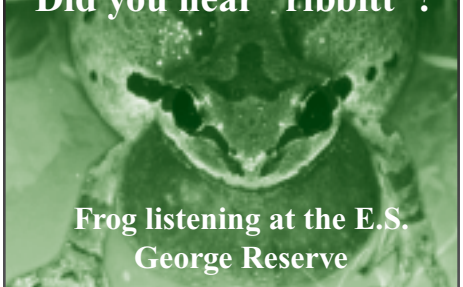
THE UNIVERSITY OF MICHIGAN
DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY

NATURAL SELECTIONS

VOLUME 8 NUMBER 2 SUMMER 2011

Did you hear "ribbitt"?



Frog listening at the E.S. George Reserve

It's early spring at the Edwin S. George Reserve in Pinckney, Mich. As night falls, Chris Davis has the essential (and unusual) task of listening for frog calls rising from 37 encircling ponds.

Why does Davis, a research lab specialist with EEB and the ESGR, spend night after night, as temperatures begin to warm, with his ears finely tuned to the dusky sounds? The riotous noises require discernment to distinguish between species. In science lingo, he is performing call surveys, a method of confirming the presence of a species in a pond.

For frogs that less densely populate the ponds, calls identify which species are successfully breeding and returning. Call intensity correlates to the chance of finding a particular species. "As part of our 15-year, ongoing survey to explore the dynamics of amphibian populations, we use other sampling methods to collect larval amphibians and their predators (primarily invertebrates)," said Davis.

You could say research is "hopping" at the ESGR. In addition to frog research, there are research projects on other amphibians such as unisexual salamanders, studies of plant community composition, spatial patterns of understory trees, a census of climbing plants (lianas), white-tailed deer management and more.

For further information visit: http://sitemaker.umich.edu/esgr/home.

Distinguished University Professor Vandermeer

Consummate researcher, prolific writer, engaging personality, dedicated teacher and mentor, and the list goes on. John H. Vandermeer was recently appointed as the Asa Gray Distinguished University Professor of Ecology and Evolutionary Biology by the University of Michigan Board of Regents, the highest level of professorship that U-M confers upon a faculty member.

John Vandermeer

Asa Gray

"John is a brilliant scientist and teacher and a passionate advocate for justice and equality in academia and society – we are incredibly lucky to have him in our department," said Deborah Goldberg, EEB professor and chair.

Asa Gray (1810-1888) is considered the most important American botanist of the 19th century. He was instrumental in unifying the taxonomic knowledge of the plants of North America. He was appointed a professor at U-M in 1838, but resigned before visiting Ann Arbor and served at Harvard from 1842 - 1873. Gray knew and corresponded with Charles Darwin and was a Darwin supporter, not only of his theory of evolution in the U.S., but also with Darwin's extensive connections with and support for the abolitionist movement. Vandermeer selected Gray as much for his anti-slavery activities as for his scientific contributions.

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The "new Rachel Carson" uses unique voice to improve world

In a world according to Dr. Sandra Steingraber, instead of waking to news of a stock market crash, the media would present regular reports of the plankton crash. Did you know that plankton provide half of our oxygen and they have already declined by 40 percent? This is just one among an apparent ocean of insights from this U-M biology alumnus who would turn many mainstream priorities upside-down.

A passionate speaker, author, poet, ecologist and cancer survivor, Steingraber received her doctorate degree in 1989. The internationally recognized biologist was on the Ann Arbor campus in April 2011 to receive the Athena Award from the U-M Alumnae Council. The award honors alumnae who have achieved outstanding recognition in their field. Professor John Vandermeer introduced his former student, who he describes as intense, serious, and concerned with questions of environmental justice as well as an incredible writer, poet and inspirational speaker.

