COLLEGE OF
Natural Resources
UNIVERSITY OF CALIFORNIA, BERKELEY

101 Giannini Hall # 3100
Berkeley, CA 94720-3100

NONPROFIT ORGANIZATION
US POSTAGE
PAID
UNIVERSITY OF CALIFORNIA
BERKELEY

Want to receive **only** the online version of *Breakthroughs*? Send your name, mail ID, and email address to breakthroughs@berkeley.edu.

UC Berkeley and the College are part of a four-university, $40 million project to reinvent America's urban water infrastructure. Story on page 16.

BREAKTHROUGHS

UC BERKELEY COLLEGE OF NATURAL RESOURCES ● SPRING 2012

THE ENZYME DETECTIVE

Daniel Nomura Fights Disease by Manipulating Metabolism

PLUS

Remaking America's Urban Water Systems

On the Ground With Microbial Communities

Q&A: Green Building

LETTER FROM THE DEAN

One of our own has come home to Berkeley, and we couldn't be more pleased. Daniel Nomura earned his undergraduate degree and Ph.D. here at the College, and after three years as postdoctoral fellow at the Scripps Research Institute, he joined the Berkeley faculty last fall to continue his groundbreaking work manipulating enzymes to treat disease. He's already published results on cancer and Parkinson's disease; testing potential applications of his work for other diseases will keep him and his students busy for many years to come (page 10).

The coming five to ten years will also see CNR scientists working on a major National Science Foundation undertaking to transform America's urban water system for the 21st century. We are working with colleagues in the College of Engineering and three other universities to rethink, reclaim, recycle, and reengineer America's aging urban water infrastructure (page 16).

In this issue we've done a little retooling ourselves: two new *Breakthroughs* sections show off the impact our work has on the world. In "Q&A" you'll read interviews (highlights in print; longer online) with alumni working on different facets of a particular professional area (page 22). In "NewsMakers" you'll see a lively sampling of CNR men and women quoted in influential media stories (page 3).

This exciting science, and the passion of the people who do it, is a tribute to the fact that despite UC Berkeley's shift to depending on the state for just 10 percent of our funding, we're still delivering the outstanding teaching and research for which we are known around the world. Imagine what we could do with more. Make a gift now to the Campaign for Berkeley and get a guaranteed return on investment that will help keep Berkeley's best and brightest coming back to reinvest their intellectual capital right here at home.

I welcome your comments at gilless@berkeley.edu.

J. Keith Gilless

COVER PHOTO AND ILLUSTRATION:
Paul Kirchner Studios

THIS PAGE:
Illustration: Mary O'Reilly

In this artist's imagining of an invisible world, enzymes impact the intricate and infinite system of metabolic pathways. Story on page 10.

COLLEGE OF
Natural Resources
UNIVERSITY OF CALIFORNIA, BERKELEY

BREAKTHROUGHS

SPRING 2012

ONLINE

NEW! CNR VOICES: A Video Series
Marcy Darnofsky and David Winickoff in conversation

PLUS:
Video: Spring Albright Lecture in Conservation – The United States Farm Bill: What's at Stake? A panel discussion featuring Michael Pollan, Karen Ross, Ken Cook, Ken Hecht, and moderator Gorden Rausser

Go to nature.berkeley.edu/breakthroughs.

Yosemite's Alpine Chipmunks Take Genetic Hit From Climate Change

Global warming has forced alpine chipmunks in Yosemite to higher ground, prompting a startling decline in the species' genetic diversity, according to a new study by UC Berkeley researchers.

The study, which appeared Sunday, February 19, in the advance online publication of the journal *Nature Climate Change,* is one of the first to show a hit to the genetic diversity of a species because of a recent climate-induced change in the animals' geographic range. What's more, the genetic erosion occurred in the relatively short span of 90 years, highlighting the rapid threat that changing climate can pose to a species.

A species with low genetic diversity can be more vulnerable to the effects of inbreeding, disease, and other problems that threaten species survival, the researchers said.

"Climate change is implicated as the cause of geographic shifts observed among birds, small mammals, and plants, but this new work shows that, particularly for mountain species like the alpine chipmunk, such shifts can result in increasingly fragmented and genetically impoverished populations," said the study's lead author, **Emily Rubidge**, who conducted the research while a Ph.D. student at UC Berkeley's Museum of Vertebrate Zoology (MVZ) and the Department of Environmental Science, Policy, and Management (ESPM). "Under continued warming, the alpine chipmunk could be on the trajectory toward becoming threatened or even extinct."

Climate change may be threatening the survival of the alpine chipmunk.

PHOTO: Risa Sargent

Rubidge worked with **Craig Moritz**, professor of integrative biology and MVZ director; **James Patton**, professor emeritus of integrative biology and MVZ curator; and **Justin Brashares**, associate professor in ESPM.

The new findings build upon previous research that found major shifts in the range of small mammals in Yosemite National Park since the early 1900s. In 2003, biologists at UC Berkeley began an ambitious resurvey of Yosemite's birds, mammals, reptiles, and amphibians, retracing the steps originally taken between 1914 and 1920 by **Joseph Grinnell,** the MVZ's founder and former director (see Back Page for related story).

The Grinnell Resurvey Project, led by Moritz and museum colleagues, found that many small mammals in Yosemite moved or retracted their ranges to higher, cooler elevations over the past century, a period when the average temperature in the park increased by about 5.4 degrees Fahrenheit.

"Much of what we read and hear about the effects of climate change on biodiversity is based on model projections and simulations, and these models typically involve many moving parts and lots of uncertainty," said Brashares. "Thanks to the baseline provided by Joseph Grinnell's pioneering efforts in the early 20th century, we are able to go beyond projections to document how climate is altering life in California. The research led by Emily is novel and important because it shows empirically that climate change has led to the loss of genetic diversity in a wild mammal over the last several decades."

— ADAPTED FROM AN ARTICLE BY SARAH YANG

WEB EXTRA: Justin Brashares talks about emulating Jane Goodall, being chased up a tree by lions, and making the connection between European fisheries and African bushmeat markets. Read the interview in the inaugural issue of ESPM's *Our Environment* newsletter: http://ourenvironment.berkeley.edu/newsletters/vol1/issue1/.

DEAN:
J. Keith Gilless

EDITOR:
Ann Brody Guy

CREATIVE DIRECTOR:
Ian Price

COPY EDITOR:
Eileen Ecklund

CONTRIBUTING WRITERS:
Ronald Amundson
Sarah Craig (intern)
Eileen Ecklund
Ann Brody Guy
Robert S. Lane
Mark MacNamara
Beth Mole
Greg Weatherford
Sarah Yang

CONTRIBUTING PHOTOGRAPHERS AND ILLUSTRATORS:
Martin Bidartondo
Sharon Beals
Sarah Craig (intern)
Chris Eichler
Brooks Freehill
Clive Goodyer
Erik Haugen
Paul Kirchner
Seth Manu
Risa Sargent
Debbie Sklut
David Wakely

DESIGN & PRODUCTION:
Price Watkins Media
pricewatkins.com

ONLINE PRODUCTION:
Joseph C. Bunik

Please direct correspondence to:
Breakthroughs
College of Natural Resources
University of California, Berkeley
101 Giannini Hall, # 3100
Berkeley, CA 94720-3100

(510) 643-1041

breakthroughs@berkeley.edu

http://nature.berkeley.edu/breakthroughs

MIX Paper FSC FSC® C011786

The less often girls eat, the more weight they gain, according to a new study by **Lorrene D. Ritchie**, a researcher at the Atkins Center for Weight and Health. The 10-year study tracked the eating habits of more than 2,300 girls, starting at ages 9 to 10, to examine the relationship between eating frequency and weight gain as girls go through adolescence. Ritchie found that girls who ate more frequent meals and snacks had a lower body mass index (BMI) and smaller waist circumference than girls who ate less frequently.

"More frequent meals and snacks may have kept girls satisfied for longer, thwarting overindulgence," said Ritchie. The analyses adjusted for race, parental education, exercise and television habits, calorie intake, and other factors. Girls who ate less frequently gained nearly one BMI unit and over a half-inch in waist circumference more than girls who reported eating more than six times per day.

"Although we did not take into account the type of foods and beverages consumed at each eating episode, naturally we'd recommend for health that you snack on an apple or carrot sticks instead of a cupcake or some potato chips," Ritchie said.

Nearly one-third of American children are overweight, and obese adolescents tend to remain obese as adults. Could small, frequent snacks and meals be a new weapon combatting the obesity epidemic? "We need more research before we can recommend to children that they snack more often," Ritchie said. "But skipping healthy meals or snacks as a way to prevent unwanted weight gain does not appear to be helpful."

The study, published in the February 2012 issue of *American Journal of Clinical Nutrition,* established definitions of meals, snacks, and eating frequency that could be important groundwork for future researchers.

— ANN BRODY GUY

THE WRIGHT STUFF: In February 2012, professor **Brian Wright** was named a Distinguished Fellow of the Australian Agricultural and Resource Economics Society.

NewsMakers

"What's the cost of this going to be? There's the cost of doing nothing versus the cost of doing something. You know you are going to get older — do you plan for old age?"

Max Auffhammer, *professor, agricultural and resource economics*
Source: The *San Jose Mercury News* was one of numerous news outlets reporting on Gov. Jerry Brown's December 14, 2011, climate change conference in San Francisco. Auffhammer testified that if there is a four-foot rise in sea level by the end of the century, and then a storm surge, both the San Francisco and Oakland airports would be underwater, as would part of Silicon Valley.

