grow

Wisconsin's Magazine for the Life Sciences • Summer 2009

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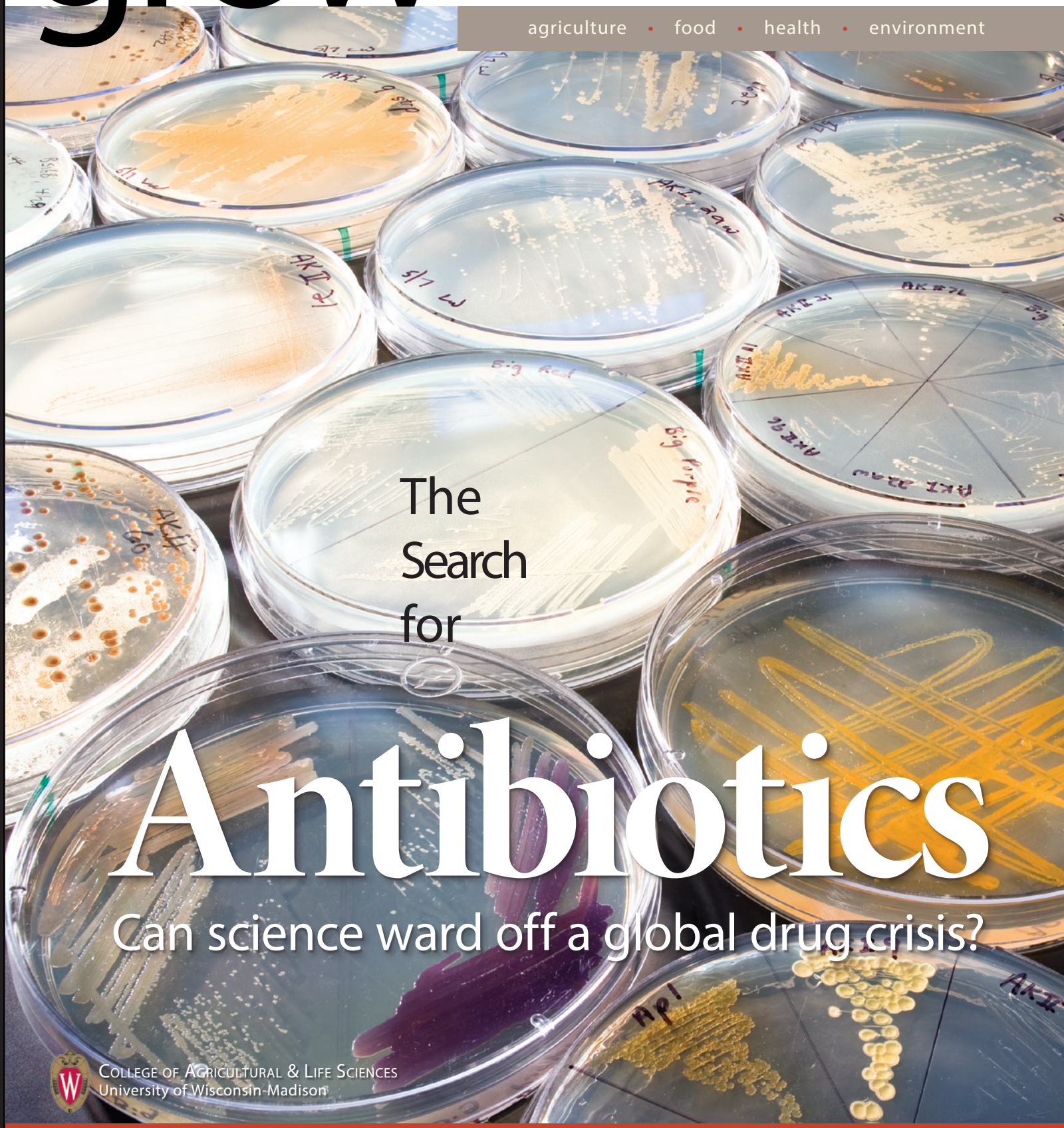

The Search for Antibiotics

Can science ward off a global drug crisis?

College of Agricultural & Life Sciences
University of Wisconsin-Madison

Volume 2, Issue 3 • Summer 2009

grow

Wisconsin's Magazine for the Life Sciences

Departments

ON THE COVER: Petri dishes containing antibiotic-producing microbes await inspection in Jo Handelsman's bacteriology lab.
Photo by Wolfgang Hoffmann

GARDEN VARIETY: Peonies aren't the only thing blooming at CALS' Allen Centennial Gardens. New director Ed Lyon is replenishing the garden's plantings and its mission. Read more about Lyon's vision on page 12.

Dean Molly Jahn

My Own Miracle Drug

In this issue, you'll read an update on a topic that has special significance for me. Antibiotics saved my life.

When I was 13, I was diagnosed with a potentially fatal staph infection. This is a sneaky and dangerous bug, and by the time the infection was detected and recognized, I was critically ill, facing major surgery and an uncertain recovery. My only hope for recovery was the drug dicloxicillin, which was prescribed and administered in massive doses. It worked. And I survived, one more life saved by these miracle drugs.

Today, it is hard for most of us to imagine a world without antibiotic pharmaceuticals. And yet it's been considerably less than a century since they were recognized and introduced into clinical use, thanks in no small part to pioneering work on our campus. But if we are not careful, we may find ourselves much too close to that world again. The rising levels of microbial resistance to our best antibiotics—and the dearth of new antibiotics in the drug pipeline—are a startling wake-up call that could imperil our ability to treat disease in humans and animals.

It's hard for most of us to imagine a world without antibiotic pharmaceuticals. But if we are not careful, we may find ourselves much too close to that world again.

Fortunately, we've heard that wake-up call. At CALS, we have one of the brightest and most creative communities of microbiologists in the world, and they are fast uncovering promising new antibiotic compounds. But they are doing more than that. By taking the next step and refining the compounds that may be significantly valuable in clinical use, they are advancing a new model of drug development that can channel more of these medications into the marketplace, where they can save more lives.

To me, this work offers a wonderful illustration of how our college continues to do what it was invented to do—to create real, lasting change in people's lives. Research does have the capacity to save millions of lives, and I am living proof of that power.

Editor's Note: We're pleased to note that Grow has been collecting a little gold recently, winning awards in two national competitions. Grow was judged best magazine by the Association for Communication Excellence, an international group of communicators from land-grant universities and research institutions. Grow writers Bob Mitchell, Nicole Miller and Michael Penn won the top three spots in the competition's feature writing category. The magazine also won a gold medal for staff writing from the Council for the Advancement and Support of Education, which represents professionals in alumni relations, communications and marketing. Thanks to everyone who has helped make Grow a success—especially our readers.

grow

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On Henry Mall

News from around the college

Piling On

Composting is taking a bite out of campus food waste.

At West Madison Agricultural Research Station, yesterday's lunch becomes tomorrow's soil.

At restaurants and cafeterias, consumers have grown accustomed to seeing a line of waste containers for recycling glass, plastic and paper items. Important as those bins are for reducing the burden on landfills, they overlook a major source of waste: the food left on diners' plates.

Food accounts for about one-third of the trash Americans throw away, and most of it ends up in landfills. While food is generally more biodegradable than some of the other items in your trash can, it's not environmentally harmless. Decomposing food produces methane, a greenhouse gas that is 22 times more effective at trapping heat than carbon dioxide.

In an effort to reduce those impacts, UW-Madison has launched a project to collect and compost food waste from campus eateries. Organized by We Conserve, a university-wide program that promotes environmental stewardship practices, the project aims to compost more than 400 tons of food waste annually when fully implemented.

"UW has been composting for years with other organic materials, but we've found that great synergy can exist by adding food. It can really improve the quality of the compost product," says Faramarz Vakili, program director for We Conserve.

Food-collection stations are now in place at Grainger Hall and in the kitchens at Memorial Union, which prepares food for all Union delis on campus. Spoiled and unused food from both sites is taken to CALS' West Madison Agricultural Research Station, where superintendent Tom Wright oversees the composting process.

Wright says the project has presented some challenges, particularly in educating consumers about how to sort food for composting. "Not all foods belong in a compost heap, especially meat and dairy products. So it's important that discarded food wastes are separated to keep out things that don't decompose well," he says. To help guide consumers, We Conserve constructed a food-collection station at the Grainger café that uses signs and pictures to designate the proper containers for different kinds of food. Vakili says the station has helped boost the number of people participating in the project, and he's confident that diners will catch on and embrace food sorting in time.

"Effective composting takes time and effort, and while we would love everyone on campus to create their own, that's just not possible," says Wright. "So this program is making it easy for them. All they have to do is give us their food, and we will do the work."

—Camille Rogers

Still in Rotation

A 44-year-old cropping study offers a window on sustainability.

It's said that with age comes wisdom. And for CALS' long-running field trials at Lancaster Agricultural Research Station, wisdom means data.

Established in 1966 to test the advantages of various crop rotations, the Lancaster trials have produced reams of feedback for producers as they weigh their planting decisions. One of the study's key findings, for example, has been to show the profitability of a corn-soybean crop rotation, says Joe Lauer, an agronomy professor who has compiled 39 years of data from the trials.

But as the study enters its 44th season, its longevity is paying off in other ways. Its four-decade history is giving agronomists a rare tool to study the sustainability of cropping systems over multiple decades.

"To truly answer questions about sustainability, you need longitudinal data across generations of farmers," Lauer says. "These trials have been in place long enough and are well-designed to address questions we never thought about when the experiments were conceived." That is why institutional support for this kind of work is critical, Lauer says.

Lauer notes that the Lancaster studies are among the longest-running replicated cropping studies in the country. Another trial at CALS' Arlington research station has been going on for 26 years. By contrast, most cropping studies focus on three- to five-year projects.

Lancaster's field trials allow researchers to take a long view on how crop rotations affect the environment.

While that time frame may be fine for studying yield or profitability, Lauer says the new questions being asked about cropping systems require a longer view. Farmers and agronomists are increasingly concerned with how soil characteristics change after decades of agricultural use, as well as the long-term effects of tillage and pesticide use. Studies such as those at Lancaster "are our best chance to address whether a cropping system is going to be sustainable," says Lauer. "Every five years, as a rotation cycle is completed, we can go back to the same piece of ground and get hard data and predict the direction the rotation is taking us."

For instance, the study's data show that it's necessary to add nitrogen to make the corn-soybean rotation effective. But without nitrogen, forage crops may offer a better option for maximizing grain yield because they leave more residue on the fields, says Lauer. In fact, if governments enacted policies based on carbon credits, he predicts that soybeans might disappear from the rotation mix because they don't create much organic material.

"These are some of the questions that society is asking," says Lauer. "Data can get at the crux of these issues."

—Lynn Grooms

An Uptick in Ticks

Last summer, Susan Paskewitz made an astonishing discovery after walking her dog in her Madison neighborhood: a deer tick crawling up her dog's hind leg. While most Wisconsinites associate ticks with summer trips to the Northwoods, the parasites have been moving slowly southward and eastward, and Paskewitz has more than her dog to prove it. The entomology professor recently completed a tick "census" by gathering ticks from deer killed in various part of the state. Comparing the results to a similar study done in 1994, she concluded that "pretty much everywhere in Wisconsin is infested now." As a result of the survey, the state's tick-awareness campaign is being expanded, and doctors in newly infested counties are being warned to watch for symptoms of Lyme disease. Paskewitz says even city dwellers in places like Madison and Milwaukee should take care, especially if they frequent natural areas or live on wooded lots where deer roam. "In Wisconsin, people sort of feel like they already know this story, but one thing this (survey) points out is that it's not a static situation," she says. "What your risk was 20 years ago may not be what your risk is today, so you should not be blasé if you get a tick on you."

Mouse Bites

Student-designed snack has Disney execs all ears.

Every parent knows the difficulty in making healthy food that kids actually want to eat. But imagine for a second if you had to please thousands of kids at the nation's biggest playland.

That was the task for a team of CALS food science students competing in a national contest sponsored by the Institute of Food Technologists Student Association. The annual event challenges university students to create novel food products that are judged by a panel of industry experts. UW-Madison's food product development team has won top prize three times since 2001.

This year's competition featured a new twist. Students were asked to design a healthy, kid-friendly snack for Walt Disney's consumer products division, which cosponsored the event. "The product had to have a fruit or vegetable ingredient and had to be Disney-themed," says Andy Renaud, who led the five students on UW-Madison's team.

Enter the Mickioli, a waffle sandwich shaped like the head of Mickey Mouse. To make the waffles more nutritious, the students used quinoa, a nutrient-packed, gluten-free grain. Between the waffles are layers of strawberry and yogurt filling.

Mickioli advanced to the final round of the competition, earning the students a trip to Disneyland to present their product to food-industry and Disney executives. Despite its showing, the Mickioli isn't likely to turn up on the menu at Disney's theme parks. The open nature of the student competition makes it difficult for companies to adopt the students' ideas, says Rich Hartel, a food science professor who advises the team.

"Typically, companies don't buy the rights to develop these products because all the information about how to make them is made public during the course of the competition," he says.

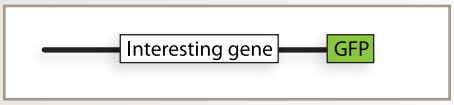
But food companies are after something else: the students themselves. "I always get asked questions about team members by companies recruiting for product development staff," says Hartel. "Companies are definitely interested in them."

