

A Bone Grease Processing Station at the Mitchell Prehistoric Indian Village: Archaeological
Evidence for the Exploitation of Bone Fats

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Abstract

Recent excavations at the Mitchell Prehistoric Indian Village, an Initial Middle Missouri site in Mitchell, South Dakota have revealed a large, clay lined feature filled with fractured and fragmented bison bones. Fracture and fragmentation analysis, along with taphonomic evidence, suggests that the bones preserved within the feature represent evidence of prehistoric bone marrow and bone grease exploitation. Further, the character of the feature suggests that it served as a bone grease processing station. Bone fat exploitation is an activity that is frequently cited as a causal explanation for the nature of many fractured and fragmented bone assemblages in prehistory, and zooarchaeological assemblages have frequently been studied as evidence of bone fat exploitation. The Mitchell example provides some of the first direct, in situ archaeological evidence of a bone grease processing feature, and this interpretation is sustained by substantial analytical evidence suggesting bone fat exploitation. This new evidence provides a clearer concept of the nature of bone fat exploitation in prehistory as well as an indication of the scale and degree to which bone grease exploitation occurred at the Mitchell site. Finally, this research demonstrates the importance of careful zooarchaeological and taphonomic analysis for the interpretation of both artifactual remains as well as archaeological features.

Keywords: Zooarchaeology, Bone Fats, Bone Marrow, Bone Grease, Subsistence, Bone Fracture, Fragmentation, Fracture and Fragmentation Analysis.

1. Introduction

Bone fat exploitation has been frequently cited as a common activity among prehistoric human groups in many parts of the world (Binford 1978; Karr *et al.* 2010; Leechman 1951; Munro and Bar-Oz 2003; Outram 1998, 2001; Speth and Spielmann 1983; Vehik 1977; and others). The nutritional importance of fat resources is indubitable, and has served as a means for understanding human subsistence practices in many parts of the world (Binford 1978; Erasmus 1986; Mead *et al.* 1986; Outram 1998, 2001, 2002, 2003; and others). Studies of bone fat exploitation rely on the ability of scholars to identify the activities involved in extracting fats from bones, the utilization those fats, and the archaeological evidence that results from bone fat exploitation.

Often, the identification of bone fat exploitation has relied on the interpretation of bone fragments alone, and a variety of methods have been developed for the identification of bone fat exploitation activities in the archaeological record (see Lyman 1994; Outram 1998, 2001 for treatments of these methods). This article describes an intact feature from the Mitchell Prehistoric Indian Village in Mitchell, South Dakota (USA). The feature is interpreted as a station for processing bones and extracting bone fats. The feature contained significant quantities of fractured and fragmented bones, which have been intensively analyzed to elucidate the economic activities of the prehistoric inhabitants of the site. This analysis provides direct evidence for the association of the fractured and fragmented bones with the feature in which they were discovered.

2. Bone Fats

The significance of bone fat exploitation to the global archaeological record cannot be overstated. Early bone fat exploitation effected profound impacts on the development of genus *Homo* (Ben-Dor *et al.* 2011; Lupo 2012) and may have also been practiced by earlier hominids (Braun *et al.* 2010). Around the world, the quest for bone fats drove human behaviors and subsistence practices throughout prehistory. Hunters and gatherers around the world practiced bone fat exploitation to support their diets, a practice which persists among ethnographically observed hunting and gathering peoples (e.g. Leechman 1951; Yellen 1991).

The exploitation of bone fats played a significant role in the nutritional subsistence of prehistoric human groups on the North American Plains (Brink 1997, 2008; Karr *et al.* 2008, 2010; Leechman 1951; Vehik 1977). Both ethnographic and archaeological evidence demonstrate the significance of bone fats to a variety of human groups, not only on the North American Plains, but also around the world (Binford 1978; Blumenschine and Madrigal 1993; Jones and Metcalf 1988; Marshall and Pilgram 1991; Munro and Bar-Oz 2005; Outram 1998, 2001; and many others)

In prehistory, fat was highly valued for its exceptional nutritional attributes. Fats contain a greater dietary potential than both carbohydrates and proteins (Erasmus 1986; Mead *et al.* 1986; Outram 2002; Speth and Spielmann 1983), and prehistoric peoples made use of fats as a primary mechanism for subsistence. Some of this fat was derived from meat and skins from carcasses, while other fats could be derived from bone marrow and bone grease.

On the Plains, archaeological and ethnographic evidence suggest bone fat exploitation activities beginning thousands of years ago, and continuing into the Contact period (Brink 2008; Karr *et al.* 2010; Leechman 1951, 1954; Quigg 1998; Reeves 1990; Stefansson 1956; Vehik 1977; Wheat 1972). During the Contact period, early explorers to the Northern Plains noted the use of bone fats among a variety of groups, including groups closely related to those who occupied the Mitchell site centuries before (Culbertson 1952; Dorsey 1884; Leechman 1954; Stefansson 1956; Wilson 1924; Winship 1896).

High levels of fracture and fragmentation have often been considered evidence for bone marrow and bone grease exploitation activities (Church and Lyman 2003; Munro and Bar-Oz 2005; Outram 1998, 2001; Vehik 1977). Many natural taphonomic processes, however, are also capable of breaking bones, meaning that bone fracture alone is not an adequate indicator of cultural activities. The size of bone fragments has also been considered an indicator that might suggest bone fat exploitation activities (Richardson 1980; Schick *et al.* 1989). The size of bone fragments (that is, a product of the intensity with which they are fragmented) does not necessarily suggest the involvement of *cultural* agencies. Instead, considering the processes that led to the fracture and fragmentation of bone elements, as well as the degree to which they are fractured and fragmented, allows for the most accurate assessment of zooarchaeological assemblages. Forms of evidence such as

bone fracture morphologies indicative of bones broken when they are fresh, dynamic impact scars, rebound scars, and differential patterns of bone element selection for higher quality fats are all indicators of cultural activity that may be directed toward the exploitation of bone fats (Karr *et al.* 2008, 2010; Outram 1998, 2001). Understanding these processes that fracture and fragment bones, and the nature of broken bone evidence that is preserved in the archaeological record, provides a means by which to assess the events, behaviors, and practices of the prehistoric past. This is especially true at prehistoric sites where the passage of centuries (or millennia) provides the opportunity for natural taphonomic processes to detrimentally affect zooarchaeological assemblages. The Mitchell Prehistoric Indian Village represents one such site.

