Quantitative Analysis of the Micromorphology of Trampling-Induced Abrasion and Stone Tool Cut Marks on Bone Surfaces

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Research Question
Can trampling-induced abrasion be effectively distinguished from stone tool cut marks using high-resolution 3-D scanning?

Background
It has been suggested that trampling-induced bone surface modification may produce marks similar to those of stone tools[1, 2, 3], leading to controversy over claims of hominin activity in faunal assemblages. Past research has relied on 2-D microscopic analysis of the qualitative features of mark micromorphology to distinguish between causal agents with limited success[1, 2, 3, 4, 5]. This study is the first to employ high-resolution 3-D profilometry to distinguish trampling marks from stone tool cut marks, a methodology that has been shown to be effective in bone surface modification analysis[6].

Methods
• Trampling marks were induced by directing cattle over fragments of long bone scattered in sandy soil sediment in a confined area.
• Cut marks were created both on long bone fragments using a standardized cutting machine with flakes and bifaces of basalt, phonolite, chert, and quartzite sourced from Olduvai Gorge as well as through actualistic experimental butchery trials.
• 3-D reconstructions of bone surface modifications were produced using a Nanovea ST400® white-light confocal profilometer. Scans were processed using Digital Surf’s Mountains® software.

Results

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<thead>
<tr>
<th>3-D Measurements</th>
<th>Profile Measurements</th>
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<tr>
<td>Surface Area (µm²)</td>
<td>Volume (µm³)</td>
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<td>Trample</td>
<td>Mean</td>
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<td>Median</td>
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<td>Cut</td>
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<td>Standard Deviation</td>
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Mann-Whitney p-values: 0.91 > 0.05, 0.61 > 0.05, 0.12 > 0.05, <0.01*, 0.35 > 0.05, <0.01*, 0.06 > 0.05, 0.04* <0.01, 0.67 > 0.05, <0.01*, 0.01* <0.01

Table 1: Mean, median, and standard deviation for trample and cut mark measurements (Mann-Whitney test used due to nonparametric distribution; * indicate statistical significance).

Discussion
• The discriminant analysis was capable of distinguishing trampling marks from stone tool cut marks with 95% accuracy. When misclassified, trampling marks were most often mistaken for cut marks created by biface tools.
• Future research will expand sample sizes and include a variety of sediment types for trampling. This experimental database will also be applied to archaeological material along with data from carnivore tooth marks and percussion marks.

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References