The Archaeological Signature of Stews or Grease Rendering in the Historic Period

Experimental Chopping of Long Bones and Small Fragment Sizes

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ABSTRACT

Small bone fragments have often been interpreted as the residues of stews or grease extraction. In international historical archaeological research, stew interpretations have often focused on enslaved or underclass groups or on those who had limited access to sufficient amounts of food or faced nutritional deficiencies. These analyses have widely been uncritical, and the small fragment sizes can be better explained as the products of taphonomic processes such as weathering, trampling, and carnivore scavenging. This work presents results from experimentally chopped long bones from cows, sheep, goats, and pigs that identify butchery and fracture patterns that can be used to evaluate past stew interpretations and provide comparative models for future analyses.

In published historic period faunal analyses, small bone fragment sizes have often been construed as evidence of the chopping or smashing of bones for stew preparation or grease rendering. Small bone fragments have been believed to have facilitated the fitting of meat into pots or to have expedited the extraction of valuable, fatty grease in boiling water. The ability to identify stews or grease extraction through highly fragmented bones by historic people of various socioeconomic groups to cope with malnutrition, to manage a demanding work regime, to maintain a traditional cuisine, or to identify industrial practices would allow significant understanding of important historic processes.

Influential interpretations in historical archaeology have often attributed the practice of stew preparation and grease extraction to underclass people such as enslaved laborers and their overseers, who had to rely on long-simmering stews in order to attend to other work responsibilities (Colonial Williamsburg Foundation 2002; Franklin 2001:97; Otto 1977:104, 1984:60, 111; Samford 1996:96). Small bone fragments, interpreted as residues of stews and marrow extraction, have also been construed as evidence of people trying to acquire as many nutrients as possible to make up for dietary deficiencies in times of stress (Arkush 2011:80–82; Cheever 1983:72–73; Crader 1984:544, 546, 548–549, 1989:230–231, 1990:710, 713; Dixon et al. 2010; Ellis et al. 2011; Hall 1992:392, 395, 1990:3; Triggs 2004:170). Some of these stew interpretations have been in contexts involving enslaved laborers, where the small bone fragments may also illustrate a possible continuation of a Western African stew-based cuisine.
The assumption that small bone fragments are evidence of stews or grease extraction is influenced by historical accounts or ethnoarchaeological observations, though these are not well cited in the historical archaeological literature. For example, Otto (1977, 1984) working at Cannon’s Point Plantation and Crader (1984, 1990) at Monticello both cited the testimony of ex-slave Charles Ball (1859). Ball recorded having eaten a “dinner of stewed pork” made from his provisioned rations after a Sunday funeral, though he provided no additional information about how it was prepared (1859:195). Influential to many of the other studies cited earlier, Otto’s and Crader’s stew interpretations were based on small fragment sizes, large numbers of unidentifiable bone fragments, and butchery through chopping. However, the rarely reported butchery traces aimed at fragmentation are minimal, with chop marks reported on only 2 percent of the bones from Monticello’s Storehouse (Crader 1984:547). The severe fragmentation at these sites has been better explained through contextual evidence due to the bones having been predominately discarded in surface deposits where natural processes such as weathering, carnivores, and trampling more likely caused the high degree of fragmentation and unidentifiability (Heinrich 2012).

In an interpretation of bone breakage and pulverization being indicative of marrow and stewed grease extraction by Native Americans at a California Spanish mission, Arkush (2011:80–82) provides some photographic illustrations of the bone fragments. Arkush also cites comparative analyses from faunal reports that themselves proposed interpretations without historical references or critical investigations of butchery (i.e., Garlinghouse 2009). Arkush’s (2011:81) Figure 11 shows large mammal bone fragments that he argues were intentionally broken for marrow, though a proportion of the illustrated bones demonstrate dry, transverse breakage and longitudinal cracking, suggesting that some fragmentation occurred after the bones had already been deposited and weathered (Behrensmeyer 1978:151). Additionally, his Figure 12 illustrates what is proposed to be “commuted faunal material typically associated with bone grease rendering” (Arkush 2011:82). Challenging this claim because of transverse breakage patterns, the image shows, instead, that the bones were largely broken after significant decomposition when grease was no longer available in the bones. A large number of other fragments in the image were clearly burned and fragmented after burning, which is not an expected result for bones that are kept in a broth-like liquid to extract grease (Gifford-Gonzalez 1993:183–184). The expected results of severe fragmentation for grease extraction can be better seen with the Nunamiut, where a photograph of post-boiled, comminuted caribou bones shows that they should be uncharred, demonstrate oblique (fresh) breakage, and contain numerous bone flakes (ECHO Space 2008:Figure 6).

