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MAYA BONE TOOL TECHNOLOGIES AT UCANAL, GUATEMALA

A Thesis
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in the Department of Sociology and Anthropology
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by

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ABSTRACT

A key part of understanding Maya bone tool production is studying the rare assemblages containing bone tools and bone tool debitage. The Late Classic J-2 assemblage is a distinct composition of lithic, charcoal, human and animal bone at the site of Ucanal, Guatemala. The number of sites with high concentrations of fauna remains are well, and sites with high concentrations of worked bone is even rarer. This thesis is an analysis of the worked and unworked faunal elements excavated in 2019 from Operation 1B of the J-2 assemblage. The primary purpose of this thesis is to further understand Maya bone tool production and potential standardization through consistent utilization of raw material, crafting techniques, and application of Dr. Emery's five stage reduction hierarchy. The secondary focus of this thesis seeks to provide, when possible, insight into the social identity of the J-2 Maya craft producers.

DEDICATION

This thesis is dedicated to my family, friends, and professors. Who, when the task set before me seem too great, walked the path with me in patience providing continual wisdom and encouragement.

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CHAPTER 1: INTRODUCTION

This thesis' primary focus is on understanding worked bone in a single deposit at the Maya site Ucanal, which is in southeastern Guatemala, during the Late Classic period (AD 550-800). The choice of bone elements and the species used to make different types of ornaments and tools such as needles and awls, including both human and non-human fauna, will provide insight into craft production at the site and possible related social implications.

Zooarchaeological analysis performed by Dr. Carolyn Freiwald, Jacob Harris, and Camille Dubois-Francoeur of the non-human worked bone in a deposit at the site will form the foundation for the analysis. I use these data to test the hypothesis that Maya worked bone was standardized and produced at the household level, including in elite households. I also argue that the data show an efficient and standardized method of bone crafting through the use of the same production sequence at multiple sites, the utilization of same animal species, a focus on the same tools, and the use of the same bone elements. This study also discusses the use of raw materials and the stages of production represented in the deposit following a bone reduction technique described by Emery (2007, 2008, 2010).

The identification of these relationships and standardization within this deposit and the relationships this standardization represents, when possible, also provide insight into the social identity of Maya craft producers and reveal aspects of the culture's economic, political, and social organization. Potential answers to questions about the diversity of Maya crafting include: Who were Maya crafters? Were Ucanal crafters operating as attached specialists, independent specialists, or both? For whom did they create their products (Emery 2009:458)?

Background

Ucanal is located the southeastern lowlands of Guatemala. Archaeological investigations were done under the aegis of the Ucanal Archaeological Project, directed by Christina Halperin and Jose Garrido, from 2014-present (Figure 1). Ucanal was occupied through the Late and Terminal Classic periods, although it was settled as early as the Preclassic period. Excavations of residential groups resulted in a medium-sized faunal assemblage (Freiwald 2016, Freiwald et al. 2017), and the identification of an unusual deposit containing large quantities of worked and unworked bone and shell artifacts, charcoal, and lithics (Freiwald 2016). Initial examination of the fauna from this deposit showed a significant quantity of debitage, along with complete ornaments and broken tools made from human bone elements and non-human fauna. Worked bone and shell have been recovered from other parts of the site, but this deposit is unique at the site in terms of the proportion of worked fauna.

Figure 1. Location of Ucanal (Halperin et al. 2018)

The deposit was associated with Structure J-2, which is located in Group J, an elite residential complex adjacent to the site core (Perea and Dubois Francoeur 2019). However, the deposit was not found in association with any of the extant Terminal Classic structures. Instead, it was a secondary deposit found within the large platform that supported the final phase of architecture. The dense bone, shell and lithic concentrations were found underneath a buried floor and in construction fill of the platform that dated to the Late Classic period, although worked bone in some units dates to the Terminal Classic period (AD 800-925).

Emery (2009:204) provides evidence that the Maya used worked bone and shell for utilitarian and ceremonial reasons. Examples of utilitarian bone tools consist of awls, needles, scrapers, musical instruments, spatulae, and fishing hooks. Ceremonial contexts such as caches and burials often include beads, pins, and autosacrificial perforators made from stingray spines and utilized in Maya ceremonial rites (Emery 2009:204). The number of excavated sites with a significant number of preserved faunal remains in the Maya region is relatively low. Even the largest faunal assemblages, such as that found at Caracol contain proportions of worked skeletal material in the single digits (Teeter 2004). However, bone tool production at Dos Pilas and Aguateca, along with Tikal and Uaxactun (Aoyama and Emery 2007; Emery 2010), Guatemala provide a template for Maya bone tool crafting and serve as both comparisons and models for the analysis of the Ucanal assemblage.

The craft producer's role in society and related social implications may relate to where the production occurred, whether specialists worked part-time or full-time, the production techniques used, and the proportion of different tool types. Costin (1991) talks about specialization as a way to organize production, where an activity is the main subsistence strategy that takes most of the individual's time, and ultimately derives from full-time versus part-time work. Shimada (2007), on the other hand, relates it to how much of a craft and the number of crafts an individual produced. In the Maya region, Inomata (2001) identified two broad categories of craft production; independent and attached. Inomata et al. (2001) define independent production as the production of goods for general uses, such as secular and non-symbolic ones, that were produced at the producer's own accord. These products are generally utilitarian, efficiently produced objects. Attached production is crafting for/by elites and governing entities where craft producer's created products are commissioned for others (Inomata 2001:321).

Maya craft production has traditionally been defined as part-time and small-scale, primarily at the domestic level, with limited occupational specialization, associated with the creation of status-enhancing decorative and ceremonial items of an elite-focused economic system (Emery 2009:458). Emery (2008) also suggested that crafting was variably part- or full-time, specialized or generalized, for trade, and for domestic consumption. At Ucanal, the deposit was found in a residential group, but in a secondary context that was formed by multiple activities. Interpretation of the assemblage is aided by comparison with other contexts in the Maya region.

Methods

The analysis of the Ucanal J-2 faunal component is divided into three primary sections. The first section is qualitative and describes the characteristics of the assemblage. This includes identification of species, percentage of completion, siding, weight, age/sex, and taphonomic damage including intentional and unintentional animal, human, and natural modifications. The next section on quantifies the assemblage numerically using Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), and Minimum Number of Elements (MNE) methods, including the benefits and drawbacks associated with using each technique. The third section is devoted to identifying the sequence of the bone tool production. Here I discuss the reduction hierarchy typology, cutting techniques, and how the categories and subcategories are differentiated.

Results

The results chapter focuses on the outcome of the statistical analysis and the subsequent interpretations drawn from the data. First, the combination of techniques show that the species most frequently found by count and weight was the white-tailed deer (*Odocoileus virginianus)*. Further, analysis of the skeletal elements found that long bones like femora, tibiae, and metapodials were identified in the highest amounts and for worked faunal elements. Taphonomic damage—with exception of tool production marks—was minimal, with almost no burning, erosion by sun and water, or degradation of bone surfaces.

In addition to a focus on white-tailed deer, the types of tools produced were limited, with a concentration on perforators such as awls, needles, and pins. A third potential standard measure of production is the ability to consistently utilize the reduction hierarchy typology when analyzing the assemblage, with repeated use of just one method even as few finished tools were found in the assemblage to ascertain standardization in the product itself. The assemblage consisted predominantly of end stage production. These findings all bear striking similarities to the few other Maya tool making production areas.

Conclusion

The results of this analysis substantiate some standardization in Maya worked bone techniques, and combined with analyses from other Maya sites, show that it related to elite households. Production of bone tools within the Ucanal J-2 assemblage followed a reduction sequence similar to that identified at other Maya sites, and was focused on the same tool types using the same key species. Simultaneously, these results provided some indication of these craft producers' social identities through patterning in the species used, bone tools produced, location, and other factors. These results contribute to the broader anthropological understanding of Maya craft production.

CHAPTER 2: BACKGROUND

This chapter provides background information for the site of Ucanal and the Maya region during the Classic period. An emphasis on worked bone and craft specialization in the Maya region is supplemented by a discussion of midden typology, which provides an interpretive framework for the Ucanal worked bone deposit. Finally, zooarchaeological case studies show what is known about Maya worked bone and provide a framework for understanding bone production at Ucanal.

Crafting and Bone Tool Production among the Maya

The Maya region extends from southern Mexico to Honduras, encompassing five countries, and is best known for its Classic period cultural traits (A.D. 250-900). During this time, cities were built from stone and exhibited evidence of a shared writing system, the mathematical concept of zero, and public art. One defining characteristic of the Maya, among other North American civilizations, is the use of wild and domesticated game and a reliance on non-metal tools. Combined with a limited understanding of key aspects of the economy, there is little information on the production of bone tools that stems from a lack of preserved faunal material within the region. In addition, information concerning the production of bone tools comes from a small number of worked bone tool assemblages excavated from past and ongoing excavations throughout the Maya region. In the relatively few large faunal assemblages which have been preserved and excavated, within those faunal assemblages the worked bone is scarce

(Götz and Stanton 2013; Moholy-Nagy 2004; Teeter 2004). The worked bone deposit at Ucanal offers a unique opportunity to better understand craft production and its role in Maya society.

Ucanal Site Excavation History

Ucanal lies in the southeastern lowlands of Guatemala and was first noted in 1908 by Teobert Maler (Halperin and Garrido 2019:6). The site was later documented in greater detail and then published by Sylvanus Morley in 1938 (Halperin and Garrido 2019:6). However, it was not until the late twentieth and early twenty-first century that the first excavations occurred, which were headed by Juan Pedro Laporte (Halperin and Garrido 2019). These excavations focused on both monumental and residential architecture (Halperin and Garrido 2019:6). More recently, archaeological excavations at the site in 2014 and again in 2016-2019, were headed by Christina Halperin and Jose Garrido, co-directors of the Ucanal Archaeological Project (PAU). These excavations have focused on the core zone of the site, which consists of a continuous settlement approximately 7.5 km^2 large, and the surrounding periphery settlement. Archaeological and architectural evidence shows that Ucanal was primarily occupied during the Classic period and into the Postclassic period (Table 1).

Table 1. Maya Timeline. Timeline of Maya Civilization (Coe 1993)

Period	**Division**	**Dates**
Archaic		3000–2000 BC
Preclassic	Early Preclassic	2000–1000 BC
	Middle Preclassic	1000–300 BC
	Late Preclassic	BC 300—AD 250
Classic	Early Classic	AD 250–550
	Late Classic	AD 550–800
	Terminal Classic	AD 800–925
Postclassic	Early Postclassic	AD 925–1200
	Late Postclassic	AD 1200–1511
Contact period		AD 1511-AD 1697

Within the site, the architectural complex designated Group J, was adjacent to the site core and the Group I ceremonial complex and is one of the most important architectural complexes at the site. The large structures surrounding the tall platform are associated with elite occupation throughout different time periods (Cruz and Garrido 2016; Halperin et al. 2019; Halperin and Garrido 2018). The J-2 structure has been interpreted as also having a residential function because of the presence of household waste found in the immediate area and along the structure's edges. The faunal assemblage was recovered from excavations in front of and under Structure J-2, a Terminal Classic building on the north site of the platform facing a patio surrounded by three other structures and auxiliary buildings (Perea and Dubois-Francoeur 2019). The deposit came from the lower levels of three main excavation units, that were located under 120 cm of platform fill and the first of a sequence of floors buried under the final platform construction stage. The deposit is associated both with platform fill and fill below the patio (Perea and Dubois-Franceour 2019:33).

Excavations of other residential groups resulted in a medium-sized faunal assemblage (Freiwald 2016, Freiwald et al. 2017). By contrast, the J-2 deposit contained thousands of worked and unworked bone and shell artifacts, charcoal, and lithics. Initial examination of the fauna shows a significant quantity of bone debitage, along with complete ornaments and broken tools made from human bone elements and non-human fauna. Worked bone and shell have been recovered from other parts of the site, but this deposit is unique in the proportion of worked faunal remains consisting of both debitage and final stage tools such as perforators. Most of the analyzed faunal assemblage dates to the Late Classic period. To interpret the assemblage, both a background on craft production and a practical knowledge of production techniques follow.

Zooarchaeological Background

The following studies discuss the presence of fauna and worked faunal tools and ornaments at Maya sites, and provides an overview of Maya faunal assemblages and the frequency of worked bone. There are relatively few large faunal assemblages in the Maya region, especially when compared to the number of excavations. Most faunal assemblages have small quantities of bone products, and only a handful show evidence of how those products were made. This discussion presents evidence for the unique nature of Ucanal where, despite currently less fauna present than most other Maya sites, still has a higher amount of worked bone.

Maya Zooarchaeological Assemblages and Worked Bone Deposits

The following paragraphs discuss six different sites and their respective faunal assemblages in the Maya region. The first example is Götz and Stanton’s (2013) analysis of six different sites in the northern lowlands that show the range in size of the average Maya faunal assemblage. The NISP, or number of identified specimens, show a total of 9,212 analyzed bones mostly derived from midden contexts (Götz and Stanton 2013). The smallest is found at the site of Siho with a total of only 93 bone fragments. The next three sites Champotan, Xcambo, and Dzibilchaltun, have an NISP of 1,000-2,000 bones each. The largest of the six assemblages is

Chichen Itza which had a NISP of 4,001. Götz and Stanton (2013) note that the mammalian assemblage of both northern and southern lowland sites shares great similarities in types of species present, yet regardless of fauna count, there is little to no worked bone present.

The Maya site of Caracol has one of the largest faunal assemblages yet an extremely low number of worked bones. Caracol was consistently populated from the Preclassic through the Terminal Classic periods (Teeter 2004). As a result of eighteen years of archaeological research, the Caracol assemblage shows a wide variety of faunal use from across the site's different socioeconomic sectors and an assemblage of 84,763 fragments (Teeter 2004). Teeter (2004) identified a wide variety of animals present, including mammalian, reptilian, avian, and amphibian species; out of these categories the mammals comprised the bulk of the assemblage (50,000+). Most fauna in this assemblage seems to have accumulated during the Terminal Classic period, which accounted for 91% (61,427) of the faunal material, most from the epicenter of the site (Teeter 2004).

The center of the Caracol site is also where the bulk of the modified bone was found (580 of 754 worked bone pieces). Yet, the amount of modified animal bone is rather low, as 99.2% of bone is unmodified and most (598 of 754) came from burial contexts (Teeter 2004). Therefore, the Caracol assemblage provides a direct example of how little worked bone is present even in the larger faunal assemblages found within the Maya region. There are, however, a small number of sites with large worked bone deposits including Dos Pilas, Tikal, and Ucanal in Guatemala.

