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Fluorescence micrograph of *Agrobacterium tumefaciens*, a plant pathogenic bacterial species, on the root surface of the model plant *Arabidopsis thaliana* (mouse-ear cress). Each of the rod-shaped cells is about 2 microns in length. The plant root autofluoresces, but the bacteria are expressing green fluorescent protein (GFP) originally from jellyfish. Photo by Thomas Danhorn, Fuqua Lab, ca. 2004



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INDIANA UNIVERSITY College of Arts + Sciences

BioNews

Keeping you updated on what's happening in the Department of Biology

Spring 2019



Dan Tracey (left) turns his dream research mission into reality as he searches for fruit flies during a three-month voyage across the Lesser Antilles. Photo by Dan Tracey, IU Biology 2



Ph.D. candidate Olivia Ballew balances graduate school with training as she prepares for the 2020 Olympic marathon trials. Photo by Matt Dwyer, IU Biology 11



Known as the Froot Loops mascot, the keel-billed toucan (*Ramphastos sulfuratus*) is one of many birds seen by BIOL-L 433 students in Costa Rica. Photo by Roger Hangarter, IU Biology. 8

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IU scientist embarks on Caribbean ‘treasure hunt’ in search of flies and wasps

Mission to understand evolutionary changes in *Drosophila* launches IU Biology’s Dan Tracey on three-month voyage across the Lesser Antilles

by Chloe Seletz



▲ Dan Tracey on his boat. *Courtesy photo*

For Indiana University laboratory biologist Dan Tracey—who set sail Feb. 1 to study the evolution of genetically isolated fruit flies on the volcanic islands of the Lesser Antilles—the chance to collect data on these insects during a months-long sea-faring adventure is both a scientifically significant endeavor and the realization of a longtime dream.

Growing up near Buffalo, New York, Tracey grew up sailing with his father on Lake Erie. Being out on the water on their boat was a large part of their life together. But it wasn’t until Tracey’s father passed away from cancer last year that he started to seriously think about turning his dream research mission—which he

often talked about with his father—into a reality.

“I started thinking, ‘What would I do if I could do anything I want?’” said Tracey, a professor in the IU Bloomington College of Arts and Sciences’ Department of Biology and a Gill Chair in the Linda and Jack Gill Center for Biomolecular Science. “What would my dream research project be?”

With support from Jack M. and Linda Gill of Texas, whose generous gift to IU established the Gill Center in 1999, Tracey is retracing the steps of William B. Heed, a well-known biologist who conducted a similar expedition in the Caribbean in 1959. Heed traveled the Lesser Antilles and discovered that

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▲ Midgley picking up a nitrogen deposition collector from a Cook County Forest Preserve. Midgley has deployed nitrogen deposition collectors around Chicagoland to assess nitrogen pollution at fine scales and relate deposition rates to soil properties and tree seedlings. *Courtesy photo*



▲ A mesocosm experiment designed to examine the impacts of invasive *Amanthas* spp. worms on different types of forest soils. Midgley and her master's student are evaluating whether *Amanthas* (aka, jumping worms) have different impacts on white pine, white oak, sugar maple, or European buckthorn soils. *Courtesy photo*

public. She meets with area land manager groups such as Chicago's oak ecosystem recovery working group and the Obama Center's landscape contractors. She presents workshops for the public and writes informational articles.

Although Midgley's job involves speaking for the trees, she finds that listening is just as important.

"I've learned that 'practitioners' are not one homogenous group and 'the general public' isn't really a thing," she says. "We all care about different things in our lives for different reasons. To get people excited about my research, it's critical to connect it to the things they care about, not the things I think they should care about."

For details about Meghan Midgley's research, visit <https://www.mortonarb.org/science-conservation/scientists-and-staff/meghan-midgley>.



▲ Midgley collecting soil from under a sugar maple tree at The Morton Arboretum. She is using trees planted in the arboretum's collection to examine the effects of roots on soil processes. *Courtesy photo*

the fruit flies on each island differed in pigmentation.

