An Experimental Butchery Study on the Influence of the Amount of Flesh on Resulting Cut Marks

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BACKGROUND

- To date, there is little to no consensus regarding some of the carcass acquisition and processing behaviors that facilitated Oldowan hominin butchery. Questions about whether hominins engaged in hunting or scavenging behaviors to acquire animal tissues, the timing of hominin access to carcasses, and the quantity and importance of meat consumed by Oldowan hominins are still frequently debated.
- Various hypotheses of the relationship between cutmark patterning (especially frequency and location) and the amount of meat present on carcasses prior to butchery – as a proxy for timing of access to carcasses – have been offered. Examples of contrasting hypotheses include Binford's (1986: 446) assertion that a high frequency of cutmarks indicates "extreme difficulty in processing already partially desiccated limbs", versus Bunn and Kroll's (1986) claim that a high frequency of slicing marks would represent the removal of substantial quantities of meat. Experimental butchery studies have not found a relationship between cutmark frequency and pre-butchery meat quantity (e.g. Pobiner and Braun 2005).
- Here we present results from an experiment that manipulated the amount of meat present on ungulate limbs prior to butchery as a proxy for the timing of hominin access to animal carcasses and investigated whether this was related to the number, length, angles, and cluster area of cut marks present on the bones after butchery, following methods developed by Merritt (2015). We also explored possible correlations among these variables.

RESEARCH QUESTION

Does the quantity of flesh present on ungulate limbs prior to experimental butchery affect the following cut mark variables?
(1) cut mark count
(2) cut mark cluster area
(3) median and standard deviation of cut mark length
(4) standard deviation of cut mark angle

Table 1: ***Following Merritt (2015), we predict the following relationships between bulk vs. scrap defleshing and the cut mark variables listed below:***

Defleshing Action	CM Count	CM Cluster Area	Median CM Length	Standard Deviation of CM Length	Standard Deviation of CM Angle
Bulk Defleshing	Less	Greater	Longer	Less	Less
Scrap Defleshing	More	Less	Shorter	Greater	Greater

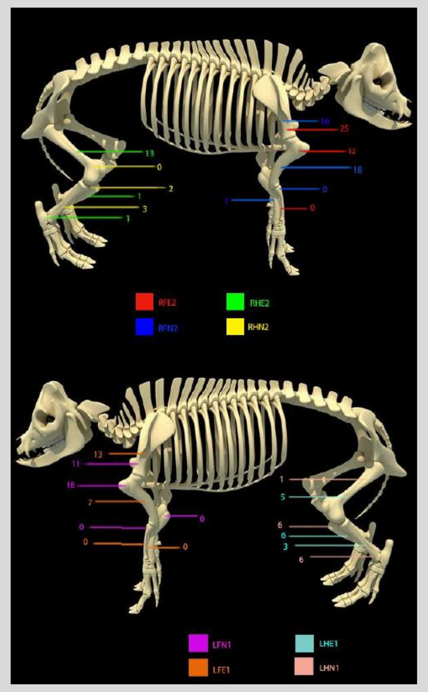

Figure 1: *Distribution of cutmarks on the two pigs. Scapulae were not included in our analyses.*

Figure 2: *Photograph of a cutmark cluster on a humerus.*

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METHODS

- Experimental butcheries of 8 fresh limbs of two young adult domestic pigs (*Sus domesticus*) obtained from a commercial butcher in Maryland, USA were conducted in June 2014.
- The primary variable manipulated was pre-butchery meat quantity on whole limbs. Two categories of pre-butchery meat quantity were used: fully fleshed (as an analog for primary carcass access) and partially defleshed (as an analog for secondary access). Limbs were initially carefully disarticulated from the main carcass using metal knives to insure no cutmarks were inflicted on the bones and weighed. Partially defleshed limbs had 50% of their total mass carefully removed using metal knives, avoiding contact with bone. Flesh was removed predominantly from the upper limbs (femur and humerus) in order to simulate large felid carnivore carcass consumption patterns observed by Blumenschine (1986) and Domínguez-Rodrigo (1999).
- Higson and Schindler each butchered two fully fleshed and two defleshed limbs Simple Oldowan flakes made of argillite and flint made by novice flintknappers were used in equal amounts throughout the butchery. Butchers were given the freedom to choose their own tools from a large selection of flakes of similar sizes and were allowed to use as many flakes as they decided during the butchery. Butchers were given no instructions except to remove as much meat from the limbs as possible, and was no time limit imposed.
- Bones were examined for cutmarks using oblique light and a 10x magnification lens (following Blumenschine et al. 1996). All linear striations were identified and recorded by skeletal element and portion (proximal epiphysis, proximal shaft, midshaft, distal shaft, and distal epiphysis). Cutmarks that crossed over more than one portion were recorded on the portion where the mark was predominantly located. Bones used in analyses were the femur, humerus, radius, ulna, and tibia.
- Following Merritt (2015), we define a cluster of cutmarks as a series of adjacent cut mark striations that occur in an anatomical location and are bounded by unmarked cortical surface. The clusters were individually labeled and the number of cutmarks in each cluster was counted. We made molds of each cluster with 3M Express STE putty and photographs were taken of the cutmarks on both the molds and the bones. Finally, we used ImageJ to measure the length and angle of each cutmark as well as the area of each cluster. Data are presented in Table 2.

