

Charlotte Francoeur: A reminder to appreciate the little things in life.

By Julia Buskirk

Charlotte Francoeur, a fourth year graduate student in the Microbial Doctoral Training Program, speaks candidly. “I love microbiology, but I don’t think it’s something I’ve been super passionate about for my whole life,” Charlotte says, laughing. We’re discussing her research, and how on earth she came to study the bacteria living in leaf-cutter ant gardens.



Charlotte Francoeur (left) and fellow students identifying insects sampled during the California Life Science's two week Ant Course in French Guiana. Photo by Brian Lee Fisher

“When I meet scientists, a lot of them—this may be a little more true in entomology with insects,” Charlotte Francoeur quickly adds, “But people are like, ‘I’ve loved insects since I was four!’ and I don’t think that’s necessarily the case for me,” she says. “I think I’m interested in a lot of things and I decided to go through with [microbiology], and based on opportunities and decisions I made at certain crossroads, it reinforced itself.”

That's not to say Charlotte doesn't love microbiology. Or insects, for that matter. She actually happens to find both of them incredibly fascinating, a result of having worked with the leaf-cutter ant system for the past four years.



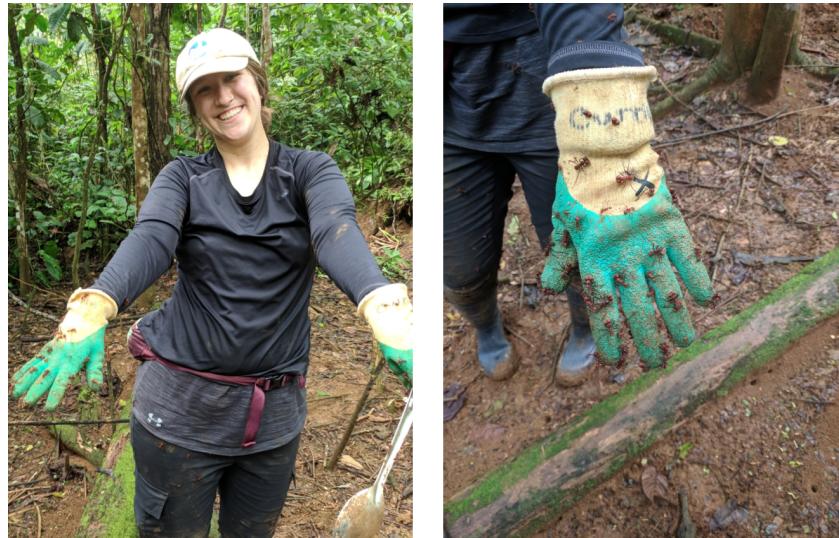
Charlotte (left) ecstatic that one of her favorite kinds of ants, the Turtle Ant (pictured right) is crawling on her hand.

Her first introduction was to microbiology, after having an amazing teacher in high school. “Most of your traditional microbiology courses are just pathogenic, which is really cool like microgenetics and microphysiology,” Charlotte says, “But then I took an environmental microbiology course my senior year and thought *this is amazing*.”

Suddenly, microbes weren’t just the bad guys that get you sick or infect our crops. In fact, they aren’t always directly tied to humans at all. “Learning about beneficial bacteria that exist and perform important functions for ecosystems, but don’t necessarily *have* to benefit humans, it was a completely different context for thinking about microbes away from humans.”

This new perspective of microbes followed Charlotte as she began pursuing Graduate School. “I think what really drew me to [the Currie] lab was learning about the ant system, I really started falling in love with it.” When it came to choosing between a lab focused on human pathogens or the leaf-cutter ant system of the Currie lab, she pursued the ants, fascinated by colonies that

depend on microbes to run successfully. “Also, being outdoors is really important for me and the opportunity to be able to do fieldwork was honestly one of the biggest reasons!” she adds.



Leaf-cutter soldier ants—known for their painful bites—climbing all over a smiling Charlotte, who is extracting leaf-cutter ant colonies from the rainforests of Costa Rica to bring back to the Currie Lab in Madison, WI.