Steingraber's newest book, "Raising Elijah: Protecting Our Children in an Age of Environmental Crisis," is "at once a call to action and a poignant meditation on the simple joys of motherhood." Previous books include "Having Faith: An Ecologist's Journey to Motherhood" and "Living Downstream: An Ecologist's Personal Investigation of Cancer and the Environment," now the subject of an award-winning documentary film. Steingraber received the Rachel Carson

see Steingraber, page 5

chair's notes

Deborah E. Goldberg
Elzada U. Clover Collegiate Professor and Chair, Ecology and Evolutionary Biology

Dear Friends,

We have hired three outstanding new faculty members who will join us as assistant professors over the next year. Dan Rabosky, currently a Miller Fellow at UC Berkeley, has already made very significant contributions in understanding the rates of diversification over evolutionary history, and will serve as a curator of herpetology as well as assistant professor in EEB. Stephen Smith, currently a postdoctoral fellow at Brown University, is a computational evolutionary biologist, who has developed innovative approaches that enable studies of huge phylogenetic trees to answer questions about rates of phenotypic and molecular evolution, with a focus on plants. Together, Rabosky and Smith greatly strengthen our program in evolutionary biology; we hope to add one more position in evolutionary biology next year. Vincent Denef is the EEB hire in an interdisciplinary cluster in microbial ecology. He brings expertise in metagenomic analyses of microbial communities, where the genes and proteins of entire communities of microbes, rather than single organisms are examined to understand systems-level functioning.

In other faculty news, we congratulate Professors Trisha Wittkopp, Chris Dick, and Aaron King, who were all promoted from assistant professor to associate professor with tenure this year, and wish the best to Professor George Estabrook, who began his retirement furlough.

On a much more somber note, in January, the department was greatly saddened by the death of Professor Emerita Beverly Rathcke, after a short illness. Beverly had begun her retirement less than a year before and was immensely enjoying her freedom to travel, long visits with friends, and the time for cooking and sharing marvelous meals. Beverly was a distinguished ecologist and beloved by many generations of graduate students – she served as major advisor to 29 Ph.D. students and on more than 50 dissertation committees in Biology, EEB and SNRE. She was a wonderful colleague and friend and we are still mourning her loss.

Beverly Rathcke

Finally, a brief preview of our next newsletter. Just a few weeks ago as the end of June approached, we suddenly realized that a very significant date was coming up: EEB would be 10 years old on July 1, 2011. To celebrate, the next newsletter will include a review of some of the many accomplishments of our faculty, students and staff over the past 10 years and a look at our plans for the next 10 years. So, alumni, this is a good time to send us your news – you can do that on the alumni news page of our website http://www.lsa.umich.edu/eeb/alumni/alumni-news.asp or send an email to me (degold@umich.edu) or to our communications specialist and editor, Gail Kuhnlein (kuhnlein@umich.edu).

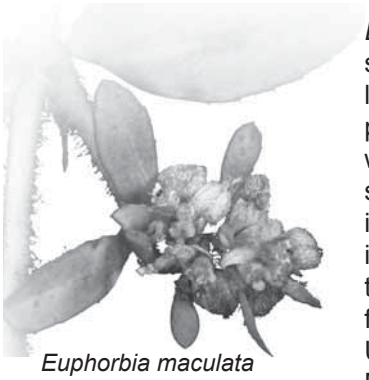
My warmest regards to all of you,

Editors: Deborah Goldberg, Nancy Smith
Writer, editor: Gail Kuhnlein
Production, illustration: John Megahan
Photographer: Dale Austin

student profile

DNA evidence links plant stories

Pull up a chair and get comfortable because EEB Ph.D. student Ya Yang has a story to tell, but even though it begins 30 million years ago, don't worry, it won't take nearly that long.



Euphorbia maculata

Euphorbia is considered the second largest genus of plants in the world, with some 2,200 species, the majority of which grow in Africa, although they are also plentiful in the southern United States and Mexico. Yang is working on the *Euphorbia* Planetary Biodiversity Inventory Project, supported by the National Science Foundation, and she is studying one of four major groups within the genus.