"I think it's pretty clear when you can see this beautiful green swath of wetland growing next to the brown hills at this time of year, you can see, this is carbon."

Whendee Silver, *professor, ESPM*
Source: An NPR story broadcast on December 7, 2011, featured the research of ESPM professors Silver and Dennis Baldocchi on "carbon ranching" — growing dense fields of reeds to soak up carbon from the atmosphere, then selling greenhouse gas offsets.

"My real motivation for this sock drive is so that I don't have to stand in line at Walmart with two or three cartloads full of all the socks I can find. I get a lot of stares and a lot of interesting questions."

Rick Sweitzer, *associate adjunct professor, ESPM*
Source: The KQED news blog, December 14, 2011, was one of multiple news agencies publicizing Sweitzer's unique holiday-season drive for "gently used" socks, which he uses to hold bait for the elusive Pacific fisher, a rare weasel his project is studying. Sweitzer received more than 10,000 socks as a result of the viral news story.

In Battle to Save Vineyards, Scientists Try Tricking Bacteria

Every grapevine in the 28-acre Bonny Doon Vineyard had to be ripped from the earth and torched in 1994. New vines might have faced the same fate the following year. Instead, owner Randall Grahm, numb from years of battling an incurable plague, sold his whole vineyard of dead and dying Syrah, Viognier, and Marsanne grapes.

But that was just the beginning of a statewide killing spree by a new duo behind Pierce's disease: the sap-sucking insect known as the glassy-winged sharpshooter and the vine-choking bacteria *Xylella fastidiosa*. Together they drained more than $30 million out of Northern California's $3 billion-a-year grape industry in the late 1990s. The wine industry retaliated with millions of dollars of pest-management and protection measures — in a battle it's still fighting.

Now scientists have come up with a new and cheaper tactic: confuse the germs as soon as the sharpshooter delivers them into a healthy vine. **Steve Lindow,** a plant pathologist from the Department of Plant and Microbial Biology (PMB), is using something similar to a Jedi mind trick: Convince the bacteria they've already caused disease. But to stop these microscopic killers, scientists had to do some criminal profiling.

When *Xylella* get into a grape vine, they're released in the vascular tissue — the plumbing of the plant that pumps water up from the roots. From there the bacteria use the tissue as hallways to invade the whole vine. They then start exploring and munching on the plant.

"We think that the exploratory phase involves rather promiscuous movement of bacteria," Lindow said. But as they spread from place to place, there are only a few bacteria in each area. This is key, he said, because when *Xylella* populations start to get big, they run into each other and switch tactics.

Each bacterium constantly sends out a molecular beacon, similar to the ping of a submarine's sonar. When many cells are stuck in part of the hallway at once, they're aware of each other because they pick up the pings. Then they mob up.

"It's kind of a switch — a lifestyle switch," Lindow said. In a mob, they make themselves sticky — to each other and to a spot — so they can be sucked into a sharpshooter, their getaway car.

Lindow and his team of researchers realized that this beacon is the bacteria's glaring weakness — without it, they wouldn't make it into their next sharpshooter or kill the vine. So the researchers engineered transgenic grape vines to make the same beacon.

If the vines constantly produce the signal for clumping, the arriving bacteria will get confused and act as though they've already infected the plant. They won't explore. They'll stay right where they landed and wait for their getaway insect — even though they didn't pull off a heist. Lindow thinks they'll start seeing results in fields in the next few years, but in the meantime, he'll explore other methods of treating Pierce's disease.

— ADAPTED FROM THE ARTICLE "IN BATTLE TO SAVE BONNY DOON VINEYARDS, SCIENTISTS TRY TRICKING BACTERIA," BY BETH MOLE. REPRINTED WITH PERMISSION FROM THE *SAN JOSE MERCURY NEWS*.

Land Donation to Double UC Research Forestlands

The University of California stands to receive 4,584 acres of Northern California mixed-conifer forest, doubling the size of its research forests, as a result of a land donation approved November 16, 2011. The transfer would be the largest single acquisition of forestland in the University's history — part of a Pacific Gas and Electric Company (PG&E) bankruptcy settlement to ensure that over 140,000 acres of California's pristine watershed lands are conserved for the public good. "This four-and-half-thousand acres is a tiny portion of the total PG&E lands, but it will be an enormous boon to UC's research and outreach capabilities," said Dean J. Keith Gilless, a professor of forest economics. Gilless said the new lands will enable researchers to study how forest ecosystems will respond to climate change, test a range of forest-management approaches, and broaden outreach to schools and the public.

— ANN BRODY GUY

BiGCB Gets Bigger, Thanks to Keck Grant

The Berkeley Initiative in Global Change Biology, pronounced informally as "The Big CB," received a boost in January when the W. M. Keck Foundation awarded the project $1.5 million. "Big" is an apt acronym: the initiative involves faculty members from eight campus departments and four campus natural history museums. Tapping the unique combination of data and talent from across UC Berkeley, the BiGCB is an effort of unprecedented scale and complexity; more than 40 CNR faculty are involved. The project is addressing global change biology by integrating analysis of fossil, historic, and current data in order to uncover new knowledge of California ecosystems' responses to environmental change. In other words, BiGCB scientists say, understand the past, understand the present, and predict the future. The Keck grant will help them do just that, by supporting the development of the informatics infrastructure they need to build the next generation of models that will put all that data to work.

— GUY

HONOR ROLL: Of the 11 new UC Berkeley-based fellows of the American Association for the Advancement of Science (AAAS) announced in late 2011, 4 are affiliated with CNR:

- **Dan Kammen,** professor of energy and resources
- **Sheila McCormick,** adjunct professor, PMB
- **Anastasios Melis,** professor, PMB
- **Carolyn Merchant,** professor of environmental science, policy, and management

The AAAS is the world's largest general scientific society and publisher of the journal *Science*. Fellows are chosen by their peers in recognition of their distinguished efforts to advance science or its applications.

SUBJECT:

Why I Do Science

ENTRY BY: **Robert S. Lane**

ENTRY #: **007**

Long ago, while sitting in a Berkeley eatery conversing with a visiting scientist, we asked each other, why do we do science? It was a no-brainer: Science provides a lifetime of experiencing the joy of discovery! My love affair with my chosen field, entomology, began when as a young boy in Los Angeles I first saw a mourning cloak butterfly on the wing, and decided instantly to pursue insects as a hobby. Innumerable days spent roaming the then-undeveloped Baldwin Hills (now colonized by homes and oil derricks) yielded collections of insects, scorpions, spiders, lizards, snakes — basically anything that crawled, ran, flew, bit, or stung. In the 1950s, I even witnessed a rare event, a massive irruption of black-tailed jackrabbits, in the adjacent grassy flatlands.

This early-life passion continued unabated until my 13th year, but wasn't rekindled until I took courses in entomology while a graduate student at San Francisco State University. After completing my doctoral training in medical entomology at UC Berkeley, I began studying the ecology and epidemiology of tick-transmitted diseases impacting public health. Recent research has sought to clarify what behaviors and environmental factors increase one's probable risk of exposure to infected human-biting ticks.

Life sometimes comes full circle. Certain animals I either collected or observed in my youth proved to be key players in maintaining natural cycles of human bacterial disease agents. Western fence lizards (aka "blue-bellies") were discovered to reduce the force of transmission of Lyme disease to people bitten by adult western black-legged ticks by cleansing attached, infected juvenile ticks of their bacterial burdens. Jackrabbits were found to be important hosts for certain kinds of spotted fever- and Lyme disease-group bacteria and their carrier ticks. The research is never-ending; the devil is in sorting the details, but the great joy remains the chase and the occasional epiphany.

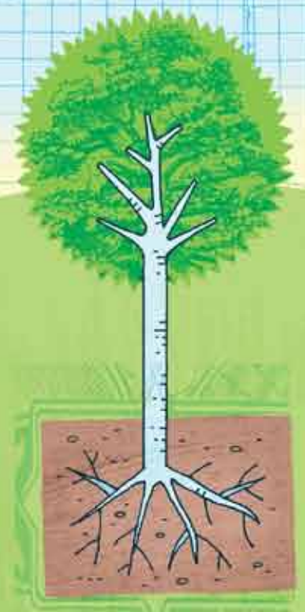
Robert S. Lane is a professor emeritus of medical entomology in ESPM. He has studied the biology of ticks and the ecology, epidemiology, and prevention of tick-borne diseases in the far-western United States since the 1970s.

ON THE GROUND:

Microbial Communities

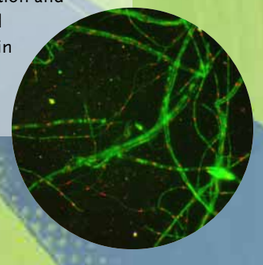
Here are just a few CNR projects happening on the ground with microbial communities.

Illustration by Clive Goodyer



WHAT MAKES MICROORGANISMS TICK?

Using methods that recover the genome sequences and identify the proteins and other small organic molecules in natural microbial community samples, geomicrobiologist and biogeochemist **Jill Banfield** studies the effects of inter-organism interactions and environmental geochemical controls on the activities of microorganisms and microbial communities. Her lab uncovers genomic variations that shed light on evolution and natural selection. Current work includes the use of stimulated microbial activity for bioremediation of metal contamination in natural environments; investigations of microbial adaptation to extreme environments; and the early colonization of the premature human infant gut.



