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Long-distance carcass transport at Olduvai Gorge? A quantitative examination of Bed I skeletal element abundances

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ABSTRACT

Relative abundances of skeletal elements at Plio-Pleistocene archaeological sites have long been interpreted to represent selective transport of portions of large prey. Models from optimal foraging theory suggest that the degree of carcass transport selectivity reflects transport constraints, particularly transport distance. A quantitative analysis of skeletal element abundances in five bone assemblages from Bed I, Olduvai Gorge, indicates that within the subset of elements most likely to resist attritional processes, there is no evidence for preferential transport of small or large mammals. The results suggest relatively low carcass transport costs and are most consistent with site formation models favoring short-distance carcass transport. The data are also consistent with the possibility that hominins were not responsible for transporting bones at some sites. Several Bed I assemblages, with the exception of FLK-*Zinjanthropus*, lack evidence of a functional relationship between flaked stone artifacts and the faunal remains, such as cut-marks or percussion-marks on bone. In conjunction with the skeletal part data, this suggests that hominin involvement with the bone assemblages was minimal at all sites but FLK-*Zinjanthropus*. The patterning at Bed I contrasts strongly with Middle Stone Age and Middle Paleolithic assemblages, which provide clear evidence for selective transport, suggesting higher transport costs and longer transport distances.

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Introduction

Ethnographic observations indicate that hunters faced with carcass transport constraints must select a limited number of body parts for transportation from the kill site to the consumption site (Yellen, 1977; Binford, 1978; Bunn et al., 1988; O'Connell et al., 1988a, 1990; Bartram, 1993b; Abe, 2005). These observations provide underlying support behind the long-standing zooarchaeological tradition of examining the relative abundances of skeletal parts in order to interpret butchery and transport decisions (White, 1952, 1953, 1954, 1955; Perkins and Daly, 1968). The incorporation of skeletal element analysis into foraging theory models has provided faunal analysts with the tools to examine butchery and transport decisions in relation to energetic costs and returns (Broughton, 1994, 1999; Grayson and Cannon, 1999; Cannon, 2003; Marean and Cleghorn, 2003; Egeland and Byerly, 2005; Nagaoka, 2005, 2006; Faith, 2007). Examination of skeletal element abundances within the context of foraging theory stems largely from Binford's ethnoarchaeological study of the caribou-hunting Nunamiut (Binford, 1978). Binford reasoned that the nutritional value of different body parts plays a critical role in determining Nunamiut butchery and transport decisions. He collected data from caribou (*Rangifer tarandus*) and sheep (*Ovis aries*) carcasses to develop indices of the economic utility of skeletal portions as a tool for examining their frequencies in bone assemblages. Binford's development of economic utility indices assumes that people optimally forage across carcasses of large prey in the same manner that people optimally forage for prey across larger landscapes (Grayson, 1988, 1989). It is now widely accepted that butchery and transport decisions are mediated by the economic value of different body parts in relationship to the energetic costs of transporting them (Bunn et al., 1988; Metcalfe and Jones, 1988; O'Connell et al., 1988a, 1990; Bartram, 1993b; Cannon, 2003).

The analysis of skeletal element frequencies within a foraging theory framework can be used to examine the carcass transport decisions of Plio-Pleistocene hominins. Were butchery and transport decisions constrained by long-distance carcass transport, similar to that documented for modern hunter-gatherers

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(e.g., Bunn et al., 1988; O'Connell et al., 1988b, 1990; Bartram, 1993b), or by rather short-distance carcass transport, perhaps on the scale of only tens to hundreds of meters? Among carnivores, short-distance transport has been defined as that regularly documented in their peripheral transport of prey from kill sites, less than 500 meters, in contrast to longer-distance transport to their dens (Domínguez-Rodrigo, 1994). In human foragers, short-distance transport of complete carcasses has been documented among the Hadza to be between 3 and 5 km, and long-distance transport, which includes discard of carcass remains at the kill site, from 5 km to more than 14 km (Bunn et al., 1988). Answers to the question of carcass transport behavior is relevant to one of the most contentious issues in Plio-Pleistocene archaeology: What is the behavioral significance of Plio-Pleistocene archaeological sites (e.g., Domínguez-Rodrigo et al., 2007; O'Connell et al., 2002, and references cited therein)? Do they represent "central places" to which Plio-Pleistocene hominins transported fully fleshed animal carcasses from long distances (Isaac, 1978, 1983)? Or were they "near-kill accumulations" to which hominins brought small quantities of meat and marrow from carcasses defleshed and abandoned by carnivores nearby (O'Connell et al., 2002)? The goal of this study is to assess Plio-Pleistocene hominin carcass transport strategies through a quantitative examination of skeletal element abundances recovered from five sites in Bed I, Olduvai Gorge, Tanzania.

Historical background

Associations of fragmented faunal remains with flaked stone artifacts in Plio-Pleistocene archaeological sites traditionally justified the interpretations of these sites as "living floors" (Leakey, 1971), "home bases", or "central-place foraging sites" (Isaac, 1978, 1983), to which hominins transported a variety of foods, especially meat acquired from big-game hunting. This interpretation provided the basis for assigning numerous modern human behavioral characteristics to early *Homo*, including reciprocal food sharing, sexual divisions of labor, and the emergence of nuclear families (Isaac, 1978; Clark, 1997).

