Ecology and Evolutionary Biology

SPRING/SUMMER NEWSLETTER 2012 NUMBER 19

FIRST UCONN MCDONELL FOUNDATION GRANT GOES TO PROFESSOR MARK URBAN

Dr. **Mark Urban** is the recipient of the first James S. McDonnell Foundation grant awarded to UCONN. Urban will receive $450,000 over 5-years to test his mathematical theories of ecological and evolutionary change.

Dr. Urban was one of only ten researchers funded world -wide for research on the topic of complex adaptive systems, the focus of which is creating mathematical models to explain phenomena in fields such as biology, climatology, epidemiology, demography, economic development and governance.

"Scientists have a hard time explaining which species will make up a new community," says Urban. "It's context-dependent, and these experiments will help us understand the assembly of diverse sets of communities in nature."

A complex adaptive system is composed of many different parts that, once put together, exhibit properties that the individual parts don't display on their own. An electricity grid is a common example says Urban.

The grid consists of the four criteria of a complex adaptive system: diverse elements that respond differently to change (homes with different energy demands); a spatial hierarchy (houses and businesses spread out over an area); movement between the parts of the system (electricity flows among the buildings); and a dependence on chance events (such as a squirrel being electrocuted and cutting the power to a neighborhood).

Urban says, "In this example, we would want to know: How do all these parts work together to allocate energy to the whole?"

The complex adaptive system idea originated in the description of living things forming communities in nature, he says. These natural systems can be utilized for his theory, which combines both ecology and evolution into what he calls a "doubly complex adaptive system.

Ecologists predict that when a species colonizes a new area, an island for example, that species will settle in the niche most suited to its natural history. Evolutionary biologists, however, argue that given enough time before a second species arrives, the original species could evolve, adapting to other niches available on the island excluding other colonists.

"To have perfect sorting of animals into niches would be an ecological view, but to have adaptation into different niches is an evolutionary view," says Urban. "I'm looking at the intersection of these two."

Urban will experiment using plankton to test his theory. He says plankton are ideally suited to his study because they reproduce quickly, thus evolving rapidly. He will allow different types of plankton to colonize an artificial "island" in his lab and will observe the results.

He predicts that if he allows many species to colonize around the same time, they will fill the niches to which they are predisposed. However, if they're spread out over time, the earlier ones should evolve to fill more niches and exclude later arrivals.

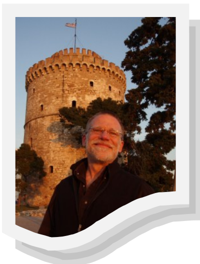
Urban is the first to test these mathematical theories experimentally. His work could help advance the fields of both ecology and evolutionary biology.

Urban says, "It's great being in an EEB department because both ecologists and evolutionary biologists can work together on these problems." "We can focus on these interesting and less-explored areas."

Urban also received a 3-year, $500,000 NSF grant to student the evolution of local salamanders in different ecological niches. Find out more about Urban's work on his webpage: http://hydrodictyon.eeb.uconn.edu/people/urban/

—Adapted from UCONN Today
article by Christine Buckley

FULBRIGHT SCHOLARSHIP AWARDED TO PROFESSOR ERIC SCHULTZ



Dr. **Eric Schultz** received a Fulbright Scholarship to study the evolution of landlocked fishes in Greece. Schultz's work will investigate how fish species that were once only found in salt water have evolved to flourish in fresh water. I'm looking at a deep part of our own physiology," he says. "We came from freshwater fish that once came from the oceans."

What many people don't realize about fish, says Schultz, is that they are in a constant state of disequilibrium. If they live in salt water, their surroundings are saltier than they are, and salt is constantly trying to get into their bodies. Conversely, if they live in fresh water, then salt is constantly trying to get out of their bodies.

Adapting to live in fresh water when your ancestors have lived in salt water for millions of years seems like a difficult task says Schultz. To date, no scientists have tested exactly what it takes to make that transition.