—Camille Rogers

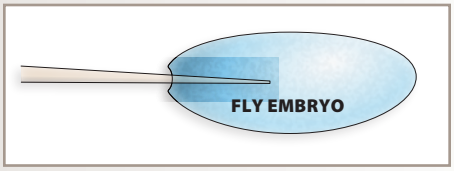
how to see a gene work

Researchers often want to know when and where a particular gene is "turned on" inside an organism. How do they accomplish such a feat? When genes are on, they produce telltale proteins. Unfortunately, it's no good looking for these directly; proteins are much too small to see, even with the most powerful microscopes. Over the years, scientists have come up with a number of innovative workarounds. Here's a particularly bright (green) one:

Tag the gene. Scientists splice the gene for Green Fluorescent Protein (GFP) to the end of their gene of interest. This way, when the gene is expressed, it will produce a protein with a GFP "tail" attached to its end.

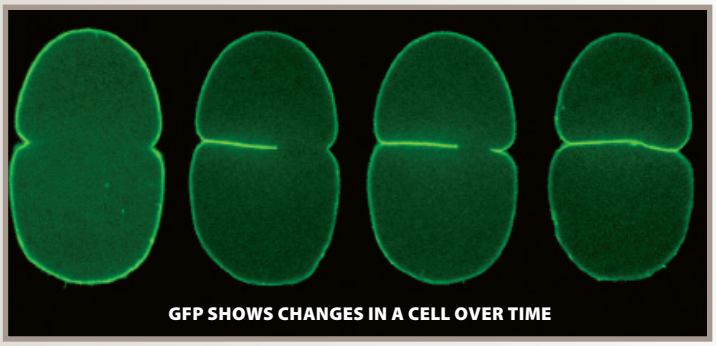


Transfer the tagged gene. The methods used to deliver this extra DNA vary from organism to organism. For the common fruit fly, by way of example, a tiny needle is used to inject the DNA into early fly embryos.



Illustrations by H. Adam Steinberg

Switch on the black light. GFP, originally discovered in a naturally fluorescing jellyfish, emits green light after absorbing certain wavelengths of UV light. This makes the cells expressing tagged genes glow bright green, while cells with no gene activity remain black. With special microscopes, scientists can see exactly which cells inside an organism are producing these glowing proteins, and then monitor changes in those protein levels over time.

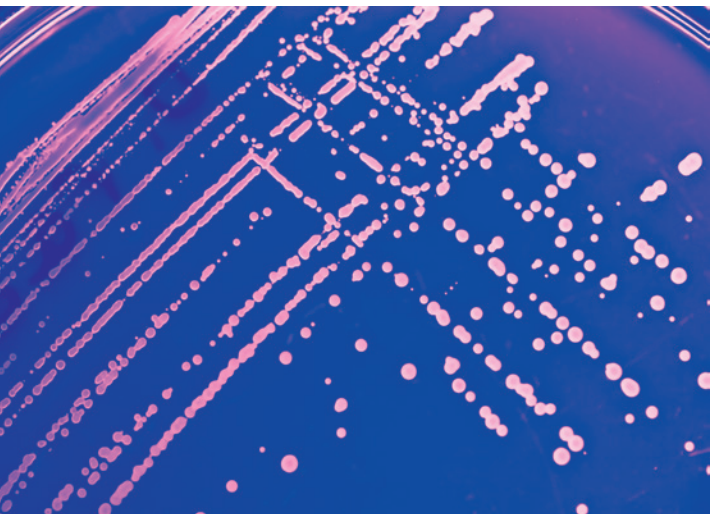


GFP SHOWS CHANGES IN A CELL OVER TIME

Location, location, location. For researchers trying to develop safe genetic therapies, it's vitally important that they be able to control where therapeutic genes are expressed inside the body. Using GFP-tagged proteins, scientists can quickly determine whether a new gene therapy approach targets the correct organs or tissues. To make this kind of analysis possible in larger organisms, scientists introduced GFP into the core DNA of several lab animals, including mice, cats, pigs and fish.

A Microbe Made for CSI

DNA-fixing bacterium may help piece together crime-scene evidence.



After a dose of radiation that would kill most things, these pink-hued bacteria piece themselves back together and live on.

The microbe *Deinococcus radiodurans* is one resilient bug. Even when exposed to levels of radiation that would reduce a drinking glass to a pile of brown crumbles, the bacterium won't die. Instead it goes about sorting and reassembling its fractured DNA, re-emerging whole in a mere three hours.

"Like a phoenix," says Michael Cox, a professor of biochemistry who studies the bacterium, "it rises from the ashes."

Scientists have worked for years to understand how *D. radiodurans* pieces itself back together, a process that Cox describes as the most amazing DNA-repair mechanism in all of biology. Now they're entertaining an even more far-reaching possibility: that *D. radiodurans* could be used to reassemble human DNA.

As forensic scientists and CSI fans know, DNA is fragile, easily damaged by sunlight, heat, water and even just the passage of time. This means that the genetic trail in crimes quickly grows cold. If DNA recovered from a crime scene is damaged, it can reveal little about the identity of suspects.

But what if the DNA could be fixed? After a scientist in California's Orange County Forensic Science Services lab posed that question, Cox pursued a grant from the U.S. Institutes of Justice to explore the idea. "Nobody has ever gotten DNA double-strand break repair to work from an extract," he says. "But these bacteria should give us the best chance of making it happen."

D. radiodurans cells keep multiple copies of their chromosomes on hand, which allows them to sort through DNA fragments, match overlapping pieces and stitch them back together. Cox is currently mixing samples of damaged DNA with cellular extracts from *D. radiodurans* to see if the bacterium can sort through human DNA, as well. If it can, the experiment could reveal a potent tool for solving cold-case crimes. But it also could help scientists figure out their own mystery: what genes the bacterium uses to accomplish its reassembling magic.

To learn this, Cox has exposed normal *E. coli* bacteria to successive doses of near-lethal radiation to identify mutant strains able to withstand radiation. But so far each experiment has led to a different group of candidate genes. "What this has told us at a minimum is that there are multiple paths to get to this phenotype," he says. And that means the case of *D. radiodurans* remains a genetic whodunit—for now.

—Nicole Miller MS'06

No More Free Lunch

Jeremy Woodhouse/Getty Images

WHEN WISCONSIN CORN GROWERS switched to a safer insecticide recently, an unexpected problem descended out of the clear blue sky. Famished sandhill cranes, fresh from their spring migration, began arriving in farmers' fields and gobbling up seed and young plants.

"They started having cranes come in and pull all the corn—maybe 30 percent of their stands. Some growers would have to replant an entire field," says Eileen Cullen, a CALS associate professor of entomology.

Normally, cranes wouldn't fall within the purview of an entomologist, but growers connected their woes to a change in their insect management practices. Previously, they had treated corn seed with lindane, a carcinogenic insecticide that cranes found unappetizing. When lindane was banned for corn use by the EPA in 2006, Cullen began receiving calls for help, and she decided to help "take corn off the menu" for cranes.

At first, some growers asked Cullen to help bring back lindane, but Cullen, who specializes in integrated pest management to control insects, pursued another strategy. Working with the International Crane Foundation, the Wisconsin Corn Growers Association, a private company, and state and federal agencies, she led testing of several low-toxicity bird repellents derived from plants. After some lab work and field trials, she sought and gained approval for a biopesticide that can be safely applied to corn seeds.

Cullen says some farmers are hesitant about the added costs of the treatment and would prefer a crop-loss compensation program. But the seed coating provides at least one tool for farmers to keep their corn profits from going to the birds.

Rock the Boat

Songs strike a chord for invasive species prevention.

As a singer/songwriter, CALS graduate student James Spartz evokes a little bit of Johnny Cash with his twangy, rockabilly style. But while Cash crooned about loves lost and found, Spartz has a trickier muse: viral hemmorhagic septicemia.

Sure, it may make for a tough rhyme, but the fish disease known as VHS is of vital interest to Wisconsin boaters. And that's why Spartz sings about it in "Clean Boats, Clean Waters," one of three songs released by UW-Extension and the Wisconsin Department of Natural Resources to raise awareness about the spread of diseases and invasive species in state lakes. Directed at boaters and anglers as they head out for summer water activities, the songs wrap reminders about spraying off boats and disposing of leftover bait around folk and rock-and-roll riffs—a creative experiment inspired by Bret Shaw, an assistant professor of life sciences communication.

"Research shows music can influence how we respond to messages, affecting memory, emotion, attitudes and even behavior," says Shaw, who recruited Spartz and two other local songwriters to record the tunes. "These songs were created to encourage behaviors that will protect the quality of our lakes and rivers for future generations."

Several Wisconsin radio stations are playing the songs, which are available at www.uwex.edu/erc/music/. Now the test will be to see whether boaters join in the chorus.

—Michael Penn

Number Crunching

64 NUMBER OF BIRTHS IN WISCONSIN PER 1,000 WOMEN OF CHILDBEARING AGE IN 2007, according to CALS Applied Population Laboratory. That's about 7 percent below the national fertility rate, which hit an all-time high in 2007, leading to speculation that the United States is entering a new baby boom. But if so, Wisconsin is sitting it out, according to the demographers' study. Wisconsin's birth rate mirrored the nation's until the "baby bust" of the mid-1970s, but while the national rate has steadily climbed since then, Wisconsin's fertility has stayed flat. "There is likely something that is happening in the U.S. that is not happening in Wisconsin," the researchers conclude. Must be those cold winters.

audrey gasch BS'94

- job Assistant Professor of Genetics
- lab Third floor, Genetics -Biotechnology Center
- what I do Study how yeast cells respond to stresses in their environments

Bryce Richter/UW communications

What's a typical day like in your lab? Sadly for me, it's mostly meetings. The fun is in the lab where all the research happens.

Is your work 9-to-5 or 24/7? It used to be more like 24/7, but my toddler enforces the 9-to-6 rule for me now, plus some after-hours work.

What piece of equipment do you rely on most? Besides my computer, it's the coffee pot.

If you had to evacuate your lab/office, what would you grab first? My collection of animal skulls.

Clean desk or messy desk? Messy to an outsider, completely organized to me.

What's playing on the lab radio? A mix of electronica from the Pandora web site.

Where do you get your best work done? I get the best thinking done in the loudest coffee shop I can find.

What's your favorite way to recharge the batteries? Camping and fishing.

Why did you go into research as a career? Doing biological research is like solving a fascinating but never-ending puzzle. Every time we answer one question, it generates five new questions we didn't anticipate.

What's the research question on your mind right now? We've recently been looking at how gene expression and stress tolerance evolve in natural yeast strains (as opposed to lab strains), which has been a lot of fun.

CHINA

The Diet Secrets of a Shy Monkey

To many Chinese environmentalists, the Yunnan snub-nosed monkey is the poster child of the country's emerging commitment to conservation. But the endangered animal, which lives in the high elevations of southwestern China, isn't one for the limelight. Skittish and nomadic, it's rarely seen in the wild by humans, and even scientists know little about where and how it lives.

Heidi Bissell

In eastern China (above), snub-nosed monkeys have coexisted with humans mostly by avoiding them.

This summer, UW-Madison graduate student Heidi Bissell is headed to Yunnan province to change that. But she's not hunting monkeys. She's after their food.

"People have done behavioral observations of these monkeys to measure what they're eating," says Bissell, who is pursuing her Ph.D. in zoology. But it's an imperfect science because the monkeys live in steep terrain and avoid run-ins with people, making close observation difficult. Bissell's alternative is to examine the monkeys' feeding grounds, collecting bits of plants and feces to create a more precise model of their diet.

"It's a lot easier to find feces than it is to catch a sight of one of these animals," she says.

Collecting monkey droppings may not sound glamorous, but the setting most certainly is. The section of Yunnan occupied by the monkeys—a rugged stretch of mountains sliced by the Salween, Mekong and Yangtze rivers—is one of the most biologically diverse temperate regions on Earth. China established its first national park in the area, which was listed by UNESCO as a world heritage site in 2003.

The region has also been a locus for scientific collaboration. In 2006, UW-Madison secured a grant through the National Science Foundation to fund U.S. graduate students working on conservation and sustainable development in Yunnan. Since then, more than a dozen UW students have conducted research in areas ranging from plant diversity to agricultural practices, usually in collaboration with Chinese scholars.

"Our hope is that these students will be part of a new generation of scientists that can do interdisciplinary work really well," says wildlife ecology professor Bill Karasov, Bissell's advisor and one of the architects of the China collaboration. "From a conservation standpoint, they are also producing knowledge about the key features of this area that can contribute to protecting its biological treasures."

Bissell's research, for example, may help refine conservationists' understanding of the kinds of habitat needed to protect snub-nosed monkeys, whose total population is estimated below 2,000. She hopes to develop a "nutrition map" of the region to identify the most suitable places for the monkeys to live.

"Right now, they're living in some pretty harsh habitat," she says. "I want to figure out whether they've been pushed there and that's the limit of where they can go, or whether they're fine and they can find everything they need."

— Michael Penn

SOUTH AFRICA

Pleasing the Eyes with a Splash of Color

When people think of Africa, they imagine a place of brilliant colors. But while that may be true of Africa's artistic palette, the same can't be said for its culinary palate. In many African nations, cuisine is dominated by a bland assortment of pasty white foods, such as potatoes, rice and white maize.

"I went to Zambia for a week, and all I ate was white food," says Sherry Tanumihardjo, a CALS professor of nutritional sciences. "It was utterly bizarre."

But Tanumihardjo's concern is more than aesthetic. In Africa and Asia, more than 140 million children don't get enough vitamin A, a dangerous situation that can lead to blindness or even death. Tanumihard-

jo, who has conducted research on preventing vitamin A deficiency around the world, says that orange-hued foods like carrots and sweet potatoes—which derive their color from beta carotene, a compound that turns into vitamin A in the body—would give African diets a healthier dash of color. "If we could get people to start changing their dietary habits—switching from white (vegetables) to orange—it would have a huge impact on their vitamin A status," she says.

