Lion genetics study uncovers major consequences of habitat fragmentation

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Over the course of only a century, humanity has made an observable impact on the genetic diversity of the lion population. That's the conclusion of a recently published study by Drs. Caitlin Curry and James Derr from the Texas A&M University College of Veterinary Medicine

& Biomedical Sciences.

By comparing the DNA of lions today to lions from 100 years ago, they found that there is clear genetic evidence of recent population fragmentation, which is when groups of a species are isolated from each other. This fragmentation could ultimately have a long-term impact on the genetic health of the iconic species. The research was published in the journal *Molecular Biology and Evolution*.

"I was surprised at what we found—surprised and disappointed, because it's not what I wanted to see," Derr said. "I really wanted to be able to tell everyone that the management we've been doing for the last 100 years is perfect and to keep doing what we've been doing and everything will be fine. But that's not the take-home lesson; unfortunately, that's not the story we can tell.

Curry and Derr started their study with one overarching question: Has the genetic structure of lion populations changed over the last 100 years?

There have been several studies on modern lions, so gathering data for the modern populations was straightforward. Curry pulled together DNA data from three previously published studies on lions that lived between 1990-2012.

The historical populations, against which they wanted to compare the modern lion DNA, provided more of a challenge. Fortunately, scientists have a way to turn back time. Many of those lion remains still reside perfectly preserved in collections around the world. Curry used DNA extracted from bones, teeth and hides of 143 lions that lived between 1880-1949 to create a historical population data set.

Both population data sets cover the same geographical range from India to Southern Africa where lions are found. Scientists call this type of

analysis, comparing data from the same space at different times, a spatiotemporal study.

No Room To Roam

It has been understood for a long time that female lions tend to stay close to the pride in which they were born, while males travel great distances to find new prides. Therefore, males are almost exclusively responsible for the movement of genes in the population, which helps keep genetic diversity within the species high.

As the human population continues to rapidly grow across Africa and more and more barriers to lion movement have gone up in the form of cities, fences and farmland, male lions haven't been able to travel the distances they once could.

According to Curry, while lions are still genetically diverse right now, the results in the DNA were more pronounced than she expected.

"In the historical population, you couldn't easily identify where a lion was from based on its nuclear DNA. This is due to high historical levels of gene flow across the population," she said. "But in the modern population, you can determine the general area, or sub-population, for most of the lions. But, even with sub-populations being more isolated, the overall level of genetic diversity is still considered high across all lion populations."

Consequences Of Low Genetic Diversity

If lions are still generally genetically healthy today, then why does this matter?

"Over the last 100 years or so, we have restricted the natural movements of many species," Derr said. "This isolation leads to reduced gene flow and ultimately may result in reducing genetic diversity to a level that threatens the survival of local populations."

Perhaps the most well-known example of what happens with a lack of genetic diversity is another large cat, the African cheetah.

According to genetic analysis, scientists believe cheetahs have suffered two large bottleneck events, or events that lead to a rapid shrinking of the gene pool. When these events happen, it results in the breeding of closely related individuals in the population, or inbreeding, creating very low genetic diversity.

This has led to a current cheetah population that, even in the wild, struggles to fend off new diseases, has difficulty breeding, and faces other significant health problems.

A Story Of Hope

But that fate can still be avoided in lions, especially now that experts are armed with proof that lion populations have been significantly impacted by isolation and subdivision.

"This should not be a disheartening story but rather one of hope," Curry said. "Yes, we see a decrease in genetic diversity across lion populations over the past century. But, currently, compared with other mammalian species, lion genetic diversity is still considered high across all lion populations.

"With responsible management focused on giving prides enough space to breed and allowing males to move more freely between isolated pockets, it is possible to increase the genetic diversity and reduce population sub-

division across lion populations."

There have been multiple reintroduction programs bringing lions back to areas where lions once roamed, and coexistence strategies are increasingly being integrated into wildlife conservation programs.

"The positive take-home message is now that we've documented this and we understand it, policies can be tailored to manage these populations differently," Derr said. "We know now that you can't treat all lions the same. Now we have the responsibility to manage these animals, and many other managed wildlife species, in ways that better reflects their current biology."

More information: Caitlin J Curry et al, Spatiotemporal Genetic Diversity of Lions Reveals the Influence of Habitat Fragmentation across Africa, *Molecular Biology and Evolution* (2020). DOI: 10.1093/molbev/msaa174

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