SOLS

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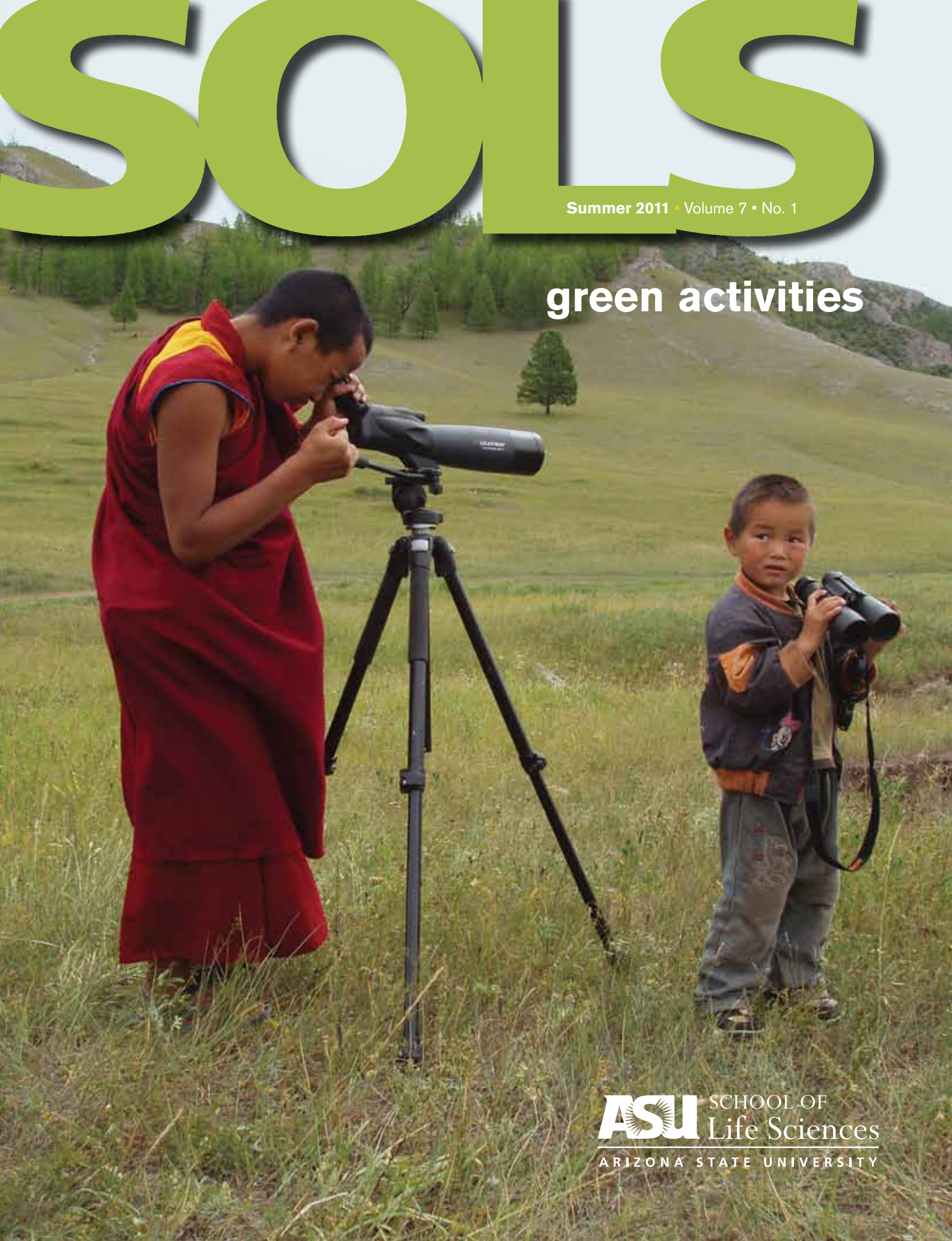
green activities



ASU SCHOOL OF Life Sciences
ARIZONA STATE UNIVERSITY

This SOLS Magazine cuts a swath from the color wheel, representing a range of "green" activities in ASU's School of Life Sciences. This issue features stories from the laboratory of **Kenro Kusumi**, an associate professor who is working to develop an *Anolis* lizard model to study traumatic spinal injury and regeneration. We also delve into photosynthetic processes and the development of bioengineered biodiesel with Professor **Willem Vermaas**, food crops that thrive in poor soils to produce bigger yields of leaves and roots with Assistant Professor **Roberto Gaxiola**, and cyanobacteria's natural sunscreens with Professor **Ferran Garcia-Pichel**. In addition, we trace the conservation efforts of doctoral student **Mimi Kessler** with the Great Bustard in China and the progress of SOLS undergraduate researchers with doctoral student **Emily Richter**, as they discover antibiotic proclivities in local cholla cactus. Taking green pigment more literally, we offer a few photos from ASU's Sustainable Phosphorus Art Show, developed by graduate students and faculty in the School of Life Sciences and others, and spend a day with 41 elementary and middle school students, mentored by Associate Professor **Susanne Neuer** and doctoral student **Erick Peirson**, as they study killer whale calls and draw unicellular dinoflagellates. So whether it is art, K-12, undergraduate or doctoral student discovery and development, conservation, sustainability, biomedicine or bioenergy, SOLS is striving to color our shared future green.

MARGARET COULOMBE

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You can now find us on *Science 360* radio, a portal sponsored by the National Science Foundation. SOLS' ***Science Studio*** podcast program provides fun, intimate conversations with thought-provoking experts and cutting-edge science and ***Ask A Biologist*** podcast, an award-winning children's and life-long learners program, offers adventure and discovery along with resources for teachers and home-schoolers.

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On the cover: culture and technology take flight in capturing The Great Bustards of Mongolia

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A note from SOLS new director: Brian H. Smith

Since I came to ASU and SOLS in 2005, I feel like I've joined a real community with a sense of shared mission. Taking SOLS forward will be an exciting challenge and an amazing opportunity to work with wonderful students, staff, faculty and alumni to build on the strengths found in SOLS' highly collaborative, interdisciplinary framework.

We all owe Rob Page a debt of gratitude for the hard work and leadership he has shown molding SOLS from very separate departmental entities and advancing what is now such a cohesive framework. His success is admirable. I know that we all wish him well and look forward to working with him as our new Vice Provost and Dean of College of Liberal Arts and Sciences.

How will our next three to five years look? I want to hear your ideas as we go forward about the "SOLS to come." We have some significant challenges before us, from the changing budget picture to the historically low funding rates for sponsored projects. To be sure, facing these challenges will call on us all to choose approaches that are creative and proactive, while also sustaining, and even expanding our mission. However, we are drawing from a place of strength in this effort, able to capitalize on the strong infrastructure built in SOLS and supported by the many new faculty hires of the past few years, the significant grant funding we historically have had and development of interdisciplinary undergraduate and graduate degree programs. In particular, I envision three new initiatives for SOLS under my tenure 1) pursuit of multidisciplinary, collaborative research proposals, 2) the establishment of new technologies to enhance classroom education, and 3) the extension of innovations in graduate education, including a move toward interfacing biology with art and design programs, and promotion of training in creative scientific communication strategies.

What is ahead can and will be built with some of the world's most creative scientists, students, educators and creative partners. What more could a director wish for?

Best wishes,

Brian H. Smith
Professor and Director, School of Life Sciences

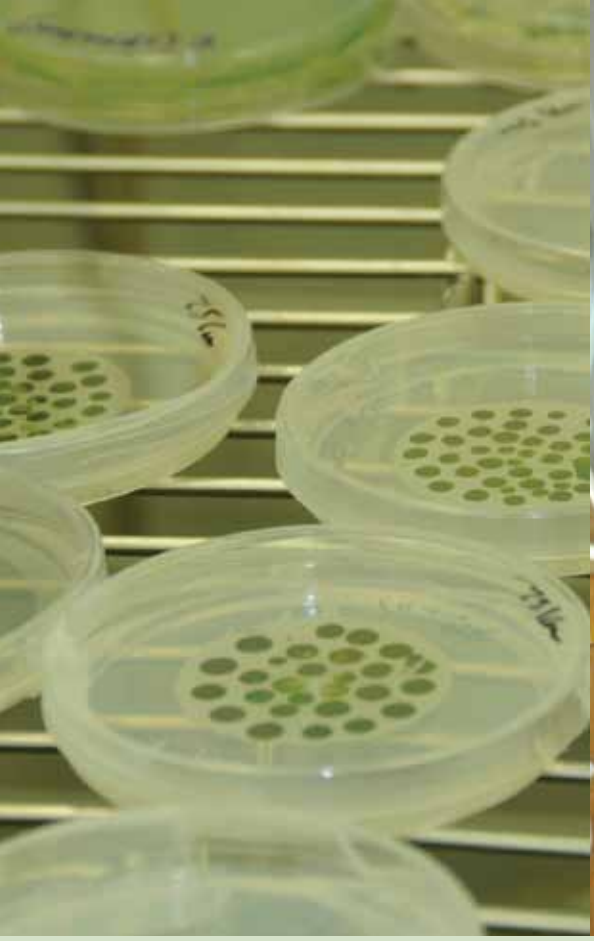
Green energy: Mini-biofactories for carbon friendly fuel

BY KIRSTIN TRAYNOR

Cyanobacteria, the ancient granddaddy of all photosynthetic machinery in plants, may soon provide a carbon-friendly fuel. Professor **Willem (Wim) Vermaas** and his team are studying a species of this ancient water-dwelling cyanobacterium, *Synechocystis*, with a long-term goal in mind. The group hopes to create a living platform, a mini factory, which uses the energy of the sun and photosynthesis to produce and excrete products such as octane fuel, bioplastics components or precursors for rubber.

Most photosynthetic biofuel platforms, such as algal systems or terrestrial plants for ethanol, require processing of the whole organism to extract the fuel, an expensive and time-consuming process. Vermaas and his colleagues want their cyanobacteria, which they colloquially refer to as "cyanos," to do the dirty work of churning out a harvestable product. The cyanos need not be destroyed to reap the fuel, Vermaas explains. Instead, the desired end product is simply siphoned off from the "pond" the cyanos inhabit, saving processing, energy and costs. With water, sunlight and carbon dioxide to support them, the intact cyanos can then continuously manufacture fuel, much like a dairy cow produces milk.