"My research is mostly about the evolutionary history and relationship among plants in the subgenus *Chamaesyce* and how they evolved to their current shape, form and distribution." The subgenus is over 30 million years old. Familiar *Euphorbia* plants are Poinsettia (*E. pulcherrima*), crown of thorns (*E. milii*), and the ubiquitous weeds that spread out from sidewalk cracks, such as *E. maculata*. Many plants in the genus closely resemble cacti.

Because the genus is so large and variable, for a long time botanists erroneously put various *Euphorbia* plants in different genera. "Now we know they are all deeply nested in the genus *Euphorbia*," said Yang. However, there's still much that is unknown about how these plants are related. Yang's role is making sense of the subgenus *Chamaesyce*, which comprises about one-quarter of the species within *Euphorbia*.

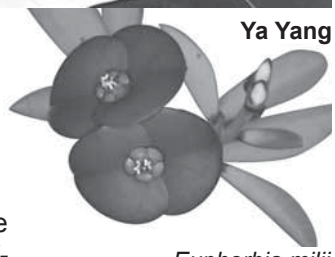
There are three chapters to Yang's dissertation. Chapter one is a phylogenetic analysis and updated classification of the entire 600 species within *Euphorbia* subgenus *Chamaesyce*. "We found that the subgenus originated in Africa, and there was long distance dispersal to the New World," she said. "We used the DNA to identify the relationships between the species, and we tell the story by making the evolutionary tree."

Euphorbia is the only genus of plants whose members contain all three types of photosynthesis and all are found in the subgenus *Chamaesyce*. C_3 is the most common photosynthetic system, whereas C_4 and CAM are adaptations to hot, dry habitats.

There are 330 species of *Chamaesyce* in the C_4 group. They have one millimeter sticky coated seeds, which evolved as an adaptation for seed germination in the desert because the sticky coat absorbs water. The seeds adhere to migrating birds, giving these plants the widest distribution in the genus.

Ya Yang

Chapter two involves a group of 330 plants with an identity crisis. With C_4 photosynthesis and a unique growth form, they are so different from the rest of *Euphorbia* that they have been recognized as their own genus *Chamaesyce* Gray. However, molecular data by Victor Steinmann of the Instituto de Ecología, Mexico, confirmed by Yang and colleagues, places it deeply nested within the giant genus *Euphorbia*, as section *Anisophyllum.*



Euphorbia milii

These prostrate and spreading weedy species originated in warm, dry areas of North America. Many species are seen growing from sidewalk cracks in summer. The group diversified globally through widespread interspecific hybridization (between different species in the same section) and multiple long-distance dispersal events from the New World to the Old World.

As part of the Euphorbia Project, which runs through 2012, the researchers have created a website, www.euphorbiaceae.org/

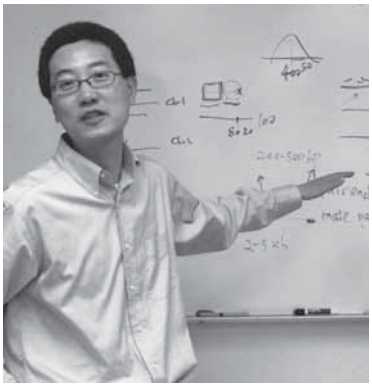
Yang and colleagues are collaborating with a physiologist at the University of Toronto, Rowan Sage, who researches the change in photosynthetic types from C_3 to C_4. The change in plant photosynthesis involves complicated changes in biochemistry, physiology and anatomy. There is a great deal of interest in the evolutionary change from C_3 to C_4 photosynthesis in relation to climate change because C_4 is more adaptive in hot and dry environments.

