Early Mongolians ate dairy, but lacked the gene to digest it

Ancient DNA and protein help solve evolutionary riddle

By Andrew Curry

More than 3000 years ago, herds of horses, sheep, and cows or yaks dotted the steppes of Mongolia. Their human caretakers ate the livestock and honored them by burying the animal bones with their own. Now, analysis of deposits on ancient teeth shows that early Mongolians milked their animals as well. That may not seem surprising. But the DNA of the same ancient individuals shows that as adults they lacked the ability to digest lactose, a key sugar in milk.

The findings deepen an emerging puzzle, challenging an oft-told tale of how people evolve lactase persistence, the ability to produce a milk-digesting enzyme as adults. From other studies, “We know now dairying was practiced 4000 years before we see lactase persistence,” says Christina Warinner of the Max Planck Institute for the Science of Human History in Jena, Germany. With its long history and culture of dairying, “Mongolia shows us how.”

As University of Copenhagen paleo-proteomicist Matthew Collins, who was not on the team, puts it, “We thought we understood everything, but then we got more data and see how naive we were.”

Most people in the world lose the ability to digest lactose after childhood. But in pastoralist populations, the story went, culture and DNA changed hand in hand. Mutations that allowed people to digest milk as adults would have given their carriers an advantage, enabling them to access a rich, year-round source of fat and protein. Dairying spread along with the adaptation, explaining why it is common in herding populations in Europe, Africa, and the Middle East.

But a closer look at cultural practices around the world has challenged that picture. In modern Mongolia, for example, traditional herders get more than a third of their calories from dairy products. They milk seven kinds of mammals, yielding diverse cheeses, yogurts, and other fermented milk products, including alcohol made from mare’s milk. “If you can milk it, they do in Mongolia,” Warinner says. And yet 95% of those people are lactose intolerant.

Warinner wondered whether dairying arose recently in Mongolia or whether early Mongolians had lactase persistence and then lost it in a population turnover. Ancient people there might have picked up such mutations from the famed Yamnaya herders—about a third of whom were lactase persistent—who swept east and west from central Eurasia 5000 years ago.

To find answers, her team analyzed human remains from six sites of the Deer Stone-Khirigsuur Complex, a Mongolian culture that between 1300 B.C.E. and 900 B.C.E. built burial mounds marked with standing stones. Because those nomads rarely built permanent structures, and constant winds strip away the soil along with pot fragments and trash pits, archaeological evidence for diet is scarce. So Warinner’s Max Planck colleague Shevan Wilkin took dental calculus—the hard plaque that builds up on teeth—from nine skeletons and tested it for key proteins.

The calculus yielded milk proteins from sheep, goats, and bovines such as yak or cow. Yet DNA from teeth and leg bones showed the herders were lactose intolerant. And they carried only a trace of DNA from the Yamnaya, the team reports this week in the Proceedings of the National Academy of Sciences. “They're exploiting these animals for dairying even though they're not lactase persistent,” Collins says.

That disconnect between dairy and DNA isn't limited to Mongolia. Researchers recently found milk proteins on pots at Çatalhöyük in Turkey, which at 9000 years old dates to the beginnings of domestication, 4 millennia before lactase persistence appears. “There seem to be milk proteins popping up all over the place, and the wonderful evolution we expected to see isn’t happening,” Collins says.

Modern Mongolians digest dairy by using bacteria to digest lactose for them, turning milk into yogurt and cheese, along with a rich suite of dairy products unknown in the Western diet. Ancient pastoralists may have adopted similar strategies. “Control and manipulation of microbes is core to this whole transformation ... that enables them to have a dairying culture,” Warinner says.

Geneticists are going back to the drawing board to understand why lactase persistence is common—and apparently selected for—in some dairying populations but absent in others. “Why is there a signal of natural selection if there was already a cultural solution?” asks Joachim Burger, a geneticist at Johannes Gutenberg University in Mainz, Germany.

How dairying reached Mongolia is also a puzzle. The Yamnaya’s widespread genetic signature shows they replaced many European and Asian Bronze Age populations. But they seem to have stopped at the Altai Mountains west of Mongolia. “Culturally, it’s a really dynamic period, but the people themselves don’t seem to be changing,” Warinner says. She thinks even though the Yamnaya didn’t contribute their genes to East Asia, they did spread their culture, including dairying. “It’s a local population that has adopted the steppe way of life.”

Given these surprising results, Warinner has a new goal: to figure out just which microbes helped Mongolians digest milk.

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