Our early forebears must have been a hardy lot.

In the long story of human evolution, they had only recently evolved to walk on two feet, were unable to fashion stone tools or make fire, and must have found it a tough duty to gather edible food of any kind.

So just what did the hominids eat? Many fossil hunters have long surmised that they subsisted in large part on grasses and grass-like sedges, or on animals -- either scavenged or slow-moving -- that grazed on those grasses.

Now a 26-year-old graduate student at UC Santa Cruz has turned to the humble African mole rat, whose underground life is nourished by bulbs and varieties of nutritious plant roots known as corms, to explain what may have been a dietary staple of the hominids who lived 2 to 3 million years ago.

Justin Yeakel journeyed to Africa to examine the teeth in fossil skulls of two ancient pre-human creatures named Australopithecus africanus and Paranthropus robustus whose tooth chemistry had been determined by other researchers. He also analyzed the chemistry of the teeth in varied species of mole rats -- both living and fossil -- whose reliance on underground food sources dates back for at least 17 million years.

The various types of foodstuffs in the diets of both humans and animals leave differing chemical signatures on their teeth. But Yeakel found that those signatures of underground foods were the same in fossil and modern mole rats, as well as in the teeth of the ancient hominids. The signatures are based on the relative abundance of specific isotopes of carbon and oxygen, and they are very different from the chemical signatures of the grasses and sedges that live on the surface.

In addition, Yeakel found that the sites in southern Africa where the two fossil species of ancient hominids lived also abounded in fossil remains of the underground mole rats.

"The bulbs and roots and probably tubers there must have been the principal fallback foods for those early hominids whenever things got tough," Yeakel said in an interview. "They were relatively untouched by other animals except the mole rats, and they were abundant, growing underground in tons per square acre. Those hominids didn't have fire, and the raw meat they scavenged wasn't always available, but their brains were..."
advanced enough to use crude digging tools to gather the underground foods that the mole rats thrived on."

As an added interest to his research in Africa, Yeakel also visited Tanzania's remote Lake Eyasi, where the hunter-gatherer Hadza people also rely in part on modern versions of the same bulbs, roots and tubers that formed at least part of the hominid diet millions of years ago.

Frank Marlowe, a biological anthropologist at Florida State University, works with the Hadza and knows Yeakel's work. He said in an e-mail Wednesday that the Hadza still eat about 10 different species of tubers they dig from underground.

"So the logic employed to argue that tubers were important for early hominids impresses me," he said. "But I am biased as I already assumed that those hominids did eat them."

Nathaniel Dominy, the anthropologist who heads the UC Santa Cruz laboratory where Yeakel works, said, "It's clear that our hominid ancestors were certainly not grazers, and while it's perfectly reasonable to assume that at least a third of their diet came from grazing animals, it's also plausible that underground foods formed a major part of it."

Dominy was a co-author of Yeakel's report, which is published in the Proceedings of the Royal Society B: Biological Sciences. Other co-authors were Paul Koch, professor of Earth and planetary sciences at UC Santa Cruz, and Nigel Bennett of the University of Pretoria in South Africa.

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