Early Bronze Age Animal Use at Lajia, a Qijia Culture Site in Qinghai Province, China

by

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Supervisory Committee

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Abstract

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The faunal remains from Lajia, a late Neolithic and early Bronze Age site in northwestern China reveal that sheep, a newly introduced domesticate during this time period, are the central source of meat for the site's residents. This represents a shift from earlier modes of subsistence in the region, which were focused on pig husbandry. This project provides important information regarding food production and animal husbandry during a period in which larger centres of power were emerging and new domesticates were being exploited.

Sheep were the most common domesticate in the Lajia assemblage, followed by pigs and cattle. This corresponds with a general pattern in northern China during this period, in which sheep are increasingly utilized. However, an examination of age profiles reveals that mature adult sheep were rare in the assemblage, which suggests that they were being exploited for meat. This is not consistent with evidence from other northern Chinese sites during this time period, where sheep are interpreted as being a source of secondary products such as milk and wool.
In addition to this, an analysis of bone breakage aimed to determine whether remains were processed. These tests were inconclusive, revealing that the main source of fragmentation in the assemblage was related to butchery, but with no significant correlation between increased levels of fragmentation and high-utility skeletal elements.

As well as providing a relevant case study for the development of animal use during the Early Bronze Age, the analysis of faunal remains at Lajia represents a building block for the continuing development of zooarchaeology in the Chinese context.

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Acknowledgments

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Chapter 1: Introduction

Relevance and Implications

The site of Lajia in Minghe County, Qinghai province (northwestern China), represents a wealth of information regarding social and cultural change in the transition from the Neolithic period to the early Bronze Age in China, between about 5000 and 3500 BP. It was occupied during a period when small agricultural villages existed within the influence of larger centres of regional power (Chang 1986; Liu et al. 2004). The main centre of power during the time of occupation at Lajia was Erlitou, a major urban centre located in the Yiluo basin of the Yellow river in central China (Liu and Hong 2007). While the nature of relationships between villages such as Lajia and larger centres of power such as Erlitou are poorly understood, discoveries of Erlitou style pottery at Lajia and other northern sites during this period suggest a network of trade and exchange (Yang 1999; Ye Maolin, personal communication 2011).

While the early Bronze Age in China is traditionally associated with increased craft production and the appearance of complex metallurgy, large scale shifts in modes of food production are also apparent. Beginning in the terminal Neolithic, domesticated sheep and cattle appear at Chinese sites in the Yellow River basin. At the site of Erlitou, sheep remains are found in greater abundance than that of pigs and other domesticates (Yuan and Campbell 2009). At Taosi, a site that is roughly contemporaneous with Lajia, the relative abundance of sheep at the site increases over time (Brunson 2008). The introduction of these new species into a system of pig husbandry that was already well established in the Yellow River basin suggests that there was a large scale shift in animal use during the transition from the late Neolithic to the early Bronze Age.

Since detailed faunal analyses were not commonly conducted for archaeological sites of this time period and region, the faunal assemblage at Lajia represents an opportunity to better understand processes of food production as well as the social and ritual use of animals during a period where larger centres of power were emerging and new domesticates were being exploited. While the preliminary identification of species richness at Lajia was already completed prior to this research project, the remains were not analyzed based on spatial arrangements at the site, or quantified. These types of analyses (discussed in Chapter 4) have the potential to reveal how different parts of the site were used and which species were utilized for specific purposes, including possible ritual activities and as sources of secondary products such as wool. The occurrence of pig remains in sacrificial burials at Lajia (Ye Maolin, personal communication 2011) suggests that further analysis may result in the discovery of ritual practice in other areas of the site.

Zooarchaeological research at Lajia represents the sort of site specific analysis that is required in order to better understand the relationship between the shifting use of animals across northern China and the appearance of larger centres of power during China’s early Bronze Age. Providing insight into this relationship broadens our perspective on the social and cultural transformations that would eventually lead to the historical period and the appearance of the Chinese dynastic system.

Project Scope and Objectives

The first major purpose of this project is to determine whether Lajia follows the general trend found at other early Bronze Age sites within the Yellow River basin, where sheep replace pigs as the most abundant domesticate. NISP calculations for all species at the site will be utilized to test this hypothesis.

The next major purpose is to test the hypothesis that sheep, a newly introduced domesticate in early Bronze Age northern China, provided an avenue for a local industry based on wool at Lajia. Information regarding the exploitation of cattle during the early Bronze Age is scarce so I will also test the hypothesis that cattle were being utilized primarily for traction, as is interpreted at other sites in the Yellow River basin during this time period (Brunson 2008). In order to test these questions, I constructed age profiles for each of the major domesticates by examining epiphyseal fusion and utilized Payne's (1973) framework for interpreting age profiles in an assemblage.

If sheep were being utilized for secondary products, an examination of age profiles will reveal the following characteristics: (1) a preponderance of mature, adult sheep remains, and (2) a comparatively small number of remains representing sub-adult sheep at peak meat weight. These characteristics are used as indicators of a secondary product economy because the maximization of meat yields requires the majority of individuals to be slaughtered as soon as they reach their peak weight, with only a small number of mature adult females being kept for breeding purposes. If cattle were being utilized for traction, it is expected that the majority of cattle remains will also represent mature adult individuals.

As an extension of the previously stated hypotheses, I also suggest that the introduction of sheep and cattle in the Yellow River region did not affect the longstanding importance of pigs, both ritually and as a source of food. This hypothesis relies on the assumption that pigs would continue to be a major source of meat if sheep were primarily raised for wool and cattle were primarily utilized as a source of traction. It also takes into account that faunal remains recovered from prestige burial contexts at Lajia were preliminarily identified as pig by zooarchaeologists at the Institute of Archaeology, Chinese Academy of Social Sciences, in Beijing. This hypothesis would be supported if: (1) the age profile constructed for pigs fits the model for a meat exploitation strategy, and (2) faunal remains in burial contexts are confirmed as pig.

Lastly, a preliminary analysis of the sample assemblage from Lajia revealed that the remains were highly fragmented. I hypothesize that the high level of fragmentation is due to the fact that the residents of Lajia processed bones for grease and marrow. In order to test this hypothesis, the identification of fresh versus dry breaks in the sample assemblage is necessary. This hypothesis would be confirmed if: (1) the majority of breaks in the assemblage occurred while the bone was still fresh, and (2) elements with high marrow and grease yields are more fragmented than elements with low marrow and grease yields.

Thesis Structure

Chapter 2 describes the general layout of the Lajia site, as well as the history of excavation and important findings. In Chapter 3, I provide an overview of subsistence practices and animal use in the Neolithic and early Bronze Age in order to provide cultural and historical context for the faunal material at Lajia. Chapter 4 presents a variety of taphonomic and zooarchaeological case studies that provide an analytical framework for studying the assemblage at Lajia. These case studies are used to support and provide context for my own methodological approaches. Chapter 5 presents my methods and describes the process of analyzing the data, while Chapter 6 presents a summary of the results. In Chapter 7, I present a detailed discussion of these results. I identify how my findings support or reject my hypotheses and consider how the results from Lajia fit into the larger narrative of shifting animal use in the early Bronze Age. Finally, I present my conclusions and provide directions for future research.

Chapter 2: Lajia and the Qijia Culture

This chapter provides a brief overview of Lajia, including a summary of artifacts recovered, and a description of the general layout of the site. In order to facilitate the comparison of faunal remains from different spatial contexts as presented in Chapter 6, several important features including the remnants of a stilt house structure and a large ditch are discussed. The ritual importance of domesticates at Qijia culture sites is examined, providing a framework for interpreting similar processes at Lajia. The chapter concludes with a brief discussion regarding possible trade connections between the Qijia culture and the rest of northern China, with possible implications for local secondary product industries.

The Lajia Site

Lajia is a large archaeological site in north west China that is associated with the Qijia culture. This culture type appeared during China's early Bronze Age at around 4400 BP (Yang et al. 2003). The Qijia culture is represented by a number of archaeological sites located in Eastern Qinghai and Western Gansu province. The entire area is located on the Huangtu Plateau, a loess highland environment that spans the middle and upper part of the Yellow River basin (Yang et al. 2003). The site itself rests at an elevation of about 1800 meters. Lajia is located along the banks of the Yellow River in south-eastern Qinghai province, near the border of Gansu province, and has deposits that date from 4000 to 3700 BP, with no evidence for an earlier Neolithic component. At around 3700 BP, an earthquake occurred in the area around Lajia and triggered flooding that rapidly covered the site and killed much of the local population. There is no evidence of reoccupation in the immediate area until around 2800 BP (Gao et al. 2007).

Excavations at the site began in 2000, when the remains of sixteen humans were found in two adjacent house structures which were subsequently given the designations F3 and F7. While formal burials were found at the site, human remains in these house features represent individuals that were trapped and buried during the earthquake and flooding event. The skeletons were generally intact, and remained very well preserved due to the rapid nature of deposition which resulted from the earthquake and flooding event (Yang et al. 2003). Two of these individuals, a middle aged female and a 3-4 year old child, were found in close proximity to one another in house pit F3, leading to the suggestion that the remains represented a mother and child (Ye Maolin, personal communication 2011). The other 14 individuals were located in house pit F7. Large fissures were also identified in and around the site, underscoring the destructive nature of the earthquake. Following these findings, six full seasons of excavation were undertaken at the site.

The last season of major excavations occurred in 2007 (Yang et al. 2003). In total, around 2500 square meters have been excavated, and the size of the site is estimated to be around 200,000 square meters (Ye Maolin, personal communication 2011). Lajia contains a large central plaza that connects clusters of house structures along the northern and southeastern edges. Qian (2007) interprets these house structures as being largely carved into natural cliffs with loess soil forming the ceilings and walls. This interpretation is strengthened by the fact that no postholes have been observed in any of the structures that have been interpreted as residential. Evidence of a possible altar structure containing a single burial was found on a raised portion of the plaza. Portions of a ditch that appeared to circle around the outside of the site were excavated as well (Ye Maolin, personal communication 2011).

The large plaza burial contained many jade artifacts, including a ceremonial knife that has been associated with the ritual sacrifice of pigs. Aside from the jade knife, the published literature relating to Lajia does not mention other evidence, such as skeletal trauma, that would also aid in the identification of ritual sacrifice. The altar burial also contained a pig mandible (Ye Maolin, personal communication 2011). The ritual treatment of pig remains is a common phenomenon across northern Chinese settlements during the Neolithic period (Liu and Chen 2012), and the research questions that have arisen regarding this and other related findings will be explored in greater detail in subsequent sections. While no pottery was found in these plaza burials, an abundance of pottery was found in and around various house structures around the site (Yang et al. 2003).

The northern portion of the site is where most of the evidence of daily life and eventual flooding was found. Along with the remains of humans, the house structures contained evidence of day to day life, including hearth features and pottery vessels, as well as plant and animal remains (Qian 2007). The remains of both wild and domesticated animals were discovered at the site. Identified taxa include pig, sheep, cow, goat, deer, dog, rodent, and various other small mammals, representing a total of 5373 total fragments. Bone tools were also found, including small polished fragments that may have been used as pins. Awls were identified, as were scapulae that have been interpreted as modified for use in the practice of divination (Ye Maolin, personal communication 2011). Oracle divination was a common practice among Qijia people, and evidence of scapulae that may have been used for this purpose have been found at a number of Qijia sites (Di Cosmo 1999).

In the southeastern area of the plaza, two larger structures contained remnants of postholes. The first structure, F20, stood on a hard packed floor, and contained pottery vessels, lacquered objects, and a variety of tools made out of stone and bone. Structure F21 is located directly to the north of F20. Unlike F20, F21 does not contain artifacts, nor does it have a hard packed floor surface. It does, however, contain faunal material. Due to these characteristics, some researchers suggest that this structure may have been on stilts (Qian 2007). An examination of the faunal remains within and around these building structures may shed light on their respective uses.

Analyses of household contents at Lajia have produced some insights about food production. Many earlier sites in the region show evidence for seasonal cooking areas. At Banpo culture sites, which existed in the middle Yellow River basin prior to the occupation of Lajia (discussed in Chapter 3), archaeologists have often discovered small hearths right outside the front entrance of house structures in addition to larger indoor hearths. These smaller hearth features have been interpreted as representing cooking areas for the warmer months when indoor hearths would have been impractical. At Lajia, ash remains have been found outside the entrances of several houses, likely representing a similar cooking system (Qian 2007).

In 2005, archaeologists uncovered a ceramic bowl containing preserved noodles at the site. Upon further analysis, it was determined that these noodles dated to around 4000 BP, making them the oldest known noodles in the world (Lu et al. 2005). Chemical analyses determined that they consisted of broom corn and foxtail millet (Lu et al. 2005). This supports previously held hypotheses that characterized millet as an important early domesticate. It would have been a central focus of food production in the Loess Plateau area of China, where an arid climate prevents the successful production of rice crops. While pottery typology remains central in the identification and classification of culture types in prehistoric and early Bronze Age China, these sorts of findings highlight another important way that archaeological sites can be analyzed and differentiated from one another (Allan 2005). Archaeological evidence relating to the treatment of plants and animals highlights the way in which natural resources were exploited and the manner in which modes of food production shifted over time.

The Qijia Culture

Although the first Qijia site was discovered in 1923, much of what is known about the Qijia culture comes from the excavations and subsequent analyses at Lajia. This is largely due to the excellent degree of preservation at the site. In 1923, J. G. Andersson conducted archaeological surveys at a site called Qijiaping that revealed important information about a previously unknown culture type that is now recognized as one of the earliest instances of a Bronze Age culture in China (Andersson 1943 in Di Cosmo 1999). The Qijia people lived in permanent settlements and relied predominantly on agriculture as a mode of subsistence (Di Cosmo 1999).

Qijia villages are located on raised terraces along the upper Yellow River basin along the border of Qinghai and Gansu province (Hu 1980 in Di Cosmo 1999). Some of the major Qijia culture sites are Lajia, Yanping, Mayingxiang, and Qingquancaotai (Gu 2008). The discovery of a Qijia burial site in the 1940's shed light on some important ritual and social aspects of Qijia culture.

Painted ceramics and bone tools such as pegs and awls were found in association with many of the single human burials. While the ceramics have been described and analyzed in great depth, the bone tools are only briefly mentioned. It is not known whether these tools represent bones from wild game or domesticated livestock (Nae 1946). Some Qijia culture sites are best known for being one of the earliest known centres of metallurgy in China (Thorp 2006). Metal implements like blades, awls and ornaments are commonly found at Qijia sites, predating metallurgy in large urban centres to the south, such as Erlitou (Thorp 2006).

The practice of divination through the use of oracle bones is associated with the Qijia culture, evidenced by the discovery of modified pig scapulae at Lajia and other Qijia sites (Di Cosmo 1999; Ye Maolin, personal communication 2011). At the Qijia site of Huangniang, 13 oracle bones were recovered, representing scapulae from pigs, sheep and goats (Gansu Sheng 1978 in Chen 2013). The inclusion of pig and sheep remains in graves is relatively common across Qijia culture sites, mostly representing the lower mandible (Chen 2013). At Huangniang Niangtai, pig mandibles were found in 15 of 62 grave contexts (IA,CASS Gansu 1974 in Chen 2013). At the site of Dahezhuang, evidence for ritual animal sacrifice was identified. In an area with multiple stone circles, a headless cow skeleton was discovered, with the remains of a small calf inside of it (Huanghe 1960 in Chen 2013).

Apart from information about faunal remains in burial contexts, very little has been published in regards to faunal material at Qijia culture sites. The Qijia culture is associated with an intensification of animal husbandry in the region. The remains of pig, sheep, cow, dog and horse have all been recovered. Of these, pig remains are found in the greatest abundance at Qijia sites

(Chen 2013). Goat remains have also been found at various Qijia sites, including Lajia. This is interesting because goats are not thought to be native to northern China, and their presence at Qijia sites may suggest some sort of trade or exchange network between northern China and the Near East (Ye Maolin, personal communication 2011). Due to stylistic similarities between certain metal tools found at Qijia sites and sites in Siberia and Central Asia, it has been postulated that there may have been some cultural connection between these groups as well (An 1993 in Di Cosmo 1999). These sorts of findings highlight the importance of viewing the archaeological findings at Lajia within a larger context of cultural and social change across and beyond northern China during this period. These trade networks had possible implications for the development of secondary product industries at sites like Lajia, which was situated on the periphery of Erlitou, an increasingly influential state power. It is possible that goods, including meat and wool, would have been exported from peripheral villages in exchange for ceramics and metal implements manufactured in large craft workshops in more urban areas. The following chapter will present faunal evidence from relevant Chinese sites in order to examine the way in which animal use shifted, from the appearance of domesticates in the early Neolithic to the emergence of large state powers in the early Bronze Age.

Chapter 3: Domestication and Subsistence in the Late Neolithic and Early Bronze Age

In this chapter I aim to situate the findings at Lajia within a larger framework of changing subsistence practices in Neolithic China, from the rise of pig husbandry and decline of hunting in the early Neolithic, to the introduction of new domesticates in the early Bronze Age. I will do this by examining the ways in which modes of food production shifted in the time leading up to the appearance of the Qijia culture during the transition from the late Neolithic to the early Bronze Age at around 4400 BP. In order to provide evidence that is as directly relevant to Lajia as possible, I will focus on cultural groups that directly preceded the Qijia culture along the middle and upper Yellow River basin (Figure 1), although any archaeological or historical evidence from other regions of China that is directly relevant to the findings at Lajia will also be included. Culture types and important sites are presented chronologically, beginning in the early Neolithic.

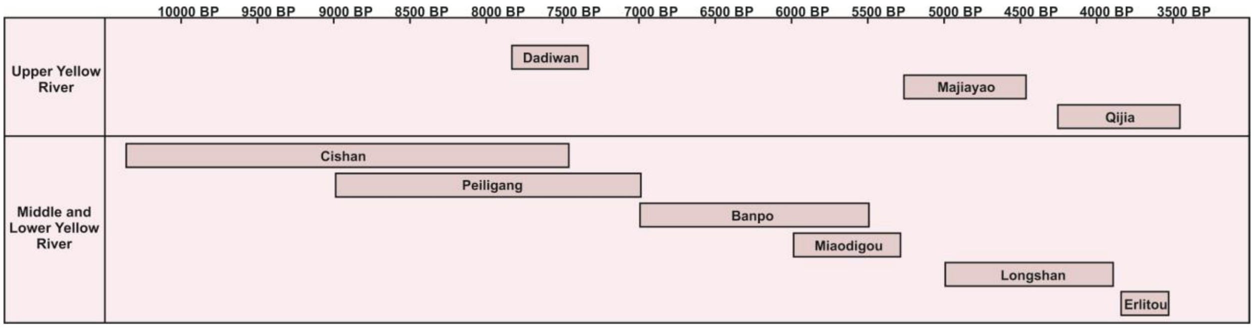

Figure 1. A timeline of Yellow River cultures discussed in the text.

Introduction

Many of the earliest publications on Chinese prehistory focused on descriptive analyses of pottery and the creation of culture types based on these typologies (Andersson 1923; Gernet 1968). In more recent times, the development of technologies for analyzing ancient plant remains as well as an increasing focus on the study of faunal remains from archaeological sites has contributed to a more holistic perspective on the shift from economies based on mobile hunting and gathering in the Paleolithic to more sedentary and village-based settlement patterns in the early Neolithic period.

Within the archaeological literature, the prehistoric period in China is often addressed with northern and southern China as separate units. While this division does not necessarily reflect the complexity of interaction across China during this time, it provides a way in which a vast landscape can be more succinctly analyzed and more effectively ordered in an archaeological sense (Chang 1986). The Qinling mountain range (Figure 2) in southern Shaanxi province is often seen as marking the border between northern and southern China, although it is unclear how much of a natural boundary this range creates between the two regions (Underhill 1997). There are two main river systems in China, both of which were critical to the early appearance and development of agriculture and animal husbandry. In the south, the Yangzi River flows from the Tibetan highlands, around the Sichuan basin, eastward into the Pacific Ocean. The Yellow (Huang) River, along which Lajia and other Qijia culture sites are located, flows through northern China, through desert and into a loess plateau, before draining into the ocean. (Ebrey 1996). Throughout the Neolithic period, the Qinling Mountains seem to represent a boundary between millet-based agriculture in the north, and rice-based agricultural in the south, as evidenced by the analysis of plant remains found in hearths and on grinding stones at several archaeological sites (Zhejiangsheng and Xiaoshan 2004, Lee et al. 2007 in Liu and Chen 2012).

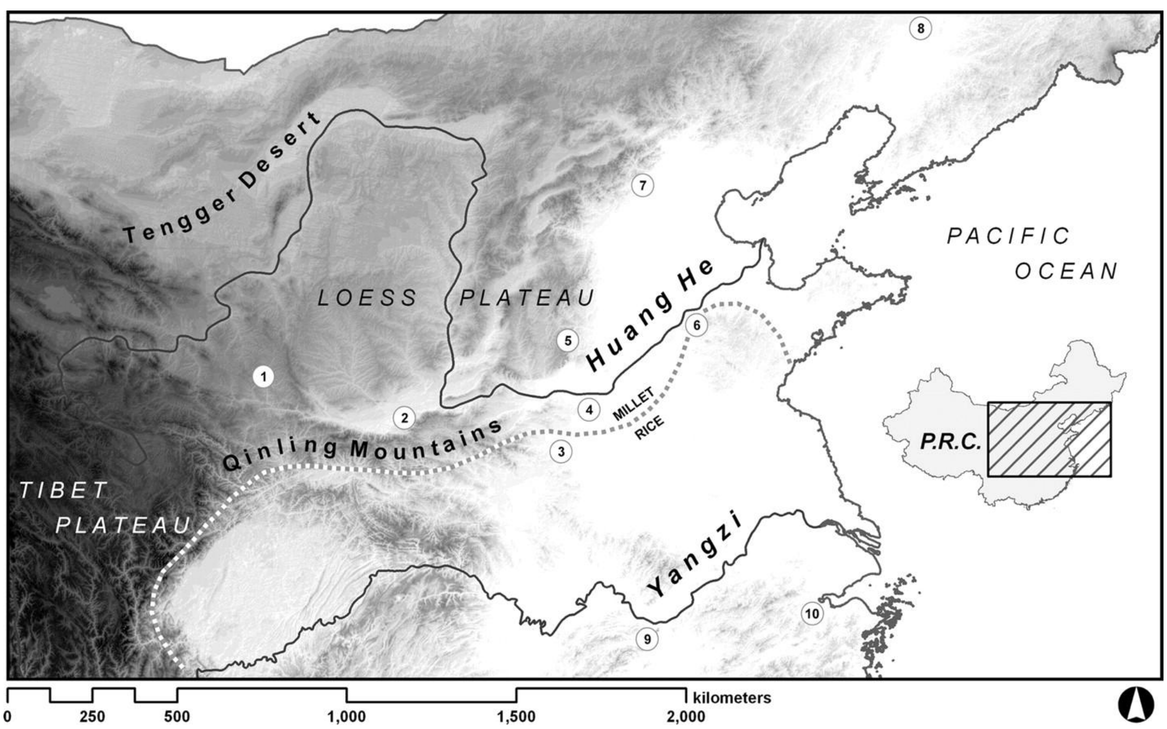

Figure 2. Map showing the extent of the Yangze and Huang (Yellow) Rivers, and the Qinling Mountain range (Barton et al. 2009 p. 5524).

While Neolithic settlements in northern China represent many different populations, ideas, subsistence practices and material culture types, there are some broad similarities. Beginning with sites such as Nanzhuangtou and Cishan (discussed in the next section) around 10,000 years ago, small scale farming villages that contain evidence for the cultivation of millet and the domestication of pigs and dogs are found throughout the Neolithic and into the early Bronze age, with the occupation of sites such as Lajia. Given these broad similarities, it is important to follow this subsistence pattern through time and space and to examine how the implementation of different technologies and the utilization of new domesticates were associated with the rise of centralized state powers during the Bronze Age.

Setting the Stage

Before 10,000 BP, much of northern China was covered by tundra. At around 10,000 BP the climate became warmer and moister, allowing for a wide range of plants and animals to spread into previously uninhabitable areas. Humans also moved into these areas and exploited the widening array of flora and fauna. Large permanent settlements appear across northern China, as does evidence for the intensification of agriculture and the domestication of animals (Chang 1986).

While dates for the beginning of the Neolithic period vary around the world, Chinese archaeologists identify early Neolithic sites by determining the "presence of one or more key traits such as pottery, ground stone tools, sedentism, cultivation, and animal husbandry" (Underhill 1997 p.105). Determining exactly why populations within a particular region might begin to incorporate domesticated plants and animals into an already established system of hunting and gathering is a complex question, and one that has no single answer.

Domestication represents a complex and often long-term relationship between humans and a particular species. As relationships between humans and animals change, so too do the physical characteristics of the species being domesticated. Zooarchaeologists have identified physical markers that can be used in conjunction with contextual data in order to determine whether remains at a site represent wild species or their domesticated counterparts. For the suite of species, including dog, pig, sheep, and cattle, that have been identified as common domesticates within northern China, teeth are the most important elements to examine. A reduction in tooth size, improper alignment of the tooth row, and a higher frequency of linear enamel hypoplasia (LEH) are all associated with domestication (Luo 2007 in Liu and Chen 2012). With regards to examining early evidence for the use of domesticates, the purpose of zooarchaeological research is not only to determine what suite of species was most extensively exploited at a particular site, but also to explore how and why these relationships came to be.

The Early Neolithic

The First Domesticates

Much of the earliest evidence for domestication comes from the Fertile Crescent, where goat and sheep are thought to represent the earliest species of livestock (Zeder et al. 2006). This is in contrast to the pattern seen in China, where pigs represent the earliest domesticated livestock and are of importance throughout the Neolithic (Epstein 1969). Pig remains were uncovered at the site of Nanzhuangtou in Hebei province (Figure 3), one of the earliest Neolithic sites in China, dating to between 12,000 and 10,000 BP (Ren 1995 in Underhill 1997). While these pig remains are believed to represent wild species, researchers have recently confirmed that dog remains at the site do represent domesticated species, providing the earliest example of domestication within China (Sheng 2010 in Liu and Chen 2012). At the site of Zengpiyan (12,000 - 8000 BP) in Guangxi province, southern China, pig remains were originally thought to represent domesticated species. More recently, however, questions have been raised about the interpretations of these remains. It has been noted that the context of these bones were not clearly recorded, and that pig remains were identified as domesticated through the analysis of age profiles, rather than more definitive methods such as tooth measurements (Yuan and Flad 2002). With the size range of individuals from the site overlapping values for both wild and domesticated species, it has been suggested that this assemblage may be the result of a combination of pig husbandry and hunting, thus still providing an early example of pig domestication (Liu and Chen 2012).

