Evidence contradicts idea that starvation caused saber-tooth cat extinction

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This shows Larisa DeSantis preparing dental molds of saber-tooth cat teeth at the La Brea Tar Pits in Los Angeles. Credit: Courtesy of Larisa DeSantis, Vanderbilt University

The latest study of the microscopic wear patterns on the teeth of the American lions and saber-toothed cats that roamed North America in the late Pleistocene found that they were living well off the fat of the land in the period just before they went extinct.

In the period just before they went extinct, the American lions and saber-

toothed cats that roamed North America in the late Pleistocene were living well off the fat of the land.

That is the conclusion of the latest study of the microscopic wear patterns on the teeth of these great cats recovered from the La Brea tar pits in southern California. Contrary to previous studies, the analysis did not find any indications that the giant carnivores were having increased trouble finding prey in the period before they went extinct 12,000 years ago.

The results, published on Dec. 26 in the scientific journal *PLOS ONE*, contradicts previous dental studies and presents a problem for the most popular explanations for the Megafaunal (or Quaternary) extinction when the great cats, mammoths and a number of the largest mammals that existed around the world disappeared.

Sabertoothed cats were not limited by food in California during the late Pleistocene. Citation: DeSantis LRG, Schubert BW, Scott JR, Ungar PS (2012) Implications of Diet for the Extinction of Saber-Toothed Cats and American Lions. *PLoS ONE* 7(12): e52453. doi:10.1371/journal.pone.0052453 Credit: Mauricio Anton

"The popular theory for the Megafaunal extinction is that either the

changing climate at the end of the last Ice Age or human activity – or some combination of the two – killed off most of the large mammals," said Larisa DeSantis, assistant professor of earth and environmental sciences at Vanderbilt, who headed the study. "In the case of the great cats, we expect that it would have been increasingly difficult for them to find prey, especially if had to compete with humans. We know that when food becomes scarce, carnivores like the great cats tend to consume more of the carcasses they kill. If they spent more time chomping on bones, it should cause detectable changes in the wear patterns on their teeth."

In 1993, Blaire Van Valkenburgh at UCLA published a paper on tooth breakage in large carnivores in the late Pleistocene. Analyzing teeth of American lions, saber-tooth cats, dire wolves and coyotes from La Brea, she found that they had approximately three times the number of broken teeth of contemporary predators and concluded, "...these findings suggest that these species utilized carcasses more fully and likely competed more intensely for food than present-day large carnivores."

The latest study uses a new technique, called dental microwear texture analysis (DMTA), developed by co-authorPeter Ungar at the University of Arkansas. It uses a confocal microscope to produce a three-dimensional image of the surface of a tooth. The image is then analyzed for microscopic wear patterns. Chowing down on red meat produces small parallel scratches. Chomping on bones adds larger, deeper pits. Previous methods of dental wear analysis relied on researchers to identify and count these different types of features. DMTA relies on automated software and is considered more accurate because it reduces the possibility of observer bias.

This is a skeleton of a saber-toothed cat exhibited at the Page Museum at the La Brea Tar Pits in Los Angeles. Credit: Courtesy of Larisa DeSantis / Vanderbilt University

DeSantis and Ungar, with the assistance of Blaine Schubert from East Tennessee State University and Jessica Scott from the University of Arkansas, applied DMTA to the fossil teeth of 15 American lions (*Panthera atrox*) and 15 saber-tooth cats (*Smilodon fatalis*) recovered from the La Brea tar pits in Los Angeles.

Their analysis revealed that the wear pattern on the teeth of the American lion most closely resembled those of the present-day cheetah, which actively avoids bones when it feeds. Similarly, the saber-tooth cat's wear pattern most closely resembled those of the present-day African lion, which indulges in some bone crushing when it eats. (This differs from a previous microwear study using a different technique that concluded saber-tooth cats avoided bone to a far greater extent.)

The researchers examined how these patterns changed over time by selecting specimens from tar pits of different ages, ranging from about 35,000 to 11,500 years ago. They did not find any evidence that the two carnivores increased their "utilization" of carcasses throughout this period. If anything, their analysis suggests that the proportion of the

carcasses that both kinds of cats consumed actually declined toward the end.

The researchers acknowledge the high rate of tooth breakage reported in the previous study, but they argue that it is more likely the result of increased breakage when taking down prey instead of when feeding.

"Teeth can break from the stress of chewing bone but they can also break when the carnivores take down prey," DeSantis pointed out. Species like hyenas that regularly chew and crack bones of their kills are as likely to break the rear teeth they use for chewing as their front canines. Species like the cheetah, however, which avoid bones during feeding are twice as likely to break canines than rear teeth. This suggests that they are more likely to break canines when pulling down prey.

The researchers report that previous examinations of the jaws of the American lions and saber-tooth cats from this period found that they have more than three times as many broken canines and interpret this as additional evidence that supports their conclusion that most of the excess tooth breakage occurred during capture instead of feeding.

In addition, the researchers argue that the large size of the extinct carnivores and their prey can help explain the large number of broken teeth. The saber-toothed cats were about the size of today's African lion and the American lion was about 25 percent larger. The animals that they preyed upon likely included mammoths, four-ton giant ground sloths and 3,500-pound bison.

Larger teeth break more easily than smaller teeth. So larger carnivores are likely to break more canine teeth when attempting to take down larger prey, the researchers argue. They cite a study that modeled the strength of canine teeth that found the canines of a predator the size of fox can support more than seven times its weight before breaking while

a predator the size of lion can only support about four times its weight and the curved teeth of the saber-toothed cats can only support about twice its weight.

"The net result of our study is to raise questions about the reigning hypothesis that "tough times" during the late Pleistocene contributed to the gradual extinction of large carnivores," DeSantis summarized. "While we can not determine the exact cause of their demise, it is unlikely that the extinction of these cats was a result of gradually declining prey (due either to changing climates or human competition) because their teeth tell us that these cats were not desperately consuming entire carcasses, as we had expected, and instead seemed to be living the 'good life' during the late Pleistocene, at least up until the very end."

More information: DeSantis LRG, Schubert BW, Scott JR, Ungar PS (2012) Implications of Diet for the Extinction of Saber-Toothed Cats and American Lions. PLoS ONE 7(12): e52453. doi:10.1371/journal.pone.0052453
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