[crickets chirp]

[chime plays]

[music plays]

[NARRATOR:] African savannas are famous for their diversity of large mammals. But how do so many similar species co-exist in the same place?

[music plays] Princeton University biologist Rob Pringle is captivated by this question -- one of the enduring mysteries of ecology. His team is working in Mozambique's Gorongosa National Park. Their focus is three closely related species of antelope: bushbuck, nyala, and kudu.

[PRINGLE:] They all occur here in the same kind of habitat and they differ in size. So that enables us to, to look at how each species is utilizing the habitat. And how do they avoid competing with each other so strongly that they start driving one another extinct?

[NARRATOR:] These species live in savanna -- grasslands interspersed with small clumps of trees. At the heart of each clump is a termite mound. Termites concentrate soil nutrients and moisture, enabling the growth of palatable trees and shrubs rarely found elsewhere.

[PRINGLE:] So this is forest that's just incredibly nutritious. I mean this is like, this is cheeseburger, basically.

[NARRATOR:] Ecological theory predicts that to coexist, each species must occupy a unique niche, defined by the combination of habitats and foods it uses. Rob has enlisted mammalogist Ryan Long. Together, they are using new technologies to gain unprecedented insights into the lives of these animals. To study habitat use, they need to track the movements of each species through time. Today, they are placing a satellite collar on a kudu, the largest species.

[RYAN:] She's right here.

[RUI:] I've got her.

[RYAN:] Dart, dart, dart. Oh yes. Alright, three minutes.

[PRINGLE:] The most critical piece, obviously, is to get this collar on. And it will provide an hourly location for ten months or so.

[NARRATOR:] Next, the researchers need to know exactly what each species is eating. This has long been difficult, because it is often impossible to identify plants while watching an animal feed in the distance. Rob's team is pioneering a new approach called DNA metabarcoding. The researchers collect animal dung, which contains undigested plant cells. They isolate the plant DNA from those cells and match it to a reference library of possible food plants.

[PRINGLE:] This is a sample about as fresh as you can possibly get it. Sometimes you get nothing at all, but we actually have nice fully formed pellets. A very clean sample. No contamination from any kind of plant DNA because it came from the inside of the animal.

[NARRATOR:] The final step-- a reversal injection to wake her up. The team has collared 20 individuals of each species. Now they can start to build a picture of each animal's ecological niche by monitoring its movements and diet through time.

[PRINGLE:] So what we can do when we have our GPS collared animals, we can get multiple fecal samples from them over the span of several months. Over time what that'll enable us to do is, we can actually look at the dietary profile of each individual.

[NARRATOR:] Rob is examining the location data from a bushbuck, the smallest species in the study.

[PRINGLE:] So each of these little green points has been logged over the last twenty-four hours. That's certainly a termite mound, as is that. So it looks like she's hopping from termite mound to termite mound.

[NARRATOR:] Now that Rob knows her approximate position, he can try to collect a fecal sample.

[PRINGLE:] Each of these collars also got a VHF radio transmitter, which we are using to get a fine scale location. I guess she is actually on that termite mound over there. We'll try and approach very, very quietly so we don't cause her to run off. Oh yeah, there she is. There she is.

[PRINGLE:] I didn't expect we'd be able to sneak up on her so close.

[NARRATOR:] The dung must be no more than a few hours old to obtain high-quality, uncontaminated plant DNA.

[PRINGLE:] Got a nice clean one. Put that on ice and then we're out of here.

[NARRATOR:] Back in the lab at park headquarters, several additional steps ensure that the DNA is well preserved.

[PRINGLE:] These are nice fresh samples. And so I'm going to homogenize by just mushing it up in the bag there. Pop it into the vortexer. Let her run for about 30 seconds. Enough shaking to break open the cells and spill the DNA out. That's pretty good. Looks like a chocolate milk shake. That's a good sign.

[NARRATOR:] Later, in Rob's lab at Princeton, Tyler Kartzinel oversees DNA extraction and sequencing. The team uses bioinformatics and statistical software to identify the plant species in each fecal sample and compare the dietary niches of different species.

[PRINGLE:] Our preliminary analysis is, you know, the data look very exciting. As we predicted the smallest species bushbuck is, you know, almost living on top of termite mounds to have the highest quality diet.

[NARRATOR:] The researchers are finding that bushbuck feed almost exclusively on the highly nutritious termite mound plants. The larger species forage more widely, both on and off mounds. This is because bigger animals need a greater quantity of food to sustain themselves, even if it means that each mouthful is less nutritious on average.

[PRINGLE:] Kudu should have the lowest quality diet, and nyala should be sort of somewhere smack-dab in-between. What our DNA metabarcoding studies have revealed is this really interesting picture of how animals partition the niche.

[NARRATOR:] Each species uses the habitat differently and feeds on a different combination of plant species in varying proportions. Such "niche partitioning" reduces the strength of competition, preventing a single species from monopolizing all of the resources. In this way, all three species can co-exist.

[PRINGLE:] So what we're finding is that plant diversity may be really important in helping to maintain large mammal diversity. The presence of termite mounds is actually increasing what would might otherwise be a fairly monotonous homogenous landscape and adding more diversity to it.

[NARRATOR:] The Pringle Lab's work is revealing how food webs are organized and biodiversity maintained. And it reminds us that ecological communities are profoundly interconnected-- from the tiniest termite to the mighty kudu and all of the plants in between.

[music plays]