To that end, Tanumihardjo has been working with a number of international partners to promote and assess the effectiveness of eating orange. In one study, funded by the International Potato Center, a group of South African school children were fed orange sweet potatoes five days per week for five months at school, while another group received white sweet potatoes. Tanumihardjo designed a special test to monitor the students' vitamin A levels, which improved among students who ate the orange potatoes, while levels in the white-sweet-potato group declined.

Now, several countries are taking steps to put more color into their food crops. "In Mozambique, they started introducing (orange sweet potato) vines at the community level, and they were able to change community vitamin A status. And the same thing is happening in Uganda. These potatoes are starting to show up at the supermarkets, and people are starting to make better choices," says Tanumihardjo. "So there has been what I would call a success story for orange sweet potatoes in Africa."

—Nicole Miller MS'06

KOSOVO

For Forage Crops, Timing is Everything

On one of his many trips to Kosovo during the past five years, CALS agronomist Dan Undersander found himself chatting with a dairy farmer amid a field of ripening corn. As they talked, Undersander asked when the farmer planned to harvest the crop. He shrugged, saying he'd cut the corn in a couple of weeks.

"Oh, I wouldn't wait that long," Undersander replied. "In fact, I think you should start tomorrow."

As an expert on forage quality, Undersander knows that when it comes to feed crops, timing is everything. Farmers are tempted to wait as long as possible to maximize the yield of their silage, but in doing so, they risk the nutritional value of the feed. In the case of corn, waiting too long causes kernels to harden, making them more difficult for cows to digest. The same is true for grasses, which lose protein and energy content once they head out.

Courtesy of Dan Undersander

A farmer straddles a sheep pasture in southern Bosnia that researchers left half-fertilized to demonstrate the effects of the treatment.

Simple as they sound, these lessons are vital in places such as Kosovo, where dairy cows typically yield 25 to 30 percent as much milk as herds in the United States. "We can do many things at no cost to the farmer that can often times double milk production," says Undersander, who has traveled to 45 countries for CALS and UW-Extension. "For a lot of these farmers, there's a real willingness to learn, but there's not a good source of information, so being there to say now is the time and show them how to do it is very important."

In Kosovo, Undersander worked with a project funded by the U.S. Agency for International Development to do just that. On six trips to the country—once part of the powerful Soviet agricultural belt, but more recently scarred by war and ethnic conflict—he introduced concepts that many American farmers take for granted, such as growing corn for silage and integrating legumes into forage grasses. He also helped researchers at the University of Pristina calibrate equipment for testing forage quality.

But the real signs of progress may be in the smallest details. When a group of farmers received a grant to buy a bale wrapper, for instance, they had little mastery with the equipment, and their bales were soon full of holes. The plastic tape they used to patch the bales melted in the sun. When Undersander saw the degrading bales, he offered a simple fix: duct tape.

"It's one thing to give these countries donations of equipment, but they have to have the training to go with it," says Undersander. "Without the proper training to use the equipment effectively, it won't do them much good."

—Michael Penn

Turning a New Leaf

At Allen Centennial Gardens, director **Ed Lyon** is rejuvenating the landscape with new plants—and a new idea about how gardens fit into our busy lives.

As a graduate student, Ed Lyon ms'01 spent many hours toiling in and admiring CALS' Allen Centennial Gardens. In fact, the 2.5-acre garden inspired his career. Now, after stints at the Chicago Botanic Garden, Madison's Olbrich Botanical Gardens and Janesville's Rotary Botanical Gardens, he's come back home to direct activities at the popular Allen gardens. It's a job that requires balancing the garden's role as an educational resource with its wide appeal among alumni and the community.

What's this lovely garden doing in the middle of the CALS campus?
Our primary mission is to be an outdoor classroom. A lot of different students use the gardens for different purposes. We have music students and art students come do projects here; it's not just horticulture or landscape architecture students. We also strive to be an educational resource for the public and the whole horticultural industry.

What was your most immediate concern when you became director last summer?
Rejuvenation. Because the garden is 20 years old, an awful lot of the plant materials that were originally planted here are either overgrown or not the most appropriate plant materials any more. So probably the biggest things I've been doing since I got here are massive weeding, getting things back in control, cutting a lot of stuff out and then bringing in new plant materials that are more appropriate.

What do you mean by more appropriate?
Do you remember the big burning bush tree at the front of the house? Well, I took that out. It was too big and it blocked the house, plus burning bush is now on the list of invasive plant species. I don't feel I can be responsible in running a public garden if I have plants in here that are on the invasives list. I took out some other overgrown plant materials nearby and then replaced it all with five different kinds of small-scale maples. These are more appropriate to the small-scale garden that most people have today.

What is your vision for the future of the gardens?
There is a huge change occurring in our industry right now, and most of my vision for where this garden is going to go over the next 20 years is based on this change. Our past audiences were baby boomers and older. They're the home gardeners—they're the ones that have English perennial borders; they are the ones doing ponds and streams. I'm on the tail end of that generation, and I'm typical of that. My entire yard—even right to curbside—is garden.

This happened because the baby boomers raised their children and then in their 40s decided they wanted a hobby. They probably had an agrarian background or a mother or grandmother who had a vegetable garden. It was sort of this psychological connection to their past that made them start gardening. But that audience is disappearing. They're downsizing their homes and moving into condos.

Who's the new audience, then?
It's the X and Y generations. These are the kids that moved out of the house before Mom and Dad got involved in home gardening. They don't have that same attachment and recollection about gardening. They are probably both working, and so they don't have as much free time. They want to spend their weekends doing things with their children and not maintaining an English perennial garden. We call them the do-it-for-me generation. They want somebody to come in and trim the hedges and mow the lawn so they can spend their quality time doing something else.

Can you attract these people to gardening?
I think you can. They are very interested in ecology and food issues. They are interested in the safety of their food and where it comes from. Farmers' markets are huge. Organics and sustainability, those are big issues, too.

How will you address these interests at Allen?
Eventually, we want to have a home demonstration garden where we will do composting and have rain barrels. Maybe we'll do worm castings. It's all part of making the garden more organic and more Earth-friendly.

Are you starting to move in that direction?
Actually, we have two areas in the garden where we're doing some experiments: the vegetable garden and the lawn. This year, we're splitting both of those areas in two. One half is going to be fertilized with compost tea and the other will be done traditionally. We're going to try this for a couple of years and then see if there's something to these compost teas.

And what about food issues? Can the vegetable garden play a role there?
That's the goal. We don't want to just grow and demonstrate these plants—we want to use them.

When I was at Rotary Botanical Gardens, we did large displays involving heirlooms and ornamental

"We must always have these kinds of places, where people can go simply for beauty, relaxation or solace."

edibles, as well as standard vegetable crops. When those vegetables were harvested, we held public tastings and festivals, and we also sent thousands of pounds of fresh produce to local food banks. Unfortunately, I do not have the labor force to do that here, but we are trying to connect with some other groups on campus to make use of the harvest.

This year, (food science instructor) Monica Theis helped us set up an arrangement with UW Housing's catering unit, which will use our produce through the season. They will serve it at Frank's Place, and they are planning some special events to feature the produce. So it's a great partnership, because connecting with Housing and with Monica and her students gives us the labor and expertise we need to do this.

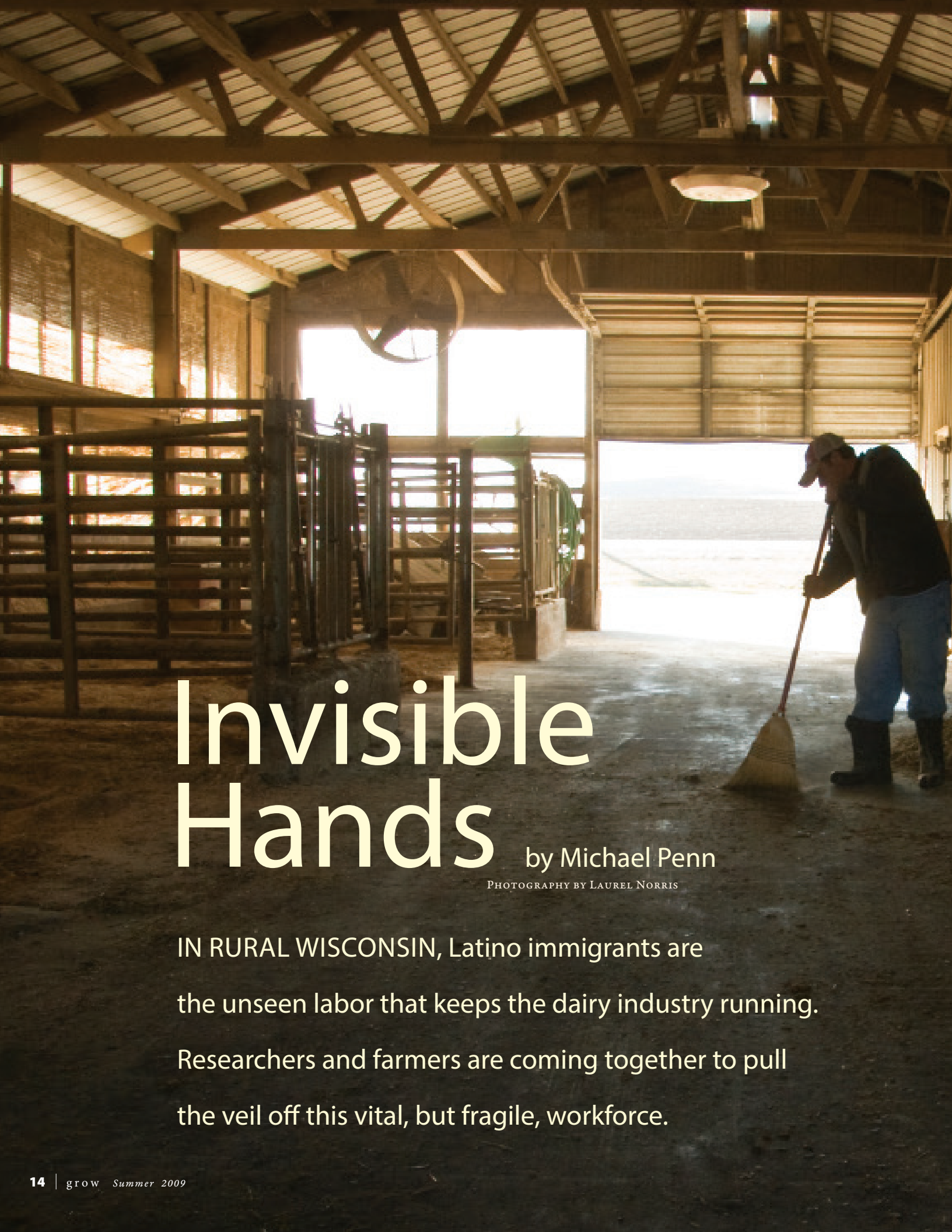
So you're closing the loop. Is that an important part of the message?

The first reason this is important is because I was raised by farm-based parents who lived through the Depression and scarcity of food. So I don't waste! But it is also important because these kinds of relationships allow us to expand our educational base and our worth to the community. This is just one small step in that goal.

What reaction do you get when you share this vision with your traditional patrons?

When I started describing my vision in talks, I got a number of people saying, 'Oh, no, he's going to move away from this being a beautiful garden.' But that's not it at all. There will always be areas of this garden that will be there for the beauty, the solace, the relaxation and the inspiration because that's a very important part of a public garden.

I was at Chicago Botanic during 9/11, and on that day, they closed every public museum in Chicago. We stayed open because we were north of the city. I have never seen more people from more different cultures and backgrounds flood into a place than they did that day. And that's when I really recognized we must always have these kinds of places where people can go simply for beauty, relaxation or solace. So that's not something I'm going to take away. Beauty will always be part of what we do here. Even when we do home demonstration areas, we'll always do things in an aesthetic way.



Invisible Hands

by Michael Penn

Photography by Laurel Norris

IN RURAL WISCONSIN, Latino immigrants are the unseen labor that keeps the dairy industry running. Researchers and farmers are coming together to pull the veil off this vital, but fragile, workforce.

The cows amble toward the milking parlor with a languid ease that brings a smile to Magdaleno Tecpile's face. Such divas, those ladies. He whistles softly at the laggards, nodding toward the open gate at the front of the pen, before returning to the task of scraping their droppings from the barn floor.

"They will go by themselves," he says in Spanish. "They know when it's time to be milked."