Tikal is one of the largest Maya cities; the central part of the city alone covered approximately 16 km^2. Decades of excavations by multiple projects recovered a large faunal assemblage. Moholy-Nagy (2004) noted at the time of publication that more than 30,500 unworked fragmented faunal elements had been excavated. In addition, 1,200 bone artifacts and

500 pieces of bone debitage were recovered (Moholy-Nagy 2004). While Tikal has fauna recovered from across all periods of occupation and across the site, there is a concentration in the city's epicenter with 87% of the recovered faunal sample or over 26,500 fragments recovered. Of this 84% dates to the Classic period (Moholy-Nagy 2004).

However, it is likely that most bone present at the site, especially in the areas outside of the epicenter, disappeared from archaeological contexts due to a variety of reasons~~.~~ (Moholy-Nagy 2002).

In addition, over half of the bones (56% or approx. 17,000 fragments) were found in burials, caches, or other special deposits (Moholy-Nagy 2004). Tikal is relatively unusual among Maya sites of this period in that it has almost 1200 artifacts and 500 debitage fragments (Moholy-Nagy 2002, 2004). As with other sites, there was a high frequency of perforators identified within the worked bone assemblage. However, a limited but diverse number of bone tools were also identified. For example, tools like spatulates, tie-rods, rasps, worked antler, and beveled-end long bones were all identified (Moholy-Nagy 2002). Ponce de Leon (1987) noted that worked fauna often consisted of finished objects with no evidence for bone working in sealed deposits with different concentrations of lithics, ceramics, shell, and bone found with both primary and secondary burials and ritual activity. For example, Deposit 21 contained little evidence of bone working debitage yet had a high number of finished artifacts (Ponce de Leon 1987).

Moholy-Nagy (1997) argued for Maya crafting as spatially flexible in nature, with debitage differentially removed for disposal, which leads to most accumulations of crafting debitage, including bone, in secondary deposits. There were several deposits with heavy loads of bone debitage of household middens and/or dumps as secondary accumulations (Moholy-Nagy

1994,1997). Several household deposits spread across residential occupational surfaces and unassociated with the actual manufacturing site had high numbers of bone and lithic debitage (Moholy-Nagy 1997:114).

The site of Dos Pilas in Guatemala is perhaps the best example of a worked bone deposit in the Maya region and dates to the Terminal Classic period. Almost half the bone tools were debitage from the production of awls, pins, needles, and other perforators (Emery 2009). The faunal assemblage of Don Pilas had over 10,000 bones present in a single midden that measured 6 feet wide, which is ten times the amount found anywhere else in the Don Pilas excavation, an average of 425 bones per unit (Emery 2009). This assemblage consists of large mammals and some reptiles, predominantly turtles (Emery 2009). A number of human bones were found within the assemblage as well, consisting primarily of postcranial elements representing 15 to 20 individuals (Emery 2009).

Of the 10,000 recovered bones, 80% exhibited manufacturing marks. Through this, the author determined that the Maya used standardized reduction practices in the creation of bone tools, especially in tools recognized as perforators (Emery 2009, 2010). The main deposit was associated with Structure L4-3 and consisted almost entirely of debitage (~2600 bone fragments) (Emery 2009). The size and preservation of the L4-3 assemblage reveals important characteristics about Maya bone working technology. Emery's (2008) analysis of the L4-3 assemblage demonstrates that the craft producers who worked the bone at Dos Pilas primarily chose the sturdiest and straightest skeletal elements like the tibia, femur, and metapodial bones. Further analysis of the same deposit indicated the producers preferentially chose *O. virginianus* (white-tailed deer) but that the deposit also contained humans, other artiodactyls, and large felids.

The analysis of the Dos Pilas L4-3 assemblage shows the use of a efficient and highly standardized reduction strategies and techniques. Emery (2008, 2012) identified the use of both lithics and string abrasion method to process the bone. Lithics implements were used to make deep longitudinal grooves to split the bone, sawing and then snapping the epiphyseal bone ends to reduce the limb bones and form blanks (Emery 2008). Emery (2008) identified five stages of production to produce perforators and other tools.

Strong evidence for in situ, large scale production of utilitarian tools with low diversity of tool types, and the use of standardized raw material and production methods support the suggestion of specialized bone crafting at Dos Pilas in the Terminal Classic. The assemblage itself is in a concentrated area and centrally located, where the crafters produced a large volume of standardized utilitarian artifacts, or those that lack decoration and contrast with ornate ceremonial artifacts. The large volume was interpreted as beyond domestic use, extending crafting of the products for export (Emery 2009).

Emery utilizes the definition of production area (Moholy-Nagy 1997) rather than workshop to avoid the socio-economic markers attached to the general definition of a workshop, and approaches specialization through the selection of raw material as selective rather than expedient (Emery 2009). Bone as a raw material is generally available to the domestic producer. In turn, this allowed the domestic producer access to a large variety of different species and skeletal elements, and in the L4-3 assemblage the raw material is as great as the discarded subsistence remains (Emery 2009). However, the L4-3 assemblage exhibits a non-domestic pattern in that both the taxa and skeletal elements used were highly uniform. The sheer number of different flanks calculated through MNI and other zooarchaeological methods indicate that, despite the assemblage being centrally located in one residential area, the flanks were brought in by multiple hunters and not just a single family (Emery 2009). Gathering of a specific type of raw material was not reflected in discard patterns at other Petexbatun region residences.

In addition, the size of the assemblage suggests crafting beyond consumption due to the absolute density of finished artifacts found per unit excavated at each site (Emery 2009). The of K4-3 density is distinct, as shown by its 6.97/unit density, as compared to other non-ceremonial deposits density of finished artifacts which never exceeded 0.62/unit. (Emery 2009, 2012).

Further, the presence of small quantities of ceramics and bone work debitage in other areas of Dos Pilas and Petexbaun site led Emery to suggest that bone artifact specialization was not the general rule, with many bone implements likely produced within the household by a non-specialist (Emery 1997, 2009). The L4-3 assemblage included large amounts of ceramic spindle whorls, lithic debitage, and other non-bone/shell artifacts (Emery 2009), which suggests that these crafters were not specialized in only bone working, and that the residential location of the assemblage suggests part-time production as they still would have had to carryout daily subsistence activities (Emery 2009).

Despite other indications that Maya crafters were generally associated with the ruling nobility, Costin (1991) states that typically the production of utilitarian wares in large quantities is suggestive of independent production and not from the commissioning of the elite. This is supported by Terminal Classic abandonment of Dos Pilas by elites and continuation of crafting activities in the L4-3 assemblage (Emery 2009). Emery’s interpretation is that the L4-3 assemblage was probably the result of independent, part-time, specialized bone crafting produced at volume beyond domestic use for probable exportation within the region (Emery 2008, 2009, 2012).

The Don Pilas worked faunal assemblage is like that of the Aguateca site where elite crafting served as only a part-time activity (Emery 2009). Aguateca is located near Dos Pilas and was rapidly abandoned circa AD 800, leaving a Pompeii-style assemblage of *in situ* activities that provides a unique look at domestic elite activities (Inomata 2001). The faunal assemblage consisted of 9,510 shell and bone remains, including 4,452 worked faunal remains representing 46.81% of the total faunal assemblage (Inomata 2001, 2007). That percentage does not include processing marks that would be associated with butchery which were only found on 0.27% of the remains (Emery and Aoyama 2007). Faunal elements at Aguateca were produced using lithic instruments made predominantly of chert and occasionally obsidian. Furthermore, both shell and bone artifacts provide evidence of being worked with lithic tools in an assortment of ways including flaking, sawing, percussion, and abrasion (Emery and Aoyama 2007). The bulk of the analyzed faunal material came from three comprehensively excavated structures; M7-22, M8-4, M7-32, and M8-8.

This unique perspective is available due to the rapid abandonment of Aguateca, and these elite structures provide a rare instance for understanding Maya craft production and producer identity (Emery and Aoyama 2007; Inomata 2001). One part of the analysis attempts to identify elite residents as possible elite crafters. The *in situ* layers of the assemblage and faunal/lithic use-wear study suggest that the Aguateca elite were indeed crafters involved in multiple forms or aspects of craft production, likely all by members in the elite court (Emery and Aoyama 2007). It is further theorized that even the ruler and his or her court could have been crafters based on analysis from Copan (1995) which had included a dump of marine-shell ornaments left by high-ranking courtiers of the royal family (Emery and Aoyama 2007). Though attached production via low status workshops with access to high status materials like at the site of Cancuen (Kovacevich et al. 2001) have been identified, the discovery of worked material in the space of these elite structures supports the idea that the elite themselves were also crafters.

Emery (2009) suggests that bone working occurred across social classes, but that specialization might differ based on social status. Beyond the concept of crafters existing within different socioeconomic levels, the analyst also looked to identify if these elite occupants were specialists, and if so, were they only participating in one type of crafting or in multiple crafting activities. Inomata (2001) provides archaeological precedent for most households having a specialty such as scribing or woodworking. Yet, there are elite households in which multiple specialties overlapped at Aguateca. Emery and Aoyama's (2007) analysis provides evidence that, regardless of specialties, most of the residents on site were involved with some stage of crafting bone and/or shell artifacts. Any of the structures that held any bone/shell assemblage also provided evidence of bone and/or shell crafting debris from all stages of production apart from the first stage of the linear reduction hierarchy (Emery and Aoyama 2007).

The Aguateca analysis also provides clarity on the Maya craft production by identifying whether these producers were acting in an attached or independent manner, or if the producers were acting in a full-time or part-time fashion. Emery and Aoyama (2007) combined research on multiple lines of evidence from lithics, ceramics, and other goods that led them to conclude that despite evidence for specialization, even in multiple areas, these elite crafters were likely working part-time with overall low production volume (Emery and Aoyama 2007). The categorization of the production volume was provided by comparing the quantity of debitage from the sites of Dos Pilas and Tikal. Broadly, attached and independent production of crafts are often viewed as being dichotomized (Emery and Aoyama 2007). The site of Aguateca has been interpreted as having luxury goods produced within a hierarchical attached system while domestic goods were produced by non-specialists at the same time (Emery and Aoyama 2007). However, the lithic research at Aguateca has shown that elite craft producers worked within independent and attached frameworks and in doing so manufactured both luxury goods like weapons and utilitarian items such as bone perforators.

Further, through the process of trying to understand craft producer identities, the role of women as crafters was evaluated. Both ethnographic and ethnohistoric sources show that women were involved in both food preparation and textile production, which is further supported by excavations at Aguateca (Emery and Aoyama 2007, Inomata et al. 2002). Emery and Aoyama (2007) suggest that it is reasonable to think that women would have been involved in the early stages of animal product crafting (Inomata et al. 2002). This is partially based on the bone and shell debitage and lithic evidence found within the area of the women's workspace/area, which is established as generally being left of center with animate objects including houses (Emery and Aoyama 2007). It is from this unique assemblage and the rapid abandonment of these elite structures is the identity of craft producers could start to be analyzed and understood.

These studies provide a lens through which to interpret the results of the Ucanal J-2 faunal assemblage using Emery's (2010) worked bone reduction hierarchy, what it shows about Maya craft production, and perhaps the craft producers themselves. Background on some additional aspects of the faunal assemblages such as the human bone and other raw materials, adds additional perspective needed to interpret the assemblage.

Worked Human Bone

The presence of human bones in varying quantities in each of these worked bone assemblages suggests that humans also served as a raw material for worked bone implements. Human bone perforators and carved limbs are reported throughout Mesoamerica.

For example, El Palacio, Michoacán, contained a deposit of human artifacts initially excavated in 1898 (Pereira 2005). The modified human bones were made into musical rasps known as *omichicahuaztli*, but at the time of the original excavation, that was all that could be determined (Pereira 2005). In the new analysis, the cutmarks showed that they were made when the cadavers were fresh from at least eight of the individuals; author theorized these could have been from sacrificial victims (Pereira 2005). The different types of cut marks, grooves, and scrapes on these artifacts, and the variation in how these instruments were made, led Pereira (2005) to determine that they made by multiple individuals.

Pereira (2005) also concluded that most of the musical instruments were deliberately broken right before being put in the graves of multiple individuals, who he noted were all males buried with traumatic lesions on their skulls, strongly suggesting they were warriors. While the contexts and culture both differ, this study and others show the use of human bones as raw materials. A comparison of the use of the finished product with the production context may provide broader information on bone working not just in the Maya region, but across Mesoamerica.

Pre-working Treatment

The observation that bones were worked fresh in the Michoacan context requires additional consideration. The secondary nature of most worked bone deposits can reveal which animals were acquired, but not when and how, or where the bones were stored. Campana (1989) utilized experimental archaeology to understand the best way of pretreating bones for them to be easily worked with non-modern tools.

Campana (1989) surveyed different types of pretreatment. Specifically, he examined if the bone was best worked by utilizing fresh bone and_dried bone which had been soaked in water. He found that dry and untreated bone was the hardest to work with; even high-pressure techniques barely penetrated the bone's outer layer and would chip or break the flint tool (Campana 1989). When the dried bone was soaked, the surface was easily worked, but needed continuous re-soaking to be workable (Campana 1989).

Campana (1989) further found that antler needed to be soaked for the material to be malleable. Despite soaking, the pressure on the tools and surface irregularities would cause vibrations and result in "chatter-marks" or markings which were oriented in a traverse nature of the flint tool's movement.

Campana (1989) performed experimental archaeology with this question by also working fresh bone with the flint tools and found that the fresh bones were the easiest to work without extensive pretreatment to the bone and non-expedient damage to the lithic tools.

Because most mammalian, avian, and reptilian bone share the same composition across the globe, the ancient Maya craft producers would have likely met the same challenges as the experimental archaeologists (Campana 1989). In doing so it is logical that they may have tried to circumvent those challenges via the same method of continually re-soaking or working the bones when they were still fresh. If the latter method was chosen, then becomes difficult to identify the window of time in which a bone is fresh before it is dried out and hardens, a window which can significantly vary based on factors like environmental exposure and specific regional environments.

Craft Specialization

Specialized craft production is associated with more complex societies and defined as "regular, repeated provision of some commodity or service in exchange for another" at different levels of social class, community, or even household depending on the society's stratification type (Costin 1991:3). The scholarship of craft specialization serves to answer complex questions such as ideological interest, use, and thought behind the acquisition of material, and other cultural implications of tools and crafts that stem from ideologies and technical capacities in a given culture (Shimada 2007). As such, Maya craft production studies attempt to provide a better context in which the Ucanal J-2 assemblage can be understood and interpreted building on the zooarchaeological analysis, interpreting the midden typology via location, and gaining at least a minimal understanding of the craft producers from the volume and tool types present within.