Yang is most excited about chapter three of her dissertation. Usually species diversification is studied on a mainland where many other factors come into play and because the land has existed for so long, it is difficult to know the full history. In contrast, there is not much competi-

see DNA evidence, page 7

Euphorbia ingens

Uncovering the mysteries of evolution piece by piece



Jianzhi "George" Zhang

Ten years ago, the human genome sequence was completed and in that same year, Professor Jianzhi "George" Zhang arrived at the University of Michigan to embark upon his career – it was a good year for molecular and genomic evolution.

The genomic revolution began in the mid-1990s and ushered in an era of excitement in evolutionary genetics, according to Zhang. Scientists began by sequencing the genomes of microbes, such as bacteria, because they are easier to sequence and assemble. Gradually, sequencing and computational technologies improved and researchers began sequencing larger genomes, including the human genome. "There has been a lot of discussion lately about what we have learned in the last decade since sequencing the human genome," Zhang said. "In a sense, the genomic revolution trained a generation of evolutionary biologists, because to make sense of the genomic data, you need to understand the evolution of genomes and compare the genomes of different species."

Evolutionary biology has a long history of theoretical studies. Many theories and hypotheses remained untested because despite a massive quantity of data, certain types of data were missing. "With the genomic revolution, we now have the opportunity to test many hypotheses and this, I think, is very exciting."

"In a sense, the genomic revolution trained a generation of evolutionary biologists, because to make sense of the genomic data, you need to understand the evolution of genomes and compare the genomes of different species."

In addition to generating new data, the genomic revolution also uncovered previously unknown phenomena such as gene expression noise, which refers to random variation in gene expression among genetically identical cells in the same environment. All cellular processes, including gene expression, depend on random encounters of molecules, but many molecules are present in very low numbers per cell. Consequently, the expression level of a gene varies substantially among cells simply due to chance.

In what was the first empirical demonstration that expression noise, commonly thought to be deleterious, is sometimes beneficial, the Zhang lab found that a group of yeast cell-membrane transporters have exceptionally high noise that has been elevated by positive Darwinian selection. They built a mathematic model to explain why high noise in some genes can be beneficial. In a nutshell, when the environment fluctuates frequently and unpredictably, a population of cells with high expression noise will include some cells that are by chance "preadapted" to the new environment. Mathematically, they proved that, under such conditions, the expected fitness of a high-noise genotype is greater than a low-noise genotype. The study was published in 2009 in the journal *Molecular Systems Biology*.

For most genes, however, expression noise appears to be harmful, but why it is bad and how bad it is are not well understood. Imagine you are on an auto assembly line. You need four tires, but you may get three or five tires. You may get zero, one or two engines. Every car component fluctuates in amount in this noisy assembly line. What is the chance that the car you assemble will function? Probably zero.

Cells have a lot of expression noise, akin to not having the correct number of car parts, but the cell still functions quite well. "That is amazing," Zhang said. "That means the cell is quite robust to this type of noise, but this doesn't mean cells don't suffer from noise." Zhang and his graduate student, Zhi Wang, built a model and estimated that, compared to an ideal cell without noise, the mean fitness of a cell with noise is at least 25 percent lower. They also observed that enzymes whose functions are more important to the cell tend to have lower noise. It's as if the engines, very important for running the car, have low noise. This is indicative of natural selection against harmful noise. This work was published in the April 19, 2011 issue of the *Proceedings of the National Academy of Sciences of USA*.

The big question the Zhang lab investigates is the genetic basis of evolution. That is, what types of mutations are responsible for evolutionary changes and what evolutionary forces and constraints are involved. His lab has a wide array of interests, and individual projects focus on different aspects of this broad ques-

see mysteries of evolution, page 7

alumnus profile

Steingraber from page 1

Leadership Award from Chatham College, was named one of "25 visionaries who are changing your world" by the *Utne Reader*, and was named a *Ms. Magazine* Woman of the Year. She lectures on many college campuses and at medical schools, is a visiting scholar at New York's Ithaca College and is a columnist and contributing editor at *Orion* magazine. She and her husband, Jeff, have two children, Elijah and Faith, ages 9 and 12.