However, to create and perfect these cyano-biofactories, the scientists must first tinker with *Synechocystis*' DNA. *Synechocystis* is ideal for this work because its genome is fully sequenced, making it easier to identify key genes and determine how they are regulated. Vermaas' group can readily make genetic modifications by taking advantage of a useful feature unique to *Synechocystis*. While most gene manipulations, especially in higher plants and algae, require scientists to use special vectors or procedures to infiltrate the organism and insert the desired genes, *Synechocystis* spontaneously takes up DNA and integrates it directly into its own genetic code.



Vermaas and his team have already built version 1.0 of their cyano-biofactory. They have modified *Synechocystis* to churn out medium chain fatty acids. These fatty acids, with chains of 12-16 carbon atoms, are then harvested and shipped to North Carolina, where carbons are chopped off in a process called decarboxylation. Once the excess carbons are removed, alkanes remain – essentially the same product as gasoline.

Although decarboxylation produces carbon dioxide, it simply releases the carbon *Synechocystis* initially removed from the atmosphere during photosynthesis. Thus the end product – except for transport and processing costs – is carbon neutral.

To further improve the carbon footprint of his system, Vermaas is already busy assembling version 2.0 of the cyano-biofactory. He wants the cells to do the decarboxylation of the fatty acids all by themselves. Some of the genes needed for decarboxylating the fatty acids have been identified, although the important details of how these genes are turned on and off are still being worked out.

Other types of biofuels systems are far less carbon friendly and sustainable. Biofuels based on corn production require prime agricultural lands. The corn is then transported by truck to processing plants, where it is turned into alcohol via fermentation, a process that releases carbon dioxide. The end product, ethanol, does not have a very high energy content, and our cars "don't like to run on it," says Vermaas. In contrast, the cyano-produced alkanes, in essence larger versions of octane, are highly compatible, combustible fuels.

Once Vermaas has the nitty-gritty details worked out and his cyano-biofactory fine-tuned, it could easily be reconfigured to produce other products, including biodegradable plastics, rubber, hydrogen and medicines. The beauty of such a biofactory is that all the products will be biodegradable. The inserted genes produce naturally occurring products, and enzymes already exist to break those products back down and recycle the nutrients. "Oil plastics are manmade," Vermaas says. "Mother Nature hasn't created enzymes to degrade them."

Vermaas' research endeavors are currently supported by grants from the Department of Energy Advanced Research Projects Agency-Energy (ARPA-E). In addition to the significant energy challenges ahead throughout the globe, fueled by dwindling oil reserves and the need for alternatives, there are also concerns about developing clean energy that limits the impact of carbon dioxide on our atmosphere. Processing and burning of fossil fuels have pumped excess carbon into our atmosphere, which is implicated in changes in the Earth's climate, and while the environmental costs of conventional mining run deep, those costs are often not shouldered by mining companies and keep the market cost of fossil fuels low. "It's hard to compete with a few dollars per gallon," Vermaas notes. However, when governments start to charge companies for the carbon dioxide they generate, "then it's a no brainer." Studies of such ancient bacterial systems will then pay high dividends as carbon neutral systems and offer viable and green, clean alternatives. ■

http://sols.asu.edu/podcasts/index.php?year=2008#Vol_27

One tale told is two tails gained: In pursuit of medically applicable regeneration

BY KARLA MOELLER

Anolis lizards first entered Arizona State University biologist **Kenro Kusumi's** life in 1980 when, as a member of a junior curator program, he recorded in his field notebook that he had found an *Anolis* egg on a field trip. Kusumi still has those notes, along with other memorabilia that document the influence that both his early life and more recent experiences have had on his current pursuits in developmental biology. One such souvenir is a small Pueblo lizard sculpture that sits on a table in his office. With one missing leg and a tail, broken and repaired in two places, it is not particularly eye-catching, but it does symbolize Kusumi's current research model: a lizard which can "fix" or more accurately, regenerate, its broken tail.

Human regeneration is mainly limited to small portions of liver tissue, bone or muscle, yet understanding how regeneration occurs in other taxonomic groups may enable scientists to improve human regenerative abilities in the future. With fellow ASU School of Life Sciences faculty members **Jeanne Wilson-Rawls**, **Alan Rawls**, **Rebecca Fisher** and **Dale DeNardo** (collectively referred to as "JARKD" by their students), Kusumi is working to understand the molecular processes that enable some lizards to regenerate their tissues. Lizards can regenerate facial bones, certain areas of the spinal cord, and, as is most commonly known, most lizards can regenerate their tail – including muscles, cartilage and spinal cord. The regenerated tail does not contain bone, but instead is supported by a tube of hyaline cartilage – the same cartilage humans have lining many of their joints. With widespread medical problems such as arthritis and spinal cord injuries, the application of these regenerative abilities is of extreme interest to medical institutions. "Members of my family have terrible osteoarthritis," Kusumi explains. "That means the cartilage at the joints has degenerated. These lizards can regenerate that kind of cartilage and they have no problem doing so. How is it that we can't do this, but they can?" With the help of the *Anolis* model, Kusumi and the rest of the JARKD team are delving into this mystery, recently funded by a $412,606 grant from the National Institutes of Health and a $225,000 grant from the Arizona Biomedical Research Commission.

Anole images by Karla Moeller

Many vertebrate and invertebrate species can regenerate tissues, but there are several kinds of regeneration. Lizards most likely use stem-cell mediated regeneration, where new cells involved in regrowth arise from tissue-specific progenitor cells. This type of regeneration is the best bet for a regenerative process compatible with the human system, Kusumi says. Now that the *Anolis carolinensis* genome is sequenced, rather than trying to solve the puzzle blind, the research team has a view of the bigger picture as a guide to work from.

Molecular methods have improved to the point that the JARKD team is focusing on this question at the perfect time. Kusumi mused, "the beauty is that now we know enough about development that we can actually have candidates for what cells are making this new tail – we can have guesses as to what might be right." Using this candidate approach, Wilson-Rawls and graduate student **Rajani George** have successfully identified and isolated lizard cells that can make new muscle. Meanwhile, the Kusumi lab is working to uncover what developmental control genes are being expressed in regenerating tails. Here, with collaborators from the Translational Genomics Research Institute (TGen), JARKD is using RNA-Seq, a next-generation technology that allows researchers to take a more unbiased approach, finding all the genes being expressed in a tissue at one point in time. When compared with embryonic development of the tail, which is being investigated by graduate student **Walter Eckalbar**, differences between initial tissue generation and regenerative processes can be identified. The genes involved in regeneration are likely conserved across various taxonomic classes, but the genetic switches for those genes may be turned off or down. "Once we understand the nuts and bolts of how this is happening, we can use available technologies to manipulate and change that," Kusumi explains, "then we will try to translate that to the mouse model."

A regenerating mouse tail is only one of the many images inspired by Kusumi's *Anolis* studies. In concert with colleagues at the Smithsonian Tropical Research Institute (STRI) in Panama and **Elizabeth Hutchins**, one of Kusumi's graduate students, the JARKD team is adopting an evolutionary perspective of various *Anolis* processes or adaptations. "Occasionally you have a very unique opportunity to look at a natural experiment where one species arrived on one island or was isolated in a region, which then led to the adaptive radiation of many species to fill a variety of niches," Kusumi says. *Anolis* has in fact been described by some scientists as the "Darwin's finch" of reptiles. This reference points to the number and range of ecomorphs in the Anolis genus, as species have arisen in different regions bearing highly similar behaviors and morphology (also known as convergent evolution). While anoles have been the focus of many evolutionary studies, the JARKD-STRI team is focusing on the intersection of evolution and development, where "you can look for the regulatory changes that drove a limb to be longer or muscles to be more robust."

With such a bright road ahead for both the regenerative and evolutionary undertakings, Kusumi hopes ASU will lead internationally, as a center for the *Anolis* work. The opportunity to create such an interdisciplinary research program attracted him in part to School of Life Sciences in ASU's College of Liberal Arts and Sciences, which Kusumi describes as a place that "breaks down the walls between disciplines. Of course, the realization of this vision depends on complex collaborations, which Kusumi jokes are growing so large that listing those not involved may be easier. Kusumi's *Anolis* collaborations go well beyond JARKD, STRI, TGen and ASU, and also include some of Kusumi's undergraduate mentees. **Glenn Markov**, a Barrett The Honors College undergraduate and member of School of Life Sciences Undergraduate Research (SOLUR) program, has spent two years contributing to the ground work of the regeneration project. Much like the tissue-specific process of human progenitor cells, each member of the collaborative team – whether undergraduate, graduate student, or faculty – makes unique contributions to ensure the creation of a functional end product.