Tracey is eager to discover what the evolution of this pigmentation means.

He and two others are sailing from the south to the north of the Caribbean, stopping at 11 islands along the way: Grenada, St. Vincent, St. Lucia, Martinique, Dominica, Guadeloupe, Montserrat, St. Kitts, Antigua, Anguilla, and St. Martin, where the journey ends May 1. During the voyage, the crew is working and living aboard a 41-foot rented catamaran named "Sea Salt."

On each island, Tracey and colleagues are spending about a week collecting *Drosophila*, the Latin name for fruit fly. They will later store and genetically analyze the insects at IU to trace the origins of their pigmentation.

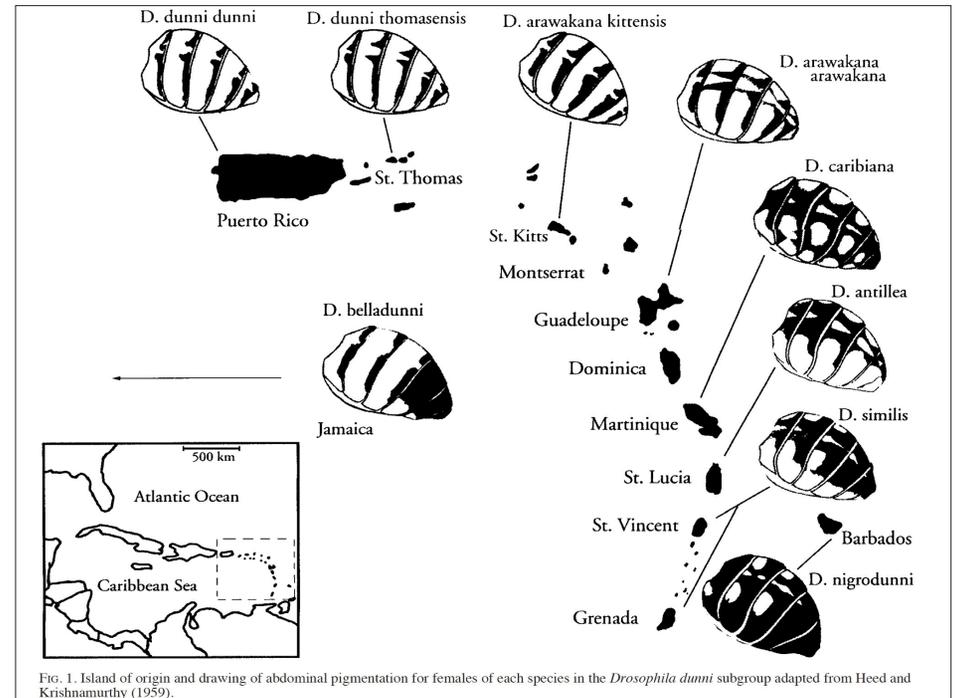


Fig. 1. Island of origin and drawing of abdominal pigmentation for females of each species in the *Drosophila dunni* subgroup adapted from Heed and Krishnamurthy (1959).

▲ A map of William B. Heed's journey of the Lesser Antilles islands and pigmentations of *Drosophila*. Image courtesy of Hollocher et al., *Evolution*, 54(6), 2000, pp. 2046–2056

Drosophila to protect against their aggressors: an immune response that “walls off” the eggs inside the larvae so they’re unable to feed upon the larvae after hatching.

If parasitoid wasps are found on the journey, it could shed new light on the co-evolution of these insects. The volcanic origin of each island also represents the chance to study these evolutionary systems isolated from outside influences.

Tracey will be accompanied on his journey by Jeremy Davis, an IU Ph.D. student with extensive experience capturing *Drosophila* in the field. In 2016, Davis spent six weeks traveling across the U.S. collecting fruit flies under a grant from the Graduate and Professional Student Government’s Research Awards program.



