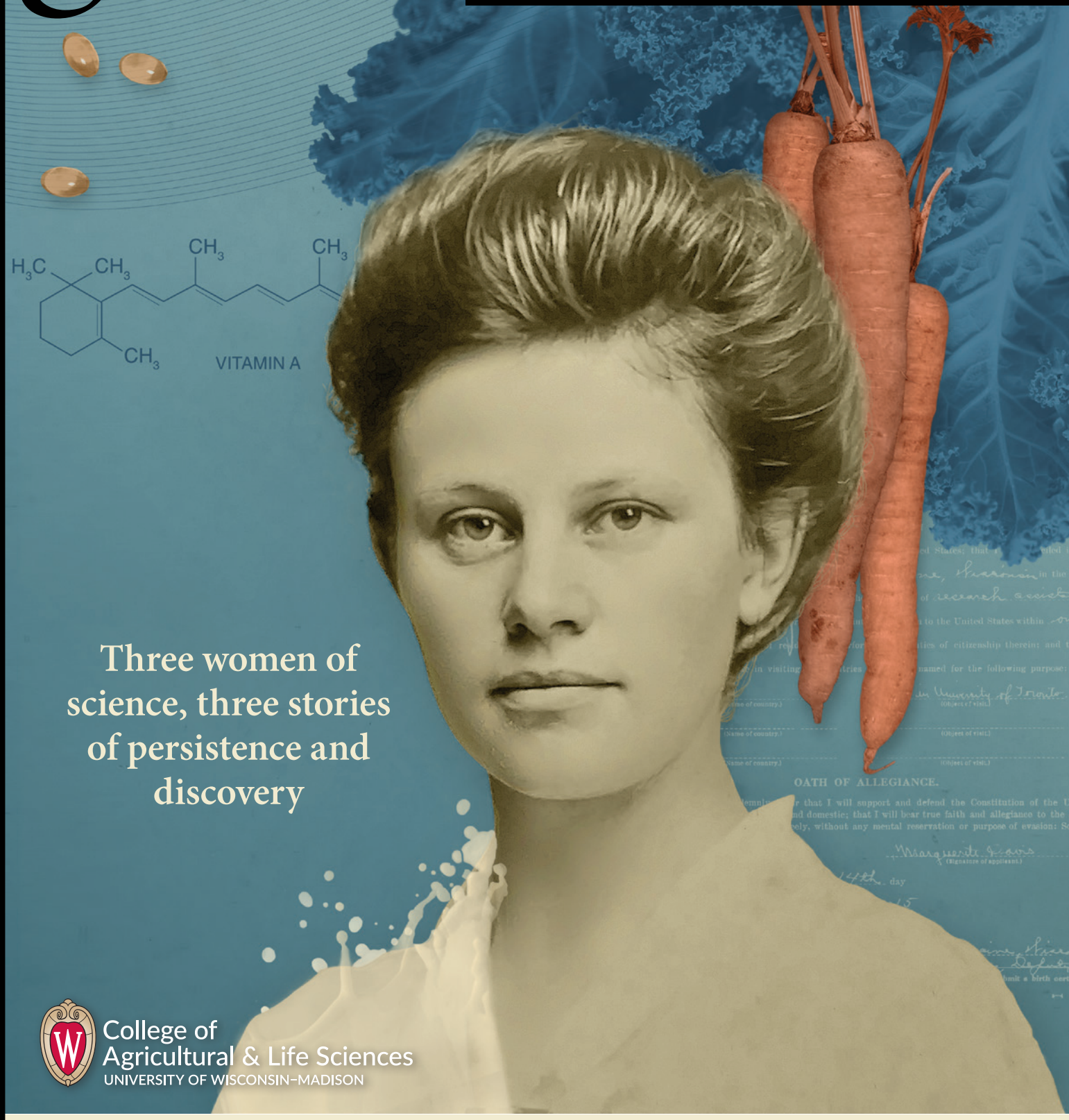
grow

Wisconsin's Magazine for the Life Sciences • SPRING 2020

food systems • health • bioenergy • environment • climate • communities



Three women of science, three stories of persistence and discovery

College of Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN–MADISON

THE SOIL DOCTOR • WATER FILTERS FROM TEQUILA WASTE • CURE FOR PLANT BLINDNESS

Tunnels from wood-boring bark beetles cover the surface of this piece of bark found at the Pleasant Ridge cemetery, which is connected to the Lancaster Agricultural Research Station just outside Lancaster, Wis.

Photo by Michael P. King

Volume 13, Issue 2 • Spring 2020

grow

Wisconsin's Magazine for the Life Sciences

FEATURES

DEPARTMENTS

ON THE COVER: Vitamins are ubiquitous today, but no one knew about the presence of these compounds in food until Marguerite Davis became a lab assistant at the University of Wisconsin.

Photo illustration by Danielle Lamberson Philipp. Original photos: National Archives, Michele Blackwell, Laura Johnston, Jagoda Kondratiuk, and Markus Spiske

Dean Kate VandenBosch

19 in '19

"These new scholars possess a diverse range of talents and specialties."

The faculty ranks are growing at CALS, and it's a positive sign for the future of the college.

Some major challenges in the last few years, from budget cuts to policy changes, led to an overall decline in the number of faculty searches we were able to carry out across the college. But we've weathered that storm, and the trend is beginning to reverse.

Over the course of 2019, CALS brought in a total of 19 new faculty members. Much credit goes to our academic departments. Their strengths in existing programs and innovative visions for the future attracted great candidates.

This expansion in faculty numbers brings many benefits to CALS. We will strengthen existing areas of expertise and bolster our departments with new disciplines and diverse perspectives. We will increase our research capacity while fostering new collaborations across campus and with other institutions. And we will be in a position to serve more students and offer a greater variety of subject matter in their courses.

These new scholars possess a diverse range of talents and specialties. **Zhou Zhang** joins the Department of Biological Systems Engineering looking to combine advanced remote sensing with machine learning for agricultural applications. **Scott Coyle** brings his investigations of microscale molecular and cellular machines to the biochemistry department. **Sarah Rios** in community and environmental sociology studies environmental health risks and environmental justice. And in entomology, **Amy Trowbridge** examines how climate variability can alter the ability of trees to defend themselves against insects. And this is just a sampling. A comprehensive list can be found at **go.wisc.edu/19in19**.

You may be wondering how we are able to do this hiring now. Some of the funding for these new positions stems from retirements, departures, or gifts, and our departments have generated new revenues to contribute to salaries. Some new faculty positions are shared appointments, co-funded with departments in different UW–Madison schools and colleges.

Other new hires are made possible with support from UW–Madison initiatives spearheaded by the Office of the Provost. This includes the Cluster Hiring Initiative and a faculty diversity effort called the Target of Opportunity Program. The first is designed to establish interdisciplinary groups of scholars, chosen for their shared research interests and specialties, who can collaborate and pool resources from departments across campus. The second seeks to hire faculty members identified for their potential to enhance the quality and diversity of an academic department.

The upward trend in hiring looks to continue beyond 2019. Several new professors already started earlier this year, and with recently completed or ongoing searches, the college is likely to see at least a dozen total new faculty hires in 2020. And thanks to a significant influx of state funding for the new Dairy Innovation Hub, which I described here in the fall 2019 issue of *Grow*, we will be hiring at least a dozen more faculty with dairy expertise in the coming years.

It's exciting to see so many phenomenal scholars join our community. I am beyond pleased to welcome them to CALS, and I look forward to all that they will accomplish.

grow
Volume 13, Issue 2 · SPRING 2020

Editor
Nik Hawkins

Writers
Stephanie Hoff BS'19, Michael P. King, Nicole Miller MS'06, Caroline Schneider MS'11

Designer
Danielle Lamberson Philipp

Photographer
Michael P. King

Editorial Assistants
Brenna DeNamur BSx'21, Jori Skalitzky BSx'22

Additional content contributed by University Communications and various freelancers.

Contact *Grow*
Grow Editor, 136 Agricultural Hall, 1450 Linden Drive, Madison, WI 53706
grow@cals.wisc.edu
grow.cals.wisc.edu

Five things everyone should know about . . .

‘Plant Blindness’ (and How We Can Cure It)

By Benjamin Futa

1. **“Plant blindness” is the inability to recognize or notice the plants in one’s environment.** For many people, it’s far easier to discern or recall an image of an animal than that of a plant, and this deficit diminishes interest in the critical role that plants play in the biosphere and human affairs. American botanists James Wandersee and Elisabeth Schussler first gave plant blindness its name in 1998 after noting its rapid spread — a trend that has continued under the pressure of forces such as urbanization and digitization.

Illustration by Danielle Lamberson Philipp

2. **Plant blindness results in an underappreciation of plants and limits future interest in plant sciences and conservation.** This is problematic because plants matter for human health, and more time spent on digital devices leads to “nature deficit disorder” — a term coined by author Richard Louv in his book *Last Child in the Woods*. While not meant to be a medical diagnosis, a lack of connection to nature can lead to serious negative health effects — mental, emotional, and physical.

3. **Public gardens are in a unique position to help reverse plant blindness.** These spaces provide meaningful and authentic experiences with plants that invoke curiosity about the flora in our midst and help build personal affinity and awareness. Where I work, at UW–Madison’s Allen Centennial Garden, we achieve these experiences through community co-creation and participation, which means we carefully craft our offerings *with* — rather than *for* — the audiences we want to reach.

4. **Public garden experiences can combat plant blindness by increasing public engagement with plants in innovative ways.** One example from Allen is our annual Plant Adoption Day. Participating students agree to adopt and care for an indoor plant. Our student interns also become involved in the adoption process by educating new “plant parents” about each species’ unique needs. In 2019, when nearly 2,000 UW students participated, the event evolved into a collaborative social media project between the interns and “master gardener” volunteers through an Instagram account, **@UWPlantParents**.

5. **We must cultivate a new mind-set among younger generations to ensure that plant blindness does not persist.** As a living museum, Allen is a repository of our community’s natural and cultural commonwealth. Our events make plants provocative; they transform plants into social objects that mediate conversations and spark connections. As a result, students want to work with us — with plants, in a garden. This is evidenced by the 100-plus applications for summer internships we received last year. We’re cultivating a community of future leaders who are inspired to care about plants and pursue professions that nurture, support, and embrace nature. We believe gardens can — and will — save the world.

With a background in landscape architecture and sustainability studies, **Benjamin Futa** is passionate about connecting people to plants — and each other — through public gardens. He is executive director of Allen Centennial Garden, the Department of Horticulture’s living laboratory, outdoor classroom, and public botanical garden. More at **allencentennialgarden.org**.

'There's No War on Science among the American Public'

An analysis of opinion polls over time shows that Americans across the political spectrum maintain high levels of confidence in scientists

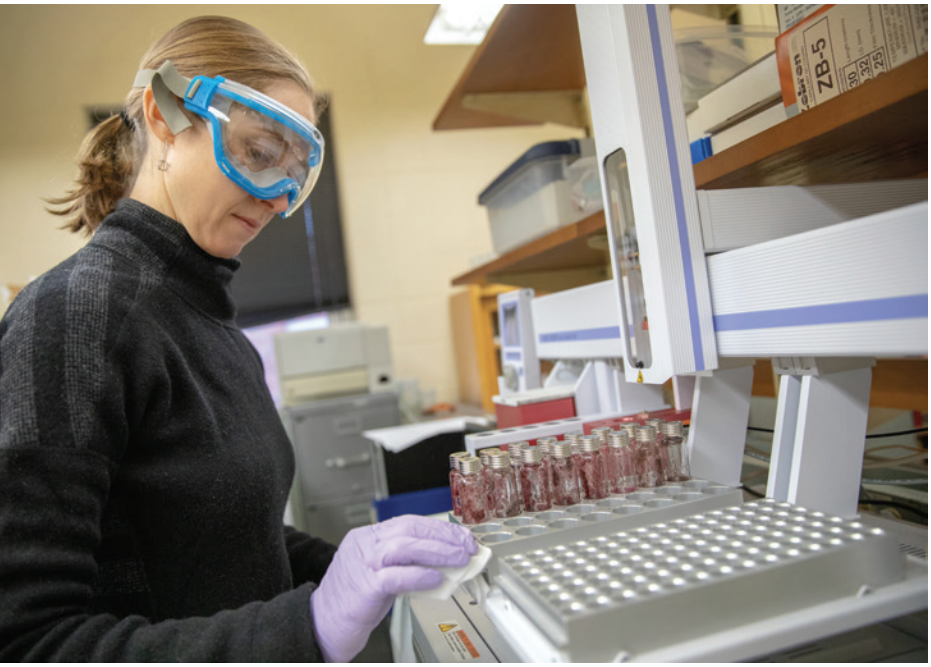


Photo by Michael P. King

Turns out science may not be so partisan after all. A recent report analyzing decades of public opinion surveys reveals that the public's trust in scientists has remained stable and high, regardless of political party affiliation.

By various measures, Americans reported that they trusted scientists more than they trusted many other institutions and professions, including journalists, judges, and Congress. That trust can affect how people interpret scientific information related to human health or government policies.

In the 2018 General Social Survey (GSS), about 40% of respondents reported a great deal of confidence in the leaders of scientific institutions, a number that has changed little since surveying began in 1973. A majority expressed either a "great deal" or "some" confidence in the scientific community throughout the survey period.

"We can say without a doubt that the vast majority of Americans have confidence in the scientific community," says **Dominique Brossard**, senior report author and professor and chair in the Department of Life Sciences Communication. "Over and over again, scientists are at the top of trustworthy professions."

This finding is further supported by Harris Polls showing that, over the last two decades, roughly three-quarters of Americans surveyed said they would trust scientists to tell them the truth. This was more than they trusted most other professionals, aside from doctors and teachers.

Brossard says increasing concerns among scientists over science becoming partisan are not reflected in recent GSS polls, which show fairly modest differences between Democrats' and Republicans' confidence in the scientific community. While Democrats reported higher confidence in scientists than Republicans did in 2018, members of both parties have reported similar, high levels of confidence over the past 45 years.

Yet the research team did uncover a persistent, large gap between rural and suburban residents' confidence in science. About 30% of rural residents expressed confidence in scientists over the last 30 years, well below the 40% average among all Americans. In contrast, nearly half of suburban residents reported a great deal of confidence in scientists. Trust among urban residents fluctuated more widely over time.

The study by Brossard and her team, including graduate student and lead author **Nicole Krause**, appeared in the fall 2019 issue of *Public Opinion Quarterly*. They analyzed long-term polls that measured some aspect of trust or confidence in institutions. Their findings suggest that recent political events have done little to erode Americans' overall high trust in science and scientists.

Brossard's team began its investigation following the 2017 March for Science. The protest sprang out of concerns that the Trump administration would discount or suppress scientific information, and it appeared to mark an increase in the politicization of science.

Yet Brossard's team found little evidence of major differences between Democrats and Republicans in their confidence in scientific leaders. In the 2018 GSS, the proportion of Republicans reporting confidence in scientists — about 40% — was comparable to the proportion among all Americans.

