Evidence for Meat-Eating by Early Humans

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The first major evolutionary change in the human diet was the incorporation of meat and marrow from large animals, which occurred by at least 2.6 million years ago.

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U.S. military, Marine Corps, 2006

Eating Meat and Marrow

The diet of the earliest **hominins** was probably somewhat similar to the diet of modern chimpanzees: omnivorous, including large quantities of fruit, leaves, flowers, bark, insects and meat (e.g., Andrews & Martin 1991; Milton 1999; Watts 2008). Tooth morphology and dental microwear studies suggest that the diet of some hominins may have included hard food items such as seeds and nuts, and underground storage organs (USOs) such as roots and tubers (Jolly 1970; Peters & O'Brien 1981; Teaford & Ungar 2000; Luca *et al.* 2010). By at least 2.6 million years ago, a remarkable expansion in this diet started to occur; some hominins began incorporating meat and marrow from small to very large animals into their diet. Let's explore the evidence for this dramatic shift using the 5 "W" questions: When, Where, Who, What, Why (and How).

When and where did hominin carnivory first occur?

The strongest evidence for meat and marrow eating are butchery marks found on bones. Slicing meat off a bone with a sharp-edged tool can leave cut marks (Figure 1). Pounding a bone with a large stone to break it open and extract the marrow inside can leave percussion marks. Cut and percussion marks, which together are called butchery marks, may be the result of skinning, disarticulation, and bone breakage for dietary and non-dietary reasons (Blumenschine & Pobiner 2006). Scientists began to recognize these butchery marks on Early Stone Age fossil assemblages in the 1980s (e.g., Bunn 1981; Potts & Shipman 1981; Blumenschine & Selvaggio 1988). Experimental and prehistoric evidence for human chewing on bones has only recently begun to be explored (e.g., Landt 2007; Delaney-Rivera *et al.* 2009; Fernandez-Jalvo and Andrews 2011; Pickering *et al.* 2013).

Figure 1
(a) 1.5 million-year-old fossil antelope lower leg bone (metapodial)
from Koobi Fora, Kenya, bearing cut marks; (b) close-up of these
cutmarks.

Only those fossilized bones with butchery marks can confidently be tied to hominin diet (Blumenschine & Pobiner 2006). The earliest well-accepted evidence for this novel dietary behavior comes from about 2.6 Ma at the site of Gona, Ethiopia (Domínguez-Rodrigo *et al.* 2005). Probably not coincidentally, it's also around this time that we start to see the first evidence of archaeologically visible accumulations of stone tools (Semaw *et al.* 2003). There may be evidence of hominin-butchered bones at 3.4 Ma at Dikika, Ethiopia (McPherron *et al.* 2010), where *Australopithecus afarensis* remains have been found, but this evidence consists of only a few bone specimens and has been disputed (Domínguez-Rodrigo *et al.* 2010). The earliest well documented evidence of persistent hominin **carnivory** from ***in situ*** excavated fossil **fauna** occurring in association with large concentrations of stone tools is at about 2.0 Ma at Kanjera, Kenya (Ferraro *et al.* 2013). In addition to terrestrial animals, evidence from one site at Koobi Fora shows that hominins began to incorporate aquatic foods like turtles, crocodiles, and fish into their diets by about 1.95 Ma (Braun *et al.* 2010). Multiple localities at Olduvai Gorge, Tanzania, dating to 1.8 Ma also show evidence of *in situ* butchered mammal remains, ranging in size from hedgehogs to elephants; these are also associated with large numbers of stone tools (Domínguez-Rodrigo et al. 2007; Blumenschine & Pobiner 2006 and references therein). Three sites at Koobi Fora, Kenya, preserve evidence of several butchered mammals from about 1.5 Ma but are not found in association with any stone tools (Pobiner *et al.* 2008). Perhaps this signals a shift toward intentional specialization of activities, such as animal butchery and stone tool making, in different areas across the landscape.

Who was eating this meat and marrow?

Currently, there is fossil evidence for at least three species of hominins occurring at around 2.6-2.5 Ma: *Australopithecus africanus, Australopithecus garhi,* and *Paranthropus aethiopicus; H. habilis* was established by around 2.4-2.3 Ma (Figure 2). There are no butchered bones (or stone tools) found at stratigraphic levels associated with *A. africanus* or *P. aethiopicus*, so those taxa are less likely to be our perpetrators. While butchered bones have been found near *A. garhi* fossils (de Heinzelin *et al.* 1999), it's only in the *Homo* lineage, especially in *Homo erectus*, that we see biological features often linked to meat-eating, such as a decrease in tooth and gut size and an increase in body and brain size (e.g., McHenry 1992; Aiello and Wheeler 1995; Antón 2003; Braun *et al.* 2010).