Figure 3. Relevant early Neolithic sites with evidence for domestication.

At Cishan, a site dating to around 8000 BP, evidence for pig domestication is stronger. This is largely due to the fact that age profiles suggest intentional population control for meat exploitation rather than hunting, although analyses of teeth have led to mixed interpretations (Yuan and Flad 2002; Tong 1984 in Liu and Chen 2012). There is clearer evidence for pig domestication by around 7000 BP at the Peiligang culture site of Jiahu. In addition to being associated with human burials, pig remains at the site differ from those found at earlier sites due to larger tooth size, high LEH frequencies, and improper tooth alignment (Luo 2007 in Liu and Chen 2012). An analysis of age profiles at Dadiwan, a site in Gansu province, shows that most individuals were younger than 3 years old, a pattern that has been associated with animal husbandry. However, isotopic analyses of pig bones from the earliest site phase revealed that they were eating nuts and other wild plants, as opposed to millet, suggesting that they represented a wild species of pig. However, it is important to note that the sample for this portion of the isotopic analysis consisted of only 4 bones (Barton et al. 2009), so it is likely that a larger sample size would produce more conclusive results. Since the early remains at Dadiwan exhibit the same age profile pattern as the later remains, it raises questions about the diagnostic value of age profiles as an indicator of domestication.

Yuan and Flad (2002) identify several factors that may have facilitated domestication at these earliest sites. Firstly, as regional populations increase in density and settlements become larger, hunting may not provide a sufficient source of meat for all inhabitants at a given site. Indeed, the early Neolithic period in northern China is associated with the domestication and cultivation of cereal crops that would have allowed for “denser and more permanent settlements” (Ebrey 1996 p. 17). Secondly, the presence and surplus of cereal grains would be necessary in order to feed both the human population and the herd of livestock.

In her analysis on the use of pigs in the Hongshan culture, which are first found in Inner Mongolia at around 6000 BP, Nelson (1995) points to the lack of quantitative data relating to the relative and actual frequencies of pig remains at early Chinese sites, as well as a similar lack of information regarding butchery patterns and age profiles of pigs and other domesticates. This observation highlights the need for more quantitative and site-specific analyses of faunal remains at early Chinese archaeological sites.

In many regions, the shift from hunting to pastoralism is not marked by a clear and sudden change in the archaeological record. Jiangxigou 2 is an early Neolithic site in the Qinghai Lake basin that dates from between 9000 BP and 5000 BP and exhibits possible evidence of this shift. While the remains of sheep have been found at the site, it is unclear whether they were domesticated or wild. Rhode et al. (2007:605) state that several teeth were "tentatively identified to sheep" and that they most likely represent Himalayan blue sheep, a wild species, although no reason is given for this interpretation. More definitive evidence for sheep domestication does not appear until much later. It will therefore be discussed in a later section.

Plant Use in Early Neolithic China

Much of the literature relating to early plant cultivation patterns in northern China focuses on the abundance of grinding stones at a number of early Neolithic sites as evidence for intensive cereal grain agriculture. Millet and other domesticated cereal grains have been identified at a number of early Neolithic sites, and an analysis at the Peiligeng culture site of Shigu, one of the earliest Neolithic sites in the middle Yellow River valley, suggests that wild food products like acorns, hazelnuts, elm fruit and jujube contributed heavily to the diet of these early Neolithic populations (Liu et al. 2010). Undermining the idea that cereal grain agriculture gained immediate status as the dominant mode of subsistence in the region during the early Neolithic, this study suggests that wild crops were still an important source of food, and that the implementation of an intensive agricultural system may have been a more gradual and complex process than previously thought.

The Middle Neolithic

From Hunting to Husbandry: The Yangshao Period

In comparison with the early portion of the Neolithic, the middle and late Neolithic is represented by a much larger number of small-scale settlements across northern China, with a greater abundance of artifacts and faunal material available for study. As a result, the next portion of this chapter will go into more detail about specific phases of the Yangshao period that are most relevant to Lajia. Within the Yellow River basin, these include the Banpo (7000-5500 BP), Miaodigou (6000-5000 BP) and Majiayao (5300-4000 BP) phases.

While the middle and upper Yellow River basin is only one of many regions that saw an explosion of human settlement and cultural innovation during the Neolithic period, the region is often referred to as “the cradle of Chinese civilization” due to the large amount of archaeological material that was discovered there in the early twentieth century when modern archaeological inquiry was gaining traction in the Chinese context (Chang 1986; Shao 2005). The archaeological site of Yangshao in Mianchi County, Henan Province, was uncovered in 1921 and was the first Neolithic period archaeological site in China to be extensively excavated and studied (Shao 2005). While earlier sites and culture types have since been found in different regions around northern China, the Yangshao period remains a central focus of Chinese archaeological inquiry due to the abundance of sites that have been uncovered in the middle and upper Yellow river basin. This period is directly relevant to archaeological analyses at Lajia because, in the upper Yellow River basin, it directly precedes the appearance of Qijia culture, the culture type with which Lajia has been associated.

Figure 4. Middle Neolithic sites relevant to Lajia.

The Yangshao period is represented by a large number of sites from a variety of different culture groups around the middle and upper Yellow river basin (Figure 4). The period spanned from around 7000 to 5000 BP (Zhang 2005). As a general trend, an emphasis on hunting and fishing seems to have been replaced by animal domestication and agriculture over the course of this period. Not all sites in the region follow this pattern and a wide variety of subsistence patterns have been archaeologically identified (Zhang 2005). While cultivated rice has been identified in other regions such as the Yangtze River valley, the dominant crop in the middle and upper Yellow river basin was millet (Zhang 2005). A wide variety of different materials such as bamboo, stone, wood and pottery were utilized for the construction of tools, crafts and ritual objects (Zhang 2005). As with the Lajia site, jade artifacts have also been found in a wide variety of Yangshao settlements and have been associated mainly with ritual activity (Yu 1990; Zhang 2005). Copper manufacturing also appeared during the Yangshao period. A recent study of materials from the site of Jiangzhai examined the chemical composition of the metal artifacts and identified them as mainly copper and brass (an alloy of cooper and zinc) (Zhang 2005). Since the Yangshao period represents archaeological sites and culture types across a large region over a span of 2000 years, there are many regional developments and cultural phenomena that are not common across all Yangshao period sites.

Banpo Culture

Banpo culture sites are attributed to the larger Yangshao cultural tradition, and existed in the middle Yellow river basin region roughly between 7000 BP and 5500 BP. The Banpo culture is perhaps best known for the early instances of polychrome painted pottery with which it is associated (Yang 1999). Ceramics with pictures of frogs are very common in the Banpo ceramic tradition (Zhang 2005). Interestingly, these same sorts of frog designs are also seen at Lajia, highlighting the entangled nature of cultural relationships across space and time in Chinese prehistory. These sorts of connections underpin the importance of presenting and analyzing Lajia within a larger context rather than as a site-specific case study. While there are a number of archaeological sites with occupation sequences attributed to the Banpo culture, the three most extensively studied sites are Banpocun, Jiangzhai, and Beishouling (Yang 1999). All three of these sites have similar layouts including a circular arrangement of house structures that open into a common area where there is evidence of enclosures that were designed to hold animals (Yang 1999; Zhang 2005; Lee 2005). At Jiangzhai, archaeologists have uncovered five distinct groupings of house structures that may indicate a lineage-based social system (Chang 1986;

Yang 1999). The central location of the livestock enclosures highlights the importance of animal husbandry and the shared nature of resources in Banpo culture.

The Banpo culture is associated with horticulture and the cultivation of foxtail millet as a main food source. In addition, the remains of domesticated dogs, chicken and pigs have also been found across all major Banpo sites (Lee 2005). It is unclear whether Banpo people practiced shifting agriculture, or whether they stayed at the same site over a period of multiple generations (Lee 2005). Much like Lajia, many Banpo sites have evidence of a large ditch that is found along the outer perimeter of the settlement. While archaeologists have not determined the purpose of these ditches, a few possibilities have been suggested. In conjunction with a wall, the ditch may have been a part of a defensive structure which would indicate hostility between different settlements or culture groups (Xi'an et al. 1988 in Lee 2005). Another possibility that I have not seen discussed in the literature is that these ditches may have been used to keep animals from escaping the site, much like modern cattle guards are used today.

At Wangjiayinwa, a late Banpo settlement in Gansu province, archaeologists uncovered a large ceramic water vessel with an image of what has been interpreted as a domesticated pig (Yang 1999). This suggests that pigs played an important role in Banpo society, something that is seen almost universally across northern China during the period that directly preceded the occupation of Lajia.

Miaodigou Culture

Unlike the small and communal settlement patterns associated with earlier Banpo sites along the middle Yellow River, Miaodigou sites (6000-5000 BP) are larger in size and contain evidence for a large degree of social stratification. Evidence for this comes from both prestige burials and the appearance of larger and more complex structures in addition to smaller house pits. Like Lajia, Miaodigou sites contain a central square and a large ditch surrounding areas of the site that do not directly face the Yellow River (Ma 2005 in Li 2013). At the site of Xipo, dating to around 5300 BP, there is evidence for intensive pig husbandry. An MNI count revealed that there were 244 individual pigs represented within the faunal sample from the site (Ma 2005 in Li 2013). Interestingly, a paleo-parasitological analysis of the soil from abdominal cavities of human skeletons at the site revealed the presence of parasites that are associated with pork consumption (Lan 2010 in Li 2013). Dogs were the only other domesticated species at the site. Dogs, along with a variety of wild species, were found in very limited quantities, suggesting that pigs were the major source of meat for residents at the site (Ma 2005 in Li 2013).

Majiayao Culture

Majiayao culture sites are located in present day Gansu and Qinghai provinces, very near to where Lajia was discovered. With some of the oldest sites dating to 5300 BP, the Majiayao culture preceded the Qijia culture by about 600 years and disappeared from the archaeological record by around 4500 BP, although there is some variation in these dates in the literature (Guo 1958 in Yang 1999; Liu and Chen 2012). Since the Majiayao culture type directly preceded the Qijia culture and occupied the same area along the upper Yellow River basin, an analysis of important Majiayao sites and artifacts has direct implications for further research at Lajia. While the latter part of the Majiayao culture type extends beyond the Yangshao period, it is recognized as a regional variation of the previous Xiyin culture type that was located further east, around the middle Yellow river basin (Zhang 2005). This connection has in large part been established through the identification of similar painted pottery designs in different regions at different times

(Zhang 2005). The Majiayao culture type is associated with a wide variety of high quality painted ceramics as well as the production of metal objects such as a bronze knife that was found at the site of Linjia in Gansu province (Zhang 2005). The age of the bronze knife is debated by archaeologists due to the fact that this sort of complex metalworking did not appear in any other archaeological context until the middle of the Qijia culture period hundreds of years later. It has been suggested that the knife represents a later intrusion rather than an early example of bronze manufacture (Gansu 1984 in Yang 1999).

Linjia is the largest site associated with the Majiayao culture and contains the remains of 27 houses that are generally oriented towards the Yellow River. A number of ash pits were also found in association with the dwellings. One of these ash pits contained the remains of millet. In addition to evidence of a reliance on millet, bone arrowheads and spears suggest that hunting wild game was a prominent feature of Majiayao society (Gansu 1984 in Yang 1999). A large burial at the site of Hetaozhuang also points to the importance of domesticated animals for the Majiayao people. In addition to large numbers of bone and turquoise beads, archaeologists uncovered the remains of a sheep as well as the crania of several domesticated pigs in a high-status burial (Yang 1999). While domesticated animals would have been an important source of food throughout the Yangshao period, these sorts of findings suggest that their possible ritual importance should also be taken into consideration when animal remains are identified and analyzed at early Chinese sites.

The Late Neolithic/Early Bronze Age

The Seeds of a First Dynasty

The shifting use of domesticated animals both in a ritual and a utilitarian sense is seen in the transition from the Neolithic to the early Bronze Age. Pigs remain present at late Neolithic sites as well as Bronze Age sites like Erlitou, but they no longer dominate the faunal assemblages (Yuan and Campbell 2009). Instead, sheep, which appear in the Chinese archaeological record at the same time as cattle at around 4500 BP, become the most commonly represented species in northern China by the start of the early Bronze Age (Yuan and Campbell 2009). Due to the late appearance of sheep in the Chinese archaeological record, Zhou et al. (2006) examined mitochondrial DNA from the remains of sheep at the Erlitou site and determined that the Erlitou sheep were genetically similar to lineages from central Asia and the Near East, although further research is required before a clear picture of early sheep domestication in China can emerge.

Evidence for sheep domestication in the Near East dates back ten thousand years, in a region known as the 'Fertile Crescent'. Within China, the origin of sheep husbandry is less clear, with two main hypotheses dominating the literature (Cai et al. 2011). The first hypothesis suggests that between 6,000 and 4,000 years ago, sheep from southwest Asia were brought into the area now known as Qinghai province (Cai et al. 2011). This hypothesis suggests that the region where Lajia is located would have represented an entry point for domesticated sheep, thousands of years prior to the appearance of the Qijia culture type. However, other researchers suggest that sheep husbandry in China was the result of an independent process of domestication that occurred as early as 8000 years ago (Bo 1986 in Cai et al. 2011).

While these hypotheses specifically address sheep domestication, they reflect a larger debate about whether early examples of agriculture and animal husbandry in China were the result of introduced species and ideas from the Near East, or whether they resulted from an independent process of domestication. In the 1960's and 1970's, researchers often suggested that the shift towards cereal agriculture and animal husbandry in the Yellow River Valley was an extension of similar types of changes that had occurred in the Near East several thousand years prior (Watson 1961, Epstein 1969). Watson (1961 p. 36) states that "it is asking too much of coincidence to assume that such a fundamental revolution as had already occurred in the Fertile Crescent of the Near East should have happened independently a second time in China." More recently, however, there is a growing belief that agricultural practice and animal husbandry may have developed independently in the area around the middle and upper Yellow River basin as well as in southern China, along the Yangzi River. Researchers have pointed to the unique suite of domesticates, including millet, rice, pigs, dogs and chickens, as evidence for this hypothesis (Barton et al. 2009).

The site of Taosi, a Longshan culture site occupied between 4600 and 4000 BP in the middle Yellow River Valley (Figure 5), is important in relation to Lajia because it represents one of the most intensively analyzed faunal assemblages for this particular time period. Importantly, this site marks a shift from the predominant use of pigs in the earliest phases to the appearance of large numbers of sheep remains in the later phases (Brunson 2008). An analysis of age profiles at the site suggests that pigs would have been utilized for meat, while sheep were raised for wool and cattle for traction (Brunson 2008). This pattern is also seen at Zhukaigou (4000-3500 BP), where sheep outnumber pigs and the remains of wild species are found in very small quantities

(Hu et al. 2008 in Liu and Chen 2012). Both of these sites represent a large scale shift in northern China towards the intensification of sheep husbandry and a move away from the utilization of wild species more broadly. Since sheep remains were found in abundance at Lajia, analysis of these remains will provide a clearer picture regarding the use of new species within a longstanding tradition of pig husbandry. This intensification of sheep husbandry continued into the early Bronze Age.

Figure 5. Relevant late Neolithic and early Bronze Age archaeological sites.

Erlitou

The early Bronze Age in China was marked by the appearance of large urban centres, and the development of new technologies, most notably the appearance of complex metallurgy in northern China (Liu 2004). While the early Bronze Age is not attributed to any single region within China, the Erlitou culture type is often given central focus in discussions related to this time period. This is largely due to the size of the Erlitou site and the increased level of social stratification that is apparent in the layout (Thorp 2006). The Erlitou site stretches about 2.4 kilometres east to west and about 1.9 kilometres north to south (Thorp 2006). House pits, individual high-status burials and workshops have all been unearthed at the site, the latter pointing to a high level of craft specialization (Thorp 2006). This increased level of specialization is one of the main characteristics attributed to the early Bronze Age by Chinese archaeologists (Underhill 1997).

In the later phases at Erlitou, agricultural implements were less abundant, while craft goods are found in greater amounts. This suggests that early urban centres may have relied more on trade from surrounding farming communities such as Lajia, rather than maintain a localized and self sufficient system of food production (Liu and Chen 2012). Interestingly, Erlitou style pottery has also been found at Lajia. Furthermore, a Qijia style ceramic jar has been uncovered at the Erlitou site dating to roughly the same time period (Ye Maolin, personal communication 2011). This suggests that either through trade or migration, cultural groups that were very distant from one another were not isolated in a cultural sense. This also provides evidence for a possible trade network that may have involved livestock and/or millet being traded from Lajia and other Qijia culture sites to Erlitou.

Lower Xiajiadian Culture

The Lower Xiajiadian culture is a Bronze Age polity that is associated with a large area across southeastern Inner Mongolia. The earliest dates given to the Lower Xiajiadian culture are roughly contemporaneous with the earliest dates from Lajia, although it was centred far to the north of the Yellow River (Lu and Yan 2005). It followed the Hongshan culture, which was briefly discussed in a previous section. Archaeological sites attributed to the Lower Xiajiadian culture are found until 3500 BP, around 200 years after Lajia was destroyed by earthquakes and flooding. The locations and layouts of these sites suggest that defence was an important consideration. While many sites are located in river valleys, many mountaintop sites have also been found. These mountaintop sites are characterized by very large circular walls and watchtowers (Shelach 1994).

Many Lower Xiajiadian human burials contain faunal remains. The heads of pigs and dogs are often found next to human bodies, while some burials contain small shelves above the body that hold pig limbs (Shelach 1994). This highlights the continuing importance of pigs during this period. At the site of Dashanqian, almost half of the faunal remains are attributed to domesticated pig, while only 15% represent sheep, a change from earlier sites like Taosi (Wang 2004 in Liu and Chen 2012). The difference between this and earlier sites such as Taosi likely represents regional differences rather than a general trend across northern China.

The Overall Picture

In this chapter, I have summarized a small portion of the most relevant literature in order to highlight some broad subsistence trends that are evident through the Neolithic and into the early Bronze Age. Dogs and pigs were the earliest domesticates. There is archaeological evidence from hearths, house pits and burials that suggests that they were ritually important as well as a source of food for Neolithic populations.

Small self-sufficient farming communities that relied on pig husbandry and millet agriculture dominated the northern Chinese landscape for thousands of years until power shifted to larger urban centres like Erlitou during the early Bronze Age. Importantly, these changes in social structure coincide with the introduction of sheep and cattle into a long-standing tradition of pig husbandry. Sites such as Lajia present an opportunity to examine how these new domesticates were used, and how they may have been incorporated into emerging trade networks that were created by larger centres of power. Inferences regarding animal use at Lajia rely on the examination and comparison of sheep, cattle and pig remains. It is therefore important to identify how the behaviours and actions of humans at the site, including selective culling and cooking practices, may have affected how these remains were deposited. It is also important to consider the possible effects of post-depositional processes. The following chapter presents taphonomic case studies that address these issues, and provides guidance for the identification of human behaviour in the faunal assemblage at Lajia.

Chapter 4: Human Behaviour and Faunal Assemblages

In this chapter, I will examine how human behaviours are expressed in faunal assemblages. I define and discuss kill off patterns and their significance for testing my hypothesis that sheep, cattle and pigs at Lajia were being utilized for wool, traction and meat, respectively. I also present several studies that provide a framework for testing my hypothesis that high levels of fragmentation in the assemblage are related to the processing of bones for grease and marrow by the residents of Lajia, the analysis of which is presented in Chapter 5. Finally, I examine criteria for identifying cut marks and other bone modifications, the data for which are presented in Chapter 6.

Taphonomy

Within the zooarchaeological literature, the term *taphonomy* refers to the entire set of processes that affects an archaeological faunal assemblage between the death of an animal to the eventual excavation of its skeletal remains (Reitz and Wing 2008). The entire faunal population of an area or site during the time of original occupation is known as the *life assemblage* (Meadow 1980; Klein and Cruz-Uribe 1984; Reitz and Wing 2008). These animals are selected and utilized in different ways by local humans. The way in which certain species are hunted and butchered, or otherwise processed at their place of death, are the main factors involved in the formation of the *death assemblage* (Davis 1987; Reitz and Wing 2008). Many wild animals are caught and brought to the site, while domesticated animals are often raised and butchered on site. This means that for wild species, only the elements that have been selectively transported back to a site are deposited. All of these actions impact the creation of the *deposited assemblage* (Reitz and Wing 2008). The way in which humans cook and discard animal remains at the site, as well as scattering and destruction by scavengers, can also affect the assemblage at this stage. Once the bones are deposited, there are a number of processes that continue to shape and modify the assemblage. Chemical weathering, rodent damage, and displacement by wind, water and animal burrowing are just a few of the ways in which the *faunal assemblage* is eventually formed (Davis 1987). The modification of a faunal assemblage continues to occur as the archaeologist excavates the site. The way in which faunal material is recovered, including whether or not screens are used during excavation, continues to have an impact on the *sample assemblage,* which is eventually analyzed in a laboratory setting by the zooarchaeologist (Reitz and Wing 2008).

With that general framework in mind, it is useful to consider taphonomic questions that are directly relevant to Lajia. Are cattle bones more likely to be represented at Lajia due to their size? Are particular skeletal elements of the major domesticates at Lajia more resistant to destructive processes? How does the way in which the site was excavated and sampled ultimately affect both the assemblage and quantitative data that are produced? The following section addresses some of the taphonomic issues that must be considered for analyses at Lajia and presents relevant case studies in order to highlight how researchers have addressed similar issues in the past. Special attention is given to assemblages dominated by domesticated species, since these studies provide information that is most relevant to Lajia. By examining methods that other researchers have used to address the questions posed above, I have created a framework for understanding the processes that shaped the assemblage at Lajia.

Kill-off Patterns

One of the ways in which the differential use of domesticates can be studied is through the examination of kill-off patterns. Kill-off patterns are defined as “the relative representation of different age groups in a sample” (Payne 1973 p. 281). This type of analysis uses information regarding age at death to infer the hunting or herding practices of a site’s inhabitants. During the mid-twentieth century, many archaeologists began to use kill-off patterns in order to help identify whether assemblages represented mainly domesticated or wild species (Perkins 1964). The assumption was that the age and sex profile of wild animals killed by hunters who want to maximize their meat yield will differ from that of domesticated animals that are killed by herders who are also concerned with maintaining the growth of a herd and maximizing yields of secondary products, like wool (Zeder 2006).

Archaeologists have also used kill-off patterns in order to examine the use of certain domesticated species (Payne 1973; Brunson 2008). Sakellaridis’s (1979) examination of cattle bones from a Neolithic site in Switzerland revealed that adult females were overrepresented in the assemblage, suggesting that the herd may have been kept for milking purposes. At the late Neolithic site of Taosi (4300-3900 BP), mortality rates were highest for young and sub-adult pigs, while sheep and cattle survived well into adulthood. In this case, Brunson (2008 p.72) suggests that pigs were being utilized primarily for meat, while sheep and cattle were being utilized for wool and traction, respectively. This interpretation is based on established herd management structures, which will briefly be discussed below.

Payne (1973) examined sheep and goat remains in order to identify a number of age structure patterns that are associated with certain types of herd management. In herds that are raised primarily for meat, young males are butchered when they have reached a peak weight. Since only a few males are kept for breeding purposes, there is a general absence of males beyond 18 – 30 months old (Payne 1973). In other words, at sites where meat production is the central subsistence strategy, young male individuals will dominate the assemblage (Greenfield 1991; Ma 2004). In general, more females are kept beyond their peak weight in order to maintain herd numbers, so the number of older female individuals is greater (Payne 1973). These patterns were observed for sheep and goats, so it is important to remember that for pigs and cattle, these patterns will vary slightly. For example, the absence of male cattle beyond 48 months of age suggests that they are being exploited for meat, since that is when they reach their peak weight. In general, size is used as the major indicator of sex for faunal material. In an experimental study that involved the comparison of male and female goat skeletons, Zeder (2001) found that the distal humerus and metapodials display a high level of sexual dimorphism relative to other elements, making them useful for distinguishing males and females in an assemblage. However, she also points out that there is a potential problem of misclassifying young males as females (Zeder 2001 p. 74).

There are a number of herd management patterns relating to the production of secondary products, such as wool, that are also relevant to Lajia. Unlike meat exploitation patterns, which are marked by a drastic decrease in the number of males after a certain age, age profiles relating to wool production are characterized by a gradual and consistent decline in the number of older males and females (Payne 1973 p. 283). An examination of the way that different domesticated species were utilized is an important consideration at Lajia since the earliest archaeological evidence for sheep herding in northern China appears to coincide with a number of socio-cultural changes associated with the early Bronze Age. As discussed in Chapter 2, these changes included an increased level of social stratification and the development of large urban centres of power (Chang 1986; Liu 2004). Domesticated sheep appear in the Chinese context at around the same time that Lajia was occupied. The presence of large numbers of mature adult individuals, both male and female, would suggest that the appearance of sheep was related to early wool production. A large number of mature females with few mature males would suggest exploitation for milk. The sex of individuals could not be determined for the vast majority of specimens at Lajia so a large number of mature individuals at the site would suggest exploitation for secondary products more generally.

Archaeologists use several approaches to determine the age of an individual based on skeletal material. At the Bronze and Iron Age site of Dinkha Tepe, in Azerbaijan, epiphyseal fusion was used as an indicator of age at death for cattle, sheep and goat remains (Gilbert and Steinfeld 1977). The authors point out that established fusion sequences for modern domesticates may not be accurate for ancient breeds. In order to account for these potential differences, the timing for epiphyseal fusion was associated with broad age ranges, rather than specific months. Skeletal elements were sorted into three categories, based on whether they are early, middle or late-fusing specimens. The proportions of fused and unfused specimens within each category were then compared for all species. This analysis revealed that sheep were surviving longer than goats, which was interpreted as evidence for a wool economy at the site (Gilbert and Steinfeld 1977).