3. The Mitchell Prehistoric Indian Village

The Mitchell Prehistoric Indian Village is an Initial Middle Missouri (IMM) village site located in the James River valley of southeastern South Dakota (Alex 1973, 1981; Karr *et al.* 2011; Meleen 1938). The villages of the Middle Missouri complex were home to sedentary hunting-foraging horticultural peoples, largely between A.D. 1050 and A.D. 1200 (Alex 1981; Johnson 2007; Tiffany 1982, 2007). These groups resided in villages of semisubterranean earthen lodges, typically located on prominent, partially enclosed hilltop locations above streams, creeks, and rivers. IMM villages occur in two principal concentrations: 1) along the main stem of the Missouri River and major tributaries in central South Dakota, and 2) along the Little Sioux River, lower Big Sioux River, and ancillary drainages in Northwest Iowa. A smaller number of IMM sites are located along the drainages of the James River in southeastern South Dakota (Figure 1). Archaeological evidence from IMM sites commonly includes large quantities of bones, principally from bison, along with evidence of extensive ceramic and lithic industries, large numbers of freshwater mussel shells, and groundstone tools (Alex 1981; Jeffra and Karr 2013; Karr *et al.* 2010, 2011; Lehmer 1971; Tiffany 1982, 2007).

The IMM complex represents the emergence of widespread horticultural sedentism from earlier Woodland lifeways. The Middle Missouri region in the 12th century A.D. bore witness to the rapid rise of numerous villages like the Mitchell site. These villages relied

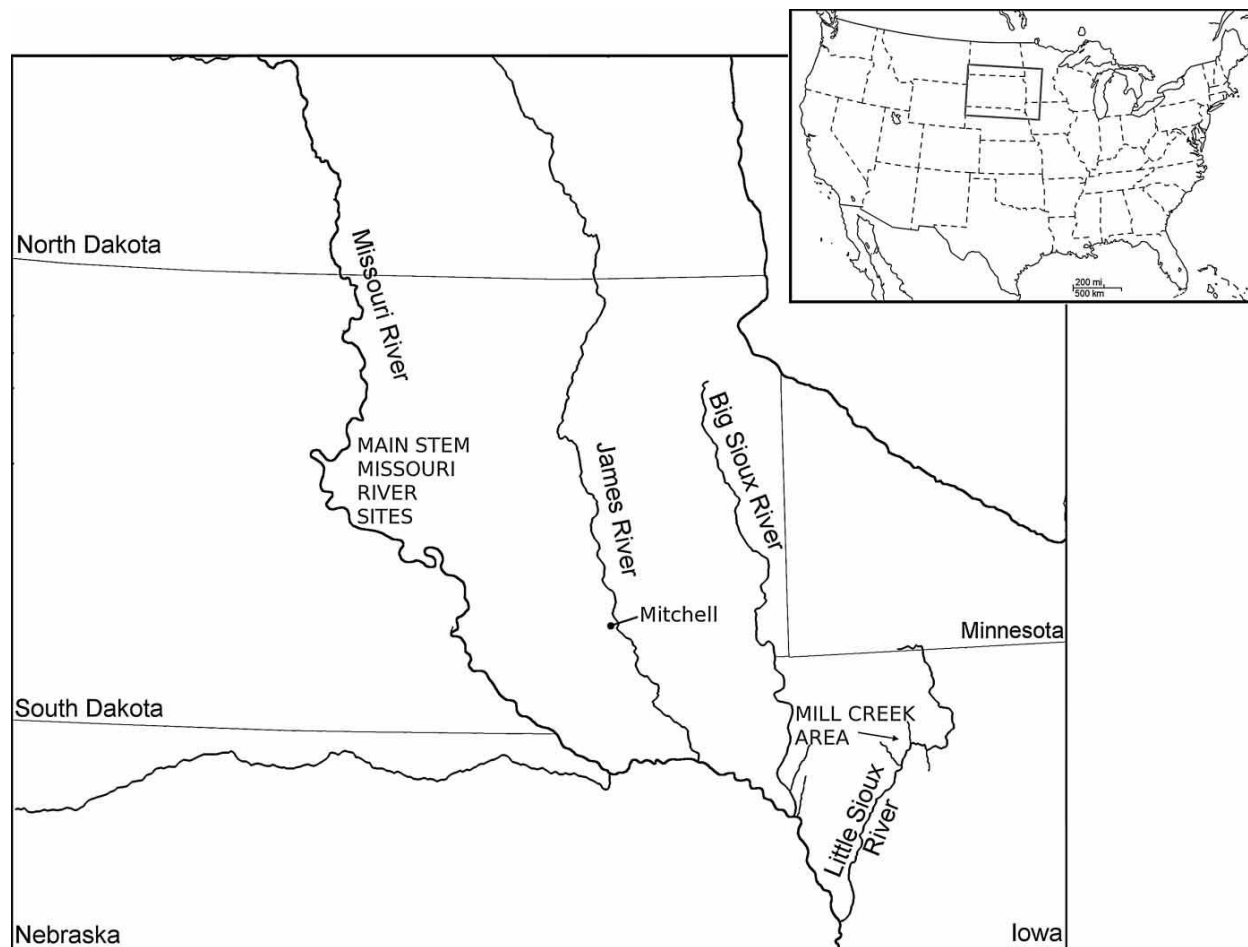


Figure 1 Map of the Middle Missouri region, indicating the location of the Mitchell site and other concentrations of IMM sites discussed in the text.

heavily on both hunting and foraging lifeways, as well as on the practice of horticultural sedentism. Direct archaeological evidence (seeds, charred corn cobs, etc.) and material cultural evidence (manos and metates, extensive ceramic industries, etc.) suggest the rise of significant levels of agricultural production at this time, however, hunting and foraging persisted through the IMM period as activities critical to the survival and subsistence of human groups in the region. Extensive midden deposits across the Mitchell site (and other IMM village sites) contain large numbers of animal bones, often in association with projectile points. This suggests that local animals were hunted and transported to back to the village, where the hides, horns, meats, fats, and bones were utilized for a variety of purposes.

Though many of these organic materials do not survive in the archaeological record, the Mitchell site and other IMM sites in the region preserve large quantities of fractured and fragmented bison bones that bear testament to the activities of the past. These large assemblages of fractured and fragmented bones are likely the product of extensive bone marrow and bone grease exploitation at the Mitchell site (Karr *et al.* 2008, 2010, 2011). Previous studies at the Mitchell site have relied on generalized samples of fragmented bone material derived from the large midden accumulations at the Mitchell site. While these large, complex midden deposits are common components at IMM sites (especially Eastern IMM sites), they represent a palimpsest of artifactual evidence that derives from a variety of different cultural events over an extended period of time. Beneath these complex, possibly disturbed midden deposits, however, intact occupational surfaces and features remain relatively undisturbed at the Mitchell site. The recent discovery of a discreet feature at the Mitchell site that contained a large quantity of heavily fractured and fragmented bones provides an opportunity to analyze and interpret the contents and function of a single feature, and to demonstrate the utility of analytical approaches for reconstructing and quantifying the events of the past.

