A campus bug's life

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While many of us have been working from home this summer, a secretive activity has been going on in full swing across campus: Several species of insects and plants have been acting out fascinating plays of interactions and mutual interdependence. We wouldn't know about it if not for Judith Bronstein, University Distinguished Professor of ecology and evolutionary biology and BIOS Institute member, who is an expert on intricate plant-animal relationships known as mutualisms. Lo Que Pasa spoke with her about the protagonists of a fascinating spectacle that is happening out of sight, yet right in front of our eyes, if we know where to look.

You and your students have been studying plant-animal interactions right here on campus. Can you tell us more?

Over the decades, some very smart people established interesting arid-lands plants from all over the world right here on campus; animals find them and use them, and these interactions are easy to watch. Here's an example that's easy to see: Many campus buildings have small Tecoma trees planted in front of them, and they are blooming right now. Their yellow or orange tubular flowers are hard to miss, and bees and hummingbirds love them. Some bees put their heads down in the flowers, collect nectar, and get dusted with pollen, and transfer it between flowers.

But if you look closely, you'll see slits cut into the sides of some flowers. Those are evidence of "cheaters" – certain bee species don't bother crawling head-first into the flower; instead, they slice into the flower and get out nectar that way.

This behavior benefits them as they get the nectar out fast, but definitely doesn't benefit the plant. We're interested to see what, if anything, the plants do to deter these "cheaters."

You discovered some crawly action on some of our barrel cactuses. What did you find?

There's a large group of barrel cacti planted near the stadium on the north side of Sixth Street. If you look closely, you'll notice ants crawling on them, occasionally stopping at bumps on the top. These bumps are actually nectar-secreting structures called extrafloral nectaries. The ants feed on this nectar, then get aggressive towards other insects that feed on the cactus' flesh. This proprietary behavior benefits the plants by keeping their enemies away. We're interested in which ants do a better and a worse job at protecting the cactus that feeds them. The barrel cactus is a Sonoran Desert native, but on campus, many of the ants associated with them are invasive species.

While you might assume that the invasives would be incompetent at protecting their plant, my students and I are starting to discover that they're actually at least as good as our native ants at carrying out the job.

Here's another puzzling interaction that's easy to observe: If you look at the leaves of a great many broad-leafed plants on campus, you'll see perfect semicircles missing. These have been snipped and removed by leafcutter bees. You might be lucky enough to see a bee cut the leaf, then straddle the piece and fly off with it. She's taking it to her nest, where she'll add it to growing cigar of leaf fragments, within which she lays her eggs. The bees have extremely strong preferences for some plant species over others, some plant individuals of the same species over others, and even some leaves within a plant over other, adjacent leaves. No one knows why. We're trying to figure it out.

What is mutualism, why do we see it in nature, and why is it important?

Mutualisms are cooperative interactions between different species. Mutualisms are, essentially, economic exchanges: Each of two species uses a mutualist to acquire something they don't otherwise have access to. In that sense, you could think of mutualisms as "reciprocal parasitisms" – each species is exploiting the other and, interestingly, it ends up working out well for both of them. All species rely on mutualists at some point in their lives. In the examples above, Tecoma and the bees that transfer its pollen are involved in a pollination mutualism; the barrel cacti and their ants are involved in a protection mutualism. Our own gut microbiomes are complex networks of mutualists, and of course our health depends upon them. We are only just beginning to understand how mutualisms arise, which organisms rely upon them the most, how they are being disrupted in a changing world, and how we can save them. We now realize that to save species, we have to move beyond a species-by-species approach, and think about a species in association with all the other organisms it relies upon.

How did you become interested in studying this phenomenon?

I actually started out in college interested in environmental policy and law, but quickly realized I was more interested in the basic science that forms policy's foundations. I took a course in tropical biology in Costa Rica as a young graduate student and got completely entranced by one of the craziest and most mysterious mutualisms we know of – the interaction between fig trees and their minuscule wasp pollinators. I started thinking about the conflicts of interest in this mutualism –
what figs "wanted" from fig wasps and vice versa, how these interests conflicted, and how these conflicts played out ecologically and across evolution. From there I started thinking about mutualisms in general. The study of mutualism has really taken off in the last 20 years, and I have been there since the beginning.

How do you and your students study these interactions scientifically?

We use every tool available in an ecologist's arsenal: We make observations, we conduct experiments, and we construct mathematical models able to explore interactions in ways we couldn't with real data. A lot of what we're doing is discovering and describing poorly understood mutualisms, and the best tools for that task are simply your eyes, your intuition and your creativity. When I walk across campus, I'm always on the lookout for potentially new and interesting interactions.

Ecology is a very young science — much that catches your eye has probably never been documented before. That's really exciting for students, including those completely new to science.

Is there anything the human species can learn from mutualisms?

I have a longstanding interest in "cheating" in mutualisms. Everywhere in nature, we see mutualistic partners that don't pay their partners back for services rendered. Just like in human societies: lots of cheating. Humans have long been convinced that cooperation can only persist in our own species because we're able to envision the consequences of a breakdown in society and harm coming to ourselves, our families and our communities if we are cheated or caught cheating. So, all human societies design systems that overtly foster cooperation: We reward cooperators and we punish defectors. But the mutualisms I study — between plants and insects, insects and insects, plants and bacteria, and so on — are able to persist just fine in the face of cheating and defection. There are mechanisms that enforce cooperation in these systems, but they aren't actually very effective.

Nature has a lot to teach us about how we can keep cooperation thriving, even in the face of "bad actors" who seem to be at an advantage.

You are known as a faculty member who has inspired many students and prioritizes their success. What are some of the key things that help students succeed?

Students thrive when faculty treat them with respect, as individuals with unique interests, talents and backgrounds. This is not easy to achieve at a large university, where we all have so many other jobs to do and there are only so many hours in the day. But there are enormous payoffs if it can be achieved. When you know even a little bit about a student — when you take the time to ask questions, and then take what they say seriously — you begin to instill in them the confidence they need to make the most of their education and to take it further than they ever expected.

In May, you were elected president of the American Society of Naturalists. What does this mean for your work at the University and in your field?

The American Society of Naturalists is one of the oldest scientific organizations in the United States. It has a very old-fashioned name, but a very modern scientific mission: It integrates knowledge at the intersection of ecology, evolution and behavior. Science itself has become progressively more cross-disciplinary and integrative; the ASN captures that spirit exactly. Meanwhile, the University's Department of Ecology and Evolutionary Biology is the oldest department of that description in the world, and one of the very best. In a way, the spirit of the ASN and the spirit of EEB are one and the same. Moving into the presidency, I'm excited that I have the opportunity to be an ambassador for my field, but also an ambassador for the scholarship represented right here.

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