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**ANCIENT FOSSILS SHOW THAT HEAD-BASHING COMBAT
CONTRIBUTED TO THE EVOLUTION OF GIRAFFES' LONG NECKS**

**NEWLY DESCRIBED 17-MILLION-YEAR-OLD FOSSILS SUGGEST THAT
NECK ELONGATION WAS NOT DRIVEN BY FOOD COMPETITION ALONE**



Analysis of a newly described species of ancient giraffe relative that lived about 17 million years ago shows a unique skull and neck that are adapted for head-bashing competition. Previously, the common assumption among scientists was that giraffes' long necks evolved to help them reach an otherwise untouchable source of food – treetop leaves. But the study, published today in the journal *Science*, indicates that this classic example of adaptive evolution is more complex and that a variety of head-neck morphologies and behaviors played a role in giraffe evolution.

Modern giraffes are the tallest land animal and largest ruminant on Earth, with an elegant form that is unique in the animal kingdom. Like other mammals, giraffes have

seven cervical vertebrae, but the average length of each vertebra is over 30 centimeters (nearly 12 inches), with a total length of 2.5 meters (more than 8 feet). In comparison, even-toed ungulates of similar weight, such as buffalo, have cervical vertebrae that are only about 5 centimeters (2 inches) long. Even the okapi of the Central African forests, the giraffe's only living relative, does not have a particularly elongated neck, with an average length of just over 10 centimeters (about 4 inches) per vertebra.

"How did the giraffe's long neck evolve? This question has fascinated scientists for years, all the way back to Darwin and Lamarck, two of the founding fathers of evolution," said co-author Jin Meng, a curator in the Museum's Division of Paleontology. "Darwin, Lamarck, and many scientists since have agreed that the giraffe evolved a long neck to get to higher foliage and thus survive its competition, but as we've learned and discovered more, we've found an alternative explanation."

The idea that food drove neck elongation was the prevailing theory until 1996, when a set of researchers argued a "necks-for-sex" hypothesis, suggesting sexual selection driven by intermale competition may have also contributed to neck evolution. Male giraffes compete for dominance by swinging their necks and delivering blows to each other with their heavy skulls, small horns, and stout ossicones on their heads. The result of these "necking" competitions, the researchers proposed, is the evolution of ever-longer necks. The idea has been hotly debated since.

Also in 1996, Meng, then part of a team from the Institute of Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences, discovered a mysterious fossil skull with thick bones and associated large cervical vertebrae in a remote corner of the Gobi Desert in northwestern China that he called a "strange beast." Nearly 20 years later, Shi-Qi Wang at the Chinese Academy of Sciences and colleagues renewed an analysis of the specimen, which has disk-shaped helmet-like headgear and highly complex head-neck joints. In the new study, the team reports it to be a new species of Miocene giraffoid, which they named *Discokeryx xiezhi*.

The peculiar morphological characteristics of *D. xiezhi*—explored through high-resolution CT scans and 3D reconstruction, including of the inner ear structures—show an adaptation for fierce head-butting behavior, the authors say.

The researchers also studied tooth enamel isotope data from the fossils, which

suggest that the species also likely filled a specific ecological niche in the ecosystem unavailable to other contemporary herbivores. The scientists suggest that early giraffoid evolution is more complex than previously known, where, in addition to competition for food, sexual combat likely played an important role in shaping the group's unique skull and necks.

"Feeding may be an evolutionary outcome, sex may be the pathway that leads to this outcome, and, above all, each species must find its place in the ecology if it is to survive in a challenging environment," Meng said.

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Image:

Male combat in the representative giraffoids: The newly described *D. xiezhi* (head-to-head butting, bottom) and the modern *Giraffa camelopardalis* (neck blowing, top) show different combat styles and head-neck morphology.

Illustration by Y. Wang and X. Guo

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