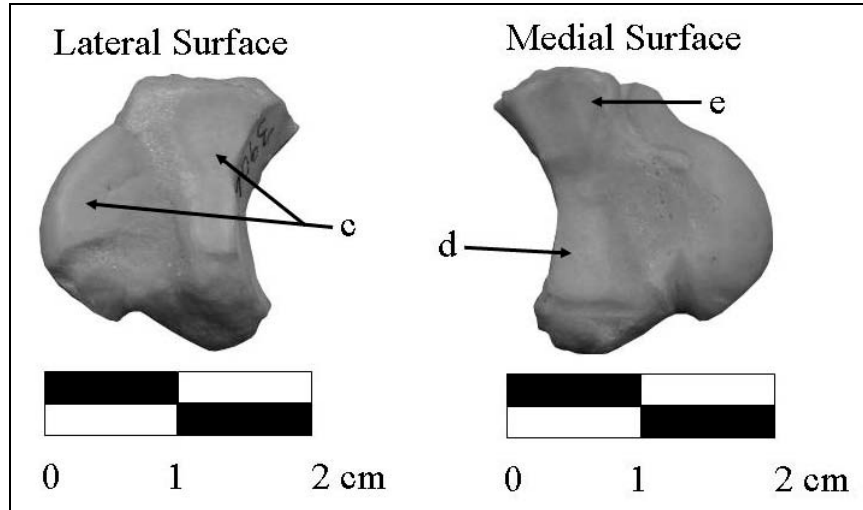


Figure 25. Right bear capitate lateral and medial surfaces.

Key: c, hamate articular facets; d, MC 4 articular facet; e, trapezoid articular surface.

- c. There are **two hamate articular facets** located on the lateral surface. The first is triangular in shape, narrow and located anteriorly. The second is positioned on the head and exhibits a semicircular appearance.
- d. The **MC 4 articular surface** is located on the anterior portion of the medial surface. This landmark exhibits a narrow rectangular shape.
- e. The **trapezoid articular surface** is located adjacent to the MC 4 articular surface on the medial surface along the dorsal border. This landmark is small and non-distinct.

Possible confusion with human elements:

The bear capitate is similar to the human capitate in size and basic structure (Figure 26 and Figure 27). Both have a large articular head, a square-like body and a flattened distal end. To distinguish between these two elements look for the following distinctive characteristics.

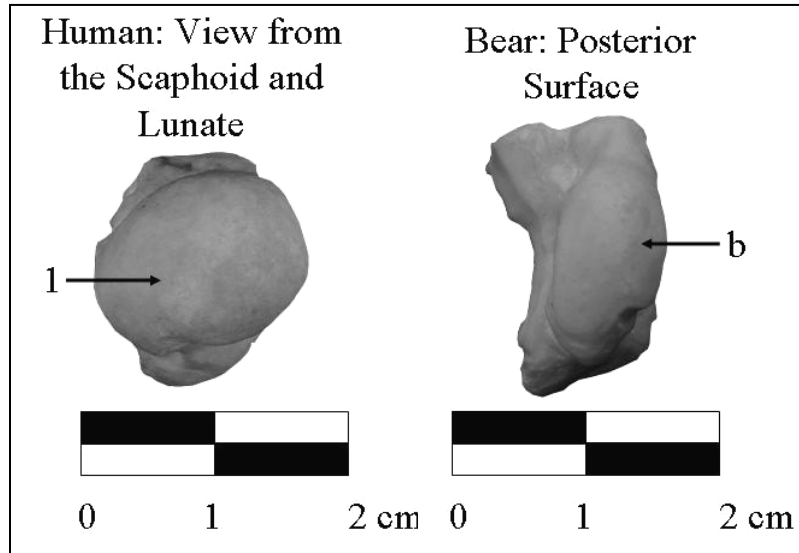


Figure 26. Right human capitate view from the scaphoid and right bear capitate posterior surface. Key: 1, head; b, head.

- The head of the human capitate (1) is round whereas in the bear (b) it is oval.
- The overall shape of the bone is chunky in human and rectangular in bear.

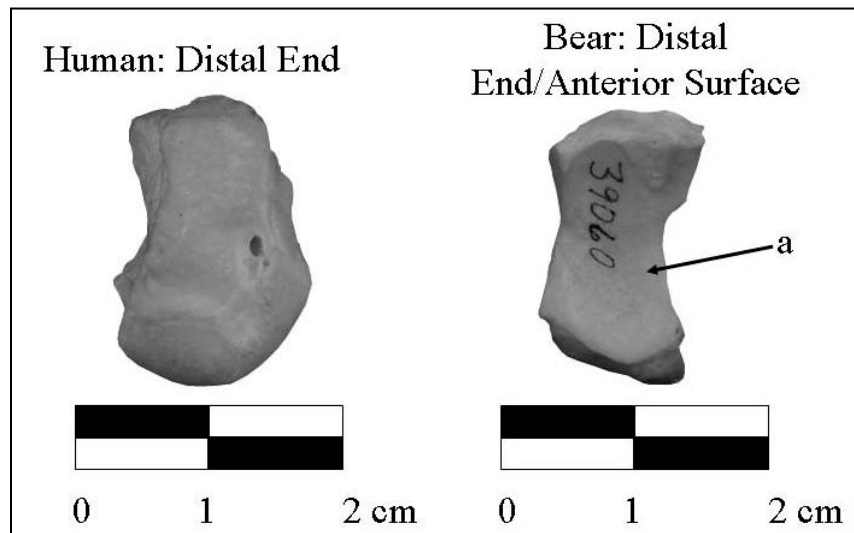


Figure 27. Right human and bear capitate distal ends. Key: a, MC 3 articular surface.

- The distal end of the human capitate is less rectangular than that of the bear, and it does not exhibit pinched medial and lateral borders.

Hamate

The hamate, which is also commonly referred to as the unciform, is located in the distal row of the carpal block. It is named for and easily distinguished by its hamulus or hook-shaped process (Sandefur 1977; White 2000).

Deer Hamate (Unciform)

The deer unciform is positioned in the distal row of the carpal block on the lateral side (Figure 28 and Figure 29). It articulates with the lunate and the cuneiform (superiorly), the trapezoid-magnum (medially) and the metacarpal (inferiorly). The unciform can most easily be identified by its stair stepped appearance when viewed posteriorly (Figure 28).

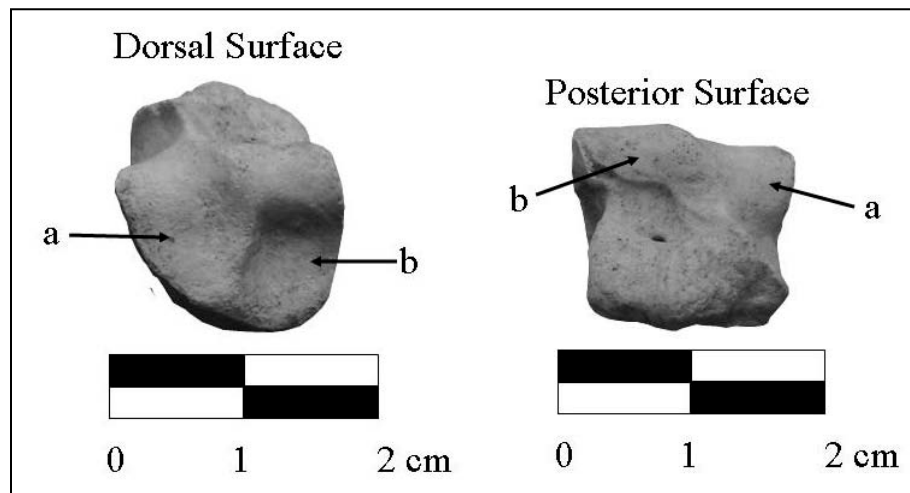


Figure 28. Right deer unciform dorsal and posterior surface.
Key: a, cuneiform articular surface; b, lunate articular surface.

- a. The **cuneiform articular surface** is located on the lateral portion of the dorsal surface and continues onto the posterior surface. It is adjacent to the lunate articular surface from which it is separated by a slight ridge.
- b. The **lunate articular surface** is located on the medial side of the unciform's dorsal surface, adjacent to the articular surface for the cuneiform.

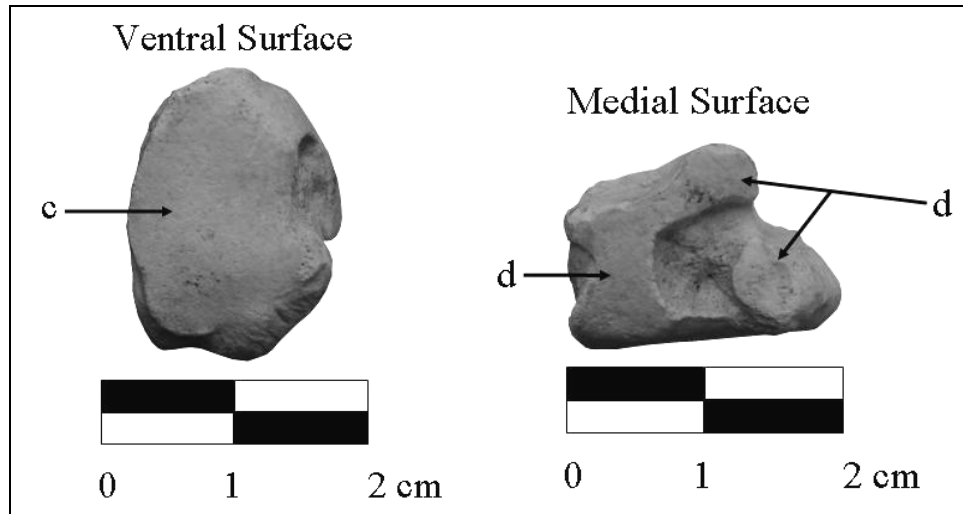


Figure 29. Right deer unciform ventral and medial surfaces.
Key: c, MC articular surface; d, lunate articular facets.

- c. The **MC articular surface** composes the entire ventral surface of the unciform. It is flat and resembles a kidney bean in shape.
- d. There are **three articular facets for the lunate** located on the medial surface of the unciform. The two posterior facets are circular where as the anterior facet is more rectangular.

Bear Hamate

The bear hamate is cuboidal in shape and is located on the lateral side of the distal row in the carpal block (Figure 30 and Figure 31). It articulates with five other elements including the scapho-lunar (posteriorly), the triquetral (laterally), the capitate (medially) and the fourth and fifth metacarpals (anteriorly).

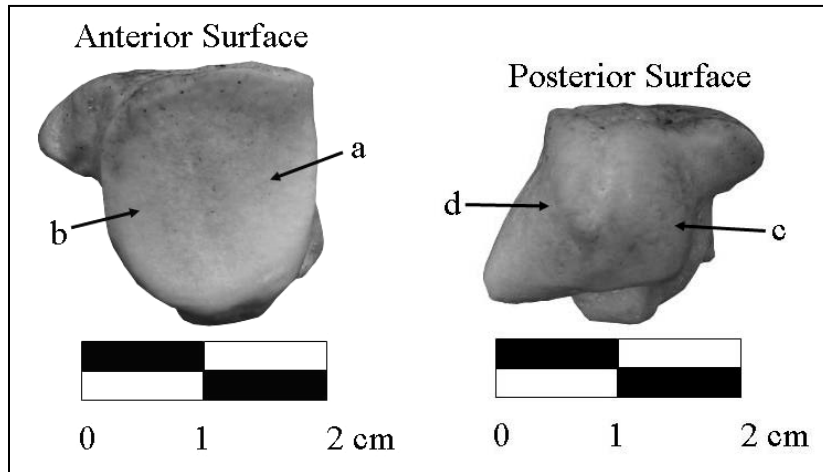


Figure 30. Right bear hamate anterior and posterior surfaces.

Key: a, MC 4 articular surface; b, MC 5 articular surface; c, triquetral articular surface; d, scapho-lunar articular surface.

- a. The **MC 4 articular surface** composes the medial half of the anterior surface of the hamate. This facet is slightly concave and adjacent to the MC 5 articular surface, from which it is separated by a very slight depression.
- b. The **MC 5 articular surface** composes the lateral half of the anterior surface of the hamate. This facet is slightly concave and adjacent to the MC 4 articular surface.
- c. The **triquetral articular surface** is a large convex facet that can be seen on both the posterior and lateral surfaces. It is positioned adjacent to the scapho-lunar articular surface from which it is separated by a groove.
- d. The **scapho-lunar articular surface** can be seen from both the posterior and medial surfaces. It is large, irregularly shaped and extends inferio-medially.

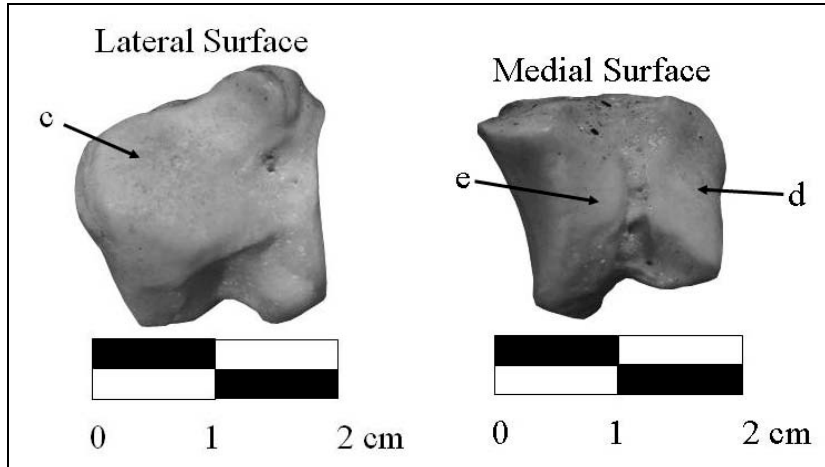


Figure 31. Right bear hamate lateral and medial surfaces.

Key: c, triquetral articular surface; d, scapho-lunar articular surface; e, capitate articular surface.

- e. The **capitate articular facet** is positioned along the anterior border of the medial surface. This landmark is slightly convex and angular.

Possible confusion with human elements:

The overall shape of the bear hamate could be confused with the human cuboid, as both are very irregular (Figure 32). However, the human cuboid is about twice the size of the bear hamate and also exhibits a large number of foramina. In addition, the human cuboid has primarily flat articular facets, where as the facets on the bear hamate are more rounded.