4. A Bone Grease Processing Station

Open-area excavations within an enclosed, indoor excavation facility at the Mitchell site have revealed the presence of a large feature interpreted as a bone grease processing station (Figure 2 is a plan of the feature and Figure 3 is an artistic interpretation of its prospective use). This feature measures 2.56 m by 1.66 m, and can be characterized as a clay-lined basin about 0.21 m deep which is adjacent to a relatively flat clay-lined surface. Resting within the basin and on the adjacent flat surface, large quantities of highly fractured and fragmented bones were present. In total, this bone accumulation produced 21 kg of bones, along with smaller quantities of ceramic sherds, largely intact shells, lithic debitage, fire-cracked rock, and charcoal. Several bone tools were also found among the bone fragments in the feature. The basin shaped portion of the feature was excavated and recorded as Feature 290, while the adjacent flat surface portion was excavated and recorded as Feature 287. Collectively, these two features were later named Feature 320.

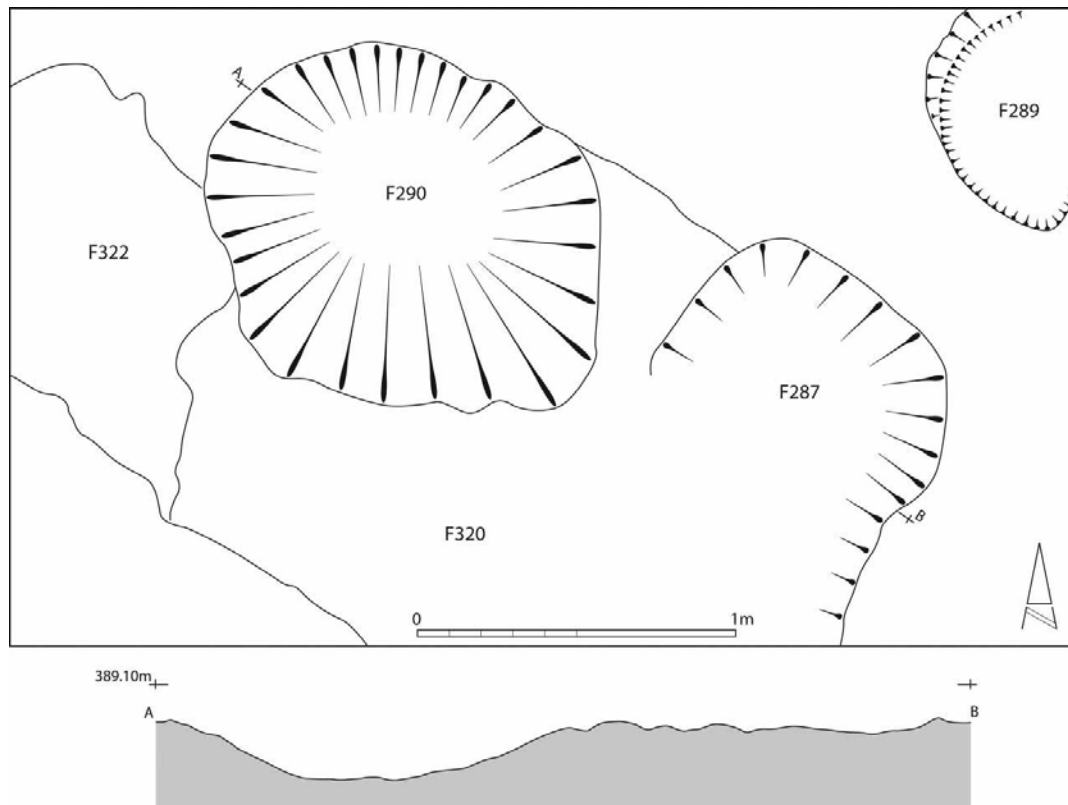


Figure 2 Plan and profile of Feature 320 (Features 287 and 290, together).



Figure 3 Artistic interpretation depicting the interpreted use of a bone grease processing feature.

The shape and contents of the feature lend themselves to the interpretation of their potential significance. The clay-lined basin may have served as a lined pit suitable for rendering fat from the large quantities of bone fragments found within the feature. This may have occurred by any of a number of means. The artistic interpretation depicted in Figure 3 suggests that this may have occurred through the use of a hot-rock boiling technique. Though no surviving archaeological evidence suggests the presence of logs or other structures for supporting a hide lining within the pit, the interpretive drawing depicts the basic method by which we believe bone fat exploitation occurred at the Mitchell site. Hot-rock boiling was likely a component of the process, though only a small quantity of fire cracked rock was discovered within the feature. Certainly, water may have been boiled above fires in some of the many ceramic vessels known at the Mitchell site, and poured into the clay-lined or hide-lined pit in order to render fat from the bones. Other methods utilizing hide bags may have similarly been employed. The flat clay-lined surface adjacent to the pit may have been used as a processing area for the purpose of fracturing and fragmenting the bones. This area is clearly delimited by the presence of distinct clay lining which in places exhibits a lip that is slightly raised from the elevation of the otherwise flat surface.

While certain organic component parts of the material culture that surrounded bone fat exploitation are absent from the archaeological record, the process of extracting bone fats remains relatively clear. First, selected bone elements (likely long bones) from animals that had recently been killed were likely broken open using a simple hammerstone-and-anvil approach. Bone marrow from within those bones was removed mechanically, probably using simple wooden or bone tools. This bone marrow could be consumed immediately or reserved for later use. The epiphyses of the bones were likely subjected to intensive fragmentation using any of a variety of methods involving hammerstones and anvils. The difficulty implicit in fracturing and fragmenting the epiphyses of long bones (especially fresh bones as large as those of bison) is significant, and likely required carefully cleaning the epiphyses, followed by repeated episodes of hammering, battering, and pounding in order to fracture these bone element parts. Once broken into small pieces, these bone grease bearing epiphyseal bone fragments were simmered in water until the bone grease was liberated from the matrix of epiphyseal cancellous bone. This fat could

then be skimmed from the surface of the water, and preserved in ceramics vessels, hide bags, or other suitable waterproof containers (Karr *et al.* 2010; Outram 1998, 2001).

While many deposits at the Mitchell site are significantly disturbed by the action of bioturbation, desiccation cracking (Karr *et al.*, in press), and other taphonomic processes, Feature 320 remains almost entirely intact and undisturbed. One small rodent run and several small desiccation cracks interrupt the feature in several places, however, these do not significantly affect the nature of the deposit. The exceptional preservation of the assemblage is manifest in the preservation of many complete freshwater mussel shells within the deposit. While freshwater mussel shells are frequently encountered at the Mitchell site, they are most frequently significantly fragmented by the action of a variety of taphonomic processes. Within Feature 320, relatively few fragments were encountered among many complete specimens, including cases in which both halves of the bivalve were preserved in their natural anatomical orientation. This suggests that the normal range of taphonomic processes, including trampling, carnivore gnawing, sediment loading, and chemical decay, among others, had little effect on the assemblage preserved within the feature. This exceptionally well-preserved feature is ideal for intensive fracture and fragmentation analysis of the bone assemblage that it contained.