▲ Jeremy Davis working in the lab. Photo by James Brosher, Indiana University

That project took him from “city parks in New Orleans to the bayou, the mountains, and dried-up riverbeds,”

he said. The experience not only gave him a good eye for finding flies but gave him experience capturing them.

Davis is a member of the lab of IU biology professor Leonie Moyle, who recommended him for Tracey’s project because of his experience in the field.

“It sounded like a once-in-a-lifetime experience,” Davis said. “I’m very excited about the science aspect of the trip, as well as traveling and learning to sail.”

The third member of the team is Amalia Rowan, an experienced sailor who is working toward the next level of her captain’s license. Rowan has worked on Alaskan fishing vessels and, most recently, sailed across the Atlantic in a small ship.

But it wasn’t until a few weeks ago in Miami that all three members of the crew finally met in person, after which they took a short flight to Grenada to join their boat and equipment. The team is currently spending their days hiking the islands, setting up fly traps, and searching for wasps.

“The truth is we still don’t know a lot about these species because no one has looked in a long time,” Tracey said. “That’s why we’ve got to go there and do it.”

To follow Tracey’s fly-hunting adventures aboard “Sea Salt,” follow him on Twitter at @HoosierFlyMan.

Chloe Seletz—news and media intern at IU Communications—focuses on science and research. She is a senior at Indiana University majoring in journalism.

Alum Profile: Meghan Midgley

I speak for the trees for the trees have no tongues.

— *The Lorax*, Dr. Seuss



◀ Meghan Midgley earned her Ph.D. in Evolution, Ecology & Behavior in 2015. She was a member of Associate Professor Rich Phillips’ lab.

Courtesy photo

In her own way, IU Biology alumna Meghan Midgley [PhD ‘15 Evolution, Ecology & Behavior] speaks for the trees.

Midgley is a soil ecologist at The Morton Arboretum in Lisle, IL—a nonprofit organic garden outside of Chicago with a mission to enhance tree conservation, health, and growth. There she studies plant-soil interactions. Through field experiments and observations as well as laboratory studies, Midgley works to understand how interactions among plants, microbes, and soil bring about ecosystem-specific responses to environmental changes.

Focusing on temperate hardwood forest ecosystems, Midgley investigates how plants impact the physical, chemical, and biological properties of the soils in which they grow. She uses this information to (1) predict ecosystem-specific

responses to environmental changes and (2) manage the urban soil environment for healthy, long-lived trees.

Her research projects include:

- Linking root and microbial traits with soil biogeochemistry
- The Tollway Trees Initiative: From right tree/right site to right soil/right tree
- Vacant lots and soil ecosystem services
- Invasive earthworm impacts on forest soils and seedlings
- Nitrogen deposition effects on current and future forests
- Controlled burn impacts on soil biogeochemistry and forest dynamics

One of the arboretum’s goals is to encourage the planting and conservation of trees and plants, so part of Midgley’s time is spent conveying her research findings to practitioners and the general

mechanisms to divide a cell: meiosis and mitosis. In humans, meiosis produces female eggs and male sperm while mitosis produces the remainder of the cells in the body. Although cells most often faithfully divide, the processes of meiosis and mitosis are not completely error free. Checkpoints are the surveillance mechanisms in cells that sense these errors and delay cell division, allowing the cell time to correct errors. Research into meiotic checkpoints is necessary because errors can lead to developmental disorders and infertility. Similarly, studying mitosis is imperative because many cancer cells have defective checkpoints which allow unrestrained cell division.”

Ballew ran track and cross-country in high school in Roanoke Rapids, North Carolina. Although she received some offers to run in college, she didn't pursue them. She majored in biology at University of North Carolina where she developed an interest in genetics that led her to study at IU.

Not having run competitively since 2008, Ballew began to train again in late 2016. Remarkably, after only two years of training, she has found herself in the position to compete with some of the country's fastest marathoners.