"If you take an animal that has the historical ability to tolerate salt, how long does it take for that ability to disappear:" asks Schultz. "Is there a tradeoff? Do they get better at living in fresh water than salt water?"

In Connecticut, Schultz studies alewives, a group of fishes that has historically traveled from salt to fresh water to spawn, but now also includes some forms that live exclusively in fresh water. This summer, he's testing the tolerance of different landlocked populations for living in salt water.

At this newsletter is being written, Schultz is currently in Greece working in the laboratory of Constantine Stergiou at the Aristotle University at Thessaloniki. About 10 percent of freshwater fish in Greece have moved from salt water to fresh water, he says. Schultz will explore the challenge of living in a saline environment in these fishes.

Schultz is also teaching at the university, giving lectures and conducting workshops in laboratory methods with undergraduate and graduate students. He is also visiting with other scientists and hopes to forge collaborations for future research.

The most exciting thing about this work, says Schultz, is that he is reconstructing the major evolutionary event that led to the formation of four-legged creatures; in his words, "recapitulating the swim upstream" of so many fishes.

"In the Silurian period (about 430 million years ago) aquatic areas were silty and didn't offer much for vertebrates to live on," he says. "But by the end of the Devonian (360 million years ago), fish were in fresh water and some of them were starting to grow limbs. Somehow, they made that profound change."

"Half the fishes in the world live in fresh water," he says. "And none of that would have happened if they hadn't crossed the salt barrier."

*—Adapted from UCONN Today
article by Christine Buckley*

PROFESSOR KURT SCHWENK STUDIES THE BIOMECHANICS OF SNAKES' TONGUE FLICKING

Originally, as a young person when **Kurt Schwenk** thought about pursing a career studying animals, he considered studying dinosaurs and vertebrate paleontology. However, while in college, he realized he could never really test his ideas about them — he felt it would be too frustrating never to know anything for sure. Thanks to an inspirational teacher, and a course on comparative vertebrate anatomy, Kurt Schwenk was set on a path to study herpetology.

As a graduate student, Kurt Schwenk became interested in snakes' and lizards's tongues because "they are so incredibly diverse in form, unexpectedly so, compared to other animal groups" says Schwenk. "No one understood why there was so much variation in the group, and my goal was (and is) to figure out why."

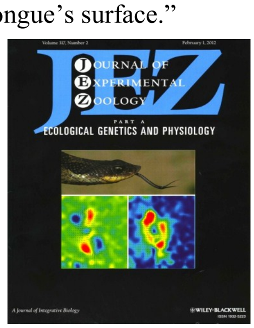
Schwenk's early work concentrated on feeding.; however he also became interested in so-called "tongue-flicking" behavior. According to Schwenk, this is a chemical-sensing behavior — the animals collect odor molecules on the tongue tips and bring them back into the mouth where they are delivered to two tiny sensory organs above the palate. "It is a kind of secondary or accessory sense of smell (not taste) that most terrestrial animals have, but sadly, not primates like us," says Schwenk. His work included studying chemoreception and how the tongue worked as part of a sensory system.

Schwenk's research led to the realization that "two tips collect different amounts of chemical and provide directional information in a single tongue-flick, like stereo smell." He adds, "it helps snakes follow chemical and pheromone trails left by prey and mates." While it seems obvious, no one had provided the evidence necessary to support the hypothesis until Schwenk's research.

Schwenk and his graduate student, Bill Ryerson, are currently researching the biomechanics of tongue flicking in snakes. They are studying on a detailed, mechanistic level exactly how the behavior helps snakes pull odor molecules out of the air and concentrate them on the tongue tips.