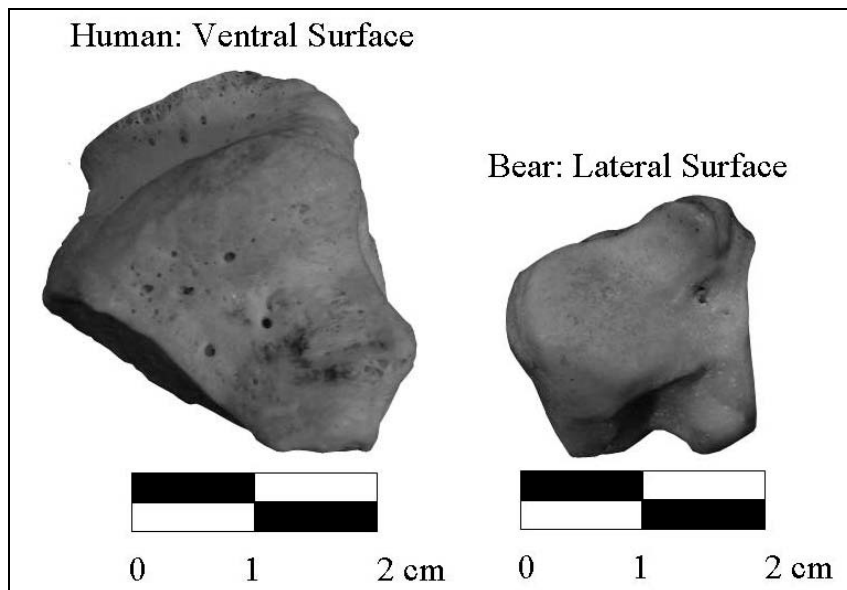


Figure 32. Right human cuboid ventral surface and right bear hamate lateral surface.

Pisiform

The pisiform is a sesamoid bone that is often highly developed. In humans it is approximately the size of a pea and its single articular surface is its primary distinctive feature. The size and shape of the pisiform varies greatly among mammals.

Deer Pisiform

The deer pisiform is roughly the size and shape of a kidney bean and it articulates with only one element, the triquetral (anteriorly) (Figure 33). It is situated in the upper region of the carpal block and is positioned on the posterior side.

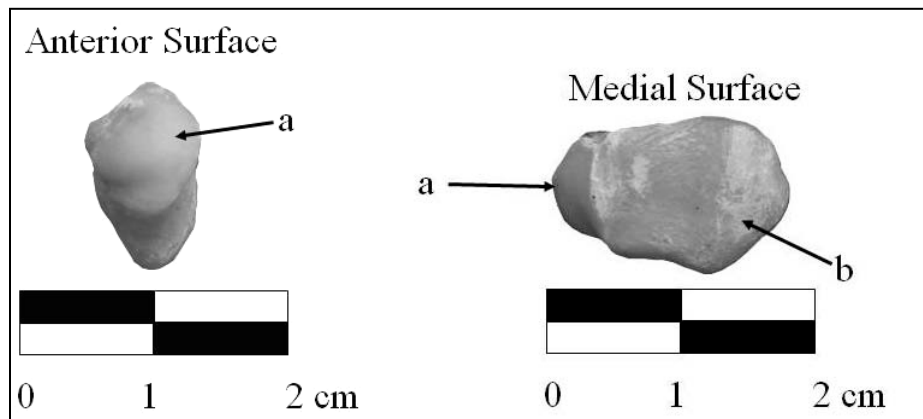


Figure 33. Right deer pisiform anterior and medial surfaces.
Key: a, triquetral articular surface; b, non-articular body.

- a. The **triquetral articular surface** is slightly convex and circular in shape. It is located on the anterior surface.
- b. The **non-articular body** of the pisiform is rough in texture and serves as an attachment site for soft tissue.

Possible confusion with human elements:

The deer pisiform could be confused with the human pisiform as they are both small rounded elements with a single articular surface for the triquetral (Figure 34). However, the deer pisiform is more elongated and flattened than that of the human.

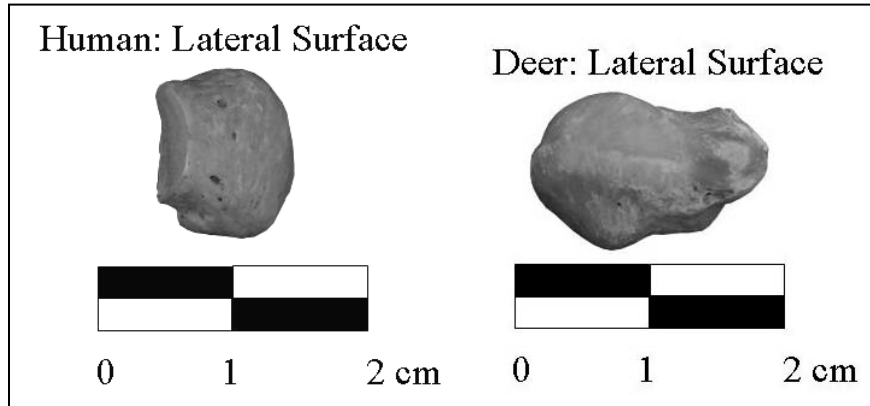


Figure 34. Right human and deer pisiforms lateral surfaces.

Bear Pisiform

The bear pisiform is a large sesamoid bone with an elongated, tubular shape (Figure 35 and Figure 36). Its most distinctive feature is its bifurcated anterior surface which has two articular facets for the ulna and triquetral.

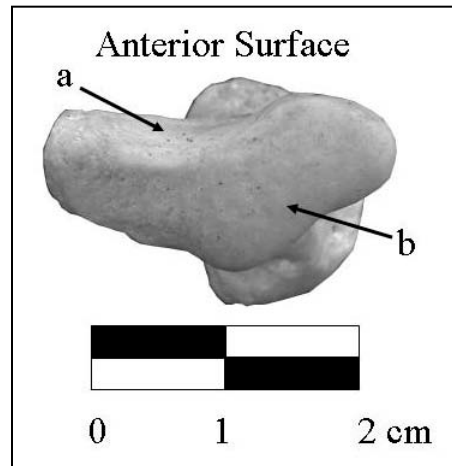


Figure 35. Right bear pisiform anterior surface.
Key: a, ulnar articular surface; b, triquetral articular surface.

- a. The **ulnar articular surface** is located on the anterior surface, just superior to the articular facet for the triquetral. It is horizontally oriented and concave. This landmark is also visible from the dorsal view of the element.
- b. The **triquetral articular surface** is located on the inferior portion of the anterior surface. It is horizontally oriented, concave and is longer than the ulnar articular facet which it is adjacent to. This landmark is also visible from the ventral view of the element.

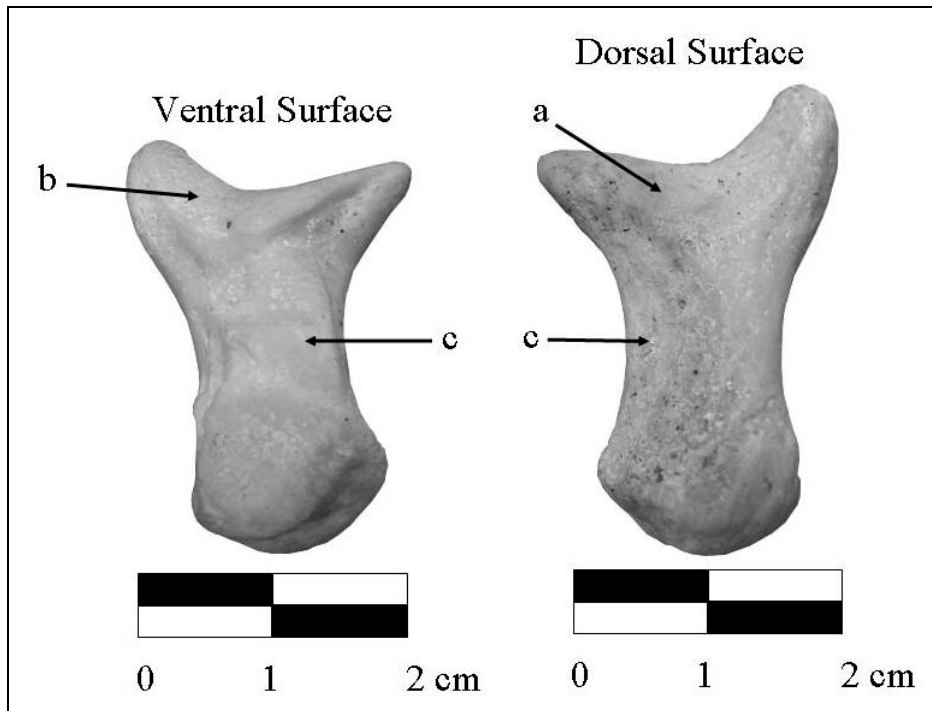


Figure 36. Right bear pisiform ventral and dorsal surfaces.

Key: a, ulnar articular surface; b, triquetral articular surface; c, non-articular body/shaft.

- c. The **non-articular body/shaft** of the pisiform is rough in texture and serves as an attachment site for soft tissue.

Possible confusion with human elements:

The bear pisiform with its elongated tubular shape does not resemble a human carpal or tarsal. However, it could be confused with the human MT 1 if fragmented. (Figure 37). The posterior end of the bear pisiform is rounded and bulbous like the distal end of the MT 1 and both also exhibit a round shaft. The shaft diameter of the bear pisiform is generally smaller than that of the human MT 1, however it does fall into the range of a gracile human.

To distinguish between these two elements look for the following distinctive characteristics.

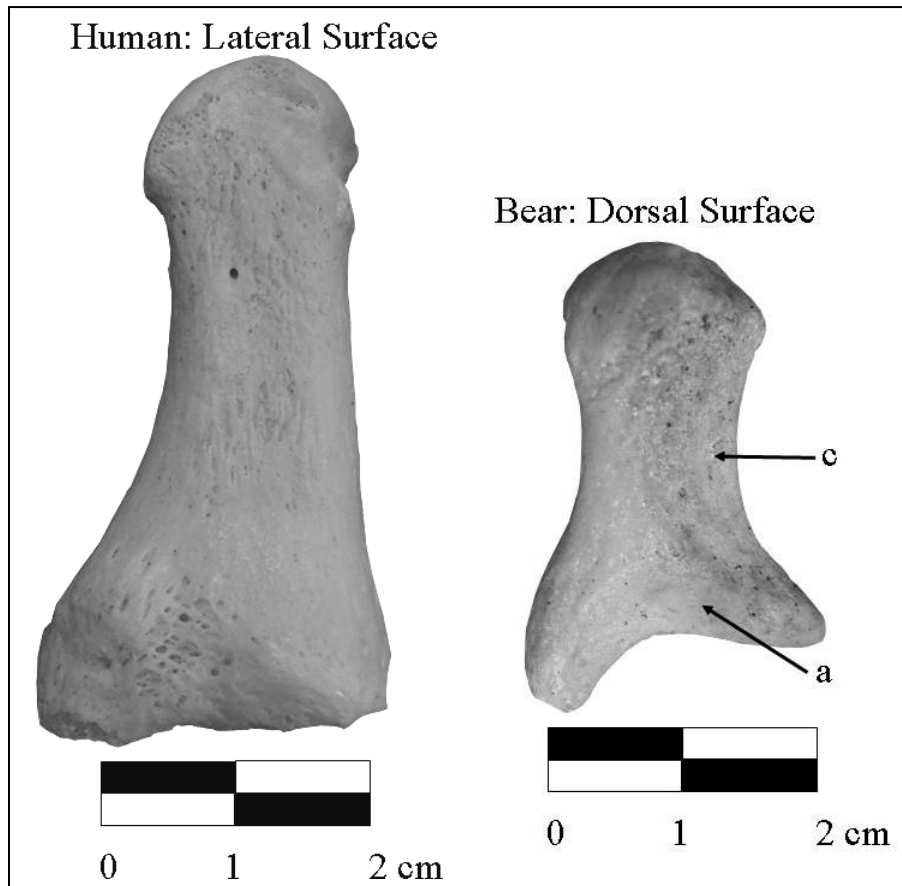


Figure 37. Right human MT 1 lateral surface and right bear pisiform dorsal surface. Key: a, ulnar articular surface; c, non-articular body/shaft.

- The bear pisiform is much shorter in length than the human MT 1.
- The anterior end of the bear pisiform is bifid with two elongated articular facets (a and b), while there are no features on the human first metatarsal that could be confused for this feature. The proximal end of the human MT 1 exhibits a flat surface with a single large rounded articular facet for the medial cuneiform.

CHAPTER V: THE MORPHOLOGY OF THE ANKLE

The mammalian foot (pes) generally has 26 bones, which are divided into three groups: tarsals, metatarsals and phalanges. The lower hind-limb with which the foot articulates is composed of the tibia and fibula.

Tarsals are small irregularly shaped bones that form from single primary ossification centers. The one exception to this rule is the calcaneus, which forms from two (Flower 1885; Scheuer and Black 2000). Tarsals articulate with each other through synovial joints, resulting in very limited mobility. Further, the most proximal tarsal, the astragalus articulates with the lower leg elements (tibia and fibula) and the distal carpals (medial, intermediate, and lateral cuneiforms and the cuboid) articulate with the metatarsals (MT).

Generalized mammals have five metatarsals, numbered one through five (medial to lateral) (Flower 1885). Deer however, exhibit a more derived anatomy with the loss of foot elements typical of the even toed artiodactyls. They exhibit vestigial 2nd and 5th metatarsals and one large metatarsal formed from the fused 3rd and 4th metatarsals (Cornwall 1964; Flower 1885). Metatarsals are tubular bones that form from two centers of ossification. All metatarsals have epiphyses at the distal end except the first, which has an epiphysis at the proximal end. All of the metatarsals are positioned in a parallel arrangement and have limited mobility between them. The metatarsals articulate proximally with the tarsals and distally with the corresponding proximal pedal phalanges.

The phalanges of the foot, like in the hand, comprise five digits. Deer are again an exception with only four digits and two of which are reduced. Each digit has a proximal, an intermediate, and a distal (ungual) phalanx. The one exception is the first digit, the hallux, which is comprised of only two phalanges, a proximal and a distal. Phalanges all form from two ossification centers with epiphyses at the proximal end.

The Tarsals

In the general mammalian form there are a total of seven tarsal bones that are arranged in two (proximal and distal) transverse rows. The proximal row includes the astragalus (talus in humans) and the calcaneus. The distal row includes the medial, intermediate, and lateral cuneiforms and the cuboid. An additional tarsal, the navicular, is positioned between the proximal and distal rows on the medial side (Figure 38).