It is important to consider that older individuals cannot reliably be aged using this technique, due to the fact that fusion is complete in mature individuals (Payne 1973). Furthermore, unfused bones representing juvenile individuals are generally less dense than fused bones of the same element (Symmons 2005). Therefore, the possible underrepresentation of specimens representing juvenile individuals at Lajia should be taken into account.

Tooth wear and eruption are also often used as an indicator of age at death. This is because teeth are a more precise indicator of age than epiphyseal fusion and are more resistant to taphonomic destruction than other parts of the skeleton (Greenfield and Arnold 2008). A study of pig husbandry practices at the site of Hallan Çemi, in Turkey, involved the examination of molar eruption patterns in order to create survivorship curves (Rosenberg et al. 1998). Based on these data, it was observed that a large number of pigs at the site were butchered before the age of 12 months, which is consistent with evidence from sites in Egypt, Iraq and the Levant, where large numbers of domesticated pigs were raised and kept for meat. Although teeth were found in the Lajia assemblage, they were simply recorded as being present. No further analysis was undertaken due to the small size of the sample.

Skeletal Element Representation

The issue of skeletal element representation ─ the relative abundance of different skeletal elements ─ is an important concept to explore in relation to the faunal remains at Lajia. Reitz and Wing (2008, p. 213) state that "skeletal frequencies may distinguish among commensal animals, animals used for food, and those used as beasts of burden, in rituals, or for other non-food purposes." Binford's (1978) concept of bone 'utility' is a foundational tool in this regard. His work involved the creation of an index that compared the relative nutritional value of particular skeletal elements over others (Binford 1978). The lower legs and head, for example, are seen as having less food utility than other portions of the animal due to a lack of meat and marrow. The concept of food utility has been adopted by zooarchaeologists working in many different parts of the world. At Hallan Çemi, limb bones of sheep and deer were classified as either 'meat bearing' (scapula, humerus, radius, ulna, innominate, femur, patella, tibia and fibula) or 'non-meat bearing' (metapodials, podials and phalanges), and the relative proportions of these categories were examined in order to make inferences about animal use at the site. Since the relative abundance of 'meat bearing' bones was greater than expected for both sheep and deer, the interpretation was that preliminary butchering was done elsewhere, with only higher utility skeletal portions brought back to the site, a phenomenon known as the 'schlepp effect' (Rosenberg et al. 1998 p. 34).

The construction and use of utility indices is commonly undertaken by researchers who are interested in examining why certain elements might be concentrated in particular areas of a site (Binford 1978; Jones and Metcalfe 1988). For example, if certain high-utility elements are confined to the largest building structures at Lajia, while other elements are distributed broadly across the site, it could suggest that these structures represented sites for ritual feasting or residences for elite members of the community.

Bone density is one of the factors that make certain skeletal elements and portions of elements more likely to survive in the archaeological record. It is therefore important to note that there are biases inherent in the way skeletal frequencies are quantified that will also affect an archaeologist's interpretation of an assemblage. Traditionally, efforts to quantify faunal remains at archaeological sites have focused on the counting of long bone epiphyseal ends, due to the fact that fragments from long bone shafts are much more difficult and time-consuming to identify to both element and species (Lam et al. 2010). In more recent years, there has been a move to include shaft fragments when quantifying faunal remains. Norton and Gao (2008) provide an example of this in their analysis of 889 equid specimens from Xujiayao, an archaeological site in northern China. While the research project focuses on human hunting and scavenging habits in the early Paleolithic, the methods utilized and subsequent findings remain relevant to Lajia. It was determined that the inclusion of shaft fragments in analyses greatly influences interpretations.

When shaft fragments were not included, the number of equid long bones was underestimated. In addition, quantification without shaft fragments found that low-utility metapodials were the most frequent longbone. This contrasts with the results of quantification that incorporated shaft fragments, which identified tibiae as the most abundant longbone. While finding an abundance of low-utility bones at a site would have suggested that the site residents were primarily scavengers, the abundance of tibia and other high-utility bones suggests that the hominins at Xujiayao likely hunted (Lam et al. 2010). It is therefore important to recognize that particular methodologies will lead to different sorts of interpretations about animal use at an archaeological site.

Within the context of Lajia, analyzing skeletal frequencies allows for a comparison of households in order to see whether some site residents had access to better cuts of meat than others. This will provide insight into the economic and social relationships between different households at the site. It is important to remember, however, that certain portions of animals may have held ritual or material importance. For example, the head of a pig was found in association with a prestige burial at Lajia. Furthermore, many of the bone implements recovered at the site were crafted from metapodials and other bones of the lower limb (Ye Maolin, personal communication 2011). It is therefore important to consider both functional and ritual interpretations regarding the relative frequency of certain elements in different parts of the site.

Fragmentation

Since the quantification and identification of faunal remains at Lajia is largely affected by the degree of fragmentation in the assemblage, it is important to examine the nature of fragmentation more closely. There are a number of ways in which fragmentation can occur, from processes of physical and chemical weathering to the actions of humans and animals. The main aim of breakage analysis is to determine whether a bone was broken while it was fresh, which may suggest that the bone was broken for access to marrow, or dry, which often occurs as the result of trampling of faunal refuse by humans and animals at the site. Dry breaks also occur as the result of sediment pressure and damage during excavation. A curved or v-shaped fracture outline indicates that the break more likely occurred when the bone was fresh, while a transverse fracture outline indicates a high probability that it was broken when the bone was dry (Villa and Mahieu 1991). Therefore, if the relative abundance of fresh fractures is high within the Lajia assemblage, it would suggest that the fragmentation is related to human activity at the site.

At Lajia, the faunal material is generally very well preserved, though highly fragmented. The faunal remains from Taosi also show minimal signs of weathering, suggesting that the bones may have been buried in pits rather than left in piles on the surface for long periods of time (Brunson 2008). If this was also the case at Lajia, it would suggest that fragmentation is more likely related to human butchery and processing as opposed to trampling. This is because the effects of trampling are more dependent on the prolonged exposure of bone while the site is still actively being used. Sediment pressure is also an important variable to consider, since this would lead to a high degree of fragmentation without necessitating prolonged exposure on the surface. An examination of case studies where fragmentation analysis has been used to examine human behavior at a site is therefore necessary in order to provide a justification and context for similar analyses at Lajia.

A study by Blasco et al. (2008) explored methods by which bone fractures can be analyzed in order to identify the cause of the breakage. The researchers employed an experimental approach where bones were broken through various methods in a controlled environment. The resulting fractures were then examined to see whether particular methods of breakage resulted in a unique fracture pattern. It was determined that the action of trampling produces small diagnostic notches on the broken edge of a bone that distinguishes it from breakage relating to butchery practices.

There have been cases where an analysis of fragmentation within an assemblage revealed aspects of past human behaviour that might otherwise have gone unnoticed. Marshall and Pilgram (1990) examine the Pastoral Neolithic site of Ngamuriak in Kenya, where significant differences in body part representation and bone modification between caprines and cattle were observed. Since animal husbandry, not hunting, was the major subsistence activity at Ngamuriak, the concept of selectively transporting the most useful portions of the animal from a hunting area to a habitation site did not apply here. Marshall and Pilgram (1990) set out to explain why there were marked differences between caprine and cattle remains in terms of modification and representation at the site.

Bone volume data established for adolescent sheep by Binford (1978) were used to determine marrow cavity volumes for the remains at Ngamuriak (Marshall & Pilgram 1990). In terms of the caprine remains, marrow volume was the best predictor of body part representation, while the factors controlling the body part representation of cattle at the site is unclear (Marshall & Pilgram 1990). The cattle remains were observed to be more fragmented than the caprine remains. Marshall and Pilgram (1990) suggest that, unlike the caprine remains, the cattle remains were processed in order to extract grease. This highly destructive type of processing produces a much more fragmented assemblage which affects preservation and makes what is left of the skeleton more difficult to identify (Marshall & Pilgram 1990). A similar analysis can be made at Lajia, utilizing marrow volume values for pigs that were recorded in an experimental study that involved the butchery of both wild and domesticated pigs (Edwards and Steele 2011).

Cut Marks

In addition to fragmentation data, an analysis of the location, frequency, and form of cut marks also provides valuable insight into the butchering process at Lajia. More specifically, an analysis of cut marks can shed light on the way in which animals at the site were butchered and processed for meat. It can also provide information regarding the types of tools that were employed (Fisher 1995). An analysis of these types of surface modifications provides insight into subsistence practices and ritual behaviour (Fisher 1995).

In order to aid in the identification of cut marks, Noe-Nygaard (1989) identified five different categories of marks related to the butchering of an animal carcass. The identified categories are: blows, chop marks, cut marks, scrape marks, and saw marks. A study by Blumenschine et al. (1996) determined that it was possible to distinguish between cut marks and marks left by carnivore damage and various other taphonomic disturbances without the use of a scanning electron microscope. The study was done using hand lenses and low power microscopes on a faunal sample with known modifications. It was found that using these simple pieces of equipment, cut marks could be identified with 99% accuracy (Blumenschine et al. 1996).

At Taosi, it was suggested that repetitive and parallel cut marks on a number of flat pieces of bone may have been related to the dulling of stone tool edges, which is consistent with other evidence that suggests that Taosi was a centre of stone tool production (Brunson 2008). The identification of a cut mark can usually be made through the identification of four main characteristics: a v-shaped cross section, a small width to depth ratio, the appearance of micro-striations in association with the cut mark, and the parallel nature of cut marks that are near to one another (Zhang et al. 2009). These criteria were utilized for the identification of cut marks in the Lajia assemblage. The process of making these identifications is described in greater detail in Chapter 5.

Evidence for the use of certain materials can be found by examining the marks that they leave behind on faunal remains. This is especially important for materials that do not survive archaeologically. The use of bamboo is an important consideration for Lajia, given that it is depicted on pottery from the middle and upper Yellow River valley during the Yangshao culture period, between 7000 and 5000 BP (Zhang 2005). West and Louys (2007) examined markings that were experimentally produced by using bamboo knives to deflesh a sheep humerus. The researchers repeated the procedure using stone tools, and the markings were compared. Cut marks produced using bamboo implements were found to be shallower than those produced by lithic tools. These markings were described as “fainter and less obvious than lithic cut marks” (West and Louys 2007 p. 514). The bamboo markings were also associated with distinct morphological characteristics when examined under a scanning electron microscope. Although microscopes were not utilized for the faunal remains at Lajia, cut marks were observed, and are discussed in more detail in Chapter 6.

As stated earlier, each of the models and case studies that I have presented in this chapter provide a framework for studying the assemblage at Lajia. In the following chapter, I utilize models for bone utility (Binford 1978; Jones and Metcalfe 1988), kill off patterns (Payne 1973) and fracture outlines (Villa and Mahieu 1991) as frameworks for my own methodological approaches.

Chapter 5: Methods and Data Analysis

This chapter presents the methods utilized for data analysis. I describe my data collection techniques and discuss the choice to focus on long bone elements for several of the major analyses, including my examinations of bone breakage and epiphyseal fusion. My analysis of bone breakage consisted of two distinct parts, utilizing models for categorizing fracture outlines and distinguishing between high and low-utility elements. For the latter portion of the analysis, "percentage remaining" values for each long bone fragment were compared using an analysis of variance (ANOVA) test in order to determine whether there was a significant correlation between low "percentage remaining" values and high-utility elements. Finally, I constructed age profiles for each of the major domesticates at Lajia to test my original hypotheses, that sheep, cattle and pigs were exploited for wool, traction and meat respectively.

Faunal material at the site was hand collected and bagged based on spatial location (identified using a grid number) and arbitrary levels. Information regarding specific depths and associated radiocarbon dates were not available over the course of this research project. As a result, this project focused on the spatial arrangement of faunal material and the overall characteristics of the assemblage. With the exception of several bone tools and objects, all faunal material that had been recovered from the site at the time of analysis was examined for the purposes of this project.

Preliminary identifications were made using a small reference collection that was set up in a temporary lab at the headquarters of the Institute of Archaeology in Beijing. The collection consisted of the elements of one individual each of sheep, deer, dog, and pig. Elements that were diagnostic but not identifiable using this collection were taken to the Institute of Archaeology's reference collection, which included about 20 skeletons of different species of mammal, housed in another area of Beijing. One visit was made to the Institute of Vertebrate Paleontology and Paleaoanthropology (IVPP) to further identify diagnostic specimens, especially teeth. The staff at each of these institutes provided assistance in the identification of material when necessary.

Since the material at the site was hand collected rather than screened, very small fragments that could not be identified to broader class designation were not recovered at the site. The least specific category was medium sized artiodactyl – representing the majority of specimens that were not identifiable to species. In creating and attributing material to this category, I relied on knowledge regarding the range of species that were found and utilized in the region and assumed that animals of a particular size represented artiodactyl species. A medium sized bovid/cervid category was also created for those specimens that were identifiable as either sheep or deer. Cattle were usually identifiable based on size, although some small individuals may also be included in the bovid/cervid category. The major species/genus-specific categories that were utilized were *Ovis* sp. (sheep), *Sus domesticus* (pig), and *Bos* sp. (cattle).

Data Collection

A significant portion of the assemblage was already identified prior to my arrival in Beijing. The majority of time in the lab was spent corroborating the preliminary faunal work, identifying previously unidentified specimens, recording fracture outlines, examining epiphyseal fusion and photographing the contents of each bag. Although all elements were identified to some degree, data analysis focused on long bone specimens due to time constraints. In addition, long bones are utilized in a wider range of analyses than elements from the axial skeleton.

A Microsoft Excel spreadsheet was created for the purposes of documentation. Each long bone fragment was assigned a unique number and entered separately in the spreadsheet. Specimens were identified as either being fused, partially fused or unfused. Modifications such as cut marks, burning, rodent gnawing and carnivore damage were observed and recorded (Figure 6). Preliminary examinations were conducted in Beijing and corroborated from high resolution photographs once I returned to the University of Victoria. Cut marks were identified using criteria from Noe-Nygaard (1989), outlined in Chapter 4. These data were used to calculate the frequency of particular types of bone modification in the assemblage.

Level/Feature	Bone ID	Species	Element	Side	Long bone Portion					Metapodial Portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Proximal	Shaft	Distal	Proximal	Distal					
1	A741	Sheep	Tibia	Right			3	10	10				Oblique					7.5	3
1	A750	Sheep	Radius	Right			6						Oblique	Oblique				5	2
1	A751	Sheep	Radius	Right			5	1					Right	Oblique				6	2
1	A754	Sheep	Phalanx 2							10	10	9						2	1
1	A761	Bovid/cervid/suid	Radius		1	2	1							Oblique				4.5	1
3	A14	sheep	Humerus	Right			3	10	2				Oblique	Indeterminate				6.5	3
4	A387	Large bovid	Ulna	Right									Oblique	Right				13	3.5
4	A396	Sheep	Metatarsal	Left	5	4								Oblique				4	2
4	A404	Large bovid	Radius	Left	6	6								Oblique				7.5	3.5
4	A405	Bovid/cervid	Tibia	Left	2	6	1						Oblique	Oblique				6.5	2.5
4	A409	Sheep	Radius		3	3	1						Oblique	Oblique				7	1.5
4	A410	Sheep	Phalanx 1							10	10	10					Cut mark	4	1.5
4	A415	Sheep	Phalanx 2							9	7	10					Tooth marks	2.5	1.5
4	A416	Large bovid	Metatarsal		2	3								Oblique				6.5	3.5

Figure 6. Sample of collected data for long bone specimens.

Quantification

One of the most commonly used units for quantifying animal remains at archaeological sites is known as NISP, short for Number of Identified Specimens. This count measures the number of identified specimens for a particular taxon in a given assemblage (Lyman 1994). This quantification method provides insight into the relative abundance of different species at an archaeological site. While NISP does not directly represent a specific number of individuals, species represented by large NISP counts are generally thought to be more commonly utilized or hunted than species with small NISP counts.

While an *element* refers to a complete bone or tooth in the skeleton, a *specimen* refers to both complete and fragmented skeletal elements (Grayson 1984). In other words, a femur that is broken into three pieces would be counted as three separate specimens in a NISP count. The NISP count at Lajia provides an avenue for examining overall species richness as well as the relative proportion of different species. Due to limited stratigraphic data and the small quantities of faunal remains from discrete feature types at the site, MNI and other related methods of quantification were not utilized.

Bone Fragmentation

This analysis was designed to determine whether or not bones in the assemblage were broken when they were fresh or dry. This was done as a response to the high level of fragmentation in the sample that was observed during the lab identification portion of the project. Long bone fragments were recorded as exhibiting either curved, v-shaped or transverse fracture outlines (Figures 7-9). A number of fracture outlines were not attributable to any of the aforementioned categories. For these instances, a new category of 'other' was created. These categories are based on a case study by Villa and Mahieu (1991). They determined that curved and v-shaped fracture outlines are strongly associated with butchery and marrow extraction, while transverse fracture outlines are most associated with factors such as sediment pressure and excavation damage.

Figure 7. Bone fragments exhibiting curved or v-shaped fracture outlines.

Figure 8. Bone fragments exhibiting transverse fracture outlines.

Figure 9. Bone fragments exhibiting indeterminate fracture outlines.

Distal and proximal fractures on the same long bone fragment were both counted. For example, specimen A1748, a sheep long bone from the large ditch feature, exhibited a combination of fracture outline types on the proximal end and a transverse fracture outline on the distal end (Figure 10). In this case, the proximal end of the bone was classified as ‘other’. For the purposes of quantifying fracture outlines at the site, this specimen contributed two data points towards the overall numbers, while a broken long bone with a complete epiphyseal end would only contribute one.

Figure 10. Fracture outlines as observed on a sheep long bone.

The next phase of analysis was designed to examine whether high-utility elements were more fragmented than low-utility ones. In this case, utility is defined as the amount of marrow and grease that an element contains, as identified through experimental studies by Binford (1978), Munro and Bar-Oz (2005) and Edwards and Steele (2011). If high-utility elements are found to be more fragmented than low-utility ones, it provides evidence that high levels of fragmentation at the site are related to grease and marrow extraction. In order to conduct this test, "percentage remaining" values were calculated for high and low-utility elements.

Long bone elements were divided into five parts. Efforts were made to assure that each zone represented a roughly equal portion of bone. For this reason, the size of a zone changed depending on the element. Each epiphyseal end was identified as a distinct zone, while long bone shafts were divided into three parts. For every individual long bone fragment, the amount remaining in each zone was estimated and added together in order to calculate an overall "percentage remaining" value for a particular fragment. Estimations were made using a 10 point scale, where 10 represents a fully represented portion, and 1 represents 10% of a portion. All values were rounded to the nearest whole number. Portions with less than 10% remaining were assigned a value of one.

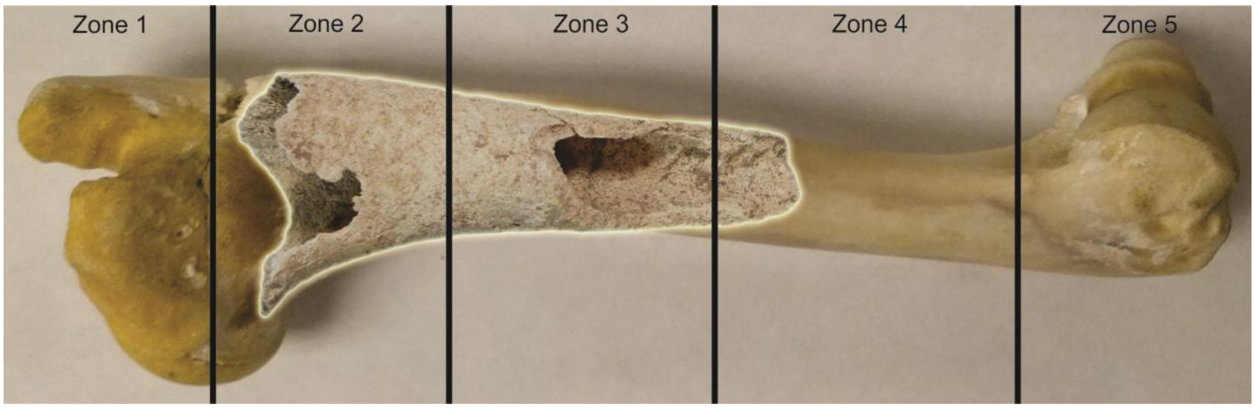

Figure 11. Utilization of zones to measure completeness for the sheep humerus.

In Figure 11, a fragment of a sheep humerus is compared with a whole element in order to determine completeness. In this case, Zone 2 is assigned a completeness value of seven, while Zones 3 and 4 are assigned values of six and one, respectively. The overall "percentage remaining" value for this fragment is 28% using the following formula:

$$\%\,remaining = \frac{(Zone\ 1) + (Zone\ 2) + (Zone\ 3) + (Zone\ 4) + (Zone\ 5)}{50}$$

A sample of collected data is also provided (Figure 12). Due to the small size of phalanges relative to other long bones, categories for phalanges were simplified to represent the proximal, medial and distal portion of the element.

				Long bone Portion							
Bone ID	Species	Element	Left/Right	1	2	3	4	5	Proximal	Shaft	Distal
A1736	large bovi	humerus					3	4			
A1752	sheep	tibia	left			7	6				
A1747	sheep	metacarpal		5	5	3					
A1737.2	sheep	1st phalanx								5	10
A1737.3	sheep	1st phalanx							10		
A1751	sheep	metapodial			6	5					
A1750	sheep	metapodial			6	5					
A1737.4	bovid/cer	femur			2						
A1737.5	bovid/cer	humerus			3						
A1753	pig	metatarsa	left	10	7	2					

Figure 12. Sample of raw fragmentation data.

Fragmentation values were used in order to compare high-utility (femur, humerus, tibia) versus low-utility (metacarpal, metatarsal, radius) skeletal elements using an analysis of variance (ANOVA) test with R statistical software. Tests were conducted in order to determine whether element type is a significant predictor of level of fragmentation for individual specimens. In addition to this, the completeness of elements in various contexts was examined in order to determine the uses of particular areas of the site. For example, remains in an area where bones were being processed for grease and marrow would be more fragmented than remains from cooking areas. In addition, tool-making areas are often associated with concentrations of complete and unmodified deer and sheep metapodials. This is because metapodials from these species are a common raw material for awls and other bone implements.

Comparing Context Types at Lajia

Radiocarbon dates indicate that Lajia was occupied from 4000 to 3700 BP. Since there is no evidence of reoccupation in the immediate area until around 2800 BP (Gao et al. 2007), it can be said with some confidence that the entire assemblage represents material that was deposited within this 300-year period. While stratigraphic information was not yet available for Lajia, a comparison of different areas and contexts at the site will still provide general insight into the use of livestock.

Since the primary focus of this research project is aimed at determining whether there was a difference in the treatment and utilization of different domesticated species at Lajia, it is important to identify the different contexts in which faunal remains have been found at the site, and how these different contexts may relate to one another (Table 1). Without stratigraphic data, these comparisons will focus on remains from discrete features, including houses and ash pits. This is because spatial and temporal association is more easily determined in these contexts as opposed to material from more general contexts.

Context Type	Area
Type I	Ditch
Type II	Ash Pits
Type III	House Features
Type IV	F20 Structure
Type V	F21 Structure

Table 1. Context types at Lajia.

A significant feature at Lajia is a large ditch that surrounds the site. Excavations revealed that the ditch is 10 meters wide and three to four meters in depth, although the overall length of the feature is unknown. Like earlier ditches that are commonly found around Banpo culture sites, this ditch has been interpreted as a defensive structure (Ye Maolin, personal communication 2013). Much of this interpretation is related to the appearance of walled settlements on hills and other evidence for increasing levels of warfare in the later Neolithic across northern China

(Shelach 1994). Faunal remains are found in abundance within the ditch itself, likely reflecting the accumulation of village waste.

In addition to the ditch, there are many ash pits located at the site, largely located around clusters of house pits. These pits contained the accumulation of waste and ash that was removed from hearth features at the site. Some of the pits are square, and others are round, with the significance of this difference unclear. Most of these pits seem to represent later phenomena at the site, although some of the square pits seem to represent an earlier period of occupation. Dates have not been obtained for these features. The F20 and F21 house depressions are much larger than any of the other residential features at the site, suggesting that they may have been used for a communal purpose, including craft production or ritual activity. There are also remnants of postholes in each of these structures, markedly different from other house structures at the site, which were carved into naturally formed cliffs and had soil ceilings and walls. While F21 contained a variety of tools and ceramics, F20 did not contain artifacts and lacked a hard packed floor, suggesting that it may have been built on stilts. The faunal material from each of these structures was examined in order to shed light on their respective uses.

Construction of Age Profiles

Age profiles were constructed for sheep, pigs and cattle in order to determine whether these domesticates were being exploited for meat or for secondary products such as wool or traction. For the purposes of this study, sheep, cattle and pig long bone fragments were examined and classified as fused, partially fused, or unfused.

	Sheep	Pig	Cattle
Early-Fusing			
Distal Humerus	3-10	12-18	12-18
Proximal Radius	3-10	12	12-18
Proximal Phalanx 1	6-16	24*	18-24
Proximal Phalanx 2	6-16	12	18-24
Middle-Fusing			
Distal Tibia	15-24	24	24-30
Distal Metapodial	18-28	24-27	24-36
Late-Fusing			
Proximal Humerus	36-42	42	42-48
Distal Radius	36-42	42	42-48
Proximal Ulna	36-42	36-42	42-48
Proximal Femur	30-42	42	42
Distal Femur	36-42	42	42-48
Proximal Tibia	36-42	42	42-48

Table 2. Summary of fusion timing for sheep, pigs and cattle.

Data from a variety of different experimental studies on fusion timing was compiled in order to construct categories that represent the major stages of life (Noddle 1974; Purdue 1983; Schmid 1972; Silver 1970 in Reitz and Wing 2008). For the purposes of this analysis, fusion sites are categorized based on whether they represent early, middle or late fusion. To begin, a brief discussion of the age ranges within each category is necessary. The general age ranges within each category are –broadly speaking– representative of different periods in an individual animal’s life. These periods represent sub-adult (early-fusing), adult (middle-fusing) and mature adult (late-fusing).

Similar age ranges are grouped together using different shades (Table 2). By doing this, it is clear that the categories of early, middle and late fusion represent significantly different age ranges for each of the major species at Lajia. For example, a large number of unfused elements that are defined as "early-fusing" for sheep might reflect the death of individuals as young as 3 months old, and no older than 16 months, while unfused bones for cattle in the same category reflect an individual that was as old as 2 years when it died.

