Cutmark Variation in Experimentally Butchered Deer Bones

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Introduction

- Identifying human-made cutmarks in the archaeological record is challenging, as they can be confused with carnivore toothmarks. Therefore, being able to confidently identify cutmarks is important, because they signal past human behavior!
- Various factors are known to affect cut mark morphology. For example, stone raw materials are known to affect cutmark morphology based on the mechanical properties of the rock (Braun et al. 2016).
- Our study examined whether stone raw materials, cutmark type, and bone element type can influence cut mark morphology and identification.

Methods and Materials

- Photographs and silicone molds were taken of marks identified on experimentally butchered deer bones (Pobiner et al. 2018).
- Each mark was measured using the computer program ImageJ from photographs. A sample of marks were further looked at under a Scanning Electron Microscope (SEM).
- Data were analyzed using different computational analysis such as Linear Discriminant Analysis (LDA).
- Variables collected for analysis include:
  - Nominal: trajectory, shape, symmetry, shoulder effect
  - Ordinal: max length, max breadth, circularity, roundness, orientation, width @25%, width @50%, width @75%, side 1 width, side 2 width

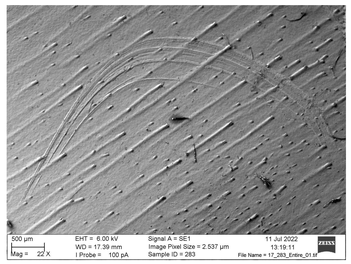

Figure 1: SEM Image of a scrape mark

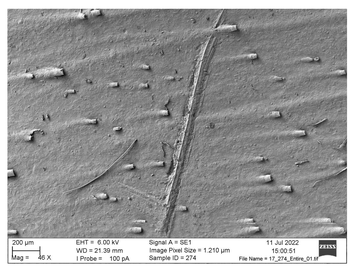

Figure 2: SEM Image of a cut mark

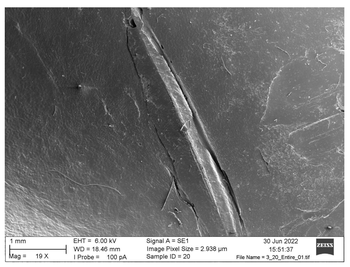

Figure 3: SEM Image of a slice mark

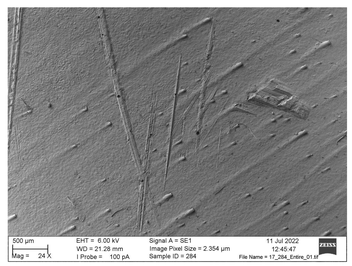

Figure 4: SEM Image of ambiguous modification marks

Figure 5:A reconstruction of an elephant butchery by *Homo erectus* nearly 1 million years ago at Olorgesailie, Kenya. Artisit: Karen Carr, Smithsonian Institution.

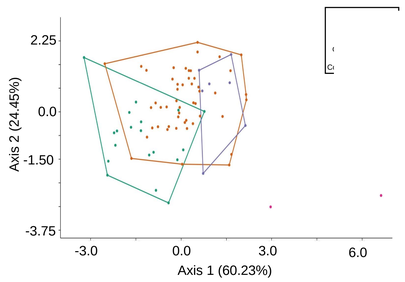

Figure 6: LDA graph using bone element type as controlled variable. There is moderate variation seen between the different bone types.

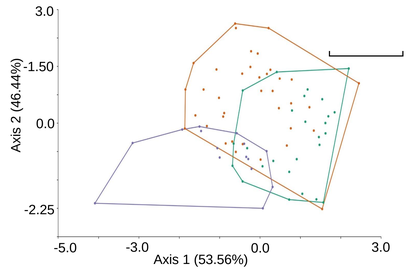

Figure 7: LDA graph using stone raw material as controlled variable. There is moderate variation seen between the different raw materials.

