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Pounding tools in HWK EE and EF-HR (Olduvai Gorge, Tanzania): Percussive activities in the Oldowan-Acheulean transition

Adrián Arroyo*, Ignacio de la Torre

Institute of Archaeology, University College London, 31-34 Gordon Square, London, WC1H 0PY, UK

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ABSTRACT

In this paper, we present pounded objects from excavations at HWK EE and EF-HR, which are studied from macro and microscopic perspectives. Analysis of HWK EE revealed one of the largest collections of percussive objects from Olduvai Gorge, while excavations at EF-HR have allowed us to recover a much wider collection of percussive tools than previously recorded. Differences are observed between the two localities. At the Acheulean site of EF-HR, percussive tools were predominantly used in the production of flakes and large cutting tools (LCTs). At the Oldowan site of HWK EE, the tool repertoire probably related to a wider range of activities, including bone breaking and bipolar knapping. Comparison of these two assemblages, potentially produced by different hominin species, helps provide a wider picture of pounding activities during the Oldowan-Acheulean transition at Olduvai Gorge.

1. Introduction

Interest in determining the function of percussive tools began early in African Stone Age studies, as illustrated by debate on the use of so-called 'bolas' and spheroids (Gobert, 1910; Leakey, 1931, 1950, 1971; Clark, 1955; Willoughby, 1985; Schick and Toth, 1994). Since then, researchers have included pounding tools in their technological analyses of Early Stone Age (ESA) assemblages documented across the East African Rift valley (e.g., Leakey, 1971; Isaac, 1997; Chavaillon, 2004; Piperno et al., 2004; Delagnes and Roche, 2005; Mora and de la Torre, 2005). More recent research has developed techniques to differentiate marks caused by natural agents from use-wear traces produced during percussive activities (Caruana et al., 2014). This has been accompanied by the development of more quantitative approaches to the study of wear traces on pounding tools (de la Torre et al., 2013; Caruana et al., 2014; Benito-Calvo et al., 2015).

Functional analysis through microscopic studies has been used extensively to assess activities on Palaeolithic sites. Despite the limited number of use-wear analyses conducted specifically on ESA assemblages to study the function of flakes (e.g., Keeley and Toth, 1981; Sussman, 1987), new investigations have shown that hominins manufactured and used stone tools to prepare not only meat but also a variety of plants (Lemorini et al., 2014; Melamed et al., 2016), emphasizing the diversity of hominin diet. It has been hypothesized that during the ESA, hominins used percussive tools to process nuts (Goren-Inbar et al., 2002, 2014, 2015), as well as plants and meat (e.g., Willoughby, 1985; de la Torre et al., 2013). Taphonomic studies have shown that hominins broke bones to access marrow (Bunn, 1981; Blumenschine and Selvaggio, 1988; Pobiner, 2007; Pobiner et al., 2008; Ferraro et al., 2013). Others have noted the benefits of pounding food in the absence of fire (Carmody and Wrangham, 2009) and the importance of consuming nuts, fruits, and tubers as a source of nutrients (Peters, 1987). Primatological studies show that nuts, processed through pounding activities, represent an important source of food for West African chimpanzees (Yamakoshi, 1998), and ethnographic studies indicate the importance of percussive activities among hunter-gatherers (Murray et al., 2001).

In her seminal publication on Olduvai Gorge, Mary Leakey (1971) described a series of objects under the category of 'utilized material,' which grouped tools bearing percussive traces such as anvils and hammerstones. Subsequent re-analysis of Olduvai lithic assemblages emphasized the importance of these objects during Bed I and II times (Mora and de la Torre, 2005). Others have examined the function of pounding tools from Olduvai Gorge through experimental programmes (e.g., de la Torre et al., 2013;

* Corresponding author.
E-mail address: a.arroyo@ucl.ac.uk (A. Arroyo).

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Sánchez-Yustos ustos et al., 2015), began to apply microscopic analyses to the study of archaeological pounding tools (Arroyo and de la Torre, 2016), and compared them with chimpanzee nut cracking stone tools (Arroyo et al., 2016). The next step in percussive tool research is to expand these new protocols on experimental objects and use such frameworks to undertake functional analysis of archaeological assemblages.

In this paper, we present a comprehensive study of percussive objects excavated by the Olduvai Geochronology Archaeology Project (OGAP) in the HWK EE and EF-HR localities. HWK EE, a late Oldowan site, was originally excavated by Mary Leakey after she had prepared her 1971 monograph, and the assemblage remained unpublished (Pante and de la Torre, submitted). Renewed excavations at this locality by OGAP have produced a detailed record of the stratigraphic sequence, in the transition from Lower to Middle Bed II (around 1.7 Ma), and revealed one of the largest Oldowan collections of stone tool and fossil assemblages (de la Torre et al., submitted 'a').

The Acheulean site of EF-HR was discovered in 1931 and is a well-known locality on the north side of the Gorge, about 1.2 km from the Third Fault (Leakey, 1971). The age of EF-HR was previously estimated at 1.6–1.5 Ma (Manega, 1993), although recent work by OGAP has refined its stratigraphic position and located this site above Tuff IIC and therefore within Upper Bed II (de la Torre et al., submitted 'b'; McHenry, submitted).

