[crickets]

[cymbal plays]

[chime]

[helicopter sounds]

[BARBER (on radio):] This looks like perfect bat habitat.

[music plays]

[BARBER:] I came to Gorongosa to study bat-moth interactions. And I've done work in the tropics all around the world, but never in Africa, and so we're here to try to fill in some really important holes in our data set. Bats are nocturnal hunters and I was really fascinated by sonar, this ability to use sound to navigate in the darkness. And as I learned more about bats, I started being interested in the prey of bats, in insects. And that led into studying bat-moth interactions, which is an arms race, a co-evolutionary battle that's been going on for more than sixty million years.

[music builds]

[clicking sound]

[NARRATOR:] An amazing aspect of the dynamic battle between bats and moths is that they use sound in the hunt. To find prey, bats rely on echolocation. They produce high frequency calls and listen to the echoes from their targets to find their position. Having long been on the bat menu, moths have evolved strategies to avoid being eaten.

[BARBER:] There's a lot of different anti-bat strategies. And the one we're studying here is sound production, ultrasound production, above the level of human hearing. They have ears to hear bats coming, and then producing their own ultrasound back at the bats.

[NARRATOR:] The diversity of bats and moths in Gorongosa makes it a great place to study these moth defenses.

[BARBER:] The first thing we have to do is catch the moths. So we put up lamps that emit a lot of ultraviolet light, and those attract the moth to the sheet. So I have two graduate students with me here in Gorongosa. Ellie Cinto Mejia is my master's student. And then there's another graduate student with me here, Nick Homziack, and he is a PhD student in Dr. Akito Kawahara's lab at the University of Florida.

[music plays]

[BARBER:] Here's a little tiger moth.

[HOMZIACK:] We've got around ...a little more than a dozen.

[NARRATOR:] After capturing the moths, we determine which ones produce ultrasound as an anti-bat defense.

[BARBER:] We play recorded echolocation attacks back to tethered moths. So we have a speaker that's playing back these recorded attacks, and then we have a microphone near the moth to record the sounds they make. This gives us a very controlled way of assaying their response to bat attack.

[BARBER:] I'm ready for playback when you are, Ellie.

[MEJIA:] OK

[BARBER:] Yes, it's making sound. Awesome.

[high-pitched clicking]

[BARBER:] A very large number of moth species make sound back at bats. And they use lots of different structures to do so. Some have these sound-producing structures on their thorax. Some use modified genitals at the tip of their abdomen to make these sounds back at bats.

[BARBER:] Acoustic warriors!

[laughs]

[NARRATOR:] The next question is, how do the moths use ultrasound to avoid being eaten? Butterflies and amphibians use striking colors to signal to potential predators that they are toxic. Some moths use the same strategy by signaling with ultrasound.

[high-pitched chirping] Other moth species use ultrasound to disguise their location by jamming the bat's sonar. We set up an experiment to distinguish between these strategies. We track wild bats hunting different moth species as we record their sounds.

[BARBER:] I'm plugging in a bunch of ultrasonic microphones so that we can record the sounds that moths make when they're attacked by bats. Then this is a high-speed camera, so behind me you can see a lot of these infrared lights and we have the whole scene around us illuminating the hunt, the bats flying through this corridor.

[NARRATOR:] We will lure bats with tethered moths, this way we can document their interactions.

[BARBER:] This is a control moth, does not make sound. So I predict that it will get caught by the bats.

[music plays]

[BARBER:] These bats are echolocating well outside of our hearing range, screaming into the night.

[music plays]

[BARBER:] This is an experimental moth, its a Noctuidae. It's a moth that we discovered makes sound. And now let's see if it's sound production protects it from bats.

[music plays]

[BARBER:] In this situation we can't tell if the bats aren't trying to catch it because they know it's chemically protected or because it's jamming their sonar. But it does seem that its sound production is protecting it.

[NARRATOR:] In the lab I synchronize the ultrasound with the video so that i can analyze what happens at the exact moment the moth makes sound. If the bat is not able to locate the moth, it suggests the sound from the moth is jamming the sonar. If the bat is going for the moth but breaks away at the last second, that suggests the bat is picking up a sound that tells it the moth tastes bad.

[BARBER:] Most of the moths we've discovered here in Gorongosa appear to be sending a signal to the bats as opposed to jamming their sonar. And warning of bad taste is this primary signal, but not all of these moths are honest. Some are trying to bluff, they're trying to fool the bat that they taste bad, and they make a sound very similar to the ones that are sending this honest signal of bad taste. And these are called Batesian mimics.

[NARRATOR:] In the visual world, Batesian mimics copy the appearance of a species that tastes bad. Here, some of the moths we have studied are doing the same by imitating the sound of toxic moths. To determine which moths really taste bad and which are just bluffing, we feed them to hungry wild bats.

[BARBER:] We lightly crush the moth's thorax, so they're not capable of producing ultrasound, because we don't want the bat rejecting the moth because it knows those sounds might indicate bad taste. And I'm gonna feed it this Geometridae. And now we want to see, is it palatable to this bat? Is it sending a signal of bad taste or is it bluffing? And the answer is, it's trying to fool the bat.

[NARRATOR:] When a moth truly tastes bad, the bat tries it and then spits it out, no matter how hungry it is. The discovery of these anti-bat strategies among African moth species adds to our knowledge of how evolution works. During the 60 million years that moths and bats have been sharing the planet, random mutations have arisen in different moth species. And over the course of generations, the ability to escape bat predation has given rise to the diversity of sound production strategies we see today. Natural selection in turn favors new adaptations in bats, locking predator and prey in a co-evolutionary battle.

[BARBER:] Each new discovery builds on the one before it. And that's the beauty of the scientific method, is it's self advancing, because that question opens up new questions. We'll never run out of questions about anything on this planet, most likely. We'll just continue to unfold it.

[music plays]