Schwenk hypothesized that the process must involve the diffusion of chemicals into the salivary fluids coating the surfaces of the tongue tips. He notes, "the extremely rapid, oscillatory tongue-flicking behavior might be a way to increase the speed at which this notoriously slow process occurs." To prove this theory, it was necessary to visualize how the air moves around the tongue tips during an actual series of tongue-flicks. This was accomplished using suspended cornstarch particles in the air illuminated by a sheet of laser light; a high speed video camera to record air/particle movement and a computer program calculated the rate and direction of particle movement.

Schwenk and Ryerson's preliminary results demonstrated that the snake's tongue actually creates two pairs of counter-rotating vortices of air as it moves up and down. Schwenk says, "each vortex is like a little donut of air moving very fast in a circle, but the donuts in a pair move in opposite directions." He notes that "the tongue tips pass right along the edges of these rotating donuts of air, moving against their direction of rotation, which creates a 'counter-current exchange' system that should vastly increase the speed of chemical diffusion into the saliva on the tongue's surface."



In February 2012, Schwenk and Ryerson's research was rewarded by publication as the featured paper in the *Journal of Experimental Zoology.* The paper is entitled: "A simple, inexpensive system for digital particle image velocimetry (DPIV) in biomechanics."

— Adapted from UCONN TODAY article by Karen A. Grava

PROFESSOR KENT HOLSINGER NAMED BOARD OF TRUSTEES DISTINGUISED PROFESSOR

At the April 25, 2012 Board of Trustees meeting, Dr. Kent Holsinger was named a 2012 Board of Trustees Distinguished Professor.

Holsinger is well known for his work in population genetics, plant evolutionary biology and conservation biology. His most influential work involves the development and analysis of mathematical models that describe the evolution of plant mating systems and of statistical models used to analyze genetic variation within populations.

His most recent work on the mechanisms responsible for the extraordinary diversity of plants in southwestern South Africa has uncovered a complex interplay between adaptation to environmental gradients and the accumulation of random differences among geographically isolated populations. This work involves students, post-doctoral research associates, faculty, and collaborators at the University of Connecticut, the University of California-Davis, the Australian National University, The University of Wageningen (Netherlands), the South African National Biodiversity Institute, and the South African Environmental Observation Network.

Holsinger joined the Ecology and Evolutionary Biology Department in 1998. He regularly teaches an undergraduate course in evolutionary biology and graduate courses in population genetics and conservation biology. For many years, he taught in the introduction biology course for biology majors, and for nearly 15 years, he co-taught a course in philosophy of science. In addition, he is an adjunct professor of statistics at UCONN; he has served as an external reviewer of Ph.D. dissertations at four universities in the U.S., three in Europe, and two in Australia. He has served as the thesis advisor for four UCONN Honors scholars and one University Scholar.

Additional honors include Holsinger's election as a Fellow of the American Association for the Advancement of Science in 2003, and of the Connecticut Academy of Science and Engineering in 2010. In 2006, he received the Centennial Award from the Botanical Society of America, and the Distinguished Alumni Award from the College of Idaho in 2008.

Holsinger recently served as the chair of the Senate Executive Committee, stepping down when he accepted his current position as interim vice provost for graduate education and dean of the Graduate School. He has served as president of the American Genetics Association, the American Institute of Biological Sciences, and the Botanical Society of America. Since 2000, he has served as chair of the Board of Directors of BioOne, a global, not-for-profit collaboration bringing together scientific societies, publishers, and libraries to provide access to critical, peer-reviewed research in the biological, ecological, and environmental sciences.

He has served on grant and fellowship review panels for many federal agencies and on the editorial board of 11 scientific journals.

— Adapted from UCONN TODAY article by Michael Kirk

HUMMINGBIRD FEEDING THEORY DEBUNKED

For more than 180 years, scientists operated under the assumption that hummingbirds fed by capillary action, the passive process of a fluid rising into a narrow tube because of forces attracting the liquid into the tongue's tube's solid internal surface.