FUNGUS-ROOT MUTUALISM

Plant and microbial biology (PMB) professor **Thomas Bruns'** lab focuses on the ecology and evolution of mycorrhizal fungi. These helpful microbes form symbiotic associations with plant roots, and this interaction represents one of the most widespread and important mutualisms in soil-based ecosystems. Current work includes using genomic information to study various species associated with pine, indoor air, and energy crops. His lab is also working to catalog the fungal species of Point Reyes National Seashore and Yosemite National Park.

SOIL MICROBES AND PLANT-ROOT INTERACTIONS

Soil microbes comprise the primary workforce for the development of nutrients in soil. In addition to mediating the transfers of nitrogen between the biosphere and atmosphere, they are almost totally responsible for the production of two key greenhouse gases, nitrous oxide and methane. Graduate students and postdocs working with soil microbial ecologist and professor **Mary Firestone** explore the complex community ecology underlying soil microbial nutrient cycling, as well as microbial interactions with plant roots; root-microbe interactions influence not only plant growth but also soil nutrient transformations, such as decomposition processes.

USING GENOMES TO UNDERSTAND ADAPTATION

Entire fields of laboratory microbiology benefit from studying one strain. Conversely, evolutionary biologists benefit by exploiting the natural variation seen among strains. Laboratory researchers love phenotypes that change when they mutate one gene and evolutionary biologists love adaptive phenotypes based on many genes. Inexpensive whole-genome sequencing is merging these two fields. PMB professors **John Taylor** and **N. Louise Glass** and Molecular and Cell Biology (MCB) assistant professor **Rachel Brem** are comparing genomes of populations of the fungus *Neurospora* to find groups of genes hypothesized to be responsible for adaptation, and then testing the hypotheses, one gene mutation at a time.

CONTROLLING A GRAPE KILLER

PMB professor **Steve Lindow** studies the bacterium *Xylela fastidiosa*, which causes Pierce's disease, lethal to grape vines. This pathogen has a complicated lifestyle that includes colonizing the xylem vessels — the veins of the plant, where it blocks water flow — and also the mouthparts of sap-sucking insects that vector it from plant to plant (see News Briefs, page 4).

UNDERSTANDING THE HERPES VIRUS

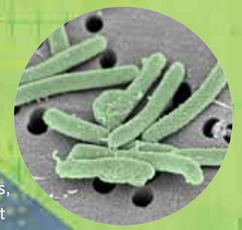
Herpes viruses are masterful manipulators. Not only are they impossible to eliminate once infection has established, but they can also reprogram the host cells to create an environment optimal for replicating more viruses. One striking example is the attack they launch on cellular messenger RNA, the nucleic acid necessary for making proteins. Researchers in PMB assistant professor **Britt Glaunsinger's** lab have been studying how the virus commandeers host enzymes to orchestrate the destruction of RNA, as well as revealing how this attack enables the virus to establish a successful infection of its host.

LEARNING FROM TERMITES

Nearly every environmental niche — from the soil we walk on to the oceans we swim in, and even our own bodies — is inhabited by a diverse community of microorganisms that together carry out functions that larger organisms are unable to perform on their own. By focusing on the exchange of corrinoid cofactors — vitamin B12 and its close cousins — and using the intestinal communities in termites as a model system, PMB assistant professor **Michi Taga** hopes to identify key factors that control the exchange of nutrients in microbial communities.

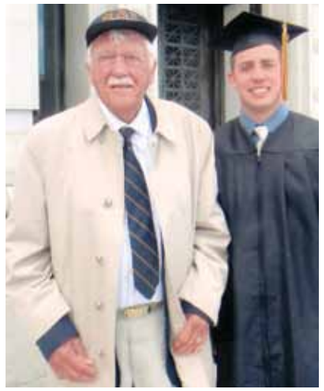
A TASTE FOR THE TOXIC

Bacteria can consume toxic molecules such as perchlorate, a putative cause of neuropsychological development deficiencies. Research in the lab of PMB professor **John Coates** focuses on microorganisms capable of removing this compound from the environment. Over the last decade this research has identified the diversity and ubiquity of these organisms and the underlying genes and enzymes, and has led to the development of several novel bioremediative technologies, not only for perchlorate but also nitrate, radionuclides, and other xenobiotics. Ongoing studies are investigating their ability to prevent biocorrosion of pipelines.



PHOTOS: Clockwise from bottom left: *Neurospora* colonies emerging from a plant that has been killed by a fire but not charred; Martin Bidartondo; microbes, courtesy of Jill Banfield Group; Pierce's disease, courtesy of Steve Lindow; termites, Seth Manu; toxin-eating microorganisms, courtesy of John Coates; herpes virus illustration, Debbie Sklut; soil microbes, courtesy of Mary Firestone

Four Generations, One College



Left: Burton Anderson and Jeffrey Hartmeier at the 2011 graduation ceremonies. **Middle:** Peter Anderson was the coxswain on the Cal crew team in 1979. **Right:** Thomas Tavernetti, who was a scout leader in his spare time. PHOTOS: Courtesy of Burton Anderson

"I've been involved with agriculture all my life," said **Burton Anderson,** '49. Anderson is the second of four generations of his family members who have received degrees from the College of Natural Resources in its various incarnations over the years.

Raised on a ranch in the Salinas Valley, Anderson spent much of his career as a department head for grower and shipper Bruce Church, Inc. He has written four books related to agriculture and the Salinas Valley, and is now on CNR's advisory board.

He was following in the footsteps of his uncle, **Thomas F. Tavernetti,** '13, who worked in agriculture education all his life, including as a member of the original faculty at UC Davis, and later served as the assistant dean of the College of Agriculture in Berkeley — CNR's precursor — from 1926 until his untimely death in 1934.

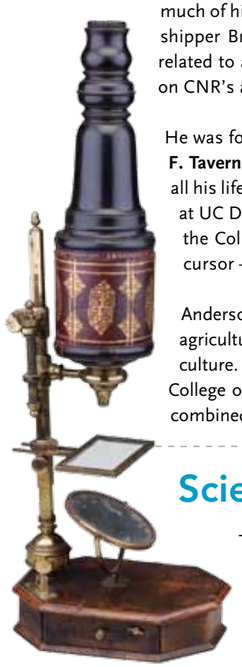
Anderson's son and grandson are both interested in agricultural economics and the business side of agriculture. **Peter Anderson,** '79, came to Berkeley when the College of Agriculture and the College of Forestry were combined to form the College of Natural Resources.

"I entered Cal at a time when protecting natural resources was beginning to be in vogue," Peter Anderson said. He majored in the political economy of natural resources, and now works, as his father did, on the business side of an international produce company. "My father influenced what I wanted to do greatly. Agriculture was part of my family and I knew that I wanted to be a part of that world."

Jeffrey Hartmeier, '11, Burton Anderson's grandson and the family's most recent CNR graduate, majored in genetics and plant biology doubled with environmental economics and policy. Less than a year out of school, he's now working for Anheuser-Busch to gain management experience and is planning to pursue an MBA. Asked why he thought the College has been at the center of his family's education, Hartmeier said the answer lies in "a true passion for the University and for CNR. We all truly believe that there is no second to it."

— SARAH CRAIG

Got your own multigenerational CNR story? Post it under this article in our alumni Facebook group: www.facebook.com/groups/cnrberkeley.alumni



Great Double Microscope, 1710
PHOTO: SFO Museum

Science Through an Antique Lens

The exhibit **"A World Examined: Microscopes from the Age of Enlightenment to the 20th Century,"** now on display at San Francisco International Airport (SFO), features a selection of antique microscopes from UC Berkeley's Golub Collection. The full collection, donated by **Orville Golub,** Ph.D. microbiology '44, is housed in the Valley Life Sciences Building and curated by CNR's Biological Imaging Facility manager **Steve Ruzin,** who guest-curated the SFO exhibit. Open through June 30.

China Is Trending

The Plant and Microbial Biology (PMB) Department doesn't have a formal exchange program with China, but several of its professors have started what might be called a PMB–China trend.

Professor **Andrew Jackson's** China connection began in 2004, when a former visiting scientist invited him to China Agricultural University to give lectures related to PMB C114, Introduction to Comparative Virology, which he co-teaches here. That led to a three-week intensive on plant RNA viruses at Zhejiang University in Hangzhou. He's returned four times since, either to teach or conduct research. "Teaching in China is immensely rewarding," Jackson said, noting that most Americans have very little understanding of day-to-day life in modern China, or of the tremendous building and investment for the future that is ongoing there.

Adjunct professor **Sheila McCormick** taught a truncated version of PMB 210, Scientific Reasoning and Logic, at the Shanghai Institute of Plant Physiology and Ecology (SIPPE) in 2009 and 2011, and at Peking University in Beijing in 2010. In 2011 she also led a writing workshop for faculty. This spring, adjunct professor **Frank Harmon** is teaching a shortened version of his PMB 200 module on systems biology at SIPPE.

The trend is resulting in new relationships and an expanded reach for PMB's work. "The Chinese educational system is quite different, and I think it is fun to show them our way," McCormick said.

— ANN BRODY GUY

MORE SINO-SCIENCE: ESPM Professor **Lynn Huntsinger** won a $25,000 research grant from the Li Ka Shing Foundation for Women in Science, which promotes and supports scientific and scholarly collaboration between female scientists in China and the United States.

CENTENNIAL: UC Berkeley's **Forestry Club** celebrated its 100th anniversary on January 26, 2012. The initial student gathering led to Berkeley's forestry major and the subsequent formation of the School of Forestry, which launched forestry education in California.