In this study, we present a systematic technological and microscopic analysis of a large sample of percussive tools from HWK EE and EF-HR, and compare them with results from other Beds I and II pounding tools (Arroyo and de la Torre, 2016), as well as experimental tools made from Olduvai quartzite (de la Torre et al., 2013; Arroyo et al., 2016). Overall, our aim is to discuss differences on the type of pounding tools across the Oldowan-Acheulean transition at Olduvai Gorge, thus contributing to a better understanding of variations in technological and functional patterns. This study is the first systematic functional analysis of complete assemblages of percussive tools from late Oldowan and Acheulean sites. In addition, to shed new light on hominin tool use and subsistence strategies, and complement the technological analysis of the lithic assemblages (de la Torre and Mora, submitted 'a','b'), our use-wear contribution aims to serve as a reference for the identification of pounding tools in other African ESA sites and sets the foundations for a better understanding of their function.

2. Materials and methods

2.1. The percussive assemblages from HWK EE and EF-HR

The HWK EE percussive collection presented and analyzed here (T1-Main Trench and satellite trenches [T27, T28, and T29]) consists of 349 pounded objects (representing 1.93% of the stone tool assemblage [$n = 18{,}107$] collected from the four trenches; de la Torre et al., submitted 'a'). As such, HWK EE has one of the largest concentrations of percussive tools in Bed I and Bed II localities (Table 1). Complete objects form 59.3% ($n = 207$) of the studied assemblage, 35.2% ($n = 123$) are fractured percussive tools, and 5.4% ($n = 19$) are hammerstone flakes/fragments. Most percussive objects ($n = 293$ [84%]) were recovered from T1-Main Trench, 3.7% ($n = 13$) from Trench 27, 6% ($n = 21$) from Trench 28, and 6.3% ($n = 22$) from Trench 29 (see details in de la Torre et al., submitted 'a').

Percussive tools from HWK EE are most abundant in archaeological layers within the Lower Augitic Sandstone (LAS; $n = 283$ [81.1%]) and the Lemuta member ($n = 58$ [16.6%]). A few isolated percussive pieces ($n = 8$ [2.3%]) were recovered from the upper interval, Tuff IIB zone (descriptions in de la Torre et al., submitted 'a'; Supplementary Online Material [SOM] S1A).

Table 1
Percussive objects from HWK EE and EF-HR (see Table 2 for brief descriptions of each pounding tool).

	EF-HR		HWK EE	
	n	%	*n*	%
Battered fragments	0	0.0	19	5.4
Fractured knapping hammerstones	8	16.0	123	35.2
Knapping hammerstones	30	60.0	119	34.1
Hammerstones with active edge	3	6.0	20	5.7
Hammerstones with fracture angles	7	14.0	19	5.4
Subspheroids	0	0.0	12	3.4
Utilized material	0	0.0	7	2.0
Pitted stones	2	4.0	19	5.4
Passive hammer with friction marks	0	0.0	2	0.6
Anvils	0	0.0	9	2.6
Total	**50**	**100**	**349**	**100**

Leakey (1971) only refers to the presence of four hammerstones and 10 utilized cobbles at EF-HR. Renewed excavations at this locality by OGAP unearthed 50 percussive objects (Table 1), most from levels L2 ($n = 44$) and L1 ($n = 3$) in T2-Main Trench, and three from trench T12. Fifty percent ($n = 25$) of EF-HR pounding tools were found in a sandy context, 28% ($n = 14$) on clay, 20% ($n = 10$) on gravel, and just one object (2%) came from within the clay (see stratigraphic details in de la Torre et al., submitted 'b'; SOM S1B).

Conservation of percussive tools shows differences according to raw material. Generally, quartzite pounding tools are well preserved; there is a low incidence of surface abrasion, with a few examples at HWK EE ($n = 4$) having scattered, abraded zones (except for one that has concentrated areas of abrasion). On the other hand, lava objects from both sites (although particularly EF-HR) show variable degrees of weathering, i.e., post-depositional chemical alterations (e.g., van Gijn, 1990; Asryan et al., 2017). Under the binocular microscope, grains of these altered tools appear rounded and have a slight sheen. At EF-HR, there are examples of tools affected by grain rounding ($n = 13$), exfoliation ($n = 2$), and surface cracks ($n = 8$).

2.2. Methods

2.2.1. Macroscopic analysis Pounded tools were grouped into two main categories, namely active and passive elements, following Chavaillon's (1979) terminology. Techno-typological classification is based on Leakey (1971) and Mora and de la Torre (2005), and a brief description of each technological category is given in Table 2. Also recorded were general features such as battered areas, number of working surfaces, and fractures. Raw material classification is based on McHenry and de la Torre (submitted).

In addition to the qualitative analysis of all percussive tools, in the case of subspheroids and hammerstones with fracture angles (HFA), we also performed statistical tests to characterize and compare their shape. This aims to shed light on the long-standing discussion on whether or not the spherical form of subspheroids is intentional (e.g., Schick and Toth, 1994; Texier and Roche, 1995). To avoid the bias introduced by raw material and blank variability, all HFA and subspheroids selected for statistical analysis are of the same raw material (i.e., quartzite). Shape analysis was undertaken using orthogonal digital images of subspheroids and HFA, processed with ImageJ (Rasband, 1997), following protocols similar to Tanabata et al. (2012). General morphological parameters (i.e., tool area and perimeter) were calculated, as well as various shape descriptors used in particle analysis, such as aspect ratio (which measures the proportional relationship between length and width), solidity (which measures the overall concavity of the shape), and

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