Richard Gould (cited in Hodder 1979:449) suggests that, in times of nutritional stress, Indigenous Australians might highly fragment bones in order to extract the fullest amount of edible material. From other ethnoarchaeological accounts, the great fragmentation of bones to extract grease has been a more routine historic behavior, particularly by Native Americans, to make soup, to make a lard-like substance called pemmican, or to tan hides (Vehik 1977:171). Leechman (1951:355) recorded how the Old Crow in the Yukon smashed bones with hammerstones and, more recently, the back side of an axe until the bone fragments were the size of fingernails. The literature of several other Native American cultural groups who crushed a variety of bones in ways similar to that reported by Leechman in order to make soups and to extract grease is reviewed by Vehik (1977) and Church and Lyman (2003). Other ethnoarchaeological accounts of the Hadza pastoralists of northern Tanzania show that bones could be chopped with a knife or axe in order to fit into pots, but these may not be highly fragmented because smaller animals and bones were not chopped into smaller pieces (Lupo 1995:291–292). Binford (1978:157–163) and Yellen (1977:291–293) echo the historic and ethnoarchaeological accounts through observations of the Nunamiut and the Kung, respectively.

Historical accounts also provide clues that bones could have been highly fragmented for some industries, such as fertilizer and soap production. A nineteenth-century account from England records:

> After they are taken home men are employed with short handled axes to chop them into small pieces on a stock and pitch them into the boilers. When well boiled the fat is skimmed off and as the bone boiler is generally also a soap boiler part of it is used for soap and the coarser part for coal and cart grease (Halkett 1840:344).

The account further records very large piles of fragmented waste bone in these manufacturing centers, as well as industrial machines that can break up the bones into .5–2 cm sized pieces for field fertilizer (Halkett 1840:344).

Archaeological research into Roman and Medieval industrial sites has shown that severe fragmentation for grease extraction has had a long tradition in Europe. Excavations at two Roman sites in Tongeren, Belgium, revealed pits full of small cattle bone fragments. Though not quantified in the publication, the bones from these pits demonstrate stronger support for industrial breakage due to sealed contexts, great proportions of fresh breakage, absence of charring, as well as common shearing marks from butchery by a sharp implement (Vanderhoeven and Eryvynck 2007:167–172, Plates VII A and VII B). The grease extraction purpose of these fragments has been informed by experimental work (Stokes 2000). In this experimentation, three long bones from a cattle forelimb were chopped according to patterns observed in highly fragmented bone samples from several Roman and Medieval sites. The results of the various products were not quantified, but Stokes (2000) concluded that high degrees of fragmentation through chops at various places along the long bone shafts can be accomplished with little physical effort. This fragmentation would imply potential butchery marks at different locales across the bone, along with fresh breakage.
Though the need to severely fragment bones has been shown experimentally to have no significant benefit over somewhat larger fragments, the wide practice of highly fragmenting bones and the perpetuation of this idea in contemporary archaeological interpretations probably stems from the belief that the greater surface area to volume ratios of smaller fragments allowed grease to be extracted more efficiently (Church and Lyman 2003). From the various ethnoarchaeological inferences, bones fragmented for stews or grease extraction during the historic period could have been broken with a sharp iron tool, such as a heavy knife or axe, as well as with the blunt side of an axe. Archaeologists must also realize that it is very plausible that small fragments could be created by natural processes, such as weathering, trampling, and carnivore scavenging, which are very common actors on historic sites (Heinrich 2012). Therefore, inferences about cultural behavior should not be based solely on a superficial assessment of small fragment sizes.

There has been a vast range of actualistic research into ways that bones could be fragmented in archaeological sites, though this research has typically focused on prehistoric time periods, as a result of which the literature has largely been overlooked by historical archaeologists (Landon 2005:5–6). Assuming the principle of uniformitarianism concerning the biology and physics of bones, the effects of processes like dynamic butchery, trampling, and carnivore chewing, and the effects of environmental forces like weathering and diagenesis, have acted in the past as they do in the present. So, experimentation and observations of modern bones can serve as strong relational analogies for understanding past taphonomic processes (Binford 1981:21–42, 1989:20–21, Gifford-Gonzalez 1991:219–226).

