

# Ecology & Evolutionary Biology

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## Letter from the Chair

By Mark Bertness



Greetings from EEB. As another school year comes to an end we continue to have plenty of good news and exciting developments on the horizon, even in tough economic times.

Our junior faculty are leading the way. Heather Leslie gets the multitasking award. She not only broke her leg in three places this winter, but (with Stephen Porder) received a grant from the Henry David Thoreau Foundation to sponsor undergraduate research partnerships co-mentored by Brown faculty and conservation practitioners on the interface of science, management and policy.

Not to be outdone, Erika Edwards led a three-day workshop at the NSF National Center for Evolutionary Synthesis in Durham, North Carolina on the "Evolutionary History and Ecology of C4 Grasses." She was escorted by a Providence-based mafia including Christine Janis, Osvaldo Sala and Yongsong Huang from Geological Science.

Another exciting development has been the emergence of Conservation Medicine at Brown spearheaded by Kate Smith, bringing together strengths from EEB, Community Health, and International Medicine. This semester Kate and Mark Laurie of Community Health launched a Conservation Medicine Working Group that ran discussions, a popular seminar series, and a successful research symposium.

Our junior faculty are clearly getting noticed. Dan Weinreich gave a keynote address this winter to the annual Population Genetics Group meeting in Porto, Portugal; Dov Sax was named an Aldo Leopold Conservation Fellow for his work on species extinction and the evaluation of assisted migration as policy, and *Discover* Magazine named Casey Dunn's invertebrate phylogenetic tree revision one of the top science stories of 2008.

Beth Brainerd and Steve Gatesy continue to get the Keck Foundation-funded XROMM up and running. This summer it should move from the development stage to collecting data. This unique facility will give our morphology group the ability to analyze vertebrate locomotion with 3-D X-Ray video.

So in spite of the economic downturn, EEB continues to rock and roll ahead. Here's to a well-deserved and productive summer.

## Recent EEB Graduates



### Devon Bradley, Ph.D.

June 12, 2008

Causes and consequences of microbial diversity: from marshes to model systems



### Jose Iriarte-Diaz Ph.D.

July 15, 2008

Flight performance in bats and its ecomorphological implications



# In the Greenhouse



By Fred Jackson

Two new experiments are going strong in the Plant Environmental Center this spring. The first is a semester-long greenhouse experiment designed by Erika Edwards and Matt Ogburn for the students in Erika's Plant Ecophysiology class. According to Matt, the experiment addresses questions about the plasticity of plant responses to drought and salinity. Because these are novel questions that haven't been asked in the literature, this was a chance to involve undergraduates in plant research.

The class exposed seedlings of *Talium paniculatum*, a widespread herb of arid regions to watering treatments varying in frequency, amount, and salt content. Students measured maximum photosynthesis rates, plant growth, overnight leaf acid accumulation (to look for CAM photosynthesis), and differences in biomass allocation and tissue succulence. One of the main hypotheses being tested was whether plants receiving infrequent pulses of water develop more highly succulent tissues, especially in their tuberous roots, when compared with well-

watered plants? In other words, would they learn to save for a rainy day (literally)?

Matt's initial results are coming in with a few surprises. The pulse-watered treatment has shown very dynamic responses to the available water, with significantly higher daytime photosynthetic rates immediately after watering that decline steadily to zero throughout the drought period. Prior to their weekly watering, these plants have a much higher acid accumulation, indicating CAM photosynthesis. Contrary to the hypothesis, pulse-watered plants displayed no plasticity in tissue allocation.

The well-watered control plants are significantly larger than the drought plants. As expected, there are large differences in root to shoot allocation between the well-watered plants that received salts and those that didn't. The no-salt controls have significantly higher root-shoot ratios than all other plants, while the salted plants have significantly higher above ground biomass. This unexpected result could be explained by greater leaf succulence in the salt plants as opposed to greater total dry biomass. The class is continuing data collection to get to the bottom of this question.

Matt Heard (EEB Graduate Student) is back in the greenhouse again to continue work with invasive plants. He is currently examining the mechanisms that promote species invasions in plant communities across Narragansett Bay. One of the critical factors that may contribute to the success of invasive plants is increased propagule pressure (they have more seeds arriving at sites than native species).

To investigate this, Matt has collected soil samples from around the Bay and has been planting all the seeds he can find in these samples. By doing this, he is hoping to accomplish two things: 1) characterize the differences in seed banks across Narragansett Bay and 2) determine if propagule pressure can contribute to an increase in species invasions.