In some cases, these large ranges reflect the fact that different species mature at different rates. A number of factors can affect the speed of maturation for species or individuals. These factors include nutrition, size of the animal and a variety of environmental factors, including local climate (Reitz and Wing 2008 p. 72). Noddle (1974) found that domesticated goats matured more rapidly than their feral counterparts, due in large part to the increased level of care given to domesticated individuals as well as selective breeding that favours individuals that mature more quickly. Due to these variables, some differences are expected when comparing the timing of fusion for each of the major species at Lajia. Since large animals mature more slowly than small ones, cattle are generally represented by an older range of ages in each fusion category when compared with pigs and sheep.

As noted in Table 2 there is one instance in which an age range seems to be inconsistent with the category in which it has been placed. For the purposes of this analysis, the first proximal phalanx will be included with middle fusion sites for pigs, while remaining in the early-fusing category for sheep and cattle. This is due to the fact that the first proximal phalanx fuses at around 24 months in pigs, which is within the range of all middle-fusing elements for this species.

Although no incidences of partial fusion were observed, many of the humeri in the assemblage are represented by the distal portions of shafts, broken around the margin of the diaphysis and distal epiphysis. There is no visible unfused surface on any of the specimens that display this characteristic. It is possible that these fragments represent partially fused specimens. This occurs when two portions of a bone are becoming fused together, but are only weakly attached. However, since fusion for these fragments was inconclusive, they were categorized as non-diagnostic shaft fragments, and were not included in the analysis. It should be noted, however, that if these specimens do represent partial fusion, then the age of these individuals would be narrowed down to around 10 months, based on Silver's (1969) stages of epiphyseal fusion.

There are some disadvantages to using epiphyseal fusion for the creation of age profiles. This type of analysis assumes the absence of differential destruction. In order to examine how taphonomic bias affects fusion data for particular skeletal elements, Symmons (2005) examines differences in bone density between fused and unfused bones. Although the analysis exclusively utilized sheep remains, the results may also be applicable to cattle, another species in the family Bovidae. His findings suggest that the pelvis, scapula, 1st phalanx, proximal humerus, and distal and proximal tibia show the largest degree of difference in density when unfused and fused elements are compared (Symmons 2005 p. 1696). This suggests that these elements would be the most susceptible to taphonomic bias when used in the creation of age profiles. Only long bones were used in the analysis of fusion at Lajia, so any bias that results from using scapulae and pelvic bones will not affect this study. The elements that show the least variation in density due to stage of fusion include the distal metacarpal and metatarsal, the distal radius, and the proximal femur (Symmons 2005 p. 1696). While all longbone fragments were utilized for the purposes of the fusion analysis at Lajia, the possible effects of differential preservation is discussed in relation to the interpretation of results.

It is necessary to clarify what the results of this analysis say about kill-off patterns at Lajia. The numbers of fused and unfused fragments in the following tables are connected to broader trends regarding the rate of mortality for each species during each stage of life. For example, a large proportion of fused distal femur and proximal tibia (late fusion sites) would support the interpretation that, in these cases, cattle were allowed to live beyond their peak meat weight, since these elements fuse later in life. This would suggest that at least some cattle were likely used for purposes other than meat, such as traction or for milk, depending on the sex of the individual. In other words, this methodology identifies the presence of broader patterns in animal husbandry, not a specific number of individuals within each age class. This is because multiple specimens may be coming from a single individual, or they may represent several individuals. The following chapter presents the results of these analyses.

Chapter 6: Results

The following section presents the results of analyses outlined in the previous chapter. I will begin by presenting the NISP counts for all of the remains at Lajia, as well as describing the general characteristics of the assemblage. This includes a description of cut marks, rodent gnawing and carnivore damage as well as modified bones that show signs of use wear. Levels of bone fragmentation are compared in order to determine whether high-utility elements are more fragmented, and age profiles for each of the major domesticates are presented. I will touch briefly on the implications of each result here, before discussing them in greater detail in Chapter 7.

Site NISP and Species Richness

The faunal assemblage from Lajia, excavated over multiple field seasons, consisted of 5373 identifiable specimens at the time of this analysis. Site level NISP counts for each taxon are summarized in Table 3. The largest categories are 'Medium-sized bovid/cervid', with 2075 specimens counted, and 'Medium-sized artiodactyl' with 1405 specimens. Artiodactyls include bovids, cervids and suids. The former category consists of fragments that were too small to represent cattle, but were identifiable as bovid/cervid. Of the taxa that are the main focus of this project, *Ovis* sp. (sheep) is most represented, with 792 specimens. *Sus domesticus* (pig) and *Bos* sp. (cattle) are the next most abundant categories, with 503 and 359 specimens, respectively. It is likely that most of the fragments in the 'Medium-sized bovid/cervid' category represent sheep. This assertion is based on the relative abundance of sheep in the assemblage in comparison with other identified bovid and cervid species of similar size at the site.

The presence of deer remains in moderate amounts suggests that some hunting did occur, representing a supplemental source of meat for the residents of Lajia. Other wild species were also identified at the site. A number of fragments were identified as representing small mammals, including weasels, rodents and rabbits. Several weasel species are found throughout northern China, including the Altai weasel (*Mustela* altaica), which prefer high-altitude environments, including areas along the Yellow River basin (Allen 1938). Several species of hare (*Lepus* sp.) are also found in the region, including the Woolly hare (*Lepus oiostolus*) (Tate 1947). None of the bird remains from the site were identifiable to species. Other species, including tortoise and marmot, were found in very small quantities.

Cultural and subsistence practices at Lajia may also affect the NISP count. For example, if pigs were more intensively butchered, while sheep and cattle were used for secondary products (as is the pattern at Taosi), then one would expect the NISP count for pigs to be inflated simply due to the greater fragmentation of pig bones.

Species	NISP	% NISP
Medium-sized bovid/cervid	2075	38.62
Medium-sized artiodactyl	1405	26.15
Ovis sp.	792	14.74
Sus domesticus	503	9.36
Bos sp.	359	6.68
Deer	87	1.62
Small mammal	76	1.41
Canis lupus familiaris	49	0.91
Rodent	12	0.22
Lepus sp.	4	0.07

Non ID bird	4	0.07
Snail	3	0.06
Mustela sp.	2	0.04
Tortoise	1	0.02
Marmot	1	0.02
TOTAL	**5373**	

Table 3. NISP and %NISP for excavated material at Lajia.

Pig remains are found in abundance at Lajia, although unlike earlier Neolithic sites in the Upper Yellow River Basin region, they do not constitute the bulk of identified taxa. The presence of sheep remains in large quantities at Lajia is consistent with evidence from other early Bronze Age sites in Northern China that suggests a general move from a regional pastoralist system focused on the exploitation of pigs to a system that utilized a greater diversity of species, including sheep and cattle.

Preservation and General Characteristics

The general preservation of material from Lajia is exceptional, as evidenced by the finding of preserved noodles in the F20 structure. This high level of preservation is related to the flooding event at the site, which rapidly buried the village along with some of its residents, and protected the remains from the effects of weathering and other destructive forces over time.

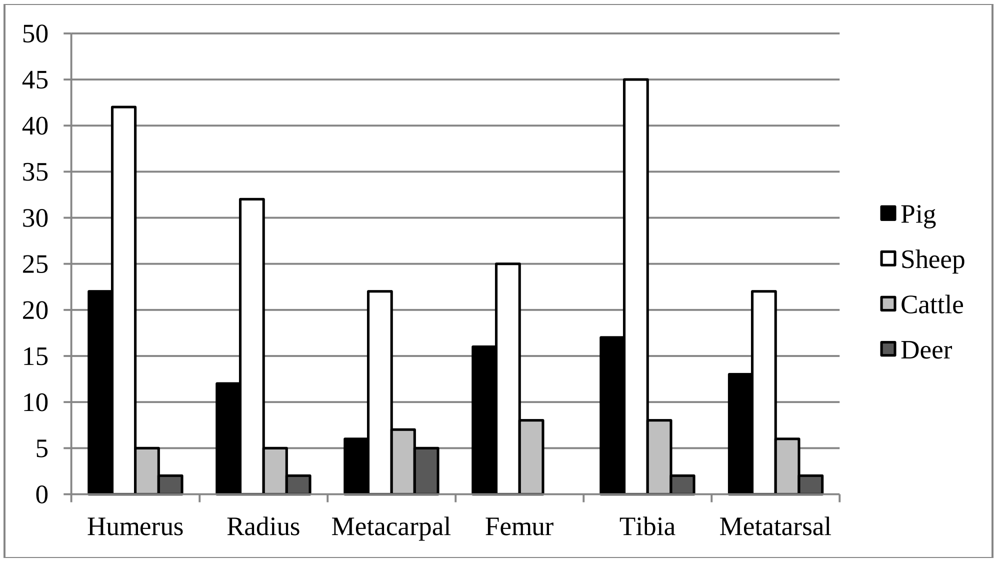

Figure 13. Number of identified long bone elements, by species.

The numbers of identified long bone fragments for each of the major species at Lajia are summarized in Figure 13. Sample sizes for these elements are important to consider, as many of the following analyses focus on long bone remains. Previous studies have also focused on long bone elements, for both human and faunal assemblages (Villa and Mahieu 1991).

Despite the low level of surface wear evident on most of the faunal remains, the assemblage as a whole is quite fragmented, evidenced by a high number of unidentifiable shaft fragments that were observed during laboratory analysis. The implications of this will be discussed in greater detail below, when the fragmentation levels of the three main domesticates - sheep, pig, and cattle - are more closely examined.

As discussed in Chapter 5, cut marks in the assemblage (Figure 14) were identified using criteria outlined by Noe-Nygaard (1989) as well as information from Zhang et al.’s (2009) analysis of Paleolithic butchery practices at the site of Ma’anshan, in southwest China. Due to time constraints, only cut marks on long bone elements were identified and recorded. Less than 5% of fragments in the assemblage exhibited one or more cut marks (40 of 804 specimens). Deer, represented by 25 long bone specimens, exhibit the highest relative frequency of cut marked remains, with 3 out of 25 fragments (12.0%) exhibiting cut marks. The sample size for this calculation is quite small relative to sheep (250 specimens; 4.8% cut marked), pig (132 specimens; 6.1% cut marked) and cattle (75 specimens; 4.0% cut marked). Several fragments representing small carnivore species, as well as one dog specimen, also exhibited cut marks.

Figure 14. Examples of cut marks in the assemblage.

Rodent damage is evident on a number of bones at the site, indicating secondary access to faunal remains for scavengers. Rats and other small rodents would have been attracted to harvested millet and other food stores within the village, and may have been a target for dogs and other small carnivores at the site. Figure 15 illustrates some of the rodent damage that was observed.

Figure 15. Evidence for rodent gnawing.

Carnivore damage was also identified among long bones in the assemblage (Figure 16). Puncture marks and other various bite marks were attributed to carnivore activity at the site. The presence of dog remains in the assemblage supports this interpretation. As with cut marks, bite marks were also identified using the methodology described in Zhang et al. (2009). Less than 6% of fragments in the assemblage display evidence of carnivore damage. While this is slightly greater than the number of cut marked fragments, neither cut marks nor carnivore damage seem to be a significant taphonomic variable.

Figure 16. Carnivore damage in the assemblage.

Bone Tool Manufacture

There were relatively few modified bones identified within the assemblage. The archaeologists who excavated the site recovered several modified pig scapulae and interpreted them as being for used for oracle divination (Ye Maolin, personal communication 2011). I had a chance to view these specimens during a visit to Qinghai province, although they were not included with the remains that I identified at the Institute of Archaeology in Beijing.

Within my own assemblage, there are two fragments that represent the by-products of bone tool manufacture. The distal portion of a sheep metapodial (Figure 17) was broken so as to produce a rectangular piece of bone. These tablets are referred to as ‘blanks’ and can be crafted into a variety of tool types. Metapodials from bovid and cervid species are symmetrical and relatively easy to break into standardized pieces due to the small ridge that naturally occurs down the length of the shaft. Due to these physical properties, bovid/cervid metapodials have been targeted as a raw material in bone tool production by populations around the world. Interestingly, this suggests that the introduction of sheep and cattle would have provided an abundance of bone material that was easier to manufacture into tools, when compared with the smaller and more rounded metapodials of pigs. Metapodials from other species that were identified at the site are also useful for the production of bone tools. Deer metapodials are similar in morphology, albeit longer, than those of sheep and cattle and would have been available in more limited quantities throughout the Neolithic and Bronze Age. A second fragment, representing the proximal portion of a deer metacarpal, shows evidence for a technique in which grooves are produced so that the epiphyses of a bone can be snapped off (Figure 18).

Figure 17. Sheep metapodial used as raw material in the creation of bone tablets.

Figure 18. Deer metacarpal with groove in surface.

A small fragment of unidentified artiodactyl bone was identified as having been ground, possibly for use as an awl (Figure 19). A small area of removed bone along the non-working end of the tool suggests that the tool may have been hafted. Lastly, a small unidentified fragment was ground and polished (Figure 20); its function has not been determined. It may represent a scraper, or some sort of fastener for clothing, though these interpretations are speculative.

Figure 19. Ground bone implement, possibly an awl.

Figure 20. Ground and polished bone implement with cancellous underside.

Long Bone Breakage Patterns

An analysis of fractures revealed that long bones with curved or v-shaped fracture outlines are much more common than those with transverse fracture outlines (Figure 21). This is the case for all of the major species at Lajia. It is therefore likely that the majority of breakage occurred while the bone was still fresh, which would suggest that skeletal elements were processed for grease and marrow. A closer examination of fragmentation at the site will shed more light on this interpretation.

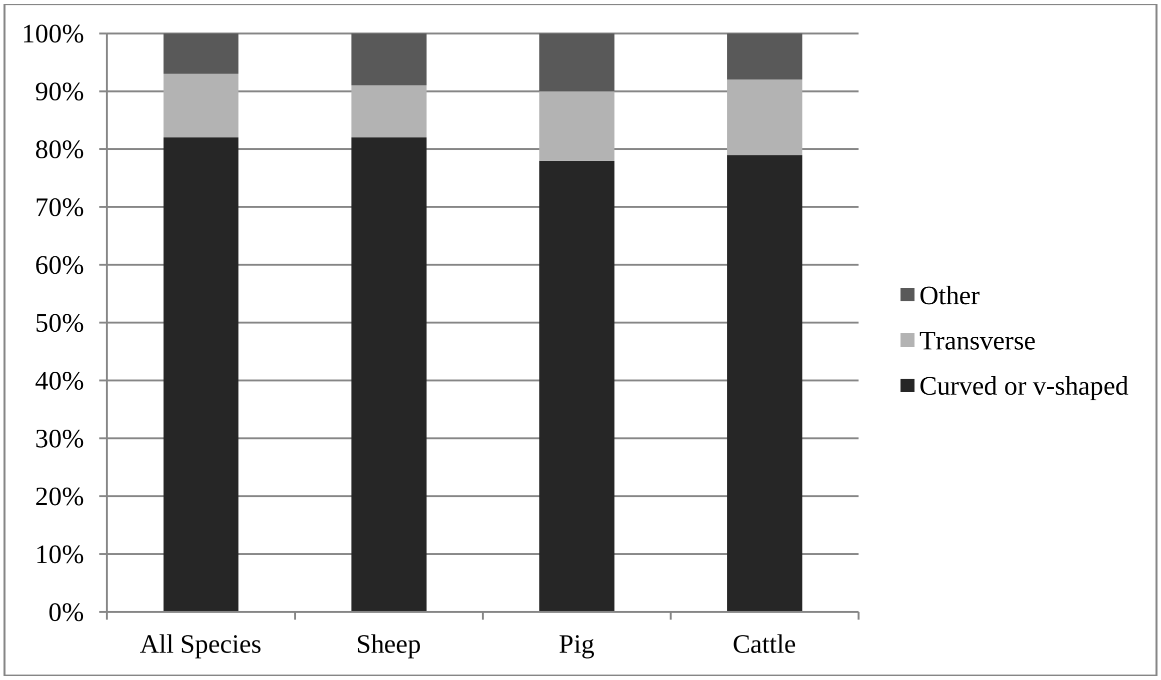

Figure 21. Summary of fracture outlines for long bone specimens.

Fragmentation Levels

The abundance of curved and v-shaped fractures in the assemblage seems to indicate that fragmentation is related to human activities at the site, rather than natural post-depositional processes. It is therefore possible to examine the use of animals at the site by examining how levels of fragmentation differ for different species and in various contexts at the site. As stated in the previous chapter, it is expected that bones that are being processed for marrow and grease would be more fragmented than those that were not.

The average percentage remaining for each element is listed in Table 4. In almost all categories, cattle elements display a greater level of fragmentation than either sheep or pig elements. Cattle metatarsals are an exception, as they are generally less fragmented than the metatarsals of sheep.

This may be caused by the specific targeting of sheep metapodials for bone tool manufacture, as cattle metapodials are quite large and may have proved unwieldy for the purposes of tool making. It should be noted that the difference in fragmentation levels for cattle and sheep metapodials is quite small and may not have any significance. Perhaps most striking is the low levels of fragmentation associated with pig metapodials. These low levels are likely related to the physical structure of these elements. Pig metapodials are shorter and more rounded than those of sheep and cattle. This difference is related to the fact that sheep and cattle metapodials represent two bones that are fused together, while those of a pig do not. Due to these characteristics, it is expected that pig metapodials would be more resistant to destructive agents, both human and non-human. In regards to human agents, the smaller size of pig metapodials also means that they would be a less likely target for grease and marrow when compared with bovid metapodials. However, it has also been observed that marrow from bones closer to the hoof contain a higher concentration of unsaturated fatty acids when compared to the humerus, radius, femur and tibia. Morin (2007) suggests that unsaturated fat is favoured by humans over saturated fat due to its biochemical properties. In addition to this, Jin and Mills (2011) determined that breaking open smaller bones is relatively easy and efficient. For other elements, pigs and sheep exhibit very similar fragmentation levels, except in the case of the femur, where pigs exhibit an average percentage remaining of 28%, compared to 19.8% for sheep.

Element	**Pig Average amount remaining per fragment (%)**	**Sheep Average amount remaining per fragment (%)**	**Cattle Average amount remaining per fragment (%)**
Humerus	26.7	25.2	13.2
Radius	25.1	27.2	17.6
Metacarpal	78.3	21.3	23.3

Femur	28.8	20	13.8
Tibia	30.8	25.6	18.3
Metatarsal	60	20.7	20

Table 4. Average percent remaining for elements in all contexts.

Fragmentation and Bone Utility

The overall aim of this statistical analysis is to determine whether element type corresponds with level of fragmentation for a given specimen. The majority of bones at the site were broken when they were fresh, suggesting that high levels of grease and marrow extraction occurred. It is therefore expected that there would be a strong relationship between high-utility specimens and low “percentage remaining” values. The null hypothesis in this test is that there is no significant relationship between element utility and “percentage remaining”. The mean and range of values for each element were calculated for each of the major species (see Figures 22-24).

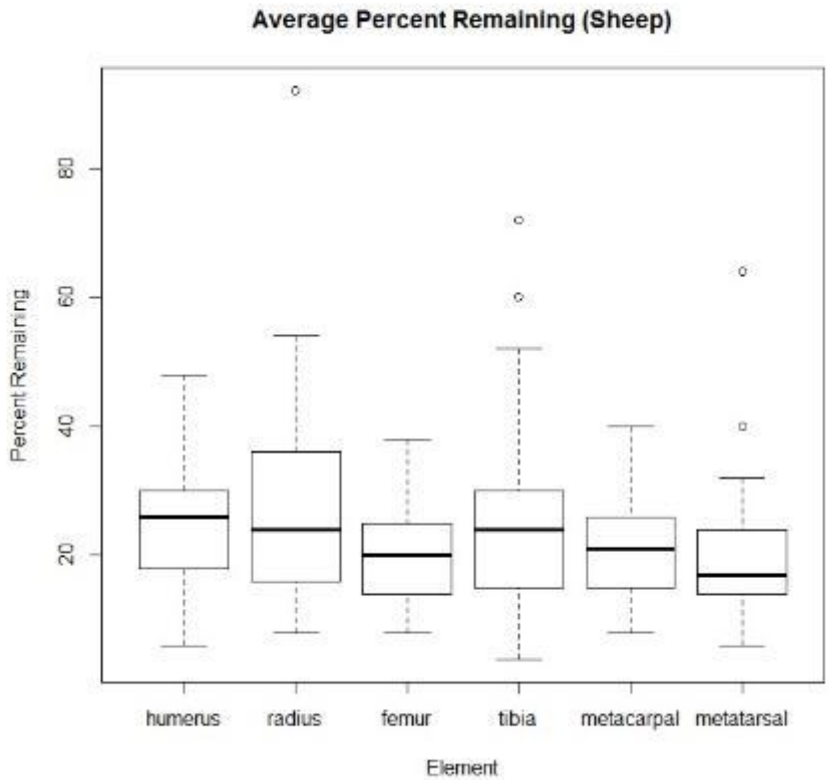

Figure 22. Box plot illustrating sheep fragmentation.

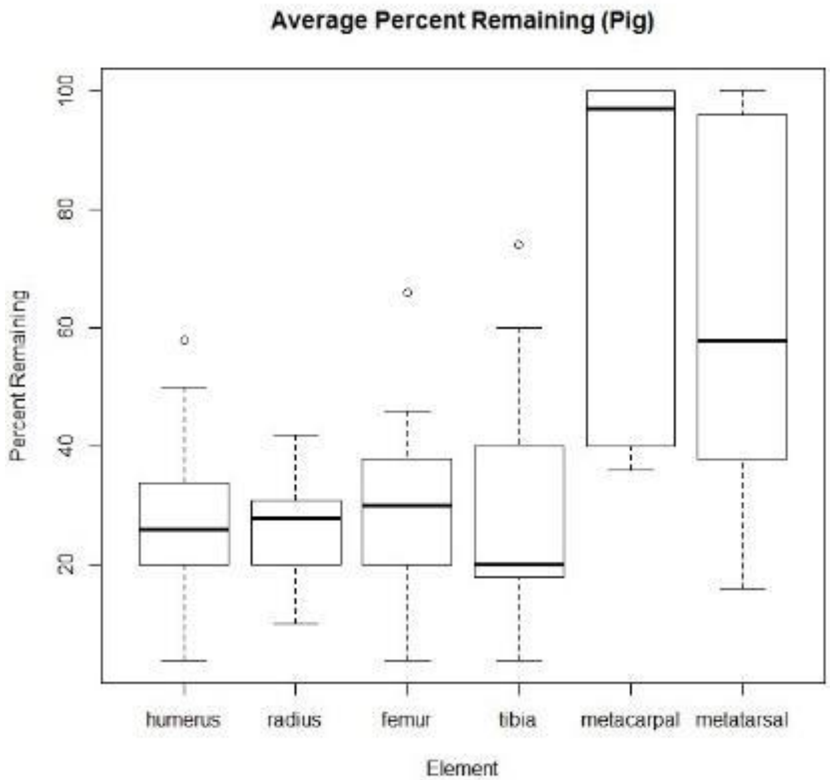

Figure 23. Box plot illustrating pig fragmentation.

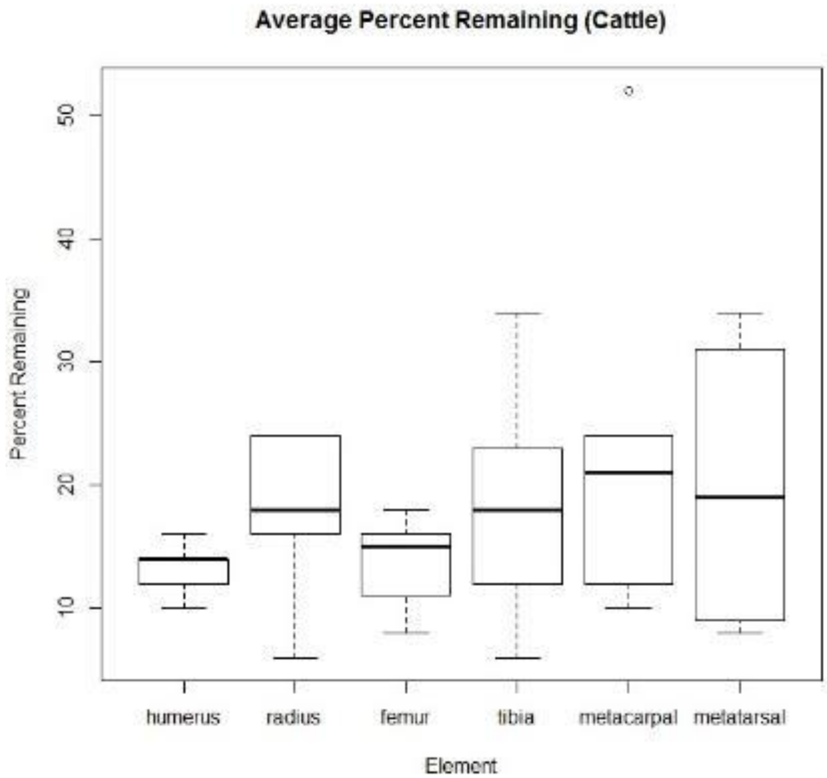

Figure 22. Box plot illustrating cattle fragmentation.

The results of the ANOVA test are given in Table 5. For sheep, bone utility was not a significant predictor of level of "percentage remaining" [F(1,189) = 0.0909, *p* = 0.7634 >0.05]. For cattle remains, bone utility was a better predictor of "percentage remaining", but the results were also not statistically significant [F(1,34) = 2.968, p = 0.09401>0.05]. However, for pig remains, bone utility was a highly significant predictor of "percentage remaining" values [F(1,85) = 17.465, *p* = 7.069e-05 <0.05]. As mentioned earlier in this section, it is likely that the physical properties specific to pig metapodials are responsible for this result. If this assumption is correct, it is expected that "percentage remaining" values for pig metapodials would be responsible for the high level of significance overall, while values for the radius would more closely match those of high-utility elements. If the difference between the radius and high-utility elements is also significant, it would suggest that particular pig elements were selectively processed for their high marrow and grease content.