Five Key Lessons

FROM ESPM C10

In his class Environmental Issues, Ron Amundson, chair of the Department of Environmental Science, Policy, and Management, examines the major environmental challenges of the next 50 years: food, energy/climate, and consumption/resource extraction. *Breakthroughs* asked Amundson to share five key lessons from ESPM c10, but he responded that five key questions would be more appropriate to the subject.

"The way society contends with these issues is anything but certain," he said, "and thus these challenges invite far more questions than answers."

1 **What is important to you?** The "environment" isn't an abstract concept; it begins with your home, community, and family. These are all at the mercy of the larger global forces at work. If we make the connection between local vs. global, the importance of what is at stake emerges.

2 **What will the world look like when you are 60?** Our environmental future will be a world of 9 billion people, with drastically different energy and climate conditions. To change the future, we must first envision it.

3 **What would Bono do?** There is a gulf between what we know and gaining public and political acceptance. Bono, U2 lead vocalist and humanitarian activist, has an intuitive grasp of effective discussion: make your point, confirm the values of those with whom you speak, and allow participants from different value systems to engage with you.

4 **What did the person who cut down the last tree on Easter Island think?** Supposedly, Easter Islanders' rapid deforestation deprived residents of even the ability to build canoes and exploit their fisheries. From our vantage point it's easy to say, "What were they thinking?" In the future, someone may ask that about oil. As Jesus reportedly said, "I speak to them in parables, for they seeing see not."

5 **Do we have anywhere else to go?** Pausing to consider the iconic images of Earth from space, I play the audio of Apollo 8 astronauts as they first caught sight of "Earthrise" over the moon in 1968. It is a powerful event. Possibly the greatest contribution of our space program was entirely unintentional: revealing our isolation in a universe that offers us nothing as beautiful as the home we already have.

THE ENZYME DETECTIVE

Daniel Nomura Fights Disease by Manipulating Metabolism

By Mark MacNamara
Portrait photography by Paul Kirchner Studios

"Cancer is the ultimate form of evolution," Daniel Nomura said one day after we'd been talking about a news-making breakthrough he made back in 2010 in the potential treatment of that insidious disease. "Cancer cells are very smart. And there's an elegance in the way they adapt so quickly." For an instant he sounded like a World War I flyer, ever the gentleman, speaking respectfully of his enemy even after a murderous day in the sky.

If Nomura, an assistant professor who joined the Nutritional Sciences and Toxicology faculty in the fall of 2011, is respectful of cancer, he's awestruck by the mysteries of his field — by the great unknown of how the body's nearly infinite metabolic pathways work and are connected, especially those that were discovered, but not defined, with the sequencing of the human genome.

The focus of his work is how metabolism functions in disease. In a paper published in *Science* this past October, Nomura showed that blocking a particular enzyme — the same one he found to be effective in slowing cancer-cell growth — also suppresses brain inflammation and protects against neurodegeneration. The implications are vast.

"We're talking about the potential for a drug that might act like a combination of marijuana and aspirin," says Nomura, "but without the psychological side effects of cannabis and without the withering effect of aspirin on the lining of the gastrointestinal system."

Applications may be able to stop or slow neuro-degenerative diseases as Parkinson's — and there may well be others not yet apparent.

A Big View of an Infinitesimal World

Nomura, 30, received his B.A. in molecular and cell biology in 2003 from Berkeley, and his Ph.D. in molecular toxicology in 2008, from the same department where he now teaches. He is, strictly speaking, a chemical biologist, but he would rather be thought of as a chemical physiologist. The difference is one of scope: Nomura and his lab are focused not only on the properties and behaviors of molecules but of entire physiological systems — "the whole body," as he puts it.

Nomura uses technology as a "theory-generating tool," to narrow the possibilities in an area that's nearly infinite.

"And that's the way I do science; I try to think of things in a macro way. I always look at the bigger picture, and of course all of our technologies are designed to look at the bigger picture."

This bigger picture is of the infinitesimal world of molecular compounds, life's most fundamental material — sugars, fats, acids, and other biological molecules — all caught in an endless drama of convolution and conversion, in among metabolic pathways, those hothouses of chemical reaction.

Imagine a single metabolic pathway as a long string of falling dominoes, a Rube Goldberg contraption using molecules. Every few feet, a falling string reaches a hub — call that an enzyme — which triggers another string to fall and then another and another, on and on, and each string is slightly different from the one before as it passes through these hubs. There might be 40 strings in a pathway, and at the very end, the last domino has a new identity and a different function from the domino at the beginning of the process.

To complete the rough metaphor, this last domino, with its new function, naturally affects other strings of dominoes. But now the result may be that a new string of dominoes stands up rather than falls down, which in turn sets off other reactions, accumulations, and conversions.

What Nomura is doing is trying to change the effect of particular pathways that cause inflammation in the brain, which is associated with many neurodegenerative diseases. In what might one day become the news story of the year, Nomura and his team have found a novel way to control brain inflammation, by using an inhibitor — a chemical compound that's essentially a drug in preclinical trial form — to block a certain enzyme.

His hope is that the discovery will result in a drug that not only stops brain inflammation — thereby lessening pain and protecting against neurodegeneration — but does so in a safer manner than current anti-inflammatory drugs.

"It's a very important breakthrough," says Tarek Samad, head of neuroinflammation research at Pfizer Neuroscience. "Dr. Nomura has identified a relationship between two metabolic pathways whose 'crosstalk' modulates inflammation in the brain. He has characterized an enzyme critical for this new pathway to work, and he has used inhibitors to block the activity of the enzyme in order to decrease brain inflammation."

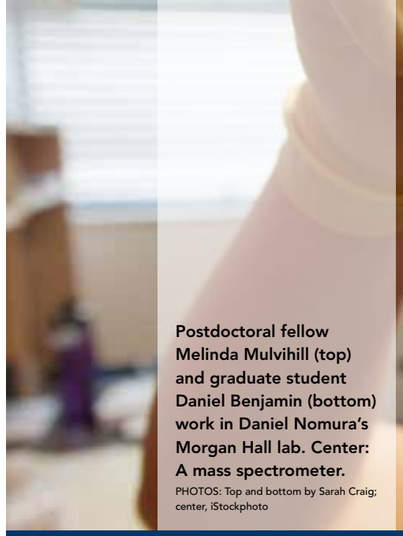
The Right Tools

Nomura's revelation was largely a matter of "brute force," as he puts it, referring partly to his bag of chemical tools, including "activity-based probes" used to assess enzyme activity. But the real plow horse is his faithful mass spectrometer, a technology born in the late 19th century that essentially uses a magnetic field to reveal properties of various kinds of molecules.

"Technology is one of the huge advantages we have, because the truth is we know very little about metabolism," Nomura says. The tools are lacking to study the unknown aspects of normal metabolism, he says, let alone metabolism in disease, so many biologists simply don't go there. "But what we can do in my lab is use our technology to uncover the unknown by tracking changes in metabolites."

Nomura uses technology as a "theory-generating tool," to narrow the possibilities in an area that's nearly infinite.

"We can agnostically go in and figure out what may be important in a disease or what the role of a pathway may be, without having a theory to start with." As a scientist, he adds, you never get breakthroughs sitting around a table thinking about things. "In biology, we make our discoveries in the lab; it's the hard data that drives us to revelations and inspirations."



Postdoctoral fellow Melinda Mulvihill (top) and graduate student Daniel Benjamin (bottom) work in Daniel Nomura's Morgan Hall lab. Center: A mass spectrometer.

PHOTOS: Top and bottom by Sarah Craig; center, iStockphoto

Nomura found that in a mouse model of Parkinson's disease, when MAGL was blocked, the mice were protected against neurodegeneration and dopamine loss.

The Rosetta Stone Enzyme

In high school in Alta Loma, Calif., Nomura excelled in both science and music. He played the saxophone, performed, competed, and listened closely to the music of John Coltrane. He planned to accept a scholarship to the Eastman School of Music, but at the last minute changed his mind, concluding that he could never start a career in science on the side, as he could with music. He ended up at UC Berkeley, where in his freshman year, looking at a job board one day, he noticed an opening to do research in a lab run by a prominent professor of toxicology, **John Casida.**

Nomura started out as a volunteer in Casida's lab, doing chemical inventory and cleaning glassware, but was soon assigned his own research project and eventually became almost completely independent. The project involved looking for "off-targets" — enzymes that are unintentionally blocked by agricultural insecticides that work by inhibiting, or targeting, a specific enzyme in insects.

He joined Berkeley's molecular toxicology Ph.D. program, continuing his research in Casida's lab. Over the next several years, collaborating with Casida and staff researcher **Gary Quistad,** Nomura began to focus on these pesticide off-targets. One of them was monoacylglycerol lipase (MAGL, pronounced mag-EL), which became something of a Rosetta stone for Nomura.

"That was certainly the most interesting enzyme we were working on," remembers Casida, who became Nomura's Ph.D. advisor. "It was known to be important, and it could be inhibited in a test tube and inside a living organism."

The Cannabinoid Connection

Because this class of insecticides had the unintentional consequence of blocking MAGL, Nomura used them to study MAGL's role in the brain. He was intrigued to find that blocking MAGL led to a dramatic rise in the level of endocannabinoids, molecules naturally produced in the brain that act similarly to the active components of marijuana, aka cannabis, by stimulating receptors in the brain, called cannabinoids, that cause a "high."

Armed with this insight, in 2008 Nomura began his postdoc work at the Scripps Research Institute in La Jolla, Calif., in a lab directed by Ben Cravatt, a professor and chair of the Department of Chemical Physiology. There, using chemical tools developed in their lab, Nomura discovered that especially aggressive human cancer cells had elevated levels of MAGL.

