The New York Times | http://nyti.ms/1FjRbFs

SCIENCE

When Birds Squawk, Other Species Seem to Listen

By CHRISTOPHER SOLOMON MAY 18, 2015

MISSOULA, Mont. — In the backyard of a woodsy home outside this college town, small birds — black-capped chickadees, mountain chickadees, red-breasted nuthatches — flitted to and from the yard's feeder. They were oblivious to a curious stand nearby, topped by a curtain that was painted to resemble bark.

Erick Greene, a professor of biology at the University of Montana, stepped away from the stand and stood by the home's backdoor. He pressed the fob of a modified garage-door opener. The curtain dropped, unveiling a taxidermied northern pygmy owl. Its robotic head moved from side to side, as if scanning for its next meal.

The yard hushed, then erupted in sound. Soon birds arrived from throughout the neighborhood to ornament the branches of a hawthorn above the mobbed owl and call out *yank-yank* and *chick-a-dee*.

As a recorder captured the ruckus, its instigator grinned with delight. "For birds, this is like a riot," Dr. Greene said afterward, adding that he heard "a whole set of acoustic stuff going on that's just associated with predators." The distinctions are subtle — "even good naturalists and birders can miss this stuff," he added.

Studies in recent years by many researchers, including Dr. Greene, have shown that animals such as birds, mammals and even fish recognize the alarm signals of other species. Some can even eavesdrop on one another across classes. Red-breasted nuthatches listen to chickadees. Dozens of birds listen to tufted titmice, who act like the forest's crossing guards. Squirrels and chipmunks eavesdrop on birds, sometimes adding their own thoughts. In Africa, vervet monkeys recognize predator alarm calls by superb starlings.

Dr. Greene says he wants to better understand the nuances of these bird alarms. His hunch is that birds are saying much more than we ever suspected, and that species have evolved to decode and understand the signals. He acknowledged the obvious Dr. Dolittle comparison: “We’re trying to understand this sort of ‘language’ of the forest.”

At his laboratory on campus, Dr. Greene plugged the recording of the pygmy owl fracas into a computer that he likened to an “acoustic microscope.” The calls appeared as a spectrogram — essentially musical notation. On the screen, they looked like a densely layered cake fallen on its side. One call lasts only a second or three, but can have up to a dozen syllables. Parsing one of myriad encounters with a pygmy or other roboraptors, even with the help of a computer, will take the researchers hours.

“It’s cutting-edge stuff,” said Jesse Barber, an assistant professor at Boise State University who studies animal acoustics. Dr. Greene is looking at communication “across large swaths of habitat, and this is really where the field has yet to go,” Dr. Barber added. “It’s a new frontier for animal communication work.”

Dr. Greene, 57, developed his fascination with birds and sound early on, growing up around Montreal as a “total nature nerd,” he said. As a young boy, he listened to classical, jazz and Renaissance music, and then played them. He recalled being “a harpsichord-playing, hockey thug, bird nerd.”

As a teenager, he met Peter and Rosemary Grant, then at McGill University in Montreal, who would gain fame for their study of Darwin’s finches in the Galápagos Islands. They offered him a yearlong job as a field assistant. He dropped out of high school and never returned.

That experience, however, helped him gain admission to Dalhousie University in Nova Scotia. There he spent much time in Renaissance consorts playing obscure instruments like the crumhorn — “which sounds like a pig being slaughtered,” he said — before attending Princeton for his doctorate in ecology, evolution and behavior.

“What I’m doing now is really a natural marriage of those sorts of interests,” Dr. Greene said of his interest in animal communication. “It’s nature’s music, in a way.”

He met his wife, Anne, before college while they were studying birds 800 miles north of the Arctic Circle. Theirs is a science family: Anne teaches science writing at the university, and the couple has two grown daughters — one teaches at a charter

school in Brooklyn that has an environmental-sciences theme, and the other is working toward a master's degree in aquatic biology.

Dr. Greene has spent much of his career at the University of Montana studying the pas de deux of predator and prey. As part of this dance, most animals, including birds, have evolved alarm signals to warn of danger. Dr. Greene's interest in the subtlest bird alarms developed several years ago while studying lazuli buntings.

The buntings occasionally stopped responding to the artificial calls he broadcast and instead dived into the bushes. "And then maybe four, five minutes later, a Cooper's hawk" — a major predator of small birds — "would cruise by," he said. Clearly, some signal was spreading among them.

So-called "seet" calls, peeps produced by many small songbirds in response to a raptor on the wing, are well-known to ornithologists. Conventional wisdom held that the calls dissipated quickly and were produced only for other birds nearby. However, that's not what Dr. Greene noticed: chatter sweeping across the hillside, then birds diving into bushes.

Studying the phenomenon, he documented a "distant early-warning system" among the birds in which the alarm calls were picked up by other birds and passed through the forest at more than 100 miles per hour. Dr. Greene likened it to a bucket brigade at a fire.

The information rippled ahead of a predator minutes before it flew overhead, giving prey time to hide. Moreover, while raptors can hear well at low frequencies, they are not very good at hearing at 6 to 10 kilohertz, the higher frequency at which seet calls are produced. "So it's sort of a private channel," he said.