Most of the historic period faunal collections that have been interpreted as stews have been recovered from surface middens (e.g., Arkush 2011:82; Crader 1984:543, 1990:692, 700; Otto 1984:45, 103, 136–138). These historic surface contexts are prime settings for fragmenting post-depositional processes, particularly carnivore scavenging and trampling. Actualistic studies have demonstrated that carnivore involvement often causes fragmentation, as well as the consumption of less dense bones and epiphyseal ends, as a result deleting them from the archaeological record (Binford and Bertram 1977:82; Blumen- schine and Marean 1993:282–289; Brain 1981:18–23; Marean and Spencer 1991:651–652; Munson and Garniewicz 2003:411–415). Carnivores also create diagnostic marks on bone surfaces with their round cusped teeth, which leave shallow rounded tooth pits, broad tooth scores, and sometimes punctures into trabecular bone (Binford 1981:44–49; Lyman 1994:205–216; Potts and Shipman 1981:577–578).

Trampling is also a common transformative agent at sites where bones are discarded around activity areas. Both animals and people walking on the fragments and sediment compaction can alter the originally deposited bones, where fragmentation is common and softer bones and bone portions like the epiphyseal ends are crushed and removed from the archaeological assemblage (Haynes 1991:379; Lyman 1994:377–382; Myers et al. 1980:487). If trampling had impact on the bones, the taphonomic picture could be identified by the presence of subtle striations in patches of sub-parallel scratches and sometimes isolated scratches that could be confused with cut marks (Behrensmeyer et al. 1986; Dominguez-Rodrigo et al. 2009; Fiorillo 1989; Olsen and Shipman 1988).

So far, there has been little work to identify specific traces and patterns that could differentiate whether small bone fragments in an archaeological collection were created through human or non-human agents. From the archaeological research, there has been no quantified explanation for what should be a small fragment that is indicative of processing for stews or grease extraction. Church and Lyman (2003:1078), reviewing the literature, show that ethnoarchaeological examples report fragment sizes that ranged from fingernail sized (one centimeter) to mean lengths of about seven centimeters, though some fragment sizes were dependent on the size of the animal processed. However, average fragment sizes or uniformity in fragment size do not necessarily point to human agency alone.

Currently, the strongest comparative criteria that can serve as models to identify bones processed for stews or grease extraction in the historic period come from research into the Donner Party starvation in California and a diasporic Chinese camp called China Gulch in Montana. Tool marks related to fragmentation include those that resulted from chopping and sawing. At the Donner Party camp, chop marks were exhibited on 9 percent and saw marks were observed on 2 percent of the bone fragments (Dixon et al. 2010:641–642). At China Gulch, chop marks were exhibited on 6 percent and saw marks were observed on 18 percent of the bone fragments (Ellis et al. 2011:107). Other dynamic fragmentary forces were applied through other tools creating percussion marks, with China Gulch showing these marks on 25 percent of the fragments and the Donner Party site showing them on 16 percent of the fragments (Dixon et al. 2010:642, Ellis et al. 2011:107). Both sites also exhibit high proportions of pieces with “pot polish” (Dixon et al. 2010:642, Ellis et al. 2011:107), which may be more indicative of highly processed starvation scenarios and not routine on bones more simply processed in stews or boiled for grease extraction.

As the Donner Party and China Gulch examples show, instead of looking simply at severity and patterns of fragmentation, an analyst should additionally seek out and quantify the marks made by the tools responsible for fracturing the bones to better demonstrate human involvement in the fragmentation. As a primary tenet of the “New” Archaeology paradigm shift, Binford (1989:20) advocated middle-range research “as a means of developing secure and intellectually independent interpretive principles and of expanding our knowledge of phenomena of relevance to our interpretive task.” The tool marks, as well as the other post-depositional taphonomic traces identifiable on bone surfaces, help bridge the middle range between the recovered static artifact and the dynamic historic behavior that created the artifact.