Analysis of Variance (ANOVA) for High and Low-Utility Elements					
	Sum of Squares	**Df**	**Mean Square**	**F-value**	**Sig.**
Sheep					
Between Groups	14.8	1	14.791	0.0909	0.7634
Within Groups	30753.0	189	162.714		
Total	30767.8	190			
Pig					
Between Groups	10086	1	10086.2	17.465	7.069e-05
Within Groups	49088	85	577.5		
Total	59174	86			
Cattle					
Between Groups	236.6	1	236.6	2.968	0.09401
Within Groups	2710.4	34	79.718		
Total	2947	35			

Table 5. Results of ANOVA statistical analysis.

Several two sample t-tests were conducted for pig remains in order to compare radii to femora, humeri, and tibiae, respectively. This test determined that there was no significant difference in "percentage remaining" values between radii and femora [$t(25.937) = -0.7545$, $p = 0.4574>0.05$], humeri [$t(27.626) = -0.3642$, $p = 0.7185>0.05$], and tibiae [$t(25.309) = -0.9671$, $p = 0.3426>0.05$]. These results determine that the highly significant relationship between "percentage remaining" values and bone utility for pigs is related to low levels of fragmentation for metapodials specifically, and not to low levels of fragmentation for low-utility elements more generally.

Fragmentation and Spatial Contexts

While there is a lack of fragmentation data from other sites in the region that can be used to contextualize the overall data, intra-site comparisons can be made. It is expected that areas where intensive bone processing is taking place would be associated with above average levels of fragmentation. On the other hand, concentrations of complete or near complete bones in certain areas of the site may provide evidence for other activities, such as bone tool manufacture or ceremonial use of skeletal elements. For example, whole scapulae with notches carved into the side have been associated with divination practices at other Qijia culture sites (Di Cosmo 1999). A summary of "percentage remaining" values for each of the major context types at the site is presented in Table 6. As with previous analyses, only long bones were used for the purposes of this analysis.

Location	# of Fragments	Average Amount Remaining (%)
Ditch	68	23.9
House Features	69	25.3
Ash Pits	48	26.5
F20 Structure	9	46.7
F21 Structure	10	22.8

Table 6. Average amount remaining for all context types.

With the exception of the F20 structure, "percentage remaining" values are similar across all context types. This includes all individual houses and ash pits, which were combined into singular categories for clarity of presentation once it was determined that no outliers were present.

In order to determine which elements were responsible for the high "percentage remaining" value for the F20 structure, average values were calculated for high and low-utility elements separately for each species (Table 7). It is difficult to make conclusive interpretations, due to the small size of the sample. A small number of these values are each derived from a single specimen, while the majority of these categories represent less than four specimens.

The F20 structure contained several whole pig metapodials. Due to the small number of remains from this context, it is clear that the presence of these metapodials significantly raised the average percentage remaining value for the F20 structure. No modifications were observed on these elements, and the survivorship of pig metapodials from this structure does not differ significantly from those found in other contexts at the site.

Species	Elements	% of Element Surviving (Average)				
		Ditch	House Features	Ash Pits	F20 Structure	F21 Structure
Sheep	High-Utility (Humerus, Femur, Tibia)	21.8	18.4	19	8	No data
	Low-Utility (Metacarpal, Metatarsal, Radius)	22	22.6	11	38	No data
Pig	High-Utility (Humerus, Femur, Tibia)	33.8	30.6	26	50	No data
	Low-Utility (Metacarpal, Metatarsal, Radius)	69	58.5	47.3	98.7	No data
Cattle	High-Utility (Humerus, Femur, Tibia)	14.7	21.2	14	6	12
	Low-Utility (Metacarpal, Metatarsal, Radius)	No data	No data	24	No data	No data

Table 7. Comparison of high and low-utility elements by context type.

Age Profiles Based on Epiphyseal Fusion

For the purposes of this study, 146 long bone fragments that were identifiable to both element and species were utilized. Only specimens representing sheep, pig or cattle were included. This sample includes only long bones where a fusion site is present. Epiphyseal fusion data from a variety of sources was compiled in order to create categories that represent major periods of an individual's life (Noddle 1974; Purdue 1983; Schmid 1972; Silver 1970 in Reitz and Wing 2008). Fusion sites are classified as either early, middle or late-fusing. These periods are sub-adult (early-fusing), adult (middle-fusing) and mature adult (late-fusing). For example, if the overwhelming majority of early fusion sites for sheep remains are unfused, it suggests that sheep were being culled before they reached maturity. A summary of fusion timing by species and element is found in Table 2 (Chapter 5).

Sheep

Stage	Element	Portion	Total Fused	Total Unfused
Early-Fusing	Humerus	Distal	14	2
	Radius	Proximal	5	
	Phalanx 1	Proximal	13	1
	Phalanx 2	Proximal	8	
Middle-Fusing	Tibia	Distal	6	10
	Metapodial	Distal	7	7
Late-Fusing	Humerus	Proximal		1
	Radius	Distal	1	5
	Ulna	Proximal		4
	Femur	Proximal	2	2
	Femur	Distal		5
	Tibia	Proximal	1	3

Table 8. Summary of fused and unfused sheep elements.

For sheep, the youngest category is represented by the largest sample size (Table 8). In this, most elements are fused, suggesting that sheep were not butchered in significant numbers until they reached adulthood. According to Payne (1973 p. 282), peak meat weight is reached between 18 and 30 months, shortly after adulthood is reached. In populations that are kept for secondary products, such as milk or wool, it is expected that most individuals will be kept beyond 42 months of age, as mature adults (Payne 1973 p. 284). Since the sex of individuals is not known in this case, an abundance of mature adult sheep in the assemblage would suggest that sheep were being utilized for either wool or milk. Figure 25 illustrates that unfused fragments are found in greater abundance than fused ones in the middle-fusing category, suggesting that the majority of specimens in this category came from individuals who did not survive to be mature adults. As well, 20 of 24 fragments in the late category are unfused. These data suggest that the majority of sheep did not live to be mature adults.

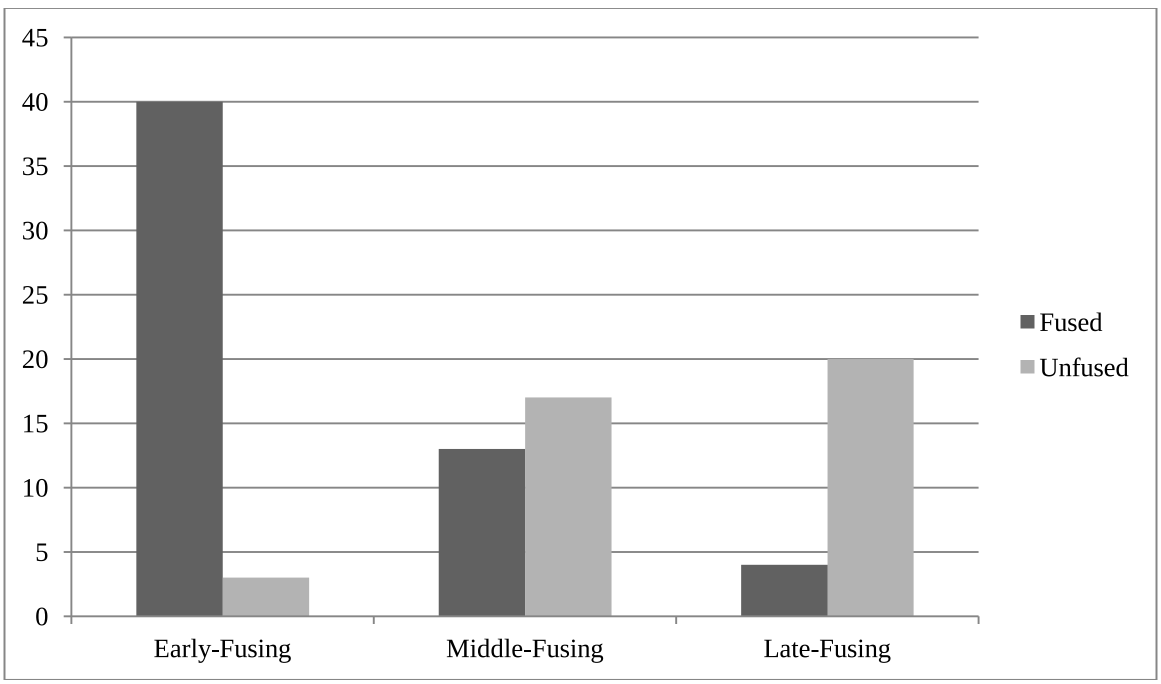

Figure 23. Relative proportion of fused and unfused sheep elements for each fusion category.

The majority of data in the middle-fusing category comes from the distal tibia, which has been identified as being heavily affected by density mediated attrition. There is a probable bias towards the preservation of fused distal tibiae based on the fact that they are much denser than an unfused portion of the same bone. Despite this fact, unfused distal tibiae were almost twice as abundant in the assemblage, supporting the conclusion that the ratios of fused and unfused bones represent a lack of mature adult sheep at the site. For all categories, removing the data from bone portions most affected by density-mediated attrition does not alter the observed trends.

Pig

Stage	Element	Portion	Total Fused	Total Unfused
Early-Fusing	Humerus	Distal	5	2
	Radius	Proximal	2	2
	Phalanx 2	Proximal	3	
Middle-Fusing	Phalanx 1	Proximal	3	
	Tibia	Distal	1	4
	Metapodial	Distal	10	2
Late-Fusing	Humerus	Proximal		
	Radius	Distal		5
	Ulna	Proximal	1	5
	Femur	Proximal		2
	Femur	Distal		2
	Tibia	Proximal		3

Table 9. Summary of fused and unfused pig elements.

While fused bones dominate the early and middle categories for pig, there is a distinct shift towards unfused elements in the late category (Table 9). While 14 of 20 fragments were identified as fused for elements fusing during early adulthood (middle-fusing category), only 1 out of 18 fragments was observed as being fused for elements that fuse during mature adulthood (late-fusing category). These results suggest that most pigs survived in adulthood, but not into mature adulthood.

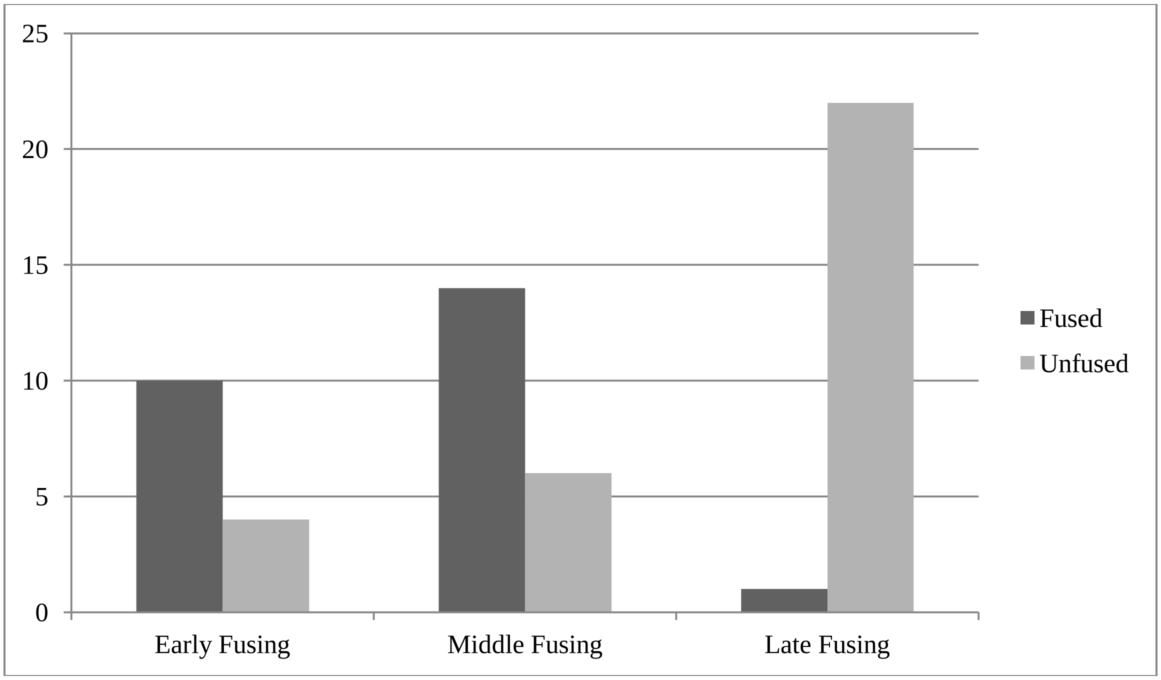

Figure 24. Relative proportions of fused and unfused pig elements for each fusion category.

One possible explanation for these results is related to the differential preservation of elements at the site due to bone density. As mentioned earlier, Symmons (2005) provides a model for determining which bones are more likely to survive in the archaeological record. Brain (1981), also presents data suggesting that elements with a low specific gravity (relating to lower density) will have a lower rate of survival. The proximal humerus, listed as having the lowest specific gravity (Brain 1981: his Table 7), is found in very low quantities at Lajia, relative to other elements. Pigs and cattle do not have any proximal humeri represented, while only one was identified for sheep. While this suggests that preservation bias may be heavily influencing the results of this analysis, it is important to note that other bone portions listed as having a relatively low specific gravity, including the distal and proximal femur, are found in relative abundance. There is also a considerable range in each of these categories, so it is difficult to pinpoint where in the data the shift from predominantly fused to unfused specimens occurs.

Cattle

Stage	Element	Portion	Total Fused	Total Unfused
Early-Fusing	Humerus	Distal	1	
	Radius	Proximal	1	
	Phalanx 1	Proximal	1	
	Phalanx 2	Proximal	6	
Middle-Fusing	Tibia	Distal		
	Metapodial	Distal	1	2
Late-Fusing	Humerus	Proximal		
	Radius	Distal		
	Ulna	Proximal		
	Femur	Proximal		1
	Femur	Distal		
	Tibia	Proximal	1	

Table 10. Summary of fused and unfused cattle elements.

Given the small sample size, it is difficult to make conclusive interpretations regarding the use of cattle but there are still some general observations that can be made. As with sheep and pigs, the majority of specimens in the first category are fused (Table 10), suggesting that significant numbers of sub-adults were not being killed. While it is only a single specimen, a fused proximal tibia provides evidence that some individuals lived into mature adulthood, beyond the time when maximum meat weight would have been reached (Figure 27). This suggests that at least some cattle were being utilized for either milk or traction.

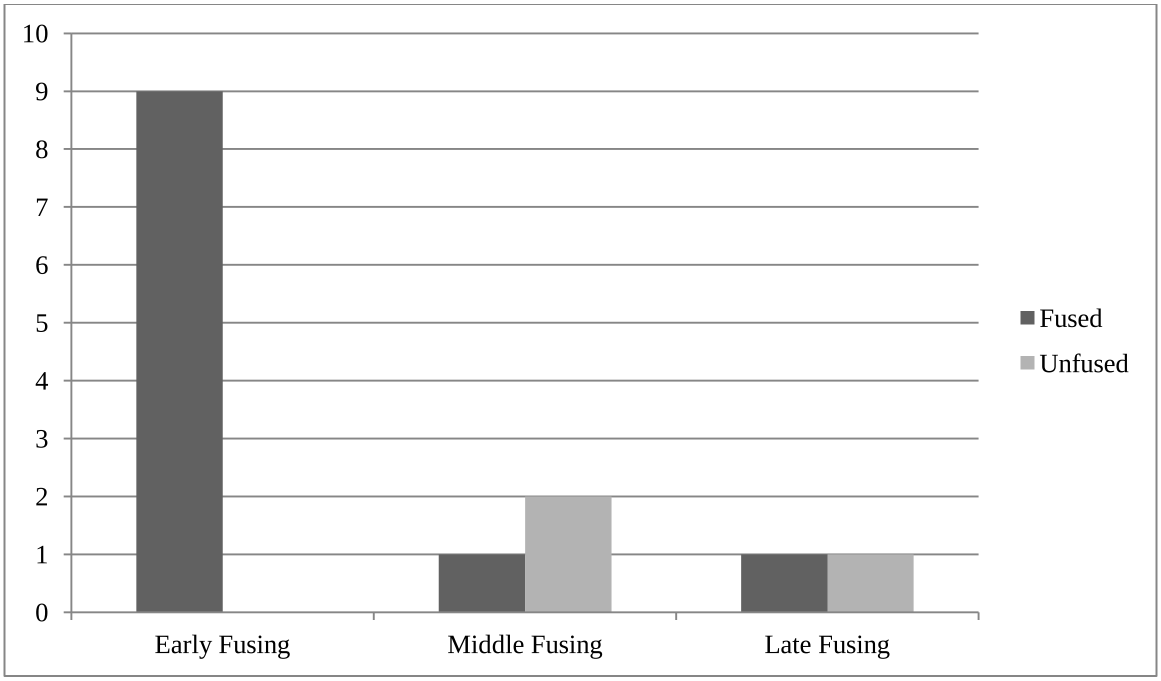

Figure 25. Relative proportions of fused and unfused cattle elements for each fusion category.

In Chapter 7, I will reintroduce my hypotheses regarding the use of domesticated species at Lajia and address them in a way that is informed by the findings above. By doing this, I aim to shed light on the broader issue of shifting animal use patterns in early Bronze Age China, when local subsistence economies were becoming increasingly entangled with larger state level powers.

Chapter 7: Discussion and Conclusions

Introduction

This project was designed to test a variety of hypotheses regarding the use and importance of domesticated species at Lajia. The analyses conducted in this thesis focused on gaining insight into how sheep and cattle were adopted into a longstanding tradition of pig husbandry. In addition to looking at the relative abundance of different species at the site, I created age profiles for each of the major domesticates in order to test my hypothesis that sheep were utilized primarily for wool, cattle for traction, and pigs for meat. Furthermore, I conducted an analysis of bone breakage to test the hypothesis that fragmentation in the assemblage was high because skeletal remains were being processed for marrow and grease. In this chapter, I will address each of my hypotheses individually and discuss how my results support or contradict these statements. I will conclude the chapter with a brief discussion of remains from various important contexts at the site, and provide directions for future research.

Species Present

My first hypothesis was that sheep would be the most commonly represented species in the assemblage. While evidence for pig husbandry is still present during this time period, sheep seem to be an increasingly common domesticate in China by the end of the Neolithic (Luo 2007 in Liu and Chen 2012). This is in contrast to earlier Yellow River sites such as Xipo, where domesticated pigs dominate the assemblage, in addition to small numbers of domesticated dogs and a variety of wild species including deer (Ma 2005 in Li 2013). An NISP count revealed that sheep were the most abundant species at Lajia, supporting my hypothesis. Interestingly, the results from Lajia differ from those at several other Qijia culture sites, where pig remains are most abundant (Chen 2013), although further details regarding the dates or relative proportions of species at these sites could not be obtained. At the Longshan culture site of Taosi, previously mentioned in Chapter 3, sheep are absent in the early layers, and become more abundant over time. In the most recent layers at the site, the NISP count for sheep is similar to that of pigs (Brunson 2008).

Given the fragmented nature of remains in the assemblage, there were many specimens that were attributed to a more general bovid/cervid category. It is probable that the majority of fragments in this more general category represent sheep, since sheep remains are found in much greater abundance than other identifiable bovid or cervid species.

The presence of deer at the site indicates that the residents of Lajia likely hunted, although the remains of domesticated species were dominant. Another possibility is that deer and other wild species were hunted elsewhere and brought to Lajia through trade. There are a number of species of deer that may have been available to early Bronze Age hunters in the region, including Père David's deer (*Elaphurus davidianus*), sika deer (*Cervus nippon*), musk deer (*Moschus* sp.) and water deer (*Hydropotes inermis*).

It is unclear whether or not fishing would have been an important industry in the area. No fish remains were recovered at the site, although their absence may reflect the collection methods employed at the site. The faunal remains at Lajia were hand collected. As no screening was done, smaller fragments are likely underrepresented. As a result, the assemblage may not accurately reflect the richness of small mammals and birds that may have been targeted through hunting. Pottery with painted fish motifs has been found at Neolithic sites in the Yellow River basin more generally, although no mention has been made regarding these types of design in the area directly around Lajia during the early Bronze Age. As well, fishing implements are not mentioned in the literature concerning Lajia.

Utilization of Domesticates

The large number of sheep at Lajia may represent new economic or subsistence based practices in the region during the transition from the late Neolithic to the early Bronze Age. This is a compelling narrative, especially since pigs, which do not provide milk or wool, remain relatively common at a number of northern Chinese sites. Therefore, my next hypothesis is that sheep provided an avenue for a local industry based on wool at Lajia.

For the sample of faunal remains from Lajia, I examined epiphyseal fusion data for each of the major domesticates in order to create age profiles. The age profile for sheep does not fit into the general age structure that is expected for the procurement of wool. Evidence for sheep mortality is most pronounced for younger adult individuals (19-42 months), which more closely fits the model for populations that are kept for meat. In populations that are being kept for wool, it is expected that the number of individuals surviving into mature adulthood would be higher (Payne 1973 p. 284).

These results do not support my hypothesis and point to a sheep exploitation pattern that is not consistent with other sites from this time period. At Taosi, over 75% of sheep were identified as surviving into mature adulthood (beyond 3 years of age), suggesting that they were being utilized for secondary products (Brunson 2008 p. 54). Importantly, this interpretation was also based on information regarding epiphyseal fusion, although it was corroborated with data on tooth eruption and wear.

It is important to consider that Lajia and Taosi are separated both spatially and temporally. Taosi is located along the Yellow River, over 500 kilometers east of Lajia, and was occupied around 500 years prior to the occupation of Lajia. Furthermore, subsistence and economic practices are affected by a multitude of factors, including the local environment and regional trade. For this reason, it is not surprising that sheep husbandry would take on different forms in different regions of Northern China during the late Neolithic and early Bronze Age. While pigs were associated with wealth and ritual importance throughout the Neolithic, more analyses of fauna from late Neolithic and early Bronze age sites are required in order to identify broader economic and cultural shifts brought on by the introduction of new domesticates like sheep.

The next hypothesis that I tested was that cattle were utilized primarily for traction at Lajia. Unfortunately, the sample of cattle remains was very small for this analysis, making it difficult to make any conclusive interpretations. The results suggest that the majority of individuals survived into adulthood. This is expected, since cattle are not generally slaughtered until they reach their maximum meat weight at around two years of age. Cattle that were being utilized for milk or traction would also survive into adulthood. If cattle were being utilized for secondary products, the expectation is that there would be a significant number of older individuals at the site, as evidenced by the analysis of remains from several late Iron Age farming villages in Britain (Grant 2002). This was also the case at Taosi, where cattle remains were interpreted as reflecting exploitation for traction (Brunson 2008). Some cattle were living into mature adulthood, beyond the time that peak meat weight is achieved, which supports my hypothesis that cattle were being utilized for traction at the site. Since this interpretation is based on a single bone specimen, a larger sample is required to more conclusively determine how cattle were utilized.

I then tested the hypothesis that the introduction of sheep and cattle would not have affected the longstanding importance of pigs, both ritually and as a source of meat. Modified scapulae for use in oracle divination were identified as representing pig, suggesting the ritual importance of pigs continued after the introduction of sheep and cattle. A pig mandible was recovered from a prestige burial at the site, also strengthening this hypothesis.

Interestingly, the age profile for pigs does not fit the general model expected for meat exploitation. My results suggest that most pigs survived into adulthood, but few survived into mature adulthood. Evidence from other sites where pig husbandry was practiced suggests that most individuals would be killed off as sub-adults if they were being exploited for meat (Rosenberg et al. 1998, Brunson 2008). Females are generally kept longer than males for breeding purposes, although they are able to produce large litters within their first year (Redding and Rosenberg 1998). However, some would have been kept around to produce multiple litters, as well as during times when meat was already abundant. It is also possible that pigs were raised at Lajia and the meat was sent to residents in the surrounding area, resulting in a lack of peak weight sub-adult individuals at the site.

In order to explore how the observed age structures from Lajia fit into a larger narrative of early Bronze Age animal husbandry, it is important to explore how pigs were utilized in sites within the Yellow River basin, and how the nature of their use facilitated the inclusion of sheep and cattle. As stated earlier, evidence for the ritual use of pigs was found at Lajia. It has been suggested that as communal agricultural systems became more stratified throughout the Neolithic period, pigs became increasingly utilized for ritual feasting that would have been associated with elite members of a village or larger community (Liu and Chen 2012). The importance of pigs during this time is evidenced by a concurrent rise in the number of prestige burials and in the frequency of pig bones found in burial contexts (Kim 1994).

Several Yellow River sites, primarily those attributed to the Dawenkou culture, provide examples of the increasing association of pig remains with prestige burials. Many Dawenkou culture type sites are cemeteries, making them ideal for the examination of burial practices. At the type site of Dawenkou, dating between 6100 – 4600 BP in present day Shandong province, early burials show only small numbers of pig remains. These burials are clustered together in a larger pattern that suggests a more communal arrangement (SPCRC et al. 1974 in Kim et al. 1994). Later burials are more irregularly spaced, with burials that contain pig remains tending to be clustered together. These burials also contain more grave goods, and tend to be larger than other burials.

At the later site of Sanlihe (5000 – 4000 BP), in eastern Shandong province, Dawenkou and Longshan culture burials were also examined in order to examine the relationship between pig remains and prestige burials (Kim 1994). Similar to Dawenkou, there was a distinct spatial patterning of burials that contained pig remains, and these burials were associated with a much larger number of grave goods than those without. Interestingly, in all time periods, burials with pig remains generally face westward.

Evidence for the ritual sacrifice of pigs is seen at the Qijia culture site of Xishanping, in Gansu province. A large pit at the site was excavated, revealing the presence of skeletons from five immature pigs that had been arranged into a T-shape (Chen 2013). At Lajia, a large structure, interpreted as an altar, was uncovered on a raised portion of the site's central plaza. A single burial, found within the altar, contained a pig mandible as well as jade artifacts. The presence of pig remains in a prestige burial at Lajia, as well as in sacrificial contexts at other Qijia sites, supports the assertion that the ritual importance of pigs was widespread across northern China, from the middle and late Neolithic into the early Bronze Age.