> **"We can say without a doubt that the vast majority of Americans have confidence in the scientific community. Over and over again, scientists are at the top of trustworthy professions."**

The same poll revealed an uptick in confidence among Democrats in 2018, to about half of the population surveyed, which created a modest partisan gap. But partisan-specific confidence is less stable than overall confidence and has fluctuated between 35% and 50% of Democrats, Republicans, and independents over the past 45 years.

"Our study focused on aggregate trends, but among the few subgroups we assessed, we didn't see sharp declines in confidence in scientists," says Krause. "Instead, we saw long-standing gaps or new gaps emerging because one group's confidence has been increasing relative to others."

The researchers also found high levels of trust in scientists on specific issues, such as the environment, and in other countries, including the United Kingdom and Germany.

The results suggest that there is stable trust in the institution at many levels, in contrast to some media narratives that highlight partisanship in science. Brossard is concerned that these narratives obscure other factors affecting trust in the institution.

"Trust in science is about more than politics," she says. "There's no war on science among the American public."

—Eric Hamilton

Awards and Honors

• • •

ON THE RHODES TO SUCCESS

Two CALS representatives, nutritional sciences major **Kevin Crosby** BSx'20 and recent agronomy and community and environmental sociology graduate **Lauren Jorgensen** BS'19, reached the final stage of competition for the 2020 Rhodes Scholarships, the oldest and most celebrated college award for international study.

• • •

A MODEL MENTOR TO WOMEN

Plant pathology professor **Caitlyn Allen** has received the 2020 American Society for Microbiology (ASM) Alice C. Evans Award for the Advancement of Women for her mentorship of and advocacy for women in the microbial sciences. The award is given in memory of **Alice C. Evans** MS1910 (see page 24), a pioneering microbiologist who, in 1928, was the first woman to be elected president of ASM.

• • •

LEADER OF THE CHEESE WORLD

Marianne Smukowski BS'80, coordinator of the Dairy Safety/Quality and Master Cheese Programs at the Center for Dairy Research, has been elected president of the American Cheese Society — an organization that supports the understanding, appreciation, and promotion of cheeses produced in the Americas.

Number Crunching | 20,000 pounds

IN OTHER WORDS, 10 TONS. It's the amount of extra produce the Seed to Kitchen Collaborative (SKC) at CALS donated to food banks and other organizations during the last growing season. Led by horticulture professor **Julie Dawson**, the SKC includes plant breeders, farmers, and chefs working together to develop improved fruit and vegetable varieties for local food systems. The research yields a leftover bounty that always goes to a good cause. More at **go.wisc.edu/skc**.

Photo by Michael P. King

How the Seeds of Heritage Are Sown

UW project supports Native American stewards of culturally significant seeds

From left, undergraduate students Michael Gilpin, Autumn Chevalier, and Patricia Castillo Venegas BSx'20 remove squash seeds for saving at FEED Kitchens in Madison, Wis.

Photos by Michael P. King

Claire Luby, assistant faculty associate in the Department of Horticulture, washes squash before saving their seeds at FEED Kitchens.

Anna Williams is an avid gardener, but when she was gifted corn and bean seeds connected to her Odawa heritage, she felt she needed more knowledge to grow them well.

"I didn't know these seeds, but they were very special to me," says Williams. "In all my years, I have never had [seeds] directly from that heritage. They were a part of my heritage that was coming back to me."

Williams, who lives near Ann Arbor, Michigan, was thrilled when she discovered UW–Madison's new seed stewardship group for members of Upper Midwest tribes. In particular, she was excited the group would be co-led by **Rowen White**, a national leader in the indigenous seed keeping movement.

Seeds play an important role in Native American culture. Each tribe has its traditional varieties — of squash, corn, beans, and other crops — that come from specific heritage seeds. Unfortunately, many of these indigenous seeds and the cultural practices surrounding them were lost during European colonization, acculturation, and assimilation. Today, very few people are growing the traditional varieties. But a shift is under way.

"We are in an era right now where there's a resurgence of [Native] people understanding how vitally important it is to have control of the way we feed and nourish ourselves," says White, national program coordinator for the Indigenous Seedkeepers Network. "When we aim as indigenous peoples to revitalize our culture, a big part of that is revitalizing the traditional foods that are at the center of culture. Being able to restore the relationships between tribal community members and their culturally significant seeds is a really important part of that cultural restoration."

Based in California, White travels all over the United States teaching seed keeping workshops. She trains people how to grow traditional crops, collect their seeds, and process and preserve them. Demand for her expertise has increased in recent years, but she can't be everywhere at once.

"Rowen travels a lot doing this work," says **Claire Luby** MS'13, PhD'16, an assistant faculty associate in the horticulture department, who first met White at a seed-related conference. "She is leading a movement to empower more people to become seed stewards and to serve as resources for others in their own communities."

Luby wondered how the university could help, so she assembled a small team to brainstorm ideas. In addition to Luby and White, the group included **Dan Cornelius**, general manager of the Intertribal Agriculture Council's Native Food Network and

outreach specialist with the UW Law School; **Jessika Greendeer**, seed regeneration manager for Minneapolis-based Dream of Wild Health; and **Irwin Goldman** PhD'91, chair and professor of horticulture.

The team came up with the idea for the seed keeping group as a program to help "train the trainers," and they were able to secure funding for it through the university's Baldwin Grant program, which supports collaborative university-community projects. In addition, the grant provided support for a garden project for Native youth; a new UW course on seed and food sovereignty; and a project to grow indigenous seeds and distribute them to tribal members.

"This is an opportunity for UW–Madison to partner meaningfully with Native Nations in the Upper Midwest to support the stewardship of the many plant varieties that have been developed by Indigenous seed keepers from these communities," says Luby. "Our goal is to help create culturally appropriate resources that will mesh with the traditions and relationships around food and land in these communities."

During last year's growing season, a cohort of around 20 Native people participated in the seed keeping group. They completed online learning modules, met for monthly online meetings, and gathered in person for two intensive hands-on workshops, one on pollination and one on seed harvest. The experience provided participants with the foundational knowledge needed to do seed keeping work — and the self-assuredness to share it with others.

"A highlight for me was when I started to see confidence building in some of these folks, and they were really seeing themselves as teachers and mentors and community leaders on this," says White.

Over the course of the growing season, while participating in the group, Williams cultivated her special Odawa seeds — with success. She also developed a network that she deeply values.

"It's been very nurturing and rewarding," says Williams. "I've grown a circle of people around me that has knowledge about how to do these things. And now it's about passing that on."

That network is already yielding good things, including — through a connection with the Seed Savers Exchange — a nonprofit seed bank that houses more than 20,000 heirloom varieties. Some of the group's more advanced gardeners are partnering with Seed Savers to grow indigenous seeds found in the organization's collection. One of these advanced gardeners is **Becky Webster**.

"[The Seed Savers Exchange] people sent me this spreadsheet, and it had its own tab for [Oneida] seeds, and I thought I was going to have a heart attack because it was so exciting," says Webster, who plans to grow the seeds in her extensive garden on the Oneida reservation this year.

"The Oneida people, we were originally from what is now New York State, and we were removed to Wisconsin. Many of the varieties of seeds that we may have carried with us, nobody grows them here anymore [except white corn]," she says. "I'm hoping to be able to pick out certain varieties of seeds and grow them here and then share the seeds with the community."

The project is a good model for participatory engagement between the university and marginalized communities, says White, and she sees the project as a solid foundation on which to build more positive collaborations that benefit tribal communities. Through their participation, members of the seed stewardship group are in a better position to promote and protect the seeds that are such an important part of their culture.

"We are doing our good works now so that we can be a good link in the chain," notes White. "[We are part of] a bigger trajectory — of people carrying these teachings and these seeds down through time."

—Nicole Miller MS'06

LEFT: **Dan Cornelius, an outreach specialist with the UW–Madison Law School and general manager of the Intertribal Agriculture Council's Native Food Network, sifts hardwood ash over boiling corn as part of the nixtamalization process while preparing for a harvest feast at FEED Kitchens.**

RIGHT: **Corn after hardwood ash is added in the nixtamalization process, where the grain is soaked and cooked in an alkaline solution, washed, and hulled to enhance nutrition and flavor and make it easier to grind.**

A Mining History Charted in Soil

New digital maps show potential for lead and zinc contamination in Wisconsin's Driftless Area

Long ago, lead and zinc mining were a way of life for the people of Southwest Wisconsin. But the industries left their imprint in the region's soils — an issue today's residents must contend with.

Lead mining began in the state's Driftless Area in the 1820s and quickly grew. In the second half of the century, the focus shifted to zinc, which is a less harmful metal but one that also contains lead in its ore. Mining of both metals left behind a toxic legacy. To help identify areas of possible contamination, a team from the Department of Soil Science has developed maps showing the aftermath of lead and zinc mining in the region.

The *Digital Atlas of Historic Mining Features in Southwestern Wisconsin* builds on digitized information about mine shafts, open-pit mines, smelters, abandoned rail lines, and other features from the 150-year history of lead and zinc mining in Green, Lafayette, Grant, and Iowa Counties.

The atlas only shows areas where contamination may be found, not the results of any soil tests for either metal. But just knowing where toxins could still be lurking is vital, says **Geoffrey Siemering**, a soil science researcher who led the project.

"The health effects of lead, especially for children, are largely irreversible," he says. "Preventing exposure is the best defense, and although this is not great news for parts of the affected counties, we feel it's essential to get the information out so people and communities can plan in order to minimize health risks."

In addition to the four Wisconsin counties, the atlas refers to adjacent portions of Iowa and Illinois and a small area in southwest Dane County. According to the atlas, "From 1830 to 1871, the mining district was by far the most important lead producing area in the United States." By the time mining for lead and zinc ceased in 1979, an estimated 600 million tons of ore had been extracted, leaving behind more than 2,000 mining and processing sites.

Lead is highly toxic to the human nervous system, kidneys, and other systems. So, as Flint, Michigan; Milwaukee; and other cities grapple with the health impact of lead water pipes and lead paint, lead contamination in the soil also needs to be considered, says soil science professor **Doug Soldat** BS'01, MS'03. Although not involved in the atlas project, Soldat has developed inexpensive lead-testing methods for urban gardeners.

The atlas is compiled from mining company records of where lead and zinc were prospected, mined, extracted, and smelted. As mines closed, their records were consolidated at the remaining mines. Eventually, six cargo vans hauled records to the Wisconsin Geologic and Natural History Survey, which digitized the Wisconsin data.

Former environmental studies graduate student **Kyle Pepp**, working with soil science professor **Stephen Ventura**, processed these records to start the new atlas.

Siemering, an expert in soil contamination, says the maps show an unfortunate overlap of lead and people. Early settlements revolved around lead mining, so people gravitated toward lead mines in Potosi, Shullsburg, Platteville, and many other population centers.

After ore was removed from near the surface, as is the case with lead, or from deeper underground mines, where zinc is found, it was concentrated by using water to separate the heavier, metal-bearing minerals. An estimated 70% of the original material removed from the mines was usually dumped in piles

ROOM UPGRADE

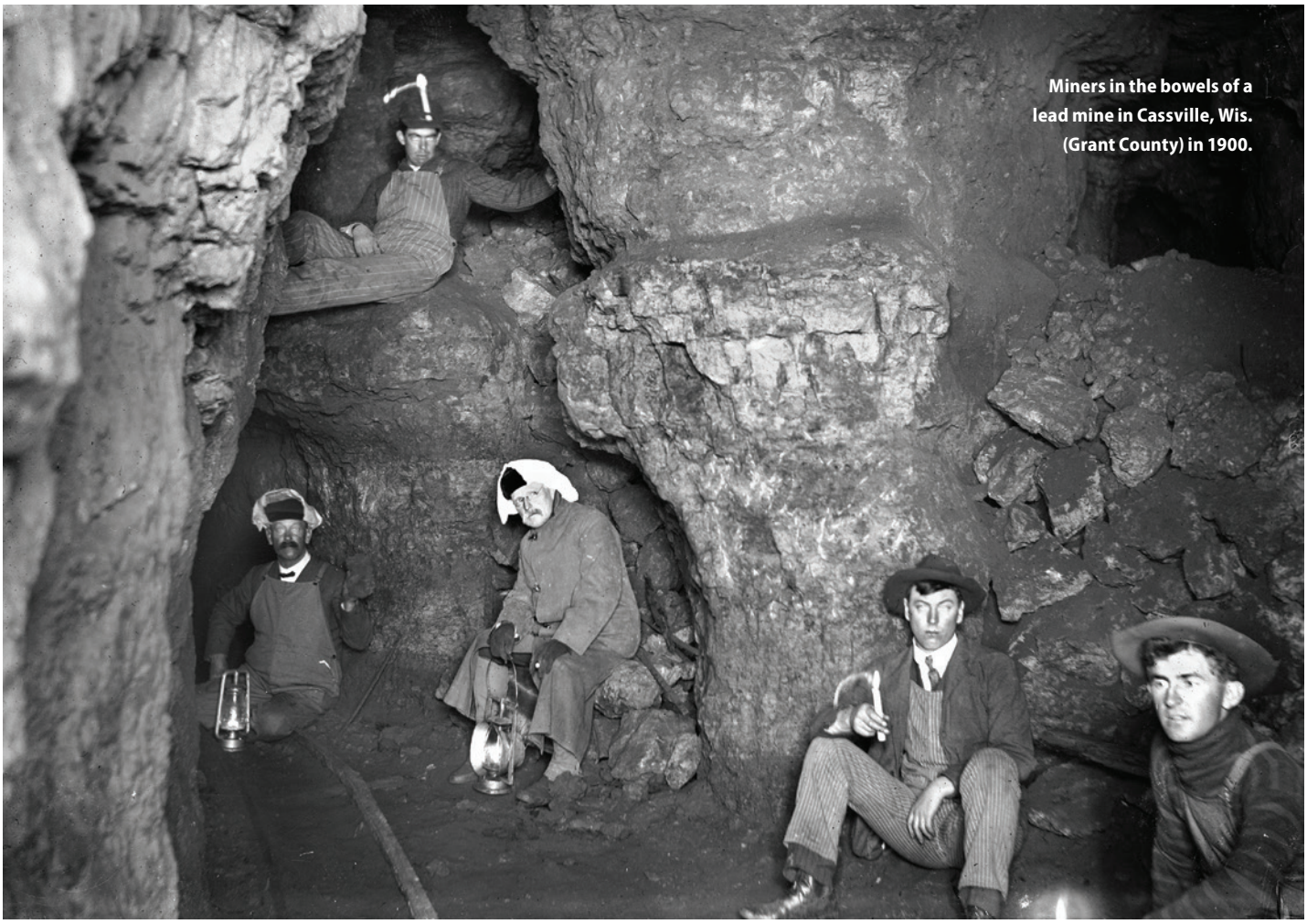
FARM & INDUSTRY SHORT COURSE

Starting in fall 2020, students in the Farm and Industry Short Course (FISC) program will enjoy a significantly enhanced residential experience. Through a new partnership with UW Conference Centers, FISC students will reside in UW's Lowell Center, a professional education hospitality facility.

