We Are What They Ate

By Jennifer McNulty

Nathaniel Dominy's hunt for the dietary jackpot that propelled human evolution has led him underground. Were our early human ancestors brainy enough to dig for their dinner? Maybe so, says Dominy.

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If anthropologist Nathaniel Dominy had a time machine, he'd set the dial for 2 million years ago and transport himself back in time.

That way, he'd finally get definitive answers to the questions about human evolution that have fascinated him ever since he picked up a *National Geographic* magazine at the age of nine.

"Why are we so different from all other primates? That's the fundamental question," says Dominy, an assistant professor of anthropology at UCSC. "Everyone who studies the past has an innate curiosity about what it was like. We all wish we had time machines, but we have to settle for the fossil record."

Dominy calls himself a "food guy," because he explores the diet of hominins—the early human ancestors who lived 2 million years ago. His work is at the center of one of the hottest subjects in physical anthropology, because researchers now believe it was a nutritional jackpot that gave our forebears a major advantage over all other primates, fueling the development of bipedalism and big brains.

But what dietary bonanza changed the path of human evolution? Dominy's quest for answers has led him to bulbs and tubers, familiar to us as onions and potatoes. These nutrient-rich underground plant structures, referred to by the unwieldy moniker "underground storage organs" or USOs, are dietary mainstays of cultures around the globe. The Hadza people of Tanzania, among the world's last hunter-gatherers, rely on starchy tubers for up to 50 percent of their diet.

The classic way to infer diet is to study teeth, but Dominy has augmented what anthropologists have gleaned from the form and structure of teeth by drawing deeply from the fields of chemistry, molecular biology, and genetics. These interdisciplinary insights have enriched our understanding of the past and helped establish Dominy, 31, as one of the top young researchers in human evolution.

"Form follows function," explains Dominy, adding that low, flat molars with thick enamel are good for chewing hard foods, while teeth with thin enamel are well-suited for eating fibrous fruits and leaves. Dental similarities have helped shape theories about evolution—and have also misled researchers. For years, anthropologists believed orangutans were most closely related to humans in part because their molar teeth are most like ours, but breakthroughs in molecular biology in the 1980s helped establish that chimpanzees and gorillas occupy that perch on the evolutionary tree.

Such advances rock the study of human evolution on a fairly regular basis, and Dominy's work is at the cutting edge of the field. He recently weighed in on a conundrum that developed eight years ago when compelling new isotopic evidence gathered from fossilized hominin teeth suggested that our early ancestors subsisted on a diet primarily of grasses and sedges. Researchers were puzzled because their flat teeth appear better adapted for chewing seeds and nuts, rather than tough grass.

Intrigued by the grassy-diet postulation, Dominy collaborated with UCSC geochemist Paul Koch, a professor of Earth and planetary sciences, and anthropology graduate student Justin Yeakel to see if USOs leave the same chemical signature on tooth enamel as grass, and sure enough, they do. In a clever twist, the team analyzed the enamel of African mole rats, which subsist entirely on USOs. They also tested the fossilized teeth of mole rats taken from sites where hominin fossils were recovered. The enamel of both rat populations matched the hominin signature. So does that mean our distant predecessors ate side-by-side with rodents who lack a sense of smell and are so dumb they literally dig until they hit something to eat? Quite possibly, says Dominy. "We know hominins were advanced enough to use crude digging tools, and they might have been brainy enough to recognize that the dirt mounds left behind by rats were good indicators of where to dig," he says.

A tireless researcher, Dominy takes nothing for granted. In a line of inquiry that will help anthropologists refine their "form follows function" correlations between teeth and diet, Dominy has field-tested the toughness of roughly 100 edible plants gathered across Africa. "Anthropologists use the terms 'tough' and 'hard' interchangeably, but we need to be more precise about how we characterize hardness," he says. Such distinctions are important because primate teeth changed over the millennia, presumably as diets changed, and Dominy's baseline data help tighten those linkages.

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Dominy's latest avenue of research harnesses one of science's newest tools, the human genome, to probe some of the oldest questions of human evolution. With the aid of molecular genetics, Dominy and his colleague P. J. Perry of Arizona State University have established that humans stand apart from apes in their ability to digest starch, and that the distinction emerged within the timeframe of modern humans—less than 2 million years ago. Moreover, among humans today, the genetic coding that regulates the capacity to process starch varies among populations depending on the amount of starch in their diet. This finding suggests that selection favors a higher capacity among those who need it most—more evidence that USOs likely helped fuel human evolution. "It sure looks like a human-specific increase in the copies of a gene that regulates starch digestion might have coincided with an adaptive shift toward eating starchy foods like tubers," he says.

Regarded as a bold and creative researcher, Dominy is as adept in the field as in the lab. "You learn more from a week in the forest than a semester in the classroom," he says. Each summer, he spends as much time as possible in Africa, crisscrossing the continent to remote areas of Cameroon, Kenya, South Africa, and other countries. He matter-of-factly describes clandestine border crossings, rough four-wheel-drive roads, and 300-mile treks by motorbike followed by 30-mile hikes into the jungle.

Dominy credits his fieldwork with shaping his research agenda. For example, the hours he has spent observing pygmies foraging for food prompted him to rethink the widely held assumption that their short stature is the result of poor nutrition. Instead, Dominy wonders if being small could be an evolutionary bonus rather than a misfortune in the rainforest, where dense growth requires constant flexing of the hip and knee.

That kind of out-of-the-box thinking is trademark Dominy. The son of astrophysicists, he hopes one day to use laser technology to quantify the three-dimensional complexity of the forest canopy. It's one of numerous projects on his "to do" list. With his energy and passion, he clearly isn't waiting for a ride on that time machine. In fact, about the only thing he seems to struggle with is the concept of "down time." "I'm not good at that," says Dominy. "I never stop working. I'm always thinking."