Steingraber reminisced about her days in what was then the Division of Biological Sciences and especially her time in the labs of Professors Beverly Rathcke and Vandermeer. "Beverly's lab was always such a warm and welcoming place," she said. "Not only did we do really good science, it was a lab where people cared for each other. I always thought of Beverly as a kind of gardener, she looked at all of her students and could figure out what soil was the best for each student. She gave us the conditions we needed to thrive.

"John's lab was just as welcoming, but different than Beverly's," she said. "It was run as almost a kind of collective or cooperative. Journals were exchanged, so I had access to a lot of literature. People were always coming and going to Central America, so they brought a global focus on ecology. It was more political in John's lab."

Both elements that Steingraber calls her "stock and trade," she said she learned as John's graduate assistant and teaching his classes.

"There are two challenges in presenting science to the general public and John's very adroit at overcoming both," Steingraber said. "Often, people are either indifferent to science or scared of it. Getting them past that is one art, by knowing how to bring not just plain spoken English to complex biology, but to tell a story where there's a mystery to understand and resolve.

"The other challenge is that there's a grief we all feel about the destruction of the planetary ecosystem and it's so profound that we turn away from the evidence because nobody wants to feel despair." Vandermeer's optimism of focusing on the many research studies that show such promise for the world has colored Steingraber's world view rosier, helping her to see hope for the future.

If Steingraber had a solitary message to impart to graduate students today, it would be that it's not enough to do the research; they have to be the advocates and champions for their own research. "You might think that if you do the research that it's someone else's job to take that research to make policy out of it. There's nobody coming (she laughed), and so you can publish all you want but it's just going to sit in an electronic shelf somewhere.

Sandra Steingraber with daughter, Faith

"There's a real joy in advocating for what you care about. I don't think it's true that there's a conflict between being objective and being an advocate. Advocacy doesn't mean you can't objectively analyze statistical data. Advocacy comes after the analysis. That's just part of being a citizen."

What does Steingraber appreciate the most about her career? "I still get to analyze data and yet I also have this public voice. I have the opportunity to tape the "Living on Earth" show, or give a lecture before the Environmental Protection Agency, or brief Congress, or speak at the European Parliament and bring insights of science and ecology into the room where decisions are being made. I guess you would call that speaking truth to power, but there's something else that I do that is even more meaningful to me. I call it speaking truth to powerlessness, which is when I get an invitation on a Friday night to a church basement in a community that is on the tail pipe end of the toxic chemicals, on the front lines. I feel really lucky when I have the opportunity to give them the basic science that they might need to make their case for change."

"Poetry and biology are more similar than most people imagine them to be. Both are about the mystery of being alive. Whereas biology attempts to solve the mystery, poetry simply says 'behold.' Both poetry and biology involve a lot of complexity. Biology tries to find an explanation for that complexity and poetry simply revels in it."

Find out more at: www.steingraber.com

Her main message overall is that "what we love, we must protect. Happily, that protection is doable. I have yet to be confronted with an environmental problem that is unthinkable. It's a matter of demanding that green solutions and ingenious innovations be brought forward into the mainstream. Environmentalism isn't about doom and gloom. It's the innovations, it's the way forward."

Vandermeer from page 1

Vandermeer is a leading scholar in ecology, recognized internationally for his theoretical insights and applied work in the field. He received his Ph.D. from the University of Michigan in 1969. After a postdoctoral position at the University of Chicago, he spent a year as an assistant professor at the University of New York at Stonybrook before returning to take a faculty position at the University of Michigan. Later, he was a Fullbright Scholar in Nicaragua and then in the Netherlands.