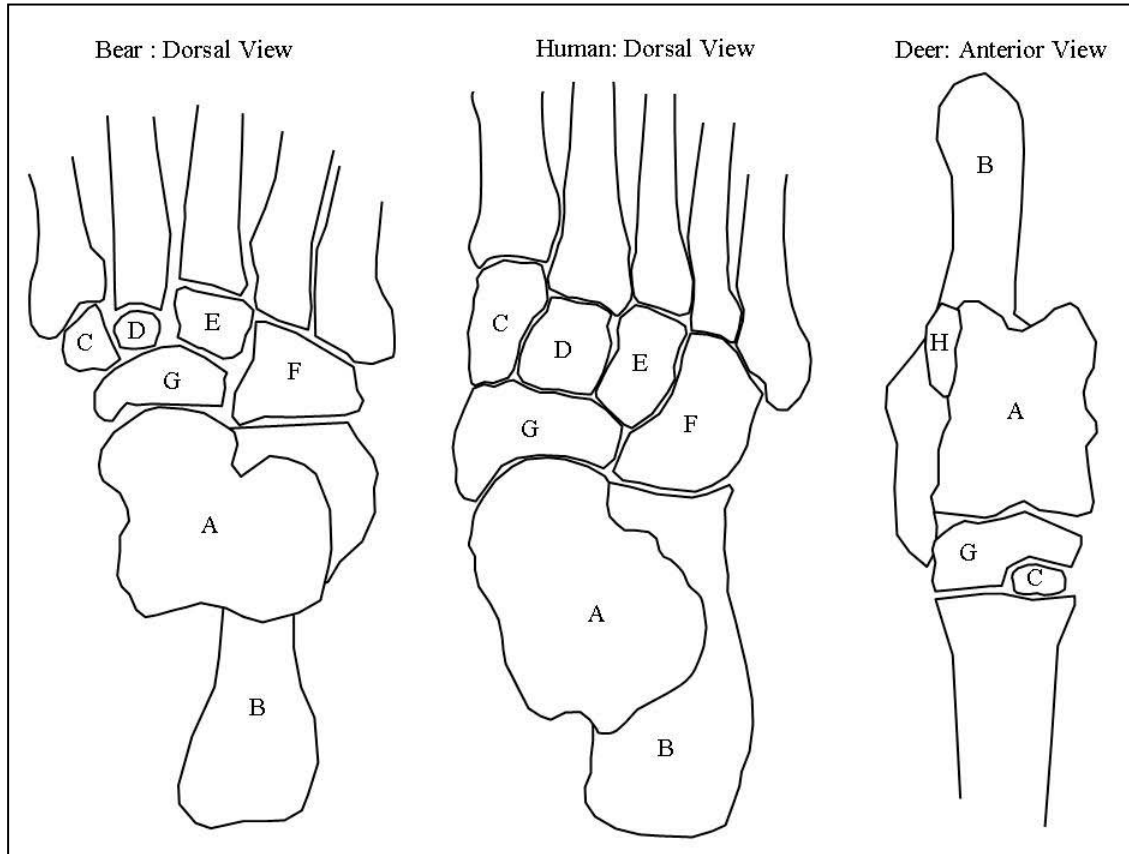


Figure 38. Schematic drawing of bear, human and deer right tarsals.
Key: A, talus/astragalus; B, calcaneus; C, medial cuneiform; D, intermediate cuneiform; E, lateral cuneiform; F, cuboid; G, navicular/naviculo-cuboid; H, lateral malleolus.

There are several systems for tarsal bone nomenclature; synonyms are presented in Table 3 (Bass 1995; Cornwall 1964; Flower 1885; White 2000).

Table 3. Tarsal Name Synonyms

Tarsal Names	Synonyms
astragalus	talus, tibiale, intermedium, ankle bone
calcaneus	calcaneum, cibulare, os calcis, heel bone
navicular	centrale, scphoideum
medial cuneiform	internal or 1st cuneriform, tarsal 1, entocuneiform
intermediate cuneiform	middle or 2nd cuneiform, tarsal 2, mesocuneiform
lateral cuneiform	external or 3rd cuneiform, tarsal 3, ectocuneiform
cuboid	tarsal 4 and 5, cuboideum
lateral malleolus	distal fibula, external malleolus, os malleolare

Astragalus

The astragalus, commonly referred to as the talus in humans, is the second largest tarsal bone. This element composes the tarsal portion of what is known as the ankle joint or tibio-tarsal joint. In most mammals the astragalus is located on the medial side of the foot. It articulates with the tibia and fibula (proximally), with the calcaneus (posteriorly and inferiorly), and with the navicular (distally).

Deer Astragalus

The specialized anatomy of the deer astragalus differs substantially from most mammals, including humans (Figure 39 and Figure 40). It articulates with four elements including the tibia (superiorly), naviculo-cuboid (inferiorly), calcaneus (posteriorly and laterally) and the lateral malleolus (laterally).

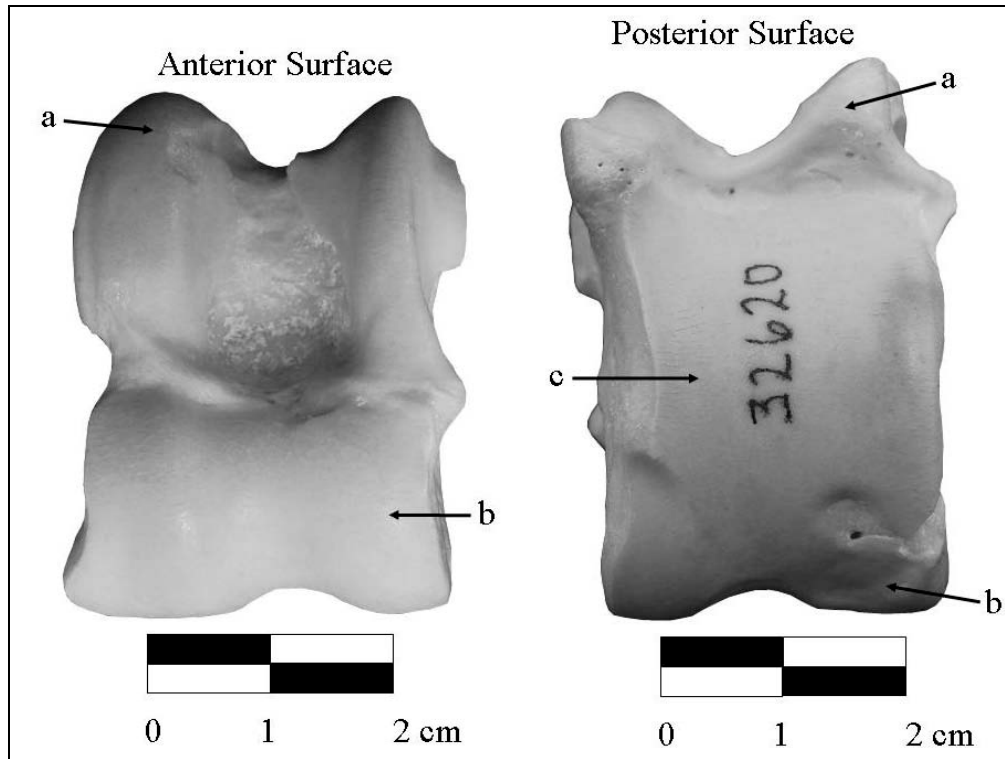


Figure 39. Right deer astragalus anterior and posterior surfaces.
Key: a, trochlea; b, head; c, calcaneal articular facets.

- a. The **trochlea** is the point of articulation for the tibia. It comprises most of the dorsal surface and can also be clearly seen from the anterior, posterior and medial views. It exhibits a pulley-like shape that is slanted medio-laterally.
- b. The **head** is the articular facet for the naviculo-cuboid and it comprises the entire ventral surface. This landmark can also be seen from the anterior and posterior views. Although, it is also saddle or pulley shaped, it can be distinguished from the trochlea by its greater robusticity and shallow midline depression.
- c. There are two **calcaneal articular facets**. The first facet comprises $\frac{3}{4}$ of the posterior surface and exhibits a convex shape. The second is semicircular and is located along the inferior border of the lateral surface as pictured below.

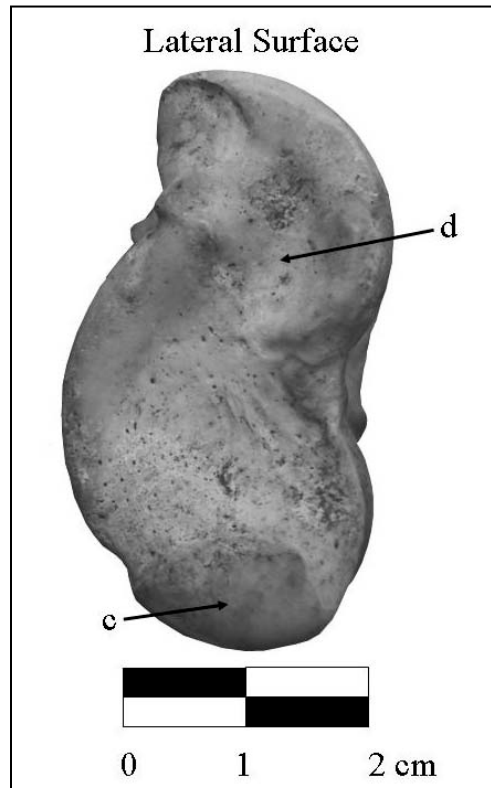


Figure 40. Right deer astragalus lateral surface.
Key: c, calcaneal articular facet; d, lateral malleolar articular facet.

- d. The **lateral malleolar articular facet** is positioned along the superior portion of the lateral surface. It exhibits an elongated curved shape.

Bear Astragalus

The bear astragalus, unlike that of the deer, exhibits a less derived structure, with a cubical-shaped body and large anterior projection known as the head (Figure 41 and Figure 42). It articulates with five elements including the tibia (superiorly), navicular (anteriorly), cuboid (anterio-laterally), fibula (laterally) and calcaneus (inferiorly).

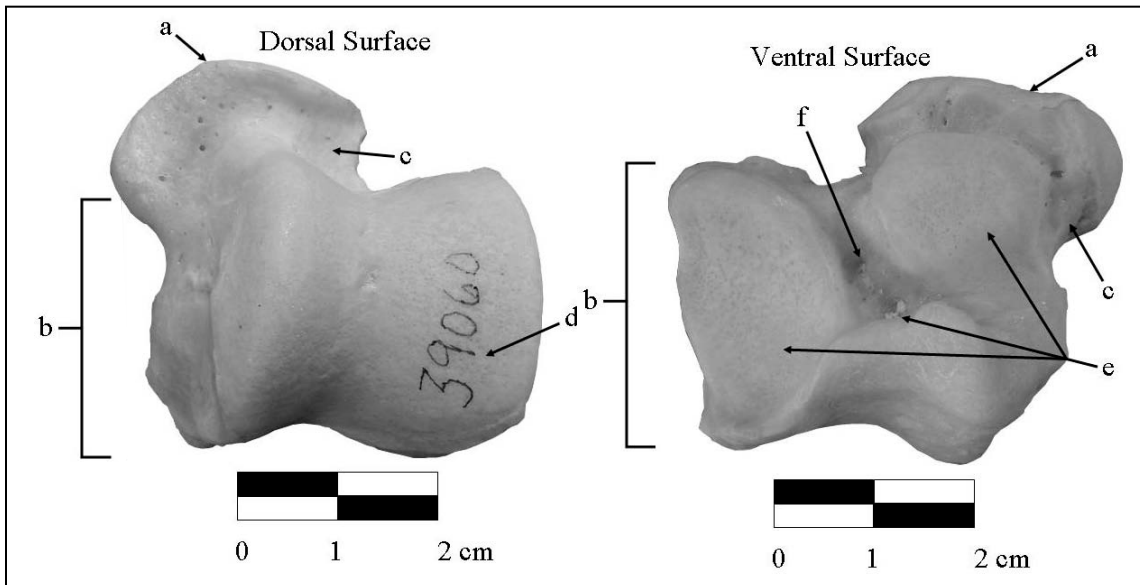


Figure 41. Right bear astragalus dorsal and ventral surfaces.

Key: a, head; b, body; c, neck; d, trochlea; e, calcaneal articular facets; f, sulcus tali.

- a. The **head** is a convex smooth oval-shaped articular surface that projects anteriorly on the medial side of the bone. It is comprised largely of the navicular articular surface.
- b. The **body** is the square shaped main portion of the element located posterior to the head.
- c. The **neck** is the portion of the element that connects the head and the body.
- d. The **trochlea** is a saddle-shaped articular surface on the dorsal surface of the body. It articulates with the distal tibia.
- e. There are **three calcaneal articular facets** located on the ventral surface of the body. The smallest facet is located in the medial posterior corner of the element and it is vertically oriented. The second is round and flat and is located along the medial border of the element, just posterior to the head. The largest of the three is located along the lateral border and is concave and oval in shape.
- f. The **sulcus tali** is a deep groove on the ventral surface that runs between the calcaneal facets.

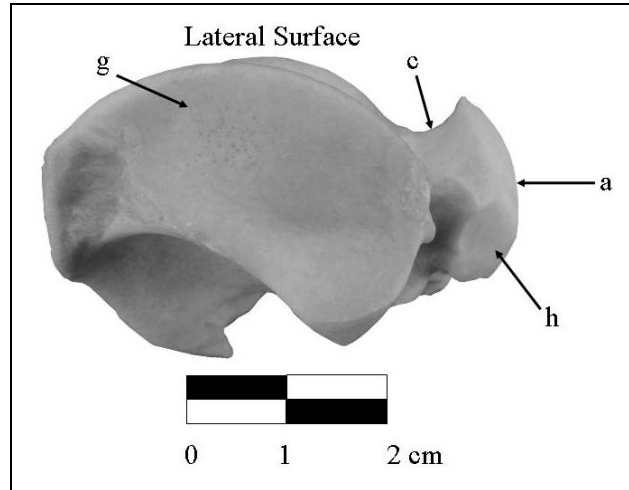


Figure 42. Right bear astragalus lateral surface.

Key: a, head; c, neck; g, fibula articular surface; h, cuboid articular surface.

- g. The **articular surface for the fibula** is located on the lateral side of the body and exhibits a concave crescent shape.
- h. The **cuboid articular surface** is a flat rounded facet located on the latero-inferior portion of the head where it meets the neck.

Possible confusion with human elements:

The bear astragalus is morphologically similar to the human talus (Figure 43 and Figure 44). Both exhibit a large cuboidal body with a trochlear surface on the superior side. On their inferior surfaces both exhibit three calcaneal facets. Further, they each have a large articular head on the medial side of their anterior surfaces and finally, both possess large articular facets for the fibula on their lateral surfaces.