The problem was this theory had never been tested since it was postulated in the 1830s. As it turns out, the theory is false. It is the research by Alejandro Rico-Guevara, a graduate student working in Margaret Rubega's lab that has debunked the theory. Using high-speed, high-definition video, Alejandro has shown that instead of using capillary action, hummingbird tongues instead trap fluids by dramatically changing their shape. Rico-Guevara published his result in May, 2011 in the scientific journal, *Proceedings of the National Academy of Sciences.*

"Hummingbirds are tiny, fast, and they feed on flowers which are hard to see into," says Alejandro. These three factors prevented scientists from closely observing hummingbird feeding until the advent of modern technology. In the early 19th century, biologists proposed that hummingbirds drank nectar from flowers using capillary action, The idea was first controversial, says Rico-Guevara, but in part because it was so difficult to test, the theory was eventually accepted.

Fast forward about 150 years, and biologist were using computer programs to model what they saw in nature. Using the capillary action theory, a group of scientists predicted that hummingbirds should prefer thin, watery nectar to thicker fluids. This finding, say Rico-Guevara, made him skeptical since many birds, in fact, prefer thicker nectars.

"The challenge was: How do you determine what's going on if you can't see inside the bird's mouth?" asked associate professor Margaret Rubega, Alejandro's Ph.D. advisor, who worked with him on this paper. "We didn't want to just accept what was written," adds Rico-Guevara. "Capillary action seemed possible, but it couldn't be the whole story."

So Rico-Guevara set about testing the theory on 30 species of hummingbirds, many in the Andes Mountains of his native Colombia. He used high-speed video to record hummingbirds feeding from nectar feeders with clear walls so that he could observe their tongues as they drank.

What he found was very different than the previous theory predicted. Alejandro observed that when in contact with a fluid, the tubes separate from each other, appearing much like a snake's forked tongue. The tubes expand to expose tiny elongate fringes that trap nectar and then retract, pulling the fluid with them into the bird's mouth.

Rico-Guevara thinks this new concept could be more far-reaching than just hummingbirds — it's possible that others of the more than 200 types of nectar-feeding birds with similar tongues also use this process. If so, this could change the way ecologists think about the behavior, ecology and evolution of these birds.

Additionally, the researchers point out, this novel fluid-gathering process could be useful to engineers. A feature of this mechanism, says Rubega, is that it requires no energy on the part of the bird; all movements are spurred by changes in pressure and molecular interactions between the bird's tongue and the surrounding fluids. This method could be instructive fore creating low-energy fluid trapping and transporting instruments.

Since it's not every day that a Ph.D. student debunks a 180-year-old scientific hypothesis, Rico-Guevara says that his own reaction to his findings has been mostly positive but at times nerve-wracking. "I'm starting to tell my colleagues about this, and it's kind of scary," he says. "But it's also super exciting."

— Adapted from UCONN TODAY article
by Christine Buckleey

DEPARTMENTAL AWARDS

GRANTS

Dr. **Bernard Goffinet** received a Faculty Large Grant for his research proposal entitled, "*Rapid Radiation and Sporophyte Evolution in the Fumariacae (Mosses): Inferences from Phylogenomics.*

Dr. **Elizabeth Jockusch** received a Faculty Large Grant for her research proposal entitled, "*Hybridization Between Salamanders with Giant Genomes."*

Dr. **David Wagner** received a grant from the Connecticut Department of Energy and Environmental Protection for his research entitled, "*Connecticut Comprehensive Wildlife Conservation Strategy Invertebrate Species of Greatest Conservation Need: Grasslands/ESS Habitats and Their Pollinators."*

AWARDS

Alyssa Borowske, Ph.D. student in Chris Elphick's lab received the Frances M. Peacock Scholarship for Native Bird Habitat from the Garden Club of America in March, 2012. Only one award is made each year.

Jessica Budke, (EEB Ph.D. 2011) was awarded the Katerine Esau Postdoctoral Fellowship at the University of California-Davis earlier this year. She will start her new position in January, 2013. Jessica is currently working as a Post Doctoral Fellow in Bernard Goffinet's lab.