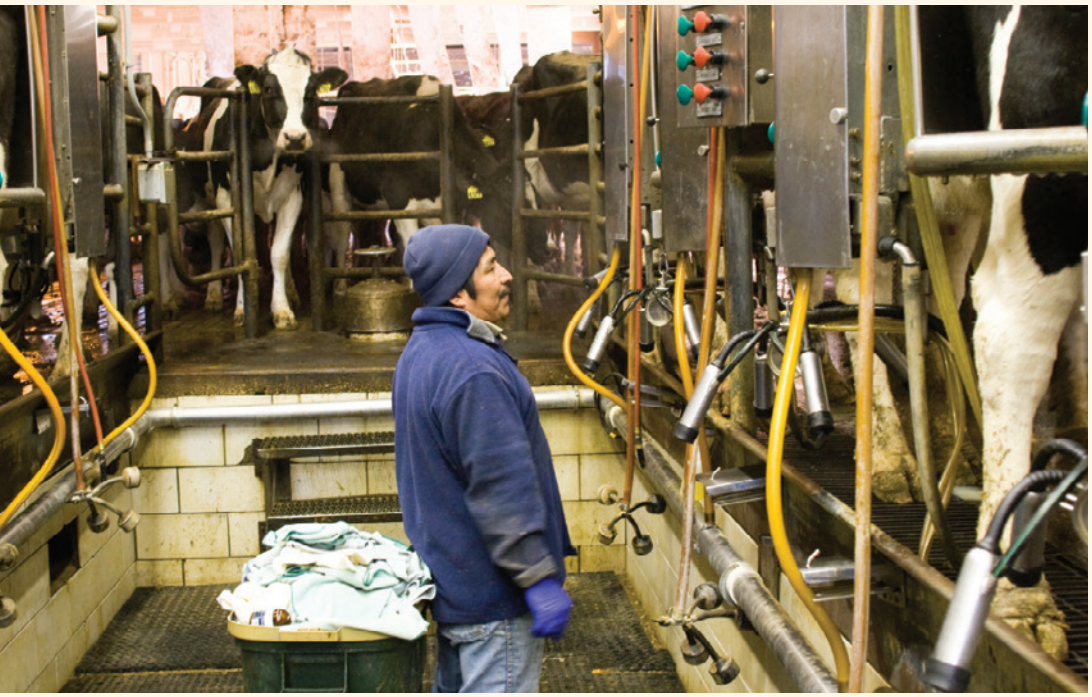
Days begin early for dairy workers like Lioncio Tentzohua, here sweeping the barn clean shortly after sunrise.

In the daily rhythm of a modern dairy, routine breeds familiarity. It's true for the cows, and so it is for Tecpile (pronounced Tec-PEE-lay), a dark-eyed young man whose face holds a strong memory of boyhood. Two years ago, living with his family in a village in rural eastern Mexico, he had never touched a dairy cow. Now he milks several hundred during a single 10-hour shift in the barn. For six days a week and 312 days a year—no holidays on a dairy farm—he ensures the uninterrupted flow of milk on the farm, one of the largest in Wisconsin's Buffalo County. Without employees like him, owner John Rosenow says simply, "I would be in serious trouble."

Rosenow is not alone. From Manitowoc to the Mississippi River, Wisconsin's signature agricultural industry increasingly depends on people such as Tecpile—immigrants, chiefly from Mexico and Latin America, who followed the path of economic opportunity thousands of miles to the American heartland. According to a new study led by CALS rural sociologist Jill Harrison, at least 5,300 foreign-born laborers now work on Wisconsin dairy farms, representing more than 40 percent of the farms' hired labor. On dairies with 1,200 cows or more, seven in 10 workers are immigrants, working an average of 57 hours a week.

Those figures describe a fast-moving trend that has fundamentally changed the face of Wisconsin dairy in the past decade. But they also hint at issues that deeply divide the American political landscape. It is likely, for example, that a significant number of these new immigrants lack legal authorization to work in the United States. Although Harrison's study didn't ask about documentation—mostly because the answers workers offer to survey takers on the issue are predictably unreliable—other estimates say 40 to 70 percent of immigrants working in U.S. agricultural jobs are undocumented. Similar findings have been made in surveys of construction and hospitality workers, two other occupations that have become significantly populated by immigrants. Depending on whom you ask, the reliance of these industries on illegal workers is either an economic necessity or an intolerable flaunting of the law. Either way, it raises hard questions about national immigration policy, a debate that swirls in deeply held passions about economics, race and justice.

But in Buffalo County, those tensions play out on a smaller stage, in the daily thrum and churn of dairies like Rosenow's, where the milking never stops in a parlor filled by the sounds of salsa music. "This is probably the biggest change to come to this community in 150 years," says Carl Duley, UW-Exten-



On John Rosenow's farm, Latino employees handle indispensable tasks of the business. In the milking parlor, Severo Rosales Sanchez (left) and Magdaleno Tecpile (far right) keep the flow of milk going around the clock, while Lioncio Tentzohua watches over newborn calves.

sion's agricultural agent for the county. And with change comes challenge ... and opportunity.

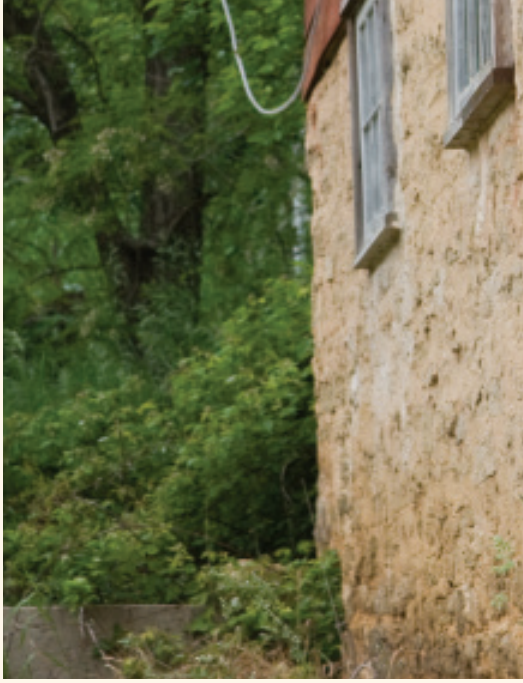
Shouldered against an eastward jog of the Mississippi River an hour north of La Crosse, Buffalo County is archetypical Wisconsin dairy country, where cows outnumber people by nearly five to one. Some 200 dairy farms dot its 712 square miles, a rolling terrain of verdant valleys and towering bluffs that climb like stairs from the river basin. When German and Norwegian immigrants arrived here in the 1850s, they planted those valleys with wheat, but battling insects and the sloping terrain proved too much. Buffalo County has tied its fortunes to animals ever since.

Among those early immigrants were John Rosenow's great-grandparents, Swiss and German homesteaders who settled on an emerald sward of pasture a few miles east of Alma, the county seat. By the time Rosenow inherited the farm in 1972, it was already among the county's largest, milking a herd of 100 Holsteins. Through modernization and mergers with neighboring farms, Rosenow has grown the operation to 550 cows, which mill about under an enormous free-stall barn.

As the farm grew, its unrelenting demands took a toll on Rosenow and his business partners. "We were really working our tails off, putting in 90 and 95 hours a week regularly. And we still weren't getting things done the way we wanted," he says. Hired help came and went, and after a while, it didn't come at all. With the roaring 1990s economy pushing unemployment to historic lows, the labor pool in rural America all but dried out. "Everyone who hired employees outside the family was struggling to fill positions," recalls Carl Duley. "There was just no labor."

Crop farmers filled the gaps with students and foreign workers, who can be hired legally under temporary seasonal work permits. But those programs offered little help for dairy, where the need for labor is year-round. Rosenow tried to make do with the peripheral characters who showed up seeking jobs, men who often sunk into drug or alcohol addiction and mishandled the cows. But by 1998, he was desperate enough to try a last resort. He flipped to the back of his Hoard's Dairyman and found an ad for a Texas agency called Amigos, which offered assistance in finding Mexican workers for dairy farms. He wrote a check for $375, and a short time later, he drove to the bus station to pick up a man named Manuel. Not knowing a word of Spanish, Rosenow sat Manuel in his milking parlor and demonstrated the equipment. "He started work the next day, and he worked the next 54 days straight," recalls Rosenow. By the end of the year, he had hired two more workers through Amigos. Now, nine of his 20 employees are Mexican.

Rosenow admits that he was at first daunted by hiring foreign-born work-



ers. He fretted about communicating with employees who spoke no English. Having never known anyone from Mexico, his assumptions were framed by the stereotypes he saw in movies. But his illusions evaporated when he saw the results in the barn. "They're very gentle with the cows," he says, noting that the amount of milk the dairy loses due to mastitis is one-third the state average. "They're reliable and consistent, and they want to work hard."

Rosenow is not blind to the circumstances that drive that reliability. For men like Magdaleno Tecpile, farm labor offers an escape from devastating poverty at home, where jobs, if they can be found at all, often pay less than $10 a day. On Rosenow's farm Tecpile makes more than nine times that, sending a significant share back to Mexico to support his extended family, including a wife and an eight-year-old son he hasn't seen in two years. He wants little more than to earn enough money to give his family a better life.

But in truth, there are few other options. Dairy hours are too long and physically taxing to allow for much socializing. Driving is risky, as most immigrant workers lack U.S. licenses. Instead, the men on Rosenow's farm unwind in the apartments that he provides for them, traveling into town for groceries and the occasional stop at the post office. Tecpile spends much of his free time in Rosenow's workshop, where he is learning woodworking in hopes of opening a furniture shop in Mexico. Asked if he ever gets bored, he shakes his head no. "For now, this is the option I have, and I like it," he says through a translator. "But if we had to leave or couldn't work here any more, I would do any job, as long as I can work."

This sense of social invisibility echoes through Jill Harrison's research, which paints an intimate portrait of the dynamics of the new wave of immigration. In 2008, Harrison and her graduate students fanned out over 83 dairy farms to ask owners and workers about their jobs, from the mundane minutiae of wages and benefits to more searching questions about their hopes and ambitions. What they heard were the tales of people who live in the shadows of a society that rarely acknowledges their presence. Workers spoke of pride in their jobs and their desire to learn new skills, but they also related fears about living outside the system—fears that often kept them from branching out into their communities. Although nearly all of the workers in Harrison's survey said they wanted to learn more English, for example, very few said taking classes was a viable option. "They don't want to make themselves visible any more than necessary," says Harrison.

A native Californian with a Ph.D. in environmental studies, Harrison knew little about Wisconsin dairy when she was hired by the university in 2006. But her doctoral thesis, a study of California's lax regulations on pesticide application, gave her a taste of the uneven terrain of farm labor relations. Her research concluded that power inequities kept immigrant workers from reporting medical problems related to pesticide exposure, potentially obscuring the true depth of the harm.

When she began studying Wisconsin farms, she saw similarities, but also some notable differences. While California leans on seasonal workers to harvest fruits and vegetables, for instance, dairy's year-round work makes Wisconsin's immigrant laborers somewhat more firmly rooted. The average worker in Harrison's surveys had been at the same job for nearly three years. Twenty percent of the workers are women, and a growing number live with spouses and children. In many ways, they resemble the European immigrants who settled Wisconsin in the 1800s, she says.

But Harrison cautions against reading those data as signs of absolute stability. "There are different dynamics in place now that create significant vulnerabilities for both employers and for employees," she says.

The most significant risk comes from the shifting winds of U.S. immigration policy and enforcement. When Wisconsin dairy farmers began hiring foreign workers in the 1990s, the U.S. government generally regarded the possibility that those workers lacked proper documentation with a winking nonchalance. The 2001 terrorist attacks brought on a harder attitude, and border security and law enforcement have intensified significantly. Farmers are especially worried about the aggressive tactics of the Department of Homeland Security's Immigration and Customs Enforcement division, which has raided dozens of farms and factories suspected of employing illegal immigrants. In 2008, ICE raids led to the deportation of more than 6,000 immigrants, a fact that terrifies farmers such as Rosenow. "Of all the worries we have to deal with on this farm, that's the biggest. It's whether ICE will come knocking," he says.

Many dairy farmers have stepped up efforts to change the system. Rosenow serves on a governor's committee that has proposed driver's certificates and other social services for foreign workers. Nationally, industry groups are pushing a bill currently before the U.S. House of Representatives that would extend the term of seasonal H2A work permits to

Jill Harrison doesn't accept the argument that foreign workers are gaming the system by entering the United States illegally. "Really, the system is gaming them," she says.

three years for dairy and sheep workers.

Laurie Fischer, executive director of the 750-member Wisconsin Dairy Business Association, says the changes are necessary to address the shifts in the labor market that began in the 1990s. "The workforce in the United States is in decline, and we can expect this trend to continue," she says. "Even during times of high unemployment, our members find that few native-born employees are interested in working on dairy farms and very few apply."

But the opposition to such measures is well organized. Groups such as NumbersUSA, a policy organization that says it represents more than 1 million members, claim that such reforms create amnesty for illegal immigrants and rob Americans of job opportunities. Heated arguments over amnesty helped kill a 2007 bill that would have expanded and enhanced guest worker programs. And while many farmers are encouraged by President Obama's recent rhetoric on immigration, the reform package remains stalled in a congressional committee.

To Rosenow, the inertia reveals something dark about Americans' complacency on the issue. "We want these people to do the jobs that they're doing, but we don't want to see them," he says. "We want them to pick our strawberries and our apples, but we don't want them to have any rights. We don't want to learn their culture, and we don't want to change ours. It doesn't make any sense."

Except that it might make perfect sense. As Harrison points out, keeping foreign workers in legal limbo creates a powerful incentive for workers to accept whatever conditions they are offered.

"You hear people say that these workers are gaming the system (by not coming here legally), and in some ways they are. But I don't think that's the real story," she says. "Really, the system is gaming them. We benefit tremendously from their labor, and it's high time we recognize that. It's time to bring them out of the shadows."

The thing about shadows, though, is that they can be a safe place to hide. And for ethnic and cultural minorities, the light is not always kind.

Just east of Buffalo County, Trempealeau County's Latino population has grown by a staggering 940 percent since 1990, one of the most profound demographic makeovers in the country. Previously homogenous towns such as Arcadia, where two large factories employ many Latino workers, have become suddenly cosmopolitan, and the transition has not always been easy. In 2006, Arcadia mayor John Kimmel made a hamfisted attempt to appease concerns about illegal immigration by proposing a passel of anti-immigrant ordinances, including a mandate that town business be conducted only in English and a curious ban on flying flags of other countries unless they were accompanied by an American flag. The ordinances failed, and Kimmel later apologized.