Matt thinks that this work will tie in nicely to the research that is currently being conducted in Narragansett Bay by a number of EEB faculty members. Additionally, he hopes that findings from his study will contribute to minimizing the impact of species invasions throughout New England. Good luck, people!

## Undergraduate Thesis Presentations

### Ben Apple

The effect of dissolved organic matter on coral microbial communities  
Advisor: Mark Bertness

### Leann Barnes

Population genetics and the rapid evolution of pollution resistance in *Fundulus heteroclitus*  
Advisor: David Rand

### Joanna Bernhardt

The role of substrate size in shaping thermal landscapes across rocky shores  
Advisor: Heather Leslie

### Anya Brown

Who wins the food fight? Inter- and intraspecific competition of two species of apple snails  
Advisor: Mark Bertness

### Michelle Goh

Mate searching behavior of a male parasitic wasp  
Advisor: Doug Morse

### Leigh MacAyeal

Vertical flight performance and load carrying in lesser dog-faced fruit bats (*Cynopterus brachyotis*)  
Advisor: Sharon Swartz

### Olivia Rhoades

Observations of a La Niña 2007-2008 bleaching event: the fate of *Pocillopora* coral colonies and their associated mobile fauna at three Galápagos upwelling sites.  
Advisor: Jon Witman

### Maggie Sogin

Impacts of ocean acidification on bay scallop, *Argopecten irradians* larval development  
Advisor: Mark Bertness

### Sophia Tintori

Gametogenesis in Cnidaria  
Advisor: Casey Dunn

### Robin Zelman

Effects of antibiotic concentration on bacterial persistence in *E. coli*  
Advisor: Daniel Weinreich

# News Update

**Aaron Ellison** (EEB Ph.D. 1986) has been appointed Editor-in-Chief of *Ecological Monographs*. Aaron is currently a Senior Research Fellow at the Harvard Forest.

**Dov Sax** has been named one of 19 Leopold Leadership Fellows for 2009. The awards program, based at Stanford University's Woods Institute for the Environment, helps mid-career academic scientists make their scientific knowledge accessible to decision-makers.

**Jennifer Knies** was awarded an NIH NRSA, a postdoctoral fellowship that will fund her salary for 2 years.

**Kristin Bishop Von Wettberg** (EEB Ph.D. 2007) will be starting a faculty position at Florida International University next year as an Assistant Professor. Kristin was hired as a vertebrate morphologist.

**Eric Von Wettberg** (EEB Ph.D. 2007) will be starting a faculty position as an Assistant Professor at Florida International University. He was hired to be a population geneticist and will spend a good portion of time at the Fairchild Tropical Botanical Garden in addition to FIU.

**Erika Edwards** recently organized a three day NSF-sponsored Catalysis meeting, at the National Center for Evolutionary Synthesis Center in Durham, NC. The theme was 'toward a new synthesis of the evolutionary history and ecology of C4 grasses'. The purpose of the meeting was to gather leading researchers from North America, Europe, Australia, and South Africa to discuss recent advances in C4 grass evolution.

**Heather Leslie** received an ADVANCE Career Development Award, which will facilitate collaborations with colleagues on the Pacific coasts of North and South America in the coming year.

**Oswaldo Sala** has given talks in the last few months at Texas A&M and Washington University in St Louis. He also participated in the South American Resilience and Sustainability Institute Steering Committee meeting in Montevideo, Uruguay; and joined the Rhode Island Ocean Special Area Management Plan Scientific Council.

The Department greatly enjoyed the visits of former honor students **Christopher Harley** (Sc.B. '94) and **Jonathan Levine** (Sc.B. '95); who presented in our Monday colloquium series (see p.6). Chris received his Ph.D. from the University of Washington with Bob Paine, followed by a postdoc at the Hopkins Marine Station. He is now an Assistant Professor at the University of British Columbia. Jonathan received his Ph.D. from UC Berkeley and was a postdoc at Imperial College, Silwood Park. He is currently an Associate Professor at UC- Santa Barbara. Chris and Jonathan provide two great examples of the impact our undergraduates and grad students are making in their chosen fields.