Lowell Center is located near the heart of campus, close to Memorial Union and the free campus bus. Rooms feature professional furnishings and modern amenities. Students will be housed on designated short course floors with on-site support from FISC house fellows and staff as well as access to a dedicated student lounge, providing support and community building.

The current FISC dorms — Humphrey Hall and Jorns Hall — will be updated and renovated by UW Housing as undergraduate residence halls.

First offered in 1886, FISC was designed to train farmers outside the growing season. It has provided training for thousands of agricultural professionals.



Miners in the bowels of a lead mine in Cassville, Wis. (Grant County) in 1900.

Image courtesy of Wisconsin Historical Society, WHS-8991

near the mine sites. Although not containing enough metal to be worth further processing, the ore waste, called tailings, still contains both lead and zinc at environmentally hazardous levels.

Later, rain and runoff carried lead and zinc from tailing sites to local wetlands, streams, and rivers. Today, the federal government lists six lead- and five zinc-impaired waterways in Southwest Wisconsin.

A second source of concern is the reuse of mine waste rock. "Photos from the 1920s show huge piles of rock that we don't see now," Siemering says. "Where did they go? No one hauls rock without a purpose, and these piles were ready sources of material for roadbeds and foundations."

Because the maps were based on mining records rather than on-site measurements, soil tests would be required to determine actual lead levels, Siemering says. In theory, removing the contaminated soil could solve the problem, but hauling it to an approved hazardous waste dump can cost $100,000 per acre. In 1994, an engineer at the Wisconsin Department of Natural Resources estimated that a three-story pile of mine tailings in New Diggings, Wisconsin, could be cleaned up — for $700,000.

Capping contaminated soil with clean soil may be somewhat less costly, and it can work if done correctly and monitored regularly. And there are other options for reducing human exposure to lead in the soil, says Soldat.

"Scientific understanding of the environmental, health, and chemical situation can point to lead-abatement tactics that are safer, healthier, and more affordable," he says. "So we are focused on finding realistic, affordable ways to reduce the hazard without bankrupting landowners."

One tactic entails vigilance for signs of contamination. Farmers in Southwest Wisconsin have noticed yellowed, stunted crops — often a sign of zinc poisoning. Siemering says they can avoid plowing these areas and plant them with permanent cover, such as prairie plants, to minimize erosion.

In addition, future residential developers can use the atlas to avoid areas that are likely to have high lead concentrations in the soil. And for homeowners, Siemering wrote a UW–Madison Division of Extension report, *Managing Mine-scarred Lands in Southwestern Wisconsin*, that offers practical steps for minimizing exposure.

—David Tenenbaum

The *Digital Atlas of Historic Mining Features in Southwestern Wisconsin* can be found online at **go.wisc.edu/mining-atlas**.

GROW ONLINE EXTRA

For an expanded version of this article, with a brief history of mining in Wisconsin, visit grow.cals.wisc.edu.

classAct

Vy Luong
Rebuild, Adapt, Learn: An Immigrant's Path to CALS

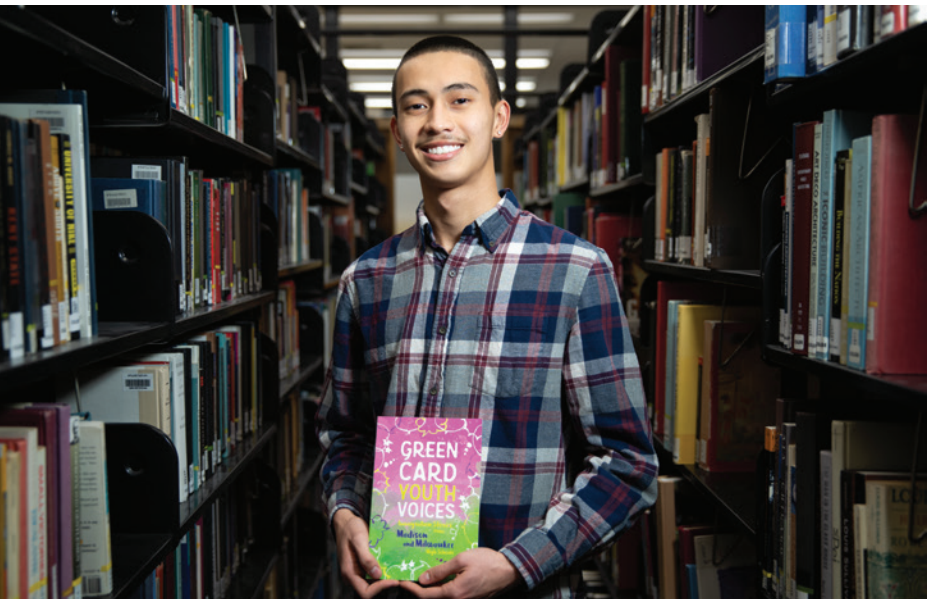


Photo by Michael P. King

'Vỹ Lương', a freshman biochemistry major, photographed at UW–Madison's College Library with the book *Green Card Youth Voices: Immigration Stories from Madison and Milwaukee High Schools*, which contains his story.

Vỹ Lương's journey to Wisconsin from Tiền Giang province in Vietnam began with a major detour. It was the first of many challenges he faced as an immigrant. But today, many years and obstacles later, the way is clear for this CALS freshman.

Lương' spent much of his youth in Châu Thành district, a poor, rural area south of Hồ Chí Minh City where he shared a ramshackle house with his mother, younger brother, grandmother, and a few cousins. His mother earned the family's only source of income. They lived on a daily diet of rice and potatoes and didn't even have the luxury of an indoor toilet.

In 2012, when Lương' was in sixth grade, his mother decided it was time to pursue a better life for her children. She also wanted to reunite with her father, an American soldier who served in the Vietnam War and afterward settled in Madison, Wisconsin. Lương', 12 years old at the time, only truly understood what he would be leaving behind when the journey began in earnest.

"I realized that I would have to rebuild my reputation and rebuild a community and learn how to adapt, learn the language, and really start over and kind of make my own path to be successful," says Lương'. "That was really hard."

Then the Lương's' flight to Los Angeles was forced to make an emergency landing in Alaska. With anxiety riding high and the language barrier ratcheting up the tension, it was an inauspicious start to their voyage. And the language barrier continued to stand in the way for Lương' when he and his mother, grandmother, and brother arrived at their new home in Madison.

"From middle school to the first two years of high school, it was pretty tough," says Lương'. "The process was long and tiring for me."

Bullies targeted him for the way he spoke and presented himself. He found it difficult to learn. Lương' began sitting in the back of his classes to observe and hear as much as he could. He soon gained a steady command of English, which he credits to constant immersion in the language. From there, his prospects quickly climbed.

In his junior year of high school, a personal essay by Lương' was published in a book titled *Green Card Youth Voices: Immigrant Stories from Madison and Milwaukee High Schools*. The next year, before graduating with high honors, he was accepted at UW–Madison, where he's majoring in biochemistry. Lương' plans to become a family physician. He says he was inspired by his family's first American doctor, **Rebecca Tharaud**.

At the time a physician with Access Community Health Centers, Tharaud assisted the Lương's with vital practical matters, from enrolling in a health insurance program to navigating the school system. She has since moved to a new practice in Massachusetts, but she remembers the Lương' family well — especially how, in the space of eight months, Lương' went from speaking almost no English to holding easy conversations with her.

"It was really amazing how quickly Vy adapted to a new environment, and I know he must have worked very hard to learn English as quickly as he did," says Tharaud. "I am thrilled to hear he is interested in becoming a family doctor, and I understand why. Vy is a hardworking and intelligent young man with a generous spirit and a love of family."

Lương' hopes to draw on this spirit in his future career. "I want to not only provide medical care; I want to connect with families," Lương' says. "[Dr. Tharaud] got us connected with the people that we needed. I want to be able to do that for other families in the future."

—Nik Hawkins

MEXICO

Electrospinning Turns Tequila Byproduct into Water Filter

Think of it as an environmental hangover.

Tequila production in the Mexican state of Jalisco yields vast quantities of agave bagasse biomass, which poses serious disposal problems. Most of this fibrous byproduct — which accounted for an estimated 40% of the 1,600 tons of agave processed in 2018 — ends up in clandestine dumps that contaminate the soil and degrade the fertility of surrounding farmland.

One potential solution is to put the waste to work. Researchers in the Department of Biological Systems Engineering have developed a novel application for the leftover biomass: They've transformed its fibers into highly effective water filtration membranes using cutting-edge nanotechnology.

The project built on groundwork laid by **Belkis Sulbarán-Rangel**, a professor at the University of Guadalajara. She had already extracted cellulose fibers from the agave bagasse biomass to create filter paper, but the paper disintegrated easily in water. While attending a conference on the UW–Madison campus, Sulbarán-Rangel consulted with members of the Gunasekaran Laboratory of Biosensing and Nanotechnology. "We suggested that electrospinning would prove a much finer way to compose the filter," says **Sundaram Gunasekaran**, professor and director of CALS Global, the college's hub for international activities.

Electrospinning runs a charged polymer solution through a spinner under a high-voltage electric field. The solution coagulates to create ultrafine nanofiber filaments, which can be woven into a membrane. "The 3D structure of nanofibers generates a higher surface area, so you're able to absorb a lot more particles than a regular sheet of paper would," explains **Hilary Urena-Saborio** MS'19, a former graduate student in the Gunasekaran Lab.

The challenge for the agave project was to find just the right blend of polymers and agave cellulose nanofibers that, once formed into membranes, could not only withstand the forces of flowing water but also retain the highest percentage of contaminants.

Urena-Saborio and **Hasbleidy Palacios Hinestroza**, a visiting graduate student from the University of Guadalajara, zeroed in on three blends of cellulose nanofibers (CNF) and a biodegradable polymer known as polycaprolactone (PCL). They evaluated the blends — containing 20%, 40%, and 50% CNF, respectively — for viscosity (degree of stickiness), conductivity (how well it carries a charge), turbidity (clarity of water), and contaminant retention.

Clockwise from top left: Fifteen pounds of these agave piñas (hearts) produce one liter of tequila. A waste pile of agave bagasse after the piñas are crushed to release the juice for tequila production. A membrane made from agave cellulose nanofibers. A vial of unfiltered tap water stands next to a vial of water filtered through a membrane made from agave cellulose nanofibers and a biodegradable polymer.

Photos courtesy of Hilary Urena-Saborio

In the end, the 50-50 blend performed the best. It retained 75% of iron and 99% of chromium pollutants and left the water samples completely clear.

"The results show that CNF is a useful biowaste from tequila production that's suitable as an eco-friendly filtration system for water purification," says Urena-Saborio.

The membranes, which are 3 centimeters in diameter, would need to be scaled up individually or assembled into a matrix to be marketable. With this in mind, Gunasekaran sees commercial and environmental promise in their results.

"If this could establish a new market for the agave bagasse biomass, the growers would not dump it in the way they are now," he says. "You'd immediately cut down on its pollution of waterways and other places."

—Kristin Baird Rattini

The Soil Doctor Is In

Jingyi Huang uses soil sensing technologies to help farmers better understand their fields, conserve resources, and increase productivity

Interview by Nicole Miller MS'06

For **Jingyi Huang**, it all started with a pair of orange hula hoops. At least, that's what they looked like to him when he was searching online for potential graduate programs and stumbled on a photo. It depicted researchers from the University of New South Wales in Sydney, Australia, using the hoops — part of an instrument called Geonics EM34 — to survey an agricultural field. Huang started reading about how the device uses electromagnetic (EM) induction to assess soil. He was fascinated.

"Using the instrument, you can actually see through the soil, see what is underneath your foot without digging any holes," says Huang. "I find this really interesting."

Huang's fascination propelled him to Sydney, where he earned a master's degree and Ph.D. During his graduate training, and later his postdoctoral position, he honed his skills with the EM34 and other soil-sensing technologies.

Now, as an assistant professor of soil science in CALS, Huang continues to focus his research on the use of soil-sensing technologies — including ground-based proximal sensing and remote sensing — to study soil processes at various spatial and temporal scales. His goal is to develop models that make sense of the data and help with efforts to monitor, map, manage, and conserve soil and water resources in Wisconsin and across the country.

At the national level, Huang has created a model that predicts soil moisture levels throughout the entire U.S. and can inform drought monitoring efforts. At the state level, one of his models estimates soil carbon stocks across Wisconsin at various points from 1850 to 2002. For some of his projects, Huang works directly with the state's farmers. This includes helping a farmer in Rock County assess a field with drainage problems and a "smart irrigation" management project in the Central Sands region, the state's so-called vegetable basket.

HOW DOES THE GEONICS EM34 INSTRUMENT WORK?

It's like if someone gets sick and went to the hospital to get some image scanning — for example, an MRI scan. They use different instruments to visualize what is going on inside a human's brain and body. And similarly, this kind of instrument can be used to understand what is inside of soil.

IT SOUNDS A BIT LIKE YOU'RE TAKING MEDICAL TECHNOLOGIES AND APPLYING THEM TO SOIL.

It's not exactly like MRI, but it has similar principles. They work in different frequency domains of EM waves, but they can both penetrate into objects.

So, from this instrument, you get an image, just like the imaging scan of your body. But you need to do a lot of complex numeric models to interpret this data. Properties that can be measured from this instrument include soil moisture, the salts in the soil, and different [types and quantities] of soil minerals, like clay particles.

Most of the time I say I'm a soil scientist. But sometimes, when I'm trying to explain what I do, I call myself a soil doctor.

CAN YOU TELL US ABOUT A PROJECT WHERE YOU'RE USING THIS KIND OF INSTRUMENT?

We have a new project in Janesville, Wisconsin. They have a roughly 80-hectare [just under 200 acres] field where they use irrigation, but the problem is the high variability of the soil. Of course, you have to manage each soil type differently.

The farmers gave me their corn yield map for last year. A lot of areas have really low yield, and we're trying to help them better understand the yield variation using soil science knowledge.

We use some of the proximal sensing instruments, like what I used for my Ph.D. We just drive the tractor with the instrument behind it, and we do many transects of the whole field to survey the soil. Now, as I said before, this sensor can capture the soil clay particles, soil water, and soil salts. We also go to the field and collect some soil samples. As a doctor, you have to do diagnostics of the farm, the soils, to know what is happening.

With the help of the sensor, we're trying to understand the variation of the soil and to make maps for the different soil properties. Eventually, we will try to use these maps to understand the yield variation. The aim is coming up with better management zones for the farmers so they can apply different management practices based on the soil types.

WHAT ARE YOU WORKING ON IN THE CENTRAL SANDS?

In central Wisconsin, if you are having a dry year, there is water stress for the region. So that's why there has been a lot of investment in the irrigation infrastructure in the region in recent decades, and some of the farmers are taking the initiative to use some newer soil-sensing technologies to help schedule the irrigation.

At the farms I visited they use irrigation systems, center pivot systems, but they also install a lot of soil moisture sensors. They want to maximize water use efficiency and only irrigate when the soil and crops need the water.

But it's cost-prohibitive for farmers to [install soil moisture sensors] at farm-scale. The farmers can only install, in this case, about 10 sensors for 10 of their fields. For the remaining 40 or so fields, they have to rely on their own experience to say, "If I think the soil is too dry, I start irrigating. If I think it is OK, then I stop irrigating." So that's a limitation for the data-driven application of irrigation.