Buffalo County has not experienced such incidents, but the relative harmony may be deceiving. According to the Pew Hispanic Center, just 132 of the county's 13,812 residents in 2007 were Latino. Many of those live on dairy farms, isolated from the kind of cultural interchange that can lead to conflict.

"We're still in that awkward place right now, where there's not a lot of real connection," says Shaun Duvall, a former Alma high school Spanish teacher who runs Puentes/Bridges, an organization that fosters cultural exchange among farmers and Latino workers. As the name suggests, Puentes is about building bridges, using both language instruction and cultural immersion to help farmers and workers find common ground. Duvall visits 40 farms each month to translate and teach language classes, and she leads annual trips to Mexico to introduce farmers to the culture and economic conditions of their employees' homeland.

"The whole point is understanding," she says. "If we just try to make them be like us, what have we gained? We haven't learned anything."

And around Alma, there are signs of cultural integration, such as the one posted on the window of the town's one-room public library: "Hablamos Español … un poquito." Inside, librarian Marie Marquardt shows off a shelf of recently acquired Spanish instruction guides, which sit next to a new computer purchased with grant money. Last fall, Marquardt and Duvall organized a Spanish language primer that was attended by 17 local business owners. They hope to repeat the course again this year.

But no one in Buffalo County expects the learning to be fast and easy. At a coffee shop overlooking the barges that steam down the Mississippi, Carl Duley relates a story about an unincorporated town just up the highway, where a German Lutheran church still stands across the street from a Norwegian Lutheran church. "It wasn't until pretty recently—maybe the last generation—that those two churches talked to each other. One service was in German and one was in Norwegian, and that lasted for about 50 years," he says. "So this is nothing new. But we hope we can do some things to make it go a little faster this time."

The Drugs S

Many forms of microbial life have the ability to produce antibiotics, from red-hued fungi growing in a Petri dish to bacteria that live in the frozen soils of Alaska (facing page), here studied by CALS researcher Lynn Williamson.

With the world's supply of antibiotics growing old and ineffective, academic researchers are leading the way in developing the next generation of microbe fighters.

Start Here

By Nicole Miller MS'06

If you were to develop one of the highly drug-resistant strains of tuberculosis, your survival might come down to a dose of capreomycin. For doctors trying to fight these newly emerging strains—the most dangerous form of the common bacterial infection—this antibiotic is a drug of last resort. If it doesn't work, the fight is essentially done. "It doesn't matter what you give them after that," says CALS bacteriologist Michael Thomas. "You can't treat them."

While much of the planet is already facing a TB epidemic—2 million people died from the disease last year and as many as 2 billion are carriers—things could be much worse without capreomycin. It is deemed so valuable that it is listed as one of the planet's essential medicines by the World Health Organization. Because bacteria evolve resistance to the weapons we throw at them, doctors are being urged to use capreomycin sparingly to preserve its killing power until something better comes along.

But new antibiotics rarely come along. During the past 38 years, only two truly novel antibiotics have been discovered, and pharmaceutical companies have largely backed away from the business of tweaking existing antibiotics to enhance their power. Capreomycin, for instance, was discovered in 1956.

The lack of activity on antibiotics is partly due to the early success of those drugs. They worked so well—and everyone assumed they'd continue working ad infinitum—that many large pharmaceutical companies dropped their antibiotics discovery programs. By the time drug resistance became a recognized problem, it no longer made sense to restart them. "It costs an obscene amount of money to develop a drug now," explains Thomas. "And there just isn't enough money (to be made in antibiotics) because when you take an antibiotic you get cured." Drug companies prefer the profit potential of medicines for chronic conditions such as high cholesterol, where patients may spend years or decades on a medication.

Pharma's disinterest has created a potentially explosive situation where our bacterial foes have evolved while the drugs to fight them mostly haven't. In microbiology circles, people are saying there will be 15 untreatable infections within the next 25 years if things don't change quickly. "Sometimes I feel like I'm being a doom-and-gloom, Chicken Little type," says Jo Handelsman PhD'84, chair of the bacteriology department. But the talk she's hearing lately tells her "it's even scarier than I say it is."

But the urgency has brought on a paradigm shift within the research community. Scientists who for decades devoted themselves to basic research have shifted gears to discover new antibiotics and improve existing ones. And they're getting support from agencies such as the federal National Institutes of Health, which has embraced the notion that academics can help bring the next generation of antimicrobials to market.

"A few years ago if I had said, 'I want to make new drugs in my academic lab,' the NIH would have responded, 'That's not the kind of work we fund,'" says Thomas. "Now they are taking it very seriously, supporting the type of research that discovers new anti-infectives, because they know there's this gap now."

Our bacterial foes have evolved while the drugs to fight them mostly haven't.

The next generation

Before antibiotics, contracting a microbial infection was often a matter of life and death. Created by bacteria and fungi to kill off competing microbes, these molecules were first co-opted by Western medicine during World War II, when penicillin worked wonders warding off infections in military hospitals. That success launched a flurry of drug discovery, during which antibiotics were located and refined as treatments for many conditions, including cholera, typhoid fever, malaria and staph infections. But over time, the bugs adjusted, and many diseases that we once considered defeated have re-emerged. And new ones have cropped up, including so-called "superbug" infections that resist virtually all known antibiotics.

In the lab, Michael Thomas is using NIH funding to try to extend the life of capreomycin, as well as its close cousin, viomycin. Capreomycin was originally discovered in a bacterium called Saccharothrix mutabilis, which does not lend itself to genetic manipulation and thus limits the ability of researchers to re-engineer its production. But Thomas transferred the entire gene cluster from the original bacterium into another host that was easier to work with. He now knows the sequence and function of all of the genes involved in the production of the two antibiotics, allowing him to mix and match genes and change the nature of the antibiotics that the bacteria produce. Through this work, Thomas's team has created 10 new compounds based on the structures of capreomycin and viomycin. And while these were made to prove the process works, each has a chance of becoming a real drug. Thomas's lab will complete the initial testing of antibiotic activity and then forward promising candidates to the feds.

"The nice thing about having NIH

In Marcin Filutowicz's lab, student Carly Campbell probes bacteria in search of molecules that block plasmids, the small pieces of DNA that microbes swap to gain resistance to antibiotics designed to kill them.

funding is that if we have something above a certain minimum (antibiotic activity level), the NIH will actually take the molecule—if you can provide them with enough of it—and do the mouse models and the in vitro analysis to figure out if it is actually a promising drug," he says.

In the case of TB, the need for such new drugs is acute. Worldwide, 2 billion people carry the bacteria that cause TB—one of every three people on the planet. And while most of those people have the ability to keep the disease at bay, approximately 8 million people suffer from the active form of the disease, which causes lung damage that in severe cases can be fatal. In the United States, TB causes more deaths than AIDS, and as many as 10 million people are believed to carry the latent form.

About 40 years ago, when more than a handful of powerful anti-TB drugs were still working, public health officials declared this disease eradicated, at least in the developed world. But "TB never really went away," explains Thomas. "It's a disease of civilization, and it spreads very easily. So wherever you have a lot of people living in a confined environment, you're going to have TB." This makes drug development critical for warding off the spread of the deadlier, drug-resistant strains of TB. Because the global threat is so great, several companies have agreed to

take whatever promising molecules that researchers like Thomas produce in the lab and build them further.

To Handelsman, this model represents an intriguing way to get more new antibiotics into the pipeline. It's clear why pharmaceutical companies are reluctant to jump back into antibiotic discovery. The costs of research, development and clinical trials, combined with the limited window offered by patent protection, makes investing in the area risky. Handelsman says pharmaceutical company representatives have reminded her that they're not in business to do things out of the goodness of their hearts; they have an obligation to shareholders to pursue profitable strategies. "And that's a reasonable position," she says. "If they can't make the books balance, it would be irresponsible for them to do it. On the other hand, someone has got to take responsibility for solving this crisis."

The solution will likely require some direction from the federal government, which could either change the patent rules to make antibiotics research more alluring or fund nonprofit groups to take over. But the partnership approach being taken with TB drugs may be even more appealing, Handelsman says. "If academic labs did the hard part—the discovery part—and took antibiotics to a reasonable level of discovery, like animal trials or something like that, I think the drug companies would pick them up," she says.

The natural solution

But engineering antibiotics is not the only approach. Handelsman is among a group of CALS scientists who believe

By genetically tweaking the structure of the antibiotic capreomycin, bacteriology professor Michael Thomas has engineered 10 new compounds that may turn out to be more effective in treating highly drug-resistant forms of tuberculosis.

that we've far from discovered the best that nature has to offer in fighting microbes. In her case, she's studying soil, which has been a rich source of antibiotics in the past. Approximately two-thirds of the antimicrobials used in medicine today trace their origins to soil microbes, which use these small molecules—much as we humans do—to engage in microbial warfare. In the soil, bacteria and fungi release antibiotics into the environment to kill or inhibit the growth of their neighbors and give themselves a competitive advantage in the hunt for resources and territory. But Handelsman, who studies how microbial communities function, suspects these small molecules may also play a second, more subtle role in microbial community dynamics.

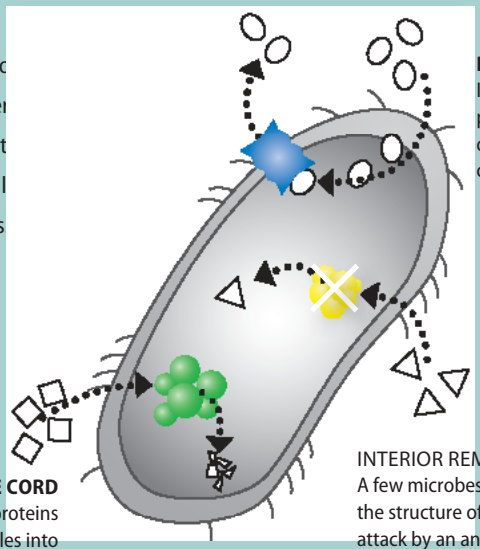
"Many antibiotics are produced at levels that are too low to be inhibitory," she says. "So we're exploring the hypothesis that antibiotics are actually signaling molecules, and that at low concentrations they provide bacteria with a way of (communicating with) each other."

Since only 1 percent of all soil microbes can be grown in the lab, metagenomics may open the door to a host of previously inaccessible antibiotics.

In the past, Handelsman's efforts to understand the inner workings of microbial communities were hampered by the very nature of these organisms. Only a tiny fraction of soil microbes—as few as 1 percent—can be grown in test tubes and on Petri dishes, meaning that scientists hadn't really even made a dent in observing microbial communities. Handelsman helped develop a revolutionary method known as metagenomics that unlocks this world. Using metagenomics, scientists can access all of the genetic material in a microbial sample without having to grow a thing, which is expected to open up a host of previously inaccessible antibiotics.

How a Superbug is Born

In nature, microbes can become resistant to antibiotics in a co
One is through random mutation. This occurs when chance e
an organism's genetic code, giving it resistance to a given ant
But microbes can pick up resistance genes by swapping small
pieces of DNA—known as plasmids—with neighboring bugs
Once resistance is acquired, it gets passed on to all of the microbe's descendants. Typically, resistance genes allow microbes to fight back against antibiotics using one of these three methods:

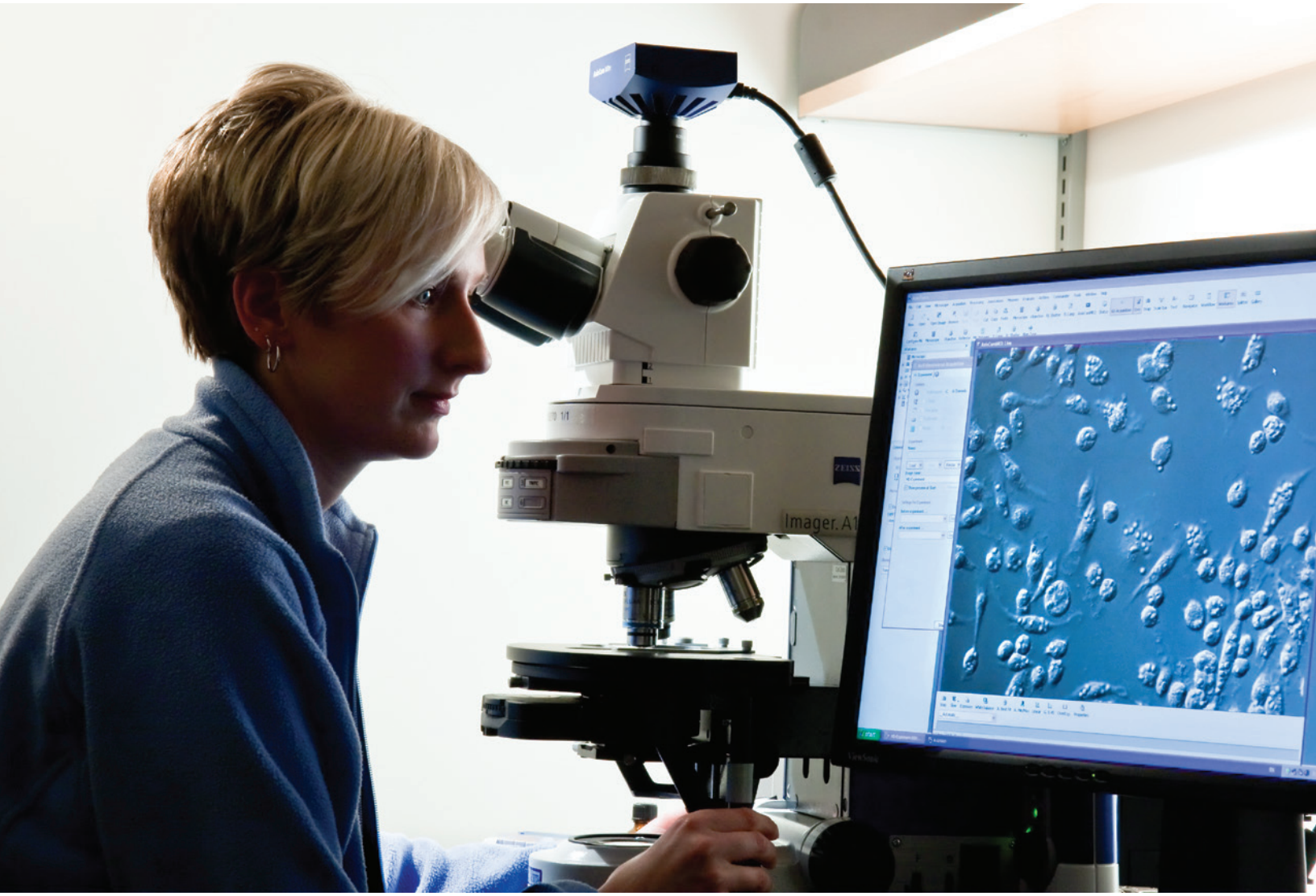


PUMP AND RUN
In this model, microbes pump the antibiotic out of the cell, where the drug can't do them any harm.

