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Landscape-scale variation in hominin tool use: Evidence from the Developed Oldowan

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ABSTRACT

The relationship between artifact manufacture, use, and discard in the Developed Oldowan is complex. Here we use digital-image-analysis techniques to investigate the intensity of reduction in single-platform cores of the Developed Oldowan of the Okote Member, Koobi Fora Formation. Data suggest that this method provides a more accurate measure of reduction intensity than previous applications of a unifacial-scraper model. Assemblages of single-platform cores excavated from extensive lateral exposures of the Okote Member provide insights into the relationship between raw-material availability and discard patterns. Variation in reduction intensity suggests that tools are not always discarded in patterns that would be predicted by the availability of raw material. Further, it appears that hominin transport decisions involved an assessment of the potential use-life of certain forms. Many aspects of Developed Oldowan technology conform to previously developed models of curated technologies.

Introduction

Stone tools represent one of the largest repositories of evidence about human behavior in the past. Recently, new approaches that incorporate aspects of cognition and sequences of reduction in the analysis of Early Stone Age artifacts have developed a more complete picture of hominin tool use (Stout et al., 2000; Stout, 2002; de la Torre et al., 2003; de la Torre, 2004; Delagnes and Roche, 2005). One approach that is providing new perspectives on the nature of Early Stone Age hominin behavior is the analysis of artifact occurrences relative to their sedimentological and paleoenvironmental contexts (Rogers et al., 1994; Dominguez-Rodrigo et al., 2002; Quade et al., 2004). In many studies of Early Stone Age artifacts, the smallest unit of analysis is still counts of artifact types. This method renders a major portion of the variation between Oldowan archaeological assemblages invisible. The combination of a contextual approach with a more quantitative investigation of Oldowan artifact variation will broaden the understanding of the adaptive nature of Oldowan technologies.

A major problem with Early Stone Age lithic analysis is that archaeologists have no independent way of understanding artifact variation other than commonsensical functional interpretations of artifacts (e.g., choppers, scrapers). Many studies of Oldowan artifacts have opted for an approach that views artifact variation as the result of the demands of specific environments within the constraints of raw-material availability and quality (Rogers et al., 1994; Brantingham, 1998; Kimura, 2002). In this framework, the availability of stone for the production of artifacts is a resource that has a variable influence on hominin behavior depending on the need for sharp-edged stones (Longo et al., 1997; Blumenschine and Peters, 1998; Blumenschine et al., 2008). Numerous studies show that when raw-material sources are scarce, artifacts exhibit higher levels of reduction (Munday, 1977; Bamforth, 1986; Marks et al., 1991; Roth and Dibble, 1998). This reductionist approach to artifact analysis has shown promise in applications to various time periods (Hayden, 1989; Dibble, 1995a; Brantingham, 2003; Shott, 2007). This perspective incorporates aspects of technological organization and the adaptive significance of discard and transport behaviors (Kuhn, 1995; Beck et al., 2002). Studies that address technological organization can begin to explain how hominin decisions formed the archaeological record (Schick, 1987; Potts, 1991). Providing empirical evidence for these behavioral patterns has proved difficult in the Early Stone Age because of the simplicity of tool kits in this time period.

This study focuses on assemblages of single-platform cores (Ludwig and Harris, 1998) at Developed Oldowan sites from the Okote Member (1.6–1.4 Ma) (McDougall and Brown, 2006) of the Koobi Fora Formation, northern Kenya. Analytical steps are detailed that support the application of digital-imaging techniques to models of unifacial tool reduction. We apply previously developed

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models of unifacial reduction (Dibble, 1995a; Shott, 1995) to an understanding of the concept of artifact curation and economization in Developed Oldowan industries (Karari Industry). We investigate these patterns within the context of landscape-scale distributions of raw material. Early Stone Age toolmakers may have been sensitive to varied levels of raw-material availability. This behavioral pattern would be reflected in a correlation between raw-material availability and toolkit maintenance. Hominins may have extended the use-life of their tools by delaying discard until their tools were extensively reduced. Results suggest that Early Stone Age toolmakers curated their toolkit at varying levels depending on variation in raw-material availability over relatively small geographic scales. Furthermore, Oldowan hominins chose to transport cores that had longer potential use-lives into regions of reduced raw-material availability. However, it is clear that factors other than raw-material availability drove the variation in reduction intensity across the landscape in Early Stone Age contexts (Blumenschine et al., 2008).