Mark Twain once stated "a man who carries a cat by the tail learns something he can learn in no other way." In a similar vein, Kusumi, with lizard tail in hand, may hold the most likely key to unlock the secrets of medically applicable regeneration.
http://www.anolisgenome.org ■

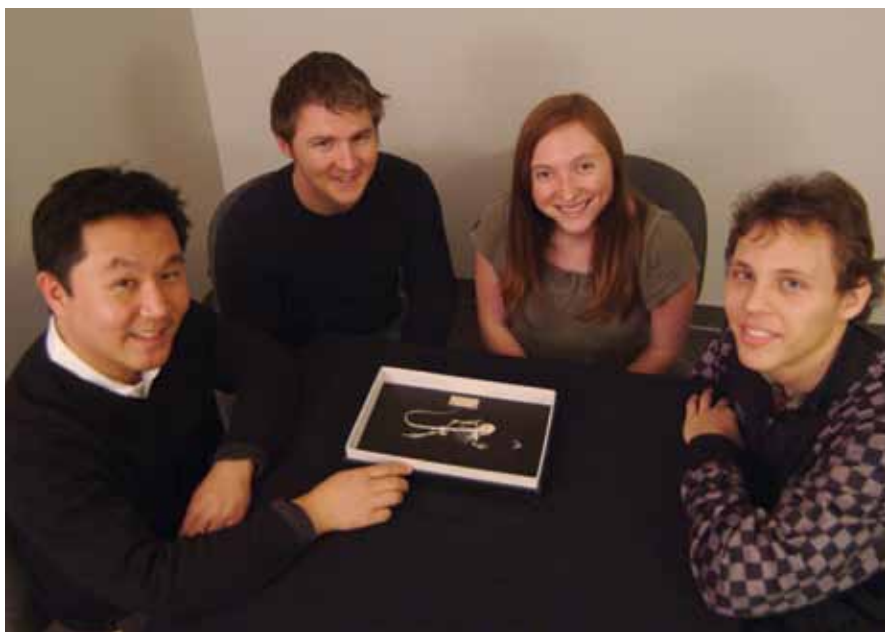


Photo by Mimi Kessler

Conservation: The Great Bustards of Mongolia

BY CLINT PENICK

In Mongolia, the *yurts* are not called *yurts*. They're called *gers*. When you enter a *ger*, there are prescribed rules. You enter without knocking and file in clockwise. The host will bring you a cup of tea, or if it's summer, a bowl of yogurt. They will set out a basket with dried cheese curds and, if they have it, maybe some candy or some bread. If the family has dogs, you have to yell from the window of your car: "Hold your dogs." The dogs in Mongolia are heavy-bodied and have yellow spots above each eye. "They bite," says **Mimi Kessler**, a SOLS doctoral student who has worked much of the last 10 years in Mongolia (and 18 years in the former Soviet Union). "They're terrible. I once had to pull an angry dog off the arm of an 8-year-old girl. She had a fever for days afterwards."

Kessler travels through northern Mongolia tracking birds she has tagged with satellite transmitters. At this moment, she's on the prowl for one transmitter, which had been sending the same location, over and over; the temperature sensor had gone cold, which meant the bird was most likely dead. Kessler has traveled with her team to the spot where they'd last received a transmission. In cases of death by a predator or natural causes, there is usually feathers or bones – something that indicates how the bird died or what killed it – but, on this particular day, the transmitter is lying out in the open with no feathers or bones, and the four straps that held the transmitter to the bird's back have been neatly clipped. "That's not something a wild animal normally does," says Kessler.

Photo by Mimi Kessler

Photo by Batsuuri Dashnyam

The bird Kessler studies is the great bustard, the world's heaviest flying bird. Kessler became aware of the bustard while working in Mongolia after college. "Here was this charismatic species that was declining and people didn't know anything about it – so it seemed an ideal species to study," says Kessler. At the time, she didn't know how difficult it would be. "We would ask local people about techniques to trap bustards before we started. You figure that local people are going to know how to catch something, right? If it can be caught." Most people would tell Kessler that you could just shoot the bustard. Then she would explain that she needed them alive. They would lean back and think; then they would say, "You probably can't."

"That's when I realized there was going to be a problem," says Kessler.

Bustard beginnings

When Kessler first decided to study bustards, she flew to the United Arab Emirates to learn a method for capturing them. Researchers in this country had, through strange circumstances, become world experts on bustard biology. There was an old tradition in the Middle East: a lone man would ride into the desert on a camel and have a falcon on his shoulder. The falcon was trained to hunt a species of bustard called the houbara. Like so many other rare species, the houbara was prized as an aphrodisiac, and the product of this hunt was an elaborate meal. However, the hunt was difficult, and the birds were cryptic and hard to find, so the meal was reserved for the rarest occasions.

Fast-forward to the rise of oil empires in the Middle East, and this traditional hunt with a lone man on a camel was transformed into an elaborate display of wealth. Sheiks spent millions of dollars on the houbara hunt and bought legions of falcons that were carried in specially-equipped Humvees with rotating turrets, infrared cameras and GPS tracking capabilities. The sheiks also carried guns and when they couldn't find birds they would trespass onto game reserves. Not surprisingly, this modern twist on tradition meant that the houbara was basically exterminated on the Arabian Peninsula.

The sheiks then fanned out. Some built private airstrips in Pakistan or North Africa and Central Asia; they landed in military-style planes with cargo bays that deployed fleets of Humvees. Other species of bustards came under threat as well as houbara diminished. At some point, however, the hunters began to grow nostalgic for the hunt in their home countries. The sheiks chose to invest in houbara breeding programs and the scientists who ran these programs became world experts on bustard biology.

Kessler learned several techniques from these scientists for capturing bustards, but there was no guarantee that these same techniques would work with her bustards in Mongolia. The Arabian scientists had even tested whether the falcon could be used as an effective capture

method. "The result, as you may presume, was that the falcon ripped the bustards to pieces."

For her first attempt, Kessler and her team tried to herd bustards into a giant net stretched across a valley. "I had to make a lot of weird calls for this work," says Kessler. She ordered the net from a commercial fishing outlet, but they kept trying to sell her a net with sinkers and a lead line. "I didn't want sinkers," says Kessler. "That would make it heavier. A lead line would just make it more visible to the birds. But that sounded crazy to the people on the phone." The net was the length of three football fields. One group would watch from a hilltop and communicate with the other group by walkie-talkie, telling them which way to move to sneak up on the bustards. "It was like a giant really slow video game," says Kessler. "Bustards kept enough distance from the group so that they had time to see a shimmer of the net in the air and avoid it. We would tell the team below which way to walk and we would watch the bustard respond. The birds would simply walk along the outside until the net ended and then fly away. Really smart."

The next method Kessler considered was a technique she saw used in the Middle East. Kessler says, "You tie a bustard chick by its leg to a tree stump and lay nooses around it." The instinct for a mother to care for her young is strong. The mother would come back to her chick and stand a short distance away, explained Kessler. "You could see the mother stare at her chick like she wanted to be with it, and the chick would be jumping, trying to get to its mom," says Kessler. But the mother would never cross the snares and the chick would become hungry. It became quickly clear to Kessler that this was not the technique to use.

The method they found that worked was spotlighting. It was a technique used to trap the American sage grouse, a bird that lives in open habitat similar to that of the great bustard and, like bustards, grouse eat vegetation so there was no special food you could use to lure them. This method only works when it is completely dark, no full moon, and when it is overcast so that the birds can't see a silhouette against the stars. One person carries a giant spotlight and another carries a radio blaring static that helps to disguise the location and distance of footsteps of the researchers approaching the bird. The person with the light walks closer and closer to the bird, flashing the light across the bird's eyes back and forth so the bird's pupils are constantly expanding and contracting and it can't focus. When they get close, one person would give a signal and bag the bird with a landing net. The bird can get up at any time during the approach and walk or fly away. And they usually do. "When you actually bag a bird, there's a big adrenaline rush," says Kessler. "It happens so rarely that we catch a bird – at the beginning it was only one a month – but I have a good team who sees this

work as a challenge and who don't get frustrated." In less than fifteen minutes, the bird can be measured, tagged and released with a satellite transmitter.

The data that Kessler has received from her transmitters has already revealed something surprising. Her birds, she has found, migrate 2,000 kilometers to China every winter. No one had been sure that they even migrated at all. Kessler has also found that, unfortunately, her bustards are dying at a rate much higher than she would have predicted, and the number one threat is human poaching.

Back in *ger*

Kessler's team takes the clipped transmitter and drives to the *ger* closest to where it had been found. They walk inside and sit silently to wait for tea. Everyone on Kessler's team is from Mongolia but Kessler, who originally hails from San Diego, California. Though she stands out with her long, blonde hair, Kessler is completely fluent in Mongolian.

Kessler's assistants introduce her to their host, "This foreign researcher [indicating Kessler], she's come to study bustards. Are there any bustards in your area?"

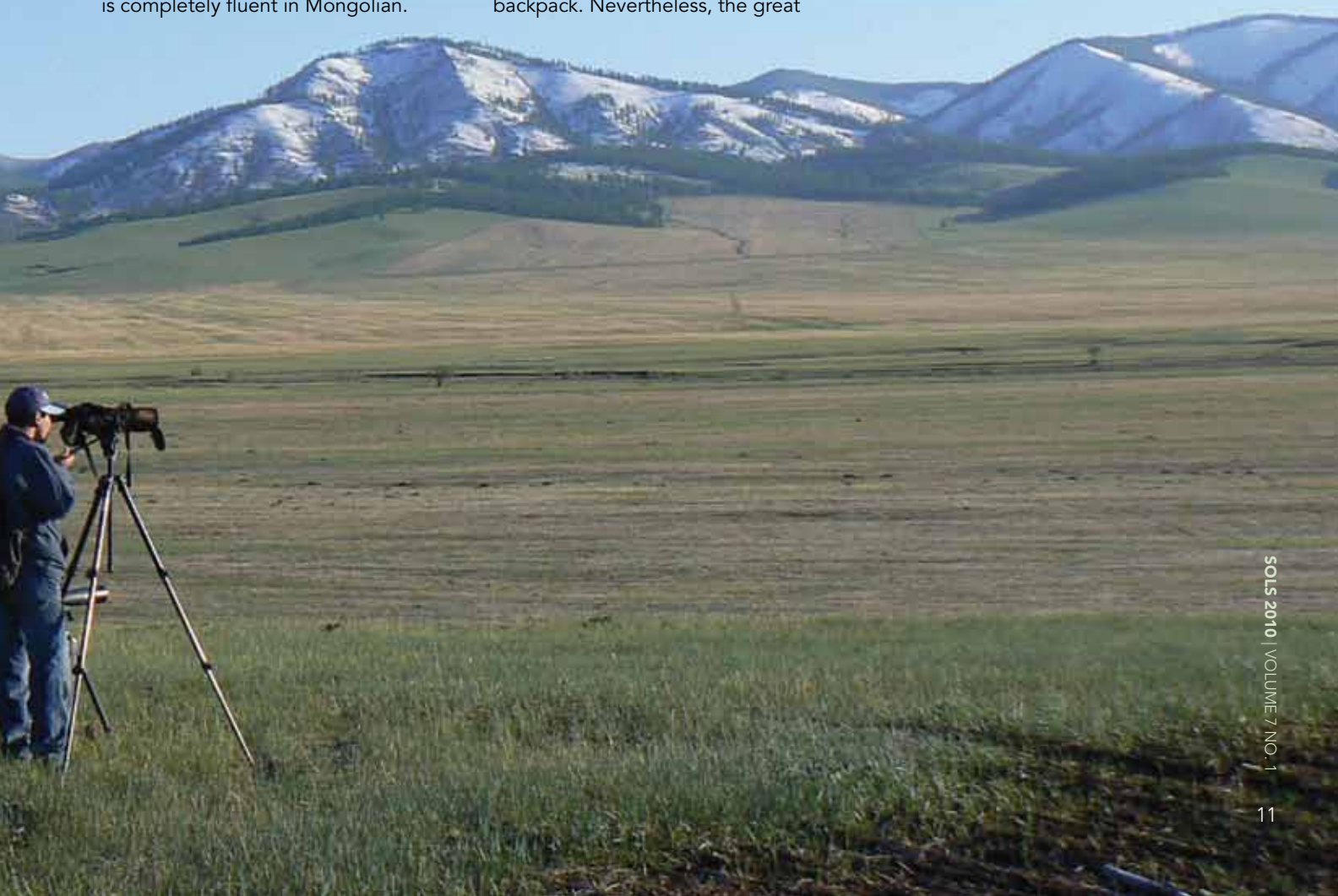
"Bustards?" says their host. "I never even *heard* of a bustard."

