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The larger mammal fossil assemblage from JK2, Bed III, Olduvai Gorge, Tanzania: implications for the feeding behavior of *Homo erectus*

Michael C. Pante

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

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ABSTRACT

Little is known about the type and amount of animal proteins consumed by *Homo erectus*, a species distinguished from its predecessors by more human-like brain and body proportions and its association with more advanced stone tool technology. Here I present an interpretation of the feeding behavior of African *H. erectus* based upon the first taphonomic analysis of the larger mammal fossil assemblage from the JK2 site, Bed III, Olduvai Gorge.

Results indicate that both hominins and carnivores consumed some flesh and bone marrow at the site. A low incidence of percussion marking suggests hominins did not break all long bones in the assemblage. Relatively high carnivore tooth mark frequencies and low cut mark frequencies independently suggest that both hominins and carnivores had access to flesh, while specimens that are both tooth- and butchery-marked demonstrate occasional hominin and carnivore feeding from the same carcass. Together, the bone surface modification data suggest a mixed and possibly time-averaged taphonomic history for the assemblage with at least some carcasses accessed by hominins early in the consumption sequence and others only by carnivores. The results for the JK2 assemblage contribute to a growing literature concerning the feeding behavior of African *H. erectus*, a species that appears to have relied on carcass foods to meet some of the nutritional demands of its larger brain and body size.

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Introduction

Since the first systematic descriptions of stone tool cut marks on larger mammal bones from early archaeological assemblages (Bunn, 1981; Potts and Shipman, 1981), much of the literature concerning Early Pleistocene zooarchaeology has focused on the order in which hominins and carnivores accessed carcasses at the Bed I, FLK 22, *Zinjanthropus* level, Olduvai Gorge (Binford, 1981, 1986, 1988; Bunn and Kroll, 1988; Blumenschine, 1988, 1995; Bunn and Ezzo, 1993; Oliver, 1994; Selvaggio, 1994, 1998; Capaldo, 1995, 1997, 1998; Domínguez-Rodrigo, 1997; Domínguez-Rodrigo and Barba, 2006). Interpretations of the site have been contradictory, with some researchers suggesting hominins had primary access to carcasses at the site based upon the location of cut marks on limb bones in the assemblage (Bunn and Kroll, 1988; Bunn and Ezzo, 1993; Domínguez-Rodrigo, 1997) and others asserting that hominins were scavengers of flesh scraps and bone marrow abandoned by felids based upon the frequency of tooth and percussion marks (Blumenschine, 1988, 1995; Selvaggio, 1994, 1998; Capaldo, 1995,

1997, 1998). Most recently, Pante et al. (2012) argued that these contradictions arose due to inconsistent methods among researchers, and suggested the examination of all types of marks simultaneously as a solution. Their analysis using statistically refined feeding trace models that include tooth, cut, and percussion marks suggests the FLK 22 hominins likely acquired larger mammal carcasses through scavenging, but may have typically had access to as much as 50% of the flesh and all bone marrow.

Researchers have also applied some of the methods originally developed for interpreting Oldowan hominin feeding behavior to fossil assemblages associated with African *Homo erectus* from Bed II, Olduvai Gorge (Monahan, 1996; Domínguez-Rodrigo et al., 2009), Member 3, Swartkrans (Pickering et al., 2004), and the Okote Member, Koobi Fora (Pobiner et al., 2008). In all cases, it is argued that the species likely had early or primary access to carcass foods. These results are not unexpected as *H. erectus* is distinguished from its predecessors by its larger brain and body size (Wood, 1992; Walker and Leakey, 1993; Kappelman, 1996), the metabolic costs of which may have required a corresponding increase in nutritional intake (Milton, 1987; Shipman and Walker, 1989; Speth, 1989; Ruff and Walker, 1993; Aiello and Wheeler, 1995). Carcass foods may have provided the nutrients necessary to meet these increasing

E-mail addresses: m.pante@ucl.ac.uk, michaelpante@yahoo.com.

metabolic costs. Currently, the most effective test of this hypothesis is through comparisons of fossil assemblages with known feeding trace models.

Feeding trace models are designed to allow inferences into the relative timing of hominin and carnivore carcass consumption and can be used to identify the type and amount of carcass foods that hominins typically acquired at prehistoric archaeological sites. These models were originally developed with the goal of interpreting fossil assemblages deposited in lake-margin or low-energy fluvial environments (Blumenschine, 1988, 1995), and as such their applicability to Acheulean fossil assemblages, often deposited in fluvial environments, was unknown.

Pante and Blumenschine (2010) were the first to assess the impact of fluvial processes on the incidences of tooth, cut, and percussion marks in modern bone assemblages using a flume. Results demonstrated that the effect of low-energy hydraulic processes was not great enough to alter interpretations of hominin and carnivore carcass consumption that are based on these criteria. These results are applied here along with statistically re-analyzed feeding trace models (Pante et al., 2012) to interpret the feeding behavior of *H. erectus* from the fluvially-deposited JK2 fossil assemblage, Bed III, Olduvai Gorge. It is hypothesized that the JK2 hominins would have practiced subsistence strategies similar to their Bed II, Olduvai Gorge, Member 3, Swartkrans, and Okote Member, Koobi Fora counterparts, typically having acquired early or primary access to carcass foods.

