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Experimental determinations of cutmark orientation and the reconstruction of prehistoric butchery behavior

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ABSTRACT

The frequency, anatomical location, and orientation of stone tool cutmarks have all been widely employed in reconstructions of ancient butchery practices. Cutmark orientation in particular has great potential to inform on various aspects of past behavior, and here we provide experimentally derived orientations with novice butchers in two contexts. The first models the butchery of a carcass part by a single individual, and the second the butchery of a carcass part by several individuals simultaneously. Our goal is to test the following hypothesis: do butchers working alone produce less variation in cutmark orientation than several working at once? Preliminary data indicate that, at least with the novices involved in this experiment, variation in cutmark angles does not differ significantly between the two scenarios. Although further experimental work is warranted, we suggest that while the number of individuals may play some role in determining cutmark orientations, experience and skill are also important factors.

1. Introduction

Cutmarks, as one of the few taphonomic traces that unambiguously link humans to the modification of animal carcasses, can reveal a great deal about the diet and subsistence practices of past peoples, and the near universal incorporation of these data into zooarchaeological analyses reflects the general consensus on this point. Much less agreement exists, however, on exactly what behaviors cutmarks do (or do not) reflect. The discord stems largely from (1) the inherently epiphenomenal nature of most cutmarks (Lyman, 1987: 260–262), (2) the myriad factors, both systematic and stochastic, that condition where, when, and how often they are created (Domínguez-Rodrigo and Yravedra, 2009; Lupo and O'Connell, 2002; Lyman, 1987: 253), and (3) divergent or incompatible analytical protocols. We believe that an actualistic approach, in both naturalistic and experimental contexts (sensu Marean, 1995: 65–66), offers a constructive framework for segregating key variables and their effect on cutmarks. Indeed, a rich literature of such work has emerged that either directly or indirectly addresses many of these factors (Bartram, 1993; Binford, 1981; Braun et al., 2008; Bromage and Boyde, 1984; Bunn, 1983, 2001; Bunn and Kroll, 1988; Capaldo, 1997; Crader, 1983; Dewbury and Russel, 2007; Domínguez-Rodrigo, 1997, 1999; Domínguez-Rodrigo and Barba, 2005, 2007; Egeland, 2003; Gifford-Gonzalez, 1989; Greenfield, 1999, 2006; Lupo, 1994; Lupo and O'Connell, 2002; Merritt, 2012; Nilssen, 2000; Padilla Cano, 2008; Pickering and Hensley-Marschand, 2008; Pobiner and Braun, 2005; Potter, 2005; Selvaggio, 1994; Shipman and Rose, 1983; Walker and Long, 1977; Willis et al., 2008).

Here, we investigate one particular characteristic of cutmarks, that of orientation. In a strictly definitional sense, a parallel or subparallel orientation of striations relative to each other has been cited as an important, though not exclusive or necessarily unique, identifying characteristic of cutmarks (Blumenschine et al., 1996: 496; Fisher, 1995: 14). Archaeologists have long used orientation as one among many attributes in reconstructions of butchery behavior (Guilday et al., 1962). Noe-Nygaard (1989: 484), for example, argued that cutmarks oriented parallel to the long axis of bones were indicative of filleting, while Binford (1984: 110) suggested that orientations could change depending on whether a carcass was fresh or supple when butchered. Lyman (1987: 325) provided a reasonable basis for such interpretations by arguing that because

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mark orientation "is indicative of the direction of application relative to the alignment of the involved muscles and ligaments" variation could reflect "different purposes and desired results." This assertion found support in Binford's (1981: 136–142) now classic ethnoarchaeological study, which showed that various butchery procedures could often result in distinctive cutmark orientations. Additional actualistic work that more closely monitored the relationship between specific activities and the cutmarks they produced, while demonstrating that Binford's (1981) guides were probably oversimplified,[1] nevertheless identified patterns in mark orientation (Costamagno and David, 2009; Nilssen, 2000). Along with anatomical location, such data continue to be used to associate particular cutmarks with skinning, dismembering, or filleting (e.g., Stewart, 2010).

