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Assessing the function of pounding tools in the Early Stone Age: A microscopic approach to the analysis of percussive artefacts from Beds I and II, Olduvai Gorge (Tanzania)

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ABSTRACT

This study explores the function of quartzite pounding tools from Olduvai Gorge (Tanzania) using microscopic and use wear spatial distribution analysis. A selection of pounding tools from several Bed I and II assemblages excavated by Mary Leakey (1971) were studied under low magnification (<100×), and the microscopic traces developed on their surfaces are described. Experimental data and results obtained from analysis of the archaeological material are compared in order to assess activities in which pounding tools could have been involved. Results show that experimental anvils used for meat processing, nut cracking and/or bone breaking have similar wear patterns as those observed on archaeological percussive artefacts. This is the first time that a microscopic analysis is applied to Early Stone Age pounding artefacts from Olduvai Beds I and II, and this paper highlights the importance that percussive activities played during the Early Pleistocene, suggesting a wider range of activities in addition to knapping and butchering.

1. Introduction

The use of pounding tools has been widely documented in the ethnographic record (i.e. Boshier, 1965; Maguire, 1965; Gould et al., 1971; Lee and DeVore, 1976; Yellen, 1977; Salazar et al., 2012) as well as in late Prehistory periods (i.e. Dodd, 1979; Adams, 1988; de Beaune, 1993; Adams et al., 2009; Dubreuil et al., 2015). Ethological research has shown that many non-human primate species habitually use stone tools for a variety of food-processing activities. For example, West African chimpanzees (*Pan troglodytes*) (i.e. Sugiyama and Koman, 1979; Sugiyama, 1997; Carvalho et al., 2007, 2008; Matsuzawa et al., 1999; Matsuzawa, 2011; Struhsaker and Hunkeler, 1971; Boesch and Boesch, 1983; Boesch-Achermann and Boesch, 1993) and Brazilian capuchin monkeys (*Sapajus libidinosus*) (i.e. Visalberghi et al., 2009; Fragaszy et al., 2004; Ferreira et al., 2010) use hammerstones and anvils to crack nuts, and Thai long-tailed macaques (*Macaca fascicularis*) (Milaivijitnond et al., 2007; Gumert et al., 2009; Gumert and Malaivijitnond, 2013; Haslam et al., 2013) use different types of hammers to process gastropods and crabs.

Recent years have witnessed an advancement in the study of percussive tools, especially those of the Early Stone Age (ESA). Interest increased in particular when researchers began to consider the mechanics of pounding as a key factor and potential previous stage leading to the emergence of knapping (de Beaune, 2000, 2004), and there has also growing interest in the analysis of wear patterns present on the pounding tools themselves (i.e. de la Torre et al., 2013; Caruana et al., 2014). Pounding tools have been recovered from Early Stone Age sites such as Koobi Fora (Isaac, 1997; Caruana et al., 2014), Melka Kunturé (Piperno et al., 2004; Chavaillon, 2004; Gallotti, 2013), Lokalalei 2C (Delagnes and Roche, 2005), Gesher Benot Ya'aqov (Goren-Inbar et al., 2002, 2014, 2015; Alperson-Afil and Goren-Inbar, 2016) and Olduvai Gorge (Leakey, 1971).

The Early Stone Age record in Olduvai Gorge, ranging from >1.8 to c. 0.5 my, is one of the best known in Africa. Lithic assemblages from different sites excavated by Mary Leakey in Beds I and II

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(Leakey, 1971) have been analysed by a number of researchers (e.g. Potts, 1982; Kimura, 1999, 2002; Ludwig, 1999; de la Torre and Mora, 2005), providing a substantial body of knowledge about hominin knapping skills and strategies. Some of this research focused on percussive tools and their role in assemblages and showed that ESA hominin activities focused not only on flake production, but also included the use of unshaped rocks probably involved in different pounding activities (e.g. Mora and de la Torre, 2005).

Further evidence for percussive activities in the ESA is preserved in fossil assemblages, the analysis of which showed bones that had been intentionally fractured by placing them on an anvil and hitting them with a hammerstone (Blumenschine and Selvaggio, 1988; Blumenschine, 1995). Such evidence supports the hypothesis that some percussive tools found at Olduvai could have been used to break bones in order to extract marrow (Mora and de la Torre, 2005). To test this hypothesis, and check whether other materials might have been processed with anvils and other battered stone tools, recent experimental programmes have developed a comparative framework to interpret archaeological material (de la Torre et al., 2013; Sánchez Yustos et al., 2015). Experimental results show that at macro- and microscopic levels different pounding tasks such as bipolar knapping, bone breaking, meat tenderizing, plant processing and nut cracking leave distinctive patterns of percussive marks on passive quartzite anvils (de la Torre et al., 2013), while other works have discussed the functionality of spheroids and subspheroids (Sánchez Yustos et al., 2015).