Figure 2: Photograph of a cast of KNM-ER 1813, a 1.9 million-year-old *Homo habilis* skull from Koobi Fora, Kenya.

This is one of the most complete skulls of this species.

What's so unique about this dietary strategy?

The carnivory of hominins is unique among primates in three ways: (1) use of flaked stone tools to access animal resources; (2) acquisition of resources from animals much larger than the hominins themselves (Figure 3); and (3) procurement of animal resources by scavenging. Chimpanzees, our closest living relatives, routinely hunt, capture by hand, and eat meat from colobus or other smaller monkeys (e.g. Mitani and Watts 2001), but meat is a small proportion of their diet and they rarely scavenge (Watts 2008), most likely because they cannot efficiently digest carrion (Ragir *et al.* 2000). How this novel source of food was first recognized by hominins remains unknown. Hominins would likely not have been able to directly exploit grass as grassland expanded habitats across Africa - (though see Sponheimer *et al*. 2013) but an increase in large (grazing) animal resources would have been useful for any species that could procure and digest them (Plummer 2004). This shift marks an encroachment of a primate onto the larger carnivore guild, which would have challenged hominins with entirely new selective pressures (Brantingham 1999; Pobiner & Blumenschine 2003; Werdelin & Lewis 2005).

Figure 3

A reconstruction of an elephant butchery by *Homo erectus* nearly 1 million years ago at Olorgesailie, Kenya.

Why did hominins start eating more meat and marrow?

"Why" questions are notoriously difficult to answer about the past, but we can examine some of the benefits that meat and marrow provide. Meat and marrow are calorie-dense resources with essential amino acids and micronutrients (Milton 1999), and aquatic fauna offer resources rich in nutrients needed for brain growth (e.g., Broadhurst *et al.* 2002). Increasing the consumption of animal foods could have allowed hominins to increase their body size without losing mobility, agility, or sociality (Milton 1999). But what was the frequency and quantity of nutrients obtained by hominins from animal tissues versus other foods? Hominins at sites FLK 22 and FLKN 1-2, Olduvai Gorge, broke long bones of small to medium-large mammals in direct proportion to their estimated gross caloric yield from marrow fat (Blumenschine & Madrigal 1993 - but see Bunn *et al.* 2010 for a different interpretation of hominin behavior at FLKN 1-2). Long bone abundance of medium-large mammals at FLK 22 is also correlated significantly and positively to the net yield of marrow bones (Blumenschine & Madrigal 2000). Optimal foraging theory dictates that foods in the optimal diet set are expected to be consumed whenever encountered; the carcass encounter rate is dependent on a variety of ecological variables (Blumenschine & Pobiner 2006). This indicates that by at least 1.8 million years ago, carcass-processing decisions may have taken into account the energy yield of a variety of foods. Assuming opportunistic encounters with carcasses, these net yields are comparable to, or higher than, those for most, if not all, non-mammal food items harvested by tropical hunter gatherers (Blumenschine & Pobiner 2006 and references therein).

How did early humans obtain and utilize this meat and marrow?

The earliest evidence for hunting technology in the form ofhafted spear points, currently dates back to about 500,000 years ago (Wilkins *et al.* 2012); complex projectile weapons only appear at 71,000 years ago (Brown et al 2012). **Persistence hunting** has been suggested as a mode of hunting that would have been possible without advanced technology, but it's not clear how we would recognize this behavior in the fossil or archaeological record. The earliest firm evidence for the controlled use of fire at hearths in the form of burned seeds, wood, and flint, likely related to cooking, dates back to about 790,000 years ago (Goren-Inbar *et al.* 2004). Evidence for earlier traces of fire in eastern and southern Africa associated with hominins at Koobi Fora, Chesowanja, and Swartkrans (e.g., Gowlett *et al.* 1981; Brain & Sillen 1988; Bellomo 1994) consists primarily of sediment discoloration and is not widely accepted (James 1989; Goren-Inbar *et al.* 2004). While modern human gut proportions and size are unique among great apes (Milton 1999), and studies have found signatures of selection in genes in modern humans that may have played a role in adaptations to dietary changes (Babbitt *et al.* 2011), it's unclear exactly when these anatomical and physiological changes that facilitated meat and marrow-eating took place.