In a headline-making study, he and Cravatt found that blocking MAGL in cancer cells slowed the spread of the disease by shutting off the release of fat in the affected cells.

Meanwhile, Nomura was also following up on his discoveries from graduate school, investigating the role of MAGL in the brain and how it might be involved in neuroinflammation.

Inflammation and Disease

In the last decade, biologists have become increasingly interested in inflammation as evidence mounts of its role in the pathogenesis of many diseases. In good times, inflammation, including fever, is part of a body's elaborate defense against not only foreign material — the splinter in your toe — but also disease. Inflammation marks the rallying point where immune cells arrive, laden with toxins to dispatch an enemy. After the battle, the process "resolves" itself, as biologists say. The chemical landscape is stable once more.

But when things go awry, you get chronic inflammation. "For example, with neurodegenerative disease, inflammation becomes a self-propagating problem," Nomura explains. "The immune cells die, which releases more toxins, which leads to more inflammation. The solution becomes the problem, unless you can shut off the faucet."

Enter MAGL, this strange rascal of an enzyme that is constantly breaking down endocannabinoids in the body. Nomura found that blocking MAGL stops this breakdown. Halting the breakdown causes the endocannabinoids to accumulate and then stimulate cannabinoid receptors, which suppresses pain and inflammation. This is how marijuana works — it can directly stimulate the receptors. However, unlike marijuana, MAGL inhibitors are not likely to make you high.

The Aspirin Effect

The discoveries continued: Nomura also found that when MAGL breaks down endocannabinoids, that process generates a fatty acid that is, in turn, converted into molecules called prostaglandins. Prostaglandins signal the body to start the inflammation process. Nomura found that blocking MAGL reduces these prostaglandins, but only in the brain — not in the gut.

Anyone who's popped an aspirin or ibuprofen has manipulated prostaglandins in their brain. These non-steroidal anti-inflammatory drugs lower prostaglandin production, thereby lowering fever, pain, and inflammation. But they can act on the stomach lining, leading to ulcers.

Thus, Nomura showed that with a little help — the blocking of MAGL with inhibitors — the body itself can provide the benefits of both marijuana and aspirin, without their side effects.

So the hypothesis for Nomura then became, if we can stop neuroinflammation by blocking MAGL, can this help alleviate neurodegeneration?

A series of experiments to test this theory yielded promising results. For example, Nomura found that in a mouse model of Parkinson's disease, when MAGL was blocked, the mice were protected against neurodegeneration and dopamine loss. He is now following up on these discoveries, testing whether blocking MAGL can protect against other neurodegenerative diseases, like Alzheimer's or multiple sclerosis.

Nomura's lab is also branching out into new aspects of metabolism in cancer. While he now understands how cancer cells use MAGL to grow tumors that can metastasize, there's work to be done exploring what other aspects of metabolism cancers use to fuel malignant tumors.

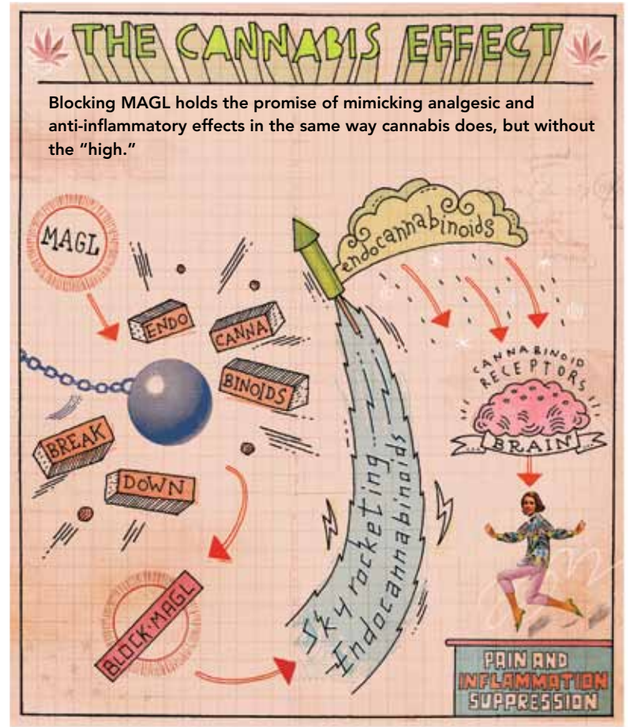
On sleepless nights, as the Agilent QQQ LC/mass spectrometer hums in a Morgan Hall lab, Nomura is at home in the quiet of his mind-lab, trying to see connections in the vast circuit board of metabolic pathways. Always, the questions remain: How are the pathways connected? How do the nodes work, and how can they be inhibited to stop inflammation or slow malignant tumors?

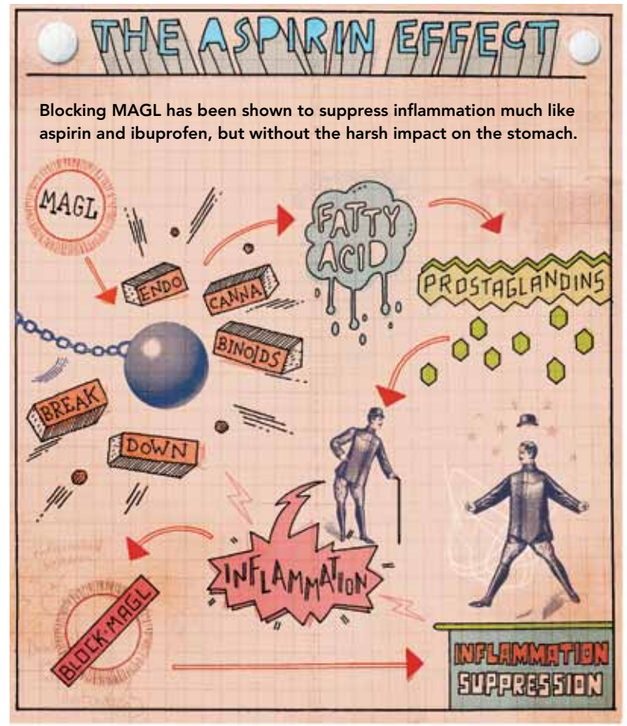
To him, one imagines, it's all a little like exploring a new music score. You take the sound apart measure by measure, try to understand it, learn it, and then play it, see what it sounds like, try things on the fly, and try to get ever closer to an interpretation that transcends intellect. In that sense, perhaps, there's something jazz-like in biology; the paradox of something that is at once orderly and chaotic, microscopic and cosmic, predictable and yet, on some days, unknowable.

"And that's how you construct a hypothesis," says Nomura, comparing the deconstruction of music to the deconstruction of, say, metabolic pathways. "In the end you take a leap of faith, that our bodies, down to the most minute chemical reactions, have some good reason for acting the way they do."

ILLUSTRATIONS: Clive Goodyer

ACCOLADES: On April 13 **Daniel Nomura** was named a 2012 Searle Scholar. The prestigious award provides generous support for outstanding new assistant professors conducting research in medicine, chemistry, and the biological sciences.





Remaking America's Urban Water Systems

By Ann Brody Guy

In the dry heat of August 2011, postdoctoral researcher **Justin Lawrence**, Ph.D. '11, hiked into the woods above campus with a group of Cal students to set up experimental structures in Strawberry Creek, which had become water-stressed from a half-dozen rainless months. The group hammered plywood and rebar into funnel-shaped contraptions to test the hypothesis that augmenting the flow of stream water can provide ecosystem benefits in urban streams — a first step in a larger plan to eventually use recycled water for urban creek restoration projects.

Lawrence, who works for a new engineering research center (ERC) on urban water systems that was funded by the National Science Foundation (NSF) last July, measured the amount of water flowing through the experimental apparatus, and also measured the quantities of aquatic insects, which are widely used as indicators of both water quality and biodiversity.

The humble tools and narrowly focused goals belie a purpose on a much larger scale. Lawrence's project is just one line of inquiry connected with the new ERC, which is called Re-inventing the Nation's Urban Water Infrastructure (ReNUWIt). Budgeted at $18.5 million over the next five years, plus the same amount on renewal, ReNUWIt is the largest project on urban water ever funded by the NSF.

The NSF's goals for the ERC are as ambitious as its nearly $40 million budget: fundamental, systemic, and far-reaching changes in the United States' aging urban water infrastructure.

"The NSF is expecting more from the ERC than just academic papers," says **David Sunding**, a professor of agricultural and resource economics involved in the project. "They want transformational research. They want to look back in five or ten years and see actual things that changed in the U.S. water sector because of our project. So our work is absolutely about delivering relevant technologies and having them adopted."

The ERC is a four-university partnership that is based at Stanford and includes UC Berkeley, Colorado School of Mines, and New Mexico State University. The project has three key focuses, called "thrust areas" in NSF parlance: natural systems, engineered systems, and resource management. It's fully collaborative and interdisciplinary — the four universities are working hand in hand on every project, and the thrust areas overlap as seamlessly as issues like technology, the environment, and delivery schemes commingle in real-world urban water systems.

New Era, New Challenges

Most experts agree that our current urban water system is inadequate to meet society's changing needs. It is only going to get worse.

"The NSF … wants transformational research. They want to look back in five or ten years and see actual things that changed in the U.S. water sector because of our project."