Ballew's days are busy—juggling laboratory work and school with running. She has little time to socialize.

“Olivia comes in to the lab at all hours and is ready to work,” says Lacefield. “Her pure dedication and flexibility to research and running have made her extremely successful. She is the only person I know who could do both.”

Ballew notes, “Running and science



▲ Olivia Ballew (right) in the lab with her mentor, Soni Lacefield. *Courtesy photo*

can go hand in hand. I was out for a run at lunch and was thinking about a problem—how can I get this to work? I came up with a solution during my run. You're always going and going in the lab. It's hard to find time to just think. Running has given me this outlet.”

Earning a place at the U.S. Olympic Marathon Trials has made all of her sacrifices worthwhile. Ballew, however, is quick to point out that publishing her first research paper was better.

“Qualifying for the trials was good, but seeing my name on a paper as first author was way better,” she says.

Ballew received an IU College of Arts and Sciences Dissertation Research Fellowship that will fund her dissertation. She hopes to complete her Ph.D. next year. In the meantime, her next competition in preparation for the trials will be the Boston Marathon.

Turning sunlight into oxygen

A study led by Professor David Kehoe of IU Biology and Frédéric Partensky of Sorbonne University/CNRS has been published in *PNAS*. Their work explains for the first time a key part of a process that allows *Synechococcus*, a widespread ocean bacterium, to efficiently convert sunlight into oxygen.

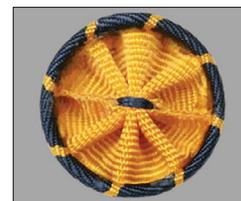
“This is an extremely important organism, and much remains to be learned about it,” Kehoe said. “Because carbon and oxygen cycles are so important for our planet's health, everything we can do to understand the inputs and outlets to those cycles is valuable information. This knowledge can help us make more informed models for predicting climate change and global warming.”

In February, Indiana University signed formal partnerships to engage in research collaboration and student exchange with Sorbonne University, one of France's top-ranked research universities. The Kehoe and Partensky labs have been working jointly since 2007. Their collaboration exemplifies the newly formed relationship between the universities.



▲ David Kehoe. *Photo by Eric Rudd, Indiana University*

Faculty awards and honors



▲ Fellows will receive a rosette pin with its gold and blue colors to signify science and engineering, respectively. *Photo by AAAS*

Six faculty members associated with IU Biology have been named fellows of the **American Association for the Advancement of Science**, an honor that recognizes their outstanding contributions to the progress of science and research. The fellows are: **Dan Kearns**, professor; **David Kehoe**, professor; **Jay Lennon**, professor; **John Patton**, associate professor and Blatt Chair of Virology; **Andrea Hohmann**, adjunct professor; and **Claire Walczak**, adjunct professor.



▲ Ankur Dalia. *Photo by James Brosher, Indiana University*

Assistant Professor **Ankur Dalia** received a **Maximizing Investigators' Research Award (MIRA)** to fund his studies to better understand the basic biology and mechanisms of biofilms as he seeks novel strategies to combat infections and stem the spread of antibiotic resistance. **Dalia** is also a 2019 recipient of the **Indiana University Outstanding Junior Faculty Award**. The award identifies promising tenure-track faculty and provides resources to further develop their research programs.

More faculty awards and honors



▲ Gabe Zentner. Photo by Sandee Milhouse

Assistant Professor **Gabe Zentner** received a **Maximizing Investigators' Research Award** (MIRA) to fund his research to understand the complex involvement of Mediator in transcriptional regulation. In eukaryotic cells, the critical role of Mediator in transcriptional regulation is underscored by the numerous human disorders linked to its dysregulation.

National Science Foundation has awarded Professor **Armin Moczek** **\$860,000** to study evolutionary development. He will use dung beetles to contrast two ways that new traits emerge in species.



▲ Armin Moczek. Photo by James Brosher, Indiana Univ.