Numerous early European explorers and traders on the Plains and adjacent regions noted the use of bone fats as important nutritional supplements, but references to the methods that Contact period peoples employed in the exploitation of bone fats are scant. This preserved feature at the Mitchell site provides an opportunity to study not only the bone fragments preserved within this large feature, but also the relationship between the fragmented bone assemblage and the feature with which they are associated.

5. Analytical Methods

In total, >21kg bone material was recovered from Feature 320, of which 19.5 kg was heavily fractured and fragmented bone material derived principally from bison. The remains of small animals and whole and partial bones account for the difference of 1.5 kg. All of this material was critically analyzed for the purposes of this study. Though Feature 320 was exposed at the Mitchell site in previous field seasons, the feature was previously

thought to represent two features (Features 287 and 290). These features were thoroughly investigated during the 2013 summer field season, and upon their excavation it became apparent that they represented two distinct portions of a larger feature, Feature 320. All of the material considered in this study derived from the 2013 excavations. The base of Feature 320 is generally 50 cm below the modern ground surface of the site, though the base of the basin shaped depression is about 70 cm below the modern ground surface. Continuous cultural midden deposits cover the site to a depth of at least 1.5 metres in places, placing Feature 320 in the middle of the occupational sequence of the site.

The methods used to analyze these materials are slightly adapted from Outram (1998, 2001) and follow Karr *et al.* (2010). Each portion of Feature 320 (Feature 287 and 290) was considered separately. The material from each of the two portions of Feature 320 was separated into seven distinct groups based upon bone type:

- 1) Appendicular cancellous bone (fragmented epiphyses of long bones).
- 2) Axial cancellous bone (fragmented cancellous bone from vertebrae, pelvis, ribs, vertebral spines, etc.).
- 3) Miscellaneous cancellous bone (fragmented unidentifiable cancellous bone).
- 4) Dense diaphyseal fragments (long bone shaft fragments).
- 5) Ribs, mandibles, and vertebral spines.
- 6) Whole and partial bones (complete, unbroken bones, and bones with complete epiphyses).
- 7) Others (cranial fragments, teeth, bones from smaller mammals, birds, fish, etc.).

Though small fragments of bones are frequently unidentifiable to the level of specific anatomical element, they are typically identifiable to the level of a generalized bone type.

These different categories of bones represent sources of bone fat of varying utility.

Appendicular cancellous bone contains high quality bone grease, while axial cancellous bone contains lower quality bone fats (Binford 1978; Brink 1997; Emerson 1990; Karr *et al.* 2010; Lyman 1994; Outram 1998, 2001; Rixon 2000; Speth and Spielmann 1983; Wilson 1924:174). The diaphyses of long bones contain high-quality marrow within the medullary cavity, while element types such as ribs, vertebral spines, pelvis, and vertebrae contain smaller quantities of lower quality fats (Binford 1978; Brink 1997; Emerson 1990; Karr *et al.* 2010; Lyman 1994; Outram 1998, 2001; Rixon 2000; Speth and Spielmann 1983). Whole

bones were not exploited for bone fats, while partial bones (complete epiphyses) represent an unexploited source of bone grease. The category of “others” represent bones from small animals unlikely to have been used for the purposes of bone fat processing, at least some of which are modern rodents intrusive to the archaeological contexts discussed in this article, and others likely represent incidental rather than intentional constituents of the assemblage.

All diaphyseal and cancellous long bone fragments, as well as all fragmented axial bone material (e.g. categories 1-5 above) were sorted in size increments of 0–19 mm, 20–29 mm, 30–39 mm, 40–49 mm, 50–59 mm, 60–69 mm, 70–79 mm, 80–89 mm, 90–99 mm, and ≥ 100 mm. Because of the difficulty inherent in identifying small cancellous bone fragments to bone type, no attempt was made to specifically classify cancellous bone fragments < 30 mm in maximum dimension, and these were grouped together as “miscellaneous cancellous bone”. Each of these size classes of each bone type was weighed in grams.

All diaphyseal long bone fragments ≥ 30 mm were assessed to determine the nature of their fracture morphology. Bone fracture morphology provides a means by which to assess the state of bones when they were broken. Bones in all environments degrade over time, and fresh bones exhibit fracture morphologies that differ radically from dry and mineralized bones (Johnson 1985; Karr and Outram 2012, in press; Morlan 1984; Villa and Mahieu 1991).

Outram (1998, 2001) defined three criteria for the assessment of bone fracture morphology, and devised a Fracture Freshness Index (FFI) to quantify the results. Each diaphyseal bone fragment was assigned a fracture score of zero, one, or two based on each of three criteria: 1) Fracture outline, 2) Angle of fracture to the cortical surface, and 3) Texture of fracture surfaces. This results in a total possible FFI score of between zero and six for each fragment. Bones that are fractured when fresh typically exhibit a helical fracture outline, fracture surfaces at sharp angles to the cortical surface, and smooth fracture surfaces (Johnson 1985; Morlan 1984; Outram 1998, 2001). Bones that have become dry or mineralized typically exhibit straight, jagged, or stepped fracture outlines, fracture surfaces at right angles to the cortical surface of the bone, and rough fracture surfaces. Fresh bones typically achieve a FFI score of 0-2, while dry and mineralized bones

achieve a FFI score of 3-6. Bone fracture morphologies of this type have been thoroughly described (Karr and Outram *in press*; Outram 1998, 2001, 2003), and general studies of bone fracture morphology are also available (Johnson 1985; Morlan 1984).

Bone degradation occurs at different rates depending upon the environmental conditions to which bones are subjected (Karr and Outram 2012, *in press*). Further, the FFI scale represents a continuum of degradation from fresh to dry (or mineralized), meaning that semi-fresh or semi-dry bone fragments represent the middle of the scale, while very fresh and very dry bone fragments represent the extremes. As fragmented bone assemblages are deposited in archaeological contexts, the FFI score of those fragments and assemblages is affected by the action of numerous natural agencies, a process known as taphonomic overprint (Noe-Nygaard 1977). In extremely well preserved assemblages, FFI scores may remain low as long as bone fragments are protected from taphonomic damage. Conversely, taphonomic overprint has the capacity to erase bone fracture evidence in contexts where the action of taphonomic processes dramatically affects bone assemblages. The state of bones when they are deposited represents the theoretical minimum FFI score that the assemblage can be ascribed; any assemblage can suffer from the effects of taphonomic overprint as bones are further fractured and fragmented over time, increasing its FFI score.

6. Results and Discussion

The bone assemblage reported here consists of exceptionally well-preserved remains within a distinct, clear feature. The results reported here consider each half of the larger feature (Feature 320) separately, as Feature 287 and 290 respectively. Analysis of each of these two contexts produced similar results, helping to establish their identity as distinct elements of a single feature.