David Sunding, professor of agriculture and resource economics

Sunding, who heads the project's resource management component, ticks off a litany of challenges currently facing the United States' urban water systems: Population growth will increase water demand, further taxing supplies and infrastructure. Climate change is likely to increase the incidence and severity of drought. Environmental problems, such as the ecological collapse of California's Sacramento-San Joaquin River Delta and habitat loss for endangered species, will continue to escalate. Rising energy costs will demand new energy efficiencies within the system.

There's consensus that the current system fails to harness the enormous potential for innovations in recycling, technology, and policy to create efficiencies.

"In California, we send most treated wastewater right into the ocean," Sunding says, instead of capturing it for recycling. And for the most part we don't differentiate between various water needs. "In most cities in the state, we are providing high-quality drinking water for use in air conditioners and landscaping."

David Sedlak, professor of civil and environmental engineering and ReNUWIt's deputy director, says that the infrastructure cannot be fixed simply by replacing rusty pipes.

"We have a 19th-century technology that was designed to address a 20th-century problem, and now we're facing a series of 21st-century challenges," he says. "Urban water systems were designed at a time of low population, unlimited energy, and a lack of complete understanding of the public health and environmental consequences."

While the current system represents tremendous accomplishments in engineering and public health that were appropriate for their times, Sedlak says, scientists' understanding of waterborne pollution has increased, technologies have advanced, and societal challenges have shifted.

Left: Lisa Hunt, a Ph.D. student in Vince Resh's lab, surveys the quantities of aquatic insects in Strawberry Creek.
Right: Researchers on the Strawberry Creek project built reinforcements to test the effects of augmenting water flow.

Left: East Bay Municipal Utility District's sewage treatment plant in Oakland, Calif. Right: In Discovery Bay, Calif., researchers are studying how natural systems affect water quality and ecosystem health. PHOTOS: Left, courtesy of EBMUD; right, David Sedlak

“We have a 19th-century technology that was designed to address a 20th-century problem, and now we’re facing a series of 21st-century challenges.”

David Sedlak, professor of civil and environmental engineering

“We are now facing the start of a new era, where the drivers of the system are changing,” Sedlak says.

A Renewable Resource

The Strawberry Creek project, for example, seeks to move beyond a past where wastewater releases into urban creeks caused pollution, to develop the scientific evidence for a potentially valuable recycling use.

“Because wastewater discharges to streams were of considerably lower quality than they are today, there’s almost no information on how to use recycling constructively, for ecosystem renewal,” Lawrence says. “This knowledge gap has been a huge barrier to progress.”

Using high-quality, low-cost recycled water to rejuvenate ecosystems could be a valuable management approach, Lawrence says, with widespread applications for restoring depleted wetlands and creating new habitat for endangered species.

And while the water treatment and delivery infrastructure uses a lot of electricity, scientists think that balance sheet can change. The ERC’s engineering facet will study ways to improve the system’s energy efficiency and generate new energy from renewable sources — everything from harvesting energy from the process to developing smart grid–type technologies that differentiate water use based on seasonal or even building-specific demands.

For example, waste itself is full of energy, Sedlak says.

“There’s a tremendous potential to turn sewage treatment plants from energy consumers to net energy producers,” he says. Biogas, which results from microbes converting the organic materials in waste into natural gas — methane — is reasonably well established, but ERC researchers are trying to improve it.

One new method has the added benefit of producing both biogas and nitrous oxide. It involves converting the ammonia present in wastewater into nitrous oxide, which can be used in a combustion process, instead of oxygen. Sedlak also cites a developing technology that generates electricity from mixing freshwater and seawater.

A long-term objective, Sedlak says, is to go beyond “net zero” water and wastewater systems that generate enough renewable energy to meet their own needs, and make energy-positive systems that produce surplus power that can be fed back into the grid.

Decentralizing Treatment Plants

There are even more seemingly obvious possibilities for recycling: for example, why doesn’t everyone water lawns and flush toilets with reclaimed water?

Highly treated wastewater, or sewage effluent, is already broadly used for irrigation, pumped from central treatment plants to nearby athletic fields and farms. But when pipe networks stray too far from sewage treatment plants, infrastructure costs spiral upward. One of the approaches the center is studying is to decentralize treatment plants so cities can reuse water close to where it was first used.

For example, Berkeley’s sewage goes to the East Bay Municipal Utility District treatment plant near the Bay Bridge. Piping the treated effluent back up to Berkeley would be prohibitively expensive, Sedlak says.

“But what if we built a small treatment plant that intercepted the sewage from the Berkeley area and used the treated wastewater to do the landscaping on the Cal campus, or for one of our local industries that needs water for boilers?” The center is working on technologies that would allow small-scale satellite plants to be built as highly automated, low-maintenance substations.

Natural Systems and the Yuck Factor

Drinking water is another huge opportunity for recycling water: sewage effluent has been treated to potable quality for more than 35 years, especially in parts of Southern California. The ERC scientists say there’s tremendous potential for expansion, but first some issues have to be resolved.

On the engineering side, it’s important to make sure that recycled water entering the drinking water supply is free from the chemicals and waterborne pathogens that are in sewage. ERC projects are testing multiple treatment steps and developing high-tech facilities to ensure that high quality.

But there’s a psychological issue as well.

“Recycled water has not been readily accepted by consumers because they perceive it to be ‘kind of yucky,’” says Sunding.

Research has shown that passing water through natural systems decreases the “toilet-to-tap” aversion and can remove contaminants that engineered treatment systems have a tough time removing, so ReNUWIt has several projects in this area. One, in the Delta town of Discovery Bay, is studying the impact of creating a wetland habitat to remove additional contaminants from wastewater that has been treated conventionally. Another is studying the use of soil and groundwater as part of the treatment process.

Tackling Social Issues

The psychology of the “yuck factor” is strong, Sedlak says, and has been the basis for discontinuing projects that made sense from a financial, economic, and public health standpoint. But that’s on the center’s agenda as well: ReNUWIt has an educational component that includes public outreach through high schools, colleges, and local science museums.

“I think one of the strengths of the center is to really start engaging the public in a dialogue about water,” Sedlak says.

It’s all part of the ERC’s mission, says Sunding.

“Reinventing urban water is about more than science and engineering; there’s an important social science and finance component as well. It’s often fruitless to ask a utility to adopt a new technology to deal with water treatment or recycling, absent some kind of pricing, financing, and allocation reforms.”

For example, water from traditional sources is often highly subsidized, resulting in artificially low prices. If customers understood how expensive it is to provide their water, Sunding says, they might make better decisions about how they use it. “Subsidies distort behavior and they make it very hard for people to make informed decisions.”

The project’s resource management component also includes a complex cost-benefit analysis that calculates which new technologies bring the most to the table, in terms of both economics and sustainability. It will also address the extreme fragmentation in the water industry — there are more than 180 retail-level water utilities water providers in Southern California alone, according to a recent study.

Sunding expects his resource management group will make recommendations on pricing structures and financing schemes, on consumer incentives, and on coordination within geographic regions — perhaps something similar to a cap-and-trade system, which would allow agencies to sell water to each other, effectively integrating separate entities without disrupting the current water rights systems.

From Research to Implementation

Water agencies are among ReNUWIt’s many institutional partners; those relationships will be key in moving from research to implementation. From water districts in Orange County, Calif., and Tampa Bay, Fla., to private companies like Bechtel Corporation, partners serve as advisers, test beds, and financial contributors.

“They are completely invested alongside the NSF, and they’re getting more bang for their buck than trying to do it on their own,” Sunding says, referring back to the center’s goal of transformational research.

To meet that goal, the urban water ERC must not only develop new technologies and economic structures, it must slowly remake public perception — creating a shift to the view that wastewater isn’t waste, but rather something infinitely useful.

“As a society we need to start looking at wastewater treatment plants as resource recovery centers,” said Sunding. “Urban wastewater systems can be about turning waste into economically, environmentally, and socially useful products.”

2001 CONSERVATION AND RESOURCE STUDIES

ELIZABARCLAY

She has reported on consumerism in China and crime in Mexico, but the story Eliza Barclay wrote that really got people's attention was about bacon. Barclay had noticed her vegetarian friends' struggles to give up the crispy, fatty treat. She proposed a piece for Shots, the online health blog from National Public Radio, where she works. Her editor wasn't quite sold on the idea, but OK'd it anyway.

By Greg Weatherford | Photos by Chris Eichler

Her January 2011 post "Why Bacon Is a Gateway to Meat for Vegetarians" examined the science and psychology behind why bacon is so tempting, even to the meat-averse. Within hours, Barclay's article had rocketed around the Internet, eventually picking up thousands of readers and more than 650 posted comments on NPR's site alone.

"The people have spoken," her editor told her, tongue in cheek, after reviewing the statistics. "And they want to read about bacon."

"I just had a hunch," she says now, smiling.

Just another day in Barclay's life as an online journalist reporting on food and health for NPR. As a host of the Salt (npr.org/blogs/thesalt), NPR's food blog that went live in 2011, Barclay manages the site's social media and writes or edits more than a dozen blog posts a week. Topics vary widely, from the surprising history of Crisco to how the U.S. Army created a sandwich that can stay fresh for two years.

"We don't do recipes or cooking tips on how to make luscious brownies — not that we have anything against luscious brownies," she explains. "It's about the ecology of food." The Salt, she adds, aims "to look at food culture and industry with a pinch of skepticism. And we try to have fun with it, too."

Barclay joined NPR in 2010 after years of freelancing for outlets including the *Atlantic*, the *Washington Post*, and *National Geographic News*, primarily about food, health, and science.