**EXPERIMENTAL DESIGN**

In order to more solidly bridge the divide between the recovered artifacts and the processes that created those artifacts, butchery experiments were performed to determine the faunal signature of bones that could have been fragmented for stews and grease extraction. Fresh, defleshed long bones of goats (*Capra hircus*), sheep (*Ovis aries*), pigs (*Sus scrofa*), and cattle...
(Bos taurus) were fractured to represent the types of animals frequently found at historical archaeological sites. Goats, pigs, and sheep represent medium sized (size 2) mammals, while the cattle represent a large (size 3) mammal to study how relative bone size might affect results. These two butchery experiments were performed to simulate the possible methods of fracturing with an 816.5 grams weight steel hand axe, sometimes also known as a hatchet. One experimental method used the sharp, chopping edge of the steel hand axe. The second method involved smashing bones using the blunt end of the steel hand axe. Strikes were made perpendicular to the long axis of the bone along the length of the bone's diaphysis.

No historical faunal analysis where small bone fragments were interpreted as evidence of stews has provided quantifiable data about the sizes of the bone fragments recovered. The Granary site within the Castle of Good Hope, Cape Town, South Africa, was initially interpreted as providing evidence of slave diet residues due to patterns of fragmentation and skeletal part representations comparable to sites like those along Mulberry Row at Monticello (Hall 1992:392, 395, 1990:3; Thackeray 1989:2). In 2005, an opportunity to reanalyze the Granary collection originally attributed to slaves instead demonstrated that taphonomic processes such as trampling and carnivore scavenging heavily contributed to the fragmentation (Heinrich 2010:159–180, 2012:19–34). The opportunity to reanalyze the collection also provided the chance to determine mean fragment sizes for medium (size 2) mammals and large (size 3) mammals. The mean bone fragments length for the Granary long bone samples for size 2 mammals is 33.1 mm, while the mean width is 14.2 mm. For the size 3 mammals, the mean length is 49.4 mm and the mean width is 21.1 mm. These measurements are similar to other sites and contexts with comparable taphonomic histones. Therefore, these measurements were considered target average fragment sizes during the butchery experiments.

After each bone was fragmented with the steel hand axe on a wooden platform, all fragments were collected, cleaned, and dried. Each fragment was then measured and all bone surfaces were examined for tool marks. Investigations of bone surface marks were performed using a 10x power hand lens under the raking angled light from a lamp (Blumenschine et al. 1996). Bone fragment edge breakage patterns were also recorded to identify oblique or transverse breakage types.

**HYPOTHESES TESTED**

Because fragmentation can be caused by human as well as by post-depositional taphonomic agents, criteria that can be securely attributed to human action need to be isolatable and definable. The following hypotheses were tested through the experimental trials:

1. Human-made, dynamic loading butchery marks (chop or impact marks) will be numerous and located across different parts of the bones (i.e., at proximal, distal, and midshaft portions of the long bones, instead of just at joints typical of carcass dismemberment or at the midshafts of radii and tibiae where feet are often removed during skinning).

2. Fracture edges will be fresh/oblique breaks because fresh bones would have been used for food, and they should not exhibit transverse breakage of weathered bone.

3. Bone flakes will be numerous due to the dynamic loading forces imparted upon the bones by chopping or smashing tools. Bone flakes are defined as products of conchoidal fracture in the dense cortical long bone diaphyses. Flakes are considered those fragments that are fully cortical and exhibiting only one or no original bone surface.

3a. Bone flakes will be more frequent from size 3 bones due to the thicker cortical bone of the diaphyses.

3b. Bone flakes will be more frequent in blunt smashing trials due to the impact from the broad surface of the hand axe.

3c. Bone flakes produced from the blunt smash trials will be longer than the flakes produced by the sharp chopping trials. The hypothesis is that the broad surface of the blunt side of the axe will produce longer flakes (in their maximum dimension) analogous to those created by the broad impact of a round hammerstone (Capaldo and Blumenschine 1994:736; Galan et al. 2009:782).

**SHARP CHOPPING EXPERIMENT RESULTS**

The sharp-edged chopping experiment consisted of 18 size 2 bone trials and seven size 3 bone trials (Table 1). Using the sharp edge of the hand axe was a relatively effective method to fracture long bones. Size 2 bones produced 2.6 to 6.4 fragments per chop (Figure 1). Fewer fragments were produced per chop for size 3 bones with ratios from 2.1 to 3.8. Repeated strikes were needed to chop into and fragment the more robust long bone near-epiphyseal ends, particularly for size 3 bones. Qualitatively, chopping with the sharp edge caused a wide scatter of bone fragments during butchery.

