New study rewrites genetic history of sheep

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Head of polled, domesticated sheep in the long grass. Credit: Michael Palmer/Wikipedia

At a time when the price of mutton is climbing and wool crashing, a groundbreaking new study has used advanced genetic sequencing technology to rewrite the history of sheep breeding and trading along the ancient Silk Road—insights that can help contemporary herders in

developing countries preserve or recover valuable traits crucial to their food and economic security.

The new findings regarding one of the first animals ever domesticated will be published in the October print edition of the journal *Molecular Biology and Evolution*. They are the product of an unprecedented collaboration involving scientists in China, Iran, Pakistan, Indonesia, Nepal, Finland, and the United Kingdom. The team analyzed the complete mitochondrial DNA of 42 domesticated native sheep breeds from Azerbaijan, Moldova, Serbia, Ukraine, Russia, Kazakhstan, Poland, Finland, China, and the United Kingdom, along with two wild sheep species from Kazakhstan. These data were compared to DNA sequences of 150 breeds from several other countries to complete the most exhaustive maternal genetic analysis of sheep ever undertaken.

The DNA of contemporary sheep can now be read like a historical record, allowing researchers to look back 10,000 years to the time when humans first started herding these animals in the Fertile Crescent of the Middle East.

"What we found is that sheep in Asia are far more genetically diverse than sheep now common in Europe and we can use that diversity to help herders in places like Mongolia and western China who now want to focus on meat rather than wool production," said Jian-Lin Han, a senior scientist working at the Joint Laboratory on Livestock and Forage Genetic Resources, established in Beijing by the Chinese Academy of Agricultural Sciences (CAAS), and the Nairobi-based International Livestock Research Institute (ILRI). Han and Meng-Hua Li, a molecular geneticist of the Chinese Academy of Sciences (CAS), are the leading corresponding authors of this study.

Not one, but two migratory waves

The scientists found that the rich genetic heritage of Asian sheep is a product of two distinct "migratory waves" of domesticated animals, not one as previously believed.

Han said that DNA analysis of thousands of tissue samples of 150 breeds from many countries confirmed previous findings that domesticated sheep first emerged in the Fertile Crescent about 8,000 to 11,000 years ago. And that they then made their way east to what is now China and Mongolia via the Silk Road, a set of trading routes extending some 4,000 miles that has facilitated commerce and human migration between Asia and Europe for thousands of years.

But Han and his colleagues discovered a second migration with evidence that herders in what are now northern China and Mongolia developed their own unique breeds some 5,000 years ago. These animals later made their way back west along the Silk Road, where frequent trading of breeding females, or ewes, allowed them to be mixed in with the progeny of their ancestors to produce yet more distinct breeds. For example, Han said, warriors of the infamous Mongol hordes of Genghis Khan often rode west with live sheep strapped to their horses.

"What this study shows is that the genetic lineages of modern sheep were shaped by thousands of years of trading and breeding moving first west to east and then back, east to west, which created a unique collection of beneficial traits," said Olivier Hanotte, a livestock geneticist and ILRI collaborator at the University of Nottingham in the United Kingdom. "This is important information for contemporary sheep breeding programs," he added. "In the world of animal husbandry, to get what you want you first need to know what you have. Until now, we barely knew anything about the genetic makeup of Asian sheep."

Beneficial traits for breeding

ILRI's Han said the study lays the foundation for more effective breeding programs that support Asia's millions of poor livestock herders, many of whom are now seeking breeds of sheep better suited for meat production.

Meat animals are now wanted because of a soaring urban demand for meat in developing countries. Mutton prices in China alone have risen more than 40 percent since 2011, presenting new economic opportunities for the country's poor herding communities. But sheep breeds globally are still dominated by animals developed mainly to produce wool—and prices of wool have dropped steadily since 1996. Furthermore, most breeds raised for meat today are found in Australia and New Zealand, where they dine on relatively expensive feeds and lush pasture grasses.

"The kind of sheep we need in places like Mongolia and western China are animals that are strong and hardy and can cover long distances every day in search of grass," Han said. "That's not the kind of animal they're producing in New Zealand and Australia."

In China today, Han often encounters herders trying on their own to develop more meat-oriented sheep. He said some herders are even experimenting with breeding local sheep with massive wild sheep known as Argali. But that experiment, he says, could bring along undesirable traits as well. New genomic data and genetic markers can guide this effort to enable the inclusion of beneficial traits, he adds.

Han and his colleagues say the next step in their work is to take the information generated from this current study and use it to build a foundation for breeding programs that can efficiently provide herding communities in Asia and sub-Saharan Africa with animals suited to local conditions and preferences.

There have already been strides in the integration of desirable traits in sheep. For example, in Kenya today, ILRI scientists have helped local livestock keepers develop an improved version of an indigenous "hair" sheep long kept by Maasai pastoralists. These red Maasai sheep are among the "climate-smart" solutions being developed to help farmers and herders adapt to climate change in East Africa. The red Maasai sheep better cope with heat stress and disease (they are naturally resistant to intestinal worm infections) and they convert poor forage grasses into meat and milk more efficiently than other breeds.

"In China and many other parts of the world today, a small herd of sheep is a family's most important asset, providing the family with food, income, clothing, and fertilizer for their crops," says ILRI's director general Jimmy Smith. "We need to be doing everything we can to ensure that the animals they raise have the genetic traits that will help the sheep endure and progress and herders benefit from new sources of income, such as the growing mutton market."

"In coming years and decades, as we face global climate, population, and other changes," Smith said, "we need to be able to put our hands on the best traits for diverse and changing circumstances. That's what research like this is giving us. To quote leading genomicist and ILRI collaborator Claire Fraser, 'Doing biology like this—with knowledge of genomes—is like doing science with the lights turned on.'"

Provided by International Livestock Research Institute