The team can tell their host is lying by his intonation and from the fact that there are several bustards in the vicinity. "My team had all kinds of ideas about how we were going to deal with the situation," recalls Kessler. In the end, they ask the man a few more questions. Then, one of Kessler's assistants pulls out the transmitter and sets it on the table. When the host sees it, he says in a low voice, "Go talk to my neighbor."

Kessler and her team drive to the neighbor's ger. They show him the transmitter, and he admits to shooting the bird. For him, living in rural Mongolia, it would have been bizarre to find a bird wearing a metal backpack. Nevertheless, the great bustard is a protected species, and poaching is illegal but not often enforced.

"This is a bird that has gone extinct in some European countries," says Kessler. "But Mongolians have managed to conserve it this long. That's something to be proud of, right?" Kessler has tried to raise awareness about bustards with local people. She has worked with schools and has planned a documentary for Mongolian television. Her research program has supported a master's student at the national university, who studies bustards with the team, and this year she is adding another student. Kessler's work has not been easy and has required an inordinate amount of fundraising and patience – it took two years before Kessler was even able to capture her first bird – but that is what makes this work so valuable. ■

Photo by Matt Toomey



Photos by Ferran Garcia-Pichel

Green challenges: Sun solutions from ancient systems

BY KIRSTIN TRAYNOR

Except for the few giant saguaros and ocotillos that break the horizon, the desert looks bare to most casual observers. Yet, almost imperceptible to our eyes, the ground teems with microbial life – colonies of cyanobacteria.

Cyanobacteria form filamentous colonies in the desert soil, interweaving long fibers through the sand to form a stable desert crust that resists erosion until foraging cattle stomp through or off-road vehicles race overhead and break their tenuous hold. To survive the harsh desert climates, some of these photosynthetic cyanobacteria have developed protective sunscreens that help them combat the relentless ultraviolet (UV) rays of the sun. Others find refuge from UV by commuting to the soil subsurface just before the soil dries up. "By studying desert soil cyanobacteria, we learn many such stories about adaptation and survival," says geomicrobiologist **Ferran Garcia-Pichel**. "Unfortunately, the only place you can still find intact desert crusts in the Southwest is now on Indian reservations and national parks."

For more than 3.5 billion years cyanobacteria have called our planet home, colonizing every known corner of the Earth. Through photosynthesis, these hardy little creatures produce oxygen and once helped to shift the early atmosphere, a change that allowed plant and animal diversity to explode. This self-inflicted shift put their existence at risk in sunny climates, where ultraviolet light combines with oxygen to produce damaging photo-oxidation, says Garcia-Pichel, noting: "The smaller you are, the deeper ultraviolet light can penetrate inside to destroy the integrity of your DNA."

In a normal environment, organisms can invest energy in DNA repair mechanisms, special proteins that scour the long, twisted strands of genetic code for errors and fix them before they cause trouble. Or they can produce antioxidants that seek out and destroy free radicals, says Garcia-Pichel, who first became interested in cyanobacteria biofilms on a drive down Baja California's long coast in the 1980s.

"I was about halfway down, driving along this beautiful desert when I found these strange black films or spots on granite boulders," he recalls. "They were all on the north side. They were so dark, they were just black." The young scientist was on his way to study coastal microbial sea mats as part of his master's work on a long-term NASA project. Fascinated by the black growths, he stopped the car to collect some samples.

It turned out the cyanobacteria colonizing the granite boulders produced a special golden-brown compound called scytonemin in the extracellular sheaths that surrounded the organism "as if it was trying to protect itself from excessive radiation," explains Garcia-Pichel, who is now a full professor in ASU's School of Life Sciences.

The only way to survive in the desert without a steady source of water is to shut down, often for long periods of time, a form a bacterial hibernation. Hibernation is broken when the rains arrive, he said. Even when cyanobacteria are inactive and have shut down all their active defense mechanisms, they're still bombarded by harmful UV light. As they can't actively repair their DNA or hunt for free radicals, they've invested significant energy to produce a thick layer of these protective pigments that act as a sunscreen.

Wondering if he had stumbled across something new, Garcia-Pichel did a search of the literature to see if other scientists had encountered this special pigment before. To his dismay, Swiss scientists had described scytonemin back in the 1800s; however, little research had been done since.

"Bacteria have a little problem," notes Garcia-Pichel. Due to their small size, the harmful light can penetrate deeper. To protect themselves against the UV light, they need a thick protective barrier of sunscreen that absorbs the harmful light rays.

Yet with equal investments in sunscreen, a small organism will benefit less than a large one, because the light penetrates proportionally deeper in a smaller organism. Humans protect themselves from the damaging effects of UV by producing a tiny amount of melanin in the skin, the protein that gives us a tanned look. Larger than most other bacteria, cyanobacteria must invest huge resources in producing sunscreen, which makes up 5-10 percent of their total dry weight. "That's like us carrying 10 pounds of melanin around," says Garcia-Pichel.

Luckily for Garcia-Pichel, sunscreens age well. "Much better than the scientists who study them!" he jokes. Sunscreen pigments can also shed light, so to speak, on Earth's early history, when life first emerged from the oceans onto inhospitable land. Because the pigment breaks down slowly, its presence can be traced in ancient soils. Whenever (and wherever) the pigment is found, it indicates that the environment experienced periods of inactivity linked with high levels of illumination. Garcia-Pichel says that in an "evolutionary sense, it can tell you the history of ultraviolet light and the development of the ozone layer." Cyanobacteria and their products also offer more than a window on the ancient climate. Besides stabilizing soils, fertilizing the desert and pointing toward natural products to protect from the sun, they may also hold the key to help curb climate change as a future source of alternative energy.

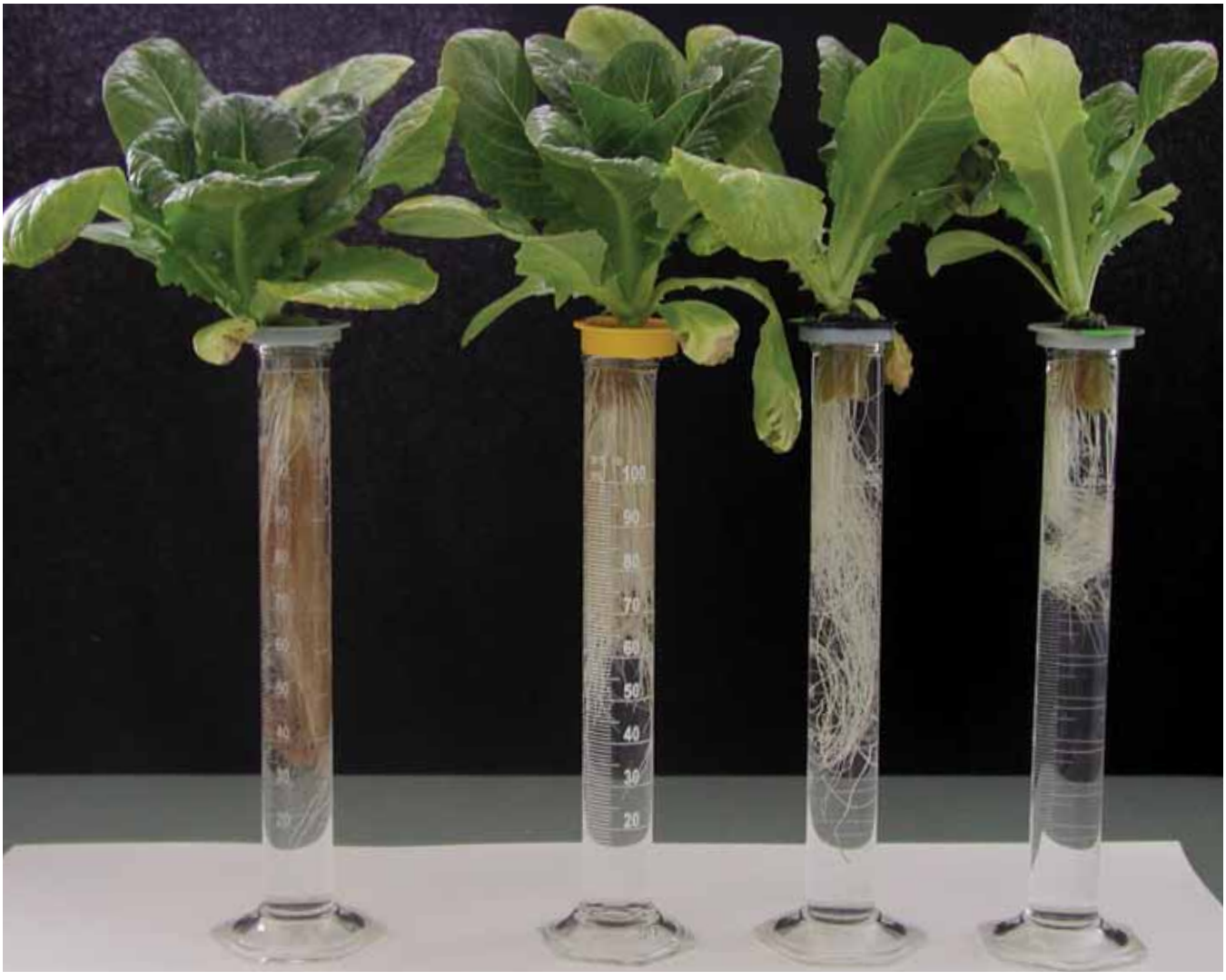
"With soil cyanobacteria, we are trying to obtain ground-breaking benefits for dirt cheap. They are the salt of our earth," says Garcia-Pichel, with a smile. ■

Getting to the Root of the Matter

BY MAYA KAPOOR

Roberto Gaxiola has spent much of his research career tinkering with tiny proton pumps found in plants cells. The surprising results of his research have potentially global applications, from increasing food availability in sub-Saharan Africa to lessening coastal contamination in the Gulf of Mexico. Gaxiola has created food crops that grow up to three times their normal size and are capable of thriving in salty, nutritionally bereft environments. The key? By tweaking the performance of a single plant gene, he has bioengineered plants with super-sized roots.