Returning to age profiles at Lajia, it was observed that many pigs were being kept beyond their peak meat weight, which many researchers identify as being reached around 6 months of age (English et al. 1988 in Ma 2004). When exploitation for meat is the main focus at a site, it is expected that an assemblage will consist of around 80% immature individuals (Greenfield 1991; Ma 2004). If pig meat was considered a prestige good rather than a staple meat source, then the abundance of adult pigs in the assemblage is not surprising. In this case, a significant number of pigs would have been slaughtered for specific events and ritual practices, rather than for the purposes of efficiently maximizing meat yields for daily consumption.

If this is the case at Lajia, then the introduction of new domesticates at the site would reflect a shift away from the consumption of pigs as a daily staple. As noted in Chapter 5, the mortality rate for sheep under the age of 2 ½ years was much higher than expected for a population being raised for wool, providing evidence that sheep represented the main source of meat for residents in daily life. It should be noted that sheep remains have also been associated with ritual contexts in the area surrounding Lajia. A Majiayao prestige burial at Hetaozhuang, representing a culture that directly preceded the Qijia culture in the same local area as Lajia, contained sheep remains alongside several pig skulls (Yang 1999).

It is also possible that pigs were being exploited for meat in a way that would not produce a standard kill-off pattern. Adult and mature adult pigs have a higher percentage of fat compared to muscle (Loon 1978 in Ma 2004). If greater amounts of fat and comparatively less muscle tissue were desired by the residents of Lajia, then the proportion of older individuals in the assemblage would be higher. At more recent, urban sites in China, researchers assert that meat was being imported from surrounding rural areas. This is the case at the site of Xinzheng (2770-2221 BP), in central Henan, where pig remains overwhelmingly represented individuals that were beyond peak meat weight. In this case, the researcher suggests that a complex relationship between the price of meat and the value of fodder may be responsible for this discrepancy (Ma 2004). In other words, patterns of consumption are affected by a variety of economic and cultural processes, and it is important to consider a variety of explanations for observed patterns.

Fracture Angles and Fragmentation

My final hypothesis states that the high level of fragmentation is due to the fact that the residents of Lajia processed bones for grease and marrow. The first test aimed to determine whether fragmentation was due to human activity or natural processes. The abundance of curved or v-shaped fracture outlines observed on broken fragments within the assemblage reveal that the high level of fragmentation resulted from activities that occurred while the bone was still fresh. Since incidences of carnivore damage were very rarely observed in the assemblage, marrow extraction and processing of bones for grease are the most likely explanations for these high levels of fragmentation. Breakage as a result of trampling is also a possibility, although fresh bones are generally more resistant to this sort of damage due to the fact that they are more elastic than dry and weathered bones (Myers et al. 1980:487; Olsen and Shipman 1988:537). In general, these results supported my original hypothesis.

The next stage of analysis aimed at determining whether there was a statistically significant correlation between element utility and increased fragmentation. The results of this analysis showed that, in general, there was no significant correlation between these two variables, contradicting my hypothesis. However, a comparison of fragmentation levels between different species provides some support for my hypothesis that grease and marrow extraction was occurring. Cattle remains were significantly more fragmented than sheep and pig remains. Since cattle bones are much larger than those of sheep and pigs, they may have been specifically targeted for marrow and grease extraction. Similarly high levels of cattle bone fragmentation have been observed at other sites where fragmentation levels between cattle and smaller species are compared (Marshall & Pilgram 1990). Based on these results, it is important to examine other possible reasons for the high level of fragmentation in the assemblage.

Although dogs are found in very limited numbers at Lajia, their presence does indicate that at least some of the breakage is the result of carnivore damage. Dog remains have been found alongside humans within ritual burials in Chinese farming settlements throughout the Neolithic, and it is suggested that they would have acted primarily as hunting aids (Gao and Shao 1986 in Liu and Chen 2012). Given the close relationship between dogs and humans, it is probable that dogs would have had primary access to skeletal remains while they were still fresh. Despite this evidence, it is unlikely that dogs were a major contributing factor for fragmentation at the site. This is largely due to the lack of evidence for puncture and gnawing marks in the assemblage, as well as the limited number of dog remains that were recovered.

Although no attempts were made to distinguish between various sources of carnivore damage, it is also worth noting that pigs are also known to scavenge on food waste in village settings (Yuan and Flad 2002). No animal enclosures were found during excavation work within the village, although further excavations in the area surrounding the village may reveal animal housing structures. It is also possible that pigs were allowed to roam freely in the village, scavenging on food waste. The utilization of pigs for controlling the buildup of food scraps and human waste has been a common practice around the world (Nelson 1995). Ethnographic data document pigs being kept in residential areas by the Tsembaga of New Guinea in order to maintain clean living areas (Rappaport 1968). Prior to the 19th century, pigs were commonly found on the streets of

New York, scavenging on garbage that was thrown into the streets (Greenfield 1988). The feeding habits of pigs have therefore affected faunal material in a variety of different contexts, due to their frequent presence in residential areas.

An experimental study by Greenfield (1988) compared the destructive effects that pigs and dogs have on faunal assemblages. It was determined that while pig- and dog-ravaged assemblages displayed many of the same characteristics, there were some key differences. Assemblages where dogs are known to be the main destructive agent are characterized by a large number of puncture marks, while pigs leave behind shovel-shaped tooth marks (Greenfield 1988 p. 478). As well, pigs were observed to completely consume smaller and less dense skeletal elements, while dogs are less likely to do so. The extent to which density mediated attrition affected the assemblage in the form of selective scavenging is unclear. It should be noted, however, that smaller bones, such as phalanges, were commonly represented at the site. As well, the shovel shaped markings described by Greenfield (1988 p. 476) were not identified in the assemblage. Both of these general observations suggest that pigs would not have been significant destructive agents.

Bone tool production may also be a source of fragmentation at the site, with smaller fragments representing the by-products of tool production. As mentioned in the previous chapter, there was some material relating to bone tool production found in the assemblage, including a multitude of possible pre-forms for tools, as well as the by-products of this manufacturing process. It is also briefly worth mentioning that metapodials were found in abundance at the site, representing 22% of all identifiable long bone fragments. Bovid metapodials are an ideal raw material for bone tool production because they are uniformly straight, and they have a natural groove down the shaft of the bone that makes them easy to split into uniformly rectangular slabs that can be ground and modified into a variety of implements. While the evidence indicates that bone tool production was occurring at the site, the extent of this production industry and its effects on the assemblage are unclear at this time.

Housing of Animals

Since many complete human skeletons were found in non-burial contexts at the site, it is likely that any penned animals near Lajia's central plaza would have been similarly deposited. As a general observation, the lack of complete skeletons in non-burial contexts is significant because it suggests that there was no housing area for live animals within the excavated area of the village itself. This assumption is based on the fact that flooding resulted in the rapid burial of the site and its residents.

At earlier Banpo sites, which are found in the same general region as Lajia, animal enclosures were generally found in the centre of a circular arrangement of house structures, suggesting a communal rather than individualistic system of animal husbandry (Yang 1999; Lee 2005; Zhang 2005). Based on this, we can determine that the Lajia site did not follow the same layout pattern as many earlier middle and upper Yellow River basin sites. The comparison here is not meant to suggest that there was a linear movement from centralized to peripheral animal enclosures. Settlement patterns can reflect any number of variables, cultural or otherwise. It is important to consider, however, that the peripheral placement of animal enclosures would allow for larger herds. This is an important consideration, given that Lajia was occupied during the transition from the late Neolithic to the early Bronze Age, when larger settlements like Erlitou would have drawn on resources from the surrounding area in order to provide enough food for increasingly dense populations.

Although having pens located outside the village may be interpreted as representing a shift from communal to individualized resource production, it is impossible to say with any degree of certainty whether or not this is the case. Lajia does have a centralized plaza area that connects various clusters of houses and other structures, but it does not contain whole animal skeletons, and it is difficult to determine from the material culture what this area may have been used for. Further excavations in the area directly around the village would likely reveal more about how the animals were housed and cared for.

Ditch Feature

Faunal material is found in abundance within the ditch feature that surrounds the site. If the ditch represents part of a defensive system, an emergent phenomenon during transition from the Neolithic into the early Bronze Age (Xi'an et al. 1988 in Lee 2005), then the material may represent waste that washed into the ditch during a period of flooding. Many Miaodigou culture sites, located in the middle Yellow River region and dating to 6000-5300 BP, have a similar layout to Lajia, including a large central plaza and large ditch features. These features surround portions of the site that are not directly adjacent to the Yellow River and have been interpreted as defensive structures (Ma 2005 in Li 2013). At Lajia, there was no observed difference between faunal remains in the ditch and remains in other contexts at the site. The variables that were examined included the frequency of bone modifications, proportion of burnt bones, general level of fragmentation, and range of species present. Material waste may have been deliberately disposed of there during the site's original occupation. As stated earlier, a lack of complete animal skeletons at the site suggests that there were few, if any, live animals kept within the area of the village itself, suggesting that the ditch would not have been a means of controlling their movement, much like a modern cattle guard.

F20/F21 Structures

One of the aims of this project was to determine whether the neighbouring structures, designated F20 and F21, were utilized for a communal purpose, such as craft production or ritual feasting. This question was posed mainly due to the large size of these structures in comparison with other house pits at the site. As well, unlike the other structures at the site, F21 may have been built on stilts. This assertion is due to the fact that there is no evidence of a hard packed floor, and unlike F20, there is an absence of artifacts and ceramic vessels (Qian 2007). Unfortunately, the lack of remains from these contexts makes it difficult to interpret their use.

Skeletal remains in the F20 structure were significantly less fragmented than remains from other discreet contexts at the site. The presence of several complete pig metapodials in this small sample was responsible for this lower level of fragmentation. Since these metapodials contain minimal grease and marrow (Binford 1978; Metcalfe and Jones 1988), they may not have been targeted for these items. A number of bone implements crafted from metapodials were found at the site (Ye Maolin, personal communication 2011), although these were not a part of the examined sample, and it is unclear if any of these represented pig.

Conclusions and Future Directions

The Lajia site represents a wealth of information regarding social and political changes that were occurring during the early Bronze Age in China. While the appearance of larger centres of power such as Erlitou are usually discussed within the framework of increasing craft production and evidence for complex metallurgy, the impact of animal use and subsistence practices must also be examined. The early Bronze Age marked the introduction of sheep and cattle into a well-established system of pig husbandry that had developed across Northern China throughout the Neolithic period.

At Lajia, it is evident that while pigs continued to be utilized, sheep were an increasingly important domesticate. The data suggest that sheep were a major source of meat for the residents of Lajia and not a source of wool as predicted. Pigs were an important part of ritual activity at the site. Their remains were modified for use in divination and included in prestige burials. In addition, it was found that they were not being slaughtered in a manner that would maximize meat yield, suggesting that they were not a daily source of meat for residents at the site. Cattle remains were limited, so conclusive interpretations could not be made regarding their use. However, the presence of a mature individual at the site suggests that some cattle were utilized for traction. Finally, the analysis of bone fragmentation revealed that the majority of bones were broken fresh, supporting my hypothesis that residents were processing remains for grease and marrow. However, there was no correlation between high-utility elements and increased levels of fragmentation.

Further excavations at the site itself may also reveal more information regarding the housing and raising of animals, especially if these excavations are conducted in the area surrounding the village. Such work may reveal the presence of animal pens or other types of housing areas, as well as cemeteries that would shed further light on the inclusion of animal remains in prestige burials. When stratigraphic information from the site becomes available, it will be possible to examine whether sheep became increasingly abundant over time, or whether they were already being heavily utilized in the earliest period of occuptation.

An examination of how new domesticates were utilized reveals important information regarding the economic and social systems that would eventually provide the foundations for a large scale Chinese civilization. Given the evidence for connections between the Qijia culture and larger centres of power, the examination of fauna from other Qijia sites will be an important step towards gaining a clearer picture of animal use in the region. Without this context, it is difficult to make interpretations regarding larger scale socio-political changes in the region. Despite this, the data from Lajia represent valuable site-specific information that can be combined with data from other sites in future research. In addition to providing a relevant case study for the development of animal use during the early Bronze Age, the analysis of faunal remains at Lajia represents a building block for the continuing development of zooarchaeology in the Chinese context.

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Appendix A. Summary of long bone attributes

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
1	A741	sheep	tibia	right			3	10	10				oblique					7.5	3
1	A750	sheep	radius	right			6						oblique	oblique				5	2
1	A751	sheep	radius	right			5	1					right	oblique				6	2
1	A754	sheep	phalanx 2							10	10	9						2	1
1	A761	B/C/S	radius		1	2	1							oblique				4.5	1
3	A14	sheep	humerus	right			3	10	2				oblique	ind				6.5	3
4	A387	L. bovid	ulna	right									oblique	right				13	3.5
4	A396	sheep	metatarsal	Left	5	4								oblique				4	2
4	A404	L. bovid	radius	Left	6	6								oblique				7.5	3.5
4	A405	Bov/Cer	tibia	Left	2	6	1						oblique	oblique				6.5	2.5
4	A409	sheep	radius		3	3	1						oblique	oblique				7	1.5
4	A410	sheep	phalanx 1							10	10	10					cut	4	1.5
4	A415	sheep	phalanx 2							9	7	10					tooth	2.5	1.5
4	A416	L. bovid	metatarsal		2	3								oblique				6.5	3.5
4	A417	sheep	metatarsal		2	3	1						oblique	oblique				5	1.5
4	A429	L. bovid	ulna	right									oblique	oblique				8	3
4	A1067	sheep	metacarpal	right	3	3	2							oblique				5.5	2
4	A1076	Bov/Cer	tibia	Left		1	8						oblique	oblique				10	2
5	A2504.2	Bov/Cer	tibia			3	3						right	oblique				9.5	2.5
5	A2504.3	Bov/Cer	tibia			3	3	2					comb	oblique	UF			14	2.5
5	A2504.4	L. bovid	tibia			3	3						ind	oblique			tooth	11	3.5
5	A2504.5	Bov/Cer	humerus				3						oblique	oblique				7	2
5	A2504.6	L. bovid	metapodial		4	3								oblique				7	4.5
5	A2504.7	L. bovid	metapodial					5					comb		UF			3.5	3.5
5	A2504.8	L. bovid	metapodial					4					oblique		UF			4	3
5	A2504.9	L. bovid	metapodial				2	9						oblique	UF			5.5	2.5
5	A2514.9	Bov/Cer	radius				3						right	oblique				7	1.5
5	A2505.2	L. bovid	metatarsal			6	7	6					oblique		UF			15.5	3.5
5	A706	pig	metatarsal 4	right	9	10	10	9	9									7.5	2
5	A709	sheep	humerus	right			1	3	9				oblique	oblique				6.5	3
5	A710	L. bovid	metacarpal				6	10	10				oblique					7.5	2.5
5	A711	sheep	ulna	Left									oblique	oblique			Tooth	5	3
5	A713	sheep	metacarpal			1	7	9	1				oblique	oblique				8	2.5
5	A714	sheep	femur			2	7	1					oblique	oblique				7.5	2
5	A728	sheep	phalanx 2							8	6	10					tooth	2	1
5	A732	B/C/S	tibia	right	1	5	2						oblique	oblique				5.5	2
5	A732.1	B/C/S	tibia			2	5	3					oblique	oblique				6.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
5	A733	pig	radius		2	9	6						oblique	oblique				5	1.5
5	A734	pig	metacarpal				4	8	6				right	ind				5.5	1.5
5	A735.1	B/C/S	radius				7						oblique	oblique				4.5	1.5
5	A968	pig	tibia	right					2						UF			2	2.5
5	A697	sheep	tibia	Left			6	8	1				oblique	oblique				9.5	2
5	A830	pig	ulna	right									oblique	oblique				9	3.5
5	A830.1	B/C/S	metapodial		2	2	1							oblique				4	2
5	A833	pig	radius	Left	9	1								oblique				3	2.5
5	A834	deer	phalanx 1							10	10	10						4	1.5
5	A835	pig	tibia	right					5				ind					2.5	2.5
5	A1472	pig	Fibula										oblique				cuts?	9.5	1
5	A667	sheep	metapodial					2	5				oblique	oblique				4	1.5
5	A667.1	B/C/S	radius				3						oblique	oblique				4.5	1
5	A668	sheep	radius			1	7						oblique	oblique				7.5	2
6	A1461	pig	metatarsal 3	Left	9	10	10	10	10									7	2
6	A1382	L. bovid	metapodial						3				right				cuts	3.5	3.5
6	A2042	pig	tibia	Left	6									oblique				3.5	5
6	A2047	pig	radius	Left				3	2				oblique		UF			3	2.5
6	A1546	pig	femur	right				3	2				oblique		UF			5.5	3
6	A1546.1	Bov/Cer	metapodial		3	3	2											6.5	2
6	A1546.2	Bov/Cer	phalanx 2									4	oblique					1	1
6	A1546.3	B/C/S	humerus				3	9	1				oblique	oblique				3.5	1.5
6	A1546.4	B/C/S	humerus				2	3	1				oblique	oblique				3	1
6	A2152	sheep	femur	right					8						UF			5	4
6	A2153	Bov/Cer	metapodial					1	1				oblique		UF			1.5	1.5
6	A2153.1	Bov/Cer	metapodial						8						UF			2	1.5
6	A2153.2	Bov/Cer	metapodial						8						UF			2	2
6	A2155	pig	humerus	right			7	10	4				oblique					4	1.5
6	A2277	L. bovid	femur	right			4	4	1				oblique	oblique				12	4
6	A2188	Bov/Cer	metatarsal		1	2	3	2						oblique				13.5	1.5
6	A2278	sheep	metapodial	Left					9						UF		cuts	2	3
6	A2506.2	Bov/Cer	tibia			2	2						oblique	oblique				6	1.5
6	A2506.3	B/C/S	radius				2						right	right				3.5	1
6	A1411.1	B/C/S	radius				5						oblique	oblique				5.5	1
6	A1411.2	B/C/S	femur				6						oblique	oblique			cuts	7.5	2
6	A1411.3	B/C/S	metatarsal		1	8	10	10	10				oblique				tooths	4	1
6	A1272	pig	ulna	Left									oblique	oblique				9	4
6	A1272.1	B/C/S	femur				5						oblique	oblique				6	1.5
6	A1275	deer	tibia	Left			3	10	9				oblique					6	3
6	A1285	sheep	femur	Left			3	10	2				oblique	oblique				6	3

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
6	A1272.3	B/C/S	tibia				6						oblique	oblique				7	2
6	A1272.4	B/C/S	tibia				3						oblique	oblique				7	1.5
6	A1036	L. bovid	tibia	Left	8	1								oblique				7	6
6	A1036.1	B/C/S	tibia				3	7					oblique	oblique				5.5	1.5
6	A1039	B/C/S	tibia	Left	3	2								oblique	UF			6	4
6	A1045	sheep	metatarsal	right	10	3								oblique				3	2
6	A1046	pig	femur										oblique	oblique				9	1
6	A1056	B/C/S	ulna										oblique	oblique				3.5	1.5
6	A1057	B/C/S	ulna										oblique	oblique				3.5	2
6	A1060	pig	metacarpal		9	10	1							oblique				3.5	1
6	A1061	deer	metatarsal			1	3						oblique	oblique				4	1
6	A1083	B/C/S	femur				5						oblique	oblique				7	2
6	A1200	L. bovid	femur				3	2					oblique	oblique				8	4.5
6	A1200.1	B/C/S	radius			4							oblique	oblique				7.5	1.5
6	A1202	B/C/S	humerus	right		1	8	1					oblique	oblique				6	2
6	A1203	B/C/S	femur		3	1								oblique	UF			3	2.5
6	A1478	sheep	phalanx 1								8	10	oblique					2.5	1
6	A788	sheep	radius				6						oblique	oblique				6.5	1.5
6	A689	Bov/Cer	tibia	Left			2	10	9				oblique					6.5	3
6	A600	B/C/S	humerus	Left			2	3	1				oblique	oblique				5	2
6	A1254	Bov/Cer	metatarsal				4	3	2				oblique	oblique				9	1.5
6	A1257	sheep	phalanx 2							4	8	10						2	1
6	A1258	pig	phalanx 2							10	10	10						2	1.5
6	A1259	sheep	tibia				5	3	3				oblique		UF			8.5	2
6	A1264	pig	Fibula										oblique	oblique			cuts?	7.5	1
6	A1265	pig	radius				5						oblique	oblique				6.5	1.5
6	A1266	B/C/S	radius				4						oblique	oblique				4.5	1.5
6	A2510.2	B/C/S	radius	right			5	10	1				oblique	oblique				6.5	2
6	A2312	pig	humerus	Left				1	9				oblique				cut	3.5	3
6	A1404	sheep	humerus	Left			2	10	7				oblique	ind				7.5	4
6	A618	L. bovid	metapodial				6						right	oblique		burned		5.5	2
6	A615	dog	humerus					5	8				oblique					5	3
6	A626	deer	tibia	right				6	10				oblique					3.5	2.5
6	A629	sheep	metatarsal				3	10					oblique		UF			6	2.5
6	A617	sheep	radius	right					9						UF			3	2
6	A625	sheep	phalynx 1								2	4	comb	comb				2.5	1
6	A615.1	Bov/Cer	humerus				4						oblique	right				2.5	2
6	A2507.1	Bov/Cer	tibia				2	3					oblique	oblique				5.5	1.5
6	A2507.2	Bov/Cer	radius				3						oblique	oblique				6.5	1
6	A2507.3	Bov/Cer	humerus				3	3					right	oblique				7	1.5

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
6	A2511.6	B/C/S	metatarsal		4	3								oblique				4	3.5
7	A2503.9	L. bovid	metapodial						5						UF			3.5	3
7	A2057	L. bovid	metapodial						4						UF			3	3.5
7	A1234	L. bovid	radius	right					8						UF			5	6.5
7	A1189	pig	femur	Left	3	10	3						oblique	oblique			cuts	8	2
7	A1209	L. bovid	metapodial				2	4	4				oblique					9.5	3
7	A1210	L. bovid	humerus	right			1	3	1				oblique	oblique				8.5	4
8	A61	Bov/Cer	metacarpal	right	5	3	1							oblique			cuts	4	2
9	A2500.9	L. bovid	phalanx 2							10	10	10						5	3.5
9	A1393	sheep	phalynx 1								4	10			UF			3.5	1
9	A2505.6	Bov/Cer	femur	Left	5	10	5							oblique	UF			8	3.5
9	A2505.7	B/C/S	radius				4						oblique	oblique				5.5	1.5
9	A2505.8	B/C/S	ulna				3						oblique	oblique				3.5	1.5
9	A2505.9	B/C/S	radius			2	5						oblique	oblique				6	2
9	A2506.1	B/C/S	radius				2	4	1				oblique	oblique				6	1
9	A2506.6	pig	metacarpal 2	Left	10	10	10	10	10									5	1.5
9	A2507.7	Bov/Cer	tibia				3	4	2				oblique	oblique				8.5	2
(1)2	A135	Bov/Cer	tibia	right	7										UF			4	2.5
(1)2	A134	Small carnivore	radius				8	5					oblique	right				6	1
(2)1	A436	sheep	femur	left		9	1						oblique	oblique	UF			6	3
(2)1	A437	pig	fibula	left										right				6	1.5
(2)1	A441	pig	metatarsal	left	9									oblique				2.5	2
(2)1	A442	sheep	ulna	right									oblique	oblique				3	1.5
(2)1	A435	sheep	radius	right		2	8	10	7				oblique		UF		cutmark	11	2.5
(3)3	A278	L. bovid	phalynx 1								3	8		oblique				4	3
(3)3	A275	pig	femur	left					10						UF			5	3.5
(3)3	A281	sheep	phalynx 2							10	10	10						2	1
(4)3	A235	L. bovid	metapodial		3	2							oblique	oblique				3	3
(4)3	A237	L. bovid	metapodial		2	1							comb	comb				3	2.5
(4)3	A247	L. bovid	metapodial		1	2							comb	comb				3	2
(4)3	A223	Bov/Cer	tibia	right		8	10	5					oblique	comb				9	2
(4)3	A243	sheep	metapodial				2	4	5				oblique					6	1.5
(4)3	A227	Bov/Cer	ulna	left									right	right				5	2
(4)3	A218	sheep	1st phalynx							10	10	10						4	1
(4)3	A222	Bov/Cer	humerus	right			1	7					oblique	right				5	1.5
(4)3	A414	pig	fibula										oblique	ind			cutmark	10.5	1
(5)5	A581	Bov/Cer	metapodial					6	1				comb	right	UF			4.5	2.5
(5)5	A577	pig	metapodial				3	10	3				comb	oblique				2.5	1
(5)5	A574	sheep	metacarpal	right	3	3							comb	oblique				3	1.5
(5)5	A2508.4	Bov/Cer	humerus					7	2				oblique	oblique				5	3

