Spidey-sense Tingles for Arachnids

By Sara Gilliam, University Communications

Oh, the way he drums his feet.

That sultry pheromone she emits.

Her flirty courtship rituals, his seductive signaling.

Spiders do more than lurk in your basement. They're communicating in complex and nuanced ways, and their behavior can teach us a great deal about the evolution of communication.

Eileen Hebets, assistant professor of biological sciences at the University of Nebraska-Lincoln, holds a National Science Foundation Career grant for her research on arachnid communication. The prestigious five-year grants are awarded to young academics in support of career-defining research.

The funding has enabled Hebets to assemble a stellar research team and purchase specialized equipment that helps her "tease out" communication methods of multiple breeds of spiders.

She looks at why animals use certain signals to communicate with each other and which animals are capable of receiving different signal modalities. She also explores how selection has driven signals to evolve over time.

"We're finding that most animals use more than one sensory mode when they communicate with each other," Hebets said. "The question is, why are they picking these modes? How can we explain the diversity of species? People have been interested in this since before Darwin, and have tried to explain what pressures have driven the evolution of certain traits."

Until recently, Hebets said, people have examined one sensory component - for example the coloration of male cardinals - so there's a tremendous foundation of literature on each of these components. Recently, there has been increasing interest in the multi-modal aspect of signaling. In other words, what are creatures paying attention to, one signal or a composite display?

Her lab is not for the arachnophobic.

"We have the most spiders we've ever had this summer, probably close to 3,000," Hebets said. "They require a lot of care and maintenance, lots of coordination and help from a lot of people. At any given time, we've got five or more species and each one is run on its own experiment, and is on different feeding regimes. Fortunately, I have an amazing lab group. Everyone is really generous with their time and everybody pitches in."

The thousands of spiders are all individually housed because they're cannibalistic. They are fed once or twice a week, and their molting progress (a way of determining their age) is checked three times a week. Lab staff members spend many days molt-checking and feeding the spiders for eight hours straight.

Hebets and her students then run their subjects through complex tests that assess the reactions of female spiders to various types of male signaling.

"Looking at spider behavior lets us explore how we see and hear something, and how we process it. This has implications for learning and teaching and creating education strategies for humans," Hebets said.

One branch of her research analyzes how the perception of two different modalities influences learning. Evidence suggests that people have an increased ability to learn if they receive information from two different modalities. Hebets ran a study with jumping spiders that showed the same results. A female spider can learn to distinguish differences in two colors in the presence of a seismic stimulus.

Hebets also conducted a study that showed that when a female has experience with a certain type of male before she matures, that experience affects whom she ultimately mates with. In short, formative experiences affect lifelong decision-making.

"We can see that these seemingly complex behaviors are happening in groups with simple nervous systems, you get a sense that maybe 20 years in the future this information could help us develop medications to help people overcome traumatic experiences they had as children," she said.

A hallmark of Hebets's teaching and research - for which she was awarded a Harold and Esther Edgerton Junior Faculty Award this spring - is her collaborative work with students.

Hebets and her team are currently immersed in a large-scale comparative study of one particular genus of wolf spider, in which males possess black brushes of hair on their legs and produce seismic signals. They are the only species exhibiting both of these traits; some closely related species have no pigmentation or brushes, but use a seismic signal, while others have pigmentation of certain parts of their legs and do some "intermediate leg waving" and signaling.

"There is so much diversity in this genus, we can look at what females are paying attention to and how signals are related to environment," Hebets said.

She and her team record the spiders' movements with a laser vibrometer, which records seismic signals without disrupting them. They run tests in light and in the dark, on granite or on filter paper. In doing this, they oblate each signal and then run mate choice trials and assess what females are paying attention to. Some males are fed a higher quality diet than their peers, so that researchers can see if female spiders can detect these "higher quality" males.

Hebets has learned to coax males to court in the absence of females. Most females lay down silk and release a pheromone, and male spiders will court in the presence of that pheromone, even if the female spider is not in sight.

The females are a bit trickier to seduce. The researchers will run tests with a male and female each on one side of a barrier, to examine how the female responds to seismic stimulation. They also utilize video playback - running video sequences of male spiders on tiny television screens - to elicit responses from females. That way, Hebets said, you can manipulate the visual signals in a way that would be difficult with live animals.

"We're right in the middle of this research, we've already gotten through six or seven species," she said. "It's a five-year grant, and we just finished our first year. We got an incredible amount done in the first year, now we have to sit down and think about what we collected."

Eileen Hebets, an assistant professor of biological sciences at the University of Nebraska-Lincoln, is in the midst of a five-year National Science Foundation Career research grant studying arachnid communication.