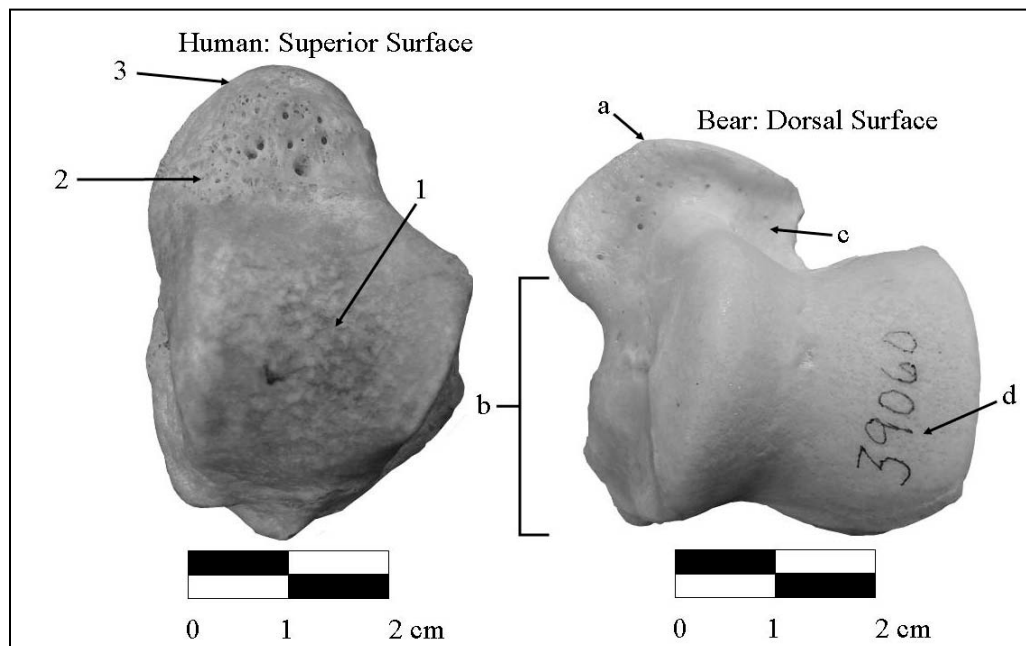


Figure 43. Right human talus superior surface and right bear astragalus dorsal surface. Key: 1, trochlea; 2, neck; 3, head; a, head; b, body; c, neck; d, trochlea.

To distinguish between these two elements look for the following distinctive characteristics.

- The human talus is more bulbous than that of the bear. Further, the bear talus exhibits a more flattened appearance.
- The trochlea on the bear astragalus (d) is concave along the mid-sagittal plane, which is not seen in the human element (1).
- The neck of the bear astragalus (c) is more pinched than the neck of the human talus (2).
- The head (3) is horizontally oriented in the bear and round in humans.

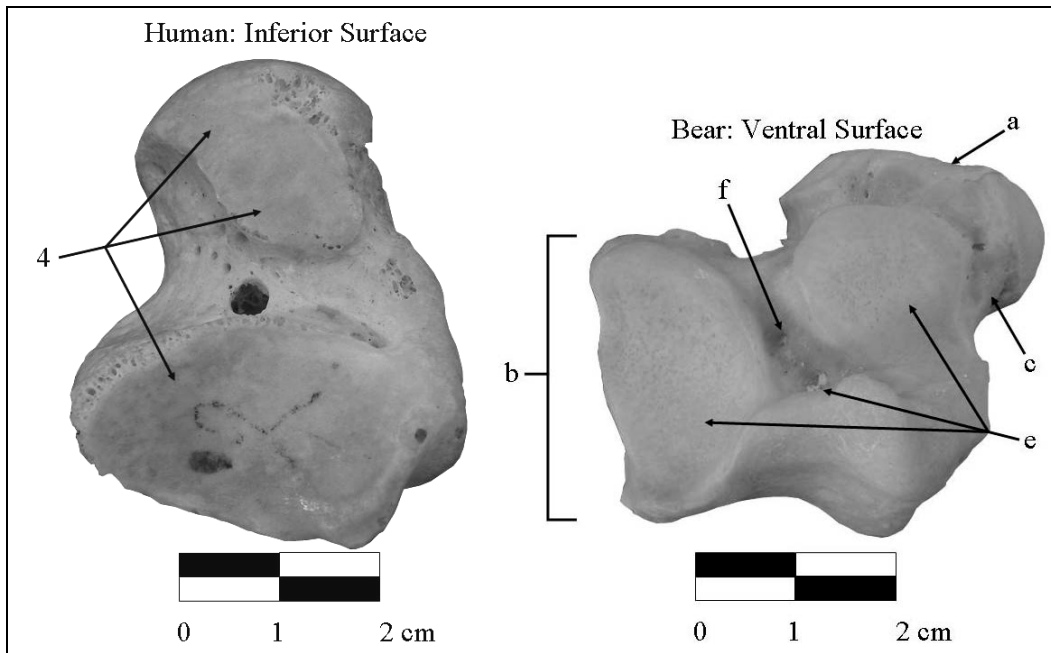


Figure 44. Right human talus inferior surface and right bear astragalus ventral surface.
 Key: 4, calcaneal articular facets; a, head; b, body; c, neck; e, calcaneal articular facets; f, sulcus tali.

- Both human and bear exhibit three calcaneal articular facets (4 & e) however, they vary greatly in their positioning.

Calcaneus

The calcaneus is generally the largest, longest and most distinct tarsal. In humans this element is commonly referred to as the heel, while it is called the hock in many non-human mammals. One of the most notable characteristics of the mammalian calcaneus is the elongated shape that runs anterior to posterior. This element is also unique because it is the only carpal or tarsal bone that often has two primary centers of ossification (Scheuer and Black 2000). In addition, an epiphyseal line can often be seen at the most posterior portion of the bone, which marks the point of fusion of a secondary ossification center, the calcaneal tuberosity (Flower 1885).

Deer Calcaneus

The deer calcaneus is notably long and narrow compared to humans and many other mammalian species (Figure 45). The positioning of the calcaneus, in a nearly vertical plane, is also quite different than that of either bear or human, which results from differences in their locomotor behaviors.

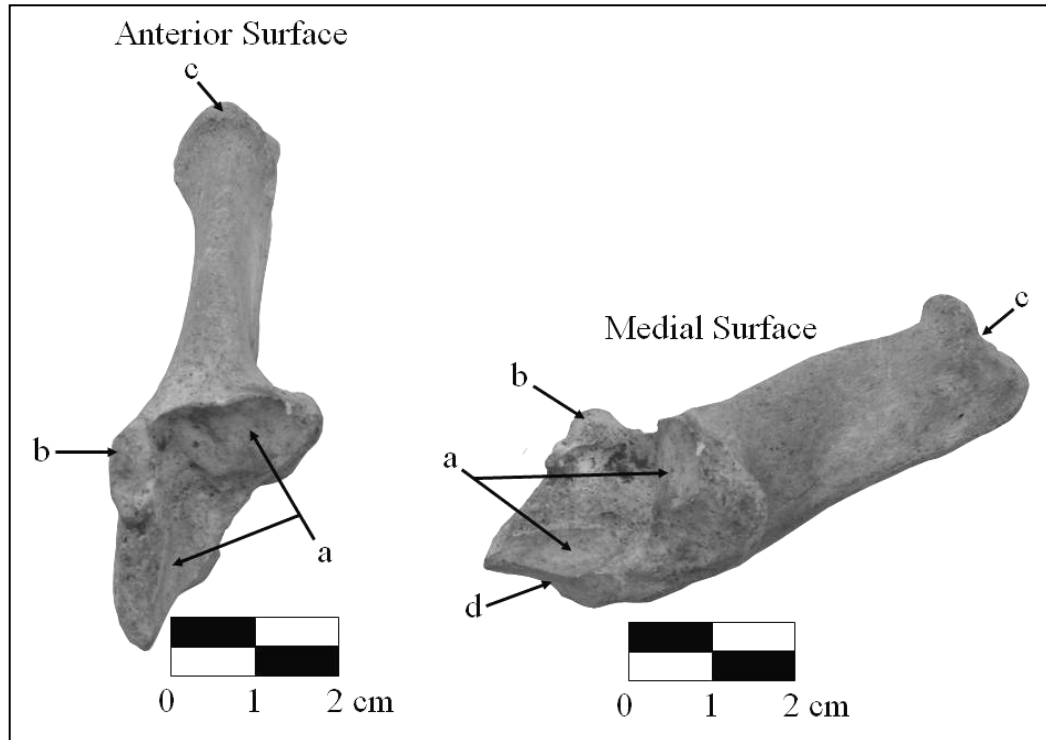


Figure 45. Right deer calcaneus anterior and medial surfaces.

Key: a, articular facets for the astragalus; b, lateral malleolar articular facet; c, calcaneal tuberosity; d, naviculo-cuboid articular facet.

- a. There are **two articular facets for the astragalus**, both positioned on the anterior portion of the element. The first is round, slightly convex and faces inferiorly. It articulates with the posterior side of the astragalus. The second facet is a long narrow landmark that faces medially and articulates with the lateral side of the astragalus.
- b. The **lateral malleolar articular facet** is a small bulbous projection located on the lateral side of the anterior portion of the element.
- c. The **calcaneal tuberosity** is a large non-articular process on the posterior portion of the bone that serves as an attachment site for the calcaneal tendon.
- d. The **naviculo-cuboid articular facet** exhibits an elongated curved appearance and is located on the inferior portion of the posterior surface.

Possible confusion with human elements:

The deer calcaneus has the same basic morphology as the human calcaneus; both have roughened and bulbous calcaneal tuberosities, shaft-like bodies and anterior ends exhibiting several articular surfaces (Figure 46). The views provided of each animal are not the same due to differences in the species' anatomical positioning.

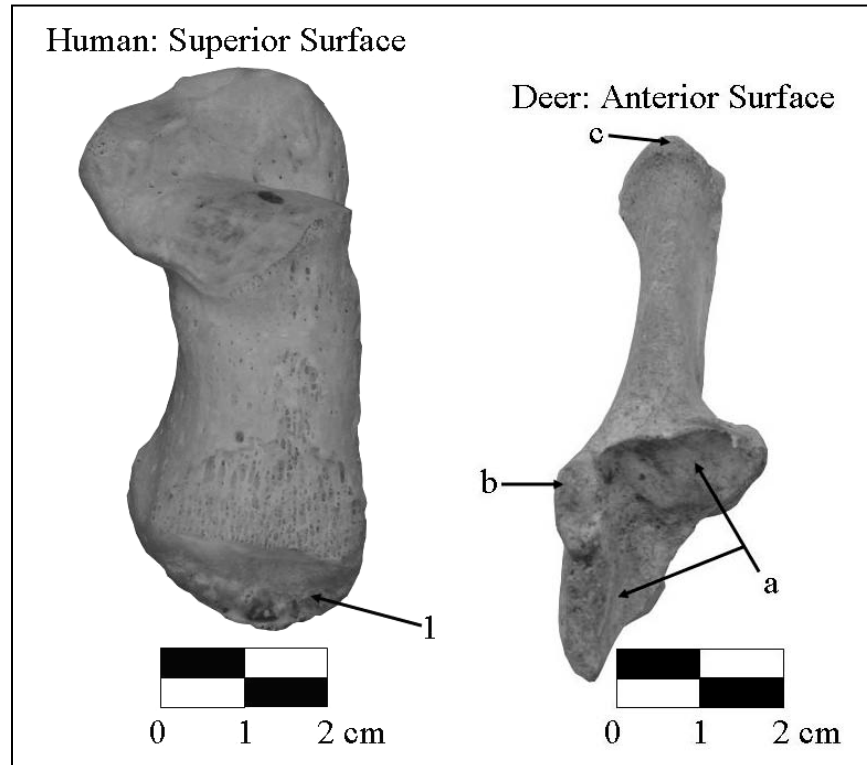


Figure 46. Right human calcaneus superior surface and right deer calcaneus anterior surface. Key: 1, calcaneal tuberosity; a, articular facets for the astragalus; b, lateral malleolar articular facet; c, calcaneal tuberosity.

To distinguish between these two elements look for the following characteristics.

- The deer calcaneus is much narrower and more angular than the human form.
- The calcaneal tuberosity is round in humans (1), while in deer (c) it is oblong and slightly bifid on its inferior aspect.
- The anterior portions of the elements share little resemblance. Note the differences in the location and shape of their articular facets.

Bear Calcaneus

The bear calcaneus is more robust and shorter than that of the deer (Figure 47). Its positioning in the body is much like that of the human form, with the astragalus superior to it and

the remainder of the tarsals positioned anteriorly. The calcaneus of the bear makes up the heel, as it does in humans.

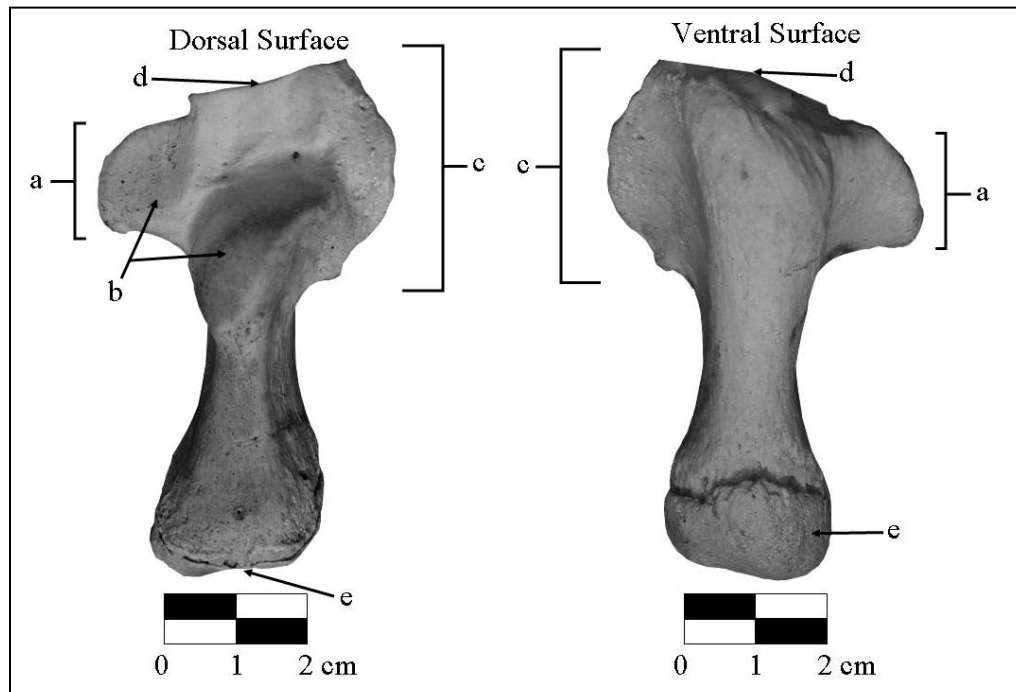


Figure 47. Right bear calcaneus dorsal and ventral views.

Key: a, sustentaculum tali; b, astragalus articular facets; c, lateral projection; d, cuboid articular surface; e, calcaneal tuberosity.