Several of our present and former students received NSF postdoctoral fellowships this year. **Whitney Brin-Deforest** '04 will enter UC- Davis in the fall and **Liana Burghardt**, research assistant in EEB will enter Duke in the fall. Other former undergrads currently in graduate schools **Lisa Mandle** (University of Hawaii) and **Laura Martin** (Cornell), also received these prestigious awards.

**Kate Smith** is making great progress in putting together a program in Conservation Medicine at Brown. She has secured funding for a first-year seminar on the subject next spring as well as support for the group itself. She has already set up regular discussion groups and sponsored seminars and a symposium with Community Health.

**Beth Brainerd** spent part of her sabbatical year at the University of British Columbia and **Jon Witman** spent his in the Galapagos.

research associates will be joining the Environmental Change Initiative this summer or fall. Each has developed an original project building on the expertise of current Brown faculty members from different departments (two in EEB).

**Sheila Walsh** just completed her PhD at the Center for Marine Biodiversity and Conservation at Scripps Institution of Oceanography and the Center for Environmental Economics at the University of California-San Diego. Working with Heather Leslie (EEB/CES) and Sriniketh Nagavarapu (Economics/CES) her project evaluates the effect of a Mexican government conditional cash transfer program on community welfare and marine ecosystem health under different ecosystem and market conditions.

**Véronique St. Louis** will work with Dov Sax (EEB/CES) and Jack Mustard (Geological Sciences/CES) on a project that combines niche modeling and remote sensing to forecast extinctions from climate change. She is completing her PhD in Forest and Wildlife Ecology at the University of Wisconsin - Madison.

**James Hull** will work with sociologist Leah VanWey and Crystal Linkletter from Community Health to examine how the transition from a barter economy to a cash economy influences social networks, agricultural intensification, and labor mobility. James is completing his PhD at the Carolina Population Center, University of North Carolina at Chapel Hill, where he was a fellow in the NSF IGERT Training Program in Population and Environment.

**Erika Sudderth** will join the Sala lab in July as a postdoctoral research associate. She will be investigating the linkages between above-ground and below-ground responses to varying precipitation in desert grassland, temperate grassland, and arctic tundra. Erika earned her PhD at Harvard with Noel Holbrook and Fakhri Bazzaz and recently held a postdoctoral fellowship in the Ackerly lab at UC Berkeley.

Three new interdisciplinary postdoctoral

# Jim Palardy

## EEB Graduate Student



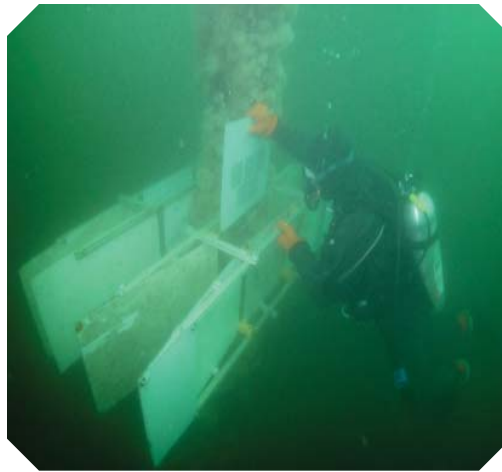
Most people want to be marine biologists at some point while growing up. And why not? Magazines are filled

with photos of exquisite coral reef seascapes that overload the senses: millions of fish dart around majestic coral colonies in a seemingly endless palette of color and shape. The notion of living in the tropics and working in clear, warm, sunlit water is a dream job for many. I certainly don't disagree - I've been there. So why do people look at me like I'm crazy after I tell them what I study? Maybe it's because it's the middle of December, and the dive gear I just checked at the airport counter is going to Anchorage - not to Aruba...

Generally, I'm interested in understanding the mechanisms that generate large-scale patterns of diversity. In subtidal systems, this remains a largely unanswered question. Although classic experiments have shown that competition, predation, and disturbance play a role in determining the species richness of communities at small scales, we have learned only recently that subtidal systems are not saturated with species. This indicates that larger-scale phenomena are likely to play an important role in determining local diversity.

One large-scale process that may have a controlling factor in determining local species richness

is water flow. The vast majority of marine epifaunal invertebrates have planktonic larval stages, and most 'go with the flow' at some stage of their development in the water column. With this in mind, it is easy to envision that areas with high flow rates will have higher delivery rates of invertebrate larvae. The increased delivery rate of larvae may be most important for rare species, whose presence or absence from a site may be a function of larval availability. As such, we expect that sites with increased flow rates will have higher species richness.