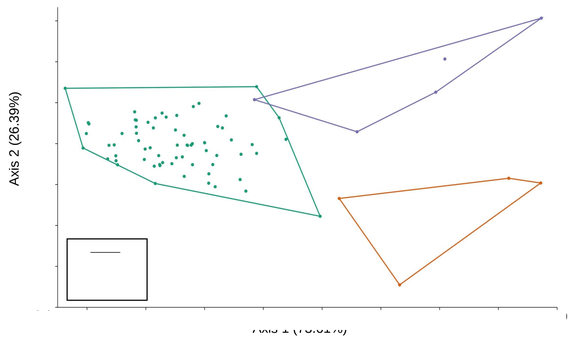

Figure 8: LDA graph using cut mark type as the controlled variable. There is enough variation between the different cut marks to cluster separately. The scrape mark clustered with the cut marks is an ambiguous mark that could be classified under either mark.

	Element						
Cut	263	94	26	74	46	3	506
Cut & Scrape	1	1	0	0	0	0	2
Scrape	52	17	1	5	8	0	83
Slice	18	5	11	13	5	0	52
Chop	0	0	0	2	0	0	2
Cut	2	10	1	55			68
Cut & Scrape	0	0	0	0			0
Scrape	0	2	1	3			6
Slice	0	0	0	4			4
Chop	0	0	0	0			0
Cut	69.12%	5	1.094	67.65%			
Cut & Scrape	0.00%	N/A	N/A	0.00%			
Scrape	33.33%	6	0.727	33.33%			
Slice	50.00%	2	1.202	50.00%			
Chop	0.00%	N/A	N/A	0.00%			

Table 1: Summary of different variables measured using the SEM. Variables were chosen based on Dominguez-Rodrigo et al. 2009

Results

- Three different factors were tested: Stone Raw Material, Bone Element Type, and Cut Mark Type.
- Stone Raw Material: There is overlap between the morphology of cut marks made by all 3 stone tool materials. The raw materials were correctly classified by the LDA analysis 70.51% of the time.
- Bone Element Type: There is overlap between the morphology of cut marks made by different bone types, except for the ulnas which cluster separately. The bone elements were correctly classified by the LDA analysis 79.49% of the time.
- Cut Mark Type: Three identified cut mark types cluster separately, indicating enough variance to separate mark type. Cut mark morphology was correctly classified by the LDA analysis 97.4% of the time.

Conclusion & Future Directions

- **Stone Raw Material**: Overlap in cut mark morphology between raw materials shows that there is a moderate amount of variance between the raw materials. However, there is not enough variance to confidently differentiate between raw materials.
- **Bone Element Type**: Overlap in cut mark morphology between bone elements shows that there is a possibility that humans butcher different types of bones differently. Although there is overlap, bones that overlap are similar in shape such as femurs and humeri. The ulna is most distinct, demonstrating that there might be some variance in how different bone types are butchered.
  - This raises the question if bone element type should be controlled when examining cut marks.
- **Cut Mark Type**: The different cut mark types cluster separately indicating that there is significant variance between them.
  - The scrape mark that is clustering with the cut marks is a mark that is very ambiguous, as it can be mistaken as either type of mark (scrape or cut).
- Future Directions include:
  - **Increasing sample size.** Due to the limited amount of time, the sample size that was looked under the SEM was a smaller subset of all the samples available. Although chosen at random, it is not representative of the entire sample.
  - **Measure carnivore tooth marks.** A common question is if human-caused cut marks can be differentiated from carnivore tooth marks. By including carnivore tooth marks in the future, we can explore whether these findings extend to a different type of bone surface modification, and whether our methods can differentiate between carnivore tooth marks and human-made cut marks.

Acknowledgements

A special thanks to Vanessa Gonzalez, Ioan Lascu, Virginia Powers, and the rest of NHRE. Would also like to thank Phoebe Fu and Scott Whittaker for all their help on the SEM. Finally, would like to thank the Smithsonian Institution NMNH for financially supporting this research project.

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