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When Ants Squeak

Eavesdropping on lesser-known bulletins from the hill

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If you haven't stuck an ant in your ear recently, don't write the insect off as the strong, silent type.

Many species make tiny squeaks that people can hear if they hold an ant close enough. The rich chemical communication of ants has claimed more attention from scientists in recent decades, but a small band of researchers has been sorting out ant sounds.

Biologists have long realized that ants can hear with their knees, picking up vibrations humming through leaves or nests or even the ground. In the past 20 years, researchers interpreting the messages that thrum in substrates have revealed a sort of ant-ernet, zinging with communiqués about lost relatives, great food, free rides for hitchhikers, caterpillars in search of ant partners, and impending doom. Improvements in recording equipment are expanding the range of ant chirps and buzzes available to human eavesdroppers. Some scientists are even challenging decades of textbook truths and suggesting that ants might also be able to detect certain kinds of airborne sounds.

For almost a century, naturalists have considered ants practically deaf to sounds traveling through the air but exquisitely responsive to vibrations. The noises that ants seem to make intentionally, drummings and fast stridulatory scrapings of roughened body parts, can buzz through substrates easily.

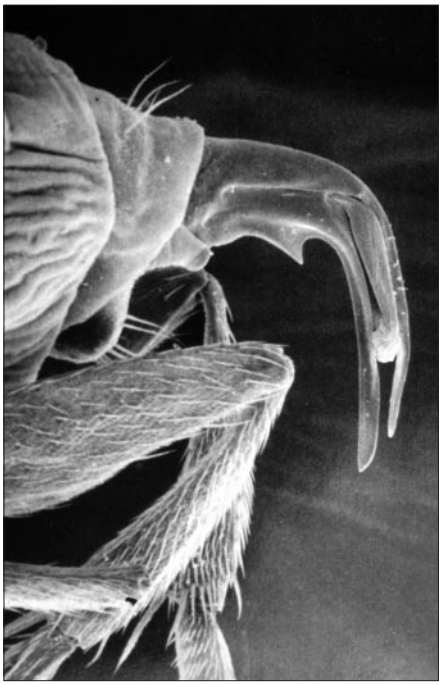
Drumming, also called body rapping, turns up most often in species with wood or dried-pulp nests. For example, when a carpenter ant nest gets disturbed, workers rock furiously back and forth so their mandibles in front and their hindmost body part wham against the nest. An ant pounds the nest in a burst, up to seven thumps at 50-millisecond intervals.

The other obvious ant sound, the squeak that people can sometimes detect, comes from stridulation. This high-pitched rasping of one surface against another occurs frequently in animals, most famously among cicadas, katydids, and crickets but also catfish and, some scientists argue, sea horses.

Ants stridulate with the hindmost body section, the gaster, explains systematist Philip Ward at the University of California, Davis. The gaster is made up of segments, one of which bears a ridged patch. Its nearest neighbor sports a file-like rasping widget. The segments remind Ward of the nested tubes of a telescope. "Imagine the meeting edges scratching a bit as they move in and out," he says.

Residents of the southwestern United States can hear stridulatory concerts by picking up red desert ants, suggests Ward. In the Northeast, the less common but hefty *Myrmica* species also squeak audibly when plucked up by a human hand.

Ants in four subfamilies stridulate, but others seem silent and don't have recognizable scraping surfaces, Ward notes. Entomologists argue about whether this pattern means stridu-



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A scanning electron micrograph of the hooked ovipositor of a phorid fly, Pseudacteon curvatus, which injects its egg into a fire ant. (Magnified about 200X)

lation evolved several times in ants or whether the Adam and Eve of ant ancestors rasped to each other but some descendants lost the ability.

In the 1970s, pioneering studies of these ant scratchings showed that they boosted the listening ants' response to the pheromone signals indicating that dinner or a nest site is available.

Stridulation also seems to summon rescuers after a nest cave-in. Hubert Markl of the University of Konstanz in Germany reported that leaf-cutter workers converged at a spot where nestmates were trapped 5 centimeters down in well-packed soil. If the workers were buried only 3 cm below ground, nestmates not only milled around the spot but dug toward the pinned ants.