HOW DOES YOUR PROJECT HELP?

I used the three years of soil moisture data they collected and coupled it with remote sensing data. Then I built a model to predict soil moisture at a resolution where every pixel on the map is 100 square feet. So, with the model, instead of one point of data [from a soil moisture sensor] for a given field, you're going to have a lot of 100-square-feet pixels showing soil moisture variations across the entire field.

Basically, now you have these high-resolution maps every six days during the growing seasons that tell you the soil moisture status across the whole Central Sands area. All the farmers can share this information and potentially use these maps to help guide irrigation. Now we are improving this model.

WHAT KIND OF IMPROVEMENTS ARE YOU MAKING?

We are applying for some grants to improve this model because it has limitations. It only tells you moisture every six days during the growing season, but in the hot summer, farmers have to irrigate every second day. We're trying to shorten the model's interval. Hopefully, in the next few years, we'll have a better version, and we can work with farmers to test it in the field.

WHAT HAS IT BEEN LIKE WORKING CLOSELY WITH FARMERS?

It's really amazing when I talk with these farmers. Some are really proactive about innovation, and they are taking the latest technology from the industry to improve their agriculture management. I feel like they really pay a lot of attention to the local community, that they want to protect their environment, protect their water resources, reduce leaching, reduce contamination, and of course, at the same time, maintain their yield, maintain their profitability. I hope the research conducted from my lab and other researchers' labs at UW can help them achieve these goals.

Jingyi Huang

Photo by Michael P. King

BY JILL SAKAI • PHOTOS BY CHELSEA MAMOTT

THESE INSECTS HELP US. HOW CAN WE HELP THEM?

For pollinators and pest-eaters in the patchwork habitats of Wisconsin, the answers may lie in land restoration and management

It's a common late summer sight in south-central Wisconsin: a prairie in bloom, with tall, waving grasses peppered with bursts of yellow, purple, and white. But turn around, and you might be greeted with another everyday Wisconsin view: a green sea of cornstalks undulating in the breeze or a low field of soy stretching to a distant wooded horizon.

With roughly one-third of its land area devoted to farming, Wisconsin is unquestionably an agricultural state. But most of that farmland exists within a patchwork of other land covers — woodlands, prairies, waterways, and urban spaces.

From a bug's-eye view, the distinct terrains offer different types and amounts of food, habitat, and other resources. What's more, those resources vary across time as well as space, as plants sprout, leaf out, bloom, and attract pests at different times during the growing season.

Entomology professor **Claudio Gratton** studies how the ecology of these mixed agricultural landscapes supports insects that provide the useful services of pollination and pest control, including several species of bees and lady beetles. Previous research in his lab helped inform Wisconsin's 2015 Pollinator Protection Plan, which identified best practices for supporting pollinating insects on farms, prairies, roadsides, and elsewhere.

But the state's agricultural landscapes are constantly shifting. Farm fields may be taken out of crop production as incomes drop or as family lands are passed down to generations no longer interested in working the land. Other land may be used to grow different types of crops, including dedicated bioenergy feedstocks such as switchgrass.

Researchers in Gratton's group, part of UW–Madison's Wisconsin Energy Institute, are working to understand how and where beneficial insects fit within the mix of agricultural and natural landscapes in the state. One goal, he says, is to understand how management decisions made on those lands affect insect populations. Another is to take a step back and look at the surrounding areas to begin to learn how the proximity of other types of land cover affects ecological outcomes.

"We might be able to learn something from our natural landscapes to then create managed landscapes that provide those same needs," Gratton says.

Entomology graduate student Jade Kochanski uses a net to collect bumble bees, which she releases after recording their species and sex.

BUMBLE BEES THRIVE IN RESTORED LANDS

Looking out from a rocky ridge outside Black Earth, Wisconsin, the diversity of the landscape is clearly visible. A narrow finger of remnant prairie meanders along the top of the ridge and slopes down to agricultural land on both sides — a corn field on one flank, a small vegetable plot on the other. Beyond the prairie lies a wooded hillside.

Jade Kochanski, an entomology graduate student in Gratton's lab, is here to look for bumble bees. The land, a state natural area called Black Earth Rettenmund Prairie, is one of about three dozen properties she has visited during the past two years for a project in partnership with the Natural Resources Conservation Service (NRCS), an agency of the U.S. Department of Agriculture. Most of the sites are privately owned former farmlands that are now enrolled in a NRCS conservation easement program aimed at restoring and protecting natural landscapes. When a landowner no longer wants to farm a piece of land, NRCS might purchase the property and restore wetlands or prairies.

The program has long focused on providing high-quality wildlife habitat, especially for game animals. But another goal, Kochanski says, "is to conserve natural resources to make our farming systems more productive. As we know, pollinators are really important for our food system. And so the NRCS has taken an interest in how these pieces of land can be used to help our pollinators."

The NRCS approached Gratton and UW–Madison botany professor **Ellen Damschen** to study easement restoration and management practices and assess how well they support pollinators. Kochanski and one of Damschen's graduate students, **Stephanie McFarlane**, visited 32 of the more than 700 Wisconsin properties enrolled in the easement program to compare the effects of different management practices, such as reseeding and controlled burning, on flowering vegetation and bumble bees. They are also comparing the restored lands with high-quality remnant prairies.

Black Earth Rettenmund Prairie is one of these remnants; and at this site, as with the others she visited in the past two summers, Kochanski followed the same steps to gather the data she needs. She walked a transect with a mesh net, catching bumble bees and recording their species and sex before releasing them, and she marked out vegetation sampling plots and tallied all the flowers. Good bee habitat should always have something blooming, she notes, so she visited each site three times to track food availability over the course of the growing season.

She is now comparing her measurements of bumble bee abundance and diversity across the sites to better understand how restoration and management practices affect bee communities. Her preliminary analyses suggest that restoration in Wisconsin is good for bumble bees. "We're seeing increased abundance and diversity at restored sites compared to nonrestored sites," Kochanski says. What's more, she adds, bee communities in the restored easements appear similar to those found in the remnant prairies they visited — an encouraging result for the NRCS's efforts to restore natural ecosystems.

Photo by Michael P. King

Professor of entomology Claudio Gratton displays shadow boxes containing bee specimens in his Wisconsin Energy Institute lab at UW–Madison.

The specific types of management practices used in restoration seem to matter less for bumble bee health than simply whether a site was restored with native seeds. But the composition of the surrounding landscape may make a difference, Kochanski says. She's still digging into her data, but she expects that having more natural habitat nearby may be more important for bees living in unrestored former fields, where high-quality habitat and food may be harder to come by.

If that holds true, it could help identify potential new easement sites that might be more likely to become successful restorations. "We're hoping at the end of the study we'll be able to give NRCS some management recommendations," she says.

DIVERSE LANDSCAPES KEEP APHID-EATERS WELL FED

Landscape context is likely to be important for other flying insects as well. **Ben Iuliano**, a graduate student in agroecology and integrative biology, is studying lady beetles, which are important predators in many Wisconsin ecosystems. They feast on soft insects, such as aphids, mites, and scale insects, many of which are plant pests. In Wisconsin, lady beetles are an important control agent of the soybean aphid, Iuliano says. He and his team of field assistants spent the summer of 2019 visiting fields, forests, and prairies to survey lady beetle numbers and potential food sources in different types of mixed natural and agricultural landscapes.

"We have 17 different landscapes across the southern part of the state that vary in their composition of different land covers. Some have a lot of corn, some have very little agriculture," he says. "What we're interested in is how landscapes with different compositions of different types of habitat are differentially supporting ladybug populations over the course of a growing season."

Past work shows that landscapes with more diverse vegetation host larger predatory insect populations, Iuliano says. He wants to know why.

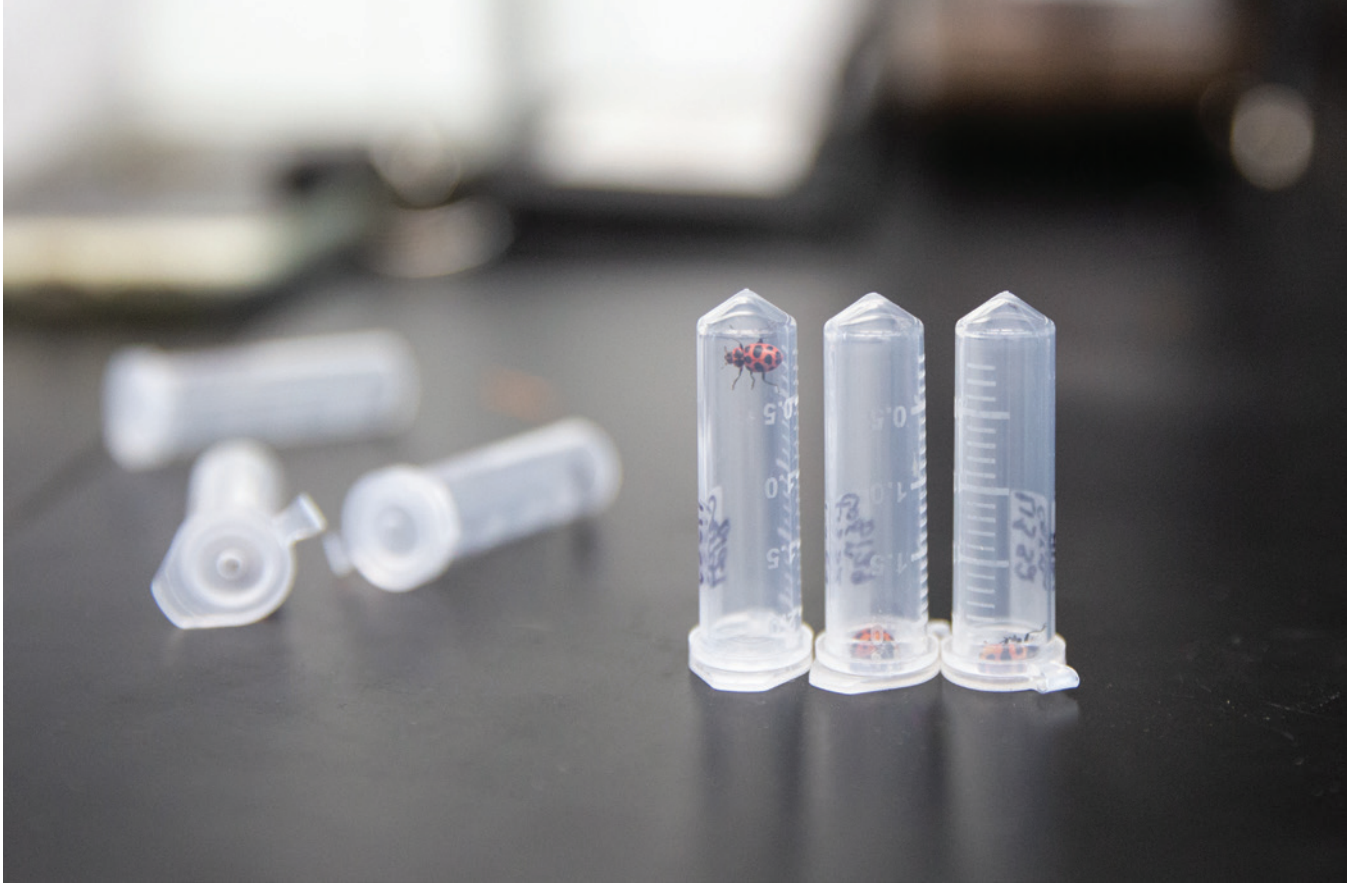
Much of that difference may have to do with food. The small, soft-bodied insects that comprise most of a lady beetle's diet prefer tender plant growth that they can pierce with their sucking mouth parts. Often that means new shoots and leaves, which predominate early in the plant's growing cycle. As plants mature, they may support fewer sap-suckers, which in turn means less food for lady beetles. So a traditional monoculture field such as soybeans might offer a rich source of food — but for only a short time during the growing season.

"Having food that's continuous in a landscape could be just as important as having lots of food at a particular point in time," Gratton says. "If there's nothing around in April and May, maybe that's not a very good landscape, regardless of what happens in July."

This concept of food continuity is well known for pollinators like Kochanski's bumble bees, which might need access to multiple flowering species to have pollen and nectar available throughout the growing season. Gratton thinks it is likely just as important for predatory species. With pest-eating critters, though, he notes that the focus tends to be more on getting rid of the prey than on ensuring that the predator has enough to eat.

For these reasons, Iuliano is looking for both predator and prey.

At each of the 17 sites, his team designated 10 sampling locations that span multiple types of terrain. In each location, the researchers installed two posts with sticky yellow cards to attract and trap flying insects. Every few weeks, they replaced the cards and counted the stuck critters to estimate what was using that landscape and the relative populations in that habitat. On each field visit, the crew also sampled more actively with large canvas sweep nets, scanning their catch for both lady



Graduate student Ben Iuliano's lady beetles crawl around in sample vials in Gratton's lab at the Wisconsin Energy Institute.

beetles and anything small and soft-bodied that the beetles might eat.

They tallied the prey, loaded each lady beetle into a tube, labeled it with the date and location it was caught, and brought it back to the lab for further analysis.

In a previous study, members of Gratton's group collected lady beetles in landscapes that were dominated by different amounts of corn; then they weighed the insects and measured their body fat composition as an indicator of the abundance of food resources. "We found that lady beetles that were collected in these high-corn landscapes tended to be the leanest ones," Gratton says. "They hadn't accumulated the amount of fat reserves that the ones that came from these more diverse landscapes had."

