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Middle stone age point technology: Blind-testing the damage distribution method

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ABSTRACT

In this paper we present further experimental validation for the damage distribution use-wear method. By reproducing the technique with a replicated tool assemblage we demonstrate its ability to distinguish between tools used as cutting/scraping implements and those with hunting, drilling or piercing functions. The method was also applied to a sample assemblage of unretouched Middle Stone Age points from the Magubike archaeological site, southern Tanzania, in combination with a conventional macro-wear approach. The results of the study suggest that points from Magubike had multiple functions including use as projectile armatures and cutting/scraping tools. These differences in function appear to conform to lithic raw material type, which indicates that tools users were selective in their use of stones.

1. Introduction

The emergence of hafted hunting weaponry such as stone-tipped thrusting or hand-cast spears and later the spear thrower and bow and arrow marked a major transition in the resource procurement systems of early human foragers. Evidence suggests that the earliest forms of these weapons appeared in southern Africa during the transition from the Early Stone Age (ESA) to the Middle Stone Age (MSA) by at least 250 thousand years ago (kya) (Rots, 2013; Rots and Plisson, 2014), and possibly as early as 500 kya (Wilkins et al., 2012, 2015; for a review see Lombard, 2016). For the most part, these early hafted hunting weapons were composed of unretouched triangular flakes affixed to an organic handle using some combination of binding and/or mastic material. These artifacts are found at many sites across Africa and are often assumed to be spear armatures on the basis of morphological similarities with more recent projectile technology and existing functional research (Brooks et al., 2006; Donahue et al., 2004; Milo, 1998; Wilkins et al., 2012). Nevertheless, we should be wary about assuming that all points shared a comparable function in light of contrasting studies showing that points frequently had complex use-lives, which may or may not have included a hunting function (Schoville, 2010; Van Gijn, 2009; Wendorf and Schild, 1993).

Although use-wear analysis is theoretically well-positioned to provide insight on this topic, in practice, the analysis of MSA points has proven challenging for several reasons (Donahue et al., 2004; Shea, 2006). Prior to recovery, many MSA artifacts are exposed to significant levels of post-depositional damage which may act to erase or confuse use-wear and residue signatures. MSA tools manufactured from coarse-grained materials are also often resistant to analysis, further limiting the pool of viable specimens (Conte et al., 2015; Shea, 2006). Lastly, diagnostic polishes do not always develop even on experimental hunting weapons, possibly because the period of use is so brief (Rots and Plisson, 2014).

Nevertheless, some recognizable types of damage appear to be correlated with high velocity impact from which a hunting function can be inferred (Fischer et al., 1984; Lombard, 2005; Odell and Cowan, 1986). These traces are referred to as diagnostic impact fractures, or DIFs. Although DIFs are one of the preferred ways of identifying hafted hunting weapons in the archaeological record they are not always present on experimental projectiles, and are sometimes found in low frequencies on tools as a result of manufacture or trampling (Pargeter, 2011). This ambiguity limits the utility of DIFs to some extent but may be overcome by analyzing assemblages of artifacts rather than individual specimens. Furthermore, a shared inventory of diagnostic fracture types and terminology has not fully coalesced, resulting in confusion in the reporting of findings (Coppe and Rots, 2017).

In the last decade another method of identifying hunting weapons has been developed and applied to MSA sites in southern Africa (Bird et al., 2007; Wilkins et al., 2012, 2015; Schoville and Brown, 2010; Schoville, 2010, 2014, 2016). The damage distribution method relies on plotting the distribution of edge damage using geographic information system (GIS) software at an assemblage scale, and has been shown to be effective at categorizing assemblages of points. The premise is that as stone tools are used they accrue the most damage on the

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portion of the edge that is in the most repeated or vigorous contact with the worked surface (Schoville, 2014, 2016). These aggregated damage profiles can then be compared to a reference collection of experimental tools using regression analysis to identify the primary manner with which they were used. At Pinnacle Point, South Africa, the method implied a scraping rather than hunting function (Schoville, 2010; Schoville and Brown, 2010) whereas at Kathu Pan 1, South Africa, the results of the method were used to argue that an assemblage of points were used as spear armatures (Wilkins et al., 2012, 2015). The technique has the potential to be particularly useful for classes of artifacts which are otherwise resistant to conventional use-wear analyses, such as heavily patinated or coarsely grained stones. It is also claimed to be more objective than conventional methods as it relies on statistical rather than visual comparison. Nevertheless, it is important to be aware that the damage profile of an individual specimen is unlikely to be informative about its function or the function of similar artifacts. Best practice dictates that the method be applied to assemblages of associated artifacts. It is also unlikely that specific contact materials could be identified in this way. For the time being, we make the conservative assertion that the method is best suited to distinguishing between two basic functional modes, which we term tip-dominant and marginal. Tip-dominant assemblages feature a large proportion of damage concentrated at the tips of the artifacts and are associated with uses like hunting, drilling, boring and piercing. Marginal assemblages, on the other hand, are correlated with a variety of cutting and scraping tasks, which causes damage to be dispersed across the lateral margins of the points. This premise should be true regardless of the lithic type or the contact material. Clearly, there is likely to be overlap between these modes; however, the distinctions that emerge at the level of the assemblage prove sufficient to test important archaeological hypotheses.