She attributes her interests to an undergraduate assignment from **Louise Fortmann,** a professor of Environmental Science, Policy, and Management, to trace the political ecology of a common dinner ingredient. She chose snow peas and tracked them back from her neighborhood grocery to a bustling wholesaler in Oakland, then to an East Coast port, and finally to Guatemala, where farmers had been urged by the U.S. government to grow snow peas for the U.S. market — only to have much of their produce rejected at the border for having too much pesticide residue.

That research sparked Barclay's fascination with the roots of food. Soon after receiving her B.S., she signed up for a course on magazine writing. She loved it, and realized her interest in travel could be supported by journalism.

Within a few years she was reporting from Mexico City for newspapers and wire services. She followed that up with fellowships and grants to report on malaria in Tanzania and Kenya, and on the effects of increasing meat consumption in China.

In 2010 she earned a master's in science writing from Johns Hopkins and landed a temporary editing job at NPR.org, which led to a full-time position. She helped launch the Salt in 2011.

'The Salt [aims to] look at food culture and industry with a pinch of skepticism.'

The blog reaches a broad readership hungry for information about food — it quickly racked up more than a million visitors a month. She and a small staff of reporters, editors, and interns spend their workdays seeking out and preparing posts.

Along the way, she's learned a few things about the Internet and about blogging in particular: clever headlines are key, although some subjects get attention just for being peculiar — one popular post on NPR's health blog explained how neti pots used improperly as a cold remedy had fatally infected two people with brain-eating amoebas.

Unlike many blogs, the Salt does its own reporting. Barclay says readers value food safety information and the debunking of myths such as which raw ingredient in cookie dough actually sickens people (flour, it turns out — who knew?) and how much sugar is in kids' cereals (even more than you thought, sometimes more than in a Twinkie).

"It's just a never-ending supply of stories," she says of food science. "The goalposts are always moving, so there's something else to report. That's just the way science is."

Left, Barclay in the radio studio at NPR's Washington, D.C., headquarters. Above, street reporting and collecting ambient sounds.

Q&A: Green Building

Real-world application is a key characteristic of work that takes place in every corner of the College of Natural Resources. Q&A is a new *Breakthroughs* department that provides snapshots of various professions through the lens of our alumni. Want to suggest your profession? Write breakthroughs@berkeley.edu.

This residence by David Warner's Redhorse Constructors is tucked into a Northern California hillside and sits underneath a living roof, which also helps to visually merge the house with the land. PHOTO: David Wakely

Taylor Keep

M.S. Energy and Resources Group '10
Principal, mechanical engineer
VITAL Environments, Inc.

Ten-cent definition: A green building is one that adapts and grows to better reflect individual, organizational, and societal wants, needs, and aspirations. The building's "greenness" is a process that must be maintained rather than a status given at the end of construction.

Next big thing: Currently most buildings treat everyone as a static, "average" person, and people have few, if any, ways to communicate their unique needs. We need ways to measure, understand, and act upon people's changing preferences, wants, and needs. I hope and expect that in the future green buildings will be able to "listen and learn" from what people change about their environment.

Motivation: I love that my work product is so intimately linked to the human experience and is important in both expressing and shaping society; if we are to grow and change for the better, we will do so in, and in conversation with, the buildings we occupy.

Role model: My first job out of college was at a firm started by Sir Ove Arup. In 1970 he delivered a key speech that discussed everything from how work fits healthily into life to the prescient concept of "total architecture," which is at least as refined as our best attempts at explaining a holistic approach to sustainability today.

Biggest challenge: To extend the responsibility of the design team beyond the construction phase. The first few months of occupancy should be an active partnership between occupants and designers to adapt the building to serve people well. All too often the design intent fails on day one, and the "green" process ends before it begins.

Mechanical engineer and ERG alumni Taylor Keep works on making buildings adapt to their inhabitants.

Matt St. Clair at the Student Union Building on campus. Like the solar panels on the building, St. Clair's UCOP position was funded as a result of student pressure, which he helped exert while earning his master's at ERG. PHOTO: Sarah Craig

Matt St. Clair

M.A. Energy and Resources Group '03
Sustainability manager, University of California Office of the President

Source of pride: The University of California system has 85 certifications through the end of 2011, which is the most of any university in the country. Also, all new buildings have to outperform California's strict energy code by at least 20 percent.

Next big thing: Developers of leading green buildings will increasingly consider the entire life cycle of building materials and of the buildings themselves. Life-cycle analysis (LCA) is only starting to mature and catch on, but the incorporation of LCA into LEED credits in the next version of LEED will greatly accelerate the use of LCA and the impact of its use throughout the supply chain. Also, various factors are likely to force energy costs up across the country and the world. The higher the price for energy, the easier the business case for building green becomes.

Motivation: Universities have an incredible opportunity and a tremendous responsibility to train future leaders to address sustainability challenges and to model sustainable solutions like green buildings to their many stakeholders, from their students and alumni to their surrounding communities. I want UC students to be agents of change for green building and sustainability wherever their careers and lives lead them.

Shining example: With limited building budgets and in a region with almost no experience with green building, it would have been easy for UC Merced to build buildings that met minimum environmental standards. Instead, Merced is the only campus in the country where every building is LEED-certified.

David Warner

Conservation of Natural Resources '76
Founder, Redhorse Constructors

Ten-cent definition: Green building should exemplify three major concepts: (1) Does the process of building result in an improvement to the social and physical environment?

Sustainable building advisor Chrissy Tsai sees net zero energy buildings as the next big thing. PHOTO: Erik Haugen

(2) When the building is complete, does it demonstrate a long life cycle and require the least amount of energy to sustain it over time? (3) Are you building with products/materials that have the lowest possible carbon footprint associated with their production and delivery?

Source of pride: I really believe in the concept of convergence. If you have pushed the envelope in your profession, then at some magical point you can leap-frog into creating social and environmental benefits. I'm involved in a project in Africa called the Human Needs Project, where all my building practices in green technology and sustainable structures are going to benefit thousands of people in Kibera, the second largest slum in Africa. My sense of accomplishment comes through those kinds of associations, where 30 years of experience can create paradigm shifts for struggling communities.

Next big thing: Currently the California Air Resources Board (CARB) is generating a policy that will shape how California develops its built systems. It even includes planning policies that will not allow towns to expand into raw space without doing carbon analyses that preclude building outward rather than inward to accomplish the same goals. CARB needs to be given the biggest teeth possible to allow for the best building practices to occur.

Role models: Initially I was motivated by the work of Sim Van der Ryn, and by the understanding of the global ecosystem I got from professor Arnold Schultz at CNR — especially his class on ecosystemology.

Crissy Tsai

Environmental Economics and Policy '04
Sustainable building analyst, Environmental Building Strategies

Ten-cent definition: A green building is both resilient and regenerative. Resilience is a concept gaining traction in the green building community, with architectural designs that are smart and simple and incorporate passive design over active technology. These buildings are designed to last longer and withstand environmental shocks and stresses caused by climate change. Regenerative buildings also incorporate strategies and technologies to restore the natural environment. Some examples include concrete that absorbs air pollutants and bioswales made from native landscapes that filter storm water and remove pollutants.

Source of pride: The EcoCenter at Heron's Head Park in San Francisco is a cutting-edge building that acts as a green building model for the surrounding low-income community of Hunters Point. I worked on the LEED and the Living Building Challenge certifications. It is the first off-the-grid, net-zero-energy environmental justice educational facility. The building has solar hot water, photovoltaics, a green roof, and a wastewater treatment system that recycles wastewater for use in landscaping.

Next big thing: Net zero energy buildings — buildings that must produce the same amount of energy as they consume, such that their total annual energy use is zero. California's AB 32 legislation, passed in 2006, mandates that new residential buildings achieve net zero energy by 2020 and new commercial buildings by 2030.

Biggest challenge: Overcoming the perception that green buildings cost more. Studies have shown that, with a knowledgeable project team, a "moderately" green building can be built with existing, proven technologies and methods at no increase in cost vs. a traditionally built structure. Furthermore, as green building becomes increasingly common practice in certain areas, we should see economies of scale develop that make "going green" even more economical.

Mark Molofsky

Environmental Planning (emphasis on urban planning) '77
Owner/CEO, Molofsky Builders Incorporated

Ten-cent definition: Green building should, to me, be characterized by the use of local resources, including labor and vendors, and of real materials with inherently sustainable characteristics — those that will last for decades or which

At the time of its construction, Molofsky Builders' Lytton Springs Winery was the largest straw bale building in the world.

can be easily recycled — and some forethought as to energy consumption within the built environment.

Source of pride: Having built a midsize company that has always stayed true to the value of quality in the final product we hand over to our clients. Also that the business has sustained all of these years in a very tough industry where the bottom line is generally the final word.

Next big thing: Buildings need to be smaller, with higher-quality products that last. I would consider this a cultural shift in this country, but I think it is happening slowly.

Motivation: That has changed over time. I started as a carpenter. I wanted to learn a skill and work hard outside. It was clean and, I thought initially, harmless. Later I began to realize that a large percentage of the materials we were building with were highly toxic. This was a long time ago, and indoor air quality was just becoming the buzz. Later on I believed I could give my clients a positive personal experience, which wasn't what you generally heard about from people who had built a house.

Pet peeve: The whole concept of calling something green. It has been co-opted into just another marketing gimmick. It's meaningless, like saying "quality construction." The building industry just needs to do it. Stop expecting all the little gold stars and awards and just do it.