Chop marks are generally conspicuous, and 99.5 percent of the chop marks are located at a fracture edge at all portions of the bones. When chops went through cortical bone, the marks usually left striations parallel to the direction of strike that reflected imperfections of the blade edge (Lynn and Fairgrieve 2009; Tucker et al. 2001). Less conspicuous chop marks are observed on thin cortical fracture edges, such as those on bone flakes. These less conspicuous marks appear as areas of roughened, crushed bone on the fracture edge, often in locations that would correspond to the platform of a flake (Figure 2). Importantly, the proportion of fragments with chop marks is very high for both relative animal sizes and all bone types. Chop marks are identified regularly on over 42 percent of bone fragments, regardless of relative bone size.
Fracture edges are predominately oblique, indicating that the bones were broken fresh before organic decomposition. Oblique fractures can be identified only on fragments that retain cortical bone. Non-oblique breakage is classified as indeterminate, meaning that the bone fragments contained only trabecular bone that lacked any cortical portion.

**FIGURE 1.** Specimen g-1b goat tibia fractured by 10 sharp chops. Note the high proportion of less-diagnostic midshaft fragments and small-sized fragments. Many of the smallest fragments are flakes.

**BLUNT SMASHING EXPERIMENT RESULTS**

The blunt smashing experiment consisted of 17 size 2 bone trials and eight size 3 bone trials (Table 2). Using the blunt edge of the hand axe produced some mixed results regarding fragmentation efficiency. Size 2 bones created 1.7 to 8.8 fragments per
strike. Tibiae produced the two lowest strike-to-fragment ratios, which seems to be related to their resilient distal shaft cylinders, which required extra strikes to fragment. Blunt smashing of size 3 bones was somewhat more efficient, with the strikes producing ratios mostly between 3.2 to 11.9 fragments per strike, though one femur produced a very low ratio of 1.7. Differences in strike-to-fragment ratios are not statistically significant between the two experimental methods for each bone size. In contrast to the sharp chopping trials, blunt smashing did not create as much bone fragment scatter away from the butchery spot, which would have made it a more effective technique if there were historic concern about retrieving all the pieces without the use of a wide platform to see where the fragments spread.

The distributions of fragment sizes are comparable between the two different fracturing methods, showing no significant differences for either relative bone size. For size 2 bone fragments, they are modally very small, where 49.7 percent of those from the sharp chop and 45.2 percent from the blunt smash are shorter than 20.0 mm in length (Figure 3). A similar distribution is produced by the size 3 fragments from both methods (Figure 4). Size 3 fragments are also modally less than 20.0 mm in length with 41.2 percent of those from the sharp chop and 48.2 percent of those from the blunt smash fitting within this measurement interval. The high proportions of small fragments from the size 3 bones are results of the great numbers of flakes produced from these bones.

Marks left by blunt smashing are often less conspicuous than those left by sharp chops, as blunt chopping fractures bones by dissipating dynamic forces into the bones while sharp chops more directly penetrate into the bone. Blunt smashing marks are at fracture edges in 95.0 percent of the observations. The blunt smashing marks are identified in two general forms. A small proportion of marks resemble hammerstone percussion marks, in which a shallow pit is found and a small number of these also

FIGURE 2. The internal roughened texture of a chop mark on a goat tibia. The strike did not fully remove a series of bone flakes on the interior shaft. A paperclip propping the fragment can be used as scale.

FIGURE 3. Distribution of fragment lengths for size 2 bones.

As shown in Table 1 and Table 2, bone flakes are common products of fragmenting the dense cortical bone of long bone diaphyses with the dynamic loading forces from chopping and smashing. Sharp chops produced flakes from 9.1 percent to 52.4 percent in the size 2 bone experiment. Within the size 2 chop experiment, pigs (30.0–52.4 percent) produced significantly more flakes than sheep (9.1–38.1 percent) or goats (27.6–38.1 percent). Size 3 bones produced significantly greater proportions of flakes (41.9–78.6 percent) than the size 2 bones in the sharp chop trials (Mann-Whitney U = 121.0; p < .001).

The blunt smash experiments did not produce significantly greater proportions of flakes than the sharp chop experiments when bone size subsamples are compared between the tests. This calls for the rejection of hypothesis 3b. Similar to the sharp chop experiments, size 3 bones (47.8–85.3 percent) did produce a highly significantly greater proportion of flakes than their size 2 counterparts (18.2–57.7 percent) in the blunt smash experiment (Mann-Whitney U = 133.0; p < .001).

