Isotopes Give Clues to Past Diets

New approaches to investigating the nature of prehistoric human diets are beginning to show great promise

By far the most trumpeted aspect of paleoanthropology is the discovery of old bones. To be sure, it would be impossible to reconstruct any kind of family tree without that ever-increasing catalog of fossils. But an equally important, though much neglected, pursuit seeks to find what caused the branches in that tree. What important changes underlay the various evolutionary shifts in direction taken by hominids extant and extinct?

Diet is, of course, a critical part of it all, perhaps *the* critical part. What dietary shift occurred, for example, with the emergence of a bipedal hominid from a tree-climbing ancestral ape? And when did meat eating become significant in the hominid diet? Closer to the present, and moving into the cultural rather than the biological realm, the consumption of domesticated rather than wild crops marked a major event in human history.

The questions of what human ancestors did as opposed to what they looked like has been within the province of archeologists for a very long time. But in recent years they have been joined on the food quest by a motley collection of investigators who are tackling the problem in many different and novel ways. A good example is reported in this issue (p. 1381) by Margaret J. Schoeninger, Michael J. DeNiro, and Henrik Tauber. On the old premise that you are what you eat, these three report techniques by which certain prehistoric eating habits can be determined by measuring isotope levels in bone collagen.

The ^{15}N isotope of nitrogen becomes concentrated as it passes up through food chains. Because marine plants have higher concentrations of this isotope than land plants, animals up through the marine food chain continue to reflect and amplify this difference. Schoeninger and her colleagues wanted to determine whether the bones of prehistoric peoples who exploited either marine or terrestrial foods as their main dietary resource would reliably reflect this isotopic signal. As their report indicates, the signal is encouragingly clear in most cases.

The group also looked at certain carbon isotopes (the $^{13}C/^{12}C$ ratio) whose distribution in the body might be affected by the dietary source. Although a clear distinction can be made between a diet of wild grasses and cereals (whose C4-type metabolism concentrate ^{13}C) and other (C3-type) plants, differential solution in sea water can make results from marine resources somewhat ambiguous. Nevertheless, in combination with the nitrogen isotope analysis, a powerful new tool emerges.

The idea of using isotope ratios as indicators of diet has been extant much longer than its practice, as was the case with application of the molecular clock to deriving phylogenetic relationships. The discovery at the end of the 1960's and the beginning of the 1970's of the different modes of photosynthesis in grasses compared with other plants, which affects incorporation of different isotopes, presented the first good opportunity to test the proposition.

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Working with Samuel Epstein at the California Institute of Technology, DeNiro, who is now at the University of California, Los Angeles, applied the test to a South American site where a shift to maize agriculture was thought to have occurred within the past thousand years or so, as inferred from archeological evidence. The isotopes told a different story: the bones show a change in diet that might have been a commitment to corn consumption 3000 years earlier.

Meanwhile, Schoeninger developed the idea of measuring strontium concentrations in prehistoric bones as a way of distinguishing between meat and vegetable diets. She has reported such a difference that correlates with status burials at a Mexican site, a result of the type that thrills archeologists, but is still somewhat controversial.

A growing number of researchers is rapidly joining this field, which has clear promise as well as clear technical traps. The matter of how much turnover of isotopes occurs in the living bones and under what conditions raises questions about the time resolution possible with the technique. It might be that turnover rates are very different in different parts of the skeleton, which conceivably could give valid data about diet at different points in the individual's life. As pertinent is the postmortem exchange of isotopes with minerals in the ground, not to mention the bothersome loss of collagen through microbial and chemical action.

In spite of such difficulties DeNiro is confident that at least several major isotopes will be further developed as important dietary indicators, and as many as 20 trace and other elements can be identified as potential indicators. Chemistry, it seems, is coming to the aid of paleoanthropology in a big way and will certainly do so if the analytical techniques can probe far back in evolutionary time. This potential has been recognized in an epoch-making decision by the organizers of the Gordon Research Conferences, whose orientation towards the chemical sciences nevertheless has them enthusiastically sponsoring a meeting on "Diet and Human Evolution" in Ventura, California, in February next year. DeNiro, who presented the case for the meeting to the Gordon Conference organizers and is to be chairman of the meeting, is delighted with the decision. "We know this approach has reached a very important stage," he says, "and we hope to interest others who are developing other novel approaches to these issues."

Alan Walker, of Johns Hopkins University School of Medicine, has been refining over the past few years a technique for seeking microscopic signatures of dietary habits etched in tooth enamel. Walker, who is to be a vice-chairman of the Gordon Conference, is beginning to pass the stage at which simple, crude categorizations—such as frugivore, folivore, carnivore, forest-floor omnivore—can be made. It might be possible, for instance, to distinguish between animals that ate hard as against soft fruit, which would be a particularly interesting differentiation in the early stages of human evolution.

Walker has been urging his colleagues to consider other novel ways to tackle these kinds of questions about past diets. "If we understand something about what these creatures ate, we understand something very important about their biology and their evolution," he says.

—Roger Lewin