As Gaxiola, an assistant professor in ASU's School of Life Sciences, tells it: these large root systems pull nutrients and water out of soil extremely efficiently. These nutrients include nitrate, potassium and phosphorous, the three main ingredients of fertilizer. He believes this targeted engineering of food crops will allow farmers to produce the same or increased yields of crops with the use of less fertilizer, which also lessens the impact and occurrence of marine algal blooms fueled by agricultural run-off.



Transgenic lettuce has increased root volume, as well as leaves, as compared to a control (last vial on the right) • Photo by Roberto Gaxiola

Higher yields of crops can be effected by modifying expression of native genes

Photo by Roberto Gaxiola

Gaxiola also sees applications for this technology in addressing food shortages. "We are extremely excited because we are doing experiments with cassava," he said. "Sub-Saharan Africa depends on cassava for carbohydrate intake. Our goal is to make these plants more efficient. If that works we're going to be very happy!" Equally exciting, greenhouse experiments suggest Gaxiola's bioengineered plants are able to thrive in sterile soils, unlike other plants that rely on healthy populations of soil bacteria and fungi to help them grow.

Gaxiola first became interested in food crop production as an undergraduate student in Sonora, Mexico. "I drove past abandoned cornfields and I asked, 'Why don't you guys plant corn?' The answer was that there was too much salt in the water." After years of irrigation, the fields were too salty for corn to grow.

At the same time, Gaxiola's studies in marine biology led him to mangrove swamps, where he saw plants thriving in brackish water. A lecture on genetic engineering given by a visiting postdoctoral fellow inspired Gaxiola to pursue creating a bioengineered solution to salinization of croplands. With what he remembers as a "naïve idea" of using mangrove genes to engineer corn capable of growing in salty environments, Gaxiola began his master's program at The National Polytechnic Institute in Mexico City.

In creating a transgenic crop plant, Gaxiola wanted to simplify and create something incredibly effective. The gene he chose is extremely conserved in all plants – 85 percent identical. "So overexpressing the gene is like up-regulating the native gene of the plant we engineer. In fact this gene is so conserved, we call our activities intragenic, instead of transgenic."

Gaxiola met his goal of creating plants that were more salt tolerant; however, there was also another very unexpected, positive result. "With this intragenic approach we noticed a very bizarre outcome," Gaxiola says. "The plants were huge! The root systems were incredibly large and, at the shoots, there were more leaves, larger leaves, more cells and more cell division."

His research team is only now unraveling the cause of the plants' unanticipated growth spurts and plans to publish those results later this year. He and his colleagues had expected to cause proton pumps to more efficiently store salt in plant vacuoles, sack-like organelles found in plant cells. This would allow plants to tolerate saltier conditions. "But we're realizing this proton pump is not only localized in the vacuoles of plants," explains Gaxiola. The pump is also in the plant tissue that moves the sugar made during photosynthesis in the leaves down to the plant's roots. It's as though Gaxiola's plants have had a reverse tummy tuck – they are able to transport sugar faster and, therefore, grow larger root systems and shoots than non-intragenic plants.

Gaxiola no longer thinks he can end the problem of over-salinization of cropland by engineering salt-tolerant plants. That's because the source of the salt, the water used to irrigate large agricultural fields, would still be there. "The green revolution had major problems," muses Gaxiola. "One of the main problems was the requirement of too much water to dilute the excess of fertilizers that eventually triggered accumulation of salts in the soils." Instead, Gaxiola believes the impact of this technology will come through lessening use and waste of water and fertilizer, and reducing impact on the environment. Gaxiola explains, "What we are creating is a *white* revolution – based in increasing the size of plants' white root systems."

When can we expect to partake of these super-sized crops? Gaxiola's hope is that his ultra-efficient crops will be on store shelves within the next five years. "What's exciting is seeing the fruits of our labor, literally," says Gaxiola. "The carrots are three times the size of the control carrots!" No report yet on how these super-sized plants taste. ■

Promoting STEM:

Forward to Professorship workshop advances women and minorities

Photo by Michael J. Traynor

Graduation deadlines spur a flurry of doctoral thesis defenses in science, technology, engineering and math (STEM). However, for many women and students from underrepresented minorities, the academic pathway from thesis defense to postdoctoral fellowship to faculty appointment in STEM is one of attrition, regardless of scientific aptitude.

Seeking to combat the loss of diversity in STEM fields, a team from Arizona State University led by **Page Baluch**, the manager of the W.M. Keck Bioimaging Facility in School of Life Sciences, an academic of ASU's College of Liberal Arts and Sciences, developed the 2011 "Forward to Professorship" workshop.

The two-day highly interactive workshop offered a series of presentations and exercises designed to bolster resources, solutions and networking opportunities and addressed topics such as funding, teaching, laboratory management, negotiation, writing and effective communication and how to negotiate the "solo" syndrome.

Forty individuals attended and contributed to the diversity of experiences, from graduate students to young faculty members; working engineers, chemists and biologists; and men, women and underrepresented groups from across Arizona and out-of-state.

"Even in fields such as biomedicine, where enrollment in graduate schools approaches 55 percent, you'll find the number of women reaching full professorship is commonly less than 20 percent," says Baluch. "This says nothing about those fields where enrollment of women and minorities in advanced degree programs starts out substantially lower. We want to help reverse this trend."

Speakers included leading ASU educators and researchers:

- ASU President Michael Crow
- Duane Roen, assistant vice provost, University Academic Success Programs
- Tamara Deuser, assistant vice president, Office of Knowledge Enterprise Development
- **Robert Page**, vice provost and dean, College of Liberal Arts and Sciences
- Bianca Bernstein, professor, School of Letters and Sciences, creator of the CareerWISE
- **Gro Amdam**, associate professor, School of Life Sciences and Norwegian University of Life Sciences
- ASU Regents' Professor **Jane Maienschein**, director of the Center for Biology and Society, CASE/ Carnegie Foundation's Arizona Professor of the Year, 2010

Guest speakers featured were Elizabeth Gould, professor of psychology, Princeton University; Joan Herbers, president of the national AWIS and professor, University of Ohio; Stephen Lee, program director, U.S. Army Research Office; and Elizabeth Pennisi, reporter and editor with *Science* magazine.

The Forward to Professorship program was sponsored by the Central Arizona Chapter of AWIS, and supported by graduate students in School of Life Sciences, School of Earth and Space Exploration and the Biodesign Institute, in addition to institutional partners at Arizona State University and the Forward to Professorship team at George Washington, Gallaudet and Ottawa Universities, funded by a National Science Foundation ADVANCE grant. To participate in the next ASU workshop, to be held January 20-21, 2012, please contact: page.baluch@asu.edu; 480.727.0725

