

Re: Apith diet cf.Afr.apes, sedges...

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very interesting – to me at least. You should explain to people the various lab techniques used, eg mass spectroscopy, photospectrophotometry, etc. Good job Marc!
Jerry

Marc Verhaegen wrote:

Contributions of Biogeochemistry to Understanding Hominin Dietary Ecology
Julia Lee-Thorp & Matt Sponheimer 2006 *Yb.phys.Anthrop.*49:131-148

Dietary ecology is one key to understanding the biology, lifeways, and evolutionary pathways of many animals. Determining the diets of long-extinct hominins, however, is a considerable challenge. Although archaeological evidence forms a pillar of our understanding of diet and subsistence in the more recent past, for early hominins, the most direct evidence is to be found in the fossils themselves. Here we review the suite of emerging biochemical paleodietary tools based on stable isotope and trace element archives within fossil calcified tissues. We critically assess their contribution to advancing our understanding of australopith, early Homo, and Neanderthal diets within the broader context of non-biogeochemical techniques for dietary reconstruction, such as morphology and dental microwear analysis. The most significant outcomes to date are the demonstration of high trophic-level diets among Neanderthals and Late Pleistocene modern humans in Glacial Europe, and the persistent inclusion of C4 grass-related foods in the diets of Plio-Pleistocene hominins in South Africa. Such studies clearly show the promise of biogeochemical techniques for testing hypotheses about the diets of early hominins. Nevertheless, we argue that more contextual data from modern ecosystem and experimental studies are needed if we are to fully realize their potential.

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The range of paleodietary methods applied to the South African hominins provides a good case study for comparisons, and allows elimination of at least some possibilities. Some firm results have emerged. For one, the $\delta^{13}C$ data clearly show that overall both australopith taxa and early Homo consumed significant proportions of C4 or C4-derived foods. These results can only be accounted for by consumption of C4 grass, C4 sedges, or animals

which ate these plants, but we cannot tell what these possibilities are from these data alone. The low $\delta^{18}O$ is consistent with consumptions of rhizomes or other roots, as well as animal foods. The microwear data discounts gelada-like graminivory, since the australopiths¹ pitted molars (Grine 1986; Grine and Kay 1988) are unlike those of modern geladas whose molar microwear is dominated by scratches (Teaford 1993). On the other hand, two recent molar microwear studies of savanna *Papio* baboon populations noted a higher frequency of pitting than was found in *Theropithecus* (Daegling and Grine 1999). These baboons consume moderate amounts of savanna grasses on a seasonal basis. The trace element data from australopith tooth enamel showed that *Australopithecus*, and to a lesser extent *Paranthropus*, had higher Sr/Ca ratios than contemporaneous carnivores, browsers, and papionins. The unusual combination of high Sr/Ca and low Ba/Ca in *Australopithecus* has only been found in modern fauna that heavily utilize the underground portions of grasses, such as warthogs (*Phacochoerus africanus*) and African mole rats (*Cryptomys hottentotus*) (Sponheimer et al.2005b). These elemental data are still preliminary, and certainly cannot be used to state firmly that early hominins consumed grass rhizomes. Nevertheless, they are entirely consistent with the possibility and suggest avenues for future research.

Comparing the results from the various techniques may also give us the opportunity to question some of the assumptions on which we base interpretations of the results. For instance, it has been suggested that hominid dental anatomy was not well suited for the processing of animal foods (Lucas and Peters 2000; Teaford et al.2002; Ungar, 2004), while the chemical evidence points towards some consumption of animal foods. It has perhaps not been appreciated that these anatomical observations pertain only to a limited class of animal foods (ie. flesh or meat-eating), while a great many animal foods require little if any oral processing. Termites, grasshoppers, ants, grubs, eggs, and a variety of other insects may be eaten whole. Soft tissues can also be consumed without oral processing if they can be reduced to a suitable size through extra-oral means. Moreover, in some cases apparent disjunctions between dental morphology and actual trophic behavior can result from the dentition being adapted for other, more mechanically challenging foods in an animal's diet. For example, capuchin monkeys (*Cebus apella*) have large, bunodont dentition with thick enamel adapted for consuming fruits and hard nuts. Nonetheless, close to 25% of capuchin diets can come from animal foods (Rosenberger and Kinzey 1976; Fleagle 1999). Similarly, Grine et al.(2006) showed that *A.afarensis* microwear closely resembled that of gorillas while their dental and enamel morphology suggested other affinities. These observations are consistent with Ungar's (2004) argument that among hominoids, differences in dental morphology primarily reflect their multifarious fallback foods, rather than their preferred foods during times of plenty.

As for the australopiths, stable isotopes suggest that they broadened the ancestral ape resource base to include C4 foods which, coupled with bipedalism, allowed them to pioneer increasingly open and seasonal environments. Yet, there are equifinality problems that are common in stable isotope and trace element studies. That is, many different diets can lead to the same stable isotope (or trace element) composition (Peters and Vogel 2005). Although some progress has been made using further indicators, including $\delta^{18}O$ and trace elements, there is little reason to believe that

this problem can be circumvented entirely by relying on chemical means. In the end, stable isotopes are one tool among many, all of which provide a slightly different window into the diets of our ancestors. Stable isotopes will prove most informative when pursued as part of a larger, integrated paleodietary investigation.

All of these tools also require a great deal of active development to improve our understanding of how they work in ecosystems today. For instance, we still have much to learn about of the stable isotope compositions of modern plants and mammals, and how physiology affects diet–tissue spacing. We must also continue to test comfortable assumptions. As a good example, earlier notions of a simple stepwise trophic system from trace elements that distinguishes, herbivores, omnivores, and carnivores has been gradually refined after a series of modern ecosystem studies in different environments (Sillen 1988; Burton et al.1999; Sponheimer and Lee–Thorp, Kruger National Park Project, unpubl.data). Rather than a simple trophic level indicator, Sr/Ca and Ba/Ca ratios may ultimately provide just as much information about plant foods. Hopefully, such actualistic and experimental work will serve to further refine the entire suite of paleodietary tools.