Colby Magazine

Volume 108
Issue 1 *Spring 2021*

Article 10

April 2021

Opening a Window to Evolution: David Angelini’s research on genetic adaptation gets push from McVey Data Science Initiative

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OPENING A WINDOW TO EVOLUTION

David Angelini's research on genetic adaptation gets push from McVey Data Science Initiative

By Christina Nunez

Most people think of soapberry bugs as little more than a nuisance, if they think of them at all. Found across much of the southeastern United States, the oblong insect is harmless to humans and likes to hang out on plants native to the soapberry family, hence its straightforward name.

For a geneticist like Associate Professor of Biology David Angelini, soapberry bugs offer a compelling window on evolution, yielding insights that connect to human health. Depending on the environment in which it matures, a bug can either develop long wings and fly or remain earthbound and reproduce more. Understanding the genetic mechanism behind this adaptive feat could help shed light on processes that relate to a variety of medical conditions, from diabetes to cancer.

Angelini's lab at Colby is crawling with hundreds of his red-bodied subjects. Working with students, he has sequenced the insect's genome, thanks in part to an award from the National Science Foundation. Now he is taking the research further with funding from the McVey Data Science Initiative.

"Two years ago, getting the full genome sequence for this insect seemed like it was technically insurmountable," Angelini said. Technological advances have made the sequencing possible, he added, but what emerged was akin to a static picture. Funding from the data initiative allows a closer look at the expression of all of those genes—the DNA in action.

Angelini first began working with soapberry bugs while teaching at American University, but it wasn't until he got to Colby in 2012, he said, that the genetics research really took off. In the intervening years, he has identified certain pathways that are important to the bug's development. Food availability, for example, helps determine the wing size; if there's less food around, the bugs will evolve so they can fly to look for more. More food, on the other hand, translates to shorter wings and more offspring.

Part of the task, then, is to explore how environmental changes beget genetic ones. He has observed that insulin exposure, for example, plays an important role in signaling to the bugs what traits they should develop. He and his students are also analyzing how the expression of certain genes varies with environment.

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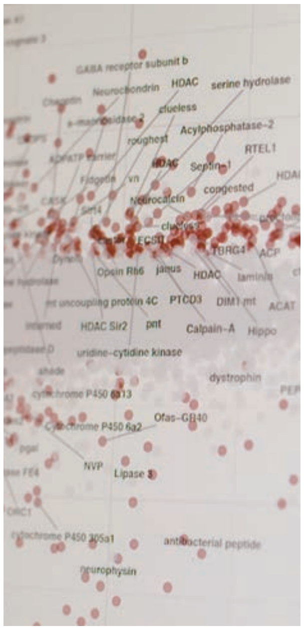
—Associate Professor of Biology David Angelini



in humans," he said. "It's not surprising, because what we're talking about here is the control of growth."

Only a centimeter long, the soapberry bug can churn out a massive amount of data. Its genome contains 2.2 billion nucleotide pairs, the building blocks of DNA. (Humans have about 3 billion.) That translates to about 20,000 genes that can be studied, and Angelini's lab is looking at the expression of those genes across some 300 individual insects, all raised under different conditions.

When he was an undergraduate at St. Mary's College in Maryland, Angelini's primary interest was history. Being a teaching assistant for an introductory biology class made him realize he liked working with students in the lab, and he went on as a postgrad to focus on molecular biology, earning a Ph.D. from Indiana University.

In his mind, biology isn't so far off from history: both disciplines are centered on the stories that got us to today.

"A lot of times in biology … we are teasing out the stories of animals, plants—these organisms that have amazing experiences," he said. "If you dig, you can figure out what kinds of experiences they've had through their evolution. It's really satisfying to work that out."

The soapberry bug's story is intertwined with that of the Chinese goldenrain, a fluffy-looking tree with yellow flowers that became a popular ornamental planting in southeastern U.S. suburbs in the 1950s. Soapberry bugs love to feed on goldenrains, and as the trees spread, so did the bugs.

This is where computational biology becomes an important tool. "You can't do this one at a time," Angelini said. "You have to have software and algorithms to handle all this data, to organize it, to draw conclusions out of it."

Colby's new computational biology major is training a whole cohort of students to work with this type of data, which has become so essential to modern science. Vaccine development for Covid-19, for example, was accelerated by the fact that the virus's genetic sequence was identified and released publicly.

It's not just soapberry bugs that respond biologically to their surroundings, Angelini points out. Every organism does it. The bugs just happen to display an obvious giveaway: their wing size. "People should not lose sight of the fact that environmental factors can also be really important, not just for the phenotype of a bug, but for health outcomes for patients," Angelini said.

Students in Angelini's lab can take the opportunity to delve into the insect's genome in any number of different directions. He doesn't lack interested apprentices: though the pandemic has reduced the lab's occupancy somewhat, he's advising more students than ever.

As analysis of the soapberry bug's genome progresses, there's an opportunity for students to dive deeper on any given gene, exploring its role, Angelini said. "That'll keep us busy for a long time."

ANGELINI LAB ALUMNA TAKES MOLECULAR BIOLOGY SKILLS TO HARVARD

Looking for an on-campus job in her sophomore year at Colby, Josefine Just '19 saw a position that involved taking care of bugs in the Angelini lab. She knew she was interested in biology and liked insects, so she applied. The post blossomed into a research track: she ended up staying on at the lab, studying genetic sex determination in milkweed bugs. The research became her honors thesis; the summer after graduating, she drafted a related manuscript, which she is now submitting to journals.

This past fall, she was meant to be in Boston, embarking on her Ph.D. at Harvard University in developmental biologist Cassandra Extavour's lab. While the pandemic kept her at home in Austria, she continued going full steam ahead on the path she started as an undergrad, exploring the mysteries of how genetic blueprints become structures essential to life.

For Harvard researcher Just, seeking answers to these questions in insects ties to a bigger evolutionary picture. "You get to understand also where we as people come from and our history, and how these really small-scale genetic pathways, over time, change a lot," she said.

Just realized she wanted to go to grad school when she was writing her thesis in her senior year. "I had worked on this project and there were all these other open questions, and I just didn't feel done," she said.

She plans to continue working with milkweed bugs and other insects to answer very fundamental yet complex questions: How do developing cells know how to arrange themselves to make an organ, such as an ovary? How do the cells determine the number of structures needed for the job? And what tells them to stop?

Early on, Angelini hoped that Just would continue on in his lab when she joined as a sophomore, simply based on the questions she asked. "I think she's worked on literally every different project we have," he said. "She's been amazing."

For her part, Just liked the community she found at the Angelini lab and the fact that Angelini encouraged her to follow her own ideas and interests. In fact, part of that community has stayed with her. Just is working with Angelini and Mara Laslo, a former student of Angelini's at American University who is now also doing graduate work at Harvard, on a paper about the evolution of genetic networks. The journal *Frontiers in Ecology and Evolution* is expected to publish it next year.

"I really enjoy thinking about complex pathways," Just said, "and how their make-up might influence how they evolve in the bigger picture."

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Adam Howard, the Charles A. Dana Professor of Education: Privilege in elite prep schools.

Stacy Doore, the Clare Boothe Luce Assistant Professor of Computer Science: Computing ethics in computer science training.

Liam O'Brien, Charles A. Dana Professor of Statistics: Data to optimize testing for sarcoma patients.

Catherine Besteman, Francis F. Bartlett and Ruth K. Bartlett Professor of Anthropology: Racialized identities and global apartheid.