Photo by Michael J. Traynor

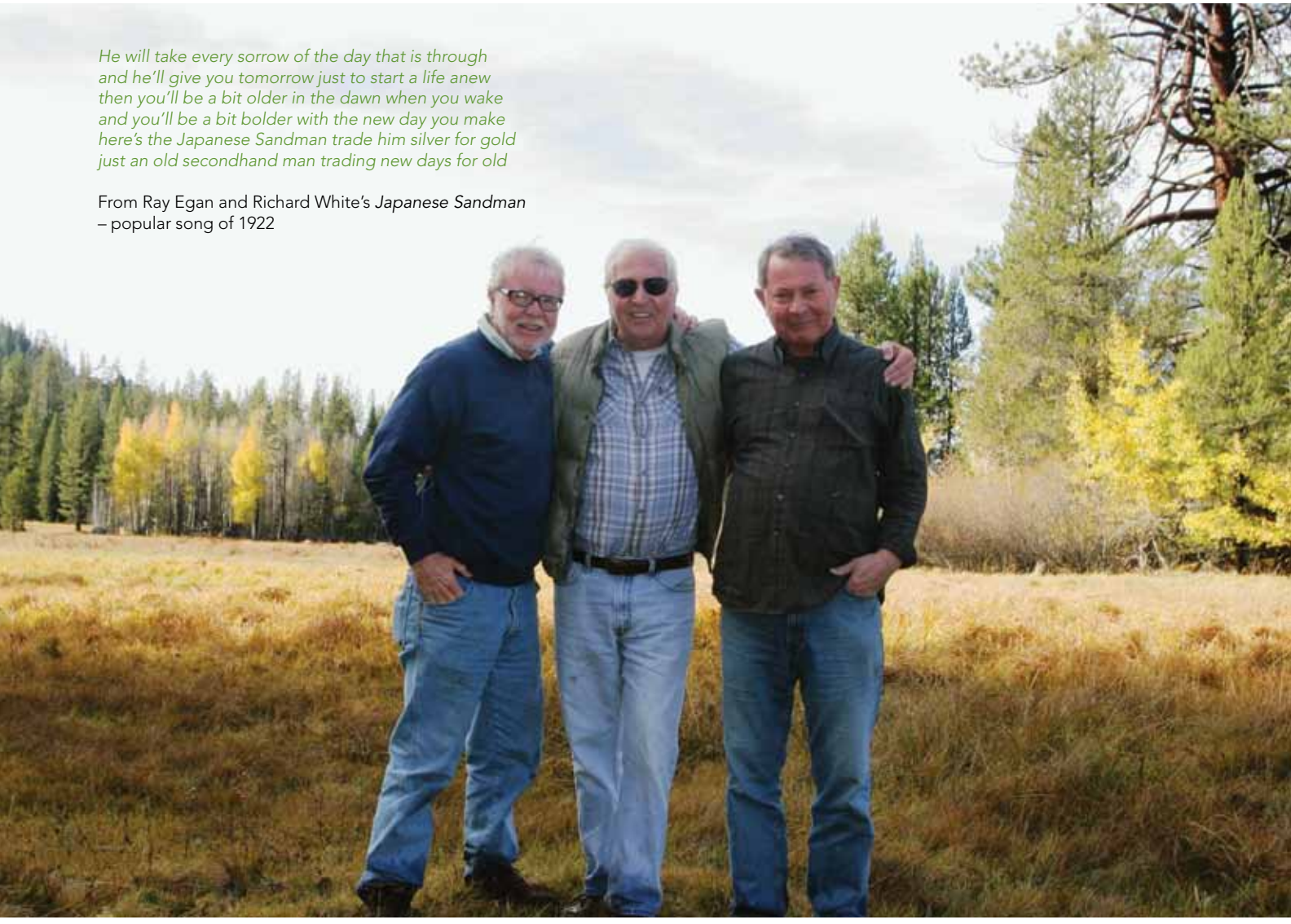
Road trips and Grizzly discoveries

Three brothers search for meaning in the last resting place of the California grizzly

STORY AND PHOTOGRAPHY BY DAVID, JAMES AND RICHARD BROWN

He will take every sorrow of the day that is through
and he'll give you tomorrow just to start a life anew
then you'll be a bit older in the dawn when you wake
and you'll be a bit bolder with the new day you make
here's the Japanese Sandman trade him silver for gold
just an old secondhand man trading new days for old

From Ray Egan and Richard White's *Japanese Sandman* – popular song of 1922



Being raised in California leaves an indelible mark like baptism. The diversity of the state and its continuing flux, since the arrival of the early Spanish padres, never fails to fascinate and draw us back within its borders, as it did in October 2010, when our most recent road trip together called for a ramble along the back roads of some little known parts of California: the southern Sierra Nevada and the old boom towns of the Tulare Basin and Joaquin Valley. Road trips for us mean that as we drive together we argue politics; we rehash and exaggerate the foibles of our youth. We make vast generalizations and, afterwards, we dissect what is or should be done, as if we actually ruled. Combined with the passing California landscapes, our jaunts together come to reinforce who we were and what we are. And, despite differing on nearly everything, on this trip in particular we share in two things: a wish to see a California either forgotten or unseen, and a desire to pilgrimage to where the last California grizzly bear was slain.

Along the way to our final destination, the Sequoia and Kings Canyon National Parks where the last grizzly fell, Rick photographs the Temblor Hills, the San Andrews Fault and Buttonwillow. We meander through the Carrizo Plains National Monument, Three Rivers and the Sierra Madre, and visit McKittrick, Taft and Maricopa, the country depicted in the film *There Will Be Blood* starring Daniel Day Lewis. We travel via the old Government Highway to Three Rivers to the waterfowl refuges and duck clubs near Gustine and Los Banos, where David had banded ducks as a college intern with the California Fish and Game Department. We traverse the length of the Carrizo Plains, sans antelope, past small desert oil towns, rocking oil rigs jammed together like cars in a parking lot, and look over vast new pistachio orchards. We spend the night in the 1920s oil town of Taft, where the newest motel is called The Capri. Our motel could have passed for a remodeled stage prop of a Hitchcock movie, but breakfast at the haunt of the local oil roustabouts turns up a feast of fresh hash browns, with added fried onions upon request. These landscapes expose us to a lot of forgotten California history, but it is the great bear, prominently displayed on the California state flag, that has always been emblematic of Old California and symbolic of all the things lost in the state's never-ceasing search for gold, be it the actual ore, agriculture, real estate speculation, movies or silicon chips.

Setting out to find the site of the last grizzly's stand can be a bit problematic. Differing localities and museums vie for the honor of the last dead great bear. We are fortunate travellers as we face this potential dilemma armed with a long-ago secured copy of Tracy Storer and Lloyd Tevis's *California Grizzly* published by the University of California Press in 1955. An exquisite obituary immortalizing California's once numerous and most notorious beast, it lists all the "last grizzlies" by county and year. It notes, for example, that the most recent grizzly specimen in a museum was collected in Tujunga Canyon in Los Angeles County in 1916, though this bear was almost certainly an escaped captive from a zoo in Griffith Park. It also records the "last" museum specimen as coming from a pair of grizzlies shot in 1908 in the Santa Ana Mountains near present day Disneyland, featured in a display in Bear Valley, California.

California Grizzly also records grizzly bear observations into the 1920s and points to the grizzly's final chapter as centered in the wild and precipitous neighborhood of Sequoia National Park in the Sierra Nevada mountain range. It was here, just outside the Sequoia National Forest's boundary, where cattleman Jesse B. Agnew shot what he swore was a grizzly on his ranch in Horse Corral Meadow at 7,500 feet elevation near the Fresno-Tulare county line in August 1922. Although the bear's pelt was later sent to Korea by Agnew's nephew, it was identified as a grizzly on the basis of a tooth sent to Clinton Hart Merriam, one of the original founders of the National Geographic Society and first chief of USDA's Division of Economic Ornithology and Mammalogy, the predecessor to the United States Fish and Wildlife Service. Though the skin of a black bear nailed to a barn in Horse Corral Meadow in 1950 later clouded Agnew's account and both bear species were present in this part of the Sierra Nevada, most grizzly experts accept the 1922 date and Horse Corral Meadow as the site of the last grizzly in California.

Our trip to Horse Corral Meadow offered many delights. It looked and felt like grizzly country. We could easily imagine the last grizzly coming out of the forest to fish or dig for gophers. The wet meadow had an October glow reminiscent of how it might have looked in 1922. Remote, pristine, surrounded by the firs and pines of the Sierra National Forest, the sedges

and tussocks of meadow grass were dissected by a wee but energetic brook populated by furtive golden trout – some of decent size. No livestock were present, nor tourists save us, and the only signs of civilization were two namesake horse corrals and a handful of dwellings located on private land. Included among these was an ancient cabin – undoubtedly the one reported as Agnew's by Storer and Tevis in the 1950s.

However, aspects of this visit and a visit to the national park nag at us long after we continue on our trek. On our minds is talk of wildlife restoration and the importance of the California Grizzly to the state's psyche. But there was no mention of grizzlies in the Park Service brochures other than "There are no grizzly bears in these parks." When queried as to the possibility of returning "Old Ephraim" to his most recent haunts, the Park Ranger had intently avoided the subject. Ditto with the folks in the Tourist Center where a jillion natural history books – other than *California Grizzly* – were offered for sale. When pressed as to the desirability of returning the bear to her role as a member of the Park's fauna, the response was to dismiss the suggestion as impractical and change the subject to a recent sighting of a wolverine farther north.

David saw his first grizzly in Abruzzo National Park in Italy in 1987 (the grizzly and the European brown bear are the same species, *Ursus arctos*). There is no reason for Italy to have a more diverse large mammal fauna than California. Both entities have alpine mountains, possess a Mediterranean climate and share similar vegetation. California with its 163,695 square miles is measurably larger than Italy's 116,305 square miles and with 57.6 million citizens is more densely populated than California, which is now occupied by 37 million people.

Nor is the discrepancy explained by a tale of two parks. Bears were present when Sequoia National Park was first established in 1890 and in 1893 when the surrounding Sierra Forest Preserve was created. Sequoia and Kings Canyon national parks now encompass 1,350 square miles. The much smaller 235 square mile Abruzzo National Park was established by executive order of Benito Mussolini in 1922 – the same year that California lost its grizzly. Horse Meadow is surrounded by public land encompassing wilderness areas containing some of the roughest terrain in the state. Restoration is obviously a much more difficult task than was preservation.

The problem, as it appears to us, is then a matter of persistence. There was no National Park Service administrating the national parks in the U.S. until 1916, and Americans considered animals either useful or bad. Grizzlies were deemed bad by the stockmen surrounding Sequoia.

The U.S. Army in charge of America's parks during the early years of the 20th century, while protecting the redwoods and meadows, did nothing to save California's totem. Grizzlies received no protection and some troopers even assisted in their removal. Although the grizzly managed to persist in Yellowstone and Glacier National Parks, Californians were less forgiving. The species was likely doomed even as President Roosevelt, John Muir and other conservationists were waging the battle to preserve the Golden State's natural heritage.

So the idea of attempting to restore the grizzly to California is perhaps futile, but not for biological reasons… for legal reasons. It is unlikely that a National Park or Forest Service administrator would reintroduce an animal that may result in tort claims. And, the truth is that grizzlies do get in trouble; sometimes they even kill people. Never mind that Italian grizzlies haven't injured anyone since 1935 when a hunter was bitten by a bear he had wounded. Italian bears have had 3,000 years to learn how to get along with armed men. America's grizzlies only had a few hundred years to adapt.

