A Buffet for Early Human Relatives 1.8 Million Years Ago

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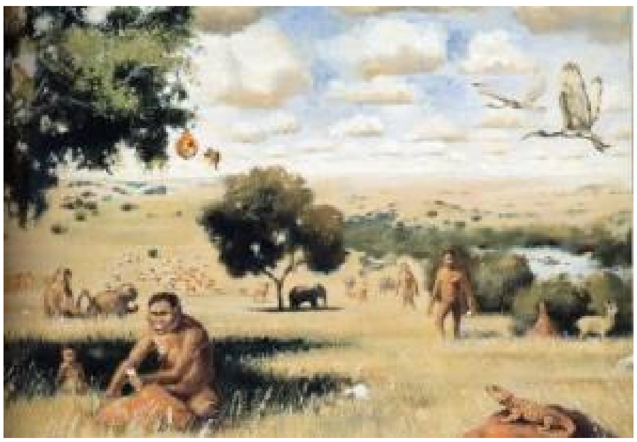


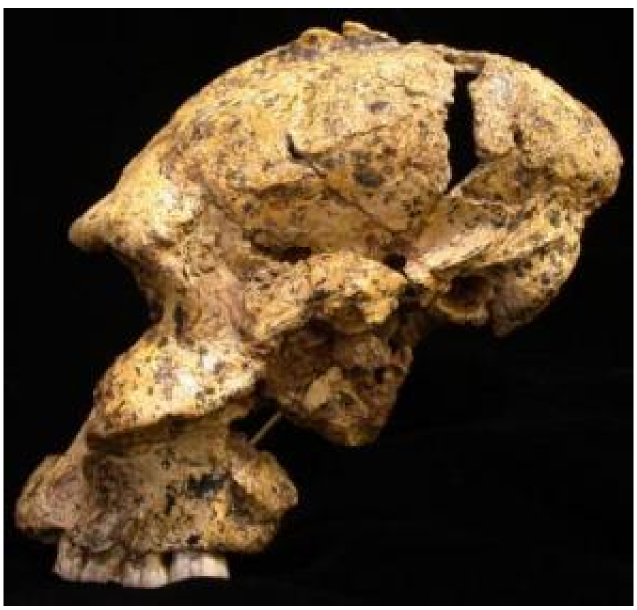
Illustration of Paranthropus in southern Africa 1 to million years ago. Credit: Artwork by Walter Voigt -provided by Lee Berger and Brett Hilton-Barber.

University of Utah scientists improved a method of testing fossil teeth, and showed that early human relatives varied their diets with the seasons 1.8 million years ago, eating leaves and fruit when available in addition to seeds, roots, tubers and perhaps grazing animals.

"By analyzing tooth enamel, we found that they ate lots of different things, and what they ate changed during the year," says University of Utah geology doctoral student Ben Passey, a coauthor of the study in the Friday, Nov. 10 issue of the journal *Science*.

"We wanted to know if they had variability in their diets on the time scale of a few months to a few years," he says. "The new method showed that their diets were extremely variable. One possibility is that they were migrating seasonally between more forested habitats to more open, savanna habitats."

Study coauthor and geochemist Thure Cerling - a University of Utah distinguished professor of geology and biology - says the study of the now-extinct, ape-like species known as Paranthropus robustus is important because it "shows that the variability in human diet has been 'in the family' for a very long time. It is this variability that allows modern humans to utilize foods from all over the world."



Paranthropus robustus skull from Swartkrans Cave, South Africa. Credit: Image courtesy Darryl DeRuiter, Texas A&M University

The researchers used a laser to remove tiny samples from four 1.8-million-year-old fossilized Paranthropus teeth, then tested the samples to determine the ratios of two isotopes or forms of carbon.

Plants fall into two broad classes depending on the way in which they use photosynthesis to convert sunlight, water and carbon dioxide into plant matter and oxygen. Carbon isotope ratios reveal the extent to which the relatives of early humans ate so-called C3 plants, which include fruit and leaves from trees in both the forest and savanna, and C4 plants, which grow mostly on the savanna and include potato-like tubers, grasses, and seeds and roots from grasses. If the early hominids ate meat from grass-grazing animals like antelope, the C4 "signal" also shows up in their teeth.