Professor **Jay Lennon** has been elected a fellow of the **American Academy of Microbiology**, an honorific leadership group within the American Society for Microbiology.



▲ Jay Lennon. Photo by Jean Lennon, IU Biology

IU Biology welcomes Jennifer Lau

Associate Professor Jen Lau is a community ecologist and evolutionary ecologist—studying plant population response to human-caused environmental change, ecology and evolution of species interactions, and natural selection in the wild. She's been with IU Biology since Aug. 2018.

Education: Postdoctoral research associate, Univ. of Minnesota, 2005-07; Ph.D., Population Biology, Univ. of California, Davis, 2005

Previous position: Associate Professor, Michigan State Univ., Kellogg Biological Station and Dept. of Plant Biology

Roots: York, Pennsylvania

What you might not know about her: Lau plans to run the Kalamazoo marathon in May, but she's only in it for the bacon (it's the only marathon with a "bacon station"—a block party that hands out bacon to the runners in her old neighborhood back in Michigan).

Jen Lau.
Courtesy photo

Ph.D. student balances graduate school with marathon training

In early November 2018, Olivia Ballew qualified for the 2020 Olympic Marathon Trials at the CNO Financial Monumental Marathon in Indianapolis. The trials will be held in Atlanta in February 2020. This gives Ballew the opportunity to compete for a spot on the 2020 Olympic Team. To reach the Olympics, she will have to place among the top three at the trials.

To qualify, Ballew had to run a time of 2:45:00, and she ran the 26.2-mile distance in 2:43:13 (6:14 min/mile pace) at Indianapolis. As of March 8, 2019, there were 285 women in the nation qualified for the marathon trials. (The qualifying window closes on January 19, 2020.)

Ballew is a Ph.D. candidate in IU Biology's Genome, Cell, and Developmental Biology Graduate Program; she is a member of Associate Professor Soni Lacefield's lab. Ballew's research focuses on repair of DNA damage, working to better understand how errors in DNA are passed from parent to child.

Ballew explains: "The average human body comprises over 30 trillion cells. These cells must safeguard their genomes throughout their lifetime to prevent diseases and cancer. Additionally, humans must be able to faithfully pass on their genetic information (DNA) to subsequent generations. There are two main



▲ Olivia Ballew runs amid the fall colors last year at Brown County State Park. Photo by Ben Meraz

L433 students and instructors stay at established biological research stations and visit world-renowned preserves. They explore tropical rain forests, cloud forests, seasonally dry forest, mangrove forests, and other habitats. They learn about biodiversity, plant-animal interactions, plant structure, physiology, and evolution. The course is an opportunity to experience a country that embraces ecological sustainability.

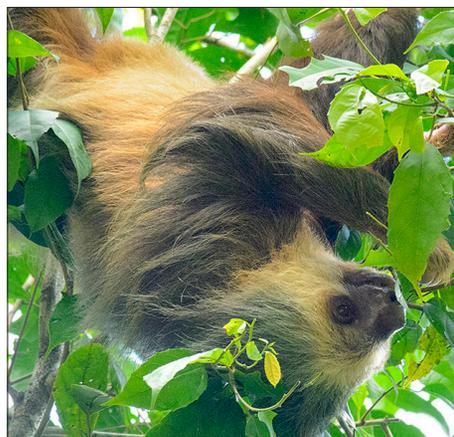
The students are required to keep field journals, including a summary of what they did and saw each day. Vincent fondly recalls, “We hung out in our shared rooms at the end of the day and tried to collectively remember everything. Our days would start at 7 a.m. and often go until 10 p.m. or later. They were so jam-packed it was difficult to



▲ Maggie Vincent at Cerro de la Muerte during the course in Costa Rica. *Courtesy photo*

remember everything. As we wrote in our journals, someone would call out, ‘Did we see that three-toed sloth this morning?’ or ‘What was the name of that bird we saw?’”