FIGURE 4. Sharp and Blunt strike-to-fragment ratios for each bone size.

BONE FLAKES CREATED THROUGH FRAGMENTATION

contain subtle striations associated with the pit (e.g. Blumen-schine and Selvaggio 1988; Galan et al. 2009:782; Pickering and Egeland 2006) (Figure 5). Predominantly, evidence for blunt smashing is found at the fracture edge, and these marks looked similar to chop marks, usually without the clear striations of the chopping blade. These marks appear as roughened, crushed bone created as the hand axe passed into the bone surface. It is important to note that many of these crushing marks are relatively inconspicuous, especially on smaller bone flakes, and they require slight magnification and a raking light angle to see. Blunt smashing marks are regularly observed on 20.5 percent to 40.0 percent of the bone fragments, except for one cattle femur for which only 13.0 percent of the fragments show marks.

Mirroring the sharp chop experiments, all fragments with cortical bone have fresh/oblique fracture edges showing the butchery of fresh bones. All non-oblique breaks were on fragments that consist only of trabecular bone. There are fewer of these fully trabecular bone fragments from the blunt smash trials because it is far more difficult to fragment the robust epiphyseal ends of long bones with the blunt side of the hand axe.
It was hypothesized that flakes created by blunt smashing would be longer than those created by sharp chops. For size 2 bones, flakes from the blunt smashing trials are significantly longer than those created from sharp chopping (Mann-Whitney U = 16952.0, p < .05) (Figure 6). There is also a highly statistical difference in flake lengths between the two experiments (Mann-Whitney U = 25940.5; p > .05) (Figure 7). A highly significant difference is noted for size 3 bone flake widths (Mann-Whitney U = 32370.0; p < .001). This allows for the acceptance of hypothesis 3c for the size 2 flakes. It also requires an amendment for flakes from size 3 bones, for which flakes created by sharp chopping are wider than those created by blunt smashing.

**FIGURE 4.** Distribution of fragment lengths for size 3 bones.

The experimental chopping and smashing presented here have been directed only at long bones. Hypothetically, if all skeletal elements were the focus of high fragmentation for stews or grease, it is proposed that the frequencies of marks could be even greater than those reported for just long bones. As an example to illustrate this idea, the ca.1730–1750 farmstead context at Elsenburg in the Western Cape, South Africa, shows chop marks on 10.9 percent of the total bone sample of 10,032 specimens (Heinrich 2010:209). The site was a place where the inhabitants slaughtered and consumed full animals, which were likely from their own herds, as they were not obtaining their meat as selected cuts from a market. This proportion also includes bones from small mammals, birds, and reptiles. At Elsenburg, the size 2 bone subsample shows chop marks on 10.9 percent, while the size 2 long bones show chop marks on 6.5 percent of the specimens. For the size 3 bones, chop marks are on 13.3 percent of the bones and on 10.9 percent of the long bones. Making these distinctions by bone size and bone type helps suggest that the butchery marks would be even more greatly represented in a faunal collection if other skeletal elements such as crania, vertebrae, and pelves were targeted for stew or grease extraction.

Creating small fragments from long bones through chopping or smashing produces high proportions of fragments that are less than 20.0 mm in length. These very small, sharp fragments could have been inhibitive to historic people if they were severely fracturing bones for stews that were likely mixed with meat, grains, and vegetables (i.e., Covey and Eisnach 2009:85, 104, 125). As inferred from ethnographic accounts, the high proportion of very small fragments could be more feasible for grease extraction, during the process of which the bone fragments could be strained out of the oily broth.
What do bones from stew preparation look like at historical archaeological sites? With the exceptions of starvation situations, historic accounts suggest that they were likely not significantly smashed or pulverized like the indigenous American, African, and Australian ethnographies suggest. Likely, past people cut meat off the bone before putting it into pots, whether the bones were included or not. Cookery books and food histories revealing heritage recipes from ethnicities such as English, West African, South African, and Malay regularly suggest that meat such as pork, mutton/lamb, and beef was removed from the bones prior to stewing (e.g., Coetzee 1977; Harris 1998, 2012; Stokes 2000). It should be noted that these cookery books often modernized the recipes for present tastes and aversions to certain parts of the animals. Slave accounts recorded by the Works Progress Administration (WPA) also suggest this removal of meat from the bone, with the exception of small animals, in the case of which deboning may have been less effective. WPA accounts indicate that stews made from turtle, fish, rabbits, and fowl sometimes included the bones, but these accounts do not record any process of highly fragmenting bones (Covey and Eisnach 2009:104, 123, 125, 129).

