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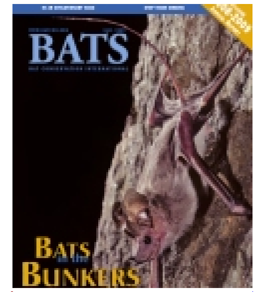

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Singing Bat Detectors
Katydids know when to shut up
Hannah ter Hofstede

In the war between bats and night-flying insects, the bats use their biosonar systems for tracking prey, while many insects evolved ultrasonic hearing to monitor bats' echolocation calls, which permits sophisticated escape maneuvers. The result is a remarkable array of predator-prey adaptations built around aerial dogfights.

Gleaning bats, however, snatch their prey off plants, rocks and other surfaces and use quieter echolocation calls that are difficult for insects to hear. How does that affect the interactions between predator and prey?

Early researchers called the gleaners "whispering bats" because their calls tend to be fainter â€“ as well as shorter and higher-frequency â€“ than those of bats that hunt flying insects. Although gleaning bats still echolocate, mostly to avoid obstacles in flight, many rely on prey-generated sounds, such as rustling noises or calling songs, to locate prey.

That suggests a potentially effective defense against gleaning bats: the insects need to know when to shut up. If insects can hear the approach of a gleaning bat, they might be able to silence themselves in time to prevent the attack.

This lethal contest between predator and prey was the subject of my Ph.D. research at the University of Toronto. Working with Professor James Fullard (author of "Predator and Prey: Life and Death Struggles" in the Summer 1991 issue of BATS magazine), I conducted my research at the Queen's University Biological Station (QUBS) in Southern Ontario, Canada. This is an ideal site that provides abandoned mines for capturing bats, a large outdoor flight room for behavioral experiments and a diverse abundance of insects.

My work was inspired by earlier research by Paul Faure of McMaster University in Canada and Ronald Hoy of Cornell University in the United States, who found that conehead katydids (Neoconocephalus ensiger) stopped singing in response to pulses of ultrasound. Could that be a defense against gleaning bats?

Katydids are closely related to crickets and, like crickets, the males produce a song to attract females by rubbing their forewings together. Katydids also have ears that are sensitive to ultrasound â€“ the high-frequency sounds, mostly beyond human hearing â€“ that bats use for echolocation.

My first step was to identify bat species that were gleaning these insects. Eight species are found in Ontario, but only one, the northern myotis (Myotis septentrionalis), appears to specialize in gleaning. I captured several northern myotis in the area and caught conehead katydids in the fields by following their songs at night and picking them off grass stems. One evening, I released several katydids and one northern myotis into the flight room for the first time, then sat back with a night-vision scope to see what might happen. I was not disappointed.

The bat perched on a wall near the ceiling, while a katydid sat barely 12 inches (30 centimeters) away. Predator and prey seemed unaware of each other. Suddenly, the katydid began to sing. The bat's ears started twitching, and after several seconds, he took off, landed on the katydid and ate it. Other northern myotis I caught that summer had similar reactions: they ignored silent katydids, but often â€“ though not always â€“ made short work of those that burst into song.

Over the next two years, we tested more than 60 northern myotis for their responses to katydid calling songs â€“ using either live katydids or a recorded calling song broadcast from a speaker â€“ during their first 15 minutes in the flight room. About one-third of the bats hovered in front of or landed on the katydid/speaker. The number of bats responding to the katydid song increased over the summer, possibly as these bats grew more accustomed to this insect as prey.

For comparison, we watched the bats' responses to the unfamiliar song of a cricket. Some bats hovered near the speaker but none landed in response to the cricket song. We also tested six bats with katydids singing in potted grasses to see if the bats can remove the prey from their natural singing perch. Three of the bats attacked the katydids in the grass; one successfully removed and ate the insect.

Next we confronted a puzzle: Northern myotis were both interested and skilled at gleaning katydids in the flight room, yet katydids have never been reported in diet analyses of these bats. The feeding behavior we observed provided a likely solution to this conundrum.

A northern myotis typically grabs the katydid by the back of the "neck" and vigorously chomps to kill the prey. Then the bat positions itself head up, grasping a surface with thumbs and hind feet so the tail membrane forms a pouch, over which the insect is eaten. The bat eats the body, starting at the head and working downward, while letting larger, harder body parts such as wings and legs fall into the tail-membrane pouch. Finally, the bat picks through the remains in the pouch, eating any meaty bits before dropping remnants to the ground.

Bat-diet analyses usually involve examining fecal samples for insect parts. When feeding on katydids, however, these bats Â-did not consume the hard parts that are used for identification, so fecal analysis may not be the best way to find katydids in a small bat's diet. Fecal analysis for several captive bats that had recently eaten katydids revealed very few parts that could be identified.

If northern myotis hunt katydids, what defenses have evolved in katydids? We recorded the "search" and "attack" echolocation calls of northern myotis and played them to katydids that were singing in cages. Sure enough, the katydids consistently stopped singing in response to calls broadcast at realistic intensities.

This seems like an effective antipredator strategy, but do the bats have a countermeasure? Could they switch from passive listening to echolocation to detect a silent target? Perhaps the bat can remember the last spot where it heard prey songs and attack there.

In collaboration with John Ratcliffe of the University of Southern Denmark, I tested whether northern myotis can outmaneuver katydids by subjecting individual bats to four scenarios: 1) a continuous calling song played from a speaker in the flight room with a dead katydid on the surface as a target; 2) same as Scenario 1, but without the katydid; 3) an interrupted calling song, in which we stopped the song as the bat flew towards the speaker

with a dead katydid on the surface; and 4) same as Scenario 3, but without the katydid.

The bats landed on the speaker as long as the calling song played continuously during their approach, but they broke off the attack if the sound stopped, regardless of whether a katydid was present. This means the bats have no countertactic up their wings, and simply shutting up is an effective katydid defense against these gleaning bats.

Katydids obviously find themselves in a difficult situation: they must sing to attract a mate, but singing runs the real risk of attracting gleaning bats. Their remarkable ability to hear and react to the ultrasonic calls of bats helps them survive this dilemma. Our flight-room observations show that bats can sometimes sneak up on katydids. But when the prey hears the predator in time, katydids can often deprive the bat of the one thing it needs to find them: that chirping beacon that seems to say "dinner."

HANNAH TER HOFSTEDE is a post-doctoral researcher at the University of Bristol School of Biological Sciences in the United Kingdom.

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