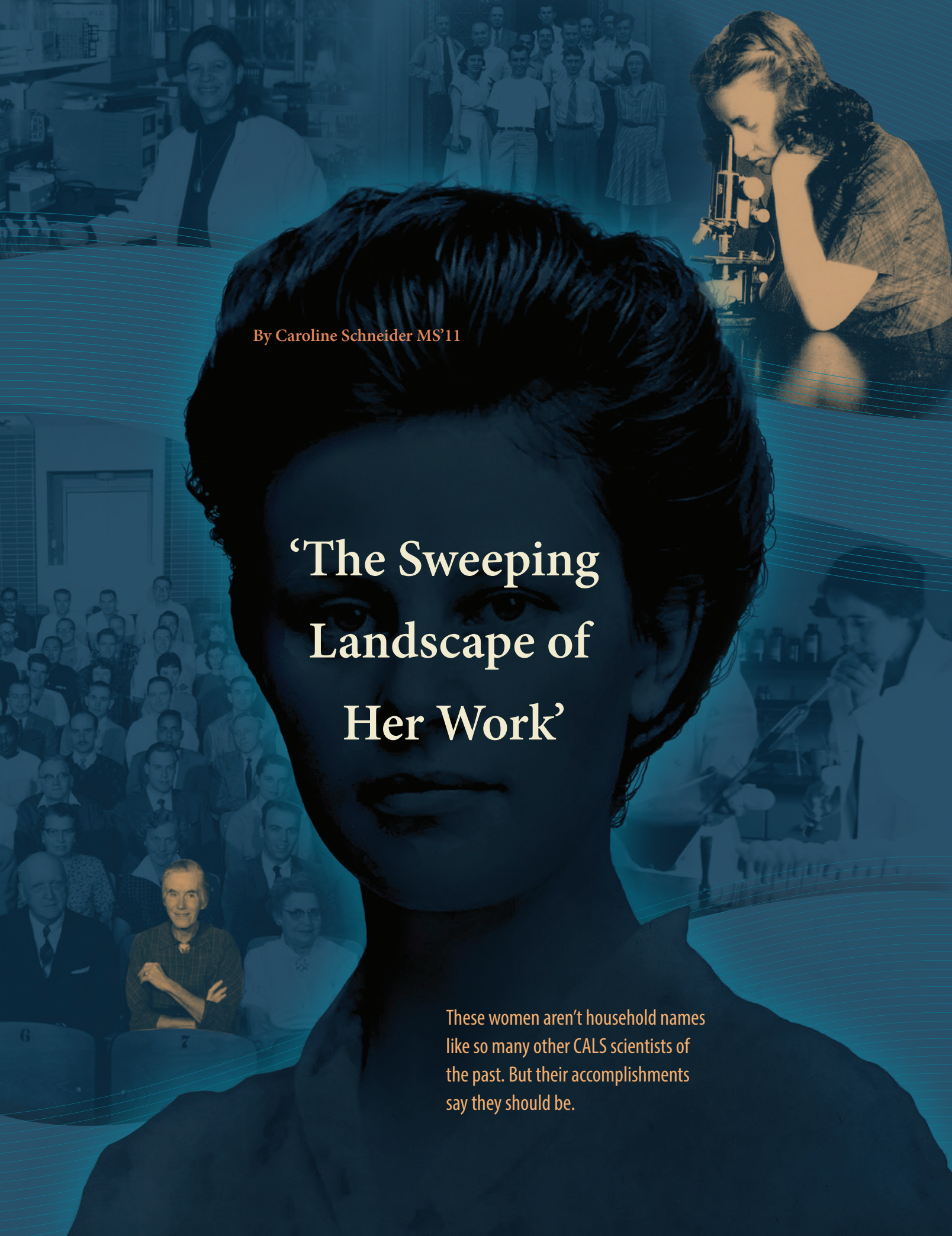
> "Having food that's continuous in a landscape could be just as important as having lots of food at a particular point in time. If there's nothing around in April and May, maybe that's not a very good landscape, regardless of what happens in July."

Iuliano is conducting similar analyses with the lady beetles that were collected in the different landscapes last summer. He's also taking it a step further to see exactly what the predators ate by studying the contents of their guts with DNA sequencing. Now he's looking at whether the beetles captured in more diverse landscapes are larger and fatter and whether they have eaten a more diverse diet than the insects captured in corn- and soy-dominated landscapes.

"Landscapes that are more diverse may have more of those early-season resources that may enable populations to persist or grow larger," Iuliano says. "We're using the DNA as a way to mechanistically link that landscape diversity with potential benefits for the predators."

Some of Gratton's previous work through the Great Lakes Bioenergy Research Center led to a web-based decision support tool called SmartScape, which shows how land-use decisions affect ecosystem outcomes, such as phosphorus runoff, soil quality, and pollinator habitat.

Iuliano hopes his results will similarly help inform land-use and farming decisions. "This is sort of the raw data that goes into a tool like that to help decide what we want our landscapes to look like" to support natural pest control, he says. For a farmer, for example, "maybe you conserve some of those patches of natural area or plant different crops, and maybe you can't plant as much. But if you're not paying for as many pesticides, it may be worth it."



By Caroline Schneider MS'11

'The Sweeping Landscape of Her Work'

These women aren't household names like so many other CALS scientists of the past. But their accomplishments say they should be.

Photo illustrations by Danielle Lamberson Philipp

It took a hard-fought battle, but in 1919, after decades of petitions, demonstrations, and arrests, women finally won the right to vote.

The passage and ratification of the 19th Amendment was one of the signature accomplishments of the first half of the 20th century — an era that would see many more. Women were stepping forward to fight for inherent rights and proper recognition in a rapidly changing society. In 1916, **Jeannette Rankin** of Montana became the first woman elected to the U.S. House of Representatives. **Amelia Earhart** flew solo across the Atlantic Ocean in 1932. In 1950, **Althea Gibson** became the first African American to play at the U.S. National Championships tennis tournament.

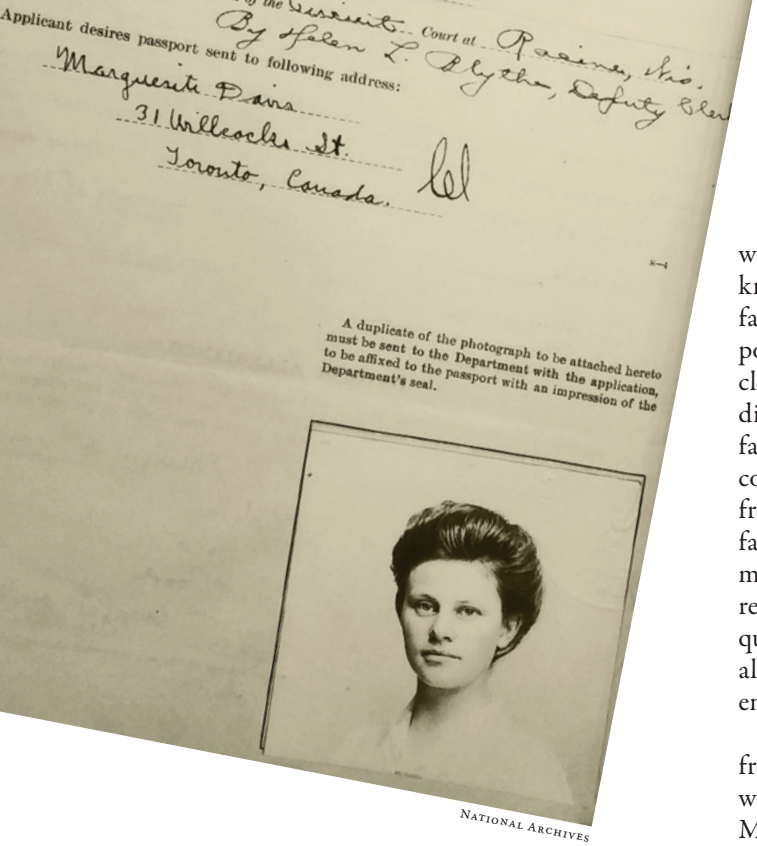
Those years also brought exciting scientific discoveries and innovations — the theory of general relativity, the model of the atom, the production of insulin, the Big Bang theory, and evidence that DNA is genetic material. Most of the advances in science and technology were attributed to men, who dominated the fields at the time. But just as women were making their marks in politics, sports, aviation, and other spheres, they were also pushing to be seen and heard in a scientific world booming with discoveries — many of which did indeed come from the hands and minds of women scientists. But a number of factors in this era made it difficult for women scientists to gain the recognition they deserved, explains **Nicole Nelson**, assistant professor in the UW Department of Medical History and Bioethics.

"Over the course of the 19th century, science transformed from being a pastime pursued mostly by wealthy men into full-time, paid work requiring particular credentials," Nelson says. "Even when women earned Ph.D.s, the job options for women scientists were limited. They were relegated to working in low-status, underpaid positions where they received little credit for their work. Their contributions were made invisible. It took the painstaking work of women historians to bring their stories to light."

The setting for many of these stories is the College of Agricultural and Life Sciences (CALS). Women have been at the forefront of some of the college's greatest advances, from the groundbreaking discovery of vitamins to a revolution in the production of penicillin. These innovations and many others — past and present, at CALS and beyond — resonated throughout the academic world and, more importantly, everyday life. And the women scientists behind them propelled the scientific community and society into a new frontier where the contributions of women are accepted, acknowledged, and appreciated.

Marguerite Davis (foreground), Esther Lederberg (top three photos), and Elizabeth McCoy (bottom two photos) each made pivotal advances in their respective scientific fields. And each one of these women scientists has a remarkable story of persistence and discovery.

Original photos: Esther M. Zimmer Lederberg Memorial Website, University of Wisconsin–Madison Archives, National Archives.



NATIONAL ARCHIVES

Left: A portrait of Marguerite Davis accompanies her passport application in 1915, when she traveled to the University of Toronto for work.

Marguerite Davis and the Discovery of Vitamins

Look at any nutrition label in your pantry or in any supplement aisle at the grocery store, and you'll see vitamins — bottles and bottles of them in pill and capsule form. But these compounds, commonly encountered today, were literal unknowns until **Marguerite Davis** took an unpaid position with biochemist **Elmer McCollum**. In a lab at the University of Wisconsin, the pair identified vitamins A and B and opened the door to decades of vitamin and nutrition research.

Davis was born in 1887 in Racine, Wisconsin. Her grandmother was an early champion of women's rights, and her father was a physician and botanist. Those influences, as well as her interest in science, led her to attend the UW in 1906. In 1908, she transferred to the University of California, Berkeley, where she earned a bachelor's degree two years later.

Davis soon returned to Madison. Her father, who had retired from medicine and moved to the city to work as a botanist, was looking for someone to care for his house. While taking care of the home, Davis looked beyond its walls to satisfy her intellectual curiosity. She found what she was yearning for in McCollum's lab in the Department of Agricultural Chemistry (the Department of Biochemistry today). McCollum requested a salary for Davis annually, but it wasn't granted until her sixth year in the department.

McCollum had been studying nutrition and was using "purified foods" — foods made with known amounts of protein, carbohydrates, and fat — to find optimum amounts of each component for a healthy diet. But it quickly became clear to him from experiments with cows that diet wasn't as simple as just protein, carbs, and fats. Cases of blindness and stunted growth in cows meant something important was missing from the purified foods. After convincing other faculty members of the value of using rats as models, McCollum turned to the rodents for his research. Compared to cows, rats reproduced more quickly and ate much less. The rat experiments also supported the idea that purified diets were not enough. But what was missing?

The answer to that question could only come from time-consuming experiments. Luckily, Davis was looking for this kind of an opportunity, and McCollum brought her on board to feed the rats and take detailed notes of what she observed.

In 1912, Davis and McCollum found that milk-fed rats grew while rats fed olive oil or lard became sick and stunted. Milkfat clearly gave the rats some kind of health benefit. Next, the researchers extracted fat-soluble compounds from milk and added them to the olive oil and lard. As expected, the rats consuming the fortified oil and lard turned out as healthy as the milk-fed rodents.

Davis and McCollum's findings were published in 1913, when listing a woman as co-author on a scientific paper was unusual — an indication of her critical contributions. They went on to call their compounds fat-soluble A. The name set their compounds apart from a different substance, described by another research team, that Davis and McCollum named water-soluble B. These sets of compounds were later renamed vitamins A and B.

To find nutrients in dairy-sourced fat was a feather in the cap for America's Dairyland, but Davis and McCollum felt the same nutrients must also be found in other foods. After all, most animals don't drink milk beyond infancy, but they continue to grow. The team went on to identify leafy greens as a source of the vitamins as well.

Right: Elizabeth McCoy in the bacteriology lab in 1953.

This body of work led to the discovery of other vitamins, the foods that contain them, and their role in human health and nutrition. For example, vitamin C was identified as the compound that could prevent scurvy, and vitamin B was found to be a complex of several different vitamins.

"Not only did Davis receive the acknowledgment from Dr. McCollum as being integral to the vitamin discoveries, she has also been given credit for founding the nutrition laboratories at

UW–Madison," says nutritional sciences professor **Sherry Tanumihardjo**. "These laboratories are still going strong in the Departments of Nutritional Sciences and Biochemistry."

Davis also branched out internationally. A passport application from 1915 shows her seeking to travel to the University of Toronto for work and provides an interesting window into society in the early 1900s. Davis states her occupation as research assistant and describes many of her physical attributes, as required by the form, such as "Forehead: medium" and "Nose: straight." She also struck through several lines at the beginning of the form where the applicant, assumed to be a man, is asked to include the names of his wife and children.

In 1940, after time spent at Rutgers University to develop a lab for its school of pharmacy, Davis retired and moved back to her hometown of Racine. In retirement, she was extremely active in civic affairs, and, in 1958, the Racine Women's Civic Council recognized her for her contributions. Davis died in 1967, three days after turning 80, but her legacy lives on today, not only in every vitamin bottle but also in modern nutrition studies seeking a better understanding of health and wellness.

Elizabeth McCoy and Penicillin for the People

At some point in our lives, many of us have been prescribed penicillin. Perhaps it fought off a childhood ear infection or treated a bout of pneumonia. The drug likely saved us from health complications, and it did so without breaking the bank — thanks to **Elizabeth McCoy** BS'25, MS'26, PhD'29. Her work in bacteriology led to the first common — and cheap — strain of penicillin.

McCoy was born in 1903 in Madison, Wisconsin. Her family owned a farm in the nearby Town of Fitchburg, recognized as the first farm in Dane County to grow tobacco. Her mother, Esther, was a nurse and passed her flair for science on to her daughter. McCoy's love of learning drove her to finish an accelerated secondary education program. Then an early encounter with a pony steered her toward the study of bacteriology.

When McCoy was a child, a family friend and bacteriologist at UW–Madison, **William Dodge Frost**, drove a horse-drawn cart to visit the McCoy family. Upon trying to pet the animal, McCoy was bitten, and her arm became swollen and painful. The family physician, while scraping the wound and applying iodine, explained the details of bacterial infection to her, and her mother went on to

Original photos: University of Wisconsin–Madison Archives, Helena Lopes, Crulina 98 [CC BY-SA (creativecommons.org/licenses/by-sa/3.0)]

Groundbreaking Women Scholars of CALS

Marguerite Davis, Elizabeth McCoy, and Esther Lederberg were all remarkable researchers and women in their own right, but CALS has seen the likes of many exceptional women scholars in its long history. Here is just a sampling of these groundbreaking women, and their accomplishments, from the college's storied past.

University of Wisconsin–Madison Archives

Alice C. Evans, who linked brucellosis to raw cow's and goat's milk, works in the laboratory in 1912.

ALICE C. EVANS MS1910 (pictured above) was the first female recipient of a graduate scholarship in bacteriology at UW–Madison. She earned a master's degree before joining the U.S. Department of Agriculture. She would go on to link brucellosis to raw cow's and goat's milk, which led to widespread mandates for milk pasteurization. Evans was awarded an honorary doctorate from UW in 1936.

MARY V. BUELL PhD1919 was the first woman to earn a Ph.D. from the UW–Madison Department of Biochemistry. She focused on nutrition, physiological chemistry, and medical chemistry in her research and worked at a number of prominent universities. She began the first of two appointments at the Wisconsin Enzyme Institute in 1948 and returned in 1960.

NELLIE ROSE MCCANNON MS'53 joined the agricultural journalism department (now the Department of Life Sciences Communication) in 1953 and served the university for 37 years. She was also president of the Madison Chapter of Women in Communications and created an annual workshop for Wisconsin women editors and reporters.