- a. The **sustentaculum tali** is a triangular shelf-like structure that protrudes from the element's medial side. This landmark is primarily responsible for supporting the medial half of the astragalus and exhibits an articular facet.
- b. There are **two articular facets for the astragalus**. The first (middle articular surface) is a rounded superior facing feature and is located on the sustentaculum tali. The second (posterior articular surface) is positioned just anterior to the shaft. This facet is a smooth convex elongated surface that slopes down from the midline of the bone laterally.
- c. The **lateral projection** is a round, shelf like landmark that serves as an attachment site for soft tissues.
- d. The **cuboid articular surface** is a large slightly concave rounded facet positioned on the anterior surface of the element.
- e. The **calcaneal tuberosity** at the posterior end of the bone is a large round billowing landmark that serves as the point of insertion for the calcaneal tendon.

Possible confusion with human elements:

The bear calcaneus is morphologically similar to the human calcaneus, with its roughened bulbous posterior end, shaft-like main portion and anterior end exhibiting several articular surfaces (Figure 48).

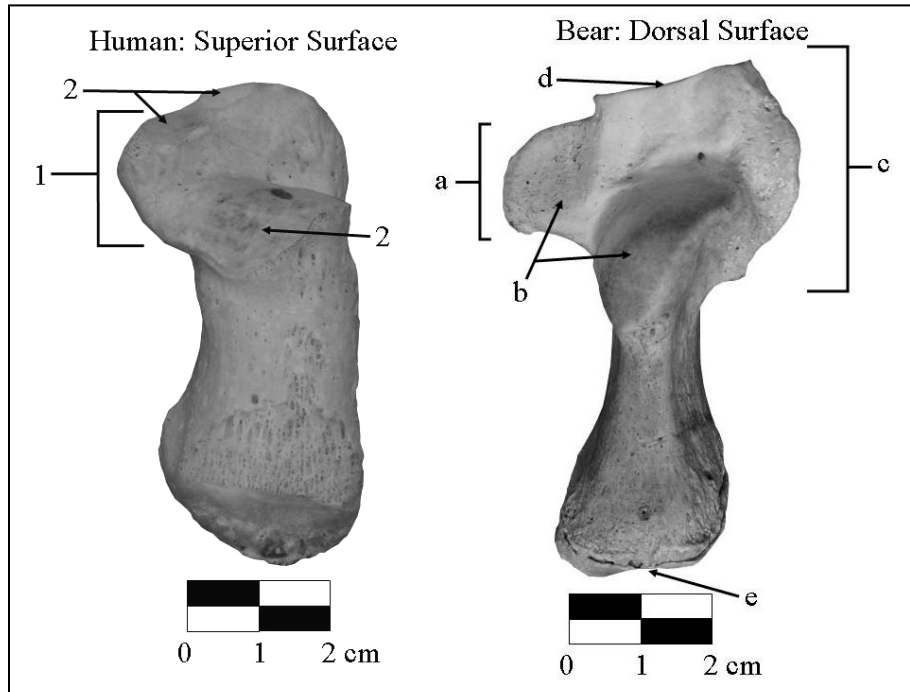


Figure 48. Right human calcaneus superior view and right bear calcaneus dorsal view. Key: 1, sustentaculum tali; 2, astragalus articular facets; a, sustentaculum tali; b, astragalus articular facets; c, lateral projection; d, cuboid articular facet; e, calcaneal tuberosity.

To distinguish between the bear and human calcaneus look for the following characteristics.

- Overall, the human calcaneus is more bulbous and robust, while the bear calcaneus is more angular.
- In humans, the sustentaculum tali (1) is more vertically oriented, while it is more horizontal in the bear (a).
- The human calcaneus exhibits three articular facets for the talus (anterior, middle and posterior) (2) whereas the bear form exhibits two distinct facets (middle and posterior) (b).

Navicular

The navicular was originally named for its large proximal articular surface, which resembles a boat. This element is located in the proximal row of the tarsal block. It articulates with the cuneiforms (distally), the talus/astragalus (proximally) and the cuboid (laterally). In some taxa, such as infraorder Pecora (which deer fall into), the navicular and the cuboid are fused. In such cases, this element is commonly referred to as the naviculo-cuboid (Flower 1885).

Deer Naviculo-cuboid

The deer naviculo-cuboid is a thick square shaped element (Figure 49). It articulates superiorly with the astragalus and calcaneus and inferiorly with the fused intermediate/lateral cuneiform, the medial cuneiform and the fused MT.

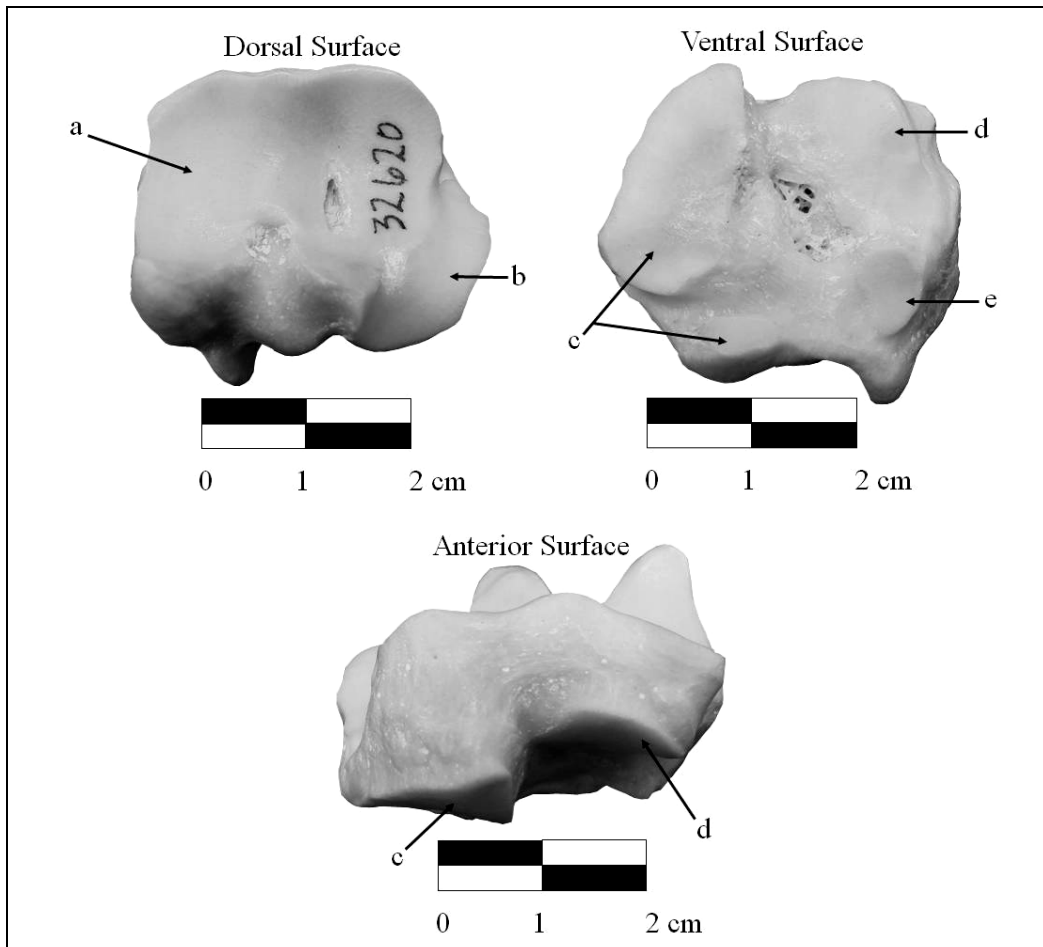


Figure 49. Right deer naviculo-cuboid dorsal, ventral and anterior surfaces.
 Key: a, articular surface for the astragalus; b, calcaneal articular surface; c, MT articular facets; d, articular facet for the intermediate/lateral cuneiform; e, medial cuneiform articular surface.

- a. The **articular surface for the astragalus** comprises the majority of the dorsal surface. This landmark has two depressed areas in which the head of the astragalus sits.
- b. The **calcaneal articular surface** is an elongated slightly convex facet located on the lateral side of the element adjacent to the articular surface for the astragalus.
- c. There are **two MT articular facets** on the ventral surface of the naviculo-cuboid. The first, located on the lateral portion of the element is tear drop shaped. The second is a small facet positioned along the lateral side of the posterior border.
- d. The **articular facet for the fused intermediate/lateral cuneiform** is positioned on the ventral surface in the anterior-medial quadrant. It is oval in shape and recessed.
- e. The **medial cuneiform articular surface** is a very small circular facet located on the ventral surface just posterior to the articular facet for the intermediate/lateral cuneiform.

Bear Navicular

The bear navicular lives up to its name as it is boat-like in appearance (Figure 50). Positioned on the medial side of the foot, the navicular articulates with the cuboid (laterally), the astragalus (posteriorly) and the medial, intermediate and lateral cuneiforms (anteriorly).

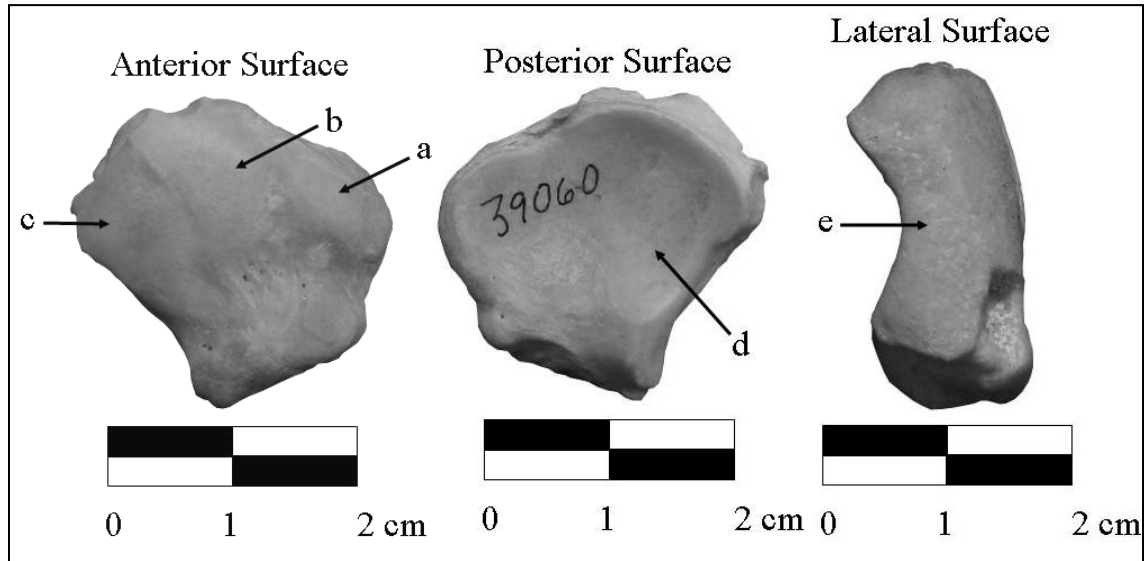


Figure 50. Right bear navicular anterior, posterior and lateral surfaces.

Key: a, medial cuneiform articular surface; b, intermediate cuneiform articular surface; c, lateral cuneiform articular surface; d, articular surface for the head of the astragalus; e, cuboid articular facet.

- a. The **medial cuneiform articular surface** is located on the medial side of the anterior surface, adjacent to the articular surface for the intermediate cuneiform. This facet is slightly convex and exhibits a non distinct shape.
- b. The **intermediate cuneiform articular surface** is located on the anterior surface between the medial and lateral cuneiform articular facets and is the largest of the three.
- c. The **lateral cuneiform articular surface** is located on the lateral side of the anterior surface, adjacent to the articular surface for the intermediate cuneiform. It is slightly convex and exhibits a non distinct shape.
- d. The **articular surface for the head of the astragalus** is a large oval concave facet on the posterior surface of the navicular.
- e. The **cuboid articular facet** is located on the lateral surface and exhibits a narrow crescent shaped appearance.

Possible confusion with human elements:

The bear navicular is morphologically quite similar to the human navicular (Figure 51 and Figure 52). In both cases the element has a flattened appearance with a large singular facet on the posterior side and an articular surface on the anterior side that can be divided into three facets. To distinguish between these two elements look for the following distinctive characteristics.

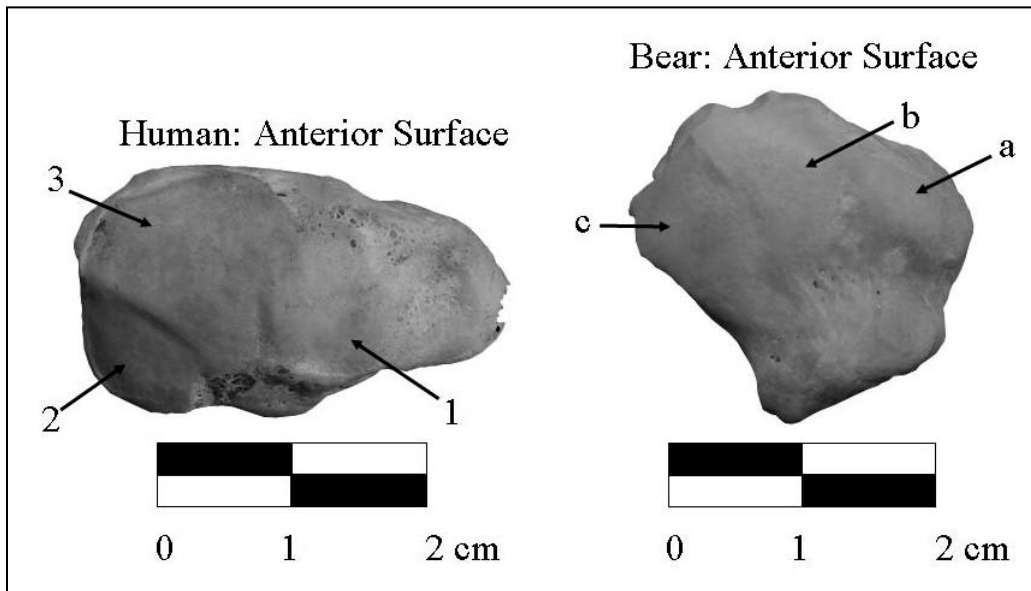


Figure 51. Right human navicular anterior surface and right bear navicular anterior surface. Key: 1, medial cuneiform facet; 2, lateral cuneiform facet; 3, intermediate cuneiform facet; a, medial cuneiform articular surface; b, intermediate cuneiform articular surface; c, lateral cuneiform articular surface.

- The human navicular is significantly larger and thicker than that of the bear.
- The human navicular is oval, whereas the bear navicular is triangular.
- The articular facets on the anterior side of the human navicular are more distinct than those of the bear. In human, the lateral and medial cuneiform facets (1 and 2) are round and the facet for the intermediate cuneiform (3) is triangular.