CUT THE CORD
Some microbes deploy special proteins that cut antibiotic molecules into pieces, rendering them powerless.

INTERIOR REMODELING
A few microbes have the ability to alter the structure of cells or molecules under attack by an antibiotic, minimizing damage and allowing the microbe to survive.

Illustration by Robin Davies



Fungal spores light up the monitor of a digital microscope as research associate Taylor Dagenais examines how they interact with white blood cells. Fungi produce an array of chemicals that can be toxic to both humans and pathogenic microbes, an ability that researchers believe may point them toward novel antibiotics.

"Because the culturable organisms in the soil produce antibiotics, we're predicting that the unculturable ones do as well, and maybe they produce different ones," says Handelsman.

Metagenomics has already helped unearth a novel antibiotic in another kind of natural system. CALS bacteriologist Cameron Currie used the technique on a colony of leaf-cutting ants to get a genetic picture of the bacteria that help the ants protect their food source from fungal invaders. The ants harbor these beneficial bacteria in small cavities in their bodies and use the antibiotics they produce to kill off the fungi that attack their larders.

Another CALS bacteriologist is taking a different tack by manipulating microbial DNA to find new antibiotics. Nancy Keller found a way to trick a kind of fungus that she studies into ramping up production of all the antibiotics and other accessory chemicals it is capable of making. The approach has shown that fungi, even well-studied ones, have the capacity to produce significantly more antibiotics than scientists originally thought. Keller says the approach is likely to work on other closely related fungi, meaning it could be used to search across hundreds of fungal species for promising new drug candidates.

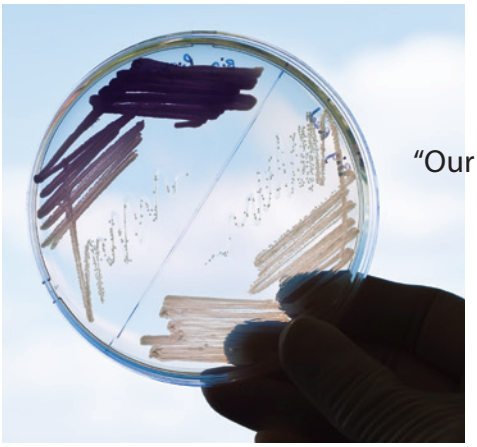
Plasmid assassin

While his colleagues search soils and other natural systems for new antibiotics, Marcin Filutowicz makes a compelling point: Why do we even need to rely on antibiotics to kill microbes? Other approaches might work just as well, if not better.

Filutowicz, also a professor of bacteriology, favors plasmids, which are small, auxiliary pieces of DNA that microbes often carry in addition to their core chromosomal DNA. Normally, plasmids are a boon—containing genes for antibiotic resistance, for instance—and microbes readily swap them around. Filutowicz, however, figured out how to turn these genetic elements against their hosts.

To make it work, Filutowicz created a renegade bacterium capable of swapping designed-to-kill plasmids with targeted pathogenic microbes. Once inside, the plasmids replicate uncontrollably until they kill the organism. "This technology is based on the idea that we can use the good bacteria in our bodies to combat the bad guys," says Filutowicz. "It's a versatile concept that doesn't apply to just one infectious agent." In 2002, Filutowicz cofounded a company called ConjuGon to begin developing killer plasmids for the commercial market. The company has produced a plasmid treatment to ward off a drug-resistant infection in burn wounds, which is administered by rubbing the plasmid-delivering bacteria directly on the affected tissue. Already, this approach has proven successful in animal trials. "It's a terrible pathogen nowadays," says Filutowicz of the bacterium that causes the infection. "Soldiers are dying because of this. It's resistant to all clinically relevant antibiotics, so the (U.S.) Army is very much interested in this technology." Not surprisingly, the U.S. Department of Defense has been a big supporter of ConjuGon's work over the past few years.

These days, Filutowicz is at work developing a second plasmid-centric antimicrobial technology. In this case, the plan is to deploy small molecules to strip away the plasmids that allow microbes to produce toxins, resist antibiotics and pass these traits on to others. The key thing about this technology is that, by getting rid of antibiotic resistance genes, it has the power to rejuvenate older antibiotics, giving powerless drugs the ability to kill again.



"Our obligation to society is not only to produce basic knowledge, but to produce knowledge that can benefit people relatively quickly."

"This is like a new venture into a new class of antimicrobials that do not kill, but they attenuate bacteria. They disarm bacteria," says Filutowicz, who recently received NIH funding to develop this technology against Salmonella enterica, the type of bacterium that causes salmonella poisoning. For this project, Filutowicz will collaborate with Handelsman and Thomas, a strategic partnership that gives him access to Handelsman's metagenomic libraries to search for plasmid-displacing molecules specific for salmonella, as well as access to Thomas's molecule-tweaking skills.

More than anything, Filutowicz would like to see a drug from one of his antimicrobial technologies come to market. Preferably more than one. He feels microbiologist have a moral obligation to do application-oriented work, and in order to promote this kind of work among his colleagues, he and Handelsman founded the Wisconsin Project for Antimicrobial Research, an initiative designed to bring campus scientists together in synergistic ways to develop new antimicrobial technologies.

"Madison's community of microbiologists is one of the most prominent and diverse in the nation, and our obligation to society is not only to produce basic knowledge, but to produce knowledge that can benefit people relatively quickly," he says. "I'd like to see the practical applications of the things we are working on become available within five to ten years."

So what to do while we wait for new treatments to become available? Simple: Wash your hands. "This is the oldest kind of public health problem, and the solution must encompass everything from the simplest things—from (people) simply washing their hands well—to the really high-tech solutions once people get these diseases," says Handelsman. "Personally, I think we should get rid of hand shaking as a cultural custom because it's really not very healthy." These are the kinds of small sacrifices we may soon need to make, measures that can help keep us safe until we find new weapons and regain the upper hand in this unending battle against our microbial foes.

Bigger storms and wider development are pushing a surge of stormwater into places like UW-Madison's Arboretum. CALS scientists say it will take a community effort to stem the tide.

WHO'LL STOP THE RAIN?

By Bob Mitchell '76

ON A HILLTOP ON MADISON'S FAR west side, David Liebl stands at the edge of a sea of sparkling new Toyotas. A salesman approaches, but Liebl's not shopping for cars. A UW-Extension educator and stormwater specialist, he's more interested in the lot itself, particularly an unpaved corner at the low end of the property. Lined with stones and an assortment of plants, this corner is sculpted into a shallow depression—a high-tech rain garden designed to divert water and the crud it's carrying from a nearby city storm drain.

"They need to get in here and clean this out," Liebl says, noting the thick layer of sand, leaves and trash that have collected in the basin. But he's not complaining too much. Every bit of material that makes its way into the drain becomes his problem. And Liebl has plenty of problems already.

Two and a half miles downhill from the Toyota dealership lies the UW-Madison Arboretum, a 1,200-acre enclave known worldwide for its collection of restored ecological communities. Bordering the shore of Lake Wingra, the arboretum sits at one of the lowest points in Madison, making it the final destination for much of the rain that falls on the city. Decades of rapid development on Madison's fringes have only worsened the problem. As more fields and woodlands are paved over to create roads, driveways and parking lots, the water arrives at the arboretum faster, dirtier and in greater volume. In one year, 115 million gallons of stormwater pass through an outlet at the western edge of Lake Wingra, reaching speeds of up to 2,244 gallons per second. The torrent has already blown out a pond built to contain it and carved a deep trench leading to the lake. The water brings with it layers of nutrient-rich sediment, which have created a delta that is filling in parts of the lake and are causing algal blooms.

"It's the same all over the arboretum. We have ponds full of sediment and ponds that are too small to carry these heavy flows," says Liebl, who chairs the facility's stormwater committee. The arboretum is already building a larger pond near the west end of Lake Wingra to contain the flow, part of a multimillion dollar effort to deal with stormwater issues. But Liebl says new ponds aren't the long-term answer.

"The arboretum can't keep giving up the natural areas it is trying to preserve," he says. "We need to treat that water and infiltrate that water somewhere closer to where it falls out of the sky and hits the ground."

BAD THINGS HAPPEN WHEN water travels. Most obvious are floods. When something prevents stormwater from soaking into the ground—say, a roof or a couple acres of asphalt—water follows the path of least resistance until it finds a place to settle. Maybe it's a lake or a stream, but maybe—in cases where there's too much water or too little penetrable ground to deal with it—it's a low-lying field or neighborhood.

But flooding is only part of the problem. Running water erodes the soil and picks up all kinds of nasty contaminants, including hydrocarbons from roads and metals such as zinc from galvanized roofing. Just as importantly, water that doesn't infiltrate the soil doesn't recharge groundwater, which contributes to the depletion of aquifers.

In 2002, these concerns led the Wisconsin Department of Natural Resources to issue new rules on stormwater management. Now communities and real-estate developers must have plans to infiltrate significant amounts of the rainfall they receive and reduce contamination in whatever does run off. For new housing developments, for instance, the DNR requires infiltration to be 90 percent of pre-development levels.

But the composition of a typical urban neighborhood makes reaching those goals challenging. Asphalt and rooftops are designed to repel water, and they do their job well. According to one estimate, 16 times more water runs off of a one-acre parking lot than a one-acre meadow. Considering that in an average medium-density residential development 20 to 50 percent of the landscape can be paved or shingled, this puts a lot of water on the loose.

And then there is the weather. Many climatologists are predicting that Wisconsin will experience more frequent violent storms as a result of global climate change. One such system, which hammered southern Wisconsin in June 2008, caused the most expensive weather-related disaster in Wisconsin history, flooding more than 800 square miles, closing hundreds of roads and causing $760 million in damages.

While those storms mostly spared the state's biggest cities, others haven't. Half of Milwaukee's 10 largest rainfalls on record have come during the past 20 years. That fact has stormwater managers worried, says Chris Kucharik, a CALS ecologist who studies the effects of climate change. At a meeting last summer, Kucharik reminded a group of municipal engineers about a storm that dumped 11 inches of rain on Vernon County during one day in August 2007. "I asked the stormwater folks, 'What would happen if you received 11 inches in Milwaukee?'" he recalls. "They kind of gasped, because they know that their stormwater and sewage systems would be overwhelmed."

If you ask David Liebl, that's because most of today's stormwater systems are based on yesterday's thinking,

"Traditionally, the idea was to move water as quickly as possible to the nearest surface water to prevent local flooding," he says. "But as you develop an area and have more and more impervious surface, the amount of water becomes difficult to manage and the impact downstream becomes more of a problem."

A good example is on the south side of the arboretum, where stormwater pours in from a neighborhood called Arbor Hills. Rain that falls at the top of the development surges down a concrete channel running through a 10-acre, park-like greenway, then under a six-lane highway into the arboretum.

"When the water's really flowing, it's like a southwestern arroyo—you don't even want to be near it," Liebl says.

The sediment eroded by that water has nearly filled a retention pond built in the 1980's. The pond will be rebuilt, but Liebl already knows it won't be enough. Detaining all of the water from Arbor Hills would require a pond three or four times as big as what's there now. So instead, Liebl is focusing on upstream solutions. "We estimate that up to one half of the stormwater reaching the arboretum from Arbor Hills could be infiltrated," he says.

To get that done, Liebl reached out to Anita Thompson, a professor in CALS biological systems engineering department. With colleague John Panuska PhD'06, Thompson assembled and advised a team of students to study the route the water travels, and find alternatives to get it into the ground. The students' proposal calls for the creation of three dry basins in the greenway to collect and infiltrate the water. Two of them would contain native plantings, like large-scale rain gardens. The third would double as a soccer field. The students estimate that this system could infiltrate as much as 80 percent of the water pouring into the greenway.