Binford (1981) suggested that the associations of stone tools with animal remains were coincidental at some sites, likely reflecting time-averaged palimpsest accumulations. At the same time, however, documentation of stone-tool-inflicted cut-marks on bones from Olduvai Gorge and Koobi Fora established a direct behavioral connection between the hominins, the stone artifacts, and the faunal remains at a few sites (Bunn, 1981; Potts and Shipman, 1981). Although cut-marked bone provided direct evidence for hominin meat-acquisition, the behavioral implications of these data were not settled. Binford (1981) reasoned that the cut-marks were the result of hominins scavenging small amounts of meat and marrow from carcasses already preyed upon by large carnivores. According to Binford, there was no evidence that hominins transported carcass remains long distances from the point of acquisition, that meat was shared among hominins, or that meat contributed substantially to the hominin diet.

In order to develop more strongly warranted inferences regarding the hominin contribution to these bone assemblages, paleoanthropologists directed their efforts towards studying early archaeological sites from a taphonomic perspective (e.g., Bunn and Kroll, 1986; Marean et al., 1992; Blumenschine, 1995; Capaldo, 1997; Selvaggio, 1998; Domínguez-Rodrigo et al., 2007). This research has led to a general consensus that the faunal remains recovered from most Plio-Pleistocene archaeological sites are the product of hominin behavior. These sites are generally thought to represent locations to which hominins transported carcass remains for processing and consumption (reviewed by O'Connell et al., 2002). Beyond this generalization, however, opinions are still conflicting. Following Isaac's (1978) original perspectives, some continue to view the Plio-Pleistocene archaeological sites as central place sites, to which hominins transported fully fleshed carcass remains from distant locations (e.g., Bunn and Kroll, 1986; Rogers et al., 1994; Rose and Marshall, 1996; Domínguez-Rodrigo, 1997; Bunn, 2001). Others favor what O'Connell and colleagues (2002) dubbed the "near-kill accumulation model" in which the Plio-Pleistocene sites are viewed as locations where hominins consumed small amounts of meat and primarily marrow or head contents from carcasses previously defleshed and abandoned by carnivores (e.g., Blumenschine, 1991; Selvaggio, 1994; Capaldo, 1997); substantial carcass transport from the point of acquisition is not inferred (but see Blumenschine et al., 1994). The latter interpretation has been challenged by recent taphonomic evidence (Domínguez-Rodrigo et al., 2007).

Differential skeletal element representation has figured strongly in various site formation models (Isaac, 1978; Binford, 1981; Bunn, 1986; Bunn and Kroll, 1986; Potts, 1988; Capaldo, 1997; Domínguez-Rodrigo, 2002; O'Connell et al., 2002). As noted by Bunn (1986), faunal assemblages from Plio-Pleistocene sites contain numerous meaty appendicular elements, whereas axial elements, including vertebrae, ribs, and pelves, are less abundant. Bunn (1986: 680) concluded that "selective transport of mainly appendicular parts of carcasses of large animals was the dominant process leading to the observed patterns of skeletal representation at the central place sites." This argument has been challenged on the taphonomic grounds that the observed patterns of skeletal element representation are also consistent with documented patterns of carnivore destruction (Marean et al., 1992). Since Marean and colleagues' (1992) criticism, the extent to which the skeletal element abundances support selective transport is no longer clear. New examinations that take into account taphonomic destruction are required in order to develop behavioral inferences from the skeletal part data.

The purpose of this study is to contribute to the debate surrounding the nature of Plio-Pleistocene archaeological sites through quantitative examinations of skeletal element representation. Skeletal element abundances from five assemblages excavated by Leakey (1971) from Bed I, Olduvai Gorge, are analyzed. Results are compared to three Middle Stone Age (MSA)/Middle Paleolithic (MP) assemblages where there is well-established evidence for selective carcass transport, presumably over long distances. The overall patterning of skeletal element abundances is interpreted within a foraging theory framework to provide insight into the costs that mediated butchery and transport decisions, and how they varied across assemblages.

The Bed I study sites

Leakey (1971) excavated numerous archaeological sites from Bed I, dating to ca. 1.85–1.75 Ma (Walter et al., 1991). Here we examine skeletal element abundances from five assemblages: FLK North: Levels 1/2, 3, and 4; FLK-*Zinjanthropus*; and FLK NN: Level 1 (Table 1). The skeletal element data represent the efforts of the most recent examination of the Bed I archaeofaunas, undertaken by Domínguez-Rodrigo et al. (2007).

Table 1
Summary of Bed I assemblages examined in this study (from Leakey 1971).

Site	Faunal remains	Artifacts	Manuports
FLK North: Levels 1/2	3,510	1,205	210
FLK North: Level 3	1,254	171	39
FLK North: Level 4	929	67	17
FLK-*Zinjanthropus*	3,410	2,470	96
FLK NN: Level 1	275	16	18

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