The complexity of this craft production issue, in turn, leads archaeologists to try and infer how people of different cultures perceive, develop, and transform the resources of their environment into crafts and tools used in either secular or religious ways (Shimada 2007). How were the producer and consumer of these goods influenced by their creation, and what did the ownership of these specialized goods mean for them (Shimada 2007)? As crucial as crafts or tools are, the location of where the tools are created is just as important. As it stands, most Maya craft specialization analysis has been of finished products and the associated debitage in the surrounding area (Shimada 2007). Workshops, or production areas, can help establish the indoor or outdoor spaces where regular manufacturing of the entire or a significant portion of the crafts were made (Shimada 2007). These workshops serve as production sites for the craftsperson. Both the location of the workshop and the methods used to create craft and tools can inform modern-day people on the social identity of the past artisan. Costin and Wright (1998) draw parallels between links of craft production and social identity through examining the ways that intensity, scale, location, and production values are perceived by producers and consumers in the culture. In the ancient Maya world, resources like animal remains were prominent in the creation of both decorative and utilitarian artifacts. Though rare, the faunal resources and material which have been excavated across these different sites corroborates the use of faunal crafts and tools in domestic, political, and sacred spheres of life (Emery 2009). It also suggests such crafts played a vital role in the economy, particularly through trade (Emery 2009).

Types of complex crafting

Artisans of complex societies specialized in crafting specific tools or objects. However, there are different types of specialization. First, is a type of multi crafting defined as, "…same or closely related artisans performing a major part of the entirety of two or more distinct crafts involving different media or raw materials near each other to produce items…mainly for consumption" (Shimada 2007:4). Second, there is a distinction in specialized craft production that is a description of "…concurrent practice of multiple crafts by different individuals or groups, each specialized in one or more crafts, in the same space or a series of adjacent spaces" (Shimada 2007:6). Though rare in frequency of being found, there are certain assemblages that indicate elites were partly responsible for the crafts of high quality of art objects and instruments (Emery and Aoyama 2007). So rather than hands-off sponsors or beneficiaries, the Maya elite were often producers (Inomata 2007).

Elite and Commoner Crafters

Questions that remain for Maya craft production is whether craft producers operated in an independent or attached manner, or in some combination depending on social factors (Emery and Aoyama 2007). The Maya site of Aguateca provides some answers to these questions. In Aguateca, there is epigraphic and iconographic data that suggests that scribes and artists carved stone monuments and painted ceramics crafted by male elites, and evidence that elite females' primary crafts were textiles (Inomata 2007). The author emphasizes that the Maya elites who were specialists in craft production would also hold different positions in societies like scribes and dignitaries. Elite craft producer specialization being not only a matter of skill but cultural knowledge as well (Emery and Aoyama 2007).

Inomata (2007) argues that a consumer perspective – a bottoms-up approach – is as important as who sponsored or controlled production. Therefore, it is important to emphasize the consumer's perspectives when examining the overall organization of sponsorship and exchange in goods. The focus on, elite craft and tool production, and the high production quality, can give the impression that they were the only social group who created crafts and tools.

Within the households themselves, there is evidence of village members producing items and crafts for intrahousehold use, including uses related to food and, architecture without any contribution from outside sources (Sheets 2000). The archaeological record also indicates the members of the household were skilled enough to be able to craft and create beyond needs in their day-to-day life (signifying at least part-time specialization) and were able to trade with other members of the village or to villages nearby (Sheets 2000). There is also evidence that villagers traded exotic material such as jade, obsidian, or polychrome for ceramics (Sheets 2000). A key difference in the specialization of craft production between Maya commoners and elites is the potential luxury and quality of elite crafted items versus a utilitarian crafted item associated with a Maya commoner. The other distinct difference of crafted items can come from what exactly was crafted by each group, as the elites items would generally require in-depth knowledge and familiarity of the history, religion, and inner workings of the culture whereas the commoners or more mass-produced items would not (Inomata 2007).

Most worked bone assemblage are found in midden contexts, however, not in *in situ* or primary production areas. An examination of middens and how they can be important in the analysis of the Ucanal worked bone assemblage is discussed below.

Midden Typology and Framework

Definitions of middens in the Maya area are key to understanding production versus disposal contexts, and therefore important in understanding the types of activities that created them and who contributed to the deposits. Midden contexts are complex, and can reflect primary, secondary, or more disturbed contexts. Some midden deposits have almost direct associations with buildings and areas where the disposal activities occurred (Lopez 2013). This may reflect activities that occurred in and around the structure associated with the midden, although the relationship between the midden and structure is less clear (Pendergast 2004). A secondary midden deposit may include refuse from other areas or nearby abandoned structures (Lopez 2013:318). Taphonomic indicators can reveal whether the bones were left to weather in the sun or were covered quickly, or were accessed by scavengers such as dogs which can suggest distance from occupied structures or a lack of concern about the items discarded in the deposit.

The second aspect of midden analysis considers whether the deposit is a result of domestic or ritual activities (Lopez 2013). Deposits with exotic animals may result from elites and/or ritual use. Locally available animals are thought (Lopez 2013) to be used more often used in domestic settings and across different socioeconomic strata. Yet, the taxa grouping itself is not enough for identifying the midden deposit context, as some ritual deposits consisted predominantly of locally available fauna rather than exotic animals (Emery 2007:57).

The final aspect of midden typology is temporal. Did it derive from continual use or a single event? Domestic consumption may occur over a period of time and can be identified using taphonomic indicators such as weathering or scavenging which can be visible in stratigraphic layers (Lopez 2013). Elite and ritual consumption may leave a large amount of refuse within a short time period (Lopez 2013). While these different types of consumption represent different ends of a “scale” there is a fair amount of variability between the two consumption types; however, using consumption midden archetypes allows for standard or consistent identification of midden creation. Even if the midden does not fit clearly into each side of the scale listed above, these categorizations allows for a solid position to start and begin to identify how these middens were created.

Summary

This background provides information on the overarching subjects that were used to develop the methods to study the assemblage and to later understand and make sense of the results. Therefore, this chapter provides readers with background on the site of Ucanal, zooarchaeological assemblages in the Maya region, craft production and specialization, midden typology, and worked bone.

CHAPTER 3: METHODS

This chapter outlines the basic zooarchaeological methods used for both qualitative and quantitative traits of the assemblage. It reviews the standard zooarchaeological observations of taphonomy, including all alteration of bone that can occur either pre- or post-deposition. Focus is placed on the classification system used to analyze stages of tool production in the Ucanal J-2 assemblage, a system modified from Emery's (2008, 2010) five-stage reduction hierarchy. Data collection was conducted in the Ucanal Archaeological Project (PAU) field lab in Flores, Peten Guatemala. To ensure analytical consistency, three analysts (Harris, Freiwald, Dubois-Francoeur) recorded the same attributes in concert with some samples re-analyzed when required. Bones were washed prior to analysis using tap water and air-dried over 2-3 days, and upon completion of analysis were then housed in curatorial quality polyethylene plastic bags with internal and external tags.

Qualitative Methods

The bones were identified to the lowest taxonomic level, and when possible identified to the species level. Identification of samples was conducted under the supervision of Dr. Freiwald and utilized a variety of reference materials, including a comparative collection housed in the field laboratory and Gilbert (1980) for classification of bone elements and sides.

Species Identification

The first step of the zooarchaeological analysis required identification of the faunal sample to the genus or species level; if the genus or species could not be determined, then it was classified into a broader class and size. Mammals not identified to species were assigned to size categories (small, medium, large, or unknown). Birds and other reptiles also were identified, as were freshwater and marine shell and human remains that are not described here. Bone was then identified to skeletal element. Skeletal elements are identified through one or more landmarks unique to that specific bone. Each identified sample received a unique entry onto an Excel database and individual paper tags.

Percentage Complete

Once identification of the skeletal element was identified and its species or class size is established, the completeness percentage of the sample is designated. Determining the percentage complete involves identifying the approximate amount of each bone present when fragmented through the siding of individual fragments or fragments bagged together when sharing a high number of similar characteristics. Using the combined information, the researcher categorizes the element's completion as either <25%, between 25-75%, or >75%. When the faunal sample is highly fragmented, the fragments receive the percentage of <25%. If the singular skeletal element is fragmented into multiple pieces, identified through refitting, then the number of fragments is noted.

Siding

Faunal elements are also sided, when applicable, and identified as either left (L) or a right (R). When a side is not identified, the specimen was recorded as indeterminate. Siding holds importance for discussion of quantification methods, as well as for possible identification of niche cultural patterns. An example of the latter is if, through siding and identifying the skeletal elements, it became apparent that one site or group only utilized left metacarpals. The ability to accurately side skeletal elements increases with higher preservation and the use of a comparative collection for common species.

Weighing

Each specimen is weighed as a key part of performing zooarchaeological analysis, and this information is used in conjunction with other information for statistical analyses purposes. For example, the total weight of bones of medium-sized mammal species within a deposit in comparison to the total weight of large-sized mammals bones provides potential insight about prey preferences. If the weight of medium-sized mammal bones was higher than it can be interpreted that medium-sized mammals were preferentially chosen over large-sized mammals, whether for food or cultural resources. In this analysis skeletal elements were weighed on a Smart-Weigh 100-gram portable scale. The scale was calibrated at the beginning of every day with subsequent recalibrations occurring periodically throughout the workday. These recalibrations served to keep the scale accurate as moving it could cause the scale to offset and prevent weight of faunal remains within the deposit from being accurate for use in later analysis.

Age/Sex

The fauna within this deposit was analyzed to approximate the age of remains and are categorized into two different categories: subadult and adult. Age classification was determined by identifying the fusion, or lack thereof, of the epiphyses and shafts. Epiphyses serve as secondary ossification centers for growth. As the skeletal element grows, the epiphyseal plate is replaced by bone as the individual epiphysis fuse to the shaft. If the epiphysis was separated from the shaft or partially fused with visible fusion lines present, then the element was identified as a subadult. The skeletal element was classified as adult if the epiphysis was attached to the shaft without the presence of fusion lines along the region where the two elements merge (Reitz and Wing 2008:75).

The sex of the faunal remains is important for interpretation of cultural preferences and patterns. However, while this part of the zooarchaeological analysis is important, it is often one of the most difficult to analyze since it is largely recognized through sexual dimorphism present within individual species, as well as bone morphology (i.e., deer antlers, turkey tarsometatarsi). The fauna within this deposit, however, lacked these markers and were highly fragmented so no estimations of sex was possible.

Burning

The presence or absence of burning was noted, as well as its extent and color, which reflects temperature. Burn damage happens to faunal elements in three ways: wildfire, controlled fire, and cremation (Lyman 2001: 386-387; Reitz and Wing 2008). Burn-induced alterations are hypothesized to happen in stages depending on the temperature of the flame and the duration of the exposure. While color change cannot pinpoint a specific temperature in which the bone was burned, it can serve to provide the range of temperature (Stiner et al. 1995). The challenge with taphonomic burn damage is identifying the type of fire, any tissue remaining on the bone, and the skeletal element.

However, it is standard that bones burned in low-temperature fires and shorter durations show signs of blackening. As the temperature and duration increase, the bones undergo a process known as calcification (Lyman 2001:386-387). As this process happens, the bone will generally fracture and shrink. However, there have been efforts to give a numeric value to explain the extent of burning (Stiner et al. 1995, Stiner 2004), and experimental archaeology that categorized the changes of the bone when subjected to different heat (Lyman 2001:386; Reitz and Wing

2008). Burning was present on the skeletal elements and noted as being present or absent with a range of colors from brown, to black and white. Burning can be used to strengthen and harden bone, but it also may reflect taphonomic processes like food processing, a topic not widely discussed in the Maya region in part most assemblages contain only small quantities of burned bone.

Weathering/Root Etching

The taphonomic process of weathering is viewed as a historical process because of the role that time plays between death and burial in the archaeological record. The environment can have different effects on bones. Exposure in a hot microenvironment causes the bone to dry quickly, and without grease within the collagen of the bone, to eventually split and crack along the surface (Lyman 2001:363; Karr and Outram 2015; Reitz and Wing 2008).

Experimental archaeology suggests that vegetation, faunal accumulation, time since death, and other factors can produce a relatively standardized set of criteria to determine the time of death and burial (Andrews 1990; Behrensmeyer 1978; Karr and Outram 2015; Reitz and Wing 2008). Weathering stages of large and small mammal bones can be categorized numerically from 1-5 based on the physical degradation of the bones which translates to a range of years that the bone was exposed before burial (Lyman 2001:355). The severity of weathering can camouflage other types of modifications (e.g., cut marks) from appearing on the bone.

The taphonomic modification of root etching occurs post-deposition once the bone is buried or, in rare cases, preburial. The cause of root etching is a result of humic acid that can come from plants and, over time, will result in shallow grooves on the bone (Behrensmyer 1978:154). While it is known how root etching occurs, there remain many elements of root etching that are unknown. It is not known which roots cause etching, the rate of root etching, how deeply bones are buried to be susceptible to root etching, and different rates of root etching from different species of plant (Lyman 2001:376-377). Nevertheless, it is essential to note that root etching is still important because it can help determine if the fracturing of bones occurred before or after root etching (Lyman 2001:377).

Bone fracture/Cutmarks

Human modification of bone can stem from food preparation or tool production, as well as unintentionally. Butchery consists of a series of acts beginning with the death of the animal (Binford 1978), which can leave marks on bones, to its initial processing, consumption and preparation of the meat, and then use of bones for marrow or as raw materials for tool making.

One key aspect of studying potential butchery marks is to identify if the individual element underwent intentional breakage, as bones can fragment through natural and intentional means. Intentional breakage of faunal bones often occurs in predeposition scenarios when humans are attempting to extract marrow, grease rendering, or in this case, turning the bones into tools. In the butchery process, cutmarks serve as one of the primary markers to identify if humans modified a bone after death. The analysis of most cutmarks can occur under macroscopic examination although a Dino-Lite digital microscope was employed in the PAU field lab. The orientation, and location of the cut mark(s) on with different skeletal elements also is important (Lyman 2001: 297-298).

Cut marks from stone tools are generally classified by their shape (a V-shape v. a U-shape in cross-section) and one or more elongated parallel striae (Lyman 2001:297). The location and orientation, or standardized placement, can show an ‘anatomical purpose’ for where they occurred and show what activity produced the marks such as butchering, skinning, disarticulating, filleting, or some combination thereof (Lyman 2001:298). Consistent placement of cutmarks also serves to differentiate them from similar marks made by carnivores as the latter are often chaotic in placement.