Having highlighted the importance of percussive tool use in the ESA record from Olduvai Gorge (Mora and de la Torre, 2005), and developed an experimental framework (de la Torre et al., 2013), the next step is to apply such analytical protocols to archaeological assemblages, and compare results with the experimental outcomes. This paper, which includes the first microscopic and use wear spatial distribution studies of archaeological pounded pieces from some of the classic assemblages excavated by Mary Leakey (1971) in Olduvai Beds I and II, contributes to the discussion of battered artefacts in the Early Stone Age. Furthermore, it demonstrates the relevance of percussive activities in human evolution through the application of new analytical methods to the study of Palaeolithic pounded tools.

2. Methods and materials

2.1. Methods

Use wear analysis is recognised as a valuable tool that can be employed to assess the use and function of stone tools. Despite development of the discipline since the 60s, it has rarely been applied to the African ESA. Use-wear studies have been conducted on African Lower Pleistocene as assemblages from Koobi Fora (Keeley and Toth, 1981), Kanjera (Lemorini et al., 2014), Ain Hanech (Sahnouni and Heinzelin, 1998; Vergès, 2003; Sahnouni et al., 2013), and Olduvai (Sussman, 1987), but all have focused on analysis of flakes using both high and low magnification approaches.

In this paper, we use a multi-scale approach (Grace, 1990) to analyse pounding tools from Olduvai Gorge that includes an analysis of morphological traces of use-wear using low power microscopy. As shown elsewhere (de la Torre et al., 2013), a low magnification approach (<100×) offers good results when analysing large percussive tools. In investigating the presence of percussive damage similar to those found on the experimental assemblage (de la Torre et al., 2013), this study analyses not only macroscopically visible damage patterns, but also areas where no damage was observable.

The analysis of artefacts was conducted at the National Museum of Tanzania (Dar es Salaam), using a fibre optic illumination trinocular microscope GX-XTL with a magnification range between 0.7× and 4.5× and a 10× eyepiece, allowing a final magnification of 45×. All photographs were taken with a Nikon D90 DLSR camera attached to the microscope and Nikon Camera Control Pro software.

In addition, and following the protocols established elsewhere (de la Torre et al., 2013; Benito-Calvo et al., 2015), a use wear spatial distribution analysis has been conducted using GIS to assess and quantify the degree of working surface modification in the pounded artefacts.

2.2. General characteristics of the lithic assemblage

Tools were selected from those assemblages excavated by Mary Leakey (1971) in Olduvai Beds I and II where a considerable number of percussive tools had previously been documented (Mora and de la Torre, 2005). On the basis of context and conditions of conservation/preservation, seven pounding tools from five different sites (BK, FC West, TK, SHK and FLK North Level 6) were selected for microscopic analysis (Fig. 1). These sites span Bed I (FLK North Level 6), through Middle Bed II (FC West and SHK) to Upper Bed II (TK and BK) (Leakey, 1971; Hay, 1976).

The artefacts analysed here are on tabular quartzite blocks from Naibor Soit, a Precambrian inselberg located about 3.5 km from the confluence of the Main and Side Gorge, and within a 5 km radius of the main archaeological sites (Hay, 1976). Morphologically, the Naibor Soit quartzite is a coarse-grained crystalline rock, composed primarily of quartz and mica (Hay, 1976). In the source area, quartzite is available in different forms, from small, flat and portable blocks scattered across the Naibor Soit hills, to large fixed boulders (Jones, 1994).

3. Results

3.1. Techno-typological analysis

From a general perspective, and despite the variety of sites from which the tools were selected, the pounding tools analysed here are all morphologically similar, and conform to Leakey (1971) original description of anvils. They have similar morphological characteristics (i.e. cuboid shapes), with mean dimensions of 123.6 × 95.9 × 72.4 mm and a mean weight of 1332.4 g (see details in Table 1).

The pounding tools showed macroscopic impact marks scattered along one or two horizontal planes on which percussive activity occurred. Occasionally, small battering areas were identified on contact zones between the horizontal and transversal planes (Fig. 2). One anvil (FLK N 1/6 10290) showed a large battered area with an elongated morphology on one lateral plane. This area measures 3.13 cm^2, and which crystals appear heavily crushed, suggesting additional use as an active element; this is due to the morphological characteristics of the pounding marks and because they are located in a zone on the blank that would not have the stability required for being used as passive element. In addition, two artefacts originally classified by Leakey (1971) as anvils (TK II 2060 and SHK 2152), have a series of non-invasive, superimposed, contiguous stepped scars, wide and short in morphology, removed from the main horizontal plane at a 90° angle, and associated with