



Identifying the accumulator: Making the most of bone surface modification data



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ABSTRACT

Taphonomic analysis is an essential component of zooarchaeology, but is employed in different ways within different research traditions. Within the Africanist Palaeolithic literature, there is a strong emphasis on quantitative comparison of proportions of different bone surface modifications to one another and to proportions observed on modern experimental collections. This work has been driven by debates about the taphonomic histories of Oldowan sites that document the subsistence strategies of early *Homo*, but this specific approach can be usefully applied to a range of contexts across many different time periods and geographic locations. One obstacle to the cross-fertilization of this taphonomic tradition with other zooarchaeological work is the restrictive manner in which data are selected from an assemblage for analysis. To ensure comparability between fossil and modern assemblages, analysts typically exclude specimens with evidence for post-depositional modification not modeled in the experimental data. Although this adds interpretive robustness, it can diminish sample size significantly, sometimes to the point of affecting statistical analyses, and results in much time invested in collecting data that ultimately are not used. Here, we describe a new method for maximizing the number of specimens that can be incorporated into analysis, thus resolving the persistent problem of poor sample sizes to make more statistically robust comparisons to actualistic datasets.

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1. Introduction

The goal of this paper is to report procedures that will allow faunal analysts to make the most of bone surface modification (BSM) data as they make direct comparisons between proportions of modified bone in archaeological and actualistic assemblages. Pioneering work in the 1980s on faunal collections challenged the idea that archaeofaunas could be interpreted as the sole residues of human or early hominin behavior (Binford, 1981, 1984; Brain, 1981). Analysis of BSM such as cut marks and carnivore tooth marks now plays a central role in this work, as researchers attempt to disentangle the potential contributions of humans, carnivores, raptors, rodents, reptiles, and other bone-accumulating agents

(Domínguez-Rodrigo et al., 2014a; Grayson and Delpech, 2003; Lyman, 2005; Marean et al., 2000; Patou-Mathis, 2000).

Although much of the inspiration derived from early work in North America by White (1955) and Binford (1978), the specific use of BSM has since diverged into slightly different traditions. All traditions rely to some extent on actualistic observations that different agents leave diagnostic traces on bones when they interact with them (Amore and Blumenschine, 2009; Armstrong and Avery, 2014; Baquedano et al., 2012; Blumenschine et al., 1996; Gidna et al., 2013; Marín-Arroyo and Margalida, 2012; Monnier and Bischoff, 2014; Parkinson et al., 2015; Saladié et al., 2013b). The strongly quantitative BSM tradition in New World contexts emphasizes the comparison of mark abundances between sites, taxa, body sizes, and skeletal elements (Burke, in press; Lyman, 2005). In Eurasia, emphasis is on reporting and comparing the abundances of BSM at archaeological sites or on different skeletal parts (Grayson and Delpech, 2003; Patou-Mathis, 2000; Rabinovich et al., 2008). In Africa, Paleolithic archaeologists

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rely on relative proportions of BSM from actualistic assemblages to guide interpretations of proportions of archaeological BSM. These different approaches to the quantitative analysis of BSM are arguably rooted in the questions that are typically asked under each research tradition. In the New World and Europe the focus is on understanding differential exploitation of various taxa and on butchery patterns, while in Africa there is more preoccupation with identifying exactly which parts of an assemblage were or were not human-accumulated.

2. Background

This Africanist reliance on using proportions of actualistic BSM to interpret archaeological BSM proportions grew from a series of debates about where early hominins fit into the sequence of access to fleshed carcasses relative to other consumers such as vultures and mammalian carnivores. Ongoing controversy has revolved around the appropriateness of different experimental analogues and the ability of analysts to correctly identify BSM, but even within this debate there is agreement that relative BSM proportions compared to experimental assemblages are a useful measure of the sequence of carcass access (Blumenschine, 1995; Blumenschine et al., 2007; Bunn and Kroll, 1986; Domínguez-Rodrigo, 2015; Domínguez-Rodrigo and Barba, 2006, 2007; Domínguez-Rodrigo et al., 2014b; Pante et al., 2012; Pante et al., 2015).

The same approach has also been found to be useful in much later time periods, where the objective is determining the relative contributions of humans, carnivores, rodents, and raptors to the accumulation of fossil faunal assemblages. Such analyses have again been primarily deployed in Africa, at sites ranging from the Middle Pleistocene to the late Holocene of South Africa (e.g., Die Kelders Cave 1 (Marean et al., 2000), Boomplaas Cave (Faith, 2013), Blombos Cave (Thompson and Henshilwood, 2011), and Pinnacle Point Cave 13B (Thompson, 2010)). However, they have also been used in Europe at Roc de Marsal, Pech de l'Azé IV (Hodgkins et al., 2016), Vogelherd, and Chez-Pinaud Jonzac (Niven, 2007; Niven et al., 2012). In China, they have been used at Xujiayao (Norton and Gao, 2008), and in Russia at Mezmaiskaya Cave (Hoffecker and Cleghorn, 2000). We argue that explicit comparison of archaeological BSM proportions to experimental BSM proportions should continue to expand in its application outside of Africanist Paleolithic archaeology, and in complement to research traditions elsewhere.

