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Lemur teeth help take a bite out of Madagascar's mysteries

March 25 2015

A ring-tailed lemur (*Lemur catta*) indigenous only to Madagascar. UC's Brooke Crowley is researching lemurs' geographic mobility. Credit: Provided by Brooke Crowley

Out of the mouths of lemurs come many answers to old mysteries about Madagascar's unique fauna. What were their origins, and how and why did they move around?

New research by UC quaternary paleoecologist Brooke Crowley, assistant professor of geology and anthropology, shows that although many lemurs typically stay put for most of their lives, their mobility may have decreased in recent years, possibly due to the deforestation of Madagascar by its human inhabitants.

Crowley will present her initial findings in a poster presentation titled "Reconstructing the mobility of Madagascar's fauna using strontium isotopes: results and implications for management and conservation," at the American Association of Physical Anthropologists meeting on March 28 in St. Louis. Crowley's efforts out of UC's McMicken College of Arts and Sciences support the UC Third Century Initiative by producing new ways of understanding and transforming the world through research and scholarship.

Crowley and her students are looking closely at the isotopes of strontium (Sr)—a common element found in rocks and minerals—that has been taken up by plants and incorporated into animal tissues. By matching modern strontium data from Madagascar's geologically diverse region with the strontium values she measures in the teeth and bones of ancient lemurs and other subfossil mammals she can trace their relative mobility during the past 10,000 years.

Among the primary goals of her study to preserve the island's fauna and unique lemur species, Crowley hopes to shed light on the environmental consequences of forest loss and the effects this will eventually have on the health of the planet.

A biodiversity goldmine

Because of Madagascar's diverse variety of rocks with different chemistries and ages—a result of the island's ancient history of colliding with other landmasses and then drifting apart—tracking animal mobility and migration patterns can be performed with confidence, explains Crowley.

For centuries, scientists have marveled at Madagascar's lemur species, whose origins are unique to Madagascar. Unfortunately, all large-bodied species of lemur (as well as other native fauna larger in size than a small dog) have gone extinct in the past 2,000 years, most likely due to hunting pressure and deforestation. Crowley believes that gaining a better understanding of how animal mobility has been affected by the loss of species and habitat will be beneficial to current and future conservation efforts on the island.

According to Crowley, strontium isotopes can impart significant information about when (and potentially why) organisms changed their mobility.

Skullbone of an Archaeolemur cranium, an extinct lemur from Madagascar.

Lemur mouths speak loudly about their origins

"In this first step, I show that there are differences in strontium in animal teeth and bones from different localities and different geologies," says Crowley. "I am creating a baseline to establish what these differences are so I can know what to expect from an animal that lives on a particular kind of rock. With this baseline information, I will be able to identify outliers. If an animal's strontium isotope values differ from what would be expected for its locality, this strongly suggests the animal is an immigrant—it's a way of tracking their mobility."

Crowley explains that strontium is an effective isotope to use for this kind of geological tracking because it is so common and varies among rock types with differing chemical compositions or ages. Strontium substitutes for calcium in our bones, so we have a fair amount of it in our tissues. It is weathered from eroding rock, dissolved in water and taken up by plants. Consequently, if you consume plants or water from a particular place, your bones and teeth will incorporate that strontium.

"Teeth are particularly good for this research. Once they are formed they don't re-equilibrate during an individual's lifetime or after it dies. This means the strontium in a tooth will reflect the strontium in the food and water consumed while that tooth was mineralizing," says Crowley. "And that record will be preserved throughout your lifetime and long after you die."

She adds that strontium strongly reflects the geology where an individual lives rather than the individual's type of diet.

There goes the neighborhood

Madagascar is an island that is a biodiversity hot spot and according to Crowley, it is a global conservation priority to try to help make sure that the animals that are endemic to the island are going to be there for the long term.

This starting point in Crowley's study reveals a contrast of lemur mobility between subfossil and living species. With additional data, she anticipates finding decreased mobility, especially in the last 150 years after humans began clearing forests and vegetation corridors (forest canopies that connect one environmental region to another).

"It is a place that has undergone a major recent extinction event, so there's been a lot of ecological loss and the goal is to hopefully not have more species disappear in the near future," says Crowley. "The big question that remains then is how has the animals' mobility been impacted by forest loss? Perhaps individuals were not particularly mobile in the past, but I expect that they were able to move beyond the small, and rapidly decreasing areas that remain forested today. We will have to continue the research to see."

Restoration efforts to help restore relocation

Another pragmatic goal for her study is to predict the future. In particular, how animals might be affected by recent habitat fragmentation or on the other side, restoration efforts. Crowley points out that several organizations—including Madagascar Biodiversity Partnership, WeForest.org and natureisspeaking.org—have put forth a great effort to plant trees and vegetation on the island. These efforts have successfully built forest corridors in the last decade that will connect previously isolated forest fragments.

Crowley also notes that it will be interesting to document whether animals are moving along those corridors. As these corridors develop they will ideally allow for greater mobility of individuals.

While Crowley has been to Madagascar four times in the last decade, her work on this study is primarily performed here in her lab using modern and historic materials borrowed from museums, universities and colleagues who do excavations. She has been particularly fortunate to have material borrowed from the Duke University Primate Center's excellent collection of subfossil materials.

Crowley is excited about this direction of her research, noting that she and her students are fortunate to be collaborating with many strontium isotope specialists, anatomists and paleontologists. Contributing researchers on this project are Philip A. Slater of the Department of Anthropology at the University of Illinois; Kathleen M. Muldoon of the Department of Anatomy at Midwestern University in Arizona; and Laurie R. Godfrey of the Department of Anthropology at the University of Massachusetts.

"Strontium isotope biochemistry is a really powerful tool that I think can add a dimension that is currently missing from the story of the recent history of Madagascar," says Crowley. "I've spent a lot of time over the years looking at other isotopes from a diversity of fauna on the island and have answered all sorts of questions about animal interactions and ecological change, but big questions remain unanswered about differences in mobility among organisms as well as changes in their mobility over time."

Provided by University of Cincinnati

Citation: Lemur teeth help take a bite out of Madagascar's mysteries (2015, March 25) retrieved

20 March 2024 from https://phys.org/news/2015-03-lemur-teeth-madagascar-mysteries.html

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