New publication led by Montana State scientist brings together plant data from researchers across more than 30 countries

Reagan Cotton, MSU News Service
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BOZEMAN – While hiking through remote sagebrush habitats in eastern California during his doctoral studies, Will Wetzel wondered why some plants he saw showed extensive insect damage, while other members of the same species were left untouched. Was this related to what insects preferred to eat, or was there something about those plants that made them more appealing? What was causing the insect damage to be so spotty and uneven?

Those questions stuck in Wetzel's mind through the rest of his doctoral work and his first years as an assistant professor. Now an associate professor in Montana State University's Department of Land Resources and Environmental Sciences, Wetzel has led a network of nearly 200 scientists around the world in exploring the variability of plant-insect interactions interactions with co-leads Nora Underwood and Brian Inouye of Florida State University Brian Inouye, Phil Hahn of the University of Florida and and Susan Whitehead of Virginia Tech. The project's steering committee includes Karen Abbott of Case Western Reserve University, Emilio Bruna of the University of Florida, Ivalú Cacho of the National Autonomous University of Mexico and Lee Dyer of the University of Nevada, Reno, along with Moria Robinson, a past postdoctoral associate in Wetzel's lab group now at Utah State University.

The resulting massive database, spanning more than 530 plant species in 34 countries, is outlined in a paper published today in the journal Science, titled "Plant size, latitude, and phylogeny explain within-population variability in herbivory." Herbivory refers to the amount that herbivores, such as insects, feed on plants.

"I started searching published studies to try to figure out what this variability could mean, and I found

almost nothing," said Wetzel. "Here's this striking pattern that I'm noticing, and theory says it's really important, but it hadn't been quantified empirically."

Montana State University associate professor William Wetzel has led a network of nearly 200 scientists around the world in exploring the variability of plant-insect interactions. MSU photo by Colter Peterson

As Wetzel grew his scientific network after finishing his Ph.D., he found that many other ecologists had noticed similar patterns in their study systems. The more he discussed it with his peers, the more like-minded collaborators he found. Ultimately, 190 scientists from more than 30 countries came together to create the Herbivory Variability Network to study global patterns in the interactions between insects and plants. In just a few years, the group has recorded patterns in herbivore feeding damage on more than 50,000 plants and hundreds of thousands of leaves, a breakthrough Wetzel said was made possible by the large and diverse research team.

"Previously, when people wanted to know how much herbivore damage there was in plant populations, they would go out and look at five or 10 plants in a site. But five or 10 plants isn't enough to quantify patterns of unevenness," said Wetzel. "Researchers in our team examined 60 plants per site across almost 800 sites around the world, giving us an enormous amount of data, both in terms of breadth and depth."

The publication in Science, one of the most respected and oft-cited research journals in the world, is a very large first step in what will be a long-term effort, Wetzel said. One major takeaway from the collected data was that the distribution of insect damage was much more even across entire plant populations closer to the equator. The damage became more uneven farther north and south, a pattern that has several implications. Primarily, it could help explain the extreme levels of plant biodiversity in the tropics.

If herbivore damage is evenly spread across a plant population,

A red-headed flea beetle feeding on a dogwood leaf, an example of the insect damage studied by the international team led by William Wetzel. Image by Alfred Daniel Johnson, courtesy of William Wetzel.

Wetzel said, then each individual plant must be prepared to withstand interactions with insects. The consistent attack and need for defense may spur evolution to a greater extent than in areas where most individual plants won't encounter the same level of insect interaction.

"There are also implications for agriculture. What's important in crop fields is whether damage surpasses the economic threshold or not," said Wetzel, referring to the threshold at which profit falls below production and pest management costs. "Our results suggest that if you compare farms as you go from the equator to higher latitudes, pests at higher latitudes may be more likely to concentrate their damage so that it surpasses that threshold. This means that growers might need to be more targeted with their pest control at higher latitudes."

To help ensure the network's continued research, Wetzel, Underwood, Inouye, Hahn, Whitehead, Abbott, Bruna, Cacho and Dyer recently received a $600,000 grant from the National Science Foundation's Research Coordination Network program. Wetzel said the next step is to create teams of scientists focused on specific dimensions of that variability in insect damage. Those dimensions will include climate factors, plant chemicals, impacts on agricultural systems and the impacts of insect damage on the fruits, flowers and seeds of plants and their reproductive success.

Teams will also focus on species that grow across large geographic areas around the world. That way, a plant's method of evolving to defend itself against insects in one region can be compared to that used by the same plant in a different area.

"Both scientists and the public are hugely focused, with good reason, on environmental change. More and more, we're also starting to appreciate that it's not just the average that is changing. It's also the level of variability in the environment," said Wetzel. "And I think that our work shows that variability is a crucial part of how ecology differs across the Earth. Our work shows that if you open your eyes to the variability in the natural world, you learn a lot through the patterns you see."

While the initial publication marks an early stage in the project, for Wetzel it shows immense progress from his first wonderings in the wild sagebrush of California. It's also the genesis of something much larger than his own research. He called the diverse and collaborative network greater than the sum of its parts.

"The plant-herbivore research community around the world is just amazing. People are so enthusiastic, dedicated, collegial and fun to work with. That's what made this possible," he said. "In most multidisciplinary research, you have scientists from different fields but all from one university. This is a different approach, where we are all plant-herbivore researchers, but we have this incredible diversity of cultures and ecosystems and ways of doing science. And I think that that was the greatest strength of the project."

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