Stridulation can also signal "stop already" from a female *Pogonomyrmex* whose sperm-storage organ can't hold any more. Ants don't make this stridulation during the earlier courtship, Markl reports, and the distinctive sound benefits both sexes by reducing time- and energy-wasting activity.

One of the more unusual notions about stridulation arose in 1995 when Flavio Roces and Bert Hölldobler of the University of Würzburg in Germany reported that leaf-cutting ants tend to stridulate as they slice off snippets of tender leaves. The vibrations make their jaws buzz as they rip through plant tissue (SN: 11/26/94, p. 358). Could ants have evolved the electric knife?

However, offering ants both prime leaves and chemically tainted ones revealed that workers stridulate more on desirable than less-favored leaves, regardless of any differences in the toughness of the cutting task.

Buzzing jaws do make smoother cuts, the researchers found, but don't improve speed or efficiency. The scientists now look to communication instead of cutting enhancement as the driving force behind the evolution of ant humming. "The electric knife is a wonderful epiphenomenon," as Hölldobler puts it, sounding a little wistful.

The same line of research on leaf-cutter stridulation revealed a related function: an invitation to hitchhikers. When the ants forage, the smallest workers, or minims, swarm along even though they're too little to do any cutting. They scurry around the cutting site or stand nearby with mandibles open and antennae outstretched. Many don't walk back to the nest on their own but literally hitchhike on the loads carried by the bigger ants.

Despite the appearance of frivolous gawking, the little hitchhikers provide a useful service. Somehow, they discourage attacks from phorid flies. These parasites swoop onto leaf-cutters and inject an egg, which hatches and chews through the ant's innards, finishing with the brain and leaving a headless corpse.

Roces and Hölldobler noted that cutters stridulate extrafast when they come to the end of their task and heave the leaf fragment into carrying position. When the researchers artificially vibrated a leaf, it attracted more hitchhikers than a leaf without an experimental buzz. The scientists suggest that the tiny bodyguards find their rides by listening for the stridulation.

Ants listen for more than the buzz of their own kind, as Phil DeVries of the University of Oregon in Eugene shows with his singing caterpillars. The larvae of many species of two butterfly groups, lycaenids and riodinids, sport glands that

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A fire ant loses its head as a phorid fly matures inside it and emerges to go parasitize other ants.

ooze a sweet liquid of interest to ants. As the ants collect the bounty, they discourage attacks from the caterpillars' predators.

DeVries found that caterpillars advertise their delicious presence with vibrations that ants can detect along quivering plant stems and leaves. He's recorded a considerable variety of these caterpillar calls, ranging from a sound, he says, like "bub . . . bub . . ." to fancier noises such as "beep ah ah ah beep" and "biddup . . . biddup . . . biddup."

DeVries has also investigated whether caterpillars can fake ant sounds. The *Maculinea* butterflies would have good reason to do so, he reasons. Very young caterpillars topple off food plants. They lie there wiggling and making noises until picked up by roving ants. Perhaps a little dim about taxonomy, the ants bring a fallen caterpillar back to their nest and tuck it into the brood chamber. They don't seem to object as the newcomer eats some of the young ants that are its nurserymates.

When the caterpillar finally matures, two ant species recognize their mistake and kill the freeloader, but a third ant leaves it unharmed. For the caterpillar, "there's strong selection to attract the right ant."

When DeVries compared the sounds made by the caterpillars and ants, he found that despite their overall differences, "some components of the caterpillar calls were dead on."

People don't do anywhere as well as caterpillars in communicating with ants. Shouting at an ant is a bit like shouting at a computer or a cat. You may not see any sign that you've been heard.

"Ants don't respond to sound on a human scale," says Robert Hickling of the National Center for Physical Acoustics at the University of Mississippi in Oxford. That quirk, he argues, has hobbled the study of ant acoustics for a century.

Ants may not pick sounds of stridulations out of the air as people do, but—in theory at least—ants may respond to airborne vibrations if scientists make the right noise.