Still, the possibility of returning the bruin to his home state continues to intrigue. Californians die every day, ranging from deadfalls to ordinary falls, and mountain lions to serial killers. Disclaimers abound on public lands, so – we wonder – why a natural area administrator should deny a hiker or photographer the adventure of encountering a California grizzly? The unlikeliness of a fatal encounter with a wild animal, no matter how remote, is a natural risk of going out-of-doors. We ask: are we less now in our spirit than when we were Native Americans, Californianos and 49ers? Are Italians less fearful and more accommodating than Californians? California is so huge and diverse that it continues to have everything it had, and like the *Japanese Sandman*, is said to constantly be making old days new. Why not a new day for the grizzly? California grizzlies should have a tomorrow to dream about. ■

The Brown brothers grew up in California. **David Brown**, a faculty associate in ASU School of Life Sciences, was the oldest and left first to become a wildlife biologist in Arizona. James, the middle brother (Jim) lagged leaving his California nest in Silicon Valley, but eventually migrated north in one of the state's periodic lemming exoduses to be a cherry farmer in Oregon. Richard (Rick), the youngest, a high school teacher turned organic farmer, relocated to the gold country of the Sierra Nevada foothills. The brothers grew apart but, after mating, breeding and rearing, awoke to rediscover one another.

Courses

Undergraduate discovery propels inquiry, potential cactus cure for bacterial woe

STORY AND PHOTOGRAPHY BY EMILY RICHTER

The diverse array of cutting-edge biological sciences and experts draws many undergraduates to ASU. However, new arrivals often don't realize that they can be the drivers behind discoveries at the bench or in the field. School of Life Sciences hosts a range hands-on research experiences for students in nearly every area that touches on biology, from the global to the molecular scale.

The most recent SOLS offering is MIC 206, an introductory microbiology course whose laboratory is integrating original student research with basic science education.

The goal of this new approach to microbiology lab is for students to learn and develop basic skills through hands-on engagement with the natural world instead of traditional textbook lab activities. Students learn to ask their own questions about microbiology, to design experiments and evaluate results, rather than recapitulating experiments with known outcomes.

The results from MIC 206 have been exciting. For example, in the fall semester of 2010, undergraduate students **Lisa Banasek**, **Nicholas Berrett**, **Michelle Brennan** and **Ashley Lang** connected their interests in medicine, familiarity with Arizona's plant life, and new microbiology knowledge to develop a project to test the use of native plant extracts as potential antibacterial agents. Using the most up-to-date research laboratory methods in their class, they discovered that two species of native cholla selectively inhibit the growth of *Pseudomonas aeruginosa*. These bacteria are commonly responsible for a significant percentage of hospital-acquired infections each year. The infections can be very hard to treat with antibiotics due to this organism's natural defenses. Although *Pseudomonas* does not often attack healthy people, once disease sets in these bacteria can be fatal.

"This is preliminary work," says **Emily Richter**, a graduate student working with Professor **Anton Lawson**. Richter developed the lab course as part of her thesis research. "But these students' find is very exciting. Whatever compound is killing the *Pseudomonas* is pretty powerful. We saw significant zones where the bacteria could not grow in every trial these students conducted. Only two of the five species of cholla species we tested showed the activity and their extracts had no effect on the growth of many other bacterial species. If the compound that is selectively killing these bacteria can be isolated, and it doesn't also kill human cells, it might someday lead to a more effective way to treat *Pseudomonas* infections."

The undergraduate students developed the idea for their research project by themselves, worked together to design a controlled study, and went into the field to identify and collect plants. They removed spines and skins from the samples and then ground them in a mortar and pestle. Sterile cellulose disks were soaked in the resulting liquid and then placed on nutrient agar plates that had been inoculated with known bacteria. If compounds in the plants killed bacteria or inhibited their growth, the students would expect to see bacteria-free zones around the disks in the next class period. In most cases, the bacteria grew up to or over the disks containing plant extracts. However, in the case of disks that had been soaked in extracts from teddy bear *(Cylindropuntia bigeloviii)* and buckhorn cholla *(Cylindropuntia acanthocarpa)*, clear zones over a centimeter in diameter were observed on the agar plates that had been inoculated with *Pseudomonas aeruginosa*.

The research project drew heavily on the students' background skills and knowledge. Berrett, a native-born Arizonan who spent many years working with the forest service before continuing his education, made the project possible through his familiarity with local plants.

"If you want people to learn," he said, "you need to light a fire for them and get their attention. I want to work in plant biology research, and I do my best work when I'm involved in something I care about. It was great to be able to do research that built on my background interests."

Lang, a graduating senior who hopes to become a physician's assistant, was excited to have made potential contributions to the treatment of disease. "I was so excited to have the opportunity for our group to design our own research project," she said. "I got to study something that is actually relevant to me and my interests, and may even have future implications for patients with *Pseudomonas* infections."

"I was glad to see these students have such a productive experience," said Richter, whose research focuses on language and science education, "but I was happier still to see them and my other students develop their problem-solving skills through independent research. There are different skills involved in learning about science and 'doing' science. I think if we want to move American education forward we need to keep working to develop both of these skill sets. The educational model we're working to develop in the microbiology lab is not more expensive than traditional instruction, and my studies show that it allows students to retain more microbiology knowledge during and after the course. Also, undergraduates are often in a very creative time in their lives. Harnessing that creativity through independent research can result in a positive experience for both the students and the larger scientific community."

The students' findings and their potential applications are being further explored by **Aurelie Crabbe**, a researcher in School of Life Sciences Professor **Cheryl Nickerson's** laboratory in ASU's Biodesign Institute. This spring cholla cactus samples from Arizona's Desert Botanical Garden are being examined and collaborations with other ASU researchers are forthcoming. Through their work in class, these ASU undergraduates have created a lasting impact on our larger research community early on, and move forward with skills that promise more to come. ■

More avenues for hands-on undergraduate research experiences: http://sols.asu.edu/ugrad/research_experiences.php


Tatiana Ugarova


Kevin Gurney


Wayne Frasch


Sudhir Kumar


Stephen Pratt


Susanne Neuer


Thomas Dowling


Cheryl Nickerson


Jane Maienschein


Sharon Hall

faculty awards

Tatiana Ugarova, an associate professor, was awarded $3.2 million in grants from the National Institutes of Health around the topics of integrins, leukocytes, and the examination of non-adhesive properties of fibrinogen. She was also elected to serve as a member of the National Institutes of Health Hemostasis and Thrombosis Study Section, Center for Scientific Review starting July 2011-June, 2015.

Kevin Gurney, an associate professor, received grants from JPL University Research Partnership, NASA, Northern Arizona University and Purdue University totaling $1,468,022 for four projects: Characterization of mega-city CO_2 emissions at high spatio-temporal resolution," "Exploration of the mechanistic relationship between improved regional North American inverse carbon fluxes and climate variability trends," "A Global high-resolution Fossil fuel CO_2 inventory built from assimilation of in situ and remotely sensed datasets to advance satellite greenhouse gas decision support systems," and "Development, improvement and assessment of the accuracy of aircraft-based mass balance measurement of integrated urban emission fluxes."

Professor **Wayne Frasch** received $1.2 million from the National Institutes of Health to examine the "F_o motor mechanisms that power F_oF_1 ATP synthesis." His group is deciphering how one of the world's smallest molecular motors works in living cells, with impact on nanotechnology development in the areas of energy production and synthetic motors.

Professor **Sudhir Kumar**, who is also the director of the Center for Evolutionary Medicine and Informatics at the Biodesign Institute, received $1,143,750 in support from the National Institutes of Health, National Library of Medicine to study the "evolutionary bioinformatics of human mutations."

Stephen Pratt, assistant professor, was awarded two three-year collaborative research grants from the National Science Foundation: $528,652 to examine "Cooperation and learning over cognitive networks," and $209,014 for "Automating the large-scale measurement of insect behavior."

Susanne Neuer, associate professor, was awarded grants totaling more than $700,000 from the National Science Foundation for the study of "Plankton community composition and trophic interactions as modifiers of carbon export in the Sargasso Sea" and "Sinking rates and nutritional quality of organic matter exported from sea ice: The importance of exopolymeric substances."

Professor **Thomas Dowling**, in partnership with former SOLS professor Paul Marsh, garnered $579,798 in awards from the US Department of the Interior Bureau of Reclamation for four-year "Genetic and demographic studies to guide conservation management of Bonytail chub and Razorback sucker in off-channel habitats."

Cheryl Nickerson, associate professor, received a three-year $450,000 award from NASA to investigate host-pathogen interactions, conserved cellular responses and countermeasure efficacy during spaceflight using the human surrogate 3-D modeling system.

Regents' Professor **Jane Maienschein** received $355,144 from the National Science Foundation for 2011 to support training and research connected to SOLS' Center for Biology and Society's "The Embryo Project."

Sharon Hall, associate professor, received $299,885 in funding from the National Science Foundation to examine "ecological homogenization of urban America." This study will test thinking that similar management practices among cities lead to homogenization in ecological structure and function, with relevance to ecosystem carbon and nitrogen dynamics, with potential continental scale implications. Their test cities are the metro areas of Phoenix, Baltimore, Miami, Los Angeles, Boston and Minneapolis/St. Paul.


Yung Chang


Osvaldo Sala


Pierre Deviche


Stephen Pyne

Yung Chang, associate professor and researcher with the Biodesign Institute, received a grant for $362,245 from the National Institutes of Health. Her laboratory focuses on mechanisms underlying the formation and progression of lymphoid malignancy, such as leukemia and lymphoma. This study will examine "Tunable nicotine DNA-nanovaccines."

Foundation Professor **Osvaldo Sala**, who is also the Julie A. Wrigley Chair with the Global Institute of Sustainability, was awarded a $290,511 grant from Brown University to study the "precipitation controls of carbon and nitrogen cycles in arid-semiarid ecosystems.

Professor **Pierre Deviche** received a $240,000 grant from the National Science Foundation to study the "Neuroendrocrine bases and environmental regulation of reproduction in a flexibility breeding songbird."

Professor **Stephen Pyne** was awarded a $200,000 grant by the USDA Forest Service to develop a book-length fire history of America, 1960-2010. ■


Charles Kazilek


James Collins


Nancy Grimm


Kenneth Mossman


Elizabeth Davidson

honors

Ask A Biologist, ASU's online K-12 science education website, created by **Charles Kazilek**, director of technology integration and outreach, received a *Science* Prize for Online Resources in Education (SPORE) award from the American Association for the Advancement of Science. The prize was established to "encourage innovation and excellence in education, as well as to encourage the use of high-quality on-line resources by students, teachers and the public."