Quantification Methods

Quantification of the data involves three primary ways of interpreting fauna within the assemblage: Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), and Minimum Number of Elements (MNE). Each way of quantifying has its own strength, weaknesses, and information it provides.

Number of Identified Specimens (NISP)

The first way of quantifying a faunal deposit is NISP. NISP is the total of all bone and tooth fragments identified to the taxon they represent (Lyman 2001:27). It is simply the total sum of bone fragments identified. Another advantage of NISP comes from it being cumulative, and so the analyst is not required to recalculate every time new specimens are identified. Instead, the analyst can just add to the accounted total (Lyman 2001:28).

NISP, however, has some disadvantages including differences in the number of teeth and bones among species (Lyman 2001:29). Differential recovery of larger species, or better-preserved specimens also is important, as well as variation in the amount of food skeletal elements or large and small species provide. Finally, NISP does not account for skeletal elements which are articulated with each other, such as teeth in a mandible and whether they should be counted as an individual specimen, and whether the mandible itself should also be counted (Lyman 2001:30). Despite these problems with NISP it still is one of the standards for zooarchaeological quantification. Analysts wary of overrepresentation of taxa when using NISP may apply other quantification methods such as MNI and MNE.

Minimum Number of Individuals (MNI)

MNI is identified as an alternative way to measure taxonomic abundance within certain deposits or assemblages, which complements NISP. MNI is used to identify the minimum number of individuals in each taxon. For example, three right humeri and two left humeri result in an MNI of three individuals for that species. The stress on the minimum number may undercount animals as it is entirely possible that the five bones represent five individuals. But it is a certainty that there is a minimum of three individuals since skeletal elements from the same skeletal species cannot overlap. If there is an overlap of skeletal elements, then that means the elements must belong to separate individuals.

This advantage of using MNI solves a key problem of specimen interdependence by how this quantification is generally defined (Lyman 2001:39). MNI quantification considers refits of bone fragments to be accounted as interdependent and only as one individual. If a refit of the element is not possible, then MNI conservatively distinguishes as the elements as belonging to separate individuals despite whatever other characteristics the fragmented skeletal elements may or may not have in common. It is MNI's conservative approach to differential fragmentation which can help avoid the difficulty of overrepresenting certain taxa within deposits and assemblages. This is largely because for a bone fragment to increase MNI the fauna is usually identified to the individual element and side, if there is more than one present within the taxa, and avoids counting the element twice (Lyman 2001: 44).

Despite the apparent strengths of using MNI as a quantification method, this method also may exaggerate the number of rarely utilized taxa. An example of this would be if you had taxon A and taxon B, taxon A has a NISP which equals 10 and taxon B has a NISP of 1. Despite, taxon

A having a higher amount NISP than taxon B, if all but one of the 10 do not meet MNI requirements then it is still classified as having an MNI of one. Another potential flaw with MNI is that it can only calculate values of the minimums, and the ratio of these values cannot be accurately assessed (Lyman 2001:47-48). The calculation of minimum values keeps the analyst from knowing true values, and as such prevents accurate comparison. One of the last problems to be discussed with MNI is that, while more resistant to increase than NISP, it will increase with NISP. However, MNI is a quantification technique that is resistant to over accounting taxa, a reason to use it in tandem with NISP when quantifying different assemblages and deposits.

Minimum Number of Elements (MNE)

The final major quantification method often used within zooarchaeological analysis and within the analysis for this deposit is MNE. Unlike the MNI, MNE identifies the number of specimens by quantifying the number of individual elements, including overlapping landmarks on fragmented bone (Reitz and Wing 2008:). This can make MNE well suited for identifying utility indexes, like the food utility index which deals with which portions of an animal are considered worth the energy expenditure it would take to transport and prepare versus which body portions are not. For example, the MNE may show that meatier portions of animals are present, suggesting a focus on maximizing food acquisition based on the prevalence of limb bones. In contrast, repetition of just one of those limbs, combined with other lines of evidence may suggest modification of bones occurred for tool creation instead of butchery. A major drawback of the MNE quantification method is that its utility drastically declines with the increase of fragmentation or weathering of bones, which obscure element and landmark identification.

Sequence of Bone Tool Production

Analysis of the Ucanal J-2 assemblage included identifying the reduction hierarchy of tool production, or the operation of taking a bone and crafting it into a tool (see Table 2). Emery (2008) identified five stages, from creating the core, to making blanks for tools, and then shaping and finishing them. Each stage is classified, and the frequency calculated to understand production in the deposit.

Table 2. Categories of Modification Process. Broad categories of the modification process (Emery 2008:211-217)

Five Stages of the Modification Process	1.Primary and Secondary Debitage Removal- removes epiphyseal and metaphyseal ends
	2.Modifications: Core Production and Finishing- reducing the core
	3. Primary Blank Production- Longitudinal cuts or scoring in cortical bone
	4. Blank Finishing- Smoothing of cortical and longitudinal smoothing
	5. Artifact Production-Finishing the product

Stage one of the production sequence process is the creation of the core through the removal of the epiphyses. Subcategories reflect different aspects of core creation: epiphysis removal (1A), epiphysis removal with evidence of longitudinal cut before a traverse cut (1B), and epiphysis removal with the removal of other irregularities (1C).

The second stage of the production was classified as core processing. In this stage, the core is modified in stages assigned A-D: an unsmoothed (diaphyseal shaft or cortex) core with a longitudinal incised line (the incised line associated with groove and split technique) (2A), an unsmoothed core is not a diaphyseal shaft or cortex (2B), or an unsmoothed cores with smoothing on the transversal ends of the modified skeletal element (2C). The final designation for this stage of production is 2D, which is categorized as a core that has been completely smoothed.

The third stage of production is the creation of blanks, the separation of individual pieces from the core that serve as the foundation for the tool's creation. The subcategories include different stages of blank production: thick blanks with unsmoothed longitudinal cuts present (3A), thin blanks, which were sized to the width of a perforator and had unsmoothed longitudinal cuts present (3B), butt removal from the blank where no smoothing of the cortical surface or edges were present (3C), and long thin fragments or 'splinters' defined as debitage from stage 3 (3D).

The next to last stage of production is stage four, where the craft producer finishes the stages of the bone product's creation through actions like polishing, smoothing, or drilling. Stage four categories include: edge smoothing of the blank as it is being shaped into a tool (4A), smoothing of the cortical surface along with the blank (4B), smoothing on the edge and cortical surface (4C), and butt removal of a formed blank which had already been smoothed (4D).

The final stage of production classifies artifacts that may be finished or are in the finishing stages:_an artifact that is finished, broken, with no apparent use wear (5A), finished, complete, with no use wear apparent (5B), broken but finished and had use wear present (5C), finished, and exhibited signs of use wear (5D), and artifacts that may be finished or in the final productions stages but cannot be categorized using macroscopic observations (5E). Fragments also were classified as miscellaneous debitage (M) if they could not be clearly assigned to a stage of production.

Within the J-2 deposit analysis, cutting techniques were divided into cuts, single striae, or incised grooves and classified as horizontal or longitudinal: longitudinal cut (LC), longitudinal groove (LG), horizontal cut (HC), horizontal groove (HG).

The technique used for the cores and blanks also followed Emery (2008, 2010), with minimal modification. Three of the nine labels involve the use of lithic implements to modify the bone (see Table 3). The first of these three is known as the groove and splinter longitudinally technique (abbreviated GS). This is where two deep longitudinal grooves are cut into the bone cortex, which would allow the resulting "splinter" to be lifted from between the groove. Another modification technique that was present is the longitudinal sawing technique (abbreviated LW). This technique results when the bone shaft is longitudinally split first in half, and then worked into smaller segments. The final lithic implement modification technique is the sawing and snapping technique (abbreviated SS), which is used to remove debitage or unwanted fragments. This technique is used to remove the epiphyses of long bone fragments so that the craft producer could handle the long bone shaft for the following production stages. Another cutting technique is the string/abrasion (ST) technique, in which a string wrapped around the bone core is pulled side to side while coated in sand or some other adhesive. This technique creates curved abrasions and a variable concavity along the cut edge (Emery 2008).

Table 3. Bone Reduction Techniques. The different lithic and non-lithic ways of working bone in the Maya region. (Emery 2008: 210-211).

Two bone working strategies	Modification Techniques	Description
Lithic Implements	Groove & Splinter Technique	Two deep grooves are cut into the bone cortex and the resulting "splinter" is lifted from between them.
	Longitudinal Sawing Technique	The bone shaft is sawn longitudinally to split it first in half, and then into smaller segments.
	Sawing & Snapping Technique	The most used for removing debitage or unwanted fragments.
String/Abrasion	String/Abrasion Technique	A string wrapped around the bone core is pulled side-to-side while coated in sand or other abrasive, creating curved abrasions and variable concavity along the cut edge.

In addition, modification such as incising (I), pecking (P), and drilling (D) was recorded. If the researcher could not confidently assign one of the cutting techniques, cut marks and breakage of unknown origin were recorded as unidentified cutting (UC) and unidentified breakage (UB). Finally, fauna with no clear markers of bone implement production were identified as not worked (NW). It should be noted that not worked (NW) does not mean that there were no signs of modification, but that analysts could not definitively state that the modification was from bone working (striations, cutmarks, etc.) versus modification from food production (pecking, green breakage).

Summary

This chapter sought to outline the different qualitative and quantitative portions of the zooarchaeological analysis performed by the different analysts. It reviews the parameters for analyzing and identifying taphonomic alterations to the bones. The chapter identifies and explains the different quantification methods of NISP, MNI, and MNE. There is also a summary of how analysts identified different the different species/categories, skeletal elements, and other attributes like siding or weathering. Focus is also given to the explanation of the five-stage reduction hierarchy, cutting techniques, and cutmarks looked for or identified within the assemblage.

CHAPTER 4: RESULTS

This chapter is broken into the distinct sections of characterizing the assemblage, interpreting the results of the characterization, and broadly looking at Ucanal bone production in a regional context. Characterization of the assemblage led to quantification of the assemblage, analysis of taphonomic damage present, frequency of cutting techniques and cutmarks, and the results of applying our typology of Emery's reduction hierarchy to the assemblage. The lens of interpretation then summarized these findings of preferred choice of raw material, consistent utilization of certain skeletal elements, and the working of those preferred elements in a consistent manner. Finally, this chapter sought to look at Ucanal when compared to the comparative sites within the region.

Characterization of the Assemblage

Quantification of J-2 assemblage

The analysis includes non-human vertebrate bone and consists of a total 6,626 (6,016.84 g) bone fragments. A minimum of 23 different classifications or types were accounted for out of total faunal remains (See Table 4) However, out of these 23 classifications most included between one and ten specimens, and most classifications are not representative of the assemblage's bulk composition.

Table 4. Frequency of Animal categories. A composite table showing the total number of different categories and respective weight in grams.

Common Name	Species/Genus	# Fragments	Weight (in grams)
Snake	N/A	1	0.43
Opossum	Didelphidae	1	1.55
Frog	Anura	1	0.08
Agouti	*Dasyprocta punctata*	2	0.4
Carnivore	N/A	2	1.08
Fish	N/A	3	0.34
Large Cat	Felidae, large	3	3.06
Crocodile	*Crocodylus* sp.	3	36.58
Dog	Canidae	3	1.76
White-tailed or Brocket deer	*O. virginianus, Mazama* sp.	4	
Pocket Gopher	*Orthogeomys hispidus*	4	2.22
Reptile	N/A	6	2.35
Turtle	Testudines	7	7.06
Peccary	Tayassuidae	8	69.27
Armadillo	*Dasypus novemcinctus*	10	3.18
Brocket Deer	*Mazama* sp.	12	18.39
Small Mammal	N/A	23	14.83
Medium Mammal	N/A	70	82.74
Bird	Aves	73	26
White-tailed deer	*Odocoileus virginianus*	235	1,398.77
Not Identified	N/A	1,683	293.53
Large Mammal	N/A	1,690	2,502.95
Mammal	N/A	2,782	1,550.27
Total		**6,626**	**6,016.84**

To better comprehend this bulk composition representation the number of bones by species is reduced to the numerically highest top seven (Table 5). The largest categories include 6,556 (5,869.09 g) or 98.9% of bone or bone fragments. Out of the top ten, the largest by count and weight are white-tailed deer and the less specific classifications of large mammal and mammal for a total of 4,707 (5,451.99 g) which represents of 71% of the total assemblage. The weight compared to the numeric amount fragments in these three categories provides information on fragmentation (Figure 2) as the mammal category numeric value is approximately just over half of its sum of weight. The large mammal category numeric value is just under half of the sum of its weight, in an inverse manner. Finally, the white-tailed deer sum of weight is almost six times higher than the numeric value.

Table 5. Top Ten Animal/Categories. Table representing the top ten highest numeric categories and their weight.

Top 7 Categories	# Fragments	Weight (in grams)
Small Mammal	23	14.83
Medium Mammal	70	82.74
Avian	73	26
White-tailed deer	235	1,398.77
Not Identified	1,683	293.53
Large Mammal	1,690	2,502.95
Mammal	2,782	1,550.27
Total	6,556	5,869.09

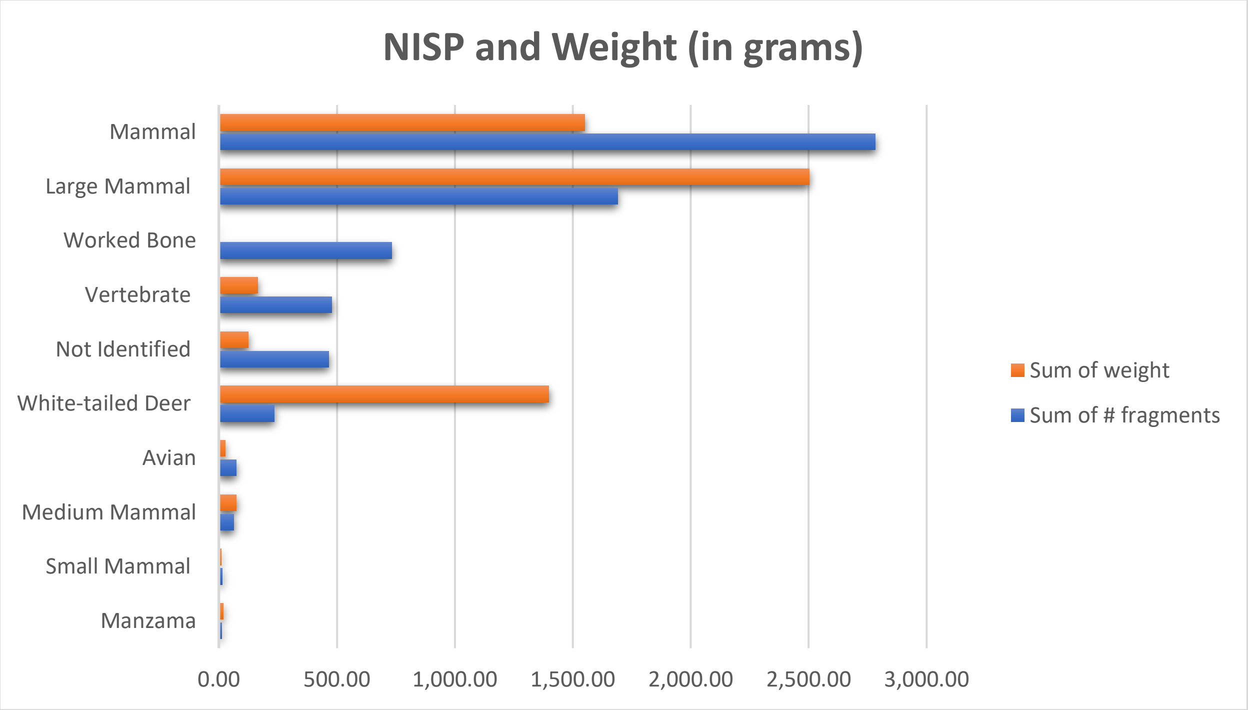

Figure 2. Graph illustrating the top ten categories and their weight within the J-2 assemblage.