Heidi Golden, Ph.D. student in Mark Urban's lab, received an EPA STAR Fellowship. The EPA STAR is a highly competitive national fellowship which includes stipend, tuition and research support for 3 years. Heidi will use the fellowship to study climate change impacts on grayling populations on the north slope of Alaska.

Lily Lewis, Ph.D. student in Bernard Goffinet's lab, received the award for best student presentation at the 3rd International Symposium on Molecular Systematics held at the NY Botanical Gardens, Bronx, NY June 14-22, 2012.

Dr. **Mark Urban** was awarded the American Associate of University Professors (AAUP) Research Promise award on March, 9 2012.

Dr. **Mike Willig** was awarded the American Associate of University Professors (AAUP) Research Promise award on March, 9 2012. Dr. Willig co-edited a new book entitled, "*The Theory of Ecology"* recently published by the University of Chicago.

Two EEB majors received awards for their research presentations at the April 2012 **Undergraduate Research Colloquium** held here on the Storrs Campus.

Outstanding Senior EEB Award went to Colin Carlson for his presentation entitled "*Rethinking the Scale of Environmental Tolerance: A new Spatial Modeling Approach to Plasticity and Climate Change."* Research Advisor: Carl Schlichting

Museum of Natural History Award went to Erika Norton for her presentation entitled "Intraspecific Variation in the Cactus Wren Song." Research Advisor: Chris Elphick

DEPARTMENTAL AWARDS CON'T

Eight EEB student received **SURF awards** this summer. The Summer Undergraduate Research Fund (SURF) supports full-time undergraduate students in summer research or creative projects.

Taylor Ferguson, Matt Gaudio, Dan Madden and **Devin O'Brien** are working on research under the direction of Elizabeth Jockusch

Grace Casselberry, Steve Ehrlich and **Emily Funk** are working on research under the direction of Eric Schultz.

Anne O'Sullivan also received a SURF Award and is working on her research under the direction of Eldridge Adams.

2012 DEPARTMENTAL RESEARCH AWARDS GRANTED

The following graduate students have been granted awards from the EEB Department for research in their fields of study listed below. Since1999, EEB has granted more than $180,000 in research awards to undergraduate and graduate students. These awards are made possible through the generosity of EEB donors who contribute to funds listed here.

Botany: Awards are made possible through the **Bamford and Andrews Endowment Funds.**

Awardees: Carolyn Ariori, Hayley Kilroy, Ursula King, Lily Lewis, Hamid Razifard, Rachel Rock-Blake, Kathryn Rymsza

Invertebrates: Awards are made possible through the **DeCoursey, Penner, and Slater Endowment Funds.**

Awardees: Frank Smith, Johana Goyes Vallejos, Beth Wade

Vertebrates: Awards are made possible through the **Clark, Manter, Rankin, Trainor, Wetzel and Whitworth Endowment Funds.**

Awardees: Alyssa Borowske, Jeffrey Divino, Heidi Golden, Brian Klingbeil, Jessie Rack, Alejandro Rico-Guevara

For information about these Funds, or how you might contribute, please contact Pat Anderson at pat.anderson@uconn.edu.

ALUMNI NEWS

There is one plant in the EEB Greenhouse that holds particular significance for UCONN horticulturalist and EEB alum, Matt Opel (Ph.D. 2004).

It's *Tylecondon opelii,* a tiny plant about 10 mm in diameter that was discovered by Opel during a research trip to South Africa in 2000 while he was a graduate student. After years of study by botanists with expertise in the genus *Tylecodon*, it was verified that Dr. Opel was the first to identify the plant as a possible new species.

The plant's native habitat is an isolated region of hilly terrain covered in quartz gravel in the northwest corner of South Africa's Western Cape Province known as the Succlent Karoo. *Tylecondon opelii* is a hardy, summer deciduous dwarf geophyte. A geophyte is a plant that survives in arid environments by utilizing an underground storage system to retain water. It is so well camouflaged that it's barely visible in the rugged landscape.