"Hominids were taking advantage of seasonal differences in food items in a savanna environment," Cerling says. "We cannot tell if they were carnivores or scavengers, but it is possible their diet included animals. We are picking up that signal."

The new study was led by Matt Sponheimer, a former University of Utah postdoctoral fellow and now an assistant professor of anthropology at the University of Colorado, Boulder. Other coauthors were Utah's Passey and Cerling; anthropologists Darryl de Ruiter at Texas A&M University and Debbie Guatelli-Steinberg at Ohio State University; and archeologist Julia Lee-Thorp at the University of Bradford, England.

Laser Dentistry on Prehistoric Teeth

The study analyzed four fossil teeth of Paranthropus from Swartkrans, South Africa. A museum loaned them to the researchers. Passey used a laser to remove and vaporize tiny samples of enamel, which then were analyzed in a mass spectrometer to determine the ratio of rare carbon-13 to common carbon-12.

"The previous way to sample tooth enamel was to take a dental drill with a diamond-impregnated bit and basically grind away at the tooth, collect the powder and then analyze that," Passey says.

In the past decade, researchers including Cerling have used "laser ablation" to remove and analyze tooth enamel samples from the large, fossilized teeth of prehistoric horses, rhinos and elephants to determine the animals' diets.

Until now, lasers were too destructive to use on the smaller teeth of human ancestors and their relatives - even those of Paranthropus, known for relatively large teeth and a strong, heavy jaw.

Passey improved the laser technique. "What I did was fine-tune the method to handle very small samples like human-sized teeth," he says. "If you tried the previous method on a human tooth, you would blast a hole clear through the enamel, and museum curators wouldn't like that."

Passey, who is working on his Ph.D. degree, "really made terrific advances in the lab to make this [study] possible," Cerling says.

The laser was used to remove samples at various points along the length of the tooth, which is marked by tiny ridges called perikymata. They run parallel to the tooth's crown and represent tooth growth, similar to tree rings. Perikymata are produced under the gums during the animal's juvenile years, when teeth are growing.

Each laser sampling vaporized enamel that formed during several months and thus represented what Paranthropus ate during that period. By taking several samples off the length of each tooth, the researchers reconstructed a few years of each creature's diet.

When the laser is used, the vaporized enamel is confined within a cylindrical chamber a few inches long. Carbon from carbonate in tooth enamel combines with oxygen to produce carbon dioxide gas, which then is analyzed by the mass spectrometer.

Your Teeth are What You Eat

If the sample has a relatively high ratio of carbon-13 to carbon-12, it means the early human relative was eating a diet rich in C4 plants most commonly found on the African savanna, such as seeds and roots from grasses, and grass-like plants called sedges, which include tubers. They also may have eaten animals that grazed on C4 plants.

If a sample has a relatively low ratio of carbon-13 to carbon-12, it means Paranthropus was eating C3 plants, including the leaves and fruits of trees and shrubs, as well as forbs, which are broadleaf herbs that are not grasses. Forests contain almost entirely C3 plants. African savanna has both C3 and C4 plants.

Analyses of the Paranthropus teeth revealed that the early human relatives had diets that varied in the proportion of C3 and C4 plants both seasonally and from year to year. The year-to-year variation in Paranthropus' diet "might reflect yearly differences in rainfall-related food availability," the study's authors write. "Another possible explanation is that these individuals were migrating between more wooded habitats and more open savannas."

Cerling says the study "shows that our early human relatives were able to eat a varied diet and therefore were more adaptable in savanna environments than other primates which had a more restricted diet."

Other studies have suggested that the diets of human ancestors and relatives became more varied about 3 million years ago when Africa's climate started getting drier and more seasonal. That was shortly before the first appearance of stone tools and of Paranthropus and Homo, the genus to which modern humans (Homo sapiens) belong.

The researchers noted that Paranthropus often has been portrayed as a specialist that lacked a varied diet, and that has been used to explain why Paranthropus went extinct as Africa became drier, while tool-wielding Homo - with a highly varied diet - survived and evolved.

The new study casts doubt on that theory by showing that Paranthropus, like Homo, also consumed a variety of foods.

"Thus, other biological, social or cultural differences may be needed to explain the different fates of Homo and Paranthropus," the scientists conclude.

Source: University of Utah

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