A calculation of the assemblage's MNI is used alongside a calculation of the NISP via identifying sided skeletal elements which do not repeat within the same side of the body. The MNI is applicable for skeletal elements by species like femur, tibia, humerus. The calculation of the MNI found 32 different individuals identified within the assemblage across the different species. Out of these 32 individuals, 14 individuals were identified as belonging to white-tailed deer, Aves accounted for two, brocket deer accounted for two, two were identified as pocket gophers. The remaining different individuals of MNI were only present in single individuals within the assemblage.

The quantification of the minimum number of elements (MNE) demonstrates which elements were being relied for toolmaking through frequency of elements present (see Table 6). Within the J-2 assemblage there is a presence of long bones when compared to the other skeletal elements within different species and categories. The greatest skeletal elements of white-tailed deer are long bones like femurs (38), metapodials (36), and tibias (41). In the category of large mammal, prominent skeletal elements are femurs (14), ribs (32), scapula's (21), and tibia's (41). In the final category of mammal, the prominent skeletal elements are cranium fragments (25), ribs (29), scapula's (10), and tibia's (17).

Characterization of the assemblage through composition involved gaining an understanding of the number of elements represented within each species and their weight. The highest values of categories with the largest amount of identified skeletal elements are mammal, large mammal, and unidentified. In all these different categories the largest numbers of skeletal elements are identified as limbs, metapodials, femurs, tibias, with other long bone skeletal elements being identified in lesser numbers. With standards and safeguards in place to protect against numeric inflation, it should be considered in most aspects as operating with the minimum.

Taphonomic observations ranged from burning to animal gnawing, along with observations on recent breakage that must be distinguished from tool production or post-depositional damage. A total of 1,580 of the 6,626 (23.9%) have the identification of being old, recent, or exhibiting signs of both categories. Of those 1,580 faunal pieces, 1,046 are identified as being recent breakage. Out of the remaining pieces 456 are identified as old breaks, and only 78 fragments were deemed showing signs of having both old and recent breaks, a result of the hard matrix in the deposit and the age of the bone fragments.

Table 6. Number of Different Skeletal Elements. The number of skeletal elements (and weight) as identified to key categories.

Categories Skeletal Element	# Fragments	Weight (in grams)
Mammal		
Cranium	25	17.24
Carpal	1	0.61
Distal end of Shaft	2	2.03
Epiphysis	2	1
Femur	5	27.2
Flat Bones	13	3.07
Humerus	3	14.52
Limb	746	561.26
Lumbar Vertebrae	1	0.2
Mandible/Maxilla	2	3.87
Not Identified	1,908	785.94
Phalanx	2	2.09
Radius	4	56.8
Rib	29	16.98
Scapula	10	14.4
Spongy bone	7	4.5
Tibia	17	32.61
Tooth	1	0.98
Vertebrae	4	4.97
Ave		
Beak	1	0

Coracoid	6	0.5
Femur	1	0.33
Humerus	1	0.05
Limb	33	7.69
Not Identified	13	8.02
Sternum	2	0.26
Synsacrum	2	0.79
Tibiotarsus	3	1.88
tarsometatarsus	1	1.78
Ulna	6	2.36
Vertebrae	4	1.98
White-tailed deer		
1st Phalanx	4	17.46
2nd Phalanx	3	1.4
3rd Phalanx	4	4.95
Antler	14	58.25
Calcaneus	1	22.09
Carpal	1	0.62
Cervical Vertebrae	1	0
CPS	1	2.87
Cuboidnavicular	3	16.80
Epiphysis	7	17.04
Distal Shaft	5	0
Femur	38	566.89
Fibula	4	4.92
Humerus	6	153.41
Incisor	1	0.19
Lower 3rd Molar	2	1.84
Mandible/Maxilla	5	27.43
Metapodial	36	113.14
Not Identified	2	12.52
Patella	1	7.54
Phalanx	1	2.43
Radial carpal	1	0.59
Radius	8	107.08
Scaphoid	1	2.08
Scapula	32	30.43
Tibia	41	210.95
Tooth	1	0.29
TRC Tarsal	2	8.21
Ulna	6	4.44

Ulnar carpal	1	0.78
Unciform	1	1.18
Upper Premolar	1	0.95
Not Identified		
Limb	43	23.61
Not Identified	396	104.35
Vertebrae	8	1.15
Large Mammal		
2nd Phalanx	1	0.92
Antler	5	15.84
Cranium	8	45.11
Epiphysis	5	12.84
Femur	14	64.11
Fibula	2	2.44
Humerus	13	36.3
Limb	1,130	1,404.70
Mandible/Maxilla	2	0.95
Metapodial	8	42.36
No Identified	369	503.22
Radius	4	66.62
Rib	32	16.8
Sacrum	1	2.83
Scapula	21	24.77
Talus/Astragulus	1	9.8
Tibia	41	205.68
Trabecular Bone	9	14.49
TRC Tarsal	1	3.17
Ulna	5	15.01
Vertebrae	18	14.99
Small Mammal		
Cranium	2	1.69
Femur	2	2.7
Limb	2	2.68
Mandible/Maxilla	1	0.74
Not Identified	11	5.86
Radius	1	0.2
Rib	1	0.16
Tibia+Fibula	1	0
Tooth	2	0.8
Medium Mammal		
Femur	3	10.23

Humerus	2	4.35
Limb	13	19.53
Metapodial	1	2.07
Not Identified	38	26.61
Proximal Femur+Shaft	1	2.36
Radius	1	2.06
Scapula	6	13.06
Tibia	3	1.97
Tooth	1	0.15
Vertebrae	1	0.35
Vertebrate		
Cranium	6	1.2
Femur	1	0
Flat Bones	10	3.25
Limb	29	14.94
Mostly Large Mammal	57	0
Not Identified	338	125.00
Shaft	24	8.5
Tibia	2	0.47
Vertebrae	12	11.06
Total	**5,799**	**5,869.09**

Note: An additional 757 bones were not identified to any of the above categories.

Taphonomic Results

The Ucanal J-2 deposit taphonomic representation evaluates the presence of degradation via natural elements. Routinely, analysts identify evidence of weathering, root etching, and possible water damage. The amount in which these degradations occurred within the assemblage are minor, only being identified as to 49 (0.74%) of the total 6,626 faunal elements and fragments analyzed. Out of the 49 fragments, 40 are identified as having root etching, 8 weathering, and 1 with both root etching and weathering. Zero fragments had water damage.

Though analyzed separately, another aspect of analysis sought to determine damage done to the assemblage via fire. Burn damage was identified to four different categories ranging in severity of brown (BR), black (BL), beige (BE), to white (W). Burn damage present within this assemblage is minimal with only 44 (0.66%) of the total 6,626 fragments. Most confirmed burn damage is identified as black or brown/black and signify that while burn damage was minimum, it is predominantly mild in severity when it is present.

The two types of animal damage present within the assemblage are animal gnawing and rodent gnawing on 13 (0.20%) different skeletal fragments. Rodent gnaw marks were identified on eight fragments, and non-specific gnaw marks on an addition five bone fragments. This suggests that animals had minimal access to the assemblage and it was quickly buried.

Crafting in the J-2 assemblage/Five-stage Reduction Hierarchy

Emery's reduction hierarchy is used in identifying and quantifying the presence of the five different stages within the J-2 assemblage. To perform this portion of the statistical analysis the reduction hierarchy is analyzed in the five separate stages before being compared broadly against one another to identify the most common stage of reduction hierarchy debitage. The five stages of the reduction process show that most modified bone fragments are in the end stages of production.

Out of the 2,048 identified worked skeletal elements, 1,846 (90.1% of totaled worked) worked skeletal elements were assigned to one of the five reduction stages (See Figure 3). The remaining 10.1% of worked skeletal elements were not categorized into one of the five reduction stages. Out of the five different stages, the highest frequency within the J-2 assemblage are stages three and four with a combined totaled of 1,144 of the assigned reduction hierarchy skeletal elements. Stage five, the final stage, is the third highest assignment frequency of the reduction hierarchy with 322 skeletal elements. The first and second stage of the reduction hierarchy which had the lowest assignment frequency within out of the entire J-2 assemblage.

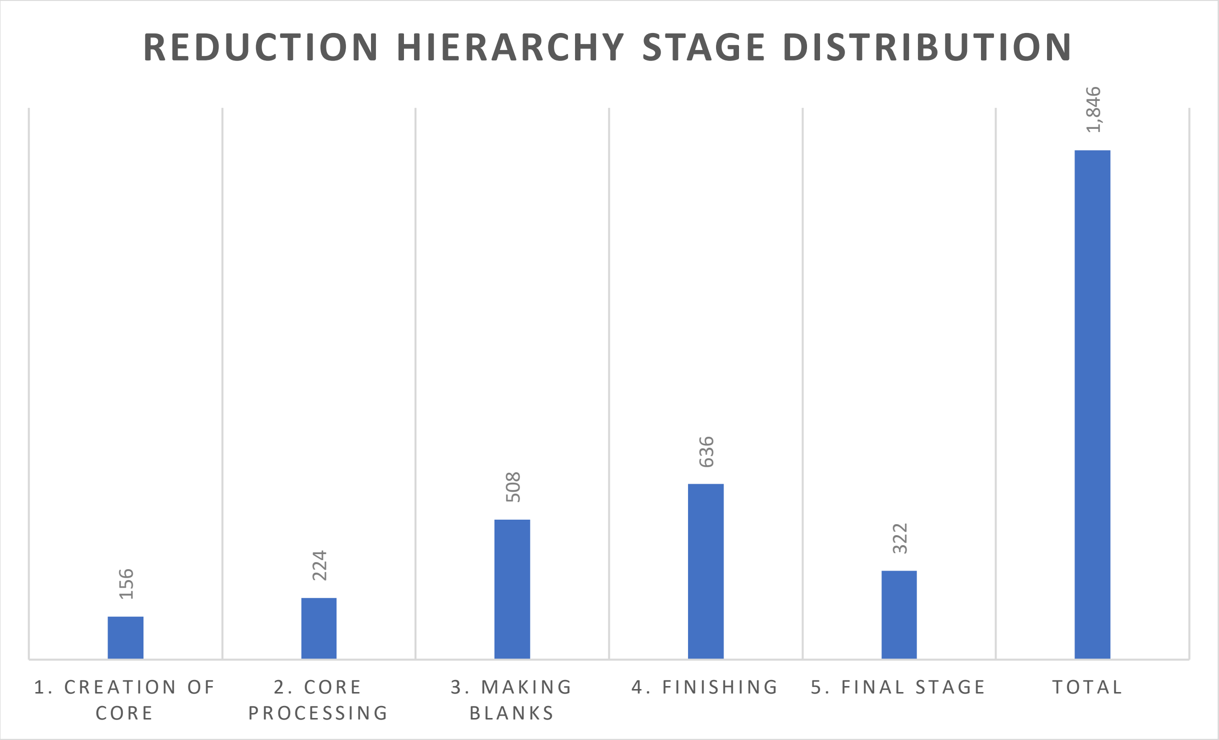

Figure 3. Frequency of distribution throughout the broader categories of the reduction hierarchy

In Stage one 156 (7.6% of worked) different worked elements are categorized to stage one or its subcategories (see Figure 4). The generic categorization of one is assigned to 17 of the elements, with the explanation that these elements are identified as epiphysis removal for the core, but with no other clear characteristics ascribed to epiphysis removal. 1A, ascribed as epiphysis removal, accounts for the highest number of elements assigned in the first stage of the reduction hierarchy. 1A totaled to 64 (3.1% of worked) different elements.

The next largest category within Stage 1 of production is epiphysis removal with longitudinal cut before traverse cut (1B) with 42 (2.1% of worked) different elements. The final sub designation of Stage one reduction is 1C, which is the epiphysis removal with removal of surface irregularities. Out of the specific sub designation given within the creation of core, 1C was the smallest category with 33 (1.6% of worked). This breakdown of stage one reduction hierarchy consists in relative low frequency.

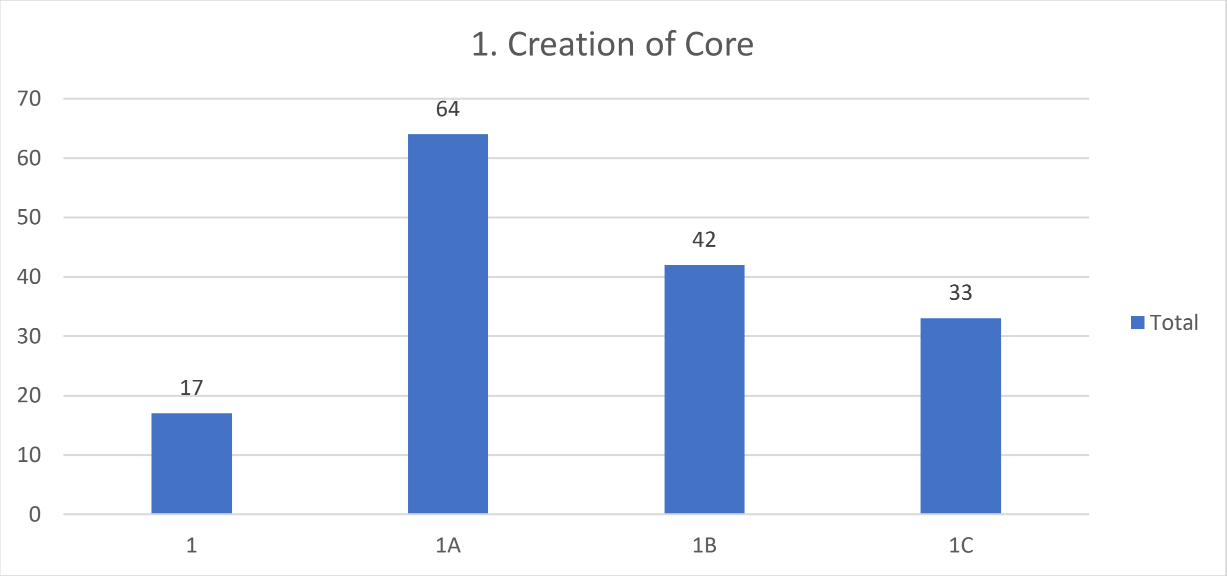

Figure 4. A distribution of different sub designation within the first stage of reduction hierarchy.