DOROTHY PRINGLE MS'51, professor emeritus of nutritional studies, was a faculty member from 1953 to 1985. Her research focused on social and economic influences on food habits and nutrition. She was a pioneer for programs in dietetics and public service in nutrition.

MARGARET "GRETEL" DENTINE became the first female dairy science professor at UW in 1985. She was known internationally as an outstanding young geneticist and animal breeder. She served as associate dean for research at CALS and executive director of the Wisconsin Agricultural Experiment Station.

MARY BETH KIRKHAM was the first female graduate student in the Department of Soil Science and earned M.S. and Ph.D. degrees in botany with a minor in soil science. She is now a University Distinguished Professor at Kansas State University. Kirkham is a leading figure in the fields of soil science and agronomy and received the CALS Distinguished Alumni Award in 2017.

teach her about bacteria in health and in the home.

These experiences led McCoy to study bacteriology at UW. In her senior year, she met bacteriologist (and future university president) **E. B. Fred**, who hired her as a research associate. McCoy took graduate courses before finishing her undergraduate degree in 1925 and went on to earn both a master's and doctorate under Fred's mentorship in 1926 and 1929, respectively. She joined the faculty after completing her Ph.D., and, in 1943, she became the second woman at UW, outside of home economics and nursing, to become a full professor.

As a researcher, McCoy pursued a number of interests. She became an expert on lake ecosystems and the bacteria living in them. She spent several summers at the Trout Lake Station in northern Wisconsin and later directed the bacteriology lab there. This field of research continues today at the university on the shores of Lake Mendota, often called the most studied lake in the United States. "I feel humbled and fortunate to be following in her footsteps in the Department of Bacteriology, studying the diverse microbes living in Lake Mendota and other Wisconsin lakes," says **Trina McMahon**, a professor of bacteriology and civil and environmental engineering who specializes in aquatic microbial ecology.

McCoy also studied a bacterium capable of producing butyl alcohol. In 1946, she secured a patent on the process used to ferment molasses into the alcohol, and she later traveled to Puerto Rico to help establish a fermentation plant there.

One of McCoy's most important findings came a few years earlier, during World War II. When penicillin was discovered in 1928, it was expensive and difficult to procure. During the war, the U.S. government made an effort to find new strains and mutants of the mold that produces penicillin and improve the ways in which the mold was grown. Researchers found a promising strain called NRRL-1951 on a moldy cantaloupe in Illinois, and they produced mutants by hitting the strain with X-rays.

The mutants were sent to UW for screening, where they ended up under McCoy's microscope.

Following extensive study, McCoy singled out X-1612 as the best mutant for penicillin production. From that mutant, UW botanists created more mutations and eventually isolated Q-176, the most useful strain to come out of the program. That finding, along with improved growing methods, doubled the production of penicillin and lowered costs. The strains produced were given to industry so that as much penicillin as possible could be produced during the war. By the end of the war, the price of the antibiotic was less than 1% of its prewar cost.

In addition to penicillin, McCoy found another antibiotic on her lab bench when she discovered oligomycin in the 1950s. She and a graduate student isolated the compound from a fungus as part of a program to discover new antibiotics. They found that it could kill plant pathogens without hurting other useful bacteria. McCoy went on to collaborate with several colleagues across campus to determine whether oligomycin could be used to treat plant diseases, and the Pfizer company launched its own development program.

The commercial promises of oligomycin never came to fruition, though, as McCoy found that it moved poorly through plants and was harmful to seedlings. The antibiotic is still extensively used in research, however. Oligomycin can block the activity of an enzyme in cells and can be used to study how cells convert energy into fuel for chemical reactions.

"Elizabeth McCoy was a towering figure in microbiology for more than half of the 20th century," says **Jo Handelsman** PhD'84, professor of plant pathology and director of the Wisconsin Institute for Discovery. "The sweeping landscape of her work — from lakes to antibiotic discovery to plant disease — is a testament to her formidable intellect and passion for all things microbiology."

"Elizabeth McCoy was a towering figure in microbiology for more than half of the 20th century. The sweeping landscape of her work — from lakes to antibiotic discovery to plant disease — is a testament to her formidable intellect and passion for all things microbiology."

Fred fully supported and praised McCoy and her work throughout her career. McCoy said she never felt discriminated against by her colleagues. Despite the support she received from others at the university, it remains troubling that McCoy is not as well known as some of the other CALS giants who have become household names.

McCoy retired from the university in 1973 but remained an active researcher, focusing on using bacteria to treat sewage. She passed away just five years after retirement and left her family farm to the Wisconsin Alumni Research Foundation, long-lasting proof of her dedication to the university and scientific pursuits.

Esther Lederberg and the Creation of Model Organisms

If you've taken a college genetics course, there's a good chance you've learned about bacteriophage lambda. The bacterial virus is used extensively in genetic research and has made possible a wide variety of research in bacteriophages — one of the most abundant biological entities on earth. All that knowledge and work is based on a discovery by **Esther Lederberg** PhD'50, a scientist who realized a multitude of breakthroughs in the world of molecular genetics.

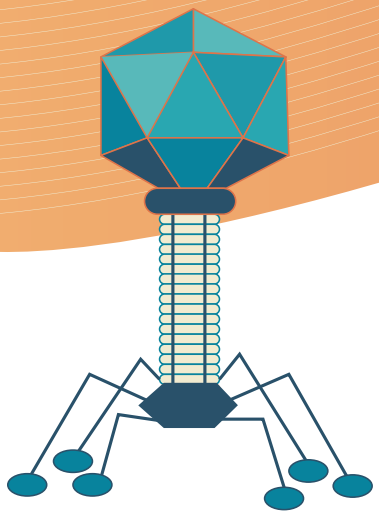
Born Esther Zimmer in 1922 into a poor family in New York City, she worked hard in school and had a strong appetite for learning. After her grandfather tried unsuccessfully to teach Hebrew to her male cousins, Esther asked if he would teach her instead. After being granted the required permission from the male cousins, her grandfather began her lessons. Esther showed an aptitude for languages, putting her in good standing at Hunter College, which she attended on scholarship after graduating from high school at age 16. While she first intended to study French or literature, she soon decided to pursue biochemistry instead. Esther ignored instructors who told her that science was too difficult for women and that it was a field where women couldn't succeed.

After completing her undergraduate degree in 1942, she went on to study genetics at Stanford University, where she pursued a master's degree. She had been awarded a fellowship for her studies, but she found it wasn't enough to live on. She worked as a teaching assistant or would earn free housing by doing her landlady's laundry. At times, money was so tight that she would even eat the frog legs used for dissections in the lab.

While at Stanford, Esther met **Joshua Lederberg**. They married in 1945 and moved to Madison, Wisconsin. At UW, Esther earned her doctoral degree under **R. A. Brink**, and she and Joshua formed a strong partnership in the lab. Joshua became known for his grand ideas, and Esther became an expert in all things necessary for careful experimentation. Their work resulted in

Esther M. Zimmer Lederberg Memorial Website

Esther Lederberg in the 1950s.



a number of exciting findings that would become the basis for genetics research. In 1956, the Society of Illinois Bacteriologists presented its Pasteur Award (named for **Louis Pasteur**, renowned for his discovery of the process of pasteurization) to Esther and Joshua in recognition of their contribution to microbiology. Although the award recognized them both, their partnership also meant that much of Esther's research and discoveries remained in the shadows of the continued celebration of Joshua's work.

In 1958, Joshua won the Nobel Prize in Physiology or Medicine for discovering that bacteria can mate and exchange genes instead of always making identical copies of themselves. While Esther made related discoveries as she and Joshua worked together, recognition of her contributions to the research that garnered the Nobel Prize was kept to a short acknowledgment during her husband's speech, in which he said he enjoyed the companionship of many colleagues, above all his wife.

Esther and Joshua, however, did take joint credit for a technique called replica plating, which allowed researchers to move hundreds of colonies of bacteria from one plate to another instead of

moving one cluster at a time, as scientists had been doing. Using this new technique, they were able to show that mutations in bacteria could pop up spontaneously — for example, even when an antibiotic treatment wasn't pushing the bacteria to change to survive.

"Esther's scientific legacy is enormous. Her discovery of bacteriophage lambda set the stage for so much downstream work that you could teach an entire molecular genetics course based on the research conducted using it."

Another finding that falls under Esther's impressive portfolio is bacteriophage lambda. Esther was the first person to isolate the phage, a bacterial virus that can infect *E. coli*. Lambda phage has since been used extensively both as a model organism and as a tool in genetics research.

"Esther's scientific legacy is enormous. Her discovery of bacteriophage lambda set the stage for so much downstream work that you could teach an entire molecular genetics course based on the research conducted using it," says genetics professor **Nicole Perna**. "Many careers of faculty here at UW–Madison and around the world were launched from studies of lambda. Even today, there is cutting-edge research using lambda phage itself. Beyond that, almost everything we know about how bacteriophages work is based on studies of lambda. And lambda is just one of many of Esther's groundbreaking discoveries."

The Lederbergs moved back to Stanford in 1959, when Joshua was asked to lead the genetics department. Esther was offered a position as a research associate and years later transitioned to an adjunct professorship, a job without tenure. From 1976 to 1986, she directed the Plasmid Reference Center at the Stanford School of Medicine.

By 1966, Esther and Joshua were divorced, but Esther stayed on at Stanford until she retired in 1985. In 1989, she met **Matthew Simon**. They shared a love of music, especially the Baroque style, and the two married in 1993. Just 13 years later, Esther passed away at age 83. Since then, Simon has maintained a memorial website to "make available to the scientific community and the public some of the accomplishments of the scientist Esther M. Lederberg."

Although support from male colleagues played a positive role in the careers of some groundbreaking women in science, for many — those mentioned here and others too numerous to list — recognition came too little or too late (and in some cases, both). The expertise and contributions of women scientists were often downplayed to administrative or assistant roles when, in fact, they completed the bulk of the bench work as well as those other duties. As women achieve greater representation on the faculty at research institutions, they are gaining a stronger grip on their place in the research community and claiming their share of the credit deserved for important scientific findings.

"I was fortunate to have strong male mentors during my Ph.D. and postdoctoral work," says Kate VandenBosch, dean of CALS and an accomplished plant biologist. "But women faculty in my programs at that time were few, so I looked to female colleagues elsewhere as supporters. Networks beyond one's home institution are so important, especially when the community of women scholars is small locally. Now, as a female dean, I am glad to be able to support and encourage women faculty in their careers. I look forward to seeing the numbers of women in academic leadership positions grow, just as we have seen the number of women faculty increase."

At UW, the proportion of female faculty members rose from 16% in 1988 to 36% in 2018. Likewise, only 9% of women held the rank of professor in 1988 compared to 30% in 2018. But there is still plenty of room for growth. While female undergraduate students in the college now outnumber male students, the number of women in faculty positions remains far from equal. As more women are hired in the future and find their way into scientific communities, they stand on the shoulders of the women who came before and fought for their place in the lab, literature, science, and society.

"This is an exciting time to be in the scientific community at UW–Madison," says Handelsman. "The increase of women on the faculty has broadened the scientific ideas and approaches and increased the vigor and dynamism of scientific dialogue. Women's discoveries have propelled science forward and diversified everything from lab management to the style of scientific debate. And perhaps most importantly, women faculty are here to support each other and the next generation, stemming the loss of talent from our outstanding community."

In addition to a master's degree in life sciences communication, author Caroline Schneider earned a Ph.D. in cancer biology from UW–Madison in 2010.


RNA

PHOTOS BY MICHAEL P. KING

Biology major and undergraduate researcher Grace Padgett, left, chats with biochemistry professor James Ntambi and fellow undergrad Abbey Stoltenburg while she prepares to genotype mouse DNA samples in Ntambi's lab at UW–Madison.

RESEARCH EARLY, RESEARCH OFTEN — *and Reap the Benefits*

It's a common sight at CALS — undergraduates creating new knowledge in the lab and in the field. And it might just be why they're uncommonly prepared for the future.

CRITICAL THINKING, SOUND JUDGMENT, MENTAL ENDURANCE. EXCEPTIONAL COMMUNICATION AND EFFECTIVE COLLABORATION. These aren't just human resources buzzwords. They're authentic skills and abilities that anyone can weave into their work and everyday life — and be better for it. They're also among the many attributes students gain from exposure to scientific research. This is precisely why CALS has made hands-on research a signature experience for undergraduates.

Among all the schools and colleges at UW–Madison, CALS has one of the highest undergraduate research participation rates. The college's flexible curriculum accommodates research opportunities — whether independent projects under mentored guidance or supervised experiences in labs — that prepare students for a long list of careers and graduate school in many fields.

Senior capstones, another CALS staple, also immerse undergrads in research. Capstone courses require students, solo or in teams, to synthesize the knowledge they've acquired to solve a complex problem or answer a burning question. And for a more focused, deeper dive into scientific work, the CALS Honors Program offers a special research emphasis with added ways to explore a discipline.

Each research experience is unique. Some students co-author peer-reviewed journal articles. Some present findings at academic conferences. Others even develop new products for companies to produce and market. But all undergraduate researchers learn how to formulate good questions, approach problems analytically, and find creative paths to answers and solutions. And they all emerge with singular stories. Here are three.

NOT-SO-BASIC RESEARCH

BY KAINE KORZEKWA MS'16

Grace Padgett, an undergraduate researcher in the James Ntambi Lab, pulls DNA samples from a laboratory refrigerator while preparing for an experiment in the DeLuca Biochemistry Laboratories.

Grace Padgett BSx'20 always thought she would become an engineer. That is, until she completed a pair of high school internships with the National Institutes of Health. Her experiences at one of the world's most prominent medical research centers introduced her to the inspiring realm of biological research. And they showed her what one can accomplish when equipped with a Ph.D. in the field.

Padgett's first step, however, is a bachelor's degree in biology. On her way, she's conducting research on the cellular and molecular mechanisms behind obesity (and the diseases often associated with it) in the lab of biochemistry professor **James Ntambi**. Her CALS lab experience has bolstered her understanding of basic scientific research, which will prove invaluable as Padgett charts a career in the study of medicine and public health.

"I'm interested in obesity and metabolic and cardiovascular disease, and I wanted to get involved in the Ntambi Lab because it's focused on the biochemical mechanisms behind them," Padgett explains. "I knew it would be a great way to gain more knowledge in that field and look at these problems from a different lens, one beyond factors like diet and exercise."

This is Padgett's third year working in the lab. She started with little experience in research but learned laboratory techniques and protocols from graduate students and postdoctoral scholars.

"Doing this kind of independent research really helped me apply what I was learning in my classes," says Padgett. "I was gaining information, but you get a whole new perspective on it when you apply it to a real case in research. Sometimes the opposite happens, too. You perform a protocol in lab and then learn about it in class, and it clicks. They feed off each other."

One of Padgett's projects, under the mentorship of **Sabrina Dumas** PhD'18, a nutritional sciences graduate student at the time, was investigating the effects of a gene called SCD-1 in the skin of mice. A little over a decade ago, researchers in the Ntambi Lab genetically engineered mice that lacked the SCD-1 gene in their DNA, meaning the gene couldn't be expressed as a protein anywhere in the body. Deleting this gene made the mice completely immune to obesity and the many associated diseases induced by high-fat and high-carbohydrate diets.