John Vandermeer and Ivette Perfecto

"John is a brilliant scientist and teacher and passionate advocate for justice and equality in academia and society."
-- Deborah Goldberg

He has made groundbreaking contributions in his major areas of research: theoretical ecology, tropical rain forest ecology, and agricultural ecology. He is unique in his ability to integrate between them, particularly in his central role in the development of the rigorous ecological theory that now underpins the understanding of complex agroecosystems and the inevitability of surprise in complex ecosystems more generally. His most recent work has shed light on the role of complex systems and spatial dynamics in ecosystem function, emphasizing the coffee agroecosystem as a model system.

"In John's work on biodiversity and ecological interactions, his insights stem not only from integrating detailed field work with ecological theory but also from evaluating properties of the system as a whole," said EEB Professor Catherine Badgley. "This appreciation of the larger context, both ecological and social, gives his research power and relevance."

The appointment recognizes Vandermeer's extensive and outstanding scholarly achievements, his commitment to excellence in education for his students, and his extensive contributions to U-M and far beyond. Vandermeer is author or co-author of 13 books, including his most recent, "Nature's Matrix: Linking Agriculture, Conservation and Food Sovereignty." He has written 27 book chapters, 15 book reviews and published 187 scientific articles. Over 35 students have been mentored by Vandermeer.

U-M Provost Phil Hanlon introduced Vandermeer at his Distinguished University Professor Inaugural Lecture and spoke of his deep commitment to social justice and passionate advocacy for the full participation of women and underrepresented minorities in communities of research and practice and how he ensures local voices are part of his research projects.

Just what was the impetus for this stellar career? "From the time I was very young I've had a fascination with nature and animals," Vandermeer said. "In college, I was a very eclectic student, all sorts of things attracted my attention," he recalled. "I was going to major in French, literature, psychology, philosophy. More or less every introductory course I took, I was going to major in it. Junior year came and I had to declare a major. I'd really like to do everything," he thought at the time. Because of his passion for the outdoors, he chose biology. His physics, astronomy and chemistry courses captured his undivided attention. A newfound love of science was born.

What really excites Vandermeer now is "being able to engage in the science of ecology in a way that I think contributes to some of the rural social movements going on today with small farmers. Figuring out the complexities in the interactions in the coffee agricultural ecosystem and how those complexities turn out, in a complicated way, to be important in practical application to pest control in the coffee – being able to work that out using the science of ecology and understanding how it contributes to the movement toward a more sustainable agriculture and to help small scale family farm agriculture."

Vandermeer and his partner, Professor Ivette Perfecto, were invited to participate in a symposium on the role of agricultural biodiversity and conservation in Germany this summer. Later, they're attending a symposium by the Scientific Society of Agroecology in Latin America where they'll participate in a course on the role of agricultural ecology in emerging rural social movements.

"What's merging is my long-term moral compass of trying to aid the popular movements for social justice with my ecological interests. The scientific work in ecology is clearly supporting my sense of social justice."

Outside of work, Vandermeer's interests turn to his two sons. Jason and his wife recently adopted a child. He is excited about being a grandfather. Jaimie is a computer programmer in San Francisco.

"Ivette has been a partner in all of this, we are intellectual partners to a tremendous degree, nothing that I've said today does not bear the stamp of her influence," Vandermeer said at the conclusion of his professorship lecture.

faculty profile

Mysteries of evolution from page 4

tion. Members of the lab published over 100 papers in the last decade, including 13 in the year 2010 alone. A few recent papers have been on positive selection in humans and chimps, why pandas became vegetarians, parallel evolution of hearing genes in echolocating bats and whales, and the amount and mechanisms of genetic interactions in yeast and *E. coli*.

"I always think the paper I'm writing now is the most interesting one," Zhang said. For example, he recently found that, because the molecular functions of proteins are highly conserved in evolution, simple model organisms can be used to study the molecular mechanism of human disease even when the disease phenotype is absent in the model organisms. A paper detailing this was recently published in *Proceedings of the National Academy of Sciences of USA*.