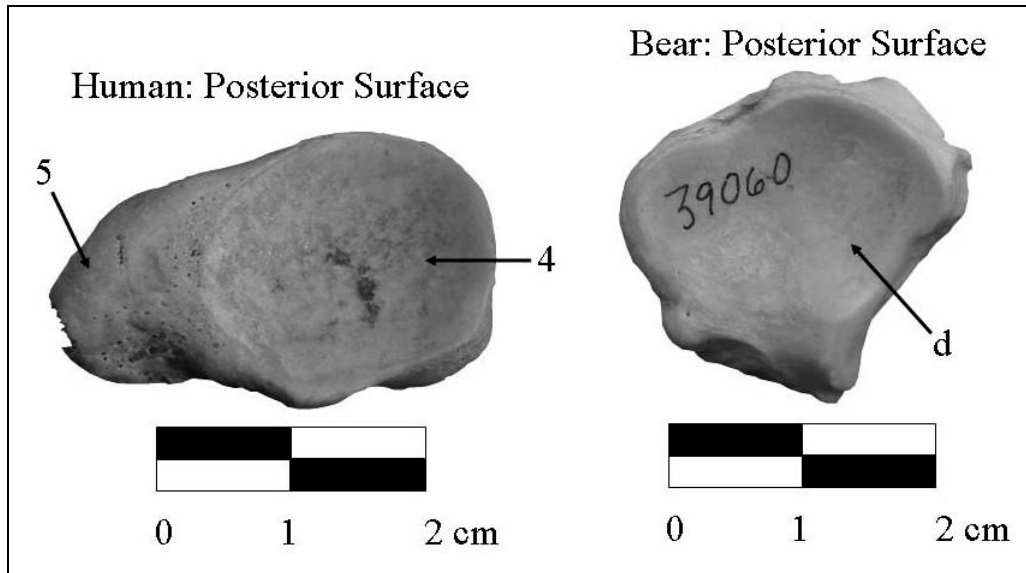


Figure 52. Right human navicular posterior surface and right bear navicular posterior surface. Key: 4, articular surface for the head of the talus; 5, tubercle; d, articular surface for the head of the talus.

- The posterior surface of both elements exhibits an oval-shaped facet for the head of the talus (4 and d). In the human form however, a large distinct tubercle (5) is present just medial to this landmark.

Medial Cuneiform

The term cuneiform stems from the Latin word *cuneus*, which means wedge-form. This descriptive term holds true for all three of the cuneiform bones of the foot. Of these, the medial cuneiform is the largest. It is positioned on the medial side of the tarsal block in the distal row. It articulates with the navicular (proximally), the intermediate cuneiform (laterally) and with the first metatarsal (distally).

Deer Medial Cuneiform

The deer medial cuneiform is spherical in form and noticeably small, measuring less than 1 cm in diameter (Figure 53). Due to this small size, it is often missing in comparative collections. Within the tarsal block this element is positioned on the medial side of the distal row, just posterior to the fused intermediate/lateral cuneiform. It exhibits a single articular facet where it contacts the naviculo-cuboid (superiorly).

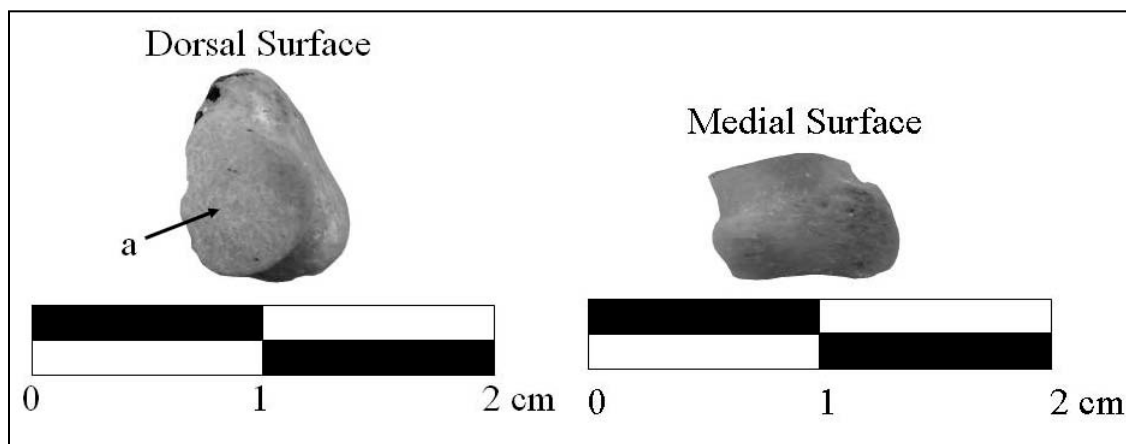


Figure 53. Right deer medial cuneiform dorsal and medial surfaces.
Key: a, naviculo-cuboid articular surface.

- a. The **naviculo-cuboid articular surface** covers the entire dorsal surface of the medial cuneiform. This landmark can be identified by its small round shape.

Possible confusion with human elements:

The deer medial cuneiform is very similar to the human pisiform, a sesamoid bone located in the hand (Figure 54). In both cases the elements are small and round and exhibit a singular round articular surface.

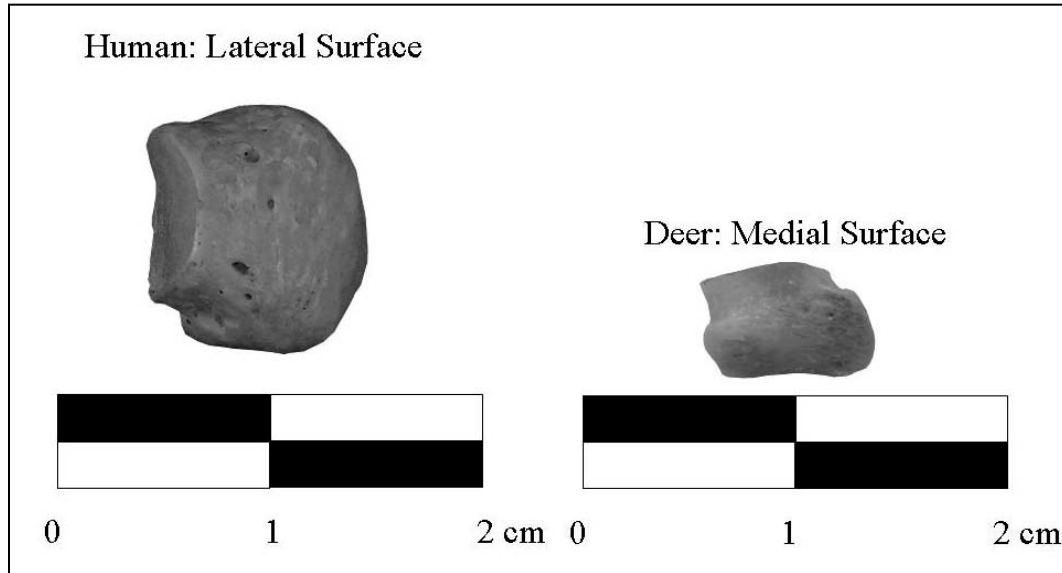


Figure 54. Right human pisiform lateral surface and right deer medial cuneiform medial surface.

- The human pisiform can be easily distinguished from the deer medial cuneiform based on its larger size.

Bear Medial Cuneiform

The bear medial cuneiform is shaped like a parallelogram and oriented diagonally on the medial side of the foot (Figure 55). It articulates with three elements including the first metatarsal (anteriorly), the navicular (posteriorly) and the intermediate cuneiform (laterally).

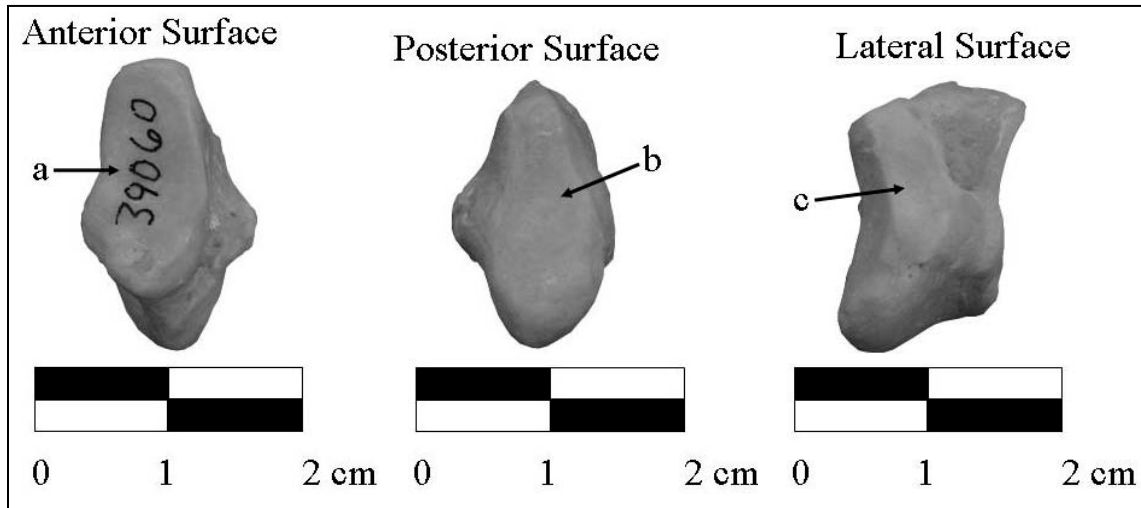


Figure 55. Right bear medial cuneiform anterior, posterior and lateral surfaces.

Key: a, MT 1 articular surface; b, navicular articular surface; c, intermediate cuneiform articular facet.

- a. The **MT 1 articular surface** covers the entire anterior surface of the medial cuneiform. This facet is concave and similar in size and shape to a kidney bean.
- b. The **navicular articular surface** covers the entire posterior surface of the element. It is slightly concave and is narrower than the MT 1 articular facet.
- c. The **intermediate cuneiform articular facet** is a small rounded landmark located on the anterior border of the element's lateral surface.

Intermediate Cuneiform

The intermediate cuneiform is the smallest of the three cuneiform bones and is located between the other two. It articulates with the navicular (proximally), the medial cuneiform (medially), with the lateral cuneiform (laterally) and with the second metatarsal (distally). In some animals, such as in the group Pecora, an infraorder of the order Artiodactyla, the intermediate cuneiform and the lateral cuneiform are fused. For lack of a better term, this element is referred to herein as the intermediate/lateral cuneiform. Common animals that fall within this grouping include: deer, sheep, goats and cattle.

Deer Intermediate/Lateral Cuneiform

The deer intermediate/lateral cuneiform is the size and shape of a kidney bean (Figure 56). It articulates with two elements including the naviculo-cuboid (superiorly) and the fused MT (inferiorly). The other surfaces are void of articular facets.

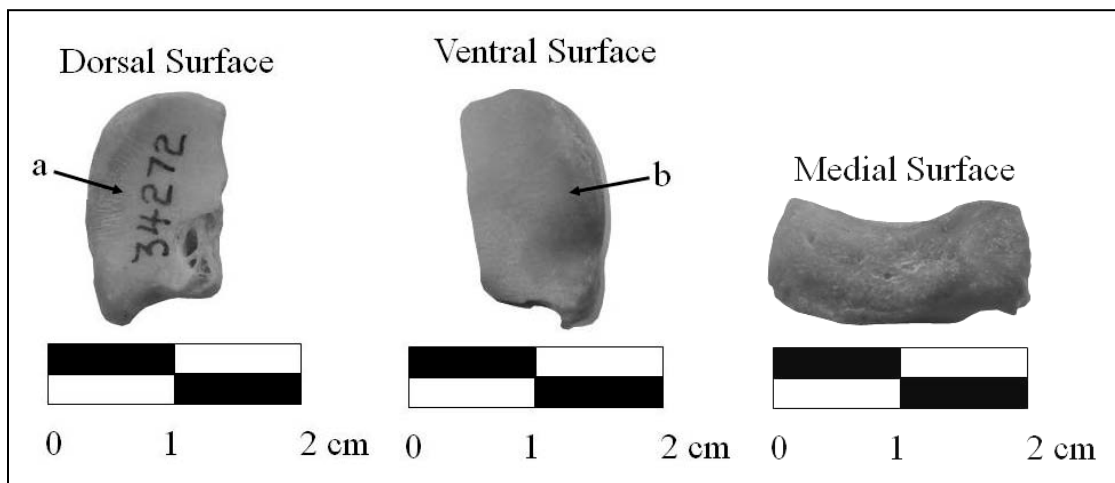


Figure 56. Right deer intermediate/lateral cuneiform dorsal, ventral and medial surfaces. Key: a, naviculo-cuboid articular surface; b, MT articular surface.

- a. The **naviculo-cuboid articular surface** covers almost the entire dorsal surface of the element. It is concave and kidney bean shaped.
- b. The **articular surface for the fused MT** is positioned on the ventral surface. It is very similar in size and shape to the naviculo-cuboid articular surface with the exception of being convex.

Possible confusion with other elements:

The deer intermediate/lateral cuneiform does not resemble the human cuneiforms due in large part to its block-like shape (Figure 57). However, there are morphological similarities between the deer intermediate/lateral cuneiform and the bear intermediate cuneiform. They share a common overall shape and size, as well as a small boney projection. To distinguish between these two elements look for the following distinctive characteristics.

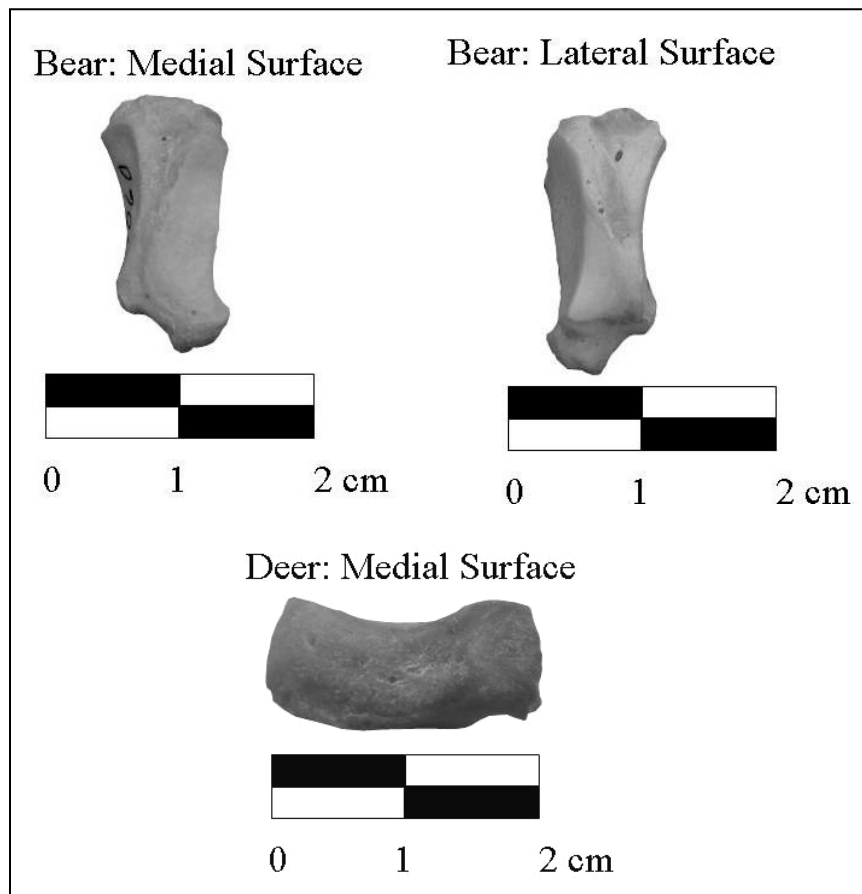


Figure 57. Right bear intermediate cuneiform medial and lateral surfaces and right deer intermediate/lateral cuneiform medial surface.

