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By Daniel Grushkin

The isotope diet

Seventeen years ago, a pair of climbers in the Italian Alps stumbled on a leathery corpse hunched in a pool of melting ice. At first they thought the body was fresh, but the copper ax, wooden bow and quiver of 14 arrows spoke of a man from another time. The iceman, affectionately dubbed Ötzi, was the oldest frozen body (5,300 years) ever found.

It would take almost a decade to crack one of the most fundamental questions about Ötzi—what did he eat? "Diet tells you something profound not just about the person and how he spent his time, but about his society and relationships," says Stephen Macko, the scientist who would become an unlikely key to deciphering Ötzi's menu.

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A professor of biogeochemistry at the University of Virginia, Macko began his career leagues under the soaring Alps, analyzing isotopes at the bottom of the sea. In 1997, he and a team of oceanographers discovered a new species living on the floor of the Gulf of Mexico—a pink worm-like creature with little oars for legs. By analyzing the isotopes in its muscles, he determined that *Hesiocaeca methanicola* fed on bacteria that lived in sulfide-spewing gas vents, an entire ecosystem no one had ever known about.

During a chance encounter at an amino acid conference, Ötzi's then-guardian, medical doctor Gert Lubec, asked Macko what the isotopic analysis used on worms

would reveal about the iceman.

"Well," Macko said, "I can tell you what he ate."

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Lubec immediately flew Macko to Innsbruck, Austria, where the body was being stored. The following day Macko returned to his lab in Charlottesville, Va., carrying a clear envelope containing a wispy, brown, 10-cm strand of Ötzi's hair.

Hair, made of keratin, tells a dietary tale in the form of stable isotopes. Different types of food contain specific amounts of nitrogen, carbon and sulfur isotopes. When absorbed by the body these signature isotopes pass into our every fiber. But they're best preserved in hair, which doesn't decompose with time like muscle or tissue.

Carnivores show high levels of nitrogen-15, which correlates with their high place in the food chain, since the isotope tends to collect in animal tissue, and therefore increases in meat-lovers. The worms Macko discovered were steeped in sulfur-35, like other creatures that feed on sulfide-eating bacteria. Macko can even distinguish between rice and wheat-eaters from those who eat corn (thanks to the different enzymes with which crops turn sunlight into sugar, corn shows higher percentages of carbon-13). Macko's dietary sleuthing culminated last year in an appearance in "King Corn," a documentary about America's corn dependency. Using hair samples, Macko found that 65% of America's nutrition comes from subsidized corn agriculture.

Ötzi, too, held some surprises. Though the iceman had carried the weapons of a hunter, his hair resembled that of a vegetarian's, and a study on the fibers of Ötzi's cloak and shoes corroborated Macko's belief (*Rapid Comm Mass Spectrom*, 22:2751-67, Sept. 2008). Instead, he was a migratory herdsman. The human bloodstains found on his dagger suggest he'd taken the weapons into battle.

"While finding cattle bones at a site might tell you that meat was eaten, isotopic analysis tells you its portion in a society's diet—a society's nutrition fills in a picture of how it lived," says Robert Hedges, of the Oxford University Research Laboratory for Archeology and Art History.

This year, Macko returns to sea, where he will aim isotopic analysis at climate change, collecting core samples of sediment off the coast of Alaska. The isotopes in the shells and detritus of organisms deposited in each layer will reveal the ebbs, flows and temperature changes, since during cold periods the ocean has a higher concentration of oxygen-18 (it doesn't evaporate as easily as oxygen-16). "We are learning the language of the earth, and the language is simply in these chemical and isotope signals," says Macko.