Following this revelation, the researchers began untangling how it's possible. They started by engineering mice that have a tissue-specific deletion rather than a global absence of the gene. They found that an absence of SCD-1 in the liver protected against illness induced by a high-carbohydrate diet — but not one consisting of high fat. Then they discovered that a gene deletion in the skin actually confers resistance to health issues caused by a high-fat diet.

Ntambi believes that understanding these mechanisms in mice can shed light on possible treatments in humans beyond lifestyle changes such as diet and exercise, which aren't possible for all patients and often don't do enough on their own to curb disease. It's why Padgett took a keen interest in the lab and pursuing undergraduate research.

"My vision for undergraduates is to have them appreciate their research experience by teaching them about the experiments, the reason they are doing them, and how it fits into the research program in the laboratory," Ntambi explains. "It's important for them to be able to articulate their results and how they can interpret them. Working in a lab among other undergraduates, grad students, and postdocs, everyone learns valuable communication skills and how to build relationships with others."

Padgett hopes to attend medical school, and she's also passionate about health in communities with underrepresented populations. Her research experience has solidified in her mind the importance of basic research in developing new treatments and prevention methods that will help her help others.

"Doing this kind of independent research, and meeting many people along the way, has helped me find where my interests lie and to narrow that down to the kind of career I might want to pursue," she says. "It's helped me learn about the many approaches to an issue, be that clinical, through a global or public health perspective, or in laboratory research."

From left, biological systems engineering undergraduates Carolyn Mahn, Eric Western, David Barrett, and Connor O'Brien test a prototype of a novel safety compliance monitoring system they developed at the UW–Madison Agricultural Engineering Lab. The system monitors lighting and visibility features to ensure compliance with federal safety standards.

LIGHTING AS A LIFESAVER

BY MICHAEL P. KING

For drivers of tractors, combines, and other farm implements, the risk of collisions with passenger vehicles may be higher than ever. Operators are working longer nighttime hours on larger, more widespread tracts of land in a tangle of urban sprawl. This means big, slow-moving vehicles are sharing busy public roadways with cars more regularly, and the disparities in speed, size, and visibility cause horrific crashes and hundreds of injuries and deaths every year. Poor lighting or reflectance is often a culprit.

"If you're on a big combine, and you've been out working all day, and you've got to run it from point A to point B, and it's 9 o'clock at night, late October, you may or may not know that you've got a burned-out flasher or a burned-out taillight," says biological systems engineering (BSE) professor **John Shutske**.

The problem calls for a technological solution. Fortunately, Shutske advises four BSE undergrads — seniors **David Barrett**, **Carolyn Mahn**, **Connor O'Brien**, and **Eric Western** — who researched and developed a device that automatically alerts vehicle operators of problems with their lighting systems. It also provides assurance that lighting and markings are in compliance with federally mandated standards.

But the standards are only helpful when they're adhered to, so the students are trying to engineer human error and negligence out of the equation.

"We did a client interview last spring, and he mentioned that there's not really anything like this on the market right now," says Mahn. "He said that he keeps a mental checklist [of lights and reflective markings] in his head. That was distressing. That inspired us to continue working."

The federal government calls for two headlights, two taillights, at least two flashing amber lights, turn signals, and various reflective markings, all clean and in working order. It seems so elementary, but these requirements weren't signed into law until 2012, and they only apply to new equipment manufactured after mid-2017. State regulations vary widely.

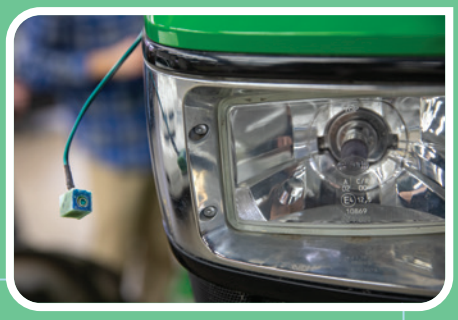
The data, however, show that the lights and reflectors required by standards work. Researchers at the University of Iowa examined farm vehicle crash rates in nine Great Plains and Upper Midwest states. They estimated that by modestly improving compliance with standards established by the American Society of Agricultural and Biological Engineers (which the federal standards reference), Wisconsin alone could expect an annual average decrease from 164 to 65 crashes — a 60% reduction.

The statistics underscore the importance of the students' work. For two semesters, they teamed up in BSE 508/509, a capstone course, poring over background information, safety studies, and existing patents and engineering standards. They conducted market research and an economic analysis and, finally, designed and built a prototype, which they tested in late fall.

In their design, operators use a vehicle-mounted touchscreen, which connects to a small, open-source computer programmed to read an array of light-detecting photoresistors. One sensor, about the size of a sugar cube, is affixed to each federally required light.

"[The screen] would display 'all lights are on' or 'all lights are off,'" says O'Brien. "If one of the lights is off, it notifies the operator and turns red — 'one or more of these lights is off.'"

"A big thing for us was ease of implementation and accessibility," says Barrett. "The easiest way — instead of diving into a tractor's hood and messing with all the electrical — is just to put a sensor on the outside. Everybody can do that with a good instruction manual."



A photoresistor is taped near a headlight on a tractor during a prototype test at the Agricultural Engineering Lab on the UW–Madison campus.

The device is also programmed to guide vehicle operators through a pre-drive checklist of safety requirements that the sensors can't detect: Are lights and reflectors free of dirt and debris? Is your "slow-moving vehicle" emblem showing? Are work lamps angled downward?

The students, who presented their findings in a December CALS poster session, say the experience has been a great bridge between theoretical courses and practical realities. Shutske anticipates continuing the line of research and development with future undergrads to keep chipping away at the problem of poor standards compliance — perhaps with universal retrofit systems to bring much older vehicles into compliance with the modern-day standards.

"There has been a lot more research involved than I would have expected," says Western. "As far as learning about researching previously made products and finding standards and guidelines that need to be followed, nothing has come close to the experience of putting this project together."

"This has been extremely satisfying to get our hands on a project and see it through from start to finish," says Mahn. "I have definitely learned a lot about coordinating workloads in a team, and my eyes have also been opened to the complexity of applying research findings to a real-world problem, which is definitely not as straightforward as I once thought."

A TICK IS A TICK IS A TICK. OR IS IT?

BY STEPHANIE HOFF BS'19

Hannah Fenelon, a senior entomology and Spanish major who is also pursuing a certificate in global health, inspects a drag cloth for tick nymphs at Tower Hill State Park near Spring Green, Wis.

"Tick checks" — thoroughly inspecting one's body for signs of the little brown parasites — are a ritual for most Wisconsinites who spend time outdoors. This fastidiousness is fueled by knowledge. Most people understand that certain species of ticks can carry the bacteria that cause Lyme disease, a potentially debilitating infection. But do they really know what to look for?

The average number of reported cases of Lyme disease has more than doubled over the last decade in Wisconsin, and awareness of the illness has also increased. Despite this, researchers have found that many people who are accustomed to checking for ticks still don't know how to properly identify them — especially when it comes to tick nymphs, the youngest and tiniest of these insects capable of transmitting Lyme.

"When you're saying 'look for ticks,' and people don't know what they're looking for, how are they supposed to do a good tick check?" asks **Hannah Fenelon**, a senior majoring in entomology and Spanish.

This is why Fenelon is working with entomology professor and chair **Susan Paskewitz** to perfect a method for suspending ticks in hard resin. With resin blocks, the untrained public can safely hold ticks in the palms of their hands and get a better idea of what they look like.

As an undergraduate researcher at the university's Midwest Center of Excellence for Vector-Borne Disease, Fenelon studied tick populations and the transmission of Lyme disease in

Wisconsin over the last two years. The center partners with Columbia University on The Tick App, which allows users to submit images of ticks for the universities to identify. The app helped the center expose some knowledge gaps.

"Some people were submitting photos of arthropods that aren't ticks," says Fenelon. "We were seeing images of lice, pseudoscorpions, and beetles like weevils, which are commonly mistaken for ticks. And it seems people are less able to recognize deer tick nymphs versus adults."

To help fill these gaps with education, she started making innovative visual aids. The disc-shaped resin blocks she fabricated encase adult male and female deer and wood ticks as well as nymph deer ticks. Some other species, such as beetles or bedbugs, are included to provide comparisons of size and features.

"We started carrying them with us in our pockets during our field research," said Fenelon. "That way, when someone asked what we were doing, we would show them a resin block."

The people they encountered were surprised to find out what they didn't know. For example, they learned that only deer ticks, not wood ticks, carry Lyme disease in Wisconsin. They also discovered how truly tiny deer tick nymphs can be, like poppy seeds on a muffin or freckles on an arm. They're arguably the most difficult infectious tick to detect on the human body, making them must-identify, must-remove hitchhikers — and prime candidates for research.

Fenelon was able to contribute to this vital area of study thanks to a financial boost. Last year, she received a Hilldale Fellowship, a $3,000 stipend exclusively for undergraduate researchers that offsets research costs, such as supplies and student travel, related to a project completed with a faculty adviser. The fellowship is made available through private dollars held in a University of Wisconsin System trust fund. It gave her the support she needed to perfect her resin block production process and test how well the blocks work as teaching aids.

"Hannah developed an extremely useful tool for tick and Lyme disease research," says Paskewitz. "One of our goals is to provide good advice to the general public about how to reduce the risk of Lyme disease. The resin blocks are a tool that we can use to ask which of these is a tick and which can transmit Lyme disease."

The use of resin blocks to preserve larger insects is nothing new, but trapped air bubbles can obscure a tick because they're so small, says Fenelon. Her process involves mixing the resin in a way that minimizes air bubbles, removing those that still form with pipettes, and using pins under a microscope to position the tick so the legs are visible.

"It's a lot more difficult than one would think to make sure they turn out right," she says. "I spent more than 10 hours a week just trying technique after technique based on what went wrong the first time."

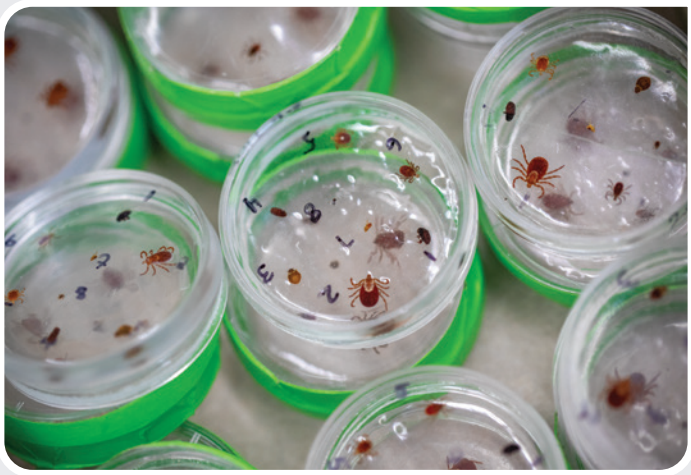
Fenelon took the final blocks to a youth camp in Central Wisconsin, where she tested whether they were more effective than photographs in educating children about ticks. "Right now, we use pictures, but we aren't sure if people are learning well from them," she says. "Especially kids, because they don't understand the size and scale of the image compared to real life."

Fourteen small groups of children were given four to six minutes of instruction about tick identification weekly at the camp. Some groups learned exclusively from pictures, while the others learned only from resin blocks.

Camp counselors answered a questionnaire about their teaching sessions with the children; campers were asked if they had any ticks on them during their stay and whether they were attached. In cases of attached ticks, campers were instructed to go to the nurse for removal, and those specimens were collected and given to Fenelon for identification.

"I received over 1,000 tick-check reports," says Fenelon. "So I was able to see how many, if any, ticks those 1,000-plus children had."

Responses from the counselors indicated that the resin blocks are easier to learn from than the pictures, but Fenelon is still sorting through the data to determine whether that's truly the case. She says the entire process has helped her develop skills for working with the public, which will prove indispensable as she pursues a career in global public health and medical entomology.



These disc-shaped resin blocks contain several species of ticks in various life stages as well as insects that are commonly mistaken for ticks. Undergraduate Hannah Fenelon worked with entomology professor Susan Paskewitz to develop the methods for creating the blocks, which have proven to be more effective than photos or illustrations in public education.

in the field

by Stephanie Hoff BS'19

LOGAN PETERMAN BS'09

At Organic Valley, a Wisconsin-based food brand and organic farmer cooperative, **Logan Peterman** serves as an organic research director and data scientist. "The agricultural biome is the largest class of land use in the world," says Peterman. "As an aspiring ecologist and conservationist, I realized that making small, incremental changes to agricultural practices could have truly massive effects as they multiply over that incredible acreage. I decided that bolstering organic farming methods was a superb way to help heal some of the huge environmental issues we face as a species." Peterman manages Organic Valley's connection with ongoing research while predicting raw supply to improve performance of the company's supply chain. He also advises a community of staff, farmer, and industry stakeholders on emerging research, implications, and opportunities pertaining to the business. "All of these efforts are enhanced by networking throughout the organic community," says Peterman, "which ensures that new academic research is relevant to farmers' needs and well informed about the actual conditions on farms and throughout the supply chain." During his time at CALS, Peterman worked in **Randy Jackson**'s Grassland Ecology Lab. "CALS introduced me to almost all of the skills I've continued to develop throughout the last decade," says Peterman. "From ecological and agricultural principles to the data management of active scientific projects, I use highly refined versions of the skills I learned nearly every day in my current work."

JAIMEE JAUCIAN BS'03

As an undergraduate, **Jaimee Jaucian** planned on going to medical school or working in the sciences. She was also a member of the UW Dance Team, and she ended up pursuing a career that combines her academic background with her favorite art form. "Graduating from UW through CALS taught me how to push through challenges and not give up, even when I doubt myself," says Jaucian. "When I found the Dance/Movement Therapy and Counseling master's program at Columbia College, Chicago, I found a way to still be in health care while fueling my passion for dance and helping others through movement." Jaucian is a licensed clinical professional counselor in Illinois and a board-certified dance/movement therapist. At Amita Health, a faith-based health system in Chicago, she is the clinical supervisor for various community mental health programs, including outpatient therapy, psychosocial rehabilitation (for reintegrating patients back into the community), and mental health court, where ordinarily prison-bound individuals go through long-term, community-based treatment. "I love getting to help people and train new therapists in the field," says Jaucian. "It's very rewarding to be part of another's journey toward reaching their full potential, whether it be a client, student intern, or staff member." Jaucian is also a dance instructor at Star Performance Company, where she provides professional expertise and choreography for Midwestern dance teams.