Table 2: ***Cut mark summary data for each cluster. Length in mm, angle in degrees.***

Fleshed/ Defleshed	CM Count	Cluster Area	Median CM Length	Length STD	Angle STD
Defleshed	1	n/a	5.778	n/a	n/a
Defleshed	1	n/a	3.905	n/a	n/a
Defleshed	8	83.357	4.535	1.124	82.325
Defleshed	1	n/a	10.165	n/a	n/a
Defleshed	8	99.237	6.757	3.732	9.291
Defleshed	1	n/a	10.787	n/a	n/a
Defleshed	5	75.976	7.008	4.509	7.963
Defleshed	9	136.416	9.736	3.668	86.059
Defleshed	1	n/a	4.587	n/a	n/a
Defleshed	1	n/a	2.239	n/a	n/a
Defleshed	1	n/a	5.091	n/a	n/a
Defleshed	4	11.819	2.175	0.658	29.297
Defleshed	4	79.193	10.358	8.447	13.198
Defleshed	2	7.073	2.039	0.376	16.607
Defleshed	2	3.885	1.893	0.378	14.839
Defleshed	4	13.074	9.095	6.108	14.510
Fleshed	1	n/a	3.82	n/a	n/a
Fleshed	2	13.991	3.465	1.384	14.491
Fleshed	1	n/a	3.724	n/a	n/a
Fleshed	2	7.184	3.147	1.565	12.526
Fleshed	2	17.586	9.949	0.453	3.946
Fleshed	2	35.239	3.928	0.612	2.307
Fleshed	4	81.583	6.682	2.981	6.146
Fleshed	4	47.317	7.801	3.599	6.897
Fleshed	1	n/a	11.659	n/a	n/a
Fleshed	2	8.142	7.871	0.228	0.540
Fleshed	1	n/a	12.830	n/a	n/a
Fleshed	2	22.632	4.853	2.198	16.215
Fleshed	3	43.291	5.746	5.120	79.222
Fleshed	3	1.293	1.421	0.359	18.412
Fleshed	2	1.113	1.257	0.063	2.121
Fleshed	7	49.157	3.801	0.949	29.457

RESULTS

- A total of 92 cutmarks were inflicted on 15 of the 24 skeletal elements in included in this analysis: 7 defleshed bones (n=53) and 8 fleshed bones (N=39). 9 bones were unmarked (8 defleshed and 1 fleshed). The maximum number of cutmarks recorded in any single cluster was 9. Cutmark length ranged from 1.01 millimeters to 18.87 millimeters and cutmark angle ranged from 0°-175.6° across the entire sample.
- Base-10 logarithmic transformations were calculated to avoid outliers skewing the distribution of cut mark attributes following Merritt (2015).
- Kruskal-Wallis tests indicate a significant correlation between the the level of defleshing and cut mark count, but not with cluster area, median length, standard deviation of length, or standard deviation of area (Table 3).
- Spearman correlation analysis indicate significant positive correlations among several pairs of variables that include cut mark count, cut mark cluster area, median cut mark length, and standard deviation of cut mark length (Table 4).

Table 3: ***Kruskal-Wallis test results for differences in mean log-transformed cluster attributes across defleshing actions. Significant p-values are in bold.***

Defleshing Action	CM Count	CM Cluster Area	Median CM Length	Standard Deviation of CM Length	Standard Deviation of CM Angle
χ^2	5.007	1.293	0.505	1.293	0.611
d.f.	1	1	1	1	1
p	**0.025**	0.256	0.477	0.256	0.434

Table 4: ***Spearman correlation test results for cluster attributes across defleshing actions. R-values are listed above the diagonal (shown in cells with x values), p-values are listed below the diagonal. Significant r-values are in bold.***

	CM Count	CM Cluster Area	Median CM Length	Standard Deviation of CM Length	Standard Deviation of CM Angle
CM Count	x	**0.764**	0.387	**0.569**	0.431
CM Cluster Area	5.42E-05	x	**0.639**	**0.683**	0.183
Median CM Length	0.083	0.002	x	**0.628**	-0.181
Standard Deviation of CM Length	0.007	<0.001	0.003	x	0.206
Standard Deviation of CM Angle	0.051	0.425	0.432	0.368	x

CONCLUSIONS

- This study is the first to find a correlation between the amount of flesh on bones before butchery and the number of cut marks produced by butchery, contradicting previous studies (e.g. Domínguez-Rodrigo 1997; Lupo and O'Connell 2002; Pobiner and Braun 2005; Merritt 2015). The reason for this discrepancy is unclear, but one interpretation of this result is that in some circumstances, cut mark count maybe indicative of hominin timing of access to carcasses. A higher cut mark count on defleshed bones supports Binford's (1986) hypothesis that partially defleshed bones would be more difficult to process (although his concern was with partially dessicated limbs), and refutes Bunn and Kroll's (1986) hypothesis that removing a substantial amount of meat would result in a high frequency of cut marks. Further research is needed to determine what may account for this variability in results of different replicate experiments.
- We found that across the entire sample, cut mark clusters with larger areas have more cut marks, longer cut marks, and a higher standard deviation of the length of cut marks.
- This study highlights that opportunity remains for actualistic studies to make some links between butchery marks left on faunal remains and the behavioral and ecological contexts under which those butchery marks were inflicted, as well as the utility of multiple replications of studies that examine the same cut mark variables. Future actualistic studies should aim to determine with greater accuracy the causal links between butchery behaviors and traces, considering a wider range of relationships between of butchery variables that have yet to be tested.

This research was funded by the Peter Buck Fund for Human Origins Research (Pobiner), a Durham University Department of Anthropology postgraduate bursary (Higson), and a Durham University Learning and Teaching Award (Kovarovic). We thank Bobby Kaplan (Smithsonian) for assistance in bone cleaning and statistical analyses, Jennifer Clark (Smithsonian) for bone photography, and Sudlersville Meat Locker for their support.