Stage 2 of the reduction hierarchy included 224 (10.9% of worked) different elements (See Figure 5). The largest of the sub-groups found within this step is the broad designation of core processing (2) with 75 or 3.7% of worked. The second largest category is unsmoothed (diaphyseal shaft or cortex) core with longitudinal incised line for groove and split (2A) which is identified on 65 (3.2% of worked) different skeletal elements. The unsmoothed core with longitudinal incised line (for groove and split) (2B) is identified on 54 (2.6% of worked) different skeletal elements. The next largest sub-designation in this stage of the reduction hierarchy is smoothed core (2D), which is identified on 27 (1.3% of worked) skeletal elements. The smallest sub-designation found within the second stage is the unsmoothed core with smoothing on the transversal ends (2C), which is only seen on three (0.2% of worked) of the skeletal elements. The frequency of the beginning stages indicates the producers were predominantly focused on end stage production of making, processing, and finishing of blank and tools.

Stage 3 is the second to largest in frequency in the reduction hierarchy with a total of 508 (24.8% of worked) skeletal elements being assigned one of the 5 different designations (see Figure 6). The smallest of these designations are thick blanks (unsmoothed longitudinal cuts) (3A), was identified on 60 (2.9% of worked) different skeletal elements. The next smallest portion identified in stage three includes unsmoothed thin blanks a width of perforator) or stage 3B. This sub-designation is identified on 73 (3.6%) different skeletal elements. These are blanks with a rough shape with their width, and possible thickness, but generally not any refinement from smoothing, reduction of length, or others.

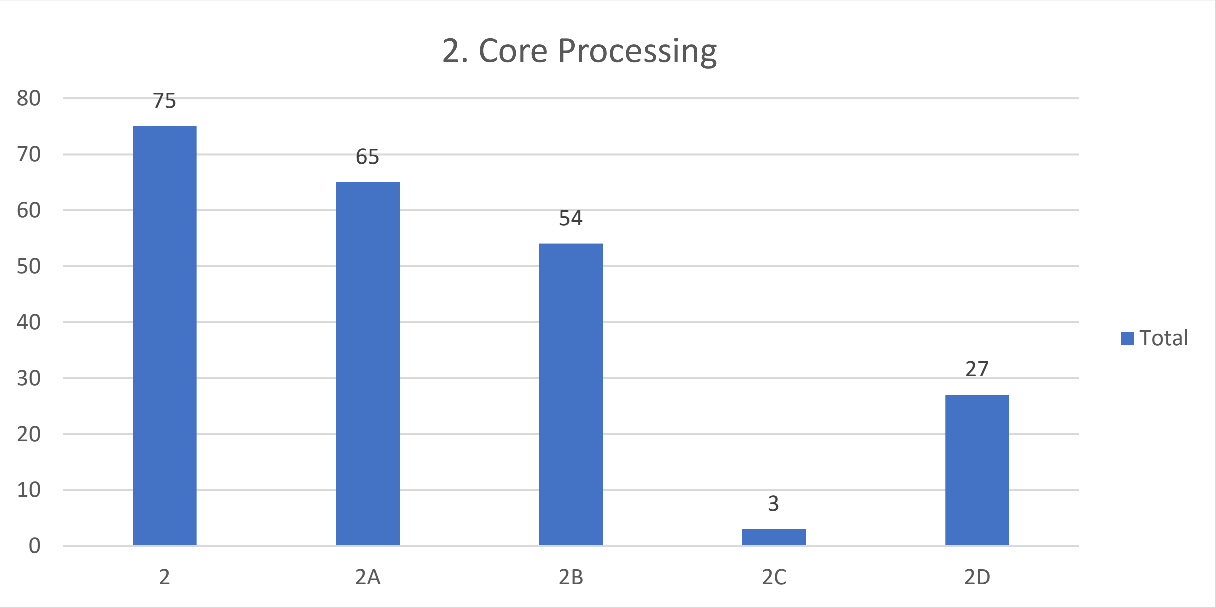

Figure 5. Distribution of skeletal elements across the different categories of the second reduction stage

The next largest category in Stage 3 of the reduction hierarchy is the broad designation of three, or the production of blanks (3). These 107 (5.22% of worked) different elements are identified as broadly meeting the visual characteristics of blanks, but not where it is distinguishable with any of the parameters within the sub-designations. The largest frequency of skeletal elements is found in the final two sub-designations of the Stage 3 reduction hierarchy as they both held the same number of skeletal elements. Butt removal (no edges or cortical smoothing evident) (3C) is identified 134 (6.5% of worked) times. Debitage (long thin fragments, splinters) (3D) from the crafting of blanks in stage three and analysts identified 134 (6.5% of worked) fragments which were derived from the initial crafting of blanks.

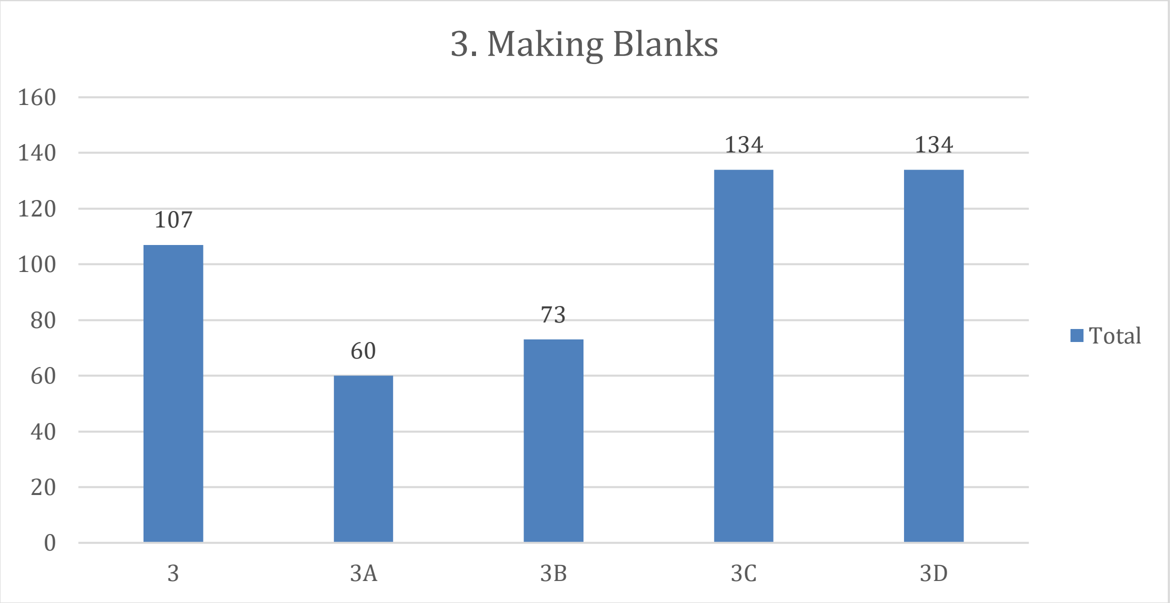

Figure 6. Distribution of skeletal elements across the different categories of the third reduction stage.

Stage 4 of the reduction hierarchy includes blanks or tools preforms with polishing or smoothing. This stage includes the large number of fragments, with a total of 636 (31.1% of worked) different fragments (see Figure 7). The smallest numeric category is cortical smoothing of a blank with smooth cortical bone surface (4B) at 64 (3.1% of worked). This is smoothing of the long sections, the shaft of long bones, of the blanks. The next smallest numeric identified is the broader categorization of 4, being assigned to 106 (5.2% of worked) different skeletal elements. This identification includes fragments which seem to be in the finishing process but were not confidently exhibiting signs of any of the other sub-designations. The butt removal of a formed blank (4D) is assigned to 126 (6.2% of worked) worked elements. These pieces identified as butt removals are thin and short squares/rectangles that had evidence of cutting on one side. The next subcategory edge smoothing of a blank (4A), is identified 141(6.9% of worked) different times within this assemblage and the second highest sub-designation within the fourth stage of the reduction hierarchy. The highest numeric frequency of this stage is 4C, edge and cortical smoothing of a blank, identified a total of 199 (9.7% of worked) different times. Consistently, 4C is categorized as furthest along in this stage as the blanks are smoothed on all sides and formed within this step.

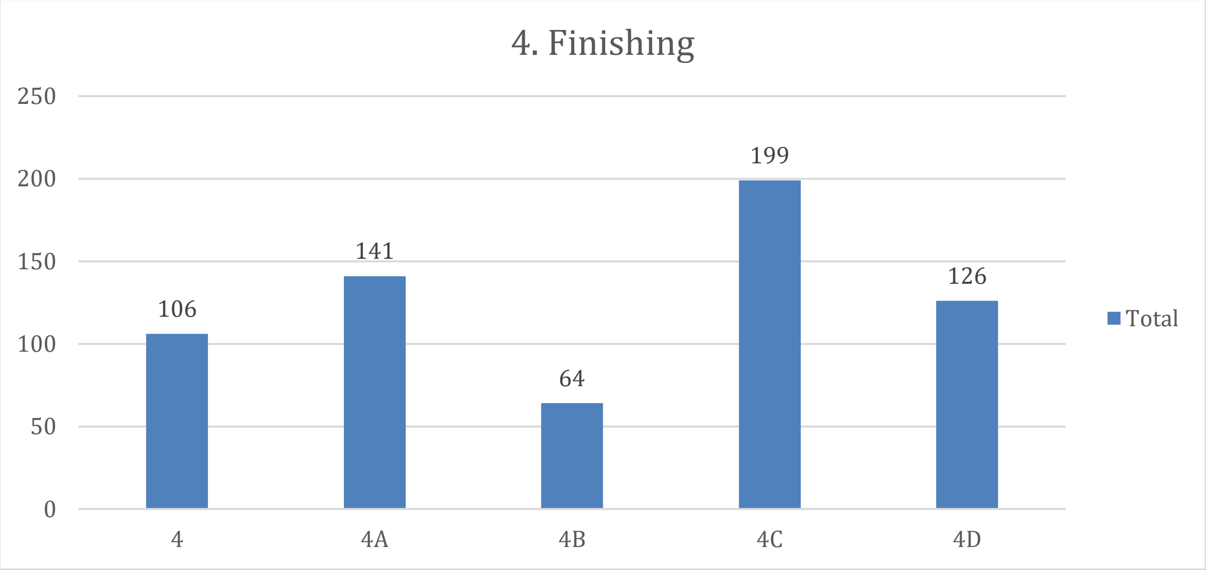

Figure 7. A graph demonstrating the frequency of the five different designations the fourth reduction stage.

The final stage of the reduction hierarchy includes almost finished artifacts classified as Stage 5. The fifth stage of the reduction hierarchy is present a minimum of 322 (15.7% of work) different times (see Figure 8). For now, however, there remains an analysis of the other sub-designations. The subcategory of 5?, is a designation for worked elements thought to be finished but were not able to confidently labelled, only consisted of four (0.2% of worked) elements. Two (0.09% of worked) were assigned to the sub-designation; used, repair (5). Another two (0.09% of worked) skeletal elements are identified as being finished but broken with use wear (5C). The next sub-designation are bone tools that are finished and completed with no use wear (5B) and only nine (0.44% of worked) skeletal elements received this label. The final sub-designation of the fifth stage is for skeletal elements exhibiting characteristics of finished, broken, and showed no signs of use wear (5A), and accounted for being present on ten (0.49% of worked) worked bones.

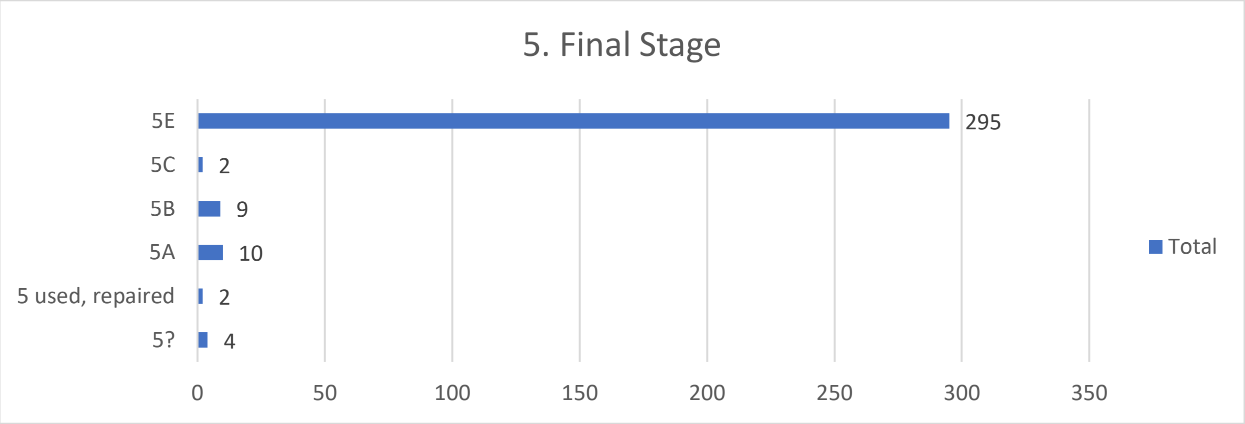

Figure 8. Distribution of the finished bone tools within the sub-designations the J-2 assemblage.

Analysis of the production techniques includes the type of cutting and associated grooves, cuts, breakage, or other damage to the bone. Bones assigned to the not worked (NW) designation only means that those fragments could not confidently identified as being utilized in a method of craft production for bone tools. Therefore, not worked element and fragments could still have been modified for the purpose of food production. The analysis surrounding the presence of subsistence within the J-2 assemblage lies beyond the scope of this paper and should be looked at in a later study.