ONE INTRIGUING ASPECT of the system is that it came out of a discipline that marries biology and engineering. Agricultural engineers have been wrestling with runoff and sedimentation issues on farmlands

115 Million Gallons Down the Drain

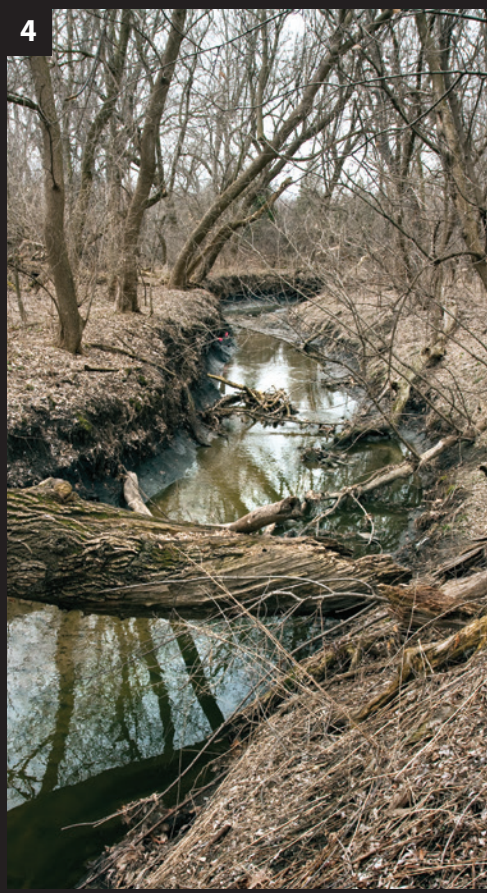
At the highest point in the Lake Wingra watershed, every raindrop begins a labyrinthine journey through ponds, culverts and channels to reach the UW-Madison Arboretum. It can take more than two hours for water to make the trip, which covers two and a half miles and a 260-foot vertical drop. Here are some of the key points along the way:

1

2

3

4



1 After draining from streets and driveways into a golf-course pond, water runs through an underground tunnel to reach a stone-lined channel designed to keep the pond from overflowing.

2 Some water bypasses the sewer altogether, flooding into neighborhood streets after big storms. One such event in June 2008 caused rapids to form on a street near the arboretum, delighting kayakers.

3 David Lieb stands near an outlet in the arboretum where storm-water pours down a cascade of rocks toward Lake Wingra a half mile away. More than 115 million gallons of water pass through this route each year, sometimes reaching speeds of up to 2,244 gallons per second.

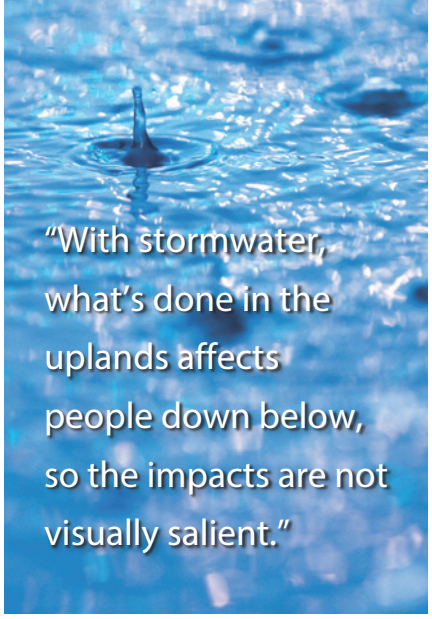
4 Near the west end of Lake Wingra, stormwater has carved a deep trench leading into the lake. Eroded sediment carried by the torrent has created a delta that is gradually filling the west end of the lake.

since the 1930s, and now that much of that land is growing houses, their expertise is coming in handy.

It's a natural fit, says Panuska, an extension specialist who works on nonpoint pollution projects in both urban and rural settings. "People in the soil and water area have an ideal skill set for this kind of work, because they have a background in biology, as well as engineering and hydrology. Runoff, erosion, water quality — all of these are areas that we have always dealt with."

Jeremy Balousek BS'97 MS'03 can vouch for that. After earning degrees in agricultural engineering, he now works as an urban conservation engineer for Dane County, dealing with everything from manure spills to runoff from golf course communities. "The practices really aren't any different. We're applying the same principles," he says. He points to a project he's doing with Panuska to convert software designed to predict agricultural erosion to work as a modeling tool for construction sites. "The soil loss equations were developed for agricultural land uses. We have to modify them to use for urban areas, but the science is the same. Some of the practices we use are different, because construction isn't done on an annual basis, but the science of how erosion occurs is exactly the same."

Over in King Hall, CALS' soil scientists are also finding the scope of their work expanding. Once dominated by agricultural research, the department is now home to researchers such as Nick Balster, a self-described "urban soil scientist." Much of Balster's work focuses on soils that have been altered by human activity, such as the highly compacted soils in most residential lawns. "Today houses are being built quickly and they're being built year-round," he says. "When you get equipment in there during the wet season moving around in the soil, you can cause pretty severe compaction, and you can disrupt the connection between pores in the soil." These kinds of activities squeeze shut the channels that carry water through healthy soil, making the earth as impervious as pavement.



That could turn out to be an important factor in the success of rain gardens, one of the most widely adopted home remedies for dealing with stormwater. Balster points out that to date, the published research on rain gardens has been done on newly planted gardens. He's currently watching over 12 rain-garden plots to try to understand the longer-term interactions between plants and soil. Do rain garden plantings help reopen those channels to filter water into the soil? And if so, which kinds of plants work best? And under what conditions?

"Rain gardens evolve. Soil and plants are in a dynamic marriage that's constantly changing," he says. "Our goal is to look at how these different gardens behave and learn what controls that behavior."

BUT THERE IS ANOTHER KIND of behavior that can aid or hinder efforts to deal with stormwater: human behavior. Back at the arboretum, David Liebl knows that the facility's water problems would be significantly reduced if residents in the Arbor Hills neighborhood took steps on their own properties to reduce runoff. The arboretum is working with Bret Shaw, an assistant professor of life sciences communication, to encourage neighbors to take steps such as planting rain gardens or installing rain barrels in their yards.

"The goal of that effort is to encourage people to take stewardship of water on their own property." Liebl says. "The hope is that as they begin to see the problem, they are motivated to do something about it, and they'll also support efforts like the greenway project."

And Arbor Hills residents did need some convincing. "The neighbors were concerned about conflicts with recreational uses," says John Panuska. "They don't want things that will infringe upon their use of the area or the aesthetics." But the neighborhood ultimately signed on, and with that approval in hand, city engineers intend to move ahead with the students' design.

Shaw, who has conducted environmental awareness campaigns in several Wisconsin communities, says the Arbor Hills project demonstrates the unique challenge to getting the public to participate in stormwater management. "With stormwater, what's done in the uplands affects people down below, so the impacts are not visually salient," he says. "That's what makes this situation interesting. In Arbor Hills, (the damage) is out of sight across the highway."

Last fall, students in Shaw's environmental communication class conducted surveys in Arbor Hills to gauge opinions on stormwater issues. The results show huge variations in awareness of the problems and readiness to address it—gaps that the students hope to close with a marketing effort targeted in the neighborhood. Shaw's near-term expectations are modest: He'd be thrilled if he could lift the number of rain gardens in the neighborhood by 10 percent.

"A lot of what I see my work doing is both improving immediate short-term outcomes, but also influencing a cultural shift," he says. "Let's be honest: How many people are really thinking about stormwater management today? But I think we're at the start of a nascent movement, where it's one more thing to do in an effort to live sustainably."

The Dark Night

Wisconsin's top bat man lives like his subjects.

For Dave Redell, night time is the right time to catch up with Wisconsin's bat population.

Dave Redell figures he'd make a lousy ornithologist.

"They are always up early," he points out. "If I were studying birds, I'd conclude there were very few out there because they do all of their singing in the morning."

Fortunately, the Wisconsin Department of Natural Resources researcher studies a species more in line with his schedule. As the state's leading authority on bats, Redell hangs out well past nightfall to observe and identify bats when they are most active. Several times each month, he sets up near the mouth of a Wisconsin cave to capture and measure bats as they emerge, often not finishing his work until 3 a.m.

"I was nocturnal before I worked with bats," Redell says. "If I let my internal clock determine things, I tend to stay up later at night and sleep later in the morning. Working with bats just pushed me about five hours later into the night."

Like many of his fellow DNR wildlife specialists, Redell's interest in wildlife was sparked by his undergraduate studies in CALS. After graduation, professor Scott Craven helped him find work with a private wildlife group studying the migration of bats living in an abandoned mine in Dodge County. That study became his master's project when he returned to CALS for graduate school and helped him get his current job. The DNR needed a bat expert to help address concerns about bats flying into the giant wind turbines being installed by the energy industry. Redell has experimented with ultrasound signals to deter the bats and encouraging wind farms to alter their schedules during peak migration times.

Another threat that concerns Redell is a fungus that has caused the death of more than a million bats in the northeastern United States since 2007. Although the fungus has not yet been identified in Wisconsin, it could arrive any day. "Since bats collect from thousands of square miles at a single hibernation site, one event could wipe out a large colony," Redell says. "Common bat species could become endangered, and those endangered now could become extinct."

Given that a bat can eat up to its own weight in insects every night, such a die-off could result in a glut of mosquitoes and crop and forest pests. Can we keep bats healthy and avoid the damage? That's the question that keeps Redell up at night.

—Bob Mitchell BS'76

wild things

The Grow Dozen

12 Alumni who are making a difference in wildlife biology

Egil Droge

Jerry Bartelt

MS'77, Wildlife Ecology

As chief of the wildlife and forestry research section of the Wisconsin Department of Natural Resources, Bartelt's charge was to provide the best possible science to guide the state's natural-resource policies. In 15 years on the job, he and his team tackled large-scale problems such as dealing with chronic wasting disease in deer and identifying sustainable farming practices that support wildlife and the environment. Bartelt recently took a two-year leave to lead the writing of a new DNR handbook on ecosystem-management planning. He credits CALS for instilling a sense of pragmatism that guides his approach to his work.

Matt Becker

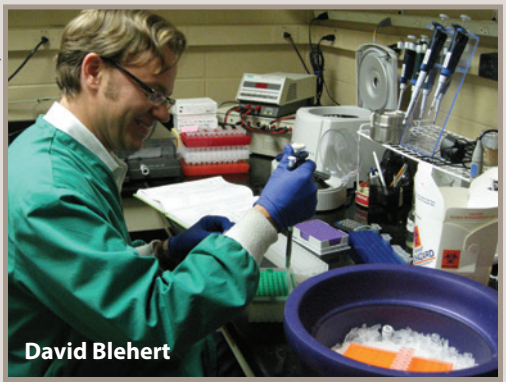
BS'96, Wildlife Ecology, Entomology, Biological Aspects of Conservation

Becker is chief executive officer of the African Wild Dog Conservation Trust, where he is working to save the second-most endangered carnivore in Africa. Only 2,000 to 5,000 of the dogs remain in the wild, primarily in protected reserves, but Becker's organization is working to preserve the species and its habitat through research, community education and cooperative conservation efforts. He's pursued alliances with the World Wildlife Fund and authorities in Zambia, where many of the dogs survive. This isn't Becker's first work with endangered species: Prior to going to Africa, he studied gray wolves in Yellowstone National Park.

David Blehert

PhD'99, Bacteriology

Along with fellow CALS alumnus Dave Redell (see story, page 33), Blehert is engaged in the scientific quest to understand white-nose syndrome, the skin infection that has killed more than 1 million bats in the northeastern United States since 2007. Blehert is head of the diagnostic microbiology lab at the U.S. Geological Survey National Wildlife Health Center, where his team recently identified a new species of fungus that causes the skin infection that is a hallmark of white-nose syndrome. They are now running more tests to determine conclusively if the fungus is behind the disease and how prevalent it is in the environment. The USGS facility monitors the emergence and spread of other wildlife infections, as well, including avian flu and the West Nile virus.



Cathy Acher, USGS

About the Dozen

These 12 alumni represent the stunning depth and breadth of CALS graduates' accomplishments. Selections for the list are made by the Grow staff and are intended to reflect a sample of alumni stories. It is not a ranking nor a comprehensive list. To read more about CALS alumni, go to www.cals.wisc.edu/alumni/

Next issue: Energy

Know someone who should be in the Grow Dozen? Email us at: grow@cals.wisc.edu

Images courtesy of source unless noted

Carin Christensen

BS'96, Recreation Resources Management

Christensen is a wilderness ranger in the largest national forest in the United States, the 17-million-acre Tongass National Forest. Covering most of southeastern Alaska, the reserve encompasses the world's largest temperate rainforest and Alaska's famous Inside Passage between the mainland and coastal islands. Christensen works on a variety of projects to balance the multiple uses of the forest's resources, including planting and maintaining lichen to monitor air quality. When she's not busy working in the Tongass, Christensen performs in a folk band called the Western Hemlock Society.

Lance Craighead

MS'77, Wildlife Ecology


Lance Craighead

Craighead is a third-generation naturalist who serves as president of the Craighead Environmental Research Institute, a nonprofit conservation and wildlife research organization founded by his father. CERI works to show people that they can coexist with


Kathy Firchow

wild ecosystems by building scientifically grounded, site-specific conservation plans in partnership with local stakeholders. Although Craighead has worked with myriad creatures during his career, including marine life in Fiji and Western Samoa, tigers in Nepal and sea birds in Alaska, he fell in love with the grizzly bear while pursuing his Ph.D. These giants inspired him to write a popular book on the bears of the world.

Kathy Firchow

BS'81, Wildlife Ecology

Firchow is the owner of Wildlife Consulting Services in Lander, Wyoming, which she operates with her husband, a fellow CALS alum and biologist. They assist organizations with development projects on public lands to ensure that wildlife and habitat are protected. A lover of the outdoors, Firchow is glad her work continues to keep her interacting with wildlife in the field and seeing first-hand the impact of her efforts. Before founding the firm, she worked as a wildlife biologist with the U.S. Fish and Wildlife Service, managing species from songbirds to bighorn sheep.