◀ Two-toed sloth (*Choloepus hoffmanni*) eating leaves on the campus of La Selva Biological Research Station. *Photo by Roger Hangarter, 2019*



“It was fifteen people having a great time in some of the coolest places I’ve ever seen,” says Vincent.

Maggie Vincent will graduate from the IU Department of Biology in May with a B.S. in biology. She plans to pursue a master’s degree in ecology and evolution.

Roger Hangarter (distinguished professor and chancellor’s professor of biology) researches plant physiology—specifically, environmental sensory-response systems and plant development. He is known for his nature photography and videos as well as his efforts to raise awareness of the importance of maintaining biodiversity where one lives.

Bill Ruf (senior lecturer) is director of the Tropical Biology Program. He began teaching L433 in 1990—picking up where faculty member David Dilcher, who conceived the course, left off.

Student news

For the fourth year in a row, IU was named top producer for the Fulbright U.S. Student Program. IU Biology alumna **Madeline Danforth**, who earned her B.S. in microbiology with departmental honors last May, is one of the 2018-19 recipients—receiving a Fulbright award to teach English in Mexico. Danforth also earned a B.A. in Spanish and a minor in chemistry in May 2018. She has been passionate about improving and practicing her Spanish in order to eventually serve the U.S. Spanish-speaking population as a physician.



▲ As a Fulbright Scholar, Madeline Danforth teaches advanced English at the Universidad Politécnica de Tlaxcala in Mexico. She will attend Washington Univ. School of Medicine in St. Louis this fall to pursue her M.D. *Photo courtesy of the IU Office of National Scholarships and Awards*

Biologists’ discovery opens up new research directions in plant biology. Ph.D. student **Brian Rutter**, Professor Roger Innes, and lab members have developed protocols for purifying and analyzing plant exosomes—providing plant scientists with new ideas about how plants communicate with microbes. Exosomes may also be useful in agricultural and medical applications. Their work was featured in *The Scientist*.