- The bear intermediate cuneiform exhibits articular facets on its medial and lateral sides, which are not seen in deer.

Bear Intermediate Cuneiform

The intermediate cuneiform is the smallest of the three cuneiforms in the bear and is shaped like a flattened rectangle, with a small projection on its inferior medial corner (Figure 58 and Figure 59). It articulates with four elements including the navicular (posteriorly), the lateral cuneiform (laterally), the second metatarsal (anteriorly) and the medial cuneiform (medially).

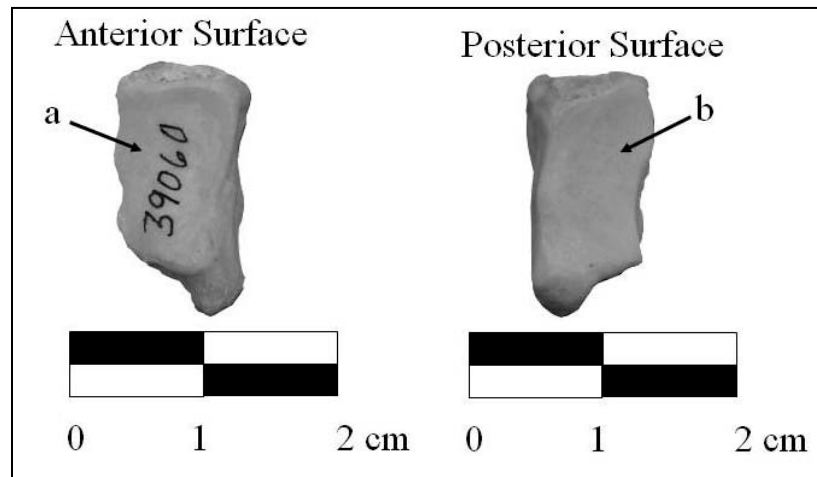


Figure 58. Right bear intermediate cuneiform anterior and posterior surfaces.

Key: a, MT 2 articular facet; b, navicular articular facet.

- a. The **MT 2 articular facet** comprises most of the intermediate cuneiforms anterior surface. This landmark is slightly concave and rectangular in shape.
- b. The **navicular articular facet** comprises most of the posterior surface of the intermediate cuneiform and looks very similar to the MT 2 articular facet. The navicular articular facet however, is more concave.

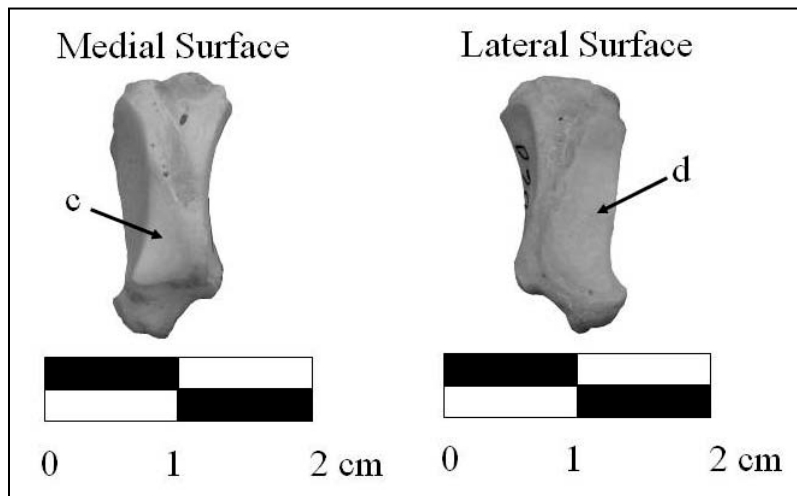


Figure 59. Right bear intermediate cuneiform medial and lateral surfaces.
Key: c, medial cuneiform articular facet; b, lateral cuneiform articular facet

- c. The **medial cuneiform articular facet** is semicircular and is located on the inferior portion of the medial surface along the posterior border.
- d. The **lateral cuneiform articular facet** is a non-distinct elongated landmark positioned along the lateral side of the element.

Possible confusion with other elements:

The bear intermediate cuneiform does not resemble a human tarsal due to its diminutive size and block-like shape. The human cuneiforms are all wedge-shaped and generally larger. However, there are morphological similarities between the bear intermediate cuneiform and the deer intermediate/lateral cuneiform. For further discussion on how to distinguish between these elements see the above deer intermediate/lateral cuneiform section.

Lateral Cuneiform

In the generalized mammal form the lateral cuneiform is larger than the intermediate cuneiform and smaller than the medial cuneiform. It is positioned in the distal row of the tarsal block between the intermediate cuneiform and the cuboid. The lateral cuneiform articulates with the navicular proximally and with the third metatarsal distally.

Deer Intermediate/ lateral Cuneiform

As previously mentioned, the intermediate and lateral cuneiforms are fused in the deer. For further discussion of this element see the intermediate cuneiform section above.

Bear Lateral Cuneiform

The lateral cuneiform is the largest of the three cuneiforms in the bear foot (Figure 60 and Figure 61). It is located on the lateral side of the tarsal block and is oriented diagonally. The lateral cuneiform articulates with four elements including the navicular (posteriorly), the cuboid (laterally), the intermediate cuneiform and the second metatarsal (medially) and with the third metatarsal (anteriorly).

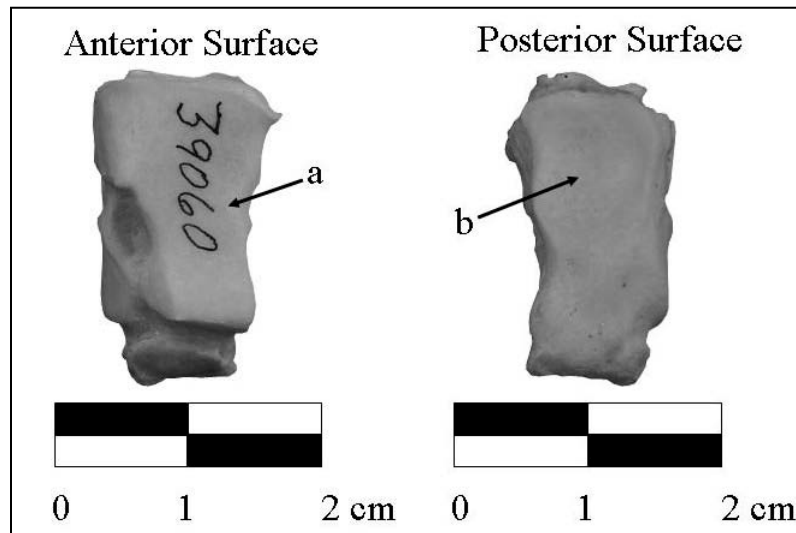


Figure 60. Right bear lateral cuneiform anterior and posterior surfaces.
Key: a, MT 3 articular facet; b, navicular articular facet.

- a. The **MT 3 articular facet** comprises most of the anterior surface. This large concave facet has angular borders and is pinched in on the inferior portion of its lateral side.
- b. The **navicular articular facet** is located on the element's posterior surface. It too is concave, but smaller than the MT 3 articular facet, and exhibits rounded borders.

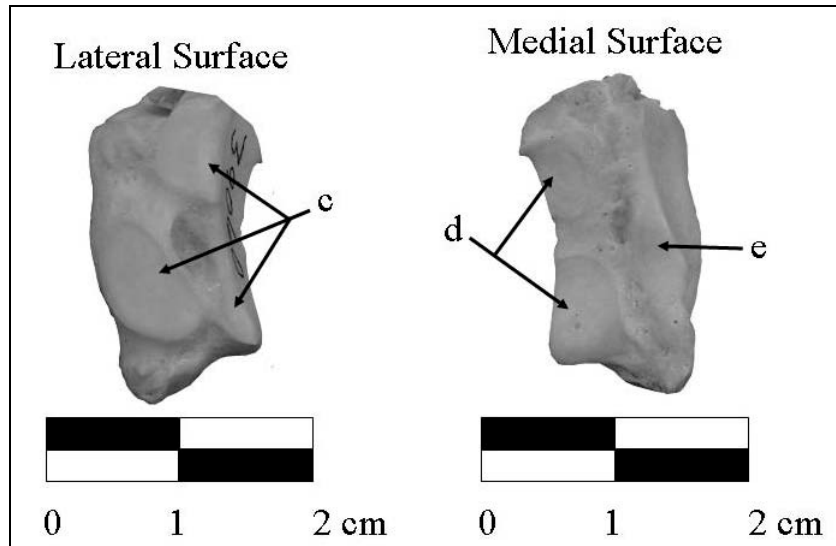


Figure 61. Right bear lateral cuneiform lateral and medial surfaces.

Key: c, three cuboid articular facets; d, MT 2 articular facets; e, intermediate cuneiform articular facet.

- c. There are **three cuboid articular facets** on the lateral surface. Two of the facets are located along the elements' anterior border and both are generally semi-circular in shape. The third and largest facet is convex, kidney bean shaped, and located along the element's posterior border.
- d. There are two **MT 2 articular facets** positioned on the elements' medial surface. Both are similar in size and are positioned along the elements anterior border.
- e. The **intermediate cuneiform articular facet** on the posterior border of the medial surface is long and narrow in shape.

Cuboid

The cuboid is named for its cube-like shape. It is positioned on the lateral side of the distal row of the tarsal block. The cuboid articulates with the calcaneus (proximally), the lateral cuneiform and navicular (medially), and the fourth and fifth metatarsals (distally).

Deer Cuboid

As previously mentioned, the deer cuboid is fused with the navicular and is commonly referred to as the naviculo-cuboid. For further discussion of this element see the above navicular section.

Bear Cuboid

The bear cuboid is quite distinctive and easily oriented in the pes (Figure 62 and Figure 63). From the posterior view, the cuboid is reminiscent of a frog. Located on the lateral side of the foot, it articulates with six elements including the calcaneus and astragalus (posteriorly), the navicular and lateral cuneiform (medially) and the fourth and fifth metatarsals (anteriorly).

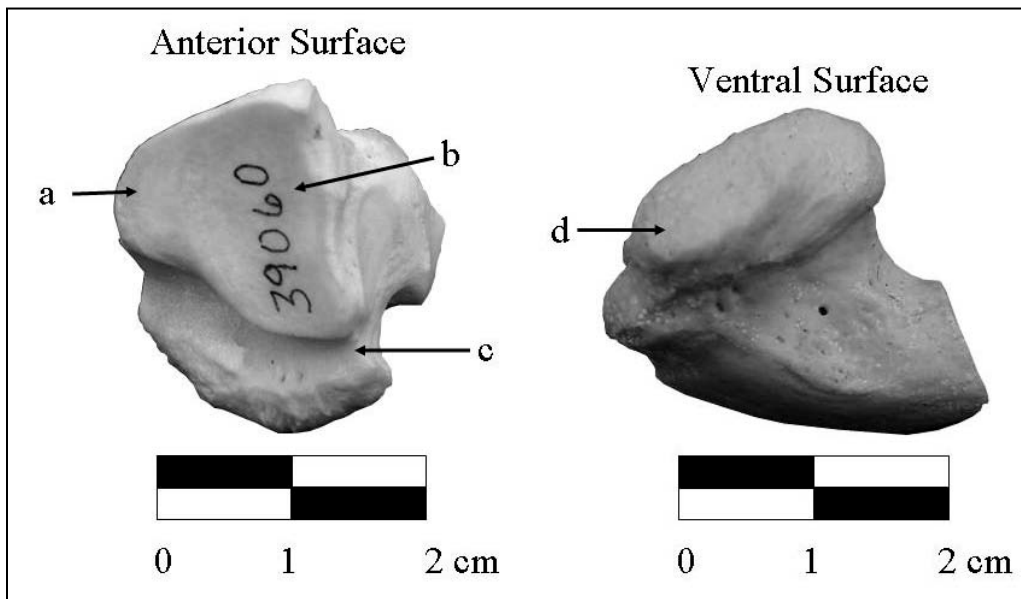


Figure 62. Right bear cuboid anterior and ventral surfaces.

Key: a, MT 5 articular surface; b, MT 4 articular surface; c, cuboid groove; d, cuboid tuberosity.

- a. The **MT 5 articular surface** on the lateral side of the anterior surface is a small round facet that is positioned adjacent to the articular surface for MT 4.
- b. The **MT 4 articular surface** is located on the medial side of the anterior surface. It is rectangular in shape and is larger than the articular surface for MT 5 to which it is adjacent.
- c. The **cuboid groove** is located on the anterior surface just inferior to the articular facets for MT4 and MT 5. It runs at a slight diagonal from the medial to lateral border.
- d. The **cuboid tuberosity** is located on the ventral surface. This large billowing surface serves as a soft tissue attachment site.

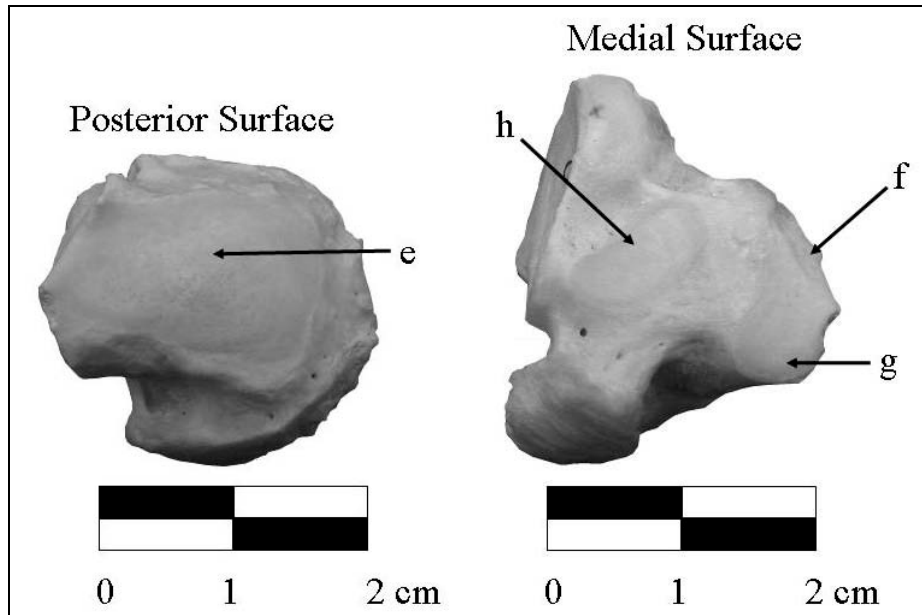


Figure 63. Right bear cuboid posterior and medial surfaces.

