

New estimates of tooth mark and percussion mark frequencies at the FLK Zinj site: the carnivore-hominid-carnivore hypothesis falsified

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Abstract

Traditional interpretations of hominid carcass acquisition strategies revolve around the debate over whether early hominids hunted or scavenged. A popular version of the scavenging scenario is the carnivore-hominid-carnivore hypothesis, which argues that hominids acquired animal resources primarily through passive opportunistic scavenging from felid-defleshed carcasses. Its main empirical support comes from the analysis of tooth mark frequency and distribution at the FLK Zinj site reported by Blumenschine (Blumenschine, 1995, *J. Hum. Evol.* 29, 21–51), in which it was shown that long bone mid-shafts exhibited a high frequency of tooth marks, only explainable if felids had preceded hominids in carcass defleshing. The present work shows that previous estimates of tooth marks on the FLK Zinj assemblage were artificially high, since natural biochemical marks were mistaken for tooth marks. Revised estimates are similar to those obtained in experiments in which hyenas intervene after humans in bone modification. Furthermore, analyses of percussion marks, notches, and breakage patterns provide data which are best interpreted as the results of hominid activity (hammerstone percussion and marrow extraction), based on experimentally-derived referential frameworks. These multiple lines of evidence support previous analyses of cut marks and their anatomical distribution; all indicate that hominids had early access to fleshed carcasses that were transported, processed, and accumulated at the FLK Zinj site.

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Introduction

The 1.8 Ma (mega annum) macro-mammal bone assemblage from the FLK Zinj site at Olduvai Gorge (Tanzania) has been extensively used to reconstruct early hominid behaviour in East Africa. The abundance of skull and limb bones at this site, as well as at most other African Plio-Pleistocene archaeological sites, has been interpreted as the result of: 1) hominids hunting and selectively transporting those parts from complete carcasses (Isaac, 1978, 1983, 1984; Bunn, 1982, 1983, 1991; Bunn and Kroll, 1986, 1988; Bunn and

Ezzo, 1993; Domínguez-Rodrigo and Pickering, 2003; Oliver, 1994; Rose and Marshall, 1996; Domínguez-Rodrigo, 1997, 2002); 2) hominids transporting complete skeletons from partially defleshed carcasses (Capaldo, 1995, 1997); or 3) hominids passively scavenging the brain and marrow-bearing long limb bones from defleshed carcasses at felid kills (Blumenschine, 1986, 1991).

Mary Leakey's (1971) excavations at the FLK Zinj site exposed what she believed to be a "living floor," based on discrete accumulations of stone and bone in association with one another. Sites similar to FLK Zinj discovered at Koobi Fora (Kenya) served as the basis for Isaac's (1978) "home base" model, in which he proposed that Plio-Pleistocene hominids selected specific locations for toolmaking, butchery, and food consumption activities. Hominids would repeatedly use

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these sites, transporting food from the original procurement location and intentionally sharing it with others at the home base. This model presumed that hominids had sufficient (i.e., primary) access to meat.

This assumption was questioned by Binford (1981), who reinterpreted Leakey's original, preliminary faunal list to form a radically different conclusion. Using skeletal part profiles (based only on the elements with epiphyses reported by Leakey) in conjunction with referential frameworks on bone accumulations from modern foragers and carnivores, Binford argued that the Olduvai Gorge sites were primarily natural and carnivore-made accumulations. Plio-Pleistocene hominids, he proposed, were the last and most marginal of scavengers upon the local meat supply.

At the same time, Bunn (1982, 1983) was also comparing the FLK Zinj assemblage against referential frameworks that he developed based on leopard and hyena dens, as well as on modern hunter-gatherer home bases. His analysis of the fossil assemblage differed from Binford's in two important ways. First, he considered all the shaft fragments, which are extremely influential on skeletal part profiles, since carnivores will often delete the cancellous (i.e., epiphyseal) tissue on which most profiles are based (Pickering et al., 2003). Second, Bunn introduced the study of cut marks on bone surfaces as a signature of hominid behaviour. Bunn's taphonomic analysis of the site led him to conclude that hominids at the FLK Zinj site had primary access to meat through hunting. The ensuing debate between Binford (1986, 1988) and Bunn and Kroll (1986, 1988) lasted nearly a decade. Ultimately, it ended in a stalemate, since skeletal part profiles could be interpreted as evidence for either primary or secondary access to meat by hominids. Binford (1988) also used data from cut marks to suggest that hominids were scavenging meat, at least from middle-sized animals. However, his interpretations of cut marks at the FLK Zinj site were inevitably flawed: first, he intentionally overlooked the cut mark data from the FLK Zinj archaeofauna that Bunn and Kroll (1986) reported because he did not agree with the way that the marks had been identified; second, no experimental framework for scavenging was available at that time to support his interpretations of cut mark morphology and location on bones.