Figures 4 and 5 display the mass of fractured and fragmented bone material from each size class. Both Feature 287 and Feature 290 exhibit dramatically greater amounts of fractured and fragmented bone material in the smallest size classes (0-19mm, 20-29mm, 30-39mm, and 40-49mm) and greatly reduce quantities of bone material in the larger size classes (50-59mm, 60-69mm, 70-79mm, 80-89mm, and 90-99mm). In Feature 287, 3.6% of

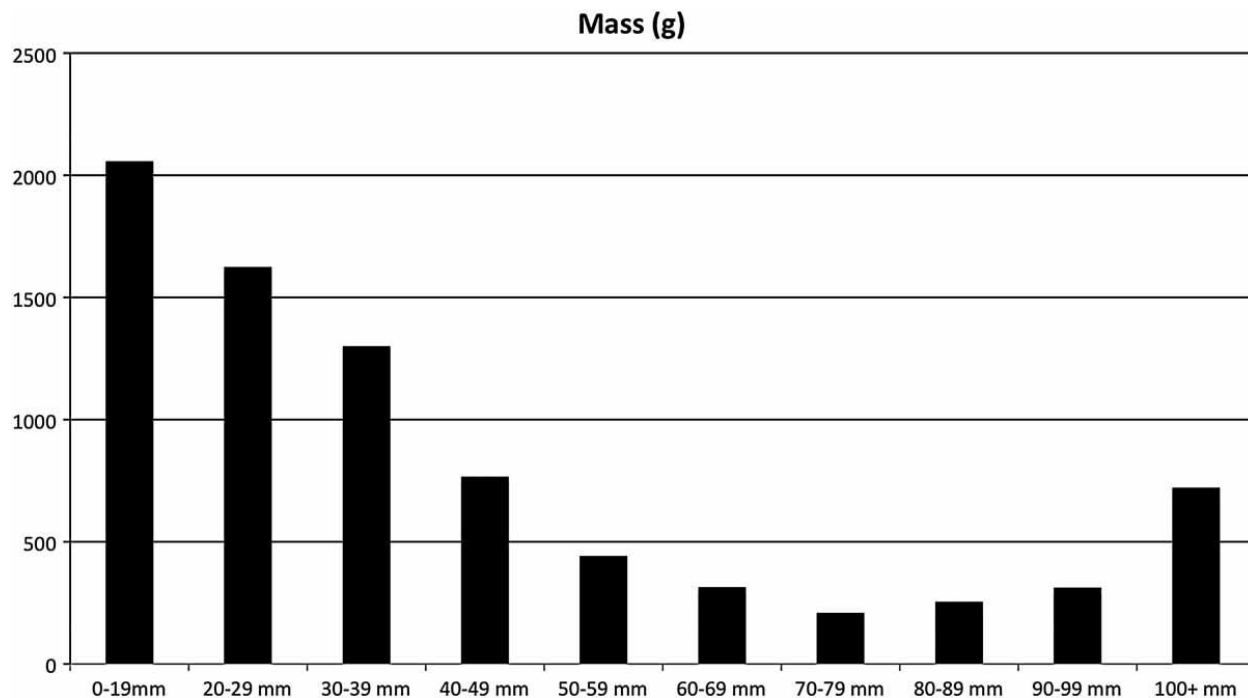


Figure 4 A column graph indicating the mass (in grams) of fractured and fragmented bone material from each 10 mm size class for Feature 287.

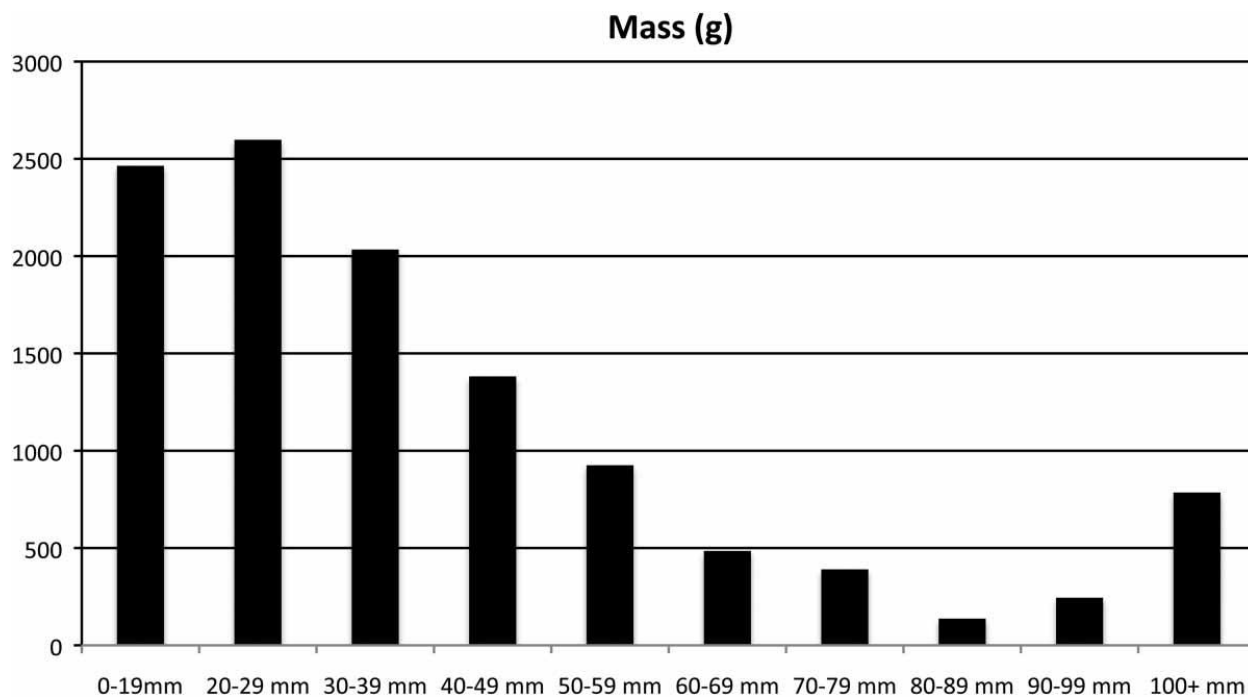


Figure 5 A column graph indicating the mass (in grams) of fractured and fragmented bone material from each 10 mm size class for Feature 290.