JK2 history, stratigraphy, and archaeological occurrences

Louis Leakey (1931–1932) discovered JK (Juma's Korongo) at the base of a reddened band believed at the time to be Bed IV, but later determined to be the only site at Olduvai Gorge that yielded significant concentrations of faunal and stone artifact material from Bed III (Kleindienst, 1964; Hay, 1976). Leakey called JK an occupation site in archaeological context and removed surface finds from the site when it was discovered. The site was first excavated three decades later in 1962 by Maxine Kleindienst at which time it was renamed JK2 because of Louis Leakey's uncertainty over the original location of the site he had named "JK" (Kleindienst, pers. comm.). The only detailed account of the associated geology of the JK2 site was published by Kleindienst (1964). As such, this publication is the basis for most stratigraphic interpretations of the site.

Bed III is dated on the basis of paleomagnetism and sedimentation rates (Hay, 1994). The JK2 site preserves Tuff IID at its base marking the top of Bed II and it is capped by Bed IV allowing the site to be confidently confined within Bed III. Hay (1994) uses stratal thickness throughout the gorge and dated fault movements to estimate the contact between Beds II and III at 1.15 Ma, while the contact between Beds III and IV coincides approximately with the Matuyama–Brunhes boundary. On this basis, along with sedimentation rates, Hay (1994) roughly estimates the age of the top of Bed III to be 0.8 Ma. Therefore, the best estimate for the age of JK2 is currently between 1.15 and 0.8 Ma.

JK2 is located on the north side of the Gorge, 2.2 km east of where the main and side gorges meet. The deposits are 10–15 m below the rim of the Gorge and have been exposed by a stream that joins the Olduvai River immediately south of the site. Kleindienst's 1962 excavations were originally confined within JK2 West, but trenches were opened up some 100 m away in what was later called JK2 East to clarify the geologic setting (Fig. 1). JK2 East and West were interpreted to have been deposited in fluvial or locally deltaic environments. Three fossil-bearing trenches were excavated by Kleindienst: trenches A and B were located in JK2 West where Leakey originally discovered cultural debris in 1931–1932, while

Trench 8 was excavated in JK2 East during Kleindienst's attempt to clarify the geology of the site.

Trench A Artifacts including handaxes, fossil bones, and teeth were found scattered throughout gray–brown silt with the size and frequency of the fossils and artifacts increasing at the gradational contact with fine sand, continuing down to the gradational contact with coarser sand. Large vertebrate fossils and artifacts were found at the base of the coarse sand at the contact with silty clay. The type and frequency of bone and the presence of debitage of all size ranges indicated to Kleindienst that the finds represented debris in a hominin occupation area such as those found on earlier undisturbed occupation areas at Olduvai. Kleindienst interpreted the environment to be continuously aggrading, and she notes that finds in the silty and clayey beds and in the fine sands may represent the remains of continuous human occupation in disturbed context. She regarded these materials as re-deposited occupation debris, which had undergone little transport and were probably a representative sample of the material from a nearby living site or sites.

Trench B In Trench B the coarse sand found in Trench A thins into a medium-fine sand. Handaxes, cleavers, small artifacts, and fossil bones were found concentrated in the basal part where a minor disconformity with coarse sand and grit overlies gray silty clay. Otherwise, fossils and artifacts were found scattered throughout the trench with no other concentrations noted by Kleindienst (1964).

Trench 8 Kleindienst described two separate archaeological occurrences in Trench 8. Scattered bones and artifacts found in the upper part of the coarse sand were designated as the upper archaeological occurrence, while concentrations found immediately overlying a coarse sand/silty clay contact were designated as the lower archaeological occurrence. In the clay, artifacts were found together with portions of two hippopotamus skeletons and a few remains of equids, suids, and bovines. Fossils and artifacts from this lower archaeological occurrence appeared to Kleindienst to have been deposited contemporaneously. She suggested the depositional environment was continuously aggrading (i.e., sandbar or stream bank) and believed this was a streamside butchery site in disturbed context. No handaxes were found in these deposits and most artifacts had been worked from lava and quartzite cobbles.

All data presented here are limited to fossils excavated from Trenches A and B in JK2 West. Analysis of JK2 Trench 8 was halted due to the paucity of specimens from taxa other than Hippopotamidae, and the complete absence of hominin-induced bone surface modifications in the analyzed sample. Further, the majority of non-hippopotamid specimens from Trench 8 were exfoliated and had been extensively gnawed by rodents. It is unlikely that Trench 8 represents a streamside butchery site as Kleindienst had hypothesized, and the association of stone tools and fossils is likely coincidental.

Methods

Experimental controls

The experimental controls used for comparison with the JK2 assemblage represent five distinct feeding scenarios (see Table 1) modeled by Blumenschine (1988) and Capaldo (1995) in the Serengeti and Ngorongoro ecosystems to simulate hominin and carnivore feeding behavior. They are based on statistical differences in the assemblage-wide proportions of tooth, cut, and percussion marks on long bone fragments that arise due to variations in the types of consumers that accessed the flesh, marrow, and grease from carcasses. Blumenschine (1988, 1995) developed the hammerstone only (HO), carnivore only (CO), and hammerstone-to-carnivore (H–C)

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