The equifinality posed by skeletal part profiles led some researchers in the 1980s-90s to develop experimentally-based referential frameworks, using bone surface modifications, to model competing hypotheses of agent interaction: carnivore only, hominid only, hominid to carnivore, or carnivore-hominid-carnivore (Blumenschine, 1988, 1995; Selvaggio, 1994; Capaldo, 1995, 1997, 1998; Domínguez-Rodrigo, 1997, 1999). The subsequent analytical shift led to a landmark publication in *JHE* (Blumenschine, 1995) in which the high frequency of tooth marks on the mid-shaft sections of long bones at the FLK Zinj site was explained by a triple-stage model supported by data from earlier experiments with human- and carnivore-modified bones (Blumenschine, 1988). According to this model, some carnivores (felids) had primary access to carcasses, removing flesh partially (Capaldo, 1998) or completely (Blumenschine, 1986, 1995); hominids had

secondary access, processing marrow-bearing bones (reflected in the percentage of percussion-marked bones); finally, other carnivores (hyenids) consumed the grease-bearing cancellous bone.

This carnivore-hominid-carnivore model was only experimentally replicated once (Selvaggio, 1994), and the samples were small and heavily biased towards small carcasses. Later experiments (Capaldo, 1995, 1997) provided more robust data for carnivore-only and hominid to carnivore models, since the samples included both large and small carcasses. Capaldo's results attested to strong ravaging of bone by hyenas, providing the first empirical proof in the wild of what Marean et al. (1992) had already documented among captive hyenas. These data further weakened the merit of skeletal part profiles, and strengthened the value of bone surface modification studies.

The models built by Blumenschine, Selvaggio, and Capaldo strongly relied on tooth marks and percussion marks as the main bone surface modifications, virtually ignoring cut marks. Yet the cut mark data from FLK Zinj originally reported by Bunn paints a very different picture from Blumenschine's (1995) model (Domínguez-Rodrigo, 1997, 1999); this contradiction prompted our reanalysis of the FLK Zinj assemblage. The carnivore-hominid-carnivore model at FLK Zinj relies on an "anomalous" high frequency of tooth marks on mid-shafts, presumably resulting from felids having initially defleshed the carcasses before hominids scavenged them, since hyenas, having late access to broken limb bones, would only mark the ends while consuming their grease. The tooth mark frequency observed by Blumenschine (1995) was clearly outside the range of variation for both the carnivore-only and human to carnivore models developed by him (Blumenschine, 1988). Therefore, the FLK Zinj assemblage stood out as an oddity never before replicated experimentally or observed archaeologically.

In the present study, we thoroughly examined surfaces of long bone specimens from FLK Zinj, and found that some surface modifications with similar morphology to tooth marks (as identified by Blumenschine) were created by biochemical processes. These are overwhelmingly the most common type of bone surface modification in the assemblage. The revised tooth mark rates at FLK Zinj are far lower than those reported by Blumenschine (1995), and are even less than new, lower estimates obtained in recent experiments with felids (Domínguez-Rodrigo et al., in press); they are much closer to those obtained in human-carnivore experiments (Blumenschine, 1988; Capaldo, 1995). Additionally, our analysis of tooth pits, percussion marks, and notches provides data which, when compared with experimentally-derived referential frameworks, suggest that hominids had primary access to fleshed carcasses. Our multiple lines of evidence point to a simple conclusion: carnivore access to the bone assemblage at FLK Zinj was secondary to butchery and marrow extraction by hominids, as originally argued by Leakey (1971), Bunn (1982, 1983), and Bunn and Kroll (1986, 1988). This conclusion further buttresses the results of earlier cut mark studies at FLK Zinj (Bunn, 1982, 1983; Bunn and Kroll, 1986, 1988; and interpretations in Domínguez-Rodrigo, 1997, 2002).

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