Dr. Greene turned to chickadees, which are highly attuned to threats. When one sees a perched raptor nearby, it will issue its well-known "chick-a-dee" call, a loud, frequent and harsh sound known as a mobbing call because its goal is to attract other birds to harass the predator until it departs.

In 2005, Dr. Greene was an author of an article in the journal Science that demonstrated how black-capped chickadees embed information about the size of predators into these calls. When faced with a high-threat raptor perched nearby, the birds not only call more frequently, they also attach more dee's to their call.

Raptors tend to be the biggest threat to birds nearest their own size because they can match the maneuverability of their prey. So a large goshawk might only merit a *chick-a-dee-dee* from a nimble chickadee, while that little pygmy owl will elicit a

chick-a-dee followed by five or even 10 or 12 additional *dee* syllables, Dr. Greene said.

The researchers next showed that red-breasted nuthatches, which are chickadee-size and frequently flock with them in the winter, eavesdrop on their alarm language, too.

Dr. Greene, working with a student, has also found that "squirrels understand 'bird-ese,' and birds understand 'squirrel-ese.' " When red squirrels hear a call announcing a dangerous raptor in the air, or they see such a raptor, they will give calls that are acoustically "almost identical" to the birds, Dr. Greene said. (Researchers have found that eastern chipmunks are attuned to mobbing calls by the eastern tufted titmouse, a cousin of the chickadee.)

Other researchers study bird calls just as intently. Katie Sieving, a professor of wildlife ecology and conservation at the University of Florida, has found that tufted titmice act like "crossing guards" and that other birds hold back from entering hazardous open areas in a forest if the titmice sound any alarm. Dr. Sieving suspects that the communication in the forest is akin to an early party telephone line, with many animals talking and even more listening in — perhaps not always grasping a lot, but often just enough.

Dr. Greene says he wants to know not only the nuances of that party-line conversation, but also how far it stretches across the landscape — and who else is listening.

If chickadees indeed issue alarm calls that indicate the size and thus the danger of predators to them, how many other species of birds — robins, crows — hear and evaluate those alarms based on their own body size? Perhaps a big Steller's jay hears a chickadee's frantic alarm in the face of a little pygmy owl and says, in effect, "'I'm not worried,' " Dr. Greene said.

Conversely, does the same jay hear a halfhearted chickadee alarm and suddenly perk up, understanding that this means a threat now lurks nearby for a bigger bird?

Here is where the stuffed animals come in. The researchers are using predators of different sizes — the owl, Cooper's hawks, sharp-shinned hawks, goshawks — to elicit responses. Back at the lab, Dr. Greene pointed to the alarm call on the spectrogram in response to the pygmy owl.

"All of these notes are acoustically very different, and they might have different meanings," Dr. Greene said. "That sound humans hear simply as *chick-a-dee*

actually could contain information differentiating between a Cooper's hawk and a pygmy owl. We know birds hear this as if it's slowed down," he said.

The researchers are also arranging arrays of audio recorders throughout the forest, playing calls of different-size raptors and recording how the alarm moves through the landscape. Dr.. Greene is teaming on the three-year study with researchers from the Cornell Lab of Ornithology, who are performing similar experiments on the East Coast. They are sharing a $700,000 National Science Foundation grant.

This work could have important implications for conservation. Manufactured noise coming from everything from natural-gas development to automobiles is increasingly considered a major pollutant. Eighty-three percent of the land area in the continental United States, for instance, now sits within two-thirds of a mile of a road, according to a 2003 study.

To test noise's effects, Dr. Barber of Boise State and several colleagues built a "phantom road" in a forest outside Boise, Idaho, that is a popular stopover for birds during fall migration. The road consisted of a half-kilometer array of speakers through the woods that broadcast automobile noise and could be switched on and off.

Noise alone, they found, had harmful effects on many of the birds. "What we found was that they had lower overall body condition and they gained significantly less weight when the road was 'on,' " Dr. Barber said. The findings are under review for publication.

Birds must make a trade-off with their time between eating and being vigilant. Alarm calls help the group share that responsibility. But when birds cannot hear predators or alarms well, each must spend more time listening and less time feeding, or else move to where they feel safer, Dr. Barber said. His related 2013 study also found more than a one-quarter decline in bird abundance when the artificial road noise was turned on; some avoided the area almost entirely.

Most migratory birds worldwide are in decline today, Dr. Barber said, and noise that hampers their ability to hear information such as warnings and forces them to change their behavior may be one factor.

Noise is relevant to his nonmigrating chickadees in cold northern Montana, too, Dr. Greene said.

"Generally in the winter, these birds are living on the edge," he added. "If they

don't meet their caloric requirements today, they're dead. And it's a trade-off: you can feed or you can watch for predators."

Dr. Greene says he relishes spending his days in the woods, watching birds and teasing out their messages. Though he has performed experiments in the lab, he would rather do them in the field. "It's more difficult, and it's messier," he said. "But it's glorious nature."

Correction: May 18, 2015

Earlier versions of picture captions with this article misidentified the subjects. In a picture in which a robotic owl is being fine-tuned in a workshop, the taxidermist is Eugene Streekstra, not Erick Greene. And in a picture in which a bird feeder is being refilled, the subject is Dr. Greene, a professor at the University of Montana, not Mr. Streekstra.

A version of this article appears in print on May 19, 2015, on page D1 of the New York edition with the headline: Sentinels of the Forest.