Jim Harris

BS'74, Agricultural Journalism

Harris served as president and CEO of the International Crane Foundation until 2006, when he stepped down to spend more time on conservation projects overseas. Now a vice president for the organization, he is particularly focused on projects in China, where six of the country's eight crane species are threatened by human development pressures. Harris believes that a narrow view of conservation too often pits people and wildlife in conflict. His work focuses on communicating the local benefits of conservation, allowing stakeholders to become allies.


Sarah Knox

Sarah Knox

BS'03, Wildlife Ecology

Knox works for Colorado State University's Center for Environmental Management of Military Lands, but you won't find her in the Rockies. Her home base is the U.S. Army's 130,000-acre Pohakuloa Training Area on the island of Hawaii, where she works as a wildlife coordinator. Her role is to survey and monitor protected species that live on the remote area, such as the Hawaiian hoary bat and the dark-rumped petrel. Recently Knox planned and initiated a fencing project to keep out feral mammals that eat native plants and prevent native habitat from regenerating.

wild things

The Grow Dozen


Mike Wallace

Erin Muths

BS'86, Wildlife Ecology
After earning her degree from CALS, Muths went on to study kangaroo rats for her master's degree and then kangaroos for her Ph.D. Her current work continues the hopping theme: At the U.S. Geological Survey in Fort Collins, Colorado, Muths studies the ecology and population dynamics of chorus frogs and boreal toads, both endangered in the state. Sadly, that's not a rare condition for amphibians—nearly one-third of the world's more than 6,000 amphibian species are threatened with extinction. Muths' work helps to understand the role of disease in amphibian populations, offering hope for bringing these fragile populations back from the brink.


Erin Muths

Eduardo Santana Castellón BS'79 MS'85 PhD'00, Wildlife Ecology

After earning his master's degree, Santana Castellón went to the University of Guadalajara in Jalisco, Mexico, where he championed the creation of the Sierra de Manantlán Biosphere Reserve. Considered one of the most significant conservation areas in Latin America, the reserve harbors an amazing richness of life found few other places in the world, including a species of wild corn that was believed to have gone extinct. After completing his Ph.D. on the dynamics of bird communities in western Mexico's cloud forests, Santana Castellón returned to the University of Guadalajara as part of its faculty, where he has received national and international distinctions for his conservation work.

Mike Wallace

MS'83 PhD'85, Wildlife Ecology
As a wildlife scientist in the Institute for Conservation Research at the San Diego Zoo, Wallace coordinates the California Condor Recovery Program in Baja, California. This program reintroduces captive-bred condors to the wild and manages the state's population of the giant birds, which face a critical risk of extinction in the wild because of habitat destruction, poaching and lead poisoning. As recently as 1982, only 23 wild condors remained, but through efforts such as Wallace's, more than 170 birds have been successfully reintroduced to the wild. Wallace hopes one day to reestablish California condors across their native range of California and Mexico.

Jim Wesson

PhD'80, Veterinary Science
In the Chesapeake Bay, Wesson is leading an innovative project to restore the one of the bay's signature features: oysters. Troubled by environmental pollution, oysters filter water and create niches for other aquatic species to thrive, making them a key link in the bay's ecosystem. As part of the Virginia Marine Commission's Division of Fisheries Management, Wesson led a project to construct artificial reefs to help reestablish the shellfish. Young oysters are raised for a year and then transplanted onto the reefs by volunteers. Wesson was spurred to action in part by personal history. He grew up in a family of commercial blue-crab fishermen and had seen the effects of declining oyster populations firsthand.

Catch up with …

Karen London MS'94, PhD'98 Zoology and Entomology

KAREN LONDON is a real-life dog whisperer. A certified applied animal behaviorist, she spent four years working with UW-Madison professor Patricia McConnell's dog-training and consulting business. Now living in Flagstaff, Arizona, she has a private practice to help owners identify and deal with behavior issues, including aggression, in their dogs. She has coauthored four books and writes a regular column on animals called the London Zoo. But what about all those entomology classes? London explains that the leap from wasps to dogs is actually quite natural.

• How were you inspired to begin working with wildlife?

Well, I took a field course on tropical field biology during my undergraduate study at UCLA. We went to the Osa Peninsula in Costa Rica, where I studied termites for my individual research project. I became fascinated by their amazing social organization and communication!

• What did you do next?

After finishing my undergraduate degree, I began pursuing my Ph.D. at UW-Madison. I started out looking at the nesting associations between two different types of social wasps. Discovering how species live together and interact captivated me.

• So after spending so much time working with social behavior in insects, how did you start working with dogs? They seem so different.

That's what everyone asks! But to me, it was a natural transition—I moved from studying defense and aggression in wasps to those same issues in dogs. The basic principles still apply—you need to really know the animal you're working with to begin understanding their behavior.

But I was really introduced to the idea while serving as a teaching assistant in Trisha McConnell's class on human-animal relationships and volunteering in her dog-training classes. From those experiences, I became interested in the close relationships people have with all kinds of animals, including their pets.

Tom Alexander

• What are you up to these days?

I mostly write because I try to spend as much time as I can with my two young sons. But I still see some clients. Also I teach a field course on tropical forest insect ecology for Northern Arizona University with my husband, Richard Hofstetter (BS'92, Zoology; MS'96 Entomology). In addition to the classroom component, we take our students to Nicaragua to complete research projects in its tropical forests.

Five things everyone should know about . . .

Mosquitoes

By Susan Paskewitz

1 | Not all mosquitoes feed on humans. Of the thousands of mosquito species flying around the world, many prefer animals to humans. Some like to feed on birds, others like turtles and frogs, and still others prey on mammals such as deer and rabbits. The species that feed on both humans and animals are the most worrisome, because they can transmit diseases from birds and other mammals to people. Mosquito-borne diseases are now responsible for one of every 17 deaths on the planet.

2 | Wisconsin is home to 55 or 56 different mosquito species. These are tough little insects. Most survive the winter in the egg stage, but some can survive as larvae frozen solid in ice. Others make it through by hiding in culverts or tree holes until it warms up enough to fly.

3 | Only the females bite. Mosquitoes feed on nectar and fruit juices, and for males, this is the only food they need. But females need the protein in blood to produce eggs. Typically, a female will lay 30 to 100 eggs per meal, usually three days after feeding. They sometimes draw more than their body weight in blood, which is why mosquitoes are heavy and slow after feeding.

4 | A mosquito might find you more attractive than your friends. It's true that some people draw more attention from mosquitoes, most likely because of subtle differences in body temperature, the amount of carbon dioxide in our breath and chemicals in our skin. There's also some evidence that certain people may produce skin chemicals that naturally repel mosquitoes.

5 | That sure-fire home remedy? It probably doesn't work. People have suggested lots of ideas for preventing mosquito bites, including eating garlic or taking vitamin B supplements. So far, there's no scientific evidence to suggest these strategies are effective. The best bets are to use synthetic and plant-based repellents, avoid brushy areas and wear long sleeves and pants. With support from UW-Madison's Industrial and Economic Development Research program, we've created a web site that explores many of these methods. To learn more, visit www.entomology.wisc.edu/mosquitosite/.

Susan Paskewitz is a professor of entomology who specializes in the study of mosquitoes. When she's not digging into the biology of mosquito-borne diseases such as malaria and West Nile, she works with environmental health agencies to monitor mosquito populations and recommend strategies for controlling them.

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Fill out your answers online. Ace our quiz and we'll enter you in a drawing for a gift box of Babcock Hall cheese. Go to www.cals.wisc.edu/grow/ for more details.

Rural Sociology: **The largest concentration of farming-dependent counties is in which region of the United States?**

a. South
b. Midwest
c. Great Plains
d. West

From Rural Sociology 140: Introduction to Rural Sociology and Development, taught by Gary Green

Soils: **Where would you expect to find a greater fungal abundance and why?**

a. In managed agriculture, because single-crop systems provide more opportunities for fungi to thrive.
b. In managed agriculture, because it uses nutrient-rich soil amendments and fertilizers.
c. In forests where higher pH levels assist fungi in decomposing food supplies.
d. In forests, because they are not tilled and have more complex food sources.

From Soil Science 323: Soil Biology, taught by Teri Balser

Nutritional Sciences: **Thirst serves as a good method for maintaining hydration in all people except:**

a. Athletes
b. Infants
c. People who are ill
d. A and C
d. B and C

From Nutritional Science 132: Nutrition Today, taught by Pete Anderson

Horticulture: **If leaves on corn plants develop a reddish or purple color early in the growing season, the corn is probably deficient in:**

a. Phosphorus
b. Potassium
c. Zinc
d. Boron

From Horticulture 375: Diagnosing and Monitoring Pest and Nutrient Status of Field Crops, taught by multiple professors

Bacteriology: **A characteristic of** Streptococcus **mutants that allows it to initiate dental plaque is:**

a. The ability to attach specifically to the pellicle of the tooth
b. The ability to utilize sucrose as a source of carbon and energy
c. The ability to produce a dextran capsule
d. The ability to produce lactic acid
e. All of the above

From Bacteriology 303, Procaryotic Microbiology taught by Kenneth Todar

LAST ISSUE: Answers were 1: A; 2: C; 3: A; 4: C; 5: A. Congratulations to UW-Madison student Colin Rayson, who was randomly selected from the six people who aced our Final Exam and wins a free box of Babcock Hall cheese.

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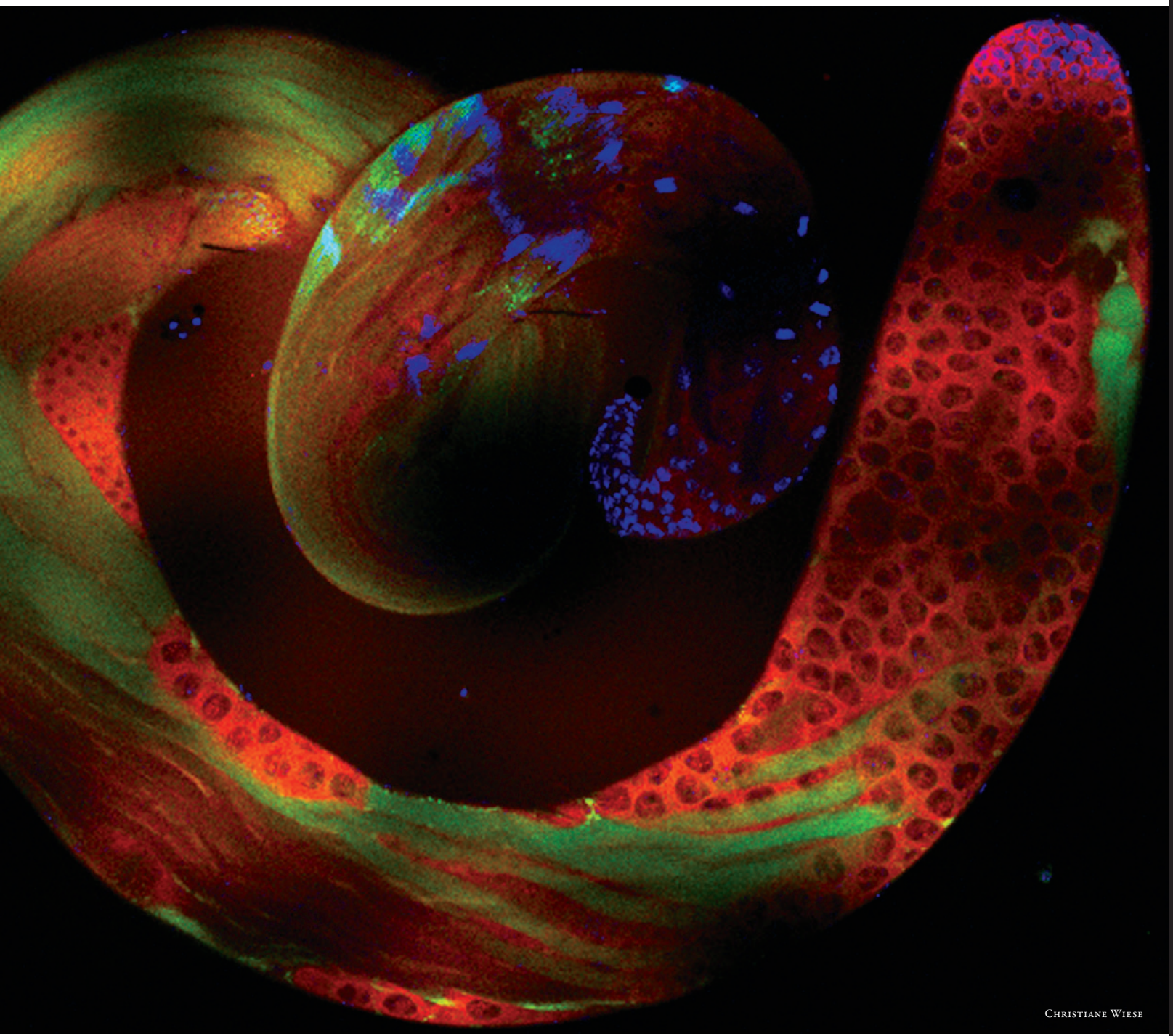

Christiane Wiese

SECRETS OF A FLY Proving that the beauty of science can arise in unexpected places, CALS biochemist Christiane Wiese captured this image while studying sex organs in fruit flies. The picture, which shows stem cells (at upper right) morphing to form long, thin sperm cells in an adult fly, is one of 40 works of scientific art on display at Madison's Dane County Regional Airport. The exhibit, called "Tiny: Art from Microscopes at UW-Madison," was organized by the university's Tandem Press. For more cool science, visit us online at www.cals.wisc.edu/grow/.