MICHELLE BOTCHEY BS'05

Throughout her career, **Michelle Botchey** has played many roles: nurse, pediatric nurse practitioner, and clinical instructor for nursing students. "My parents tell me stories about how I would talk about being a teacher, pediatrician, and nurse," says Botchey. "In a roundabout way, I have somewhat lived out my dreams." She was recently a staff nurse at Children's Healthcare of Atlanta, where she cared for children in an outpatient setting, treating nonemergency issues (ear infections, strep throat, or minor injuries) and emergency conditions (allergic reactions or major fractures). In January, she started a new position with Seattle Children's Hospital, where she works in a variety of pediatric specialties as a member of the Advanced Practice Provider Fellowship Program. "My favorite part of my work is the vibrant nature of the children I am caring for," says Botchey. "They are extremely resilient, fun to listen to, and, if you listen very carefully, very good at describing what is bothering them." She thanks CALS for giving her a solid foundation in chemistry, biology, microbiology, and anatomy, which paved the way for the health care career she loves so much. "It is often difficult to see children in a compromised state, but when I am able to witness their road to wellness, it makes my job that much more rewarding," Botchey says. "I couldn't imagine my life without the opportunity to care for, treat, and educate pediatric patients and families."

About *In the Field* | *The CALS graduates highlighted here represent the depth and breadth of alumni accomplishments. Selections are made by* Grow *staff and are intended to reflect a sample of alumni stories. It is not a ranking or a comprehensive list. For more about CALS alumni, visit* ***cals.wisc.edu/alumni****.*

Alumni making the most of their background in BIOLOGY

TRISHA PEDONE BS'11

Trisha Pedone leveraged her bachelor's in biology to pursue a doctor of pharmacy degree from the UW–Madison School of Pharmacy, which she earned in 2015. She chose a career in pharmacy for the unique part it plays within a health care team. "Pharmacists are the engineers of a treatment regimen," she says. "They understand the mechanics of the body and how those mechanics will be impacted by medications." Pedone became a lead pharmacist at Weill Cornell Medical Center before assuming her current role as pharmacy manager of strategic projects with the New York-Presbyterian Enterprise. "The reason I love my job is that it is ever-evolving," she says. "I have the opportunity to be at the heart of strategic initiatives within our department, and my projects pivot to constantly improve patient care." She initiates and leads high-priority projects for the pharmacy department, and her decisions can impact multiple patients at one time. "Currently, my projects involve automation and technology deployment," says Pedone. This includes upgrades for automated dispensing cabinets and medication carousels and electronic medical record conversion. Pedone says her time at CALS and her experience with the biology major continue to influence how she works today. "The biology program offered a well-rounded basis of biological sciences within a top-tier research institution," says Pedone. "Through CALS, I developed the foundation of my academic career, which has made me into a lifelong scholar. The rigor in academics among my bright colleagues drove me to never settle for anything less than my best."

JOSHUA BALTS BS'07

Joshua Balts knows firsthand what it's like to suffer through injuries. "I had five orthopedic surgeries growing up," he says. "So I was exposed to the field many times." Today, Balts is an orthopedic surgeon at Mayo Clinic Health Systems in his hometown of Barron, Wisconsin, where he treats fractures, hand conditions, sports-related injuries, and hip, knee, and shoulder arthritis. "I love my job because I get to help people achieve their goals of staying as active as possible with as little pain as possible," he says. "Seeing patients living active lives really fuels me." Balts chose orthopedics because he loves hands-on work, enjoys interacting with people, and appreciates the ever-evolving scientific and technical aspects of the job. "Medicine as a whole is a constantly changing field, so it definitely keeps things new and fresh having to keep up with the latest evidence for treatment of patients," he says. Balts credits CALS for his passion for continuous learning. "CALS really prepared me to be an adult learner," he says. "It's an extremely difficult transition from high school to college, but I felt that, with the help of my mentors and professors, becoming an adult learner was made easier." Balts is happy to use the skills he's cultivated in Madison in his old neighborhood. "It's been great to be back in my hometown and the surrounding area and seeing many people I grew up with," he says. "There's never a dull moment trying to provide the best, most up-to-date care for my patients."

LILY SERVAIS BS'08

Lily Servais heard about the field of genetic counseling — providing information and support to people who have or are affected by genetic disorders — in high school. She thought the combination of science and psychology would be a good fit for her. "Luckily for me, the University of Wisconsin–Madison had great genetics and biology programs for me to build my foundation in the field," Servais says. "The time I spent at CALS helped establish my lifelong love of learning and desire to understand the world around me." Servais is a genetic counselor at Color, a health technology company. Color offers its clients data-driven health programs such as clinical genetics. "As only the second genetic counselor at Color, I helped develop the company's genetic counseling service and many of the genetic counseling tools," says Servais. She has transitioned from clinical counseling to providing support for the Color team. This includes internal support, such as distilling the company's research results for the sales and marketing teams, and external support, such as walking physicians through test results so they can have productive conversations with patients. "It is beyond exciting to work for a company at the forefront of utilizing technology to transform health care, making it accessible, convenient, and cost-effective for everyone," says Servais. "I know that the work I do every day matters."

Catch up with…

John Bowman MS'80

Plant Pathology

John Bowman came to UW–Madison for a master's degree in Ibero-American studies, but fate expanded the scope of his academic pursuits. By chance, he ended up rooming with two graduate students of agronomy whose "shop talk" piqued his interest in their field. He discovered that UW is a leader in international agricultural research, with projects all over Asia, Latin America, and Africa. And he realized that combining a degree in an agricultural discipline with his expertise in Latin America could aid his quest to help people in developing countries.

Bowman found support for his plan through **Luis Sequeira**, now an emeritus professor of plant pathology, who gave him the chance to pursue an additional master's degree. Later, Bowman dove even deeper into plant pathology with a doctoral degree from the University of Illinois at Urbana-Champaign.

Bowman has worked in more than 40 countries and has lived for extended periods of time in Brazil, Mexico, Costa Rica, Philippines, and China. He brings this experience to his current position as a program area leader for the United States Agency for International Development (USAID) Office of Agricultural Research and Policy. Bowman primarily designs and manages long-term international research projects in the areas of horticulture, crop protection, post-harvest loss, and food safety, but he's also a leader on increasing USAID youth engagement in developing countries. He directs funding to programs that support young leaders who can have a lasting impact on the food security and health of communities.

GROW ONLINE EXTRA
For an extended Q&A with John Bowman, visit grow.cals.wisc.edu.

In recognition of his work, Bowman received the Excellence in International Service Award from the American Phytopathological Society in August 2018 and the award for Outstanding International Horticulturist from the American Society for Horticultural Science in July 2019.

WHY IS ENGAGING WITH YOUNG PEOPLE IN DEVELOPING COUNTRIES IMPORTANT?

USAID has to learn how to do development differently in the next 20 to 30 years. There are these demographic youth bulges in many poor countries in Africa and Asia, where 60% to 70% of the populations are under the age of 30. This a new trend that will continue to grow. We have to invest our development dollars to improve economic growth and alleviate poverty through targeting youth. If we don't, we're missing a huge swath of the target population, particularly female youth.

Our investments in agriculture development become a lot more efficient when women are heavily involved in the utilization of the donor dollars. If we can empower women in poor households and help them start up agriculture enterprises, everything goes a little bit better in improving family economics and health status. Women have that direct link to the under-age-five population because they're most responsible for them. If we support women through aid, it's much more likely that the health and well-being of children will be better.

HOW DO YOU WORK WITH YOUNG PEOPLE IN DEVELOPING COUNTRIES?

Youth in poor countries are very much isolated and vulnerable, and critical thinking is suppressed by traditions, cultural practices, or religious beliefs. We empower them to become responsible and respected members in communities with soft skills training, such as managing a loan or learning to communicate with elders in the village. They need to learn to assert themselves without causing cultural distress. We do that on top of finding them employment opportunities through agriculture and investing in training that helps them become strong young leaders. We want to make sure that investments are customized toward the youth population because youth are energetic and more likely to contribute to development solutions with innovative thinking.

—Stephanie Hoff BS'19

Above: John Bowman poses with a group of Nepalese vegetable farmers he worked to support through a project with the United States Agency for International Development.

Photo courtesy of John Bowman

Photo by Michael P. King

Rekia Salter says her research is teaching her technical skills that will be invaluable when she goes to work as a consultant in the industry.

Dairy Industry Support for Grad Students Pays Off

When it comes to generating useful ideas and solutions for the dairy industry, graduate student researchers are the unsung heroes.

"Most of the research that gets done on campus is carried out by grad students," says **Kent Weigel** MS'92, PhD'92, chair of the Department of Dairy Science. "They're the boots on the ground."

While faculty researchers provide guidance and advice, it's the students who comb through literature, work out the experimental design, and collect and analyze the data, notes Weigel, a professor and extension specialist.

"This benefits the industry in two ways," he says. "Students conduct research that leads to new products and protocols and technologies. And they graduate as highly trained potential employees."

Looking to bring in more grad students to conduct industry-related research, UW dairy scientists introduced a new initiative in 2018 to encourage dairy-related businesses to fund the roughly $50,000-per-year cost of educating a grad student. Called Dairy Farming Research Partners, the program is supporting four students who are conducting research related to nutrition, animal behavior, and reproduction. Individual firms are funding two of them, and the other two are being supported from a pool of contributions from several companies, organizations, and individuals.

One of those students is **Rekia Salter**, who is researching the effects of housing calves in pairs rather than individually. Paired housing has been shown to improve calves' cognitive skills, social development, and solid feed intake and growth.

"Hutches are the most prevalent calf management system; my goal is to create a successful way to use pair housing in a hutch system," says Salter, who is working with assistant professor and extension specialist **Jennifer Van Os**. "This would improve calf welfare while allowing producers to gain the benefits of social housing without having to change their management system."

Another industry-funded graduate student is **Megan Lauber**, who is working in the lab of reproductive physiologist **Paul Fricke**, a professor of dairy science and extension specialist. Lauber is looking at strategies to improve fertility when using sexed semen to impregnate cows and heifers.

Lauber says her research is building her technical expertise and sharpening her analytical skills.

"My research is teaching me how to think in a completely different way," says Lauber, who wants to work as a reproductive specialist. "I have to go out and find the knowledge I need by searching through literature and other sources and then think about how I'm going to apply what I've learned. This will allow me to analyze data and farm management more effectively as a consultant."

Fricke says the industry funding is essential for this "translational" research — work that distills scientific knowledge to develop solutions that can be used directly by farmers and veterinarians.

"The type of project Megan is doing wouldn't be funded by a granting agency geared toward basic science," he says. "She's looking at a way to better use an existing technology. The better we can get that technology to perform in the field for dairy farmers, the more likely they are to use it."

—Bob Mitchell BS'76

If you would like to support the Dairy Farming Research Partners initiative, visit **supportuw.org/giveto/DairyResearchPartnership**, or contact Jodi Wickham at jodi.wickham@supportuw.org or 608-308-5315.

DAY OF THE BADGER

Wear Red. Stay Connected.
Support CALS Students.

On **April 7-8, 2020**, we will direct all gifts to the college to CALS QuickStart. This new program helps incoming first-year students get a summer start on their UW–Madison coursework, reduce their time to graduation, and join a supportive cohort of fellow scholars.

All gifts of any size will count toward UW's collective goal of obtaining 1,848 gifts throughout the campaign.

dayofthebadger.org | #dayofthebadger

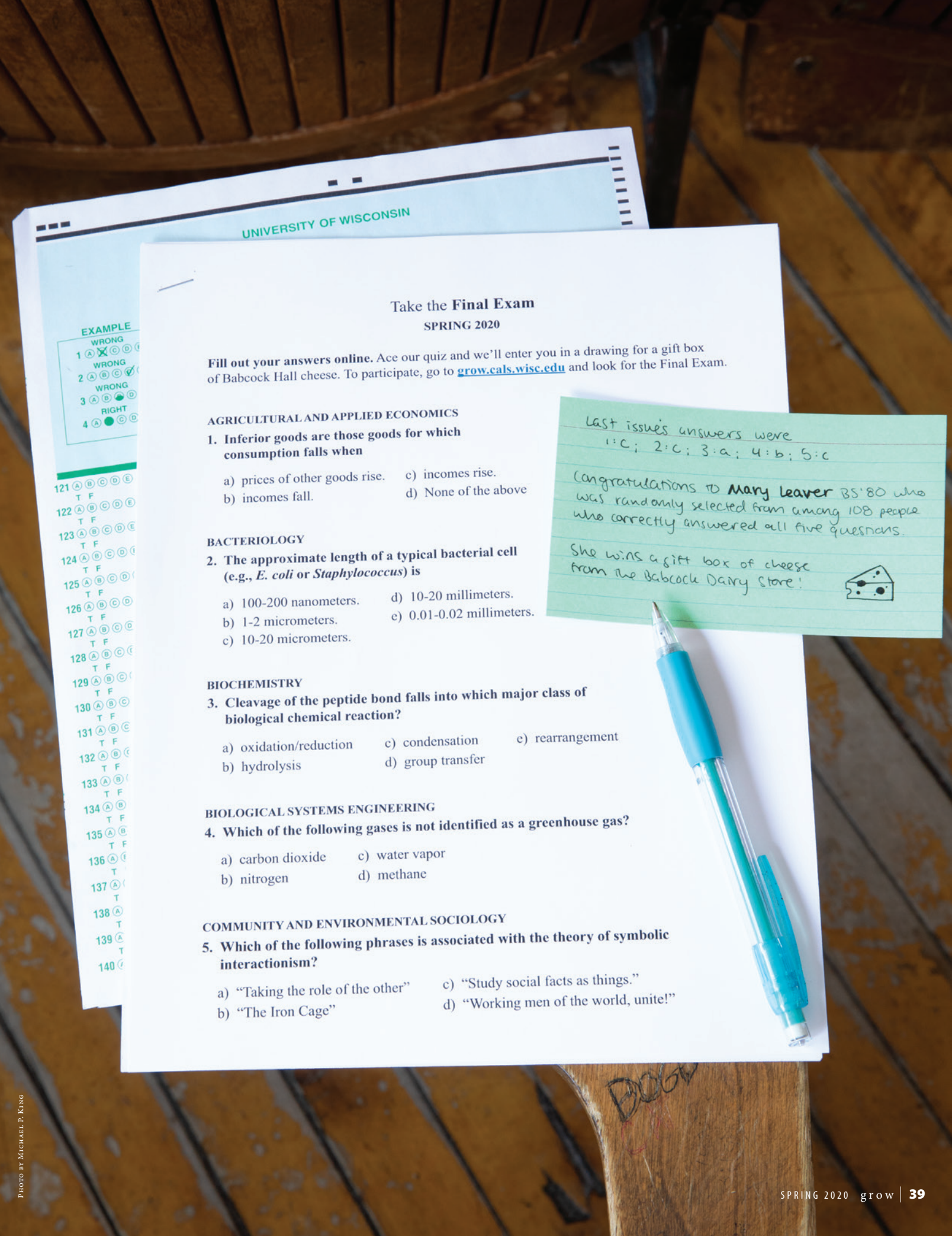


Photo by Michael P. King

College of Agricultural and Life Sciences
University of Wisconsin–Madison
136 Agricultural Hall, 1450 Linden Drive
Madison, WI 53706

Nonprofit Org.
U.S. Postage
PAID
Madison, WI
Permit No. 658

INSECT QUEST

Jackson Winslow, a visiting undergraduate in summer 2019, uses a net to sweep a cornfield for lady beetles and aphids. His work is part of a project examining the health of agriculturally beneficial insects in mixed landscapes. Read more on page 16.

Photo by Chelsea Mamott