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STRAIGHT FROM THE MOUTHS OF GRAZERS –
GRASSES SIGNAL DROP IN GLOBAL CO_2 AT 7 MILLION YEARS AGO
(From Melanie Lenart) **– Sent Oct.** 1,1997 –

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It's straight from the horse's mouth: The grasslands that pushed human evolution to new heights became widespread about 7 million years ago, probably due to lowered carbon dioxide levels.

That's what the evidence -- fossilized teeth from hundreds of grazing animals who died between 10 million and 4 million years ago -- told Jay Quade, a University of Arizona assistant professor in the geosciences department, and his colleagues. Quade, who specializes in desert geoscience, directs the Desert Laboratory on Tumamoc Hill in Tucson, Ariz.

Quade and a few other researchers from around the world joined forces on a decade-long effort to determine the diet of these long-extinct animals from the carbon isotopes in their tooth enamel. They reported their findings in Nature last month.

"From an isotopic point of view, you are what you eat," explained Quade. And because teeth are composed of minerals -- mainly apatite, ironically -- this dental record of consumption can last for millions of years. "Our teeth are basically rocks," he noted.

The carbon isotopes captured in 10-million-year-old tooth enamel speak of browsing on tree leaves and other vegetation known as C3 plants. But the isotopes record a widespread shift to a diet of C4 grasses around 7 million years ago.

This is the first sign of the C4 plants that comprise many grasslands today, particularly in the tropics.

C4 plants leave a unique isotopic signature on grazers' teeth that reflects their more efficient approach to making food out of thin air. (Of course, the recipe also calls for water and sunshine.) Basically, their photosynthesizing technique involves funneling concentrated carbon dioxide from the air to an internal carbohydrate production line where they convert carbon dioxide into sugar and starch.

C3 plants just let the carbon dioxide float into their photosynthesizing factory in the same ratio as it exists in air. For much of their long existence, they could afford to do so because there was plenty of carbon dioxide in the air.

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For instance, the atmosphere of 70 million years ago contained 10 times as much carbon dioxide as the levels found today, Quade said, judging from isotopic records in ancient soils. The level dropped -- precipitously from a C3 plant's point of view -- to its lowest point in at least 250 million years right about the time humans were evolving to stand on their only two feet.

As far as scientists can tell, the atmospheric CO_2 levels dipped roughly 7 million years ago and remained that low through through the modern-day 18th century, the geologist said.

Quade and his coauthors believe that C4 grasses evolved directly in response to these low levels of carbon dioxide. The University of Arizona researcher noted that anthropologists speculate that the need to see across widespread grasslands spurred humans to stand up, thereby freeing their hands for tool use in hunting and agriculture.

"Maybe we needed this low CO_2 condition to develop. Our ancestors never would have moved out of the trees otherwise," he asserts.

In the last couple of hundred years, humans evolved techniques for finding and burning fossil fuels, thereby raising atmospheric carbon dioxide levels from about 270 parts per million to their current level of about 360 parts per million. Ongoing fossil fuel use coupled with deforestation is expected to double atmospheric CO_2 levels sometime in the next century.

It takes more than a doubling of carbon dioxide to make a serious impression on soils, however, Quade said. So it's difficult to get the dirt on how quickly CO_2 was removed from the enriched atmosphere of 70 million years ago to become the relatively rarefied atmosphere of today.

Still, research in carbon isotopes can provide clues, sometimes indirectly as with the fossilized tooth enamel study. The influence of C4 plants shows up as a recognizably greater proportion of "heavier" carbon atoms in the soils where they grow and in the teeth of those who eat them for a living. These heavier carbon atoms, known as isotopes in this context, have seven neutrons instead of the more usual six at their center.

Quade first noticed the isotopic shift in fossilized teeth from Pakistan during a study reported in a 1989 Nature article. At the time, he thought it might have been related to the advent of a monsoonal climate.

But after working with others to collect ancient teeth from every continent, using museum collections as well as a pick and shovel to unearth new specimens, he and his colleagues became convinced that the shift to C4 plants was a worldwide phenomenon.

"To take it out of the local to the global is really significant," he said. "It requires a global shift in atmospheric carbon dioxide. That's the unifying explanation."

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