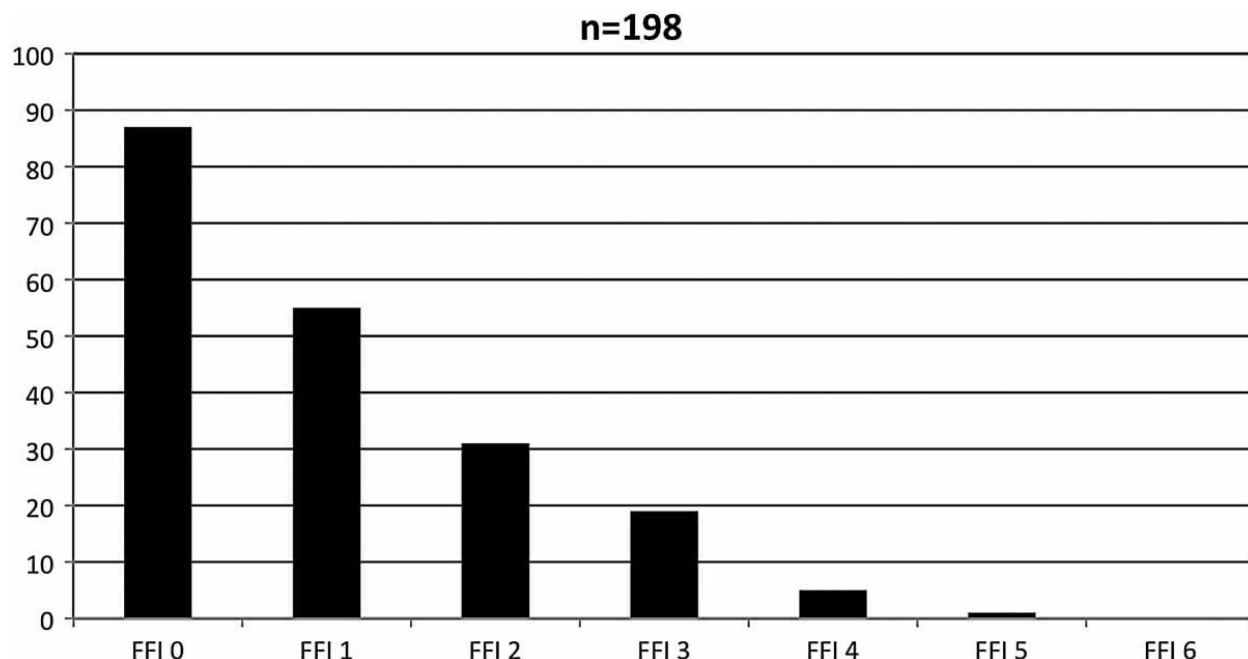


Figure 6 Column graph of FFI scores for long bone (diaphyseal) fragments from Feature 287.

all bone material (by mass) pertains to the size class of bones measuring over 100mm in maximum dimension, while 8% are whole and partial bones. In Feature 290, about 6.3% belongs to the 100mm+ size class, while 7.6% remain whole or partial. While many taphonomic processes affect the preservation and condition of zooarchaeological assemblages, significant taphonomic evidence suggests that these processes had little effect on the bones preserved within this assemblage. Almost no evidence of carnivore gnawing is preserved on the bones. While processes such as trampling and sediment loading have the potential to fracture and fragment bones, the preservation of complete, complete (undamaged) freshwater mussel shells among the bone assemblage suggests these processes had little effect on the preservation of the assemblage. The preponderance of bone material in the smallest size classes, supported by a variety of taphonomic evidence, suggests that the bones were fractured and fragmented in prehistory by cultural rather than natural processes.

Each long bone fragment >30m in maximum dimension was assessed to determine its fracture morphology, and assigned a score using the FFI system. In both Feature 287 and Feature 290, a vast majority of the long bone fragments exhibited FFI scores of between zero and two (87.4% for Feature 287 and 97% for Feature 290), indicating

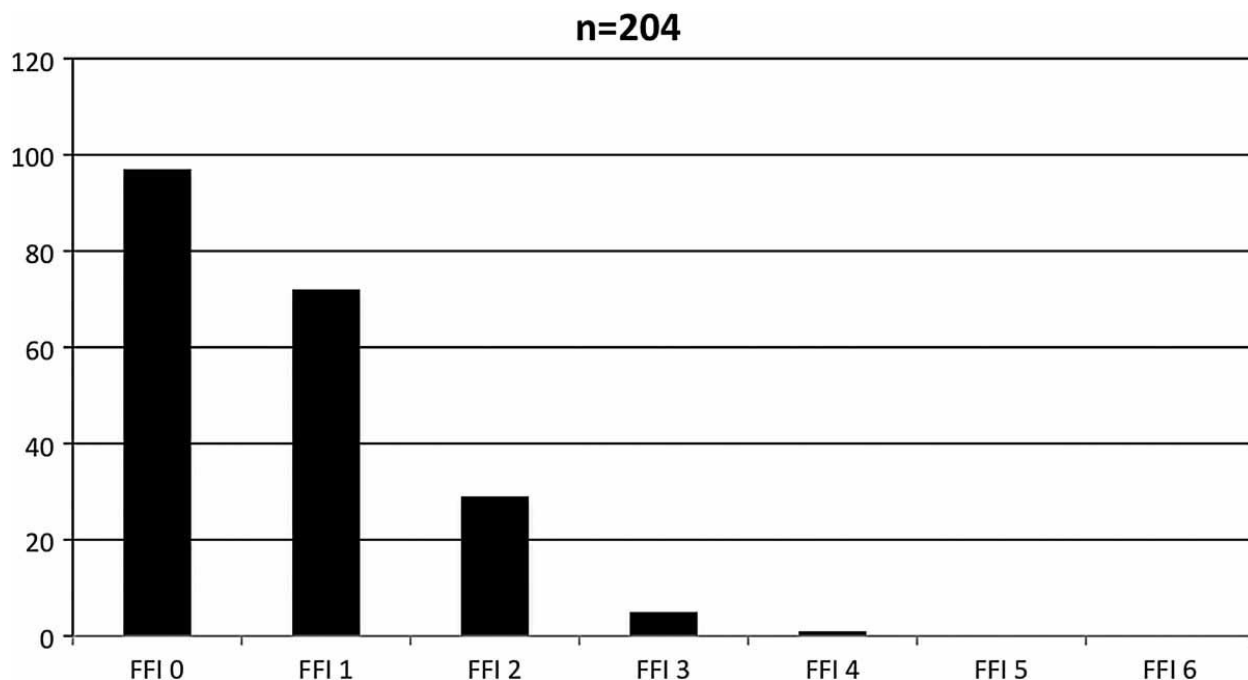


Figure 7 Column graph of FFI scores for long bone (diaphyseal) fragments from Feature 290.

relatively fresh fracture morphology (Figures 6 and 7). Small numbers of long bone fragments exhibited fracture morphologies indicative of dry or mineralized bones (3% of long bone fragments from Feature 287 and 0.5% of long bone fragments from Feature 290 were assigned FFI scores of 4-6). The predominantly fresh fracture morphologies present on bone fragments preserved in a depositional environment in which the action of natural taphonomic processes was limited serves as compelling evidence for the prehistoric cultural modification of the bone assemblage. The diaphyseal fragments from Feature 287 exhibited an average FFI score of 1.00, while those from Feature 290 exhibited an average FFI score of .79. These indicate that the bones were fractured when they remained fresh, and have remained well preserved since that time in their depositional context. By comparison, three samples of fractured and fragmented bones from generalized midden deposits across the site produced FFI scores of 1.51-1.59, suggesting that the feature reported in this article represents a well-preserved, intact feature that has been subject to minimal levels of taphonomic damage since the time of its deposition.