This approach to BSM analysis involves the direct comparison of frequencies of archaeological marks or traces to those observed in actualistic assemblages where the accumulator is known. It is used at sites where a high degree of confidence can be assigned to the identification of the BSM as being from particular agents (e.g. tool-using hominin, carnivore, rodent, etc.). It is not applicable in cases where there are very small total numbers of BSM (human-inflicted or otherwise) and/or where the context of the BSM is controversial. The problem of equifinality in the identification of the bone accumulator when BSM is poorly-represented and surfaces badly preserved is a global issue, and prominent examples include Dikika-55 in Ethiopia, the Quranwala Zone, Masol Formation in India, the Bluefish Caves in Canada, and Arroyo del Vizcaíno in Uruguay (Bourgeon et al., 2017; Fariña, 2015; Malassé et al., 2016; McPherron et al., 2010). At other controversial sites, bone breakage patterns but not specifically BSM are primary lines of faunal evidence subject to equifinality (Holen et al., 2017). Our purpose is not to add to the extensive literature on mark identification, but to address the problem of interpreting relative mark frequencies within an actualistic framework after marks have been identified.

This paper deals specifically with the problem of how to

determine the relative proportions of hominin and non-hominin contributions to faunal assemblages that meet the following three criteria: 1) Contain at least some non-controversial archaeological materials other than modified bone; 2) Date to a time period and geographic region where it is not controversial that humans were a part of the bone-modifying landscape; 3) Include a large amount (hundreds) of identifiable BSM, thus significantly reducing the probability that all represent cases of equifinality or mis-diagnosis.

The main modifications that are used are cut marks, percussion marks, and carnivore tooth marks – with accessory evidence drawn from gastric etching and rodent gnaw marks. This approach of quantitatively comparing relative frequencies of BSM in a zooarchaeological assemblage to those in actualistic assemblages is one that is thus applicable to a range of contexts, useful for addressing a variety of questions, and which we argue can and should also be employed regularly outside of the Africanist Paleolithic research sphere. However, this approach can be cumbersome in that it requires much manipulation of zooarchaeological data in order to make them comparable to published actualistic datasets.

3. Analytical challenge

In order to compare archaeological data to actualistic assemblages, the most comparable subset of archaeological data must be selected. Most published actualistic assemblages are not standardized in their methods or the kinds of bones that are input into the system (James and Thompson, 2015), but there are some general regularities. Assemblages are often published in terms of frequencies of marks occurring on specimens larger than 2 cm, and because they are modern bones they have not been subjected to the same post-depositional taphonomic surface alterations and fragmentation as have archaeological examples. Blumenschine and Marean (1993) and others have experimentally shown that midshafts provide greatest discriminatory power in actualistic assemblages, and Abe et al. (2002) have demonstrated how post-depositional fragmentation reduces total frequencies of BSM. Therefore, in order to maximize comparability between the archaeological and actualistic samples, researchers typically exclude archaeological specimens if they are not midshaft fragments, if they are smaller than 2 cm, if they have poorly preserved or obscured surfaces, or if there is evidence of post-depositional breakage. The establishment of such an analytical subset is commonplace in the taphonomic literature, but leads to the exclusion of a large amount of data and can severely limit what are already often small sample sizes (Assefa, 2006; Domínguez-Rodrigo et al., 2009; Egeland et al., 2004; Hodgkins et al., 2016; Pante et al., 2012; Pickering et al., 2008; Pobiner et al., 2008; Thompson, 2010; Thompson and Henshilwood, 2011).

The issues of fragment size and post-depositional breakage have some of the greatest potential to impact sample size. Especially for sites that already have large numbers of smaller fauna, the same fragmentation processes that depress BSM frequencies can lead to archaeological assemblages where fragments, including midshafts, are almost all smaller than 2 cm in the maximum dimension and/or have a post-depositional break (Clark and Ligouis, 2010). This raises the potential for there to be a differential impact on taxa of different body sizes, as smaller taxa (which fragment into smaller pieces) will have their sample sizes reduced more severely than larger taxa (which are more likely to retain fragment sizes >2 cm). This potentially also makes it very difficult to compare sites or layers within sites that have different body size representations, as it introduces an unmeasured source of variation into comparisons with experimental BSM. Also problematic is the fact that long bone flakes are usually smaller than 2 cm (Marean and Bertino, 1994),

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