Professor **James Collins** was chosen to be Member of the Board of Directors of the American Association of Colleges and Universities (AAC&U). Founded in 1915, the 1,200 member AAC&U are concerned with "the quality, vitality, and public standing of undergraduate liberal education and its members committed to extending the advantages of a liberal education to all students, regardless of academic specialization or intended career."

Professor **Nancy Grimm** has been selected to serve at the National Science Foundation as Program Director, Ecosystem Science and Interdisciplinary Program Liaison for the Biology Directorate. She is working with the Science, Engineering and Education for Sustainability (SEES) interdirectorate/interoffice implementation group and with several SEES components (sustainable water, sustainable energy), and involved in planning a "Sustainability Summit" to involve multiple entities in the federal government.

Professor **Kenneth Mossman** was chosen as the Robert L. Long Distinguished Lecturer and spoke at the National Museum of Nuclear Science and History in Albuquerque, New Mexico. In 2011, he also established the Kenneth and Blaire Mossman Professor of Biomedicine at the University of Tennessee-Knoxville. The first recipient of the endowed professorship was Cynthia Peterson, chair Department of Biochemistry & Cellular and Molecular Biology, College of Arts and Sciences, University of Tennessee-Knoxville.

Research Professor **Elizabeth Davidson** was chosen to deliver the Founder's Lecture at the annual Society for Invertebrate Pathology meeting in Halifax, Nova Scotia, in August 2011, honoring former SOLS professor John D. Briggs. Davidson also authored a children's book, "*Cheery: The true adventures of a Chiricahua Leopard Frog.*"


Janet Neisewander


Leah Gerber


Jane Maienschein


Scott Collins


James Elser


Eli Fenichel


Gro Amdam


Debra Page Baluch


Margaret Coulombe


Bertram Jacobs


Manfred Laubichler


Bert Hölldobler


Stephen Pyne


Michael Angilletta

Professor **Janet Neisewander** received the Bernice Grafstein Award for Outstanding Mentoring from the Society for Neuroscience. The award was established to recognize people who promote women's advancement in neuroscience. She was nominated by three former graduate students.

Leah Gerber, associate professor, was awarded a 2011 Aldo Leopold Fellowship to further the dissemination and impact of her studies at the intersection of conservation policy and society; research such as: the creation and efficacy of marine preserves, the impacts of ecotourism on local communities, both human and marine mammals, and relationship between whaling and fisheries.

Regents' Professor **Jane Maienschein** was chosen by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Educations (CASE) as 2010 Professor of the Year for Arizona. She was honored at a ceremony in Washington, D.C. ASU Alumni Farshad Fani Marvasti, a former ASU undergraduate student, described her impact thus: "She is an incredibly dedicated professor who I believe sets an infallible standard of mentorship that most professors can only hope to achieve. Her impact on students is simply amazing."

Professor **Scott Collins** was appointed the President of the Ecological Society of America.

Regents' Professor **James Elser** was selected for a 2011 Fulbright Fellowship, to study pristine Andean lakes in Patagonia, Argentina, to further his study of the impacts of anthropogenic nitrogen and phosphorus.

Eli Fenichel, assistant professor, received the 2011 ASU Faculty Achievement Award, Young Investigator for his studies of environmental tipping points, impacts of invasive species, and disease spread in human and wildlife populations.

Gro Amdam, associate professor, received the 2011 ASU Faculty Achievement Award, Defining Edge in Math/Natural Sciences for her work using honey bees as a model for human disease and aging.

The Commission on the Status of Women at ASU awarded School of Life Sciences personnel for their "Outstanding Achievements and Contributions" for the fourth year in a row. In 2011, **Debra Page Baluch**, manager of the Keck Bioimaging Facility, was selected for her leadership and creation of training opportunities for women and minorities in science. She was also elected President of the Central Arizona Chapter of the Association for Women in Science (AWIS) for 2011.

Margaret Coulombe, manager of media relations and marketing, was awarded ASU's CET Excellence in Diversity Award. These awards are given to members of ASU and the community who promote and support cultural diversity.

ASU Parents Professor of the Year 2011 special mentions included professors **Bertram Jacobs** and **Manfred Laubichler** for excellence in teaching and efforts in HIV/AIDS and undergraduate curriculum reform, respectively.

Bert Hölldobler, Foundation Professor of Life Sciences, is keynote speaker at the International Congress for Chemical Ecology in Vancouver, Canada, and was the invited opening keynote lecturer at the Symposium on Chemical Senses and Chemical Communication at the Annual Congress of the American Entomological Society in San Diego, California.

Professor **Stephen Pyne's** book about the age of exploration and space "Voyager" was named Library Journal's best books (sci-tech) for 2010.

Associate Professor **Michael Angilletta's** book "Thermal Adaptation: A theoretical and empirical synthesis" received the British Ecological Society's Marsh Book of the Year Award for 2010. ■


Mike Butler


Arianne Cease


Joanna Malukiewicz


Jessica Corman


Nick Lessios


Erick Peirson


Katherine Larrimore


Karen Wellner


Caitlin Otto


Karla Moeller


Fernando Vonhoff


Brandon Guida

students

Mike Butler, doctoral student with **Kevin McGraw's** group, garnered a range of awards in 2011, including a Faculty Emeriti Association Fellowship; Graduate College Dissertation Fellowship; ASU Chapter of Sigma-Xi Grants-in-Aid of Research; Frank M. Chapman Research Grant; and Graduate and Professional Student Association JumpStart Research Grant to support his work on his research focuses on immune function, carotenoid allocation, and coloration of mallard ducks during post-natal development.

Arianne Cease, doctoral student with Professor **Jon Harrison** and Regents' Professor **James Elser**, was awarded an International PEO Scholars Award (2011-2012) to support her work with grasshoppers and grassland ecosystems in China. In addition, Cease was recently awarded the Faculty Women's Association (FWA) Outstanding Graduate Student Award (2011).

Joanna Malukiewicz, doctoral student with Professor **Ananias Escalante's** group, received an NSF DDIG in Physical Anthropology (2011) and is the first ever international exchange graduate student at Universidade Estadual do Norte Fluminensce Darcy Ribeiro in Campos dos Goytacazes, Rio de Janeiro, Brazil.

Jessica Corman, a doctoral student in Regents' Professor **James Elser's** group, received an Achievement Rewards for College Scientists (ARCS) fellowship (2011-2012). Corman was the graduate student lead for ASU's Sustainable Phosphorus Summit (2011).

National Science Foundation Fellowship awards were awarded to **Nick Lessios** of Professor **Ron Rutowski's** group; **Erick Peirson** of **Andrew Hamilton's** group; and, honorable mention, **Katherine Larrimore** of **Tsafrir Mor's** group.

Karen Wellner, a doctoral student with Regents' Professor **Jane Maienschein**, director of the Center for Biology and Society, was accepted to the Canadian History and Environment Summer School (CHESS) at St. Andrews, New Brunswick, Canada (May 2011) to study "Environmental history and coastal communities: Huntsman Marine Science Center." She was also selected to join the workshop: NEH Landmarks of American History and Culture, in Savannah, Georgia (June 2011), which will examine "African-American environmental history in the Georgia low country: Savannah & the coastal islands, 1750-1950."

Caitlin Otto, a doctoral student in **Shelley Haydel's** group, was selected to receive a Science Foundation Arizona Graduate Research Fellowship (2010-2012).

Karla Moeller, a doctoral student with **Dale DeNardo's** group, was awarded a GPSA research grant, a SOLS GiFT award (2010), in addition to a Conservation Biology Grant from T & E, Inc. **Fernando Vonhoff**, a doctoral student with **Carsten Duch**, received a 2011 SOLS GiFT award. **Brandon Guida**, a doctoral student with Professor **Ferran Garcia-Pichel**, received a 2011 SOLS FIGG award.

Julie Getz, a SOLS doctoral student and researcher at Translational Genomics Research Institute (TGen) in **Heather Cunliffe's** group, received an AACR Minority Scholar scholarship from the Susan G. Komen for the Cure® to support her attendance at the 33rd Annual CTRC-AACR San Antonio Breast Cancer Symposium in 2010.

Rene Tellez, an undergraduate student pursuing microbiology and biochemistry concurrent majors, has received the Alumni Association Outstanding Graduate Award for Life Sciences (2011). The Arizona State Alumni Association presents the Outstanding Graduate Award each year to an outstanding graduate in the College of Liberal Arts and Sciences Humanities, Natural Sciences, and Social Sciences divisions. ■

A whale of a time

Do you get seasick? Have you ever seen a pink dolphin? What happens if you eat plankton? Associate Professor **Susanne Neuer**, an oceanographer who studies plankton and the ocean's carbon cycle, and doctoral student **Erick Peirson**, a boat driver and expert on killer whale calls, were peppered with these and other questions during a visit from teacher Kay Wallach and 41 third and fourth-grade Project Ideal kids from Lake Pleasant, Parkridge and Ira Murphy elementary schools in the with Peoria School District. The children came to ASU School of Life Sciences on a quest to understand more about the ocean, its marine creatures and careers in oceanography. Amidst a day of whale calls, dinoflagellates and stories about research cruises and polar bears gnawing on the bones of bowhead whales hunted by native peoples, the students learned something about what it means to be a scientist and a student at ASU.

"Thank you for inviting us and letting us look at the plankton and listening to the whale sounds."
— Leilani, Samantha, Jenna, Jared, Paige

"I liked it a lot! It was really fun! Please thank the students who helped us with this activity."
— Olivia and Kyle

"I want to go there when I go to college."
— Whitney

Students learn about how whales locate each other in the ocean. Divided into four groups and blindfolded the teams try to unite using only sounds to find each other.

Sustainability Art Show: Partnering creation with science

ASU's Sustainable P Art Show teamed up artists and scientists to visually explore sustainability and the current use of phosphorus. The exhibit, shown at the Desert Botanical Garden and Step Gallery, featured a variety of media including: painting, photography, collage, sculpture, illustration, multimedia installation, dance and music.

http://sols.asu.edu/frontiers/2011/art.php

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