Diasporic African cuisine has made significant contributions to modern cuisine, though any dishes that might have incorporated small bone fragments have not been maintained, as suggested by their invisibility in historic cookery books and ethnographic accounts. An exception comes in the form of curry goat, a Jamaican dish. Curry goat involves stewed meat that incorporates bones broken into small fragments from various portions of the skeleton, including vertebrae, ribs, and long bones. The recipe does not derive from a diasporic African cuisine, but instead originates and still maintains similarities to goat meat dishes from Indian and other south Asian cultures. Modern curry goat served in local Jamaican restaurants, though now made with a saw instead of chopping implements, shows patterns supporting the experimental results. Fresh bones are used, broken edges are oblique, and 100 percent of the fragments exhibit saw marks. Projected chopping implements used

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to prepare a dish like curry goat would also have high proportions of butchery marks and fresh breakage.

The key to accurately interpreting historical faunal samples is to integrate the multiple lines of evidence available to an analyst. Accuracy requires more than just tool marks, or fragment sizes, or even breakage patterns. For stews or grease extraction, the numerous dynamic loading tool marks need to be located on wide ranges of the bones, and it needs to be shown that fragmentation did not significantly result from carnivores or from trampling. So far, few historical faunal analyses have sufficiently integrated the various lines of evidence to justify the interpretation that severe fragmentation was used as a means of coping with weighty conditions such as starvation, underclass situations, transplanted diasporic cuisines, or grease product industries.

Out of this literature, the studies on starvation from the Donner Party camp and China Gulch are examples to strive toward and on which to build (Dixon et al. 2010; Ellis et al. 2011). Using frequencies of tool marks and pot polish, along with measures of fragmentation, the studies are able to provide more confident support for the sequences of events and human behavior that resulted in the bone samples.

### CONCLUSION

A motivation behind these experiments is the need to avoid equifinality in historic period zooarchaeology. Numerous interpretations have used superficial assessments of severe fragmentation as evidence of historic behaviors to make stew or extract grease from bones. A range of density-mediated attritional processes and environmental taphonomic agents often play major roles in fragmenting bones on historical archaeological sites. In this literature, contextual evidence and analytical results often point to non-butchery taphonomic agency in the creation of the small fragments recovered. This experimentation sought to identify traces and patterns that can be more confidently attributed to human agency in the fragmentation of the bones.

---

**TABLE 2.** Data Summary of Blunt Smashing Experimental Trials.

<table>
<thead>
<tr>
<th>Specimen ID and bone type</th>
<th>No. strikes</th>
<th>No. frags</th>
<th>No. chop marked</th>
<th>% chop marked</th>
<th>No. flakes</th>
<th>% oblique breakage</th>
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Both the sharp chopping and blunt smashing experiments provide traces and patterns that can model human involvement in the creation of the archaeological record. If a high degree of fragmentation was caused by human butchery in order to create small fragments for hypothesized stews or grease extraction, the following criteria should be represented:

1. Chop or smashing traces will be represented in high proportions. Sharp chopping will show some diagnostic marks with striations, and frequencies of these traces will be very high.
2. People take meat and grease from fresh bones, so fragments with cortical bone will fully exhibit oblique breakage.
3. Bone flakes will be represented in high proportions due to the dynamic loading force of fragmentation by an iron tool through the dense cortical diaphyses of long bones.
4. All portions of the bones will be represented. The diagnostic epiphyseal ends are not obliterated by chopping or smashing.
5. Fragmentation marks by chopping or smashing will be frequently observed on all segments of all the long bones that could provide stew or grease materials.

Historically, archaeological sites were places where people, scavengers, rodents, and weathering were active, so it is very likely that any human-created faunal assemblage has been modified after being deposited. It is the duty and challenge of a faunal analyst to identify the various traces to reconstruct the sequence of events that led to the final appearance of the recovered sample. By closely investigating, identifying, and quantifying the traces of these processes, an analyst may better understand why the sample looks the way it does and also be better able to peel away the layers of obscuration to reconstruct the human behavior represented by the bones. The clues to these processes often lie in small, inconspicuous traces best identified under a slight 10x magnification, as well as breakage patterns that can clarify the timing of fragmentation. Hopefully, this experimentation shows how actualistic research can allow for more confident interpretations of historic faunal collections in which high degrees of fragmentation are observed.