Key: e, calcaneal articular surface; f, astragalus articular surface; g, navicular articular surface; h, lateral cuneiform articular facet.

- e. The **calcaneal articular surface** is rectangular in shape and slightly convex. It is located on the dorsal surface of the element.
- f. The **articular surface for the astragalus** is located on the element's dorsal and medial surfaces. It is small, triangular in shape and slightly concave.
- g. The **navicular articular surface** is located on the medial side of the element just inferior to the articular surface for the astragalus. It exhibits a circular shape.
- h. The **lateral cuneiform articular facet** is located on the medial surface just anterior to the navicular articular surface.

Possible confusion with human elements:

The bear cuboid and the human cuboid are both chunky and cuboidal, but beyond this basic characteristic they share little resemblance to each other (Figure 64).

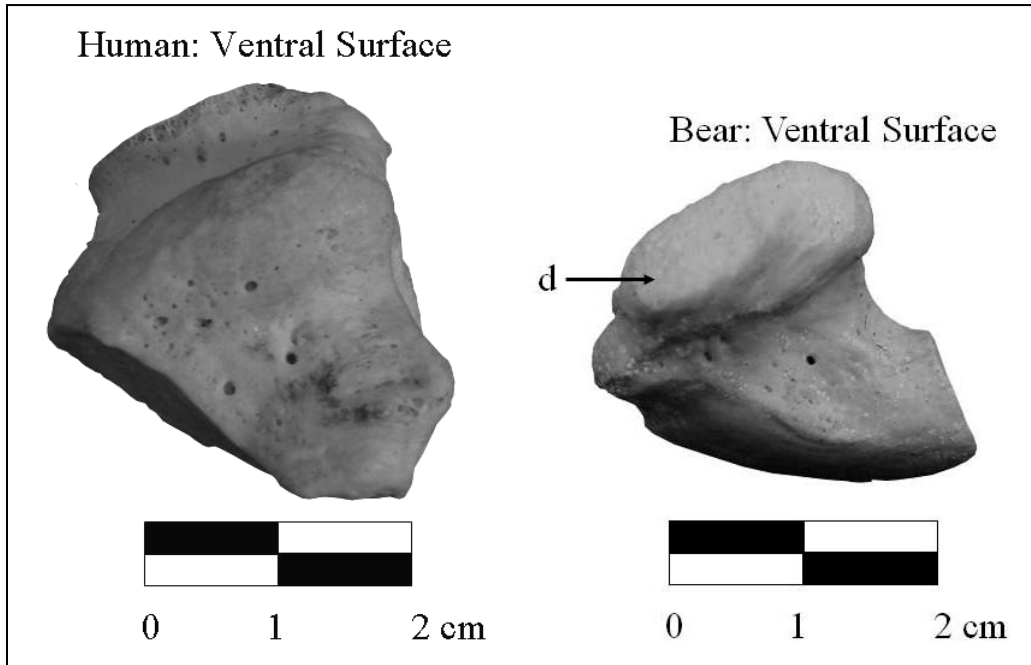


Figure 64. Right human cuboid ventral surface and right bear cuboid ventral surface.
Key: d, cuboid tuberosity.

- The human cuboid is approximately twice as large as the bear cuboid and their facets differ greatly.

Lateral Malleolus

In many mammals the tibia and fibula are fused. In such cases however, the fibula never becomes completely unrecognizable. For example, in the group ruminantia a suborder of the order Artiodactyla the only recognizable part of the fibula is its most distal portion, which is known as the lateral malleolus (Klein and Cruz-Uribe 1984; Parker 1907). In this form the lateral malleolus is a small irregular element located lateral to the tarsal block. This element articulates with the tibia, the astragalus and the calcaneus. Though this element is technically not a tarsal it has been included due to its small irregular size, position adjacent to the tarsal block and its potential of being confused with wrist or ankle elements of other animals.

Deer Lateral Malleolus

The deer lateral malleolus is a narrow irregular bone (Figure 65 and Figure 66). It is located on the lateral side of the tarsal block and articulates with the tibia (superiorly), the calcaneus (inferiorly) and the astragalus (medially).

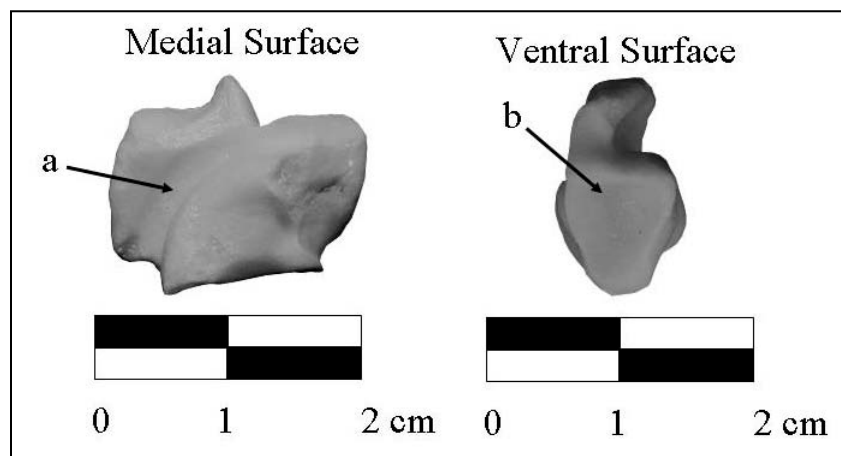


Figure 65. Right deer lateral malleolus medial and ventral surfaces.
Key: a, astragalus articular surface; b, calcaneal articular surface.

- a. The **astragalus articular surface** is located on the medial surface of the element. It exhibits a large curved groove in which the astragalus sits.
- b. The **calcaneal articular surface** is an oval shaped concave facet that comprises the majority of the ventral surface.

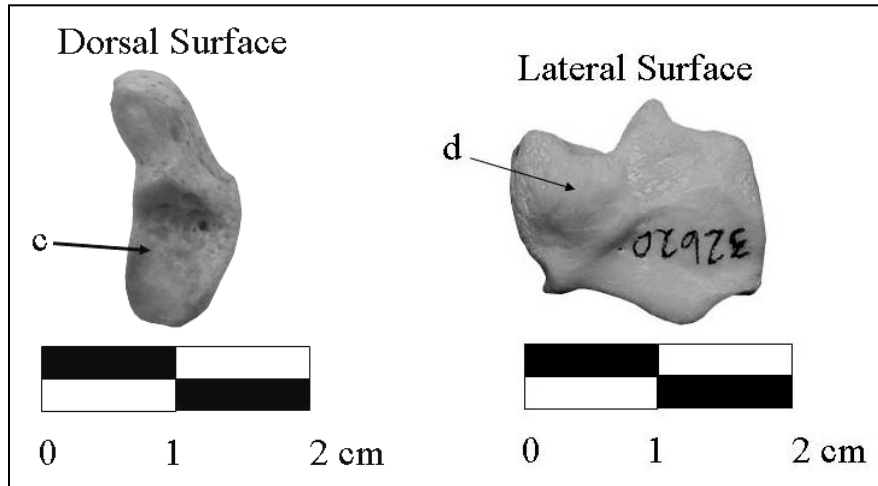


Figure 66. Right lateral malleolus dorsal and lateral surfaces.
Key: c, distal tibia articular surface; d, lateral surface.

- c. The **distal tibia articular surface** is a long and narrow facet with a small projection along its midline. This landmark comprises the entire dorsal surface of the lateral malleolus.
- d. The **lateral surface** of the element is irregular, rough in texture and void of any articular surfaces

Bear Lateral Malleolus

In bear the fibula is a long bone that is located on the lateral side of the distal hind limb. The lateral malleolus comprises the distal end of this element and articulates medially with the tibia and talus. A photograph of this element is not included as it is not a tarsal nor is it easily confused for one.

CHAPTER VI: CONCLUSIONS

The most effective way to accurately identify skeletal elements is through the use of a comparative collection. This method is not feasible for all projects; for this reason a comprehensive guidebook is the best alternative. Through the presentation of multiple views of an element (either drawings or photographs) as well as written descriptions, key morphological characteristics on even the smallest elements can be clearly distinguished. This is imperative as many elements of different species share size and morphological similarities. Furthermore, in archaeological sites where elements are often incomplete the ability to identify distinguishing landmarks is critical.

Many archaeologists are not experts in the identification of mammal and human bones and are forced to rely on osteological guidebooks when skeletal elements are encountered. Wrist and ankle elements are often overlooked in such guidebooks, which is unfortunate as their shape, density and lack of grease and marrow make them likely to preserve in archaeological sites. In an attempt to fill this gap in the literature, this thesis has provided a detailed description of the distinguishing features of the carpals and tarsals of two mammals commonly found in archaeological sites, as well as highlighted the elements that may be confused with morphologically similar human elements. As described above four of the deer elements (triquetral, pisiform, calcaneus and medial cuneiform) and eleven of the bear elements (scaphoid, triquetral, trapezium, trapezoid, capitate, hamate, pisiform, astragalus, calcaneus, navicular and cuboid) share many similar features with their human counterparts, and could potentially be confused by the non-specialist.

This thesis was a learning process in regards to both the osteological content and the methods involved in constructing a useable guidebook. The format of this work went through many revisions before this final draft was completed. Originally side by side photographs of the different species were not included, which made visual comparisons more difficult. In addition, the inclusion of a key directly beneath each series of photographs made landmark identification easier. Also, each bone was originally photographed on a black background which was replaced with the white background in the current version. This change greatly enhanced the clarity and contrast of the landmarks on each bone. These revisions are listed here to assist others in the construction of future osteological guides.

The field of archaeology would benefit greatly from the addition of a variety of osteological guides. Specifically, pictures and descriptions that focus on smaller elements of the

hand, foot, wrist, and ankle would be a great contribution. Through personal communication with physical anthropologists it has become clear that *Phoca vitulina* (harbor seal), *Castor canadensis* (beaver), *Canis familiaris* (dog), (*Ovis canadensis*) mountain sheep, and *Cervus elaphus* (wapiti) may also be useful in a comparative mammalian osteological guide because of their ubiquity and morphological similarity to the human skeleton. In addition, some animals introduced to North America during historic times such as the pig (*Sus domestica*) share osteological similarities and overlap in size with human and the indigenous fauna. The inclusion of such animals in osteological guides would assist the archaeologist in both correctly identifying the specimen and in determining the presence of an historic component. Finally, relatively few osteological works provide information on non-human sub-adults making their positive identification difficult. This is unfortunate as immature elements of domesticated animals such as dogs are commonly found in archaeological sites and are difficult to differentiate from human (Alyson Rollins, personal communication 2009; Davis 1987; Nokes 2004; Reitz and Wing 2008)

The above thesis, in guidebook form, is intended to fill a gap in osteological literature and to reduce the number of bones that are considered unidentifiable, which often results in their omission from site reconstruction. It also provides archaeologists with a means of distinguishing between human and faunal elements so that they can manage the remains appropriately.

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APPENDIX 1: BEAR AND DEER SPECIMENS

Species	Number	Type	Collection	Sex	Age	Comments
<i>Ursus americanus</i>	12950	Complete Skeleton	Burke Museum	Female	Adult	Comparative
<i>Ursus americanus</i>	39060	Complete Skeleton	Burke Museum	Male	Adult	Photographed
<i>Ursus americanus</i>	33259	Complete Skelton	Burke Museum	Male	Adult	Comparative
<i>Ursus americanus</i>	NA	Articulated Foot	Burke Museum	Male	Juvenile	Comparative
<i>Ursus americanus</i>	UA1	Hands and Feet	Personal Collection	Male	Sub-adult	Photographed
<i>Ursus americanus</i>	UA2	Hands and Feet	Personal Collection	Male	Adult	Photographed
<i>Ursus americanus</i>	NA	Partially Complete Skeleton	ERCI	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH1	Largely Complete Skeleton	Personal Collection	Unknown	Adult	Photographed
<i>Odocoileus hemionus</i>	32620	Complete Skeleton	Burke Museum	Female	Adult	Photographed
<i>Odocoileus hemionus</i>	33346	Articulated Foot	Burke Museum	Male	Adult	Comparative
<i>Odocoileus hemionus</i>	34272	Complete Skeleton	Burke Museum	Female	Adult	Photographed
<i>Odocoileus hemionus</i>	NA	Articulated Leg and Foot	WWU Geology Lab	Unknown	Sub-adult	Comparative
<i>Odocoileus hemionus</i>	NA	Left Calcaneus	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Right Calcaneus	WWU Archaeology Lab	Unknown	Adult	Photographed
<i>Odocoileus hemionus</i>	NA	Right Talus	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Left Talus	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Right Naviculo-cuboid	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Right Naviculo-cuboid	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Right Scaphoid	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	NA	Right Trapezoid-magnum	WWU Archaeology Lab	Unknown	Adult	Comparative

Species	Number	Type	Collection	Sex	Age	Comments
<i>Odocoileus hemionus</i>	NA	Left Unciform	WWU Archaeology Lab	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH2	Left Naviculo-cuboid	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH3	Right Lunate	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH4	Right Scaphoid	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH5	Right Lunate	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH6	Left Calcaneus	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH7	Right Lateral Malleolus	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH8	Right Lateral Malleolus	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH9	Right Trapezoid-magnum	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH10	Right Trapezoid-magnum	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH11	Right Unciform	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH12	Right Cuneiform	Personal Collection	Unknown	Adult	Comparative
<i>Odocoileus hemionus</i>	OH13	Right Scaphoid	Personal Collection	Unknown	Adult	Comparative

APPENDIX 2: HUMAN SPECIMENS

Species	Number	Type	Collection	Sex	Age	Ancestry	Comments
<i>Homo sapiens</i>	NA	Complete Skeleton	WWU Bio Anth Lab	Female	Adult	South Asian (India)	Comparative
<i>Homo sapiens</i>	NA	Complete Skeleton	WWU Bio Anth Lab	Male	Adult	South Asian (India)	Photographed
<i>Homo sapiens</i>	NA	Complete Skeleton	WWU Bio Anth Lab	Male	Adult	South Asian (India)	Photographed
<i>Homo sapiens</i>	NA	Complete Skeleton	WWU Bio Anth Lab	Female	Adult	Unknown	Comparative
<i>Homo sapiens</i>	NA	Largely Complete Skeleton	WWU Bio Anth Lab	Male	Adult	Unknown	Comparative
<i>Homo sapiens</i>	NA	Largely Complete Skeleton	WWU Bio Anth Lab	Male	Adult	Euro-American	Comparative