Figures 8 and 9 display the relative mass of different bone types by size class. In both Feature 287 and Feature 290, ribs fragments are generally preserved in relatively

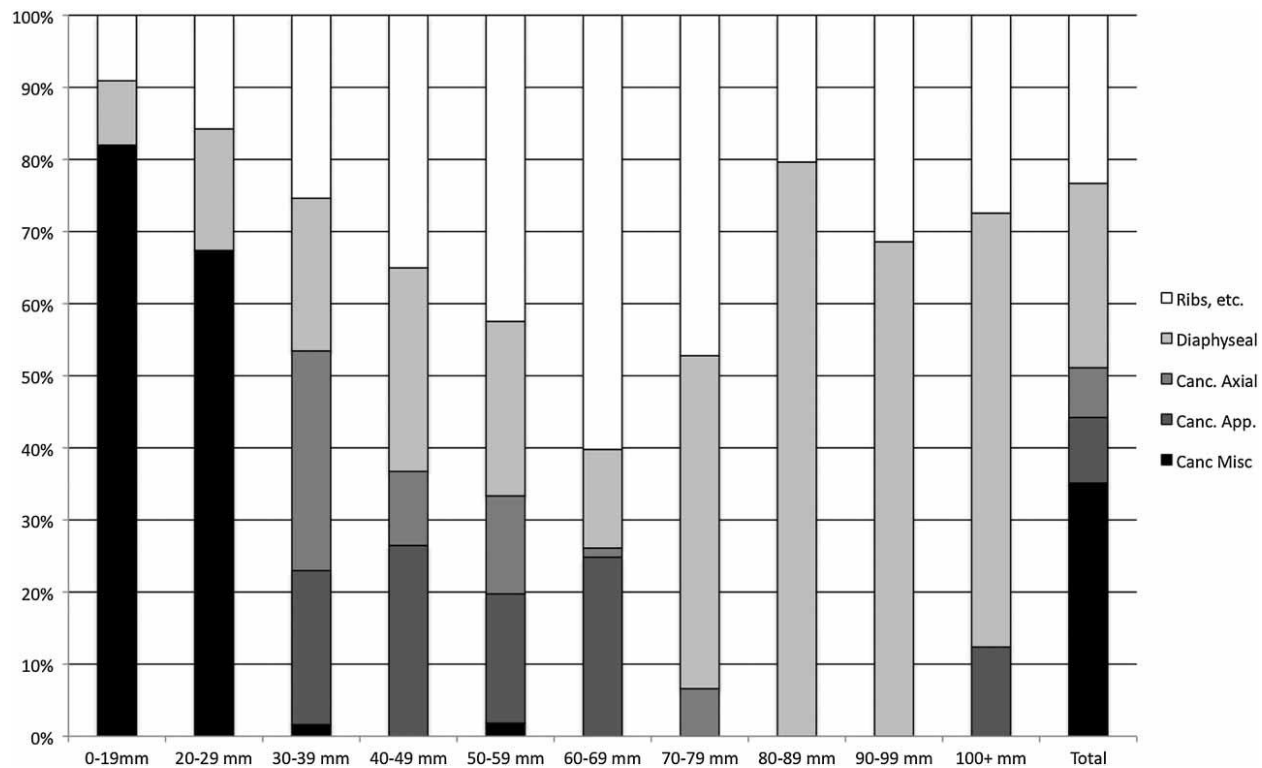


Figure 8 The relative mass of different bone types by size class for Feature 287.

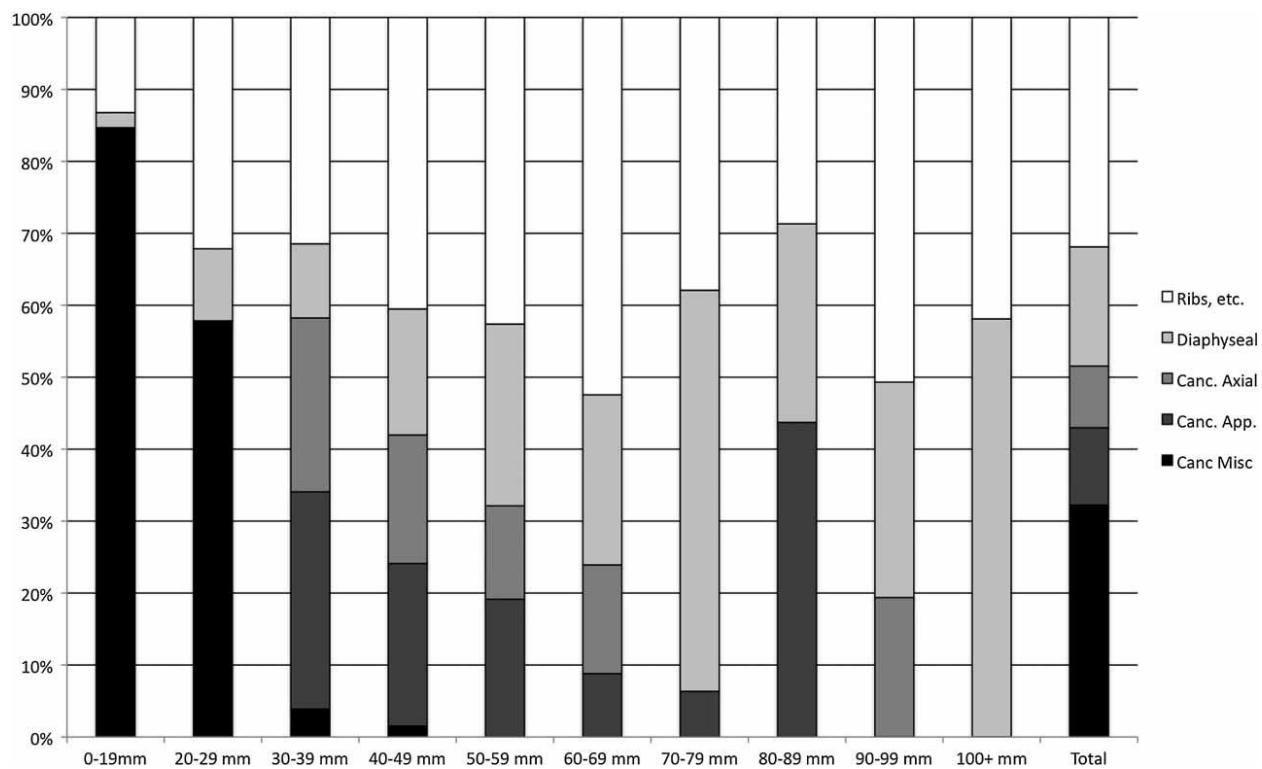


Figure 9 The relative mass of different bone types by size class for Feature 290.

large sizes, along with diaphyseal (or long bone shaft) fragments. Together, these bone categories dominate the largest size classes of bones preserved within the feature in question. Cancellous fragments, however, are rarely preserved in larger sizes, and are generally represented by very large numbers of very small fragments. Fragmented cancellous material dominates the size classes below 40mm in maximum dimension. This distribution reflects the logistical realities of bone marrow and bone grease processing. In order for bone grease to be effectively rendered, cancellous bone must be broken into relatively small fragments. Cancellous bone structures contain bone grease within the tiny pockets of the cancellous matrix. Bones must be substantially fragmented in order to obtain the greatest yield of bone grease in a way that is efficient in terms of the use of time and fuel. Once fractured and fragmented into small pieces, this material is boiled, allowing the maximum amount of valuable bone grease to be obtained.