Nevertheless, scholars like Rots and Plisson (2014) have raised important theoretical and methodological concerns and caution against the use of the technique. They remain skeptical that the damage distribution method is capable of extracting a coherent pattern from the “noise” introduced by post-depositional damage. This concern is supported by their observation that post-depositional damage is not randomly distributed across artifacts or assemblages, and thus cannot simply be subtracted. However, this claim is contradicted by experimental work that shows the opposite to be true (Asryan et al., 2014; Grosman et al., 2011; Schoville, 2014; Venditti et al., 2016; Wilkins and Schoville, 2016).The more pressing issue they advance is a lack of experimental validation, most notably a lack of blind-testing. We agree with this second point, and thus, the initial stage of our research was devoted to validating the damage distribution method using an experimental collection of points. Another possible confounder of this method is a failure to account for drilling/piercing/perforating as a use-mode. Although evidence for drilling technology during the MSA is surprisingly rare (Orton, 2008) it seems likely that drilling would result in a tip dominated damage profile similar to spear use. This possibility was approached in this study by creating and testing an experimental collection of drilling implements. Lastly, the damage distribution method was applied to a series of MSA points from Magubike Rockshelter, Tanzania. This is the first time that this method has been applied to an eastern African assemblage of prospective hunting weapons.

2. Materials and methods

2.1. Edge damage distribution method

To determine the function of the experimental and Magubike points the distribution of macroscopic damage on the margins of the tools was plotted following a modified version of the method described in Schoville (2016). In this study an image analysis approach was integrated with the existing procedure to increase its objectivity, replicability and the speed at which it can be performed. Because the original technique has been presented in detail elsewhere only a brief overview is provided below.

To document the location of edge damage photographs of the artifacts were uploaded to ESRI ArcMap 10.3 and geo-referenced, allowing them to be measured by the in-suite tools. Photographs were captured using a DSC-W330 digital camera mounted on a tripod directly above the specimens. The artifacts and replica tools were photographed against a backdrop of a 1 cm by 1 cm grid for the purpose of geo-referencing. A polyline shapefile was created for each specimen that conformed to the silhouette of the point. The shapefiles were then split to indicate the damaged and undamaged sections of each margin. All observed pre-patination edge damage, regardless of hypothesized source, was documented in this way using ArcMap. Edge damage was identified with the unaided eye and verified at 40–50× magnification using a Dinolite pro digital microscope. The data were then exported and a regression analysis was performed using IBM SPSS v24 to determine the likeliest source of damage for the Magubike points as well as the experimental assemblage consisting of scraping tools and spears (described in detail below). Potential damage sources (which were entered as predictor variables in SPSS) considered in this analysis were derived from the supplementary data in Schoville et al. (2016) as well as a series of experimental drills manufactured by JW (also described later in this section). Damage profiles from butchery implements and flakes used to field-dress carcasses (both from Schoville et al., 2016) feature high proportions of lateral wear and a result of either variable from the regression analysis was assumed to support a hypothesis of marginal use. Alternately, experimental spear-use (from Schoville et al., 2016) and drilling (this article) produce damage largely on the tips of the points and are thus consistent with tip-dominant usage. The third possibility is that the points were significantly damaged by taphonomic sources which was tested by including variables generated from a trampled assemblage and another that had been damaged in a rock tumbler (from Schoville et al., 2016). A result of either of these variables was taken to indicate that the flakes were too badly damaged to extract an interpretable functional signal.

The method described above was modified in this study by incorporating image analysis techniques in the creation of the shapefiles for each specimen. Image analysis refers to any process whereby information is extracted from digital imagery. It is particularly useful for pattern identification or the quantification of image parameters. In the method outlined in Schoville (2010, 2016) the author traced the edges of points by hand in GIS to create the necessary point shapefiles (Schoville, personal communications). Although likely sufficient for the level of detail required this step represents a potential source of error and repeated tracings will almost certainly differ to some extent. To strengthen this aspect of the analysis tools available within ArcMap were used to automatically detect the edges of the point and transform the silhouette into a polyline shapefile. To better allow the program to accomplish this task the raster images were reclassified using the “reclassify” tool available in the “spatial analysis” toolbox. All the pixel values which corresponded to the background were reclassified as “0” while the range of pixel values corresponding to the foreground (the point) were reclassified as “1”. Once the image is reclassified, the “raster to polyline” tool in the “conversion” toolbox can be used to transform the image into a shapefile. The “raster to polyline” tool operates by finding the limits of the point and creating a polyline that adheres to the margins of the artifact. The entire process takes only a few seconds, at which point a copy of the original image can be overlain back onto the new shapefile so that damage can be observed and plotted. The tools in ArcMap also increase the speed at which samples can be processed, allowing a larger sample to be analyzed with greater precision.

In addition to recording and analyzing edge damage using GIS software, evidence of damage due to high velocity impact was also noted. Because of the continued confusion concerning DIF terminology, we adopted the attribute based approach developed in Coppe and Rots (2017). These features are typically visible with the unaided eye but