Mike Moore

Conservation and Resource Studies, '93
Founder, architect, general contractor
Tres Birds Workshop

Ten-cent definition: I define genuine green building as the practice of lowering the embodied energy of making and operating places of habitation. I believe this is the true measure of a project's global environmental impact. Embodied energy [where the energy required to extract, manufacture, and transport building materials is tallied into the sum of a building's energy use] is a concept I learned at Berkeley while studying the flow of energy in our cities and global community.

Your motivation: I have had the opportunity to spend time in natural places that have not been affected by humans. In these places I have felt clear, open, and connected to a great power. I do not want these places to be developed or have their natural resources extracted. Tres Birds Workshop's consistent use of reclaimed materials to build our projects gives us independence from natural resource extraction, thus preserving existing natural places.

Role models: Jim Logan, my architecture mentor, has spent his 30-plus-year career developing a process for making carbon-neutral homes. I spent five years learning the practice of carbon-neutral design, non-toxic building, site-specific homes, and mixed-use projects with him. Peter Zumthor has been a role model of mine since I visited most of his projects in Europe and interviewed him at his studio in Switzerland. His buildings connect people to natural cycles through the senses, ultimately creating respect and value for the natural world.

Pet peeve: Building products that are marketed as green because they contain a recycled material but in reality use huge amounts of transportation and manufacturing energy, giving them higher embodied energy than the "non-green" locally made products.

Mike Moore stands in Tres Birds Workshop's first design-build project, now a photography studio. It incorporates a front door made of a bowling alley lane and a window wall made of timber extracted from a demolished Denver industrial building. PHOTO: Brooks Freehill

1996 M.S. AGRICULTURAL AND RESOURCE ECONOMICS
1997 PH.D. WILDLAND RESOURCE SCIENCE

KAUSH ARHA

Assuming the turbulence this spring does not alter the United States' long-standing strategy, NATO troops will end their combat role in Afghanistan in 2014, and the Afghan government will take over responsibility for the country's security. International aid — which currently comprises the bulk of Afghanistan's public spending — is likely to be scaled back significantly. The transition will be challenging, but if handled well, it could lay the foundation for greater stability and prosperity in Afghanistan and the surrounding region. Kaush Arha's job is to try to make sure that happens.

By Eileen Ecklund | Photos by Paul Kirchner Studios

As senior advisor for the transition and senior coordinator for agriculture at the U.S. Embassy in Afghanistan, Arha is responsible for devising and coordinating economic development strategies, with a particular emphasis on the agricultural sector, which is the mainstay of Afghanistan's economy. Approximately 8 out of 10 Afghans are employed in agriculture, and it accounts for more than a third of the country's GDP.

Historically, Afghanistan was known throughout the Indian subcontinent for the quality of its fruit — from grapes and raisins to melons, apricots, and pomegranates — and nuts, primarily almonds. Much as American children once listened for the bells of the Good Humor truck announcing the arrival of ice cream treats, Arha says, residents of India listened for the bicycle bell of the "Kabuliwala," an Afghan vendor bearing bags of dried fruits and nuts.

That reputation should give Afghanistan an advantage in exporting these high-value commodities, but first it must overcome some daunting obstacles. Decades of turmoil have constrained economic development and damaged infrastructure, including irrigation systems and the roads needed to transport goods to market. There is no rail system, and Afghanistan is landlocked. Farm practices have fallen behind and most farming is at the subsistence level.

One of Arha's key goals is to help build the elements required for commercial agriculture, from processing, packaging, and storage facilities to regional market connections. "When you have that up and going, it will mean great job growth, and in the remunerative sense, far more than just subsistence," he says.

Arha is leading an interagency effort involving the U.S. Agency for International Development, U.S. Department of Agriculture field advisors, National Guard agribusiness development teams — "they call themselves 'citizen soldier farmers,'" he says — and the State Department's International Narcotics and Law Enforcement Bureau, which supports the Afghan government's efforts to provide alternative livelihoods to opium poppy production.

He describes the agriculture strategy as "soup to nuts. We do food security, irrigation, extension services to improve farm practices, and farm-to-market connections for improving commercial agriculture. In natural resources we're working on the livestock side and on some agroforestry projects" to provide firewood and home construction materials. His group also helped create Afghanistan's first national park, Band-e-Amir, and is trying to establish a conservation area in the Wakhan Corridor, a remote and beautiful area of the Pamir Mountains that is home to snow leopards, Eurasian lynx, and four species of wild sheep.

Arha, who received a master's in agricultural and resource economics in 1996 and a Ph.D. in wildland resource science (from the Department of Environmental Science, Policy, and

'We do food security, irrigation, extension services to improve farm practices, and farm-to-market connections for improving commercial agriculture.'

Management) in 1997, as well as a law degree from Stanford, credits the richness of his interdisciplinary work at Cal for giving him a knowledge of resource management, policy, and economics that is both broad and deep — knowledge crucial to navigating the complexities he encounters in his current work. "The key in interdisciplinary work is the different paradigms, the different prisms through which a particular discipline looks at a problem or a given situation," he says. "It's more important to understand how an economist would look at an issue, or a biologist or ecologist or lawyer ... if you understand how to talk that language, that's much more important than what the law says. To accomplish that, you really have to know the discipline inside out, because one or two courses doesn't get you there."

Arha's career has been an eclectic and challenging one. At the Department of the Interior, where he was the deputy assistant secretary for Fish, Wildlife and Parks, he oversaw policy direction for the U.S. Fish and Wildlife Service and the National Park Service. He worked to improve wildlife conservation on private lands in the American West and developed policies on threatened endangered species. He also served as the associate solicitor for Indian affairs at the Department of the Interior, and advised the government of Mongolia on resource conservation and development, among other things. His work in Afghanistan, however, will likely prove the most difficult, and potentially the most rewarding, of all.

"The transition is, I think, one of the most important — if not the most important — engagements of our nation at the moment," he says.

Left and above: Arha on a recent visit to Northern California.

Spencer Yost: Paying it Forward

Spencer Yost in his office at UCSF's Mount Zion Hospital. PHOTO: Ann Brody Guy

As head of the anesthesia department at the University of California, San Francisco's Mt. Zion Hospital, **Spencer Yost,** '76, spends his days putting people to sleep. It seems worlds away from his undergraduate days at CNR, but science is an enduring link.

Yost has a busy practice providing anesthesia for patients having oncological surgery, and is also the director of Mt. Zion's intensive care unit. He met his pre-med requirements by taking the science and math classes he enjoyed, but CNR's flexible majors at the time allowed him to follow other interests, including the environment.

"I took a lot of political economy of natural resources classes. I learned a lot about the environmental laws that were just coming into the books in the '70s," he says. He wanted as broad an experience as possible.

And he got it. He calls Cal an "eye-opening experience" for a kid from Downey, Calif. — "right on the edge of the Orange Curtain," he said, referring to Orange County's famous conservative bent. Yost earned a degree in Conservation of Natural Resources. Through a Cal in Sacramento fellowship, he worked on a new task force on geothermal energy, and later, a Cal in the Capital internship took him to Washington, D.C., where his cadre of interns helped a local congressman get language banning polychlorinated biphenyls, or PCBs, into the 1976 Toxic Substances Control Act.

Ultimately Yost chose medicine over environmental law, but joining the new CNR Alumni Association Board of Directors was a natural way to stay connected to the lifelong values that sprouted here. In 2011, Yost capped off three years of service to the board with a $25,000 donation to establish the new *CNR Alumni Association Endowed Scholarship Fund* for students with financial needs.

Yost sees a connection between helping patients and helping students. "It's person-to-person activism," he says. "I really like taking care of people one on one." He likens helping a patient through a critical or stressful medical situation to the direct impact that scholarship money has on the life of a student struggling to afford the college education that Yost paid $212.75 per quarter for.

"I see it as just providing a little more freedom. One less student loan ... so they can pursue their true passion." With today's huge financial obligations pressing down on students, he says, choices narrow. "You'll take the thing that will pay off the most, rather than what you really want to do."

His hope is that the money will help awardees follow what they are really passionate about. "I just got a great education and I want to help others do the same." — ANN BRODY GUY

Double — or Triple — the Power of Your Gift

Thanks to Spencer Yost's endowment, gifts totaling up to $5,000 a year over the next five years to the *CNR Alumni Association Endowed Scholarship Fund* will be matched, doubling your impact.

Campus can help you triple your gift to this needs-based scholarship through two other matching programs:

NEW ALUMNI CHALLENGE: Alumni who graduated from 2007 to 2012 are eligible.

CHANCELLOR'S CHALLENGE FOR STUDENT SUPPORT: UC Berkeley faculty, students, and staff are eligible.

For details, contact Donna Chan at donnachan@berkeley.edu, call (510) 642-6707, or join Yost with a gift by going to http://givetocal.berkeley.edu/fund and searching on "CNR Alumni."

Photo by Sharon Beals

San Francisco photographer Sharon Beals selected specimens from three key collections of birds' nests for her book *Nests: Fifty Nests and the Birds that Built Them* (Chronicle Books, 2011).

"The idea took shape after I read Scott Weidensaul's amazing book *Living on the Wind: Across the Hemisphere with Migrating Birds*. He talks about the migratory hazards and habitat loss the birds face on their journeys. I had already been interested in native plants and habitat restoration, but his book inspired me to learn as much as I could about what birds need to survive, and what I do in my own life that affects the welfare of birds, even at a distance."

This Swainson's thrush nest was collected on June 29, 1925, by Joseph Grinnell, who started UC Berkeley's Museum of Vertebrate Zoology, where it is housed.

Previously unpublished photo courtesy of Sharon Beals