There were 12 different tool types present in the faunal material of the J-2 deposit. However, only two categories consisted of 100 tools or more. These two highest categories are needle (138) and perforator (276) (see Table 7). Understanding the tool types within the assemblage allows for analysts to understand what the J-2 Maya craft producers were making. Thus far within the J-2 assemblage it seems that Maya craft producers in an elite occupied location were primarily concerned with making utilitarian type tools like perforators but simultaneously still produced ornamented tools. The multi-faceted production of tool types in an elite level location supports craft producer's operating in a non-dichotomized manner for both attached or independent specialization (Emery and Aoyama 2007).

Table 7. Numbered of Worked Tools. A table showing the 12 different categories found in the worked and unworked category and their numeric values.

Worked Bone Categories	Total
Carved Bone	1
Flute	1
Handle	1
Pendant	1
Ornament	2
Bead	5
Ring	6
Pin	7
Spatulate	7
Awl	10
Needle	138
Perforator	276
Total	455

Bone working Techniques

In turn, the three most prominent of bone working techniques identified are longitudinal sawing (120), groove and splinter longitudinally (115), and saw and snap (335) (See Table 9). A total of 1,319 (19.9%) different faunal fragments exhibited singular to multiple bone working techniques within the total assemblage. Out of the 2,048 animal fragments identified, 1,319 worked skeletal elements have bone working techniques present (64.4% of the worked). Out of the 1,319 skeletal fragments, 181 fragments showed that multiple bone working techniques were used in the creation of different tools.

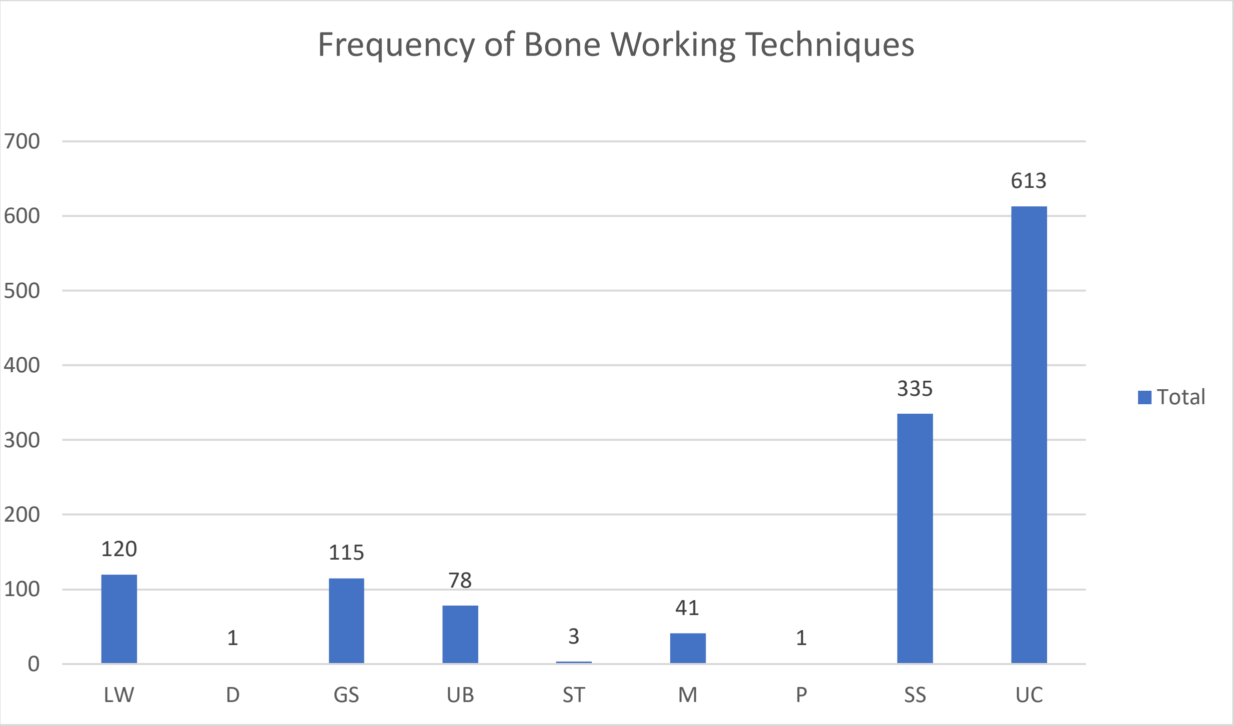

Figure 9. A bar chart demonstrating the frequency of different bone working techniques present within the worked portion of J-2's assemblage. GS (groove and splinter longitudinally), LW (longitudinal sawing), SS (saw and snap), ST (string-cutting), D (drilling), I (incising), UC (unidentified cutting), P (pecking), UB (unidentified break).

Assemblage Cutmarks

In conjunction with identifying the different bone working techniques used, focus is also given to the proliferation of different cutmarks present throughout the assemblage. The cutmarks were present in both vertical and horizontal orientation and differentiated between cutmark or grooves based on the depth of the striation. Some horizontal and vertical cutmarks, however, are byproducts of early stage production created when the craft producer initial established the cutting area. Skeletal elements with more than one or two cutmarks are interpreted as a byproduct of early stage production. The cutmarks ranged from only one type present up to all four identifiable cutmarks being present. However, within the J-2 assemblage, the most common cutmarks present were the single categories of horizontal and longitudinal cutmarks (see Figure 10). Meanwhile, combinations of three and four different categorical cutmarks were least prevalent within the J-2 assemblage. The total assortment of different cutmarks equals 989 (14.9% of total assemblage; 48.3% of worked). Greater identification of cutting techniques and cutmarks in the analyzed J-2 assemblage is unlikely as from stage three onward fragmentation reduces signs of cutmarks and cutting techniques. The type and prevalence of cutmarks is indicative that craft producers utilized chert tools rather than a string and abrasion method.

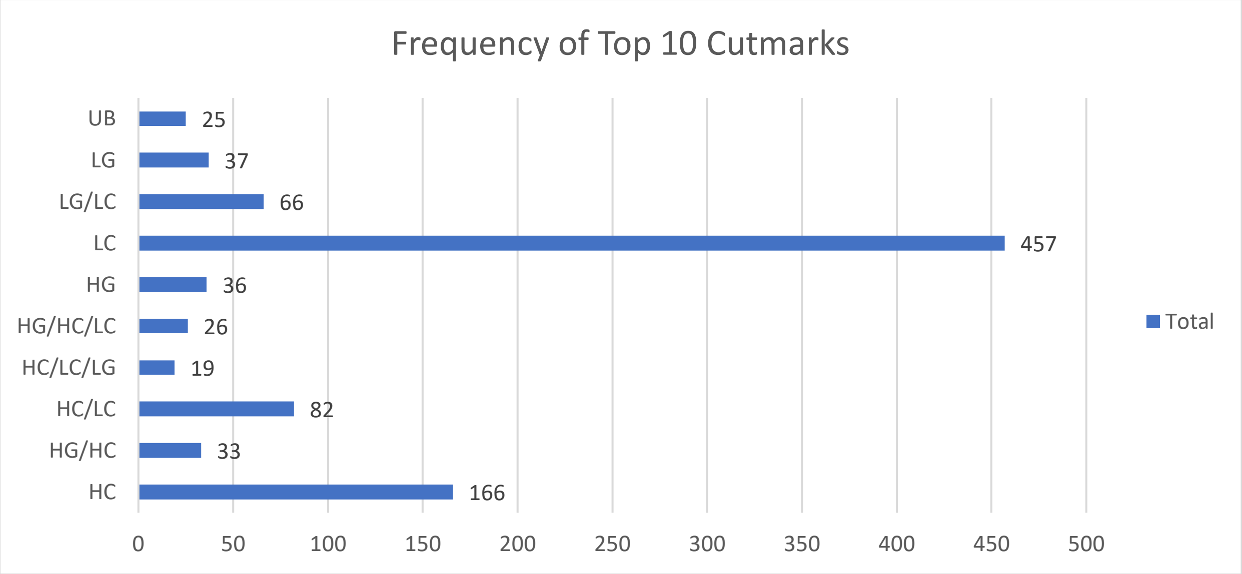

Figure 10. The numeric frequency of the different cutmarks employed by Maya craft producers in J-2 assemblage. HC (horizontal cutmarks), LC (longitudinal cutmarks), HG (horizontal groove), LG (longitudinal groove).

Lens of Interpretation

The Ucanal deposit suggests a preference for the use of large mammals, which accounts for 71% of the identified assemblage, and more specifically white-tailed deer. This choice is also seen in the worked bone assemblages from Tikal, Dos Pilas, and Aguateca. The preference for medium to large mammals within worked faunal assemblages at different sites across the Maya region is one line of evidence of a standardized production method (Emery 2008, 2012; Inomata 2001, 2007; Moholy-Nagy 1997).

Ucanal toolmakers also focused on specific elements of deer and other large mammals, especially limbs, and more specifically metapodial, femur, and tibia bones. This meets the criteria as a second form of standarrization. These categories and skeletal element high frequencies are common in Maya production of bone tools and in faunal assemblage as these skeletal elements were identified as having a high prevalence and high utilization by Emery at Dos Pilas with the L4-3 consisting of 88 femurs, 206 tibias, and 166 metapodials (Emery 2008:211, 2009:462). Furthermore, long bones are present in higher concentrations in assemblages at the sites of Aguateca and Tikal and were used to craft perforators (Emery and Aoyama 2007; Moholy-Nagy 2002, 2004).

The J-2 assemblage's low frequency of different taphonomic damage is consistent except for recent breaks. The designation of recent breaks is present in 23.9% of the assemblage and as briefly stated above happened via post depositional forces. Other taphonomic damage associated with natural elements such as exposure, water, or other damage is present on 50 or fewer skeletal elements within each different category. Furthermore, the J-2 deposit levels were separated at times by plaster floor surfaces that capped the deposit and protected it against post-depositional taphonomic disturbances and damages.

Two main types of tools, perforators and needles, produced from the Group J Late Classic faunal remains are present in frequencies higher than 100 specimens. The lack of diversity in artifacts also is indicative of specialization of specific artifacts like perforators, with the other artifacts acting as a secondary priority (Emery and Aoyama 2007; Emery 2008). In further discussion worked elements were predominantly in end stage production. When identifying the type and combination of bone working techniques within the J-2 assemblage the greatest frequency in cutting techniques is the saw and snap method, which matches the findings of Emery (2008, 2009) in the Dos Pilas L4-3 assemblage. In these findings it becomes visible that the craft producer's, during the formation of this midden, were creating tools of a pragmatic nature and doing so in a standardized manner. The predominance of end stage production elements is representative of a large number of completed tools left by experienced specialists.

The cutmark combinations range from one to all four being present. Yet, the most common frequency of cutmarks are just a single or dual identification of cutmark categories. This is because the thin horizontal and longitudinal cutmarks are the byproducts of the utilized cutting techniques. The proliferation of cutmarks on some worked skeletal elements are indicative of 3-5 quicks cuts made before the actual cutting starts in the early stages of bone tool production. The reduction to only one or two cutmarks present within the J-2 faunal component is indicative of having a higher frequency of end stage production, whereas the modified faunal element loses excess modification marks as it progresses to a fully formed bone tool at the end reduction hierarchy. Yet, in beginning stage production, specifically when applying longitudinal grooving or the horizontal saw and snap the 3-5 quick cuts surrounding the successful cut are more prominent. Understanding the frequency of successful cutmarks and the presence of the surrounding unsuccessful cutmarks is one approach to identifying beginning or end stage production present within the J-2 assemblage.

In the J-2 assemblage, all five stages of the reduction hierarchy are present and over half of the bone identified as worked were categorized into the five stages. However, there were almost no finished products, and the fifth stage (finishing) is the third highest stage present, ranking higher than both the first and second reduction stages (Emery 2008). Specifically, with the second of the first two stages being the larger, the fifth reduction stage remains larger still by 98 skeletal fragments. One explanation for the higher identification for the third and fourth stages within the J-2 assemblage is that in the crafting of these tools, it is the third and fourth when working that have the potential to produce multiple worked pieces from a singular element or produce the most debitage when moving through those third and fourth stages (Moholy-Nagy 1994,1997).

The faunal assemblage from the J-2 deposit is located outside and south of the J-2 structure platform, being separated from the structure by one lot that was previously excavated (Perea and Dubois-Francoeur 2019). Additionally, the J-2 midden typology exhibit's signs of long use during the Late Classic and the Terminal Classic period with a minimum of four major construction episodes throughout the two periods (Perea and Dubois-Francoeur 2019). Prior excavation of the J-2 structure uncovered worked human and animal bones. In addition, excavation of the J-2 structure dated to the Late and Terminal Classic leads to the interpretation of having residential use from the refuse found in and around the structures edge. Knowing the composition and location of the midden in relation to the surrounding area allows for an interpretation of midden typology. The identification and contextualization of middens is complex, and the J-2 assemblage is no different. It represents a secondary midden that combines some domestic refuse with bone working debitage (Freiwald et al. in revision). The lack of taphonomic damage shows it was covered quickly with scavengers having little access to it so can provide information on bone working and the people who crafted the bone products.

Ucanal bone production in a regional context

The Ucanal bone tool production deposit is similar to other deposits in the Maya region. The same production sequence was used at multiple sites, with a focus on the same repeated use of white-tailed deer, the same types of tools, and the repeated choice of bone elements. The Ucanal deposit and other production areas across the Maya region did not always share the same time period. As a result, the different production areas were separated by both kilometers and generations of people. For example, Aguateca's comparative production area is dated to the Late Classic, while the L4-3 deposit of Dos Pilas is dated to the Terminal Classic. Therefore, the consistent preference is shown for raw material, skeletal elements, and the ability to utilize a similar reduction method across time and space of the Maya region is supportive for broad standardization of Maya bone tool production. These consistent different preferences are discussed in-depth below.

First, within the J-2 assemblage there are similar trends in the preferred used of species and skeletal elements like the *O. virginianus* (white-tailed deer) and femur, tibia, and metapodial bones (Emery 2008, Emery and Aoyama 2007, Moholy-Nagy 2004). The identification of these preferences across the Maya region and different temporal periods provides strong zooarchaeological support for Maya craft producers having standardized choice of raw material when producing bone tools. The identified preference of skeletal elements and higher utilization of certain species is a result of both convenience and specialization on part of the craft producers. The Maya favored white-tailed deer for consumption from the Preclassic period through the Terminal Classic and would utilize all portions of the animal throughout the different stages of use (Emery 2003, 2010). Furthermore, the white-tailed deer is traditionally the largest mammal that is commonly hunted as its counterpart in size, the tapir, is not often found. The partiality of different species within a society and crafting of resources is a complex issue.

