cause of human AIDS—and sooty mangabey monkeys, is impressed by the data. "Everyone has kind of been pussyfooting around the question of whether chimps were the origin," says Hirsch. "As more isolates are studied, it becomes more believable."

Hahn began studying HIV-1's origins in 1995 when she received a call from Larry Arthur at the National Cancer Institute. A decade earlier, Arthur had tested 98 captive chimps in the United States to make sure they did not harbor HIV-1. He found that one animal, a pregnant 26-year-old named Marilyn, had antibodies against HIV-1, but she died in childbirth a few days later. Arthur put tissue samples from the chimp aside and forgot about them until he cleaned out his freezer. Did Hahn want to study Marilyn? he asked.

Hahn jumped at the chance. Scientists until then had found HIV-like viruses in only three chimps, two of which came from Gabon and the third from what was then Zaire. (The viruses do not appear to cause disease in the animals.) An analysis of the genetic sequence of these isolates, named SIVcpz, had revealed that the two Gabonese strains were closely related to HIV-1 strains found in humans, but the Zairian strain was quite different.

Hahn and her colleagues found that Marilyn harbored an SIVcpz virus similar to the Gabonese strains. They then analyzed the DNA in the mitochondria of cells from the four animals to determine which particular subspecies of chimp they came from. They found that the Gabonese animals and Marilyn all belonged to *Pan troglodytes troglodytes*, while the Zairian animal belonged to the subspecies *P. t. schweinfurthii*.

Hahn believes that SIVcpz may have been in chimps for hundreds of thousands of years, and that viral strains have evolved to be specific to particular chimp subspecies, which are isolated geographically by rivers. *P. t. troglodytes*—whose natural range "coincides precisely" with the regions in Africa that have had HIV-1 infections in humans for the longest period—appears to be the source of the HIV-1 strains that now infect humans, Hahn concludes. She believes that three separate transmissions occurred, each of which gave rise to one of the three main groups of HIV-1. Although the exact route of transmission is unknown, Hahn speculates that butchering chimpanzees and other animals for so-called "bushmeat"—a practice she notes is common in parts of west equatorial Africa—may have provided the link.

Hahn concedes that the chimp-human link would be stronger if researchers could show directly that SIVcpz is widely prevalent in at least some wild chimp populations. She and other researchers now hope to do these analyses, but they face a potential problem: The chimps are being driven to extinction. Hahn says she hopes her findings will ultimately discourage people from eating chimps, and focus more attention on the question of why the virus that decimates human immune systems rarely harms our closest primate relative.

–JON COHEN

PALEONTOLOGY

Dietary Data Straight From the Horse's Mouth

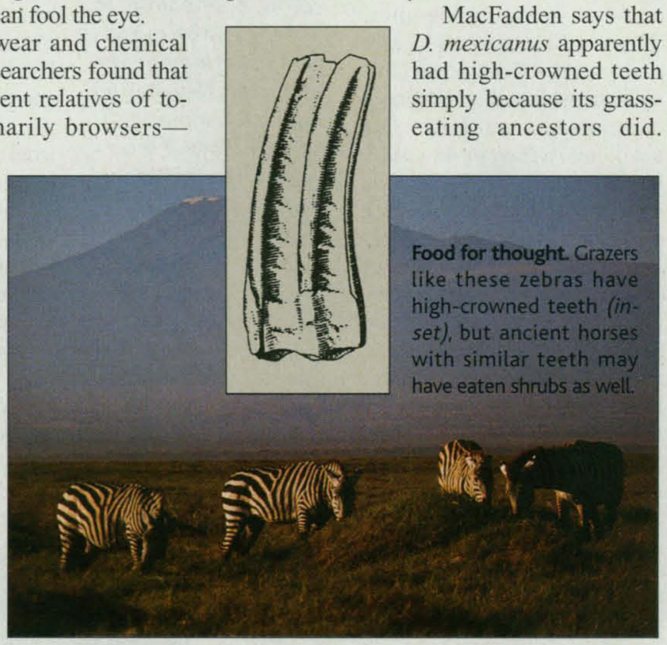
Like the horse and carriage, horses and grasses have a long history together, or so paleontologists have thought. When modern grasses appeared some 20 million years ago, the thinking went, the teeth of ancient equines evolved to crop this new food, developing the high crowns seen in modern horses, and their owners changed from deerlike browsers of shrubs and trees to pure grazers. But on page 824 of this issue, Bruce MacFadden, a paleontologist at the University of Florida, Gainesville, and his colleagues show that in horses, at least, the tooth can fool the eye.

By analyzing tooth wear and chemical traces in the teeth, the researchers found that some of the closest ancient relatives of today's horses were primarily browsers—despite having teeth shaped like those of a grazer. "This is the best study to date on horse dietary behavior and change," says John Rensberger, a paleontologist at the University of Washington, Seattle. "They've taken a novel approach that challenges the traditional interpretations" of equine tooth shape, providing a model for analyzing the diets of other extinct mammals.

MacFadden's team teased apart the dietary preferences of six horse species that shared the grassy plains of Florida about 5 million years ago. The horses ranged from small, three-toed types to the heftier, one-toed *Dinohippus mexicanus*, one of the closest relatives of modern horses. All six species bore the dental hallmark of a grazer: high-crowned (or hypsodont) teeth with enameled ridges that can cut a stalk of grass as neatly as a lawnmower blade. But MacFadden puzzled over how all six could make a living cropping grass. "Ecological theory says that they'd have to partition the environment somehow; that some of them must have looked for another food," he says.

With his colleagues, MacFadden analyzed the carbon isotopes in the horses' teeth and their patterns of wear to show that that's what actually happened. Grazing horses typically eat grasses, which in many regions use the so-called C_4 photosynthetic pathway to turn carbon dioxide into sugars and starches. Such plants incorporate different amounts of the isotopes carbon-12 and carbon-13 than do C_3 plants, which are primarily trees and shrubs. Animals that eat different plants retain different amounts of isotopes in their teeth.

The team's analyses showed that some of the six horse species ate solely C_4 grasses, but others chewed a mix of C_4 grasses and C_3 shrubs and twigs, and a couple, including *D. mexicanus*, fed mostly on C_3 plants. Similarly, a microscopic analysis of tooth enamel showed that some species, again including *D. mexicanus*, did not have the characteristic abrasive marks incised by a purely grass diet but were pitted and scratched like the teeth of a browser in spite of their high crowns. "We used to interpret those high crowns as a sure sign of a grass diet," but that's not certain anymore, says Michael Woodburne, a paleontologist at the University of California, Riverside.



Food for thought. Grazers like these zebras have high-crowned teeth *(inset)*, but ancient horses with similar teeth may have eaten shrubs as well.

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MacFadden says that *D. mexicanus* apparently had high-crowned teeth simply because its grass-eating ancestors did. When the species switched back to eating browse, its teeth did not change. He suggests that the high-crowned teeth represent an "irreversible" evolutionary change, but others are less sure. "It may be that horses invented a tooth that's simply good for eating anything—trees, shrubs, grass," says Paul Koch, a vertebrate paleontologist at the University of California, Santa Cruz.

All six horses eventually went extinct for some reason. Ironically, the future belonged to the big, one-toed browser, *D. mexicanus*, which gave rise to the oldest known species of modern horse—which was a grass-eater—some 4.5 million years ago. "That's the biggest surprise of all—I'd never have guessed that horse was a browser," says Koch. "It shows the power of these combined techniques."

–VIRGINIA MORELL