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
(5)5	A2508.7	Bov/Cer	metatarsal				4	5					oblique	comb	UF			5	1.5
(5)5	A2508.8	Bov/Cer	metapodial					3					oblique	oblique				2.5	1.5
(5)5	A2508.9	Bov/Cer	metatarsal			2	4						oblique	oblique				5	1
(5)5	A2509.1	sheep	tibia		3								oblique	oblique				5.5	1.5
(5)5	A2509.2	Bov/Cer	femur				3						oblique	oblique				4.5	1.5
(5)5	A1152	sheep	humerus	left				5	9				oblique					4.5	3.5
(5)5	A1156	L. bovid	femur	right				4					oblique	oblique				7	5
(5)5	A1172	deer	phalynx 1								6	9	oblique					2.5	1.5
(5)5	A1153	sheep	metatarsal				2	4	10				oblique				bite mark	6	2.5
(5)5	A1154	sheep	radius	left			10	9					oblique	oblique				10	2.5
(5)5	A1175	deer	humerus	right			3						oblique	oblique				5	2
(5)5	A1159	dog	phalynx 1							7	9	5						2	0.5
(5)5	A1171	sheep	phalynx 2							10	10	10						2	1
(5)5	A1162	dog	Metacarpal 4	left	8	10	10	10	4									6	1
(5)5	A1160	dog	metapodial			5	10	10	8				oblique					4	1
(5)5	A1163	dog	Metacarpal 4	left		5	10	10	7				comb					5	0.5
(5)5	A1161	dog	Metacarpal 5	left	3	9	10	10	9									5	1
(5)5	A1152.1	dog	phalynx 1		8	10	10	10	6									2	0.5
(5)5	A1164	dog	Metacarpal 2	left	8	10	10	8						oblique				3	0.5
(5)5	A1178	Bov/Cer	ulna										right	right				5	1.5
(5)5	A1159	dog	phalynx 2			10	10	10	3									2	0.5
(5)5	A1152.2	Bov/Cer	metatarsal		2	3	2						right	right				6	1.5
(5)5	A1152.3	Bov/Cer	radius				4						oblique	oblique				8	1.5
(5)5	A1152.4	Bov/Cer	tibia			3							oblique	right				4.5	2
(5)5	A1152.5	Bov/Cer	radius				2						oblique	oblique				2	1.5
(5)5	A1152.6	Bov/Cer	femur				2						comb	comb				2	1.5
(5)5 c	A1318	L. bovid	radius	left	7	5								oblique				9	8.5
(5)5 c	A1317	sheep	humerus	right				8	7				oblique					5	3
(5)5 c	A1319	sheep	radius	left	8	4								oblique				3	3
(5)5 c	A1320	pig	radius	left	8	7								oblique				3.5	2.5
(5)5 c	A1324	Bov/Cer	metatarsal		7	9	5							oblique				5	2
(5)5 c	A1328	pig	humerus	right		3	10	8	2				oblique	oblique			tooth	3	1.5
(5)5 c	A1322	pig	femur	right			7	4					oblique	oblique				7.5	2
(5)5 c	A1329	sheep	metacarpal		3	2								oblique				2	2
(5)5 c	A1318.1	sheep	humerus				4	4					oblique	oblique				6.5	2
(5)5 c	A1318.2	sheep	tibia			3							right	right				4	2
(5)5 c	A1318.3	pig	tibia			2	7						oblique	oblique				4.5	1
(5)5 c	A1327	sheep	phalynx 1								9	7	comb	comb				3	1
(5)5 c	A1318.4	pig	metapodial			8	4	2					oblique	oblique	UF	burned		3	1
(5)5 c	A1318.5	Bov/Cer	tibia			3							right	oblique				3.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
(6)5	A2252	sheep	radius	left			6	10					oblique		UF			8	2.5
(6)5	A2259	L. bovid	radius	right	4	3	2						right	oblique				10	4
(6)5	A2258	sheep	humerus	right		8	2						right	oblique				4	4
(6)5	A2257	sheep	tibia	right			4	5	5				comb	comb				11	2
(6)5	A2251.1	B/C/S	tibia			3	3						right	oblique				7	2
(6)5	A2013	pig	ulna	left										right				10	3
(6)5	A2012	L. bovid	metapodial						5									4	3
(6)5	A2015	pig	ulna	right									comb	comb				7	3
(6)5	A2013.1	Bov/Cer	radius				3						oblique	oblique				7.5	2
(6)5	A2014	pig	ulna	left										right				7	3.5
(6)5	A2009	pig	femur	right		10	2						right	oblique				5	3.5
(6)5	A2013.2	Bov/Cer	radius				4						right	oblique				6	1.5
(6)5	A2013.3	B/C/S					3						right	oblique			cutmark	7	3
(6)5	A2011	L. bovid	metatarsal	right				4					oblique	comb				8	6
(6)5	A2068	sheep	tibia	right	4	10	10	10	2				comb	comb				18	2.5
(6)5	A2079	sheep	metacarpal	right	4	2							comb	comb				4	2.5
(6)5	A2080	sheep	humerus	right				3	1				oblique	oblique				3	1
(6)5	A2069	sheep	humerus	right				8	9					oblique				5.5	3
(6)5	A1596	sheep	metacarpal						10						UF			2	4
(6)5	A2500.2	Bov/Cer	radius				4						oblique	oblique				5	1.5
(6)5	A2500.3	Bov/Cer	tibia					5					oblique	right			tooth	4	1
(6)5	A2500.4	Bov/Cer	humerus					5					oblique	oblique				4	1.5
(6)5	A1419	L. bovid	metatarsal			10	4						oblique	oblique				6.5	2.5
(6)5	A2274	sheep	metatarsal		3	3	2							oblique			tooth	8	1.5
(6)5	A2163	pig	humerus					10	8				oblique					4.5	2
(6)5	A2171	sheep	radius				5	4					oblique	oblique				8	1.5
(6)5	A2170	sheep	humerus	right			6	9					oblique	right				6.5	2
(6)5	A2161	pig	ulna	left											UF			6	2.5
(6)5	A2162	pig	ulna	left											UF			5.5	2
(6)5	A2161.1	L. bovid	tibia			3	3						oblique	oblique				9.5	2.5
(6)5	A2168	sheep	metatarsal		2	3	2						comb	comb				4	1.5
(6)5	A2125	sheep	humerus	right				10	10				oblique					8	3
(6)5	A2126	L. bovid	tibia	right		7	2						oblique	oblique				7	4
(6)5	A2146	L. bovid	phalynx 2							10	10	10						4	3
(6)5	A2147	L. bovid	phalynx 2							10	10	10						4	2.5
(6)5	A2141	sheep	radius				1	10					oblique		UF			5	3
(6)5	A2143	sheep	humerus	left			2	10					right					4	3
(6)5	A2142	sheep	tibia	left			2	10					oblique		UF			5	2
(6)5	A2130	sheep	radius	left	8	10								oblique				5	3
(6)5	A2138	sheep	tibia	left		8							oblique	right				4.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
(6)5	A2129	pig	metapodial		10	7								oblique				4.5	2
(6)5	A2136	sheep	ulna	left									right	right				4	1.5
(6)5	A2192	sheep	radius	right	8	7								oblique				4	3.5
(6)5	A2198	dog	radius	right			8						comb	oblique				4	1.5
(6)5	A2190	pig	fibula										comb	comb				7.5	1.5
(6)5	A2193	sheep	metacarpal					2	10				comb					2.5	3
(6)5	A2196	sheep	metacarpal				1	7	5				oblique	comb				4.5	2
(6)5	A2191	pig	tibia			3	10	3					comb	oblique			tooth	3.5	1
(6)5	A2191.2	Bov/Cer	tibia			4	2						oblique	oblique				6.5	2.5
(6)5	A2289	sheep	femur	left	2	10	5						oblique	right				6	2.5
(6)5	A2287	sheep	tibia	left		9	5						right	oblique				8	3
(6)5	A2288	sheep	humerus	right		2	10						right	oblique				5	3.5
(6)5	A2287.1	Bov/Cer	radius		2	4	6						comb	comb				7	2
(6)5	A2290	sheep	femur	left			10						comb	oblique				8	2
(6)5	A2287.2	Bov/Cer	tibia			2	3						oblique	oblique				7.5	1.5
(6)5	A2117	L. bovid	metatarsal		9	8								oblique				6	4
(6)5	A2121	sheep	radius				6	7					oblique	ind			tooth		
(6)5	A1333	pig	femur	right		10	5						oblique					6	3.5
(6)5	A1352	pig	femur	right			5	10							UF			12	4.5
(6)5	A1356	pig	humerus	left				5					oblique	comb				4	2.5
(6)5	A1346	pig	humerus	left			4	9					oblique	comb				7	2.5
(6)5	A1347	sheep	humerus	right			2	10	9				oblique					7	3
(6)5	A1338	L. bovid	femur				2	4					oblique	oblique				9	4
(6)5	A1353	sheep	humerus	right			3	9					oblique			burned		5.5	3
(6)5	A1343	sheep	radius	right	6	9	2						comb	oblique				5.5	3.5
(6)5	A1344	sheep	humerus	left			8	10	1				oblique	oblique				6.5	2.5
(6)5	A1360	pig	humerus	left			2	10					oblique	oblique				4.5	2
(6)5	A1340	sheep	radius	right			2	8	3				oblique	comb				6	2.5
(6)5	A1364	L. bovid	radius				3						oblique	oblique			cut	8.5	3.5
(6)5	A1351	sheep	phalynx 2								10	8			UF			3	1
(6)5	A1356.2	pig	humerus	left					3				comb	comb				5	3
(6)5	A1341	sheep	tibia	left				3	10				oblique					3	2.5
(6)5	A1356.3	pig	humerus	left				2					comb	comb				4	3
(6)5	A1359	pig	metapodial				2	10					oblique		UF			4.5	1.5
(6)5	A1354	pig	femur		3										UF			2.5	2
(6)5	A1361	Bov/Cer	humerus	right			1	5					oblique	right				4	1.5
(6)5	A1358	deer	metacarpal	left				7							UF			2	2
(6)5	A1373	pig	metatarsal	right	10	2	1							oblique				3.5	1.5
(6)5	A1342	pig	femur	right			1	6					right	right	UF			5	3
(6)5	A1349	pig	humerus	left			2	8	1				oblique	oblique				2.5	1

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
(6)5	A1333.3	Bov/Cer	tibia			4	3						right	oblique				11	3
(6)5	A1333.4	sheep	femur				6						oblique	oblique				5	2
(6)5	A1333.5	sheep	tibia					3	5				oblique			burned		2	2
(6)5	A1333.6	sheep	humerus				3						right	right				5	1.5
(6)5	A1333.7	Bov/Cer	humerus					5					oblique	right				3	2
(6)5	A1333.8	Bov/Cer	radius				4						oblique	oblique				7.5	1
(6)5	A1333.9	sheep	femur						4				comb	comb				2.5	2
(6)5	A1334.1	Bov/Cer	humerus					3					comb	oblique				5	1.5
(6)5 b	A2507.5	sheep	tibia				7	7					oblique	oblique				10	1.5
(6)5 b	A2507.6	Bov/Cer	radius				4						right	oblique				6	1
(6)5 b	A1642	sheep	metapodial						5						UF			2	1.5
(6)5 b	A1651	sheep	metatarsal		3								comb	comb				2	1
(6)5 b	A1644	sheep	metatarsal				7						oblique	oblique				5.5	1
(6)5 b	A1642.1	Bov/Cer	metatarsal			3	5						oblique	oblique				7.5	1
(6)5 b	A1642.2	Bov/Cer	femur				4						oblique	oblique				6	2
(6)5 b	A1649	Bov/Cer	humerus	left				3	3				oblique	oblique				5.5	2
(6)5 b	A1647	sheep	ulna										oblique	right				4	2.5
(6)5 b	A1641	sheep	tibia	right			5	10					oblique	comb	UF			7	2
(6)5 b	A1565.1	Bov/Cer	humerus				4	3					comb	oblique				9	1.5
(6)5 b	A1565.2	Bov/Cer	humerus				4	3					oblique	right				8	2
(6)5 b	A1559	sheep	tibia	left		9								oblique	UF			5.5	3
(6)5 b	A1565	pig	tibia	left		6	10	2					oblique	oblique				7	1.5
(6)5 b	A1565.3	Bov/Cer	tibia		8										UF			3	2.5
(6)5 b	A1565.4	Bov/Cer	humerus				2						oblique	oblique				2.5	1.5
(6)5 b	A1565.5	Bov/Cer	tibia			4	2						right	oblique				6	2.5
(6)5 b	A1583	sheep	radius	right	5	5	2						right	comb				5.5	2
(6)5 b	A1581	Bov/Cer	ulna	right									right	comb				5.5	2
(6)5 b	A1581.1	pig	metatarsal			2	4	2					oblique	oblique				7	1.5
(6)5 b	A1581.2	Bov/Cer	humerus			2	10						comb	comb				5	1.5
(6)5 b	A1581.3	Bov/Cer	humerus				7						oblique	oblique				7	2
(6)5 b	A2183.1	Bov/Cer	humerus				6	5					oblique	right				6	2.5
(6)5 b	A2183.2	L. bovid	femur			6	2						right	right				6	3
(6)5 b	A1450	sheep	metatarsal				10						oblique					6	2
(6)5 b	A1449.1	Bov/Cer	tibia			4	2						oblique	oblique				8	2.5
(6)5 b	A1449.2	Bov/Cer	tibia			9	7						oblique	oblique				7.5	2
(6)5 b	A1510	sheep	humerus	left					9				right					4	3
(6)5 b	A1511	sheep	humerus	right			3	10	2				oblique	comb				7	3
(6)5 b	A1512	sheep	metacarpal					4	7				oblique					4	2.5
(6)5 b	A1510.1	sheep	phalynx 1								2	8	oblique					1.5	1
(6)5 b	A1517	pig	metapodial						5				oblique					2.5	1.5

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
(6)5 b	A1642.4	Bov/Cer	tibia			2	3						oblique	oblique				5.5	1.5
(6)5 b	A1449	deer	radius			4	10	6					oblique	oblique				11.5	2
(6)5 b	A1518	pig	metatarsal		2	3	9	7	9				comb	comb				4.5	1
(7) AF6 H50	A1442.1	Bov/Cer	radius				3						right	oblique				7	1
(7)5 a	A2249.1	Bov/Cer	humerus				4						oblique	oblique				9	3.5
(8)5	A2309	sheep	radius			2	10						right	oblique	UF			4.5	1.5
(8)5	A1494.2	sheep	tibia				7						oblique	oblique				8.5	2.5
(8)5	A1494.3	Bov/Cer	femur				4						oblique	oblique				6.5	1.5
(8)5	A1494.4	Bov/Cer	femur			2	3						oblique	right				7	1
(8)5	A1494.5	B/C/S	tibia			3	2						oblique	right				3.5	2.5
4(5) b	A2320	sheep	humerus	right				8	5				oblique	oblique				4.5	2.5
4(5) b	A2321	sheep	humerus	Left			5	10	3				oblique					5	2
4(5) b	A2323	sheep	humerus	right				1	7				oblique					4	3.5
5(5) a	A1248	B/C/S	radius				7	6					oblique	oblique				6	1.5
5(5) b	A2292	sheep	tibia	right	3	10	4						oblique	oblique					
5(5) b	A2296	sheep	phalanx 1							8	9	6					tooths?	4	1.5
5(5) b	A2510.3	B/C/S	phalanx 2							6	2			oblique				2	1
5(5) b	A673	B/C/S	metapodial		2	3							oblique	oblique		burned		5.5	25
5(5) b	A884	pig	metacarpal 3	Left	10	10	10	10	9									7	1.5
5(5) b	A886	sheep	metapodial				4	1					oblique	oblique				7	1.5
5(5) b	A887	sheep	humerus	right			4	10	2				oblique	oblique			cuts?	8.5	3
5(5) b	A890	B/C/S	femur		2									ind				2	1.5
5(5) b	A560	B/C/S	radius				5						oblique	oblique				8.5	1.5
5(5) c	A551	sheep	phalanx 2							10	10	10						2	1
5(5) c	A641	pig	tibia	Left	1	5	3						oblique	oblique				7	3
5(5) c	A646	sheep	ulna	right									oblique	oblique				5.5	3
5(5) c	A651	sheep	humerus	right		8	2						oblique	oblique			cuts	5	3
5(5) c	A652	sheep	phalanx 3							10	9			oblique			tooths	2.5	1.5
5(5) c	A653	B/C/S	humerus	right	3	4	3						oblique	oblique			tooths	7	2.5
5(5) c	A656	L. bovid	femur	Left	3	5							oblique		UF			6	5.5
5(5) c	A661	pig	ulna	right										oblique				3.5	0.5
5(5) c	A1425	sheep	humerus	Left				1	8				oblique					4	3.5
5(5) c	A1426	sheep	ulna	Left									oblique	oblique				5.5	1.5
5(5) c	A1429	Dog	metacarpal		10	10	10	10	10								tooths?	4	1
5(5) c	A1430	B/C/S	humerus	right			3	10	3				oblique	oblique				2.5	1
5(5) c	A511	pig	humerus	Left			1	5	4				oblique	oblique				6.6	3
5(5) c	A514	L. bovid	ulna											oblique			tooths	4	4
5(5) c	A519	sheep	metacarpal	Left	6	1								oblique				2	2
5(5) c	A520	sheep	metacarpal	right	3	1								oblique				2.5	2
5(5) c	A523	L. bovid	metacarpal				2	3	1				oblique		UF			4.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
5(5) d	A876	pig	Fibula			2	7						oblique	oblique				3.5	1
6(5)	A1214.1	B/C/S	tibia					5	7				oblique	oblique				8	2
6(5)	A1214.2	B/C/S	tibia	Left					2				oblique					2	1.5
6(5)	A1118	sheep	humerus	right			1	4	1				oblique	oblique				5	2.5
6(5)	A1119	sheep	phalanx 2							9	9	9						2	1
6(5)	A1121	L. bovid	ulna										oblique	oblique				4	2.5
6(5)	A1133	pig	metapodial		1	9	10	9	1				oblique	oblique				5	1.5
6(5)	A1134	sheep	metatarsal		1	2	2							oblique				4.5	1.5
6(5)	A1228	B/C/S	radius		4	1								oblique				4.5	3.5
6(5)	A868	B/C/S	humerus	Left		1	4	1					oblique	oblique				6	2
6(5) a	A1459	sheep	metacarpal	right	3	3	2							oblique				6.5	1.5
6(5) a	A2505.3	Bov/Cer	humerus					3	8				oblique				tooths	3.5	2.5
6(5) a	A2505.4	Bov/Cer	humerus	right				1	2				oblique					3	2.5
6(5) a	A2505.5	L. bovid	phalanx 2							10	10	9						4.5	3.5
6(5) a	A2174	sheep	femur	Left			1	4	3				oblique		UF			7.5	3
6(5) a	A2176	L. bovid	metapodial					4	5				oblique					8	3
6(5) a	A2178	pig	tibia	Left	3	4	2						oblique	oblique				8	3
6(5) a	A1507	L. bovid	phalanx 2							10	10	10						4	3
6(5) a	A1507.1	B/C/S	radius			1	10	1					oblique	right				5.5	2
6(5) a	A1507	L. bovid	phalanx 2							10	10	10						4	3
6(5) a	A1507.1	B/C/S	radius			1	10	1					oblique	right				5.5	2
6(5) b	A2225	sheep	tibia	Left		4	10	10	6				oblique	oblique				14.5	2
6(5) b	A2227	sheep	ulna	Left									oblique	oblique				6.5	2
6(5) b	A2228	sheep	femur		1	10	3						oblique	oblique				7	2
6(5) b	A2229	pig	ulna	right									oblique	oblique				6	2.5
6(5) b	A2502.6	Bov/Cer	metapodial		2	3	1						right	oblique				5.5	2
6(5) b	A2502.7	Bov/Cer	femur						4						UF			5	3
6(5) b	A2502.8	Bov/Cer	tibia	right		5	10	5					oblique	oblique				9.5	2
6(5) b	A2502.9	Bov/Cer	tibia	right		2	10	1					oblique	oblique				6.5	2
6(5) b	A2503.1	Bov/Cer	humerus				2	10	3				oblique	oblique				5.5	2.5
6(5) b	A2503.2	Bov/Cer	humerus	Left			1	8	4				oblique	right				4.5	3.5
6(5) b	A2503.3	Bov/Cer	humerus				2	9	1				oblique	oblique				5.5	3
6(5) b	A2503.4	Bov/Cer	femur	Left			6	6	1				oblique	oblique				6	3
6(5) b	A2503.5	B/C/S	femur			2	10	4					oblique	oblique				5	1.5
6(5) b	A2503.6	Bov/Cer	femur	Left			7	9	2				oblique	oblique				7.5	3
6(5) b	A2503.7	Bov/Cer	phalanx 1							10	10	10						4	1.5
6(5) b	A2503.8	B/C/S	radius				4						oblique	oblique				6.5	1.5
6(5) b	A1454	pig	ulna	right									oblique	oblique			cuts?	5	3.5
6(5) b	A2087	sheep	tibia	right	1	9	8	1					oblique	oblique				8.5	2
6(5) b	A2090	sheep	femur	Left	10	8	1							oblique				7	3

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
6(5) b	A2097	pig	radius	Left			2	10	2				oblique		UF			4.5	2.5
6(5) b	A2099	pig	ulna	Left									oblique	oblique				8	3.5
6(5) b	A2101	pig	femur	Left		7	10	5					right	oblique				9	3
6(5) b	A2102	pig	femur	Left			3	10	2				oblique	oblique				6	2
6(5) b	A2500.1	Bov/Cer	radius			1	7	2					oblique	oblique				8	2
6(5) b	A2283	sheep	metacarpal	Left				2	10				oblique					3	2.5
6(5) b	A2285	deer	metapodial					4	5					oblique				5	2.5
6(5) b	A1434	sheep	phalanx 1							8	10	10			UF			3	1.5
6(5) b	A1600	L. bovid	metapodial						4						UF			4	4
6(5) b	A1600.1	Bov/Cer	humerus	right	1	3	3	2					oblique	oblique				8.5	2.5
6(5) b	A1600.2	Bov/Cer	humerus					1	3				oblique	oblique				4	2
6(5) b	A1600.3	Bov/Cer	femur			1	8	1					oblique	oblique				6	1.5
6(5) b	A1601	deer	metapodial						4						UF			3.5	3.5
6(5) b	A1602	L. bovid	phalanx 1							9	1		oblique					3.5	3.5
6(5) b	A1603	pig	tibia	Left				5	10				oblique					5.5	3
6(5) b	A1607	sheep	humerus	right		1	8	10	2				oblique	oblique				7.5	2.5
6(5) b	A1612	sheep	femur	Left	1	9	1						oblique	oblique				6	3
6(5) b	A1613	L. bovid	phalanx 1								1	7	oblique					3	3.5
6(5) b	A1614	pig	ulna										oblique	oblique				7	2
6(5) b	A1617	sheep	tibia	right		2	3	1					oblique	oblique				9	3
6(5) b	A1618	sheep	metapodial					5	5				oblique					3	1.5
6(5) b	A1619	pig	ulna	Left									oblique	oblique				6	1.5
6(5) b	A1633	sheep	metapodial					1	5				oblique					3	1.5
6(5) b	A2507.9	Bov/Cer	metacarpal				2	7	2				oblique	ind				4	2
6(5) b	A2508.1	L. bovid	humerus				1	4	1				oblique	oblique				7	5
6(5) b	A2508.2	B/C/S	humerus				3	9	1				oblique	oblique				3.5	1
6(5) b	A2510.8	pig	phalanx 2							10	10	9			UF			2	1.5
6(5) b	A2510.9	B/C/S	phalanx 1							7	1			oblique				1.5	1
6(5) b	A1032	pig	ulna										oblique	oblique				4.5	2
6(5) b	A1384	sheep	metatarsal	Left	4	10	10	8					oblique	oblique				12.5	2
6(5) b	A1389	B/C/S	humerus	Left	1	8	6						oblique	oblique				6.5	2.5
6(5) b	A2509.6	B/C/S	radius				6						oblique	oblique				5	2
6(5) b	A2509.7	B/C/S	tibia		2	6	3						oblique	oblique				6	2.5
6(5) b	A2509.8	B/C/S	radius		2	1								oblique				3	1.5
7(5)	A1496	sheep	tibia	Left			7	10	9				oblique	oblique				11	2.5
7(5)	A1496.1	B/C/S	radius			1	7						oblique	oblique				8.5	1.5
7(5)	A1498	sheep	radius	right	9	1								oblique				4.5	3.5
7(5)	A1483	sheep	tibia	right			1	9	1				oblique		UF			4	2
7(5)	A1483.1	B/C/S	radius				5						right	oblique				4.5	2
7(5)	A937	B/C/S	radius	Left		1	8	2					oblique	oblique				7.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
7(5)	A939	B/C/S	humerus	Left				5	2				oblique	oblique				5.5	3.5
7(5)	A939.1	B/C/S	humerus						4				oblique					4	2.5
7(5)	A941	deer	metatarsal			2	6	2					oblique	oblique				8	1.5
7(5) b	A2511.1	B/C/S	radius				7						oblique	oblique				7.5	1.5
7(5) c	A1374	B/C/S	ulna	Left									oblique	oblique				4	2
7(5) c	A1374.1	B/C/S	metapodial						2				oblique					1.5	1.5
7(5) c	A1375	Bov/Cer	radius		1	3	4	1	1										
9(5)	A1397	sheep	femur	right			4	10	1				oblique	oblique				6.5	2.5
9(5)	A1397.1	B/C/S	metapodial				1	3	5				oblique					4	1.5
9(5)	A1397.2	B/C/S	humerus	Left			2	9	2				oblique	oblique				5.5	1.5
9(5)	A1398	sheep	metacarpal				1	9	1				oblique		UF			4	2.5
F12	A897	L. bovid	metapodial						4						UF		tooths	3.5	3
F12	A897.1	B/C/S	tibia			5	2						oblique	oblique				5.5	2
F12	A898	sheep	humerus	right			1	9	5				oblique					5.5	3
F12	A857	pig	femur				6	9					oblique	right				7.5	2
F12	A848	L. bovid	femur	left			3	5					oblique	oblique				11	4
F12	A847	L. bovid	humerus	right			5	2					oblique	oblique				6.5	3
F12	A860	Bov/Cer	tibia			4	2						comb	oblique	UF			8.5	2
F12	A851	sheep	radius	right			4	4					oblique	oblique				6	2
F12	A858	pig	humerus	right				9	6				right		UF		tooth	4	3
F12	A848.1	Bov/Cer	tibia			3	1						oblique	oblique				5.5	2.5
F12	A848.2	Bov/Cer	radius		2	4							comb	right		burned		4.5	1.5
F12	A848.3	Bov/Cer	metapodial				3						right	right				4.5	1.5
F12	A2509.9	B/C/S	humerus				8	10	1				oblique					5	1
F14	A603	L. bovid	ulna	Left									oblique	oblique				7.5	6.5
F14	A606	sheep	tibia	Left				3	7				oblique					4.5	2.5
F14	A607	sheep	humerus	Left			1	8					oblique	oblique				4	2.5
F14	A608	B/C/S	humerus	right	3	5	1							oblique	UF			6	3.5
F15	A951	L. bovid	phalanx 3							9	9	8					tooths	5	4
F15	A953	deer	phalanx 1							10	10							2	1.5
F15	A954	pig	tibia	Left			2	7	1				oblique		UF			7	2.5
F15	A955	Dog	humerus	Left	1	10	4						oblique	oblique				7	2
F15	A678	pig	metatarsal 4	Left	9	10	10	10	9						UF		tooths	6	2
F15	A679	sheep	radius				4						oblique	oblique				5.5	1.5
F15 (2)	A796	sheep	metacarpal	Left	6	5	6	3						oblique			tooths	9.5	2.5
F15 (2)	A798	pig	metatarsal		8	9	10	1					oblique	oblique				5.5	1.5
F15 (2)	A799	pig	metapodial						4						UF			1.5	1.5
F15 (2)	A800	pig	tibia		1	8	9	2					oblique	oblique				7	2
F15 (2)	A801	sheep	phalanx 1							10	10	10						4	1
F15 (2)	A802	pig	humerus	right			2	10	1				oblique	oblique				5.5	2.5