“I’m interested in how microbes within the fungus garden are involved in protecting the system,” Charlotte says, as she begins to explain the research she does with the Currie Lab. Leaf-cutter ants harvest leaves that they feed to a fungal crop, which is what they cultivate as their main food source. When ants are chewing up the leaves, some of the bacteria *Pseudonocardia* that lives on the exterior of the leaf-cutter ants gets mashed in along with it. Amazingly, this bacteria produces an antibiotic that keeps a parasitic fungus called *Escovopsis* from taking over and eventually killing the ants’ crop. The microbes rely on the ants for a home and nutrients; the ants rely on the compounds that the microbes produce to protect their food source.

“I’m studying the bacteria and viruses associated with the fungus garden,” Charlotte says, “And thinking about it in the framework of the fungus garden as the gut-microbiome.” While humans have an internal digestive system that breaks down the food we eat into usable energy that our cells run on, the leaf-cutter ants rely on the fungi to convert the energy in leaves into a form of energy that the ants can use.



Charlotte Francoeur studies the bacteria associated with leaf-cutter ants, pictured above with their fungal crop.
Photo by Don Parson.

“Having an external gut, being able to actively culture from—this is a really big advantage,” Charlotte says. In most animals, digestion occurs internally, requiring researchers to use proxies like poop to understand what’s going on microbially. But in the ant system, Charlotte can easily access the bacteria, metabolites, and other compounds that are converting leaves into a food source for the ants.

Charlotte is working to define the different roles that microbes play in making this “external gut” work. One of the functions she is focusing on are bacteria’s ability to detoxify plants.

“Leaf-cutter ants can forage from a lot of different plants, which contain their own defenses because [the plants] obviously don’t want to be eaten,” Charlotte says. By looking at the chemical compounds bacteria produce, Charlotte can better understand how they protect the fungal garden community.

Another aspect of Charlotte’s graduate research is looking at fungus garden’s viruses—which differ from microbes in that they need the cells of a living host in order to replicate their DNA, making more of themselves. Little has been done to study the viruses in the system, so she is still looking to see if they do more harm or good.



Leaf-cutter ants are not deterred by the defenses of many plants, allowing them to cut up to 17% of the vegetation in the neotropics. Charlotte is studying how bacteria play a role in this. Photo by Don Parsons.

Outside of studying bacteria, Francoeur has continued to explore a budding entomology enthusiasm. It was “Kind of similar to microbes where once I started learning about [ants] I was like, *Wow, they can be in so many environments doing so many different things!*” To pursue this new research interest, Charlotte applied to a two week course on ants through California Life Sciences with Brian Fisher. She was helicoptered into a research station in French Guiana, and slept in a hammock the whole time!

“There were so many moments when I thought, *I can’t believe there are ants there!*” Charlotte recalls of the trip. She remembers watching one of her professors hold the stalk of a plant and say, “‘I’m gonna cut open this plant stem and we’re gonna see this ant colony that has this amazing behavior.’ And they would do it, and they would just be there!”



Professor Jack Longino (lower left) and Professor Christian Peeters (top left) with students from the California Life Sciences “Ant Course” at the Nouragues Field Station. Photo by Brian Lee Fisher.

Charlotte’s experience with ants has made her realize she wants to pursue more research in relationships between insects and microbes. She has a strong background on the microbial side, and is now seeking out more knowledge about insects which has included auditing an entomology class this semester and volunteering at Wisconsin Insect Research Collection.

“Both microbes and insects, there’s a lot of negative outlooks on them,” Francouer acknowledges about her research interests. “Ants in your kitchen are really annoying! That’s often what people say when I say I study ants, they go, ‘*How do I kill them?*’”

But Charlotte sticks up for them. She hopes people can move “[move] from that view of ants being only pests invading your kitchen”—not only do they perform important functions for the environment, but they have a huge variety of behaviors and lifestyles and histories.



Francoeur digging for insects during her two week Ant Course in French Guiana.

This extends to microbes as well. “So few of the microbes that exist on earth actually effect us negatively... when you start learning about all these other species, there are so many services microbes do for us. You can start with the gut and all the nutrients they’re providing for you, to cyanobacteria literally creating the oxygenic atmosphere that allowed us to live,” she says.

In an age where people are understandably fearful of the unseen world, Charlotte’s research is a powerful reminder of the amazing benefits that go on at the microscopic level. From the bacteria in leaf-cutter ant colonies to the bacteria in our own digestive tracts, microbes span species, ecosystems, and biomes, keeping the world going in ways we’re only beginning to understand.