Many zooarchaeologists who study **Early Stone Age** faunal assemblages think it's likely that at least some animal carcasses that were butchered by hominins, especially the larger ones, were obtained by scavenging. Soon after butchery marks were recognized on Early Stone Age fossils, articles on the 'hunting or scavenging debate' in which hunting is implicitly viewed as behaviorally superior to and more 'modern' than scavenging increasingly proliferated in the literature, especially centered around interpretations of the FLK 22 Zinjanthropus site at Olduvai Gorge (e.g. Binford 1981; Bunn 1981; Bunn 1986; Shipman 1986; Blumenschine 1988, 1995; Binford 1988; Bunn and Kroll 1986, 1988; Bunn and Ezzo 1993; Capaldo 1997; Domínguez-Rodrigo 1997; Dominguez-Rodrigo *et al.* 2007). Meanwhile, a series of **actualistic** studies of resource availability from scavenged carcasses was initiated (Blumenschine 1986, 1987; Cavallo and Blumenschine 1989; Selvaggio 1994; Capaldo 1995, Domínguez-Rodrigo 1999; Pobiner 2007), though some still viewed meat as a marginal food resource (e.g., Speth 1989). A history of this debate is beyond the scope of this paper (but see Bunn 1991; Domínguez-Rodrigo 2002; Domínguez-Rodrigo & Pickering 2003; and Plummer 2004 for reviews); it is not likely that these modes of carcass procurement - hunting and scavenging (whether **passive scavenging** or **active/confrontational scavenging**) - were mutually exclusive behaviors, but were both employed depending on a variety of behavioral and ecological variables (e.g., available hominins in the group for carcass procurement, butchery, and transport; prey size, age, and species; habitat, other available food resources, and presence of other predators). Experimental models of the frequency and location of cut, percussion, and tooth marks (e.g., Blumenschine 1988) are most often used to inform us about the timing of access (**early access** vs. **late access**), and accumulator(s) that contributed to a zooarchaeological assemblage (e.g., Blumenschine 1995; Egeland *et al.* 2004).

Some unresolved questions in this area of research are:

1. How important were animal resources to hominins (versus plants and other non-animal resources), and how did this importance vary by hominin species, time period, habitat, or other variables?

2. How does the amount of meat and marrow available for scavenging in modern ecosystems vary with the size of prey (e.g., Blumenschine 1987; Pobiner 2007), the species of prey, predator species, predator group size, and ecological variables such as season and habitat? Would any of these variables affect frequency and location of butchery marks, and if so, how (e.g., Pobiner and Braun 2005)?

3. How can we evaluate whether confrontational scavenging or passive scavenging took place at any one site? What if more than one mode of carcass procurement took place? How did the acquisition of carcasses vary with different ecological affordances at different sites? How does the mode of carcass procurement relate to the timing of hominin access to animal resources (early access or late access)?

Glossary

hominin: Refers to the human evolutionary group of species, including fossil and modern. This word comes from Hominini, a formal biological term in between the level of genus (e.g., *Homo, Australopithecus*) and the level of family (Hominidae)

carnivory: Obtaining foods from animals.

in situ: (Latin) meaning 'in the place.' In prehistoric studies, *in situ* refers to an artifact or fossil that occurs in the location where it was deposited. *In situ* materials are securely situated in a sediment layer, which allows archaeologists to date them and/or give them better context by studying other artifacts, fossils, or sediments that have been are found nearby in the same layer.

fauna: Animals, or pertaining to animals (such as faunal remains).

persistence hunting: A hunting technique in which the hunters use running, walking, and tracking to pursue their prey to the point of prey exhaustion.

Early Stone Age: A time period lasting from about 2.6 million to between 400,000 and 250,000 years ago that includes stone tools traditions called Oldowan and Acheulean. The Early Stone Age in Africa is roughly equivalent to what is called the Lower Paleolithic in Europe and Asia.

actualistic: A method of inferring the nature of past events by analogy with processes observable and in action in the present.

passive scavenging: Scavenging from an animal carcass that was killed by another predator, or that died of natural causes. Can yield a variety of amounts of different carcass resources (e.g. meat, marrow, brains) depending on whether another predator(s) had access to that carcass first and the sizes and species of the predator(s) and prey carcass.

active or confrontational scavenging: Scavenging from a carcass that involves confronting or chasing a predator in order to obtain resources from that carcass. Can yield a variety of amounts of different carcass resources (meat, marrow, brains) depending on whether another predator(s) had access to that carcass first and the sizes and species of other predator(s) and prey carcass. Often (incorrectly) assumed to yield more resources than passive scavenging.

early access: Obtaining resources from a carcass early in the carcass consumption sequence (usually first), whether by hunting or scavenging.

late access: Obtaining resources from a carcass later in the carcass consumption sequence (not first). Late access predators can obtain a variety of amounts of different carcass resources (meat, marrow, brains) depending on the size and species of other predator(s) had access to that carcass first and size of the prey carcass.

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