Background

The effect of reduction on assemblage composition of stone tools was first identified by Frison (1968). Since then, the perspective that reduction has a transformational effect on the archaeological record of stone artifacts has had a major impact on stone-artifact analysis (Holdaway, 1989; McPherron, 1994; Neeley and Barton, 1994; Barton et al., 1996; Hiscock, 1996; Shott, 2007). The application of this model to unifacial flake tools influenced the study of Eurasian stone-artifact assemblages. Studies of Mousterian industries (Dibble, 1987; Dibble and Rolland, 1992) postulated that the frequency of artifact types that had previously been attributed to cultural entities (Bordes, 1973) or functional variants (Binford, 1973) were plausibly the result of different levels of reduction intensity. Rolland and Dibble (1990) hypothesized that compound scrapers (e.g., dejete scrapers, Mousterian points, and convergent scrapers) represent higher levels of reduction than simple scrapers (e.g., single and double scraper forms). This hypothesis could only be tested with an independent method of determining increased reduction of "compound forms." Unfortunately, the evidence for this reduction lies in the fragments of the tools that had already been removed from the edges of flake scrapers. Rolland and Dibble (1990) suggested that the platform of these unifacial flake tools could be used to reconstruct their prereduction size.

The use of ratios of platform to flake size to determine reduction intensity has received criticism (Kuhn, 1992; Gordon, 1993; Clarkson, 2002; Eren et al., 2005). However, the association between platform measurements and flake measurements continues to be of interest in lithic studies (Dibble, 1997; Pelcin, 1997b,c; Davis and Shea, 1998; Dibble, 1998; Pelcin, 1998; Shott et al., 2000). An association between platform and flake measurements may provide a size- and shape-independent method of understanding tool use-lives and curation (Shott, 1989, 1995; Shott and Sillitoe, 2004, 2005).

Reduction of unifacial flake tools

Dibble and Rolland's (1992) model of unifacial scraper reduction is one method that may allow the calculation of prereduction tool size. This technique uses the size of platform attributes (platform area) relative to the size of unifacial flake scrapers (flake area or mass) to determine the intensity of reduction. The underlying assumption is that platform area is directly correlated with the size of the flake prior to reduction (Dibble, 1997; Davis and Shea, 1998; Shott et al., 2000). Consequently, the size of a unifacial flake scraper relative to its platform is an accurate measure of reduction. Here we apply this technique to unifacially flaked pieces made on large flakes from Developed Oldowan assemblages to explore reduction intensity in an Early Stone Age technological context.

Recent reviews of the use of whole-flake platform area relative to flake size suggest that there may be problems with using this method to predict the degree of unifacial flake reduction (Eren et al., 2005; Hiscock and Clarkson, 2005). Studies that use information from fracture mechanics to investigate archaeological questions suggest more work is needed to refine this measure (Dibble and Pelcin, 1995; Dibble, 1997; Pelcin, 1997a,b). The most recent empirical approach has shown that platform size is a useful predictor of flake size when regressions are calculated using logarithmic functions (Shott et al., 2000). Yet, even in the latter study, the ability to predict flake size from platform measurements still suffered from gross over- and underestimations. Dibble (1998) suggested that measurements suffer from both systematic error and random error. Systematic error stemmed from problems with the functions used to predict flake size and will likely be corrected by further refinement of fracture mechanics. A more formidable obstacle is random error. Random error originates from the nature of the measurements used in these functions. Artifact measurements are often defined in a way that allows the least interobserver error. For example, platform area, which is used in many functions of flake-size prediction is merely the platform width multiplied by platform thickness. This is only an accurate estimation for platforms that resemble rectangles (Fig. 1). However, few flake platforms resemble rectangles, and worse yet, the separation from rectangular form is neither systematic nor predictable (i.e., larger flakes are no less rectangular than smaller flakes). Considering these confounding variables, *any* association between platform measures and flake measures is rather remarkable. Here we employ higher-resolution techniques to capture platform area that may strengthen predictive models.

Materials and methods

Reduction of Oldowan unifacial scrapers

This study investigated the landscape distribution of artifact reduction and curation behaviors in the Developed Oldowan by applying the methods developed for unifacial flake reduction to multiple assemblages of single-platform cores in the Koobi Fora Formation. Single-platform cores, or "Karari scrapers," are large (5–10 cm) unifacial cores often made on large flakes (Harris and Isaac, 1976; Ludwig and Harris, 1998). Often, the original platform of

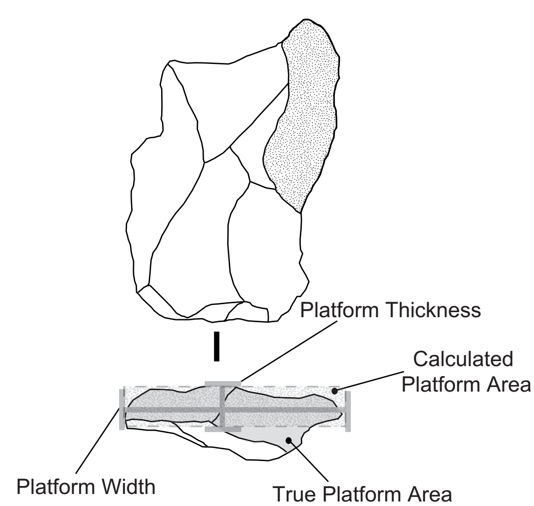

Fig. 1. Different measures of platform area.