The choice of utilization can range from convenience, symbolism associated with the different species, and/or hunting rights/practices of individuals across different socioeconomic status. Within the J-2 assemblage analysts see the continued trend for preferring white-tailed deer and other medium to large mammals. The preferential use of metapodials, femora, and tibiae in bone tool production is indicative of the ongoing crafting of bone across the different temporal periods. Consequently, resulting in a standardized production by knowing which bones are best to be worked and which skeletal elements were to be utilized in the crafting of different bone tool types. The preference in species and skeletal elements are present at Dos Pilas, Tikal, and Aguateca (Emery and Aoyama 2007; Emery 2008; Moly-Nagy 2004) and provide an important line of evidence for possible standardization of craft producers in the accumulation of the J-2 assemblage.

The J-2 assemblage also shares similarities with other worked bone assemblages in the cutting techniques employed. Lithic cutting techniques were used within the assemblage with limited evidence of string abrasion (Emery and Inomata 2007; Emery 2008), even as experimental archaeological studies are not common in Maya zooarchaeology. Additionally, like with the Dos Pilas L4-3, the J-2 assemblage, the most identified cutting technique is the saw and snap method which is identified 335 times (Emery 2008). Though both the groove and splinter (115) and longitudinal sawing (120) were both present in numeric frequencies over 100, yet it is clear from numeric frequencies that the saw and snap method is the preference for the J-2 assemblage. This saw and snap preference is likely the result of either the preferred technique of the craft producers or the preferred cutting technique for majority of tools produced. Regardless, the J-2 assemblage, when viewed in conjunction with consistent use of the reduction hierarchy, represents a decidedly standardized and overall efficient method of producing bone tools.

The utilization of this typology resulted in over half of the identified worked skeletal elements assessed to fitting into the one of the five reduction categories the J-2 assemblage. The bone production method defined by Emery (2008, 2010) was used by crafters at Ucanal, as well as the sites of Dos Pilas, Aguateca, and likely other sites across the Classic period Maya region.

This starts to provide a significant insight to standardized bone tool production in the Maya region as different cultures around the globe use different production technique and tools, leading to different taphonomic markers present along the bone.

Within the broad interpretation of the reduction hierarchy, there must be an interpretation of the frequency within each reduction stage. The first two stages were least frequently identified within the J-2 assemblage whereas an initial hypothesis considered the first stages to be possibly be the most frequent. However, as at Tikal, the interpretation of crafting being spatially flexible, and at Aguateca, identification that a minimum of the first linear reduction being done by craft producers of multiple specializations it is possible that the bulk of these initial reductions were perhaps disposed of outside of the J-2 assemblage (Emery and Aoyama 2007; Moholy-Nagy 1997). The higher prevalence of the third and fourth stages is, at first, surprising but further research and reflection leads to the interpreting this result in different ways. As a result, these stages and the debitage they produced were crafted in one space and later disposed of in another would result in these higher frequencies. Another interpretation is that the third and fourth stage production results in more associated debitage, and tools that come from a single bone which can be still identifiable within these reduction stages. Finally, the large numbers of fifth stage reduction hierarchy, which is not dissimilar to L4-3 at Dos Pilas, is interpreted in two ways. First, nearly finished bone tools broke or were damaged during this final stage. Second, multiple crafters were working in the same production areas, and like at Aguateca, had differing levels of experience in multiple craft specializations.

The location of the deposit associated with elite structures suggest that the elite were the crafters of the Ucanal J-2 assemblage. The overall lack of taphonomic damage suggests that the deposit was not accessed by animals such as dogs, was not exposed to the elements, and was buried shortly after being worked. Group J consists of large platforms and structures which are indicative of elite activities and occupation. This combination could in turn provide significant protection from the elements and in a high traffic area which had consistent lower taphonomic damage from occurring in from the weather or ground. Other comparative assemblages from Dos Pilas and Aguateca were within actual residential households, and not just near platforms and structures (Emery 2008, Emery 2009, Inomata 2001, Inomata 2007). Consequently, the finding of the worked resource material around and within elite structures support the elite as crafters of the J-2 assemblage.

With this new understanding of the J-2 faunal component, and information of other worked faunal assemblages in the region, interpretation turns to broader concepts tied to J-2's composition. Broader interpretation of the faunal component from the diversity of tools with their numeric frequency is indicative of these same elite crafters operating in a non-dichotomized manner via working in both an independent and attached framework (Emery and Inomata 2007). This flexibility to operate in both an attached and independent rather than just a single framework is known as non-dichotomized framework. The same producer operating in a independent and attached manner is first interpreted at Aguateca where the Pompeii-esque abandonment showed that elite crafters produced utilitarian items like perforators alongside elite luxury goods. This same mixture of tools and goods can be seen within J-2 faunal component as the largest tool categories belonging to different type of utilitarian perforators and other arguably less utilitarian tools like rings, flutes, or pendants, but on a much smaller scale (Inomata 2001; Emery and Aoyama 2007; Inomata and Emery 2014:128).

Additionally, while falling outside the scope of this paper, there are two other elements of the J-2 assemblage and the surrounding area which I argue further support this non-dichotomized framework of J-2 crafters operating in independent and attached manner in this assemblage. First, the J-2 assemblage had over 1,500 human bones, both worked and unworked skeletal elements, which is significant when considered alongside excavations at Dos Pilas that only recovered 30 cranial fragments maximum. Finally, the J-2 faunal component when compared to the Tikal assemblage and interpretation seems indicative that Maya crafting is spatially flexible with different debitage being removed for disposal and as such any accumulation of debitage from crafting is accumulated it is most likely secondary in nature (Moholy-Nagy 1994,1997, 2004). The J-2 faunal component as a secondary accumulation is further highlighted from current research that the structures in the J Platform and near J-2 were almost certainly occupied by the elite at the time (Halperin et al. 2019). The comparative lenses of the three studies provide direct evidence for Maya elite crafting within or around houses.

The Late Classic worked bone assemblage in Ucanal's Group J shared characteristics with those reported from other sites. First, is the preference of predominantly white-tailed deer and other medium to large mammals when crafting bone tools. Second, is that sturdy long bones of metapodials, femora, and tibiae were preferred in crafting of most bone tools. Third, is a continue shared similarity in preferred cutting techniques of saw and snap method. Next, analysis found a preference for predominantly single type horizontal and vertical cuts.

Further, different stages of these worked skeletal elements classified using Emery's five-stage reduction hierarchy showed more end stage production than initial production stages. The preference in raw material and use of a similar reduction hierarchy at different worked production sites and time periods across the Maya region represents, from a zooarchaeological perspective, a highly standardized and efficient means of bone tool production.

The fit of Emery's reduction hierarchy with the Ucanal faunal assemblage supports its continued use across the Maya region regardless of time period, and perhaps utilization even beyond the Maya region with further testing and cross analysis of faunal assemblages produced by other craft producers in different regions.

Building on the zooarchaeological analysis of this assemblage, current literature, and other comparative worked faunal assemblages' analysts sought to provide information on the secondary focus of craft producer's identity and assemblage accumulation. Current analysis of the faunal information lends interpretation to the J-2 assemblage craft producers is identified as most likely belonging to the elite socioeconomic class. These elite crafters operated in a non-dichotomized manner of existing in both an independent and attached framework (Emery and Aoyama 2007). This led to the simultaneous production of utilitarian objects and commissioned luxury goods in relatively low volume. The knowledge of Maya crafting within residences and structures and Maya crafting being spatially flexible supports that the J-2 assemblage's accumulation as secondary in nature with the primary area of craft production being north of Operation 1B of the J-2 assemblage. The primary area of production is best identified as being within the J-2 structure, or on the outside of the southern wall. I argue that further faunal analysis without the constraints as well as analysis of other pertinent lines of evidence would lead to greater support of any conclusions reached within this thesis's primary zooarchaeological focus and the secondary focus surrounding the craft producer identity.

Summary

Analysis of faunal material found this excavated portion of the J-2 assemblage is composed of predominantly medium to large mammals, with special preference of white-tailed deer. The quantification of the analysis also provides support for these Maya craft producers' favoring specific long bones within this deposit for the bone tools being crafted within this deposit. Apart from recent breaks, there was minimal taphonomic damage present which suggests that this portion of the deposit was buried quickly. Analysis of cutting techniques found that saw and snap technique, while not the only technique utilized, is utilized the most within the analyzed material. The predominant cutmarks present on the worked bones were horizontal and longitudinal cutmarks. Application of the reduction hierarchy to this portion of the J-2 assemblage found that the bulk of the worked material is representative of end-stage production. The bulk of the tools which could be identified are perforators and needles. Between the deposit's location in an elite occupied area and the type of tools and goods identified in the assemblage it probable that the producers were Maya elites. However, there are little to no finished tools present which means the finished bone tools were taken and utilized elsewhere. The elite crafters could have been making these fabrics, or textile, production tools perhaps as a way to increase their own status or operating as independent crafters meeting a need for Ucanal's textile industry, or one at another site. However, further excavation and analysis will need to occur at both the J-2 assemblage area and the site as a whole.

CHAPTER 5: CONCLUSION

This thesis provides a greater understanding of the Maya bone tool production at Ucanal during the Late Classic Period through analysis of the J-2 deposit located within the J Platform area. Within this primary focus of zooarchaeological analysis, the data demonstrates that the ancient Maya did have a highly efficient and standardized method of crafting bone tools. Statistical analysis revealed that while there are likely multiple different cutmarks are necessary for crafting purposes, the J-2 assemblage had high frequencies of singular horizontal and longitudinal cutmarks identified as different parts of the production process as end-stage production.

Standardization of production is present in the identification of cutting techniques utilized. The highest numeric frequency is the saw-and-snap method, which further demonstrates the standardization of bone tool crafting as saw and snap is also the highest identified cutting technique at Dos Pilas. The final finding that supports a standardized method in craft production of bone tools at the site of Ucanal in the Late Classic period is the repeated application of Emery's (2008, 2012) reduction hierarchy within the J-2 assemblage for over 50% of the worked skeletal elements. Further utilization of this reduction hierarchy is present at the comparative sites of Dos Pilas and Aguateca. The findings of the J-2 faunal component and surrounding region support the Maya using an efficient and highly standardized production method across different periods and largely unchanged regardless of socioeconomic status.

The J-2 faunal component production of tools is more pragmatic than cultural meaning (Emery and Inomata 2007; Moholy-Nagy 2004). The high frequency and repeated utilization of medium to large mammals, at least for utilitarian crafting purposes, demonstrate being chosen due to the size and composition of those bones. The uncovered tools within the assemblage meet the criteria as utilitarian or ornamental/ceremonial from how simple or complex the tool design is, or the nature of the tool itself. (Emery and Inomata 2007; Moholy-Nagy 2004) Relationships which were largely pragmatic rather than overt in cultural significance in the choice of skeletal elements used (Emery 2008). The sturdy, long bones of medium to large mammals are chosen in high volume for craft production of most bone tools due to the size, sturdiness, and composition (Emery 2008, 2009). Consequently, there seemingly are relationships between the different variables of tool types, skeletal elements, and species/categories for the faunal component within the J-2 assemblage; however, the relationships largely seem pragmatic rather than cultural significant as initially hypothesized.

The faunal component's findings within the J-2 assemblage start to allow a possible understanding of the Maya craft producers involved in the accumulation of the J-2 assemblage. The ability to overlay our current typology of reduction hierarchy over the different stages of Maya bone tool production and consistent choice of raw material is indicative of craft producers being specialists in bone tool production. The assemblage was primarily dated to the Late Classic, the period before a large cultural restructuring occurred, and located within an elite utilized area. These different aspects of consistent choice of raw material, elite occupied location, high frequency of end-stage production, varied tool types present, and repeated choice of saw and snap method support that the J-2 faunal craft producers were most likely elites and possibly part-time specialists due to the station of society they occupied (Emery and Aoyama 2007).

The interpretation that the J-2 assemblage results from elite craft producers with the presence of both utilitarian and ceremonial bone tools such as the creation of perforators, rings, beads, needles, ornaments, pendants, and others indicate flexibility in what the crafters could produce. These craft producers likely operating in both an attached and independent manner like seen at the similar assemblage of the Aguateca in the Classic Period. Current literature, except for unique rapid abandonment of the assemblage at Aguateca, supports the secondary accumulation of the crafting debitage where the crafting took place nearby the final gathering of debitage. Therefore, the faunal component craft producer is most likely produced this debitage near the actual J-2 accumulation before depositing in the excavation area of the midden (Moholy-Nagy 1994,1997).

Despite this intensive look into the faunal component and to an extent the broader J-2 assemblage, there is still further work and analysis which needs to occur. In the faunal component of the J-2 assemblage, there are three next steps which need to occur. First, a continued excavation of the J-2 assemblage to further gather any faunal elements still present in situ will provide a greater understanding regarding the volume of craft production within the J-2 assemblage when compared to other significant assemblages within the Maya region. Second, further work for the J-2 faunal component includes comparing target areas where bone production might have occurred versus the middens at Ucanal.

Further excavation and analysis will continue to support the trends of data discussed in the assemblage's characterization through greater identification. Outside the faunal component, there are several lines of evidence in the J-2 assemblage which need analysis. One aspect which is in the process of being understood is the human bone component of the J-2 assemblage, within this one deposit, there was an exponentially higher amount of human bone than excavated at the entire site of Dos Pilas. Of these excavated human bones, a significant number showed signs of being worked. Analysis of human bones and their modification within J-2 assemblage holds importance by themselves and by providing any similarities or differences between the modified faunal component (see analyst Dubois-Francoeur ongoing work). The other lines of evidence prevalent to the J-2 assemblage include analysis of the lithics and charcoal present within the assemblage and attempt to determine the relation, if any, to the fauna or human skeletal elements.

The current analysis, and the further work discussed above, have broader implications than just providing information for a single assemblage at a single site. This site provides evidence for the efficient and standardized Maya bone tool production being highly efficient and standardized in different regions of the Maya world. Additionally, Dr. Emery's five-stage reduction hierarchy has been applied in different time periods across the region and worked faunal assemblages of this proportion are still unique in being uncovered. Therefore, these types of worked assemblages continue to provide information on Maya's bone working and tool production and lay the foundation of broader information on the craft production of the Maya. Further than craft production, however, this assemblage and others can start to understand better the role of the Maya craft producers in the Maya culture across different socioeconomic spheres.

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