"It all started with the sensor," remembers Peng Lee, an acoustical and electrical engineer who works with Hickling. In the mid-1990s Lee was struggling to make a device sensitive enough to detect the dreaded pink bollworm just by listening for the sounds of larvae munching.

His early version succeeded miserably well. In a field test on an Israeli kibbutz, the device picked up so many faraway tractors and planes that the technological din drowned out any bollworms.

As Lee tinkered with the oversensitive gizmo back in Mississippi, lab conversation drifted to speculation on whether fire ants make noises and what they'd sound like if they did.

Two decades earlier, researchers in the laboratory of Walter R. Tschinkel of Florida State University in Tallahassee had used less elaborate equipment to try to capture sounds from the imported black fire ant and others in the genus *Solenopsis.* The experiment yielded scratchy sounds from one of the black fire ant's larger relatives, but the invader itself revealed nothing that the scientists could record.

Lee and Hickling took their new sensor out to the nearest mound of black fire ants and poked in the probe. "There was a big uproar," Hickling says. "You could hear individual ants as they passed by the microphone."

In other experiments, the team collected the noise of some important episodes in ant life. For instance, the scientists provided a caterpillar and eavesdropped on its demise. With such a sensitive acoustic view, they recorded more than the ants' sounds. "You could hear the caterpillar struggling," Hickling says. "I felt sorry for it."

They also recorded two colonies clashing. The thumps and thuds of activity, however, drowned out any stridulations from the contending armies. "The sound of the struggle tended to be quite loud," Hickling notes. Lee adds another tribulation: "I got stung a lot."

The researchers also brought a fire ant indoors, but the recording session did not turn out

to be easy. They didn't know how to cue the ant to make noises. After hours of experimentation, one of Lee's colleagues discovered that attaching a weight to the ant's antenna provoked a recordable sound.

A debut selection of black fire ant recordings are available at a special ant-sound Web site, http://home.olemiss. edu/~hickling. The site has already attracted a query from a Hollywood screenwriter, Lee notes.

Picking a relatively tranquil moment for the fire ant mound, the researchers played back recordings of the pandemonium in the colony. "I was expecting them to get all upset," Hickling recounts. However, the colony showed no sign of a response. "I had to backtrack somewhat," Lee understates.

Other scientists have interpreted ants' apparent lack of response to sounds that interest humans as an inability to hear vibrations in the air. Hickling and Lee have come up with another possibility. Ants might hear only what acousticians call "near-field sound."

A tiny source like an ant that makes long sound waves creates a special effect in the first few centimeters of the emission, Hickling explains. Such near-field sound decays not as the inverse of distance from the source but as the inverse of distance squared. An ant might respond only to this kind of sound, he suggests.

"It's not easy to test," Hickling points out. To create that special-effects zone, the sound source has to be minute compared with the wavelength. Broadcasting sounds from standard speakers, even ones a few inches tall, won't work to study this kind of hearing.

Hickling and Lee are trying to make an ant-size sound source. They've started with a source that stands a few inches high and is shielded so that sound blares only from the front. They added a long funnel that compresses the sound waves and guides them to a pinhole opening. They described the project at the annual meeting of the Entomological Society of America in Atlanta in December 1999.

Hölldobler notes that, so far, there's no behavioral evidence of airborne sound reception by the ants. He says, "There is a possibility that ants perceive near-field sound, or wind velocity produced by the sound wave, as has been shown for honey bees, but the work is preliminary as far as I can judge it."

The idea of ants perceiving near-field sound strikes Tschinkel as "plausible." In the tight spaces inside a nest, such close-range communication might prove useful because chemical communication can be difficult to modulate at close range. The possibility of near-field-sound communication interests Tschinkel because, he says, "it could fill a gap."

Acoustic studies might eventually also fill a gap in fire ant control, Hickling daydreams. "You can't just put a rock band over their mound and they'd go away—bioacoustics doesn't work like that," he acknowledges, adding, "I'm not sure whether I'd rather have a rock band in my yard than fire ants."

In either case, shouting won't help. □