Mongoose in the city: How landscape can impact disease transmission in Botswana

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Banded mongooses live in social groups called troops. Researchers are using genetic tools to track movements of mongooses living in urban centers and natural areas in Botswana to gain insight into how to better model disease transmission among wild animals living across complex landscapes. Credit: Kathleen Alexander, Virginia Tech.

Under a concrete drainage culvert at the edge of a town in Botswana, a troop of banded mongoose is getting ready to leave its den. Moving from shade into light, the cat-sized animals scan the area for signs of danger and for opportunities to find something to eat in an increasingly crowded neighborhood.

Unbeknownst to them, the genetics of this troop's members—and others like them—are providing researchers in the College of Natural Resources and Environment with new understandings of how and why animal behavior changes in proximity to human development and how that change can impact infectious disease spread.

The researchers used genetic tools to identify changes in movement behavior among mongooses living in urban centers and natural areas, gaining important insights into how to better model disease transmission among wild animals living across complex landscapes. Results of their study, which was funded by a grant from the National Science Foundation's Ecology and Evolution of Infectious Diseases program, have been published in the journal *Ecology and Evolution*.

"The question has always been how do we predict what's going to happen once an infectious disease emerges," said Kathleen Alexander, the William E. Lavery Professor in the Department of Fish and Wildlife Conservation. "By using systems that are tractable, we can begin to learn a lot more about how disease dynamics are shaped by host behavior and environmental drivers, including urbanizing landscapes."

One tractable system can be found with social groups of banded mongooses, also known as troops, that live across urban and natural areas in Botswana. Over the past 20 years, researchers from the Chobe Research Institute and CARACAL, a nonprofit organization co-founded by Alexander, have been observing the behaviors of mongoose troops in the natural environment of Chobe National Park and in increasingly

urban centers, such as Kasane.

Botswana's banded mongooses are ideal study subjects because they live in territorial social groups across the landscape, and, in northern Botswana, are infected with a novel tuberculosis pathogen closely related to human tuberculosis.

"We're looking for dispersal behaviors and movement of mongooses that may allow disease transmission to occur between these mongoose troops," said Professor Eric Hallerman, who specializes in population genetics and is a co-author of the paper. "This species tends to live in troop structures that are resistant to immigration from other troops, so it's important to know how they are moving across the landscape and interacting."

"They're a difficult species to follow on the ground because they look so similar, unlike, for example, cheetahs, which can be individually identified by their spots," continued Hallerman, who, along with Alexander, is an affiliate of Virginia Tech's Fralin Life Sciences Institute. "You can put ear tags and other markers on them, but they often lose the marks, making it difficult to track individuals across troops. Genetic approaches provide the key to addressing these difficulties."

To do so, the researchers needed samples. "We decided that the best option for trying to capture the most genetic diversity from the troops was to collect fresh stool samples," said Kelton Verble, the paper's lead author, who completed his master's degree in fisheries and wildlife sciences at Virginia Tech in 2018. He refined sample collection processes, tracking mongooses across landscape types and collecting fecal samples from a wide variety of troops.

"We also looked at the health status of the mongooses that moved

between study troops," he said. "Our previous data indicated that tuberculosis-infected animals tended not to disperse, and data from this study supports this original finding."

Genetic data obtained from microsatellite DNA markers within the genome sequence of each animal allowed Verble to not only identify individuals that had moved between troops in their lifetime, but also characterize the general genetic makeup of the various troops across the landscape—how were individuals connected and how would this influence disease transmission potential?

"With this study, we really wanted to explicitly investigate dispersal and clarify what was happening between and among troops across land type," said Alexander, who is also an affiliate of the Fralin Life Sciences Institute's new Center for Emerging, Zoonotic, and Arthropod-Borne Pathogens. "What we saw was that these urban landscapes were not only changing foraging behaviors, aggression, and den use, but also dispersal behaviors and, consequently, disease transmission potential."

The researchers discovered that mongooses living in urban landscapes were more likely to disperse to other troops in this land type, thereby increasing the chance of tuberculosis transmission. With more abundant, human-associated food sources, troops nearer to the city were also more likely to share dens and have overlapping home ranges.

"The banded mongoose is typically regarded as a philopatric species, meaning that if they're born to a troop, they stay there for life," said Verble, who is now working on a doctorate in genomics at the University of Alabama. "What we learned is that there was a lot more swapping of individuals between troops than had been recognized, which is crucial for predicting disease spread."

Such findings have implications not only for disease transmission among

animals but also for understanding how zoonotic diseases, such as COVID-19, transfer from animals to humans and how urbanization might impact that spread.

"We've never been very good at predicting disease-emergence events," Alexander said. "We don't know when a pathogen will emerge, and we have trouble predicting what will happen when it does because there are so many possible influences. For zoonotic pathogens, it will be increasingly important to understand how animals interact with and are influenced by transforming landscapes and growing urban centers, information critical to advancing our toolkit for tackling public and animal health challenges."

More information: Kelton Verble et al, Urban landscapes increase dispersal, gene flow, and pathogen transmission potential in banded mongoose (Mungos mungo) in northern Botswana, *Ecology and Evolution* (2021). DOI: 10.1002/ece3.7487

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