Opel was drawn to this semi-desert region that stretches along a coastal strip of southwestern Namibia and South Africa because of his interest in *Conophytums* (stone plants) and other succulents. The area is home to about one– third of the world's approximately 10,000 succulent species including 630 or so species of geophytes.

"I was in an area that I knew would be full of interesting plants," Opel says, "but I wasn't expecting to find something that hadn't been seen before. When I first saw these plants I recognized them as being from the genus *Tylecodon,* but there were some unusual characteristics that caught my eye."

Opel was drawn to the plant's dark green, almost black, leaves; he observed that were more rounded that the leaves on most of ther other 43 species of *Tylecodon* found in South Africa. Matt took photos and brought some samples back to Ernst van Jaarsveld at the Kirstebbiscg National Botanical Garden in Cape Town where botanists cultivated specimens and made detailed comparisons to related species. In an unexpected twist, it was found that *Tylecondon opelii,* flowers during the South African summer when it is leafless and seemingly inert.

The process to determine whether a species is truly a "new" species involves comprehensive study of its morphology and habitat. The researchers at Kirstenbosch found, in addition to an unusual leaf structure and color, the plant discovered by Opel had oblong tubers as well as subtle differences in the size and shape of its corolla when compared with other *Tylecodon* species.

The plants are not especially abundant and share space with other quartz gravel species in a region where the annual rainfall is only 3-5 inches; additional moisture comes from the fog that blows in from the cold Benguela currents of the Atlantic Ocean.

An article written by E.J. van Jaarsveld and Steven Hammer appearing in the 2011 July-August *Cactus and Succulent Journal* made it official. After years of study, the diminutive *Tylecondon opelii,* had passed all the tests that made it a separate species. It continues to grow in the small area of the Succulent Karoo where Opel first spotted it but is now cultivated and assured of a permanent place in botanical history.

— adapted from an article in *UCONN TODAY*
by Shelia Foran

Dr. Colin Young, (Ph.D. 2005) has been appointed the Chief Executive Officer in the new Ministry of Energy, Science and Technology in Belize in the 2012-2017 United Democratic Party Government.

Dr. Piotr Naskrecki (Ph.D. 2000) was on the Storrs Campus recently to discuss his new book *Relics: Travels in Nature's Time Machine.* The book focuses on organisms and ecosystems that trace Earth's evolutionary history. He is currently a research associate and postdoctoral fellow at Harvard University's Museum of Comparative Zoology.

CARL SCHAEFER ESTABLISHES NEW EEB AWARD

Over the years, it became obvious to EEB's Professor Emeritus Carl Schaefer that the expense for publishing a paper can be cost prohibitive, often deterring or delaying students from submitting their research to journals and other publications.

Carl worked with Foundation representatives for several months to create an endowed fund —the sole intent of which is to provide financial support for students whose research is accepted for publication.

It is hoped the funds from *The Carl Schaefer Fund for Student Research,* will provide an annual award to an undergraduate or graduate student (or students) enrolled in EEB which help defray some of the costs of publishing their research.

The EEB Department is grateful for Carl's generosity and foresight in creating this groundbreaking Fund — there is no other Fund within the University or the Foundation that provides the same benefit to students.

EEB GREENHOUSE RENOVATIONS TO BEGIN IN 2013

The EEB Greenhouse secured a commitment from the CLAS Dean and the Provost for $1 million for much needed renovations. The project is currently in the design phase with the actual renovations scheduled to begin in the summer of 2013.

THE DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY GRATEFULLY ACKNOWEDGES SUPPORT FROM THE FOLLOWING FRIENDS

Anonymous

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Drs. Gregory & Mona Anderson

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Mr. John Triana

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Dr. and Mrs. David Wagner

Mr. & Mrs. Harold Webb

Drs. Kent and Marta Wells

Ms. Elizabeth Wright