Acknowledgments

I am grateful to Clint Burgher, manager of the Rutgers University Research Farm, for providing a number of goat and pig specimens. I am also appreciative of the three anonymous reviewers who provided advice to improve this work.

Data Availability Statement

The artifacts created during the experimentation are stored at the Archaeology Lab, Monmouth University’s Department of History and Anthropology, 400 Cedar Avenue, West Long Branch, NJ (732-571-3440). The digital data are provided on the author’s academia.edu page: https://www.academia.edu/5509876/Stew_grease_rendering_experimental_research_measurements

References Cited

Arkush, Brooke S.

Ball, Charles
The Archaeological Signature of Stews or Grease Rendering in the Historic Period (cont.)

1859 Fifty Years in Chains, or, the Life of an American Slave. H. Dayton, New York.

Behrensmeyer, Anna K.

Behrensmeyer, Anna K., K. D. Gordon, and G. T. Yanagi

Binford, Lewis R.

Binford, Lewis R., and Jack Bertram

Blumenschine, Robert J., and Curtis W. Marean

Blumenschine, Robert J., Curtis W. Marean, and Salvatore Capaldo

Blumenschine, Robert J., and Marie S. Selvaggio

Brain, C. K.

Capaldo, Salvatore, and Robert J. Blumenschine

Cheever, Dayle M.

Church, Robert R., and R. Lee Lyman

Coetzee, Renata
1977 The South African Culinary Tradition: The Origin of South Africa's Culinary Arts during the 17th and 18th Centuries, and 167 Authentic Recipes of this Period. C. Struik, Cape Town, South Africa.

Colonial Williamsburg Foundation

Covey, Herbert C., and Dwight Eischen
2009 What the Slaves Ate: Recollections of African American Foods and Foodways from the Slave Narratives. ABC-CLIO, Santa Barbara, California.

Crader, Diana


Dominguez-Rodrigo, M., S. de Juana, A. B. Galan, and M. Rodriguez

ECHO Space

Ellis, Meredith A. B., Christopher W. Merritt, Shannon A. Novak, and Kelly J. Dixon

Fiorillo, Anthony R.

Franklin, Maria

Galan, A. B., M. Rodriguez, S. de Juana, M. Dominguez-Rodrigo

Garlinghouse, Thomas S.

Gifford-Gonzalez, Diane


Hallett, James

Hall, Martin
1990 Towards an Archaeology of Slavery in the Cape: The Castle–Cape Town. Manuscript on file, Historical Archaeology Research Group, University of Cape Town.


Harris, Jessica B.


Haynes, Gary

Heinrich, Adam R.
2010 A Zooarchaeological Investigation into the Meat Industry Established at the Cape of Good Hope by the Dutch East India Company in the Seventeenth and Eighteenth Centuries. Unpublished Ph. D. dissertation, Department of Anthropology, Rutgers University, New Brunswick, New Jersey.
The Archaeological Signature of Stews or Grease Rendering in the Historic Period (cont.)


Hodder, Ian
1979 The Archaeology of Stews and Grease Rendering in the Historic Period. In Advances in Archaeological Practice: A Journal of the Society for American Archaeology 2014 (cont.)


Landon, David B.

Leechman, Douglas

Lupo, Karen D.

Lyman, R. Lee

Lynn, Kalan S., and Scott I. Fairgrieve

McKee, Larry W.

Marean, Curtis W., and Lillian M. Spencer

Munson, Patrick J., and Ruxford C. Garniewicz

Myers, T., M. R. Voorhies, and R. G. Corner

Olsen, Sandra L., and Pat Shipman

Otto, John Solomon


Pickering, Travis Rayne, and Charles P. Egeland

Potts, Richard, and Pat Shipman

Samford, Patricia

Singleton, Theresa A.

Stokes, P. R. G.

Thackeray, Francis
1989 Report on Analysis of Mammalian Fauna from Excavations at the Castle (CA88, F1 and F2). Manuscript on file, Historical Archaeology Research Group, University of Cape Town.

Triggs, John R.


Vanderhoeven, Alain, and Anton Erynnck

Vehik, Susan C.

Yellen, John E.

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