Bone marrow, preserved within the diaphyses of long bones, is easily obtained through the fracture and fragmentation of long bone shafts. Many of the resultant fragments may remain rather large without compromising the yield of marrow from within the bones.

Ribs contain relatively small quantities of bone fats. Further, those bone fats tend to be of lower quality relative to the fats contained within long bone shafts and cancellous bone structures (Outram 1998, 2001; Speth and Spielmann 1983).

The analytical methods employed here demonstrate the clear cultural modification of bones in prehistory, and serve as a mechanism for understanding the cultural significance of bones to prehistoric groups. This clear evidence of cultural bone modification provides new insights to the nature of bone fat exploitation practices in the archaeological past. Great variation in the methods and techniques employed for the exploitation of bone fats may have existed across different geographic regions and among different cultural groups. The Mitchell example, however, provides a single example of a viable bone grease processing station in direct association with the bones from which those bone fats were derived. This allows for a better understanding of the scale and nature of bone grease processing at archaeological sites like Mitchell.

When bones are heavily fractured and fragmented, they are often classed as “unidentifiable”. Bones that cannot be identified to the level of element and species cannot

contribute to counts of either animals or bone units, even if they remain broadly identifiable to the level of general bone type (ribs, long bones, etc.). Thus, while traditional zooarchaeological measures of animal part abundance are typically applied in other situations, the heavily fractured and fragmented nature of the zooarchaeological remains at the Mitchell site precludes the meaningful application of measures such as Minimum Number of Individuals (MNI) and Minimum Number of Elements (MNE).

The timing and scale of bone grease exploitation at the Mitchell site and elsewhere should be considered. While bones that were fractured and fragmented when they remained fresh dominate the midden deposits at Mitchell (suggesting bone marrow and bone grease exploitation), the preservation of a feature where those activities occurred provides new insights to the cultural and social behaviors and practices of the past. While extensive evidence of bone fat exploitation pervades the Mitchell site, Feature 320 suggests that individual events of bone fat exploitation occurred at a relatively small scale. In total, the bone mass of 19.5 kg likely produced a relatively small quantity of bone fat, suitable for consumption by one or several domestic units rather than by a clan or village as a whole. This episode of bone fat processing may have been associated with a single hunting event, or it may indicate social divisions within the village. Previous excavations at the Mitchell site have revealed extensive deposits of heavily fractured and fragmented bone remains, however, the features reported in this article represent the first discovery of intact features that were likely used for bone grease processing.

Leechman (1951) noted that among the Loucheux of Old Crow, Yukon, bones would be left only for one day after an animal was killed before they were processed for their fats. While it is impossible to state categorically that such preferences applied cross-culturally, the Mitchell example provides an archaeological feature of a size suitable to account for a single hunting episode. The nature of the bones at the time they were processed suggests that the bones were utilized for bone grease exploitation while the bones remained fresh. Mass accumulation and industrial scale processing of bone fats would require large numbers of hunted animals to be available at the same time, and would require an organized investment in time and labor in order to execute an event of communal bison hunting, and to process the carcasses, bones, and bone fats in the intensive manner discussed in this article. The small-scale bone fat processing evident from the features

reported in this article may be evidence of a wider pattern across the site. Certainly, other deposits at the site have produced extensive evidence of heavily fractured and fragmented bone materials, however, the scale of such bone fat processing activities is difficult to ascertain in the absence of further evidence to demonstrate the length of occupation of the site and its population, among other factors.

Further, while ceramic sherds derived from thousands of vessels are represented at the Mitchell site, the bone grease processing feature described here contained much less ceramic material than what is normally encountered across the site. The shape, size, and character of the pit and processing area that constitute Feature 320 suggest that the clay-lined pit was likely lined with animal hide in order to facilitate a method boiling. Hearths have been identified at a distance of several meters from the feature in question where rocks may have been heated, and fire-cracked rock is found across the Mitchell site in abundance. The scarce ceramic evidence recovered from the bone grease processing station suggests that ceramic pots were likely not employed directly in the bone fat exploitation process, though may have served as vessels for transporting water to and from the pit, and perhaps as vessels for storing rendered bone fats. Further research is required in order to establish the nature of cooking and boiling practices at the Mitchell site, and the role that ceramics played in facilitating these processes.

7. Conclusions

While bone marrow and bone grease processing is frequently cited as an important activity in prehistory, this paper presents clear evidence for a distinct event of bone fat exploitation, along with the location and feature in which that event took place. Further, this paper applies an analytical method that considers site taphonomy, bone fracture morphology, and the significance of bone fats in the context of prehistoric human subsistence.

This and other discoveries at the Mitchell Prehistoric Indian Village continue to elucidate the nature of the archaeological past at IMM period sites. The importance of bone fats to the villagers of the Northern Plains cannot be understated. The subsistence base for the village dwelling peoples of the James valley consisted of large numbers of bison, and the

agricultural produce that could be reaped from gardens and small field plots in the vicinity of villages. Archaeological evidence from the Mitchell site suggests that the need for dietary fats required the intensive processing of nearly every bison bone that contained high-quality fats. This commitment to bone fat exploitation required immense amounts of time and energy on the part of the inhabitants of the site, suggesting that the need for these resources was considerable to the wellbeing of human groups across the region at this time.

The discovery of an intact, well-preserved feature along with clear evidence for bone marrow and bone grease processing contributes to our understanding of bone fat exploitation among the village dwelling peoples of the Plains. Rather than efforts aimed at bone fat production on a very large scale, this discovery suggests relatively small-scale bone fat processing efforts. Further, the discovery of heavily comminuted bone remains within and in direct association with the feature provides evidence of the nature of bone fat exploitation. The pit-and-platform construction of the feature suggests a method of boiling within a hide-lined pit, while the platform area adjacent to the pit provides a location for fracturing and fragmenting bone bones.

The study of bone fat exploitation continues to provide evidence that contributes to our understanding of the events of the prehistoric past. The careful, methodical study of fractured and fragmented bone remains and the archaeological features with which they are associated provides a means by which to assess complex zooarchaeological assemblages in ways that provide clear explanations of the behaviors and practices of the prehistoric past.

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