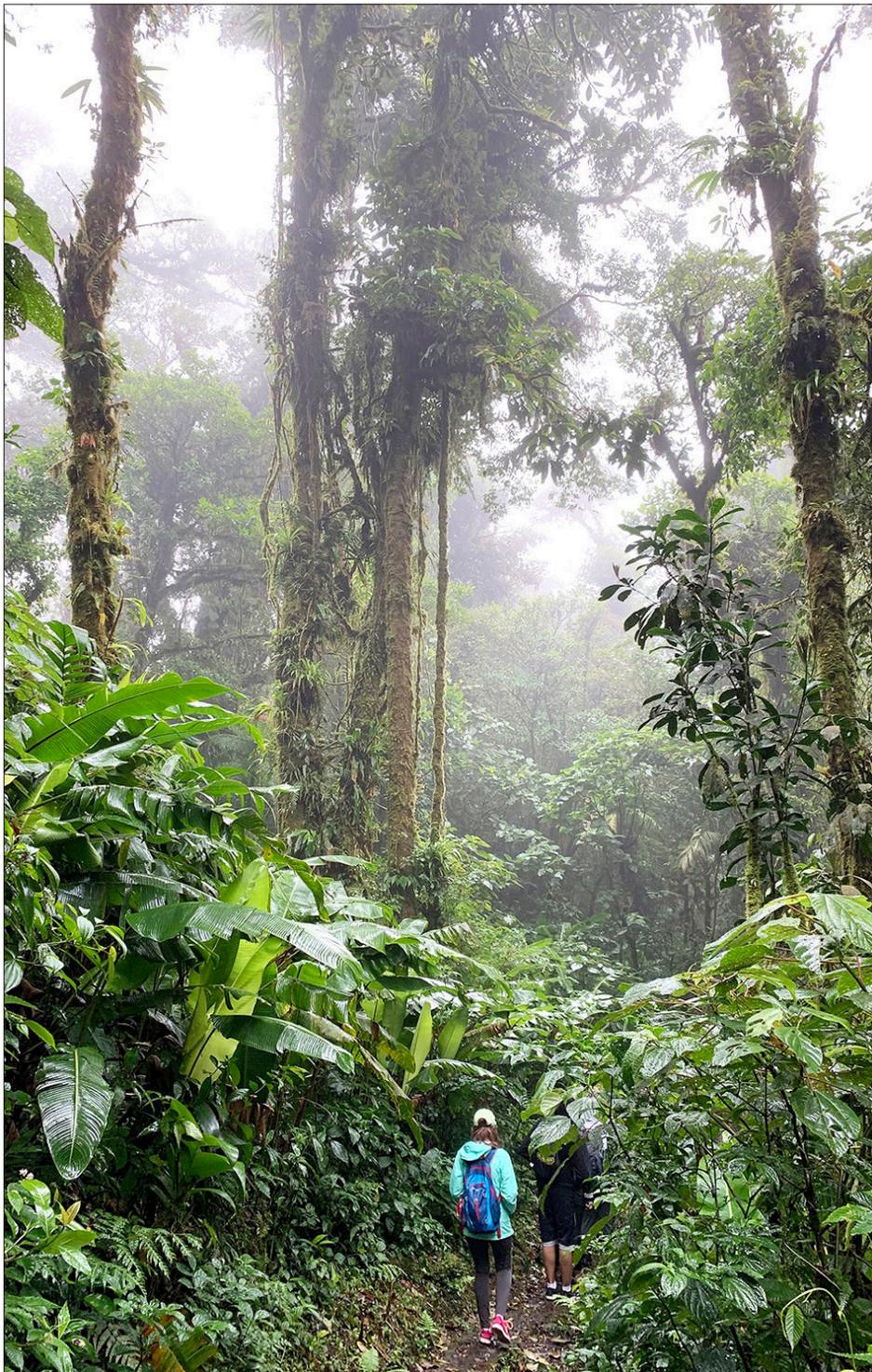


▲ Brian Rutter. *Courtesy photo*

Ph.D. student Courtney Ellison has been named a 2019 recipient of the Harold M. Weintraub Graduate Student Award from the Fred Hutchinson Cancer Research Center. The award recognizes outstanding achievement in graduate studies in the biological sciences. Ellison’s research resulted in her becoming the first person to witness a bacterium use its pilus to capture and reel in DNA from its environment.



▲ Courtney Ellison is a member of the lab of Distinguished Professor Yves Brun. *Photo by James Brosher, Indiana University*



BIOL-L 433 Tropical Biology in Costa Rica

“... a fun thing to do over winter break”

After teaching the BIOL-L 433 Tropical Biology in Costa Rica course for six years, Roger Hangarter, distinguished professor of biology, finds that “it is still a fun thing to do over the winter break.”



▲ The red-eyed tree frog (*Agalychnis callidryas*) is the poster child of Central American rain forests. La Selva, Costa Rica. Photo by Roger Hangarter, 2013

Maggie Vincent echoes Hangarter’s sentiments about the course, “L433 was an incredibly fun experience for a lot of reasons. The instructors, Bill Ruf and Roger Hangarter, created a learning environment where we got to ask the questions ourselves and follow our own curiosity. As a result, we were all eager to dive into the course. We were excited to hear what they knew on our hikes and in their lectures. It’s not often in undergraduate courses that you get to break out of the classroom the way we did.” Vincent is an undergraduate biology major who participated in the two-week course over the 2017-18 break.



▲ Glass-winged butterflies drink nectar but are also known to obtain additional nutrients from the droppings of insectivorous birds, like antbirds. Photo by Roger Hangarter, 2016

◀ Students exploring and learning about the cloud forest environment. Monteverde, Costa Rica. Photo by Roger Hangarter, 2019

Around sunrise at the La Selva Biological Research Station, the booming calls of howler monkeys resonate through the canopy. No alarm clocks are needed. Photo by Roger Hangarter