As a young college student, Zhang's interest in biology wasn't awoken until he read a translated book about population genetics and evolution. From then on, he read everything he could find about evolutionary and population genetics at Fudan University's library in Shanghai, China. He reveled in the quantitative nature of the field.

Zhang loves the freedom his profession allows, "because we can pursue whatever scientific questions we'd like. I'm a person with a lot of different scientific interests and they change quickly, so the freedom to change interests is good."

Zhang lives in Ann Arbor with his wife, Maggie Zhou, an assistant professor at the University of Maryland's Business School. They keep busy with their two boys, Daniel, 6, and Andy, 4. His wife commutes but is able to work from home when not teaching. The file cabinets in Zhang's office are brightly festooned with his boys' artwork. Faces of birds, a tiger and a panda watch over their dad, as he painstakingly studies the behind the scenes wonders of the natural world.

Artwork by Daniel Zhang

DNA evidence from page 3

tion on Hawaii and because the islands were created when the volcanoes erupted, researchers can trace the story from the beginning.

"Hawaii is a rare system for studying evolution in a more well-defined setting." Yang and her collaborators are researching plants on four Hawaiian islands, collecting samples in the mountains to add to the DNA bank samples. The goal is to provide a phylogenetic framework that will contribute to a comprehensive understanding of the dramatic radiation. There's a lot of ongoing hybridization. "Usually an evolutionary tree is seen as a tree. Scientists now see it as more of a web because sometimes species hybridize with each other to form new species, especially in plants," she explained.

Yang received the McBryde Fellowship from the National Tropical Botanical Garden. While the project involves a great deal of teamwork, the main researchers Yang works with are at the University of Hawaii at Manoa.

Yang's second chapter will be published soon in the *American Journal of Botany*. She's revising her first chapter and will be submitting it for publication soon in the journal *Taxon*. She wrote floristic treatments for 16 species for a volume of the book series, "Flora of North America."

Yang, who is in her sixth year, will graduate by the end of 2011. She loved teaching genetics last semester with Professor Patricia Wittkopp. On the end of class survey, many students wrote positive comments about Yang, their graduate student assistant, and that made her feel just great.

ecology & evolution

Our **inaugural enewsletter** flew through cyberspace and into your inboxes with the winter 2011 issue. Watch your inboxes for summer and fall issues this year. Subscribe or unsubscribe to "ecology and evolutions" at: http://bit.ly/iFWRJw

EEB's **website** has a new look! Check it out and let us know what you think: www.lsa.umich.edu/eeb/

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The University of Michigan
Department of Ecology and Evolutionary Biology
Kraus Natural Science Building
830 North University
Ann Arbor, MI 48109-1048
USA

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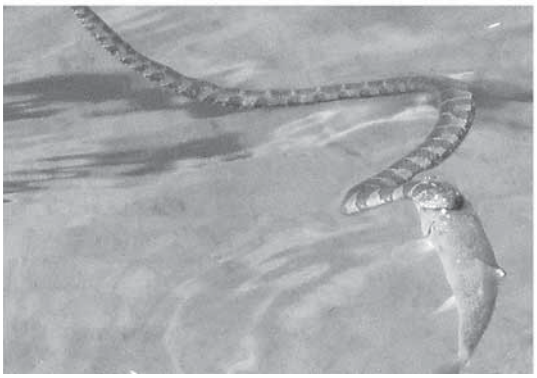

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Picture perfect!

Congratulations to our new Honorary Photographer at Large, Professor Catherine Badgley, who came in first place with "Galloping zebras, Amboseli National Park, Kenya." (1)

We have a tie for second place between EEB Ph.D. student Susanna Messinger for "Stormy Lake Michigan" (2)
and
Dan Katz, SNRE Ph.D. student, for "Everyone likes a fish." (3)

Third place goes to EEB Ph.D. student Leslie McGinnis for "Ranthambhore National Park tigress." (4)