From a slightly different perspective, Stiner et al. (2011) have noted that among modern humans, the butchery of carcasses for distribution is typically performed by one or just a few individuals, a process that often results in cutmarks that are well-aligned relative to each other. This is a potentially important observation given that the procedure of butchery (as reflected by the cutmarks) guides how meat is distributed and/or shared. Interestingly, an analysis of faunal remains from the late Lower Paleolithic levels at Qesem Cave (modern Israel) revealed that the site's cutmarks tend to be oriented in a more "chaotic" fashion than those from later (Middle and Upper Paleolithic) time periods (Stiner et al., 2009, 2011). A provocative interpretation of this finding is offered (Stiner et al., 2011: 230):

> "Hypothetically, we may be seeing evidence of a simpler or less evolutionarily derived pattern of meat consumption that was social but less canalized than those typical of … later humans. The evidence … at Qesem Cave might reflect, for example, more hands (including less experienced hands) removing meat from any given limb bone, rather than receiving shares through the butchering work of one skilled person. Several individuals may have cut pieces of meat from a bone for themselves, or the same individual may have returned to the food item many times. Either way, the feeding pattern from shared resources appears to have been more individualized than is typical of later cultures, with limited or no formal 'apportioning' of meat."

This is an extremely intriguing scenario and highlights the great potential that cutmark orientation has for uncovering aspects of prehistoric behavior that may otherwise remain obscure. While our goal here is not to evaluate all aspects of this multifaceted model, it does serve as a convenient point of departure for isolating a few specific variables. So, with this in mind, we present experimental data that document cutmark orientations in two contexts, the first in which a single individual butchers a carcass part, and the second in which several individuals are involved simultaneously in the butchery of a carcass part. In doing so, we aim to test, at least preliminarily, the following hypothesis: do butchers working alone produce less variation in cutmark orientation than several butchers working at once?

2. Materials and methods

A total of five controlled butchery events were conducted, and all involved the processing of complete fore- or hindlimb units from white-tailed deer (*Odocoileus virginianus*), a Size Class 2 animal in Brain's (1974) well-known scheme. The limbs were disarticulated from the thorax beforehand, stored in a freezer with all skin and flesh intact, and then set out to thaw 24 h before the experiments. The butchers were undergraduates with two months of zooarchaeology coursework and no prior experience with animal butchery.

Two experimental scenarios were modeled (Table 1), and all events were video recorded. The first involved an individual working alone to butcher a single limb (two events; Fig. 1), while the second involved a group of four individuals working simultaneously to butcher a single limb (three events; Fig. 1). Apart from a request that they remove as much flesh as possible, a process that necessitated the skinning of at least the upper (humerus and femur) and intermediate (radius-ulna and tibia) limb bones, the participants were given no instructions on how to butcher or when to stop. Some participants ceased butchering once all the major muscle masses had been removed while others continued to fully disarticulate the limbs and even remove tendons. The groups of four were given complete freedom to pursue any strategy they deemed appropriate; no specific direction regarding how, or whether, to divide labor was given at any time. Each individual or group was provided with a collection of unmodified stone flakes that could be discarded, replaced, and/or reused at any time. The long bones from one of the two single butcher events and one of the three multiple butcher events were broken by the participants with an anvil and hammerstone to create fragments that would more realistically mimic those found in an archaeological context. All bones and bone fragments were then collected and bagged by event and cleaned of residual soft tissue following the protocol of Mairs et al. (2004).

Surface marks were identified with hand lenses (10×) and, in some cases, with a binocular microscope (10–40×). Three different types of modification were identified. The first were classic linear slicing cutmarks that possessed deep, V-shaped cross sections. Scrape marks were also present and manifest as clusters of deep, closely spaced parallel striations, many with a "shaved" surface contour that covered relatively expansive portions of cortical surface (see also Blumenschine and Selvaggio, 1988: 765). Real-time observations of the butchery events and review of the video recordings revealed that these marks were created when participants either removed periosteum or scoured bits of flesh from bone diaphyses. The final type of modification was percussion marks, which appeared either as pits with emanating microstriae or isolated patches of subparallel, superficial scratches. Only the slicing cutmarks were considered in this analysis and, in most cases, these could be distinguished morphologically from scrape and percussion marks. Ambiguous marks that could not be confidently identified, either with knowledge of the location of anvil and hammerstone placement, which was carefully recorded for those bones that were fractured, or by referencing the video recordings, were eliminated from the analysis.

Cutmark-bearing bone surfaces were stained with pencil lead and then photographed with a mounted Canon EOS Rebel digital camera. Several photos of each modified surface were taken under various lighting angles to produce images that allowed individual marks to be readily discerned. A single image was sufficient to capture the cutmarks on smaller hammerstone created fragments

Table 1
Summary of experimental butchery events.

Event#	Limb unit	Number of butchers	Broken for marrow?
1	Hindlimb	4	No
2	Hindlimb	4	No
3	Hindlimb	4	Yes
4	Forelimb	1	No
5	Forelimb	1	Yes

[1] Binford (1988: 134) recognized, and lamented, this particular shortcoming in his data, although he could not have predicted all the contexts in which they could, or would, be used, and understandably so.