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
F15 (2)	A809	sheep	tibia				5						oblique	oblique				4.5	2.5
F15 (2)	A810	sheep	radius			3	7						oblique	oblique				6	2
F15 (2)	A814	L. bovid	metapodial		3	1								oblique				2.5	3
F15 (2)	A2509.3	Bov/Cer	metapodial		1	3	1						oblique	oblique				4.5	2
F15 (2)	A2509.4	B/C/S	radius			5							oblique	oblique				4	1
F15 (2)	A2509.5	B/C/S	femur				3						oblique	oblique				5	2
F15 (3)	A768	L. bovid	phalanx 1							4	7	8	oblique					6	3
F15 (3)	A770	sheep	radius	Left		4	7						oblique	oblique				8.5	2
F15 (3)	A771	pig	phalanx 1							7	8	10	ind	ind				3	1.5
F15 (3)	A772	sheep	femur	Left					4						UF			4.5	4.5
F15 (3)	A774	Bov/Cer	ulna	right									oblique	oblique			tooths	6.5	2
F15 (3)	A776	pig	phalanx 3							9	8	7		oblique				2.5	2
F15 (3)	A595	deer	ulna	right									oblique	oblique				6.5	2.5
F26	A2508.3	B/C/S	radius			2	8	1					oblique	oblique				5.5	1.5
F26; F27	A1551.1	Bov/Cer	tibia			3	2						oblique	oblique				8	1.5
F26; F27	A1551.2	Bov/Cer	radius				3						oblique	oblique				6.5	1
F26; F27	A1551.3	sheep	humerus				4						oblique	oblique				5.5	2
F26; F27	A1551.4	sheep	femur	right			4	6					oblique	oblique				6.5	2
F27	A1811	sheep	tibia				2	10					oblique		UF		cut	4.5	2
F27	A1815	pig	metatarsal	left		10	10	10					comb	comb				4.5	1
F27	A1811	sheep	tibia						7					comb	UF			2.5	1.5
F27	A1813	sheep	phalynx 1							2	6	9	oblique					3.5	1.5
F27	A2506.7	sheep	humerus				2	4					oblique	oblique				5.5	1.5
F27	A2506.8	sheep	tibia				3	4					oblique	oblique				6.5	1.5
F27	A2506.9	Bov/Cer	radius				3						oblique	oblique				6.5	1
F33	A100	sheep	tibia	Left			4	6	1				oblique	oblique	UF		cuts	9.5	2
F33	A103	small carnivore	metapodial			2	4						oblique	oblique			cuts	6	1
F33	A107	L. bovid	phalanx 1							5	9	8	ind	ind			tooths?	4	1.5
F33	A112	sheep	metapodial						8						UF			2	3
F33	A113	sheep	phalanx 2							9	10	10	ind				tooths	2	1.5
F33	A116	Bov/Cer	tibia	Left		3	2						oblique	oblique				7.5	2
F34	A356	deer	phalanx 1							7	9	10					tooths	3	1
F34	A357	B/C/S	tibia			2	8						oblique	oblique				3	1
F34	A355	B/C/S	femur				3						oblique	oblique				4.5	1
F5	A149	sheep	radius	Left	1	10	7						oblique	oblique				9.5	
F5	A151	Bov/Cer	radius	Left				3	8				right					4.5	4.5
F5	A155	pig	radius	right	8	3								oblique				3.5	2
F5	A157	pig	humerus	right		2	10	10	7				oblique	oblique				4	1.5
F5	A167	Bov/Cer	radius		2	2	1						oblique	oblique				6.5	1.5
F5	A171	Bov/Cer	tibia			2	3	2					oblique	oblique				7.5	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
F5	A308	sheep	tibia	right			1	8	1				right	oblique				5.5	2
F5	A309	Bov/Cer	tibia	Left	1	7	1						oblique	oblique				4	2
F5	A314	Bov/Cer	tibia	right	1	5	1						oblique	oblique				5	2.5
F6	A374	sheep	humerus	Left	1	9	10	4					oblique	oblique				9	4
F6	A375	sheep	humerus	right			2	8	1				oblique	oblique				5.5	2.5
F6	A376	Bov/Cer	tibia	right					8						UF			2.5	3
F6	A377	Bov/Cer	metapodial					1	4				oblique					2.5	1.5
F6	A378	sheep	metatarsal		3	3	2							oblique			tooths	6	2
F7	A2	sheep	metapodial				1	3	4				oblique					5	2
F7	A3	sheep	tibia		1	3	3						oblique	oblique				10	2.5
F7	A3.1	sheep	tibia			2	3						oblique	oblique				9.5	1.5
F7	A5	L. bovid	tibia				7	8	2				oblique	oblique			tooths	9	2
F8	A65	sheep	femur	right			1	8					oblique	oblique				6	3
G1 (1)	A1723.1	sheep	humerus	right			2	10	1				oblique	oblique				5	2
G1 (1)	A1723.2	Bov/Cer	humerus	right			2	5					right	oblique				4	2
G1 (1)	A1723.3	Bov/Cer					5						oblique	right				7	1.5
G1 (1)	A1723.4	Bov/Cer					4						oblique	right				5	1.5
G1 (1)	A1723.5	Bov/Cer					3						oblique	oblique				2.5	1.5
G1 (1)	A1723.6	Bov/Cer					1						oblique	oblique				2.5	1.5
G1 (1)	A261.1	Bov/Cer	humerus	right			2	3					oblique	comb				5	2
G1 (1)	A261.2	Bov/Cer	humerus										oblique	oblique				7	2
G1 (1)	A261.3	Bov/Cer	humerus										oblique	oblique				5.5	1.5
G1 (1)	A264	sheep	metatarsal	left			1	4	4					oblique				4.5	2
G1 (1)	A261.4	Bov/Cer	tibia	left		8	7						oblique	right				6	2
G1 (1)	A261.1	Bov/Cer	humerus	right			2	3					oblique	comb				5	2
G1 (1)	A261.2	Bov/Cer	humerus										oblique	oblique				7	2
G1 (1)	A261.3	Bov/Cer	humerus										oblique	oblique				5.5	1.5
G1 (1)	A264	sheep	metatarsal	left			1	4	4					oblique				4.5	2
G1 (1)	A261.4	Bov/Cer	tibia	left		8	7						oblique	right				6	2
G1 (2)	A366	Bov/Cer	humerus			5	3						comb	oblique	UF			8	2.5
G1 (2)	A362	Bov/Cer	metapodial				3	7					oblique		UF			7.5	1
G1 (2)	A359	deer	metacarpal		2	2	1							oblique				6.5	1.5
G1 (2)	A1721	L. bovid	phalynx 1								4	3	ind	ind			tooth	4	3
G1 (2)	A1718.1	sheep	tibia	left				10	3				oblique	oblique	F			6	2
G1 (2)	A1718.2	sheep	tibia	right	4	8							right	comb				4	3
G1 (2)	A1718.3	B/C/S					2						oblique	oblique				5	1.5
G1 (2)	A1718.4	Bov/Cer	tibia	right		3							oblique	oblique				5.5	3
G1 (2)	A1733	sheep	phalynx 1								4	10	oblique					2.5	1.5
G1 (2)	A1718.5	Bov/Cer	radius					4					oblique	oblique				3	1.5
G1 (2)	A1718.6	Bov/Cer	ulna	right									comb	right				8	1

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
G1 (2)	A1718.9	Bov/Cer	tibia	right		3							comb	oblique				6	2.5
G1 (2)	A1719.1	Bov/Cer	tibia	left		2							oblique	oblique				4	2
G1 (2)	A1719.2	Bov/Cer	femur				3						oblique	oblique				6	2
G1 (2)	A1719.3	Bov/Cer	radius				2	3					oblique	oblique				9	1
G1 (2)	A1719.4	B/C/S											right	right				6	2.5
G1 (2)	A1719.5	B/C/S											oblique	oblique				5	3
G1 (2)	A1719.6	B/C/S											oblique	right			tooth	5	2
G1 (2)	A1719.7	Bov/Cer	radius										oblique	oblique				5.5	1.5
G1 (2)	A1719.8	sheep	metapodial				1						comb	comb				4	1
G1 (2)	A1719.9	Bov/Cer	radius				1						oblique	oblique				5.5	1
G1 (2)	A1720.1	Bov/Cer	radius				1						oblique	comb				5	0.5
G1 (2)	A1720.2	B/C/S											comb	comb			cutmark	4	1.5
G1 (2)	A1718	pig	humerus	right				2	10				oblique			burned		5	3.5
G1 (2)	A1723	sheep	radius					9	9				oblique	oblique				7.5	2
G1 (2)	A1724	pig	metatarsal	right	10	10	10	10	10									5	1
G1 (2)	A1734	Bov/Cer	metapodial					2	2				oblique	comb				3	2.5
G1 (2)	A366	Bov/Cer	humerus			5	3						comb	oblique	UF			8	2.5
G1 (2)	A362	Bov/Cer	metapodial				3	7					oblique		UF			7.5	1
G1 (2)	A359	deer	metacarpal		2	2	1							oblique				6.5	1.5
G1 (2)	A339	sheep	metacarpal	Left	5	4	4							oblique				7.5	1.5
G1 (3)	A33	pig	tibia	right	7	10	10	10					oblique		UF			4	1
G1 (4)	A1691	pig	humerus	right		2	4						oblique	oblique				10	5.5
G1 (4)	A1691.1	L. bovid	humerus	Left		1	5	2					oblique	right				10	4
G1 (4)	A1691.2	sheep	humerus	right			2	5	3				oblique	oblique				6	2
G1 (4)	A1691.3	sheep	radius			2	3	3					oblique	oblique			cuts	12	1.5
G1 (4)	A1691.4	sheep	radius		2	3	3						oblique	oblique				7	1.5
G1 (4)	A1691.5	sheep	metacarpal		5	2								oblique				4	2
G1 (4)	A1691.6	sheep	metapodial			1	5	2					oblique	right				6	1.5
G1 (4)	A1691.7	sheep	metapodial			1	5	1					oblique	oblique				5.5	1.5
G1 (4)	A1691.8	sheep	metapodial			3	5	2					oblique	oblique				6	1
G1 (4)	A1691.9	Bov/Cer	phalanx 2							8					UF		tooths?	2	2
G1 (4)	A1692	pig	femur	right	1	10	8						oblique	comb	UF			7.5	2.5
G1 (4)	A1692.1	sheep	femur	right				3	1				right	oblique				3	2.5
G1 (4)	A1692.2	sheep	tibia	right		3	2						oblique	oblique				5.5	1
G1 (4)	A1692.3																Grinding marks?	3.5	0.5
G1 (4)	A1692.4	Bov/Cer						4	2				oblique	oblique			tooths	9.5	5
G1 (4)	A1692.5												oblique	oblique			tooths	5.5	4
G1 (4)	A1692.6	sheep				2	5	2					oblique	oblique			cuts?	8.5	1.5
G1 (4)	A1693	pig	phalanx 1							7	10	10	ind				tooths	3	1.5
G1 (4)	A1701	sheep	tibia	Left			2	10	2				oblique		UF			7	2.5

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
G1 (4)	A1705	sheep	radius	Left			7	9	1				oblique	right				9	2
G1 (4)	A1706	Small carnivore	humerus	right	1	6	10	9	6				oblique	oblique			tooths	5	1.5
G1 (4)	A1708	sheep	phalanx 1							10	10	10						3.5	1
G1 (4)	A1709	sheep	phalanx 3							10	1			oblique				1.5	1.5
G1 (4)	A1711	sheep	femur		4									oblique				3	2.5
G1 (4)	A1676	sheep	humerus	right			4	9	2				oblique	oblique				6.5	2.5
G1 (4)	A1676.1	L. bovid	femur	Left				5	2				oblique	oblique			cuts	9.5	3
G1 (4)	A1676.2	Bov/Cer	femur																
G1 (4)	A1676.3	Bov/Cer	femur	Left	1	4	4						oblique	oblique				8	2
G1 (4)	A1676.4	Bov/Cer	metapodial		5	4								oblique				4.5	2
G1 (4)	A1676.5	Bov/Cer	metapodial						2				right					1.5	1
G1 (4)	A1676.6	Bov/Cer	tibia	right	2	1							right	oblique				4.5	1
G1 (4)	A1676.7	Bov/Cer	tibia	Left		3							oblique	right				3.5	1
G1 (4)	A1676.8	Bov/Cer	tibia	right	1	3							oblique	oblique				4	1
G1 (4)	A1679	sheep	tibia	Left	1	10	5						oblique	oblique			cuts?	7	2.5
G1 (4)	A1679.1	Bov/Cer	tibia	right	2	10	1						right	oblique			cuts?	6	3
G1 (4)	A1681	pig	phalanx 3							10	10	10					tooths	2.5	2
G1 (4)	A1682	pig	phalanx 3							10	10	10						3	1.5
G1 (4)	A1684	sheep	metapodial						5				oblique		UF			1.5	2
G1 (4)	A1741	sheep	ulna	left	9	8								oblique	UF		tooth	7	2.5
G1 (4)	A1748	sheep	ulna	right	6								comb	oblique				4.5	3
G1 (4)	A1737	pig	femur	right			3	10	10				oblique		UF			10	3.5
G1 (4)	A1737.1	pig	femur						2				comina tion					2.5	2
G1 (4)	A1736	L. bovid	humerus					3	4				oblique	right				9	4
G1 (4)	A1752	sheep	tibia	left			7	6					oblique		UF			10	2.5
G1 (4)	A1747	sheep	metacarpal		5	5	3						comb	oblique				8	2
G1 (4)	A1737.2	sheep	1st phalynx								5	10	oblique					2.5	1
G1 (4)	A1737.3	sheep	1st phalynx							10					UF			1.5	1.5
G1 (4)	A1751	sheep	metapodial			6	5							oblique	UF			9	1.5
G1 (4)	A1750	sheep	metapodial			6	5							oblique	UF			7	1.5
G1 (4)	A1737.4	Bov/Cer	femur			2							oblique	oblique				3	2.5
G1 (4)	A1737.5	Bov/Cer	humerus			3							oblique	right				5	3
G1 (4)	A1753	pig	metatarsal	left	10	7	2							oblique				3.5	1.5
G1 (4)	A1737.6	B/C/S	femur						2				right	right				2.5	2.5
G1 (4)	A1737.7	Bov/Cer	metapodial			3	3						oblique	oblique				5	1.5
G1 (4)	A1737.8	B/C/S	metapodial		3	2	2						oblique	oblique				7	1
G1 (4)	A1737.9	B/C/S	metapodial		3	2	2						oblique	oblique				5	1.5
G1 (5)	A469	sheep	femur	right			9						oblique	oblique				6	2
G1 (5)	A1757	pig	tibia	right		3	9	10	8				oblique		UF			8	2
G1 (5)	A1769	sheep	tibia			2	9	10	2				oblique	oblique				9	2

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
H16	A25	Bov/Cer	femur				3						oblique	oblique			cutmark	7	2
H16	A21	pig	metatarsal	left			2	8	10					oblique				6	2
H16	A22	pig	phalynx 1							10	10	10						2	1
H16	A20	dog	radius			8	10	8					oblique	oblique			cutmark	6.5	1.5
H16	A19	sheep	phalynx 1							10	10	10						4	1
H16	A18	sheep	radius	left	4	1								oblique				3	2.5
H17	A497	sheep	humerus	Left		1	7	9	2				oblique	oblique				8.5	3
H17	A498	deer	radius	Left			1	5	1				oblique					3.5	2
H17	A503	B/C/S	tibia		3										UF		cuts?	3	3.5
H17	A506	pig	humerus	right			4	9	1				oblique	oblique				3	1.5
H17	A507	B/C/S	metapodial		3	3	1											4	2
H18	A590	pig	tibia			1	7	1					oblique	oblique				3.5	1
H2	A349	Bov/Cer	tibia	right	1	5	1						oblique	oblique				6	2
H20	A1095	deer	humerus	right				2	8				oblique					4.5	3.5
H20	A1099	sheep	femur	Left	8	9	2							oblique			tooths	6	4
H20	A1100	deer	radius	Left	10	10	4							oblique				8	3
H20	A1108	B/C/S	humerus		2	9	2						oblique	oblique			cuts	4.5	3
H20	A1145	sheep	femur	Left	7	1							ind	oblique			tooths	5.5	4.5
H27	A1007	L. bovid	tibia	Left	1	7	3						oblique	oblique				8	2
H27	A1010	B/C/S	humerus				1	5	1				oblique	oblique				5	2.5
H31	A993	sheep	metapodial						8				oblique					2	2.5
H31	A994	pig	phalanx 2							9	9	10					tooths	2	2
H31	A995	pig	radius	right			5	8	1				oblique	oblique				5.5	2
H33	A89	Small carnivore	phalanx 1							10	10	10						1.5	1
H33	A1489	sheep	tibia	Left	1	8	3						oblique	oblique				6.5	1.5
H37	A2507.8	Bov/Cer	femur				5						oblique	oblique				7	1.5
H38	A2501.8	Bov/Cer	tibia		2	3							oblique	oblique				5.5	1.5
H38	A2501.9	Bov/Cer	tibia		2	3	1						oblique	oblique				6.5	2
H38	A2502.1	L. bovid	tibia	Left					3				oblique					4	4.5
H38	A2502.2	pig	metacarpal	Left	10	10	10	9	9									6.5	1.5
H38	A2502.3	pig	metatarsal 4	right	10	10	10	10	10								cuts	7.5	2
H43	A1415	sheep	tibia		8										UF			4	2.5
H43	A1415.1	Bov/Cer	radius				3	3					oblique	oblique				10	1.5
H43	A1415.2	Bov/Cer	radius				4						oblique	oblique				6.5	1
H43	A1415.3	Bov/Cer	humerus			4	3						oblique	oblique				5.5	1.5
H44	A2301	sheep	humerus	right			3	9	2				oblique	oblique				6.5	3
H44	A2302	pig	ulna	right									oblique	oblique				7	2
H44	A2304	Dog	humerus	Left	2	6	8						oblique	oblique				8	1.5
H44	A2306	sheep	femur			3	3	3					oblique	oblique			cuts	10.5	1.5
H44 (2)4	A2244	sheep	tibia	right	10	4								oblique			cutmark	5.5	4

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
H44 (2)4	A2244.2	Bov/Cer	metatarsal		3	3							comb	oblique				5	1.5
H46	A2502.4	sheep	metatarsal	Left	4	2								oblique			tooths	3	2
H46	A2502.5	pig	ulna	right									oblique	oblique		burned		3.5	2.5
H48	A1438	pig	radius	right		1	7	2					oblique	oblique				5	1.5
H6	A182	small carnivore	phalanx 1							10	10	9					cuts	2	1
H6	A183	sheep	metapodial		3	4	3	3	2				oblique	oblique				11.5	1.5
H6	A191	deer	metacarpal		1	3	3						oblique	oblique				7	1
H6	A386	L. bovid	metacarpal	right	9	3								oblique				7	5
H65	A1816	pig	radius	right			2	9	10				right		UF			7	3
H65	A1819	sheep	tibia		2										UF			2.5	3.5
H72	A1540.1	sheep	humerus	Left			2	5	2				oblique	oblique				5.5	3
H75	A85	pig	radius	left				10					oblique		UF			2.5	2
H75	A84	pig	humerus	left			6	8	2				oblique	oblique				8	3
H75	A86	sheep	humerus			3	3						oblique	oblique				4.5	2
H89	A2501.5	pig	Fibula		8	10	10	10	8				oblique	oblique			tooths	6.5	1
H89	A2501.6	B/C/S	femur			1	8	2					oblique	oblique			cuts	5	2
H89	A2501.7	Bov/Cer	femur			1	9	2					oblique	oblique			tooths	5	1
J2	A2235	pig	metacarpal 3	Left	10	10	10	10	10									6	2
J2	A2235.1	B/C/S	metapodial				3	3	2										
J2	A2236	pig	humerus	Left		4	9	10	2				oblique		UF			7	2.5
J2 (2)2	A1412	sheep	humerus		4										UF				
J2 (3)	A2220	sheep	metacarpal	Left	5	4	4	3	3								tooths	13	2
JPK	A2214	L. bovid	tibia	right	1	6	5						oblique	oblique				13.5	4
JPK	A2215	sheep	radius	Left	9	9	1							oblique				7.5	3.5
K1	A2511.7	B/C/S	metapodial		2	2	3							oblique			cuts	5	1.5
K1	A2511.8	B/C/S	humerus	Left			3	7	1				oblique	oblique				8	3
K1	A2511.9	B/C/S	humerus			2	3						oblique	oblique				4.5	1
K1	A2512.1	B/C/S	femur		3										UF			2	2.5
K1	A2512.2	pig	Fibula										oblique	oblique				9.5	1.5
K1	A2512.3	B/C/S	radius				4						oblique	oblique				7	2
K1	A2512.4	sheep	tibia				3	9	1				oblique		UF			6.5	2.5
K1	A2512.5	B/C/S	tibia	Left		1	4						oblique	oblique				5	1
K1	A2512.6	B/C/S	tibia	right	2	1							oblique	oblique				3	1.5
K2	A541	L. bovid	femur										oblique	oblique				8	4
K2	A545.1	B/C/S	radius				2						oblique	oblique				3	1
M9	A2500.5	B/C/S	humerus		1	10	10	3					oblique	oblique				4	1
M9	A2500.6	B/C/S	femur			2	10	8	2				oblique	comb				7	1.5
M9	A2500.7	B/C/S	tibia			2	8	10	2				oblique		UF			8	1.5
M9	A2500.8	B/C/S	femur			3	9	10	2				oblique	oblique	UF			6.5	1.5
Q1	A2281	sheep	tibia			8	7						oblique	oblique				9	3

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
Z	A916	Bov/Cer	phalynx 1							1	10	1					tooths	2.5	1
Z	A917	B/C/S	humerus	right				2	2					oblique				3.5	1.5
Z	A2511.2	pig	Fibula										oblique	oblique				7	1
Z	A2511.3	pig	Fibula										oblique	oblique			cuts	8	2
	A2298.1	deer	metatarsal										oblique	right				6	1
	A2298	L. bovid	metacarpal	right	5	4								oblique			tooths	6	3.5
	A1655	sheep	radius	right			5	10	10				oblique		UF			8.5	3
	A1657	sheep	femur	Left				1	9				oblique		UF			5	4.5
	A1659	sheep	metatarsal	left			8	10	2				oblique		UF			13	2.5
	A1662	sheep	metatarsal						8						UF			2	2.5
	A1663	sheep	radius	Left			3	5	6				oblique		UF			6.5	2.5
	A1664	Bov/Cer	phalanx 1							10	10	10						4	1.5
	A1665	Bov/Cer	phalanx 1							10	10	10			UF			4	1
	A1669	Bov/Cer	phalanx 3							10	8			ind				2	1.5
	A1670	deer	phalanx 1							10	10	10					cuts	3.5	1
	A1671	deer	phalanx 1							1	10	10			UF		cuts	3	1
	A2512.7	B/C/S	humerus			2	8	9	1				oblique	ind				5	1.5
	A2512.8	sheep	radius		8	10	10	10	8						UF			4	1
	A2512.9	B/C/S	radius				3	1					oblique	oblique				8	1
	A2513.1	B/C/S	radius				3						oblique	oblique				5	1.5
	A2513.2	B/C/S	tibia			2	4						oblique	oblique				7	2.5
	A2513.3	B/C/S	tibia		2	3							oblique	oblique				5.5	2.5
	A2513.4	B/C/S	tibia		2	3							oblique	oblique				6	2
	A2213.1	Bov/Cer	tibia				6	5	1				oblique	oblique				10.5	1.5
	A2505.1	B/C/S	tibia			7	2						oblique	oblique				4.5	2
	A2505.1	B/C/S	tibia			7	2						oblique	oblique				4.5	2
	A980	sheep	phalanx 1							9	9	10						3.5	1
	A980.1	Bovid	phalanx 3							9	1			oblique				2	1.5
	A981	sheep	phalanx 1								4	10	oblique					2.5	1
	A983	pig	ulna	Left									oblique	oblique				5	2
	A2510.6	pig	Fibula										oblique	oblique				9.5	1
	A2510.7	B/C/S	metapodial		2	2	1							oblique				5	2
	A2501.1	Bov/Cer	tibia	right		7	2						oblique	oblique				6	2
	A2501.2	Bov/Cer	radius				1	10	1				oblique					5	2.5
	A2501.3	Bov/Cer	radius				4	2					oblique	oblique				6	1.5
	A2501.4	Bov/Cer	radius				5	2					oblique	oblique				5.5	1.5
	A1535	sheep	phalanx 1							9	10	10						4	2
	A2511.4	B/C/S	tibia		1	6	4						right	oblique				8	2
	A1394	pig	femur	right	1	9	10	9	4				oblique	oblique				8.5	2
	A1395	deer	metacarpal		1	9	9	6	2				oblique	oblique				7	1.5

Tag	#	Species	Element	Side	Long bone portion					Metapodial portion			Breakage		Fusion	Burned	Mod	Length (cm)	Width (cm)
					1	2	3	4	5	Prox	Shaft	Dist	Prox	Dist					
	A2510.1	B/C/S	radius				1	8	3				oblique	oblique				4.5	2.5
	A920.1	B/C/S	radius				2						oblique	oblique				4	1.5
	A2510.4	B/C/S	femur				5	6					oblique	oblique				8	2
	A2510.5	B/C/S	phalanx 1							1	8	10	oblique					3	1.5
	A1801	L. bovid	metacarpal	right	9	3								oblique		burned		5.5	6
	A1803	L. bovid	phalanx 2							9	5	8						4	3.5
	A1806	sheep	humerus	right			3	10	1				oblique	oblique				4	2.5
	A1807	sheep	femur	Left			1	9	1				oblique	oblique	UF			5	3
	A1808	sheep	humerus	Left			2	9	1				oblique	oblique				4.5	2.5
	A1809	sheep	humerus	right			4	9	1				oblique	oblique				7.5	2.5
	A2504.1	B/C/S	phalanx 1							5	9	10						3	1.5