To investigate this hypothesis, I designed and deployed 'flow enhancers' at sites in Alaska and Maine. These enhancers are basically big (~ 7 ft long, ~3 ft wide, 2 ft high) underwater funnels that increase flow by about 60% through a central working section that contains settlement plates. Each enhancer also has a paired control flow treatment. Every 15 weeks for the past few years, regardless of the weather, I've sampled diversity on all of the settlement plates by measuring the percent cover of all species present.

By comparing the number of species found in enhanced flow treatments against the richness of invertebrates that settle in control flow treatments, I'm able to quantify directly the effects of flow on species richness.

Our results indicate that increasing flow leads to a corresponding increase in species richness. In addition to these experimental results, we've surveyed natural wall communities and found a linear relationship between flow and local species richness. Since we've observed the pattern at all of our experimental and survey sites over several years, the effect of flow on diversity seems to be robust. Interestingly, in all cases, the increase in species richness is being driven by an increase in the number of rare species present in the sample.

In addition to answering fundamental questions about the generation of diversity, my dataset provides a unique opportunity to test Hubbell's controversial Neutral Theory of Biodiversity and Biogeography, which assumes that species identity doesn't matter. Because I have independent data to parameterize the fundamental biodiversity number, direct measurement of the migration parameter, as well as data covering many different-sized scales through time, my data will not suffer from many of the problems inherent to tests of the theory. Results are pending, (i.e., simulations are running) but however they end up, they're sure to be interesting!

# Tropical Marine Biology

Joseph Bahlman- EEB Graduate Student

On January 11<sup>th</sup> 2009, amidst a northeastern blizzard, a group consisting of ten freshmen, eight grad students, four professors, and one lawyer embarked on a journey to discover the tropics. After a long, tortuous journey involving canceled flights, icy roads, early mornings, a slumber party at the Bertness house, and a bus that broke down every 20 minutes in the middle of the jungle, the group arrived safely at the Blue Creek Rainforest Station in southwestern Belize.

The intimacy with nature began as soon as they arrived. The group went on night hikes viewing many of the nocturnal arthropods, especially the big spiders. And they put that knowledge to good use, finding and removing tarantulas from their dormitories. One of the biggest educational advantages of the Blue Creek station is that the students not only learn about the local flora and fauna, but also how the native people interact with the organisms. The group took ethnobotany hikes with local guides, not only to learn the names of different plants but also what plants were edible, medicinal, or useful building materials. The rainforest experience culminated in a mile swim through

a cave. Yes, the group swam up river, through grand and tiny caverns, climbing waterfalls when necessary, and all lit only by their headlamps. The experience was breathtaking (literally for some-good thing we had life jackets!).

The second part of the trip transitioned from natural history lessons to hard-core experimental science. The experiments took place on the island paradise of Southwater Caye. Although you can walk from one end to the other in less than 10 minutes, the island is rich in marine habitats.



Around different points of the island, one finds coral reefs, cobbles, seagrass beds, sandy substrates, and mangroves. All the freshmen were eager to get some hands-on experience. The first project was assigned to the freshman, in which they compared the herbivory pressure across the different habitats. Using these initial observations, the students then developed their own questions and hypotheses, and designed experiments to test them. They measured the carnivory rates across the different habitats, and

compared them to the herbivory rates. They also looked at whether or not sea grass encrusted with organisms provided an advantage in deterring consumers. All the while, the grad students provided help and inspiration; performing their own exciting experiments on hermit crab psychology, fish predation, and the locomotion of echinoderms. The research culminated with a mini-conference, allowing all the students to present their results. (Rather than my telling you their results you should ask them. The freshmen, now being budding scientists, love to talk about their research!)

In celebration of the end of the trip, and finally some real sunshine, the entire group went snorkeling out on the barrier reef. For over two hours they saw monuments of coral, giant rays, menacing urchins, and fish of every color. Overall, the trip was an entertaining and educational success, where ten freshmen got unique hands on field research and perspectives that will influence the rest of their careers.



# 2009 Spring Seminars

Brown Bag seminars usually catch up on research and work in progress within EEB, and the more formal colloquium series features speakers from outside the University.

## Brown Bag Seminars

- JAN 30** **Robert Kambic**, Graduate Student. Dinosaur foot fetish: multivariate analysis of avian and non-avian theropod pedal phalanges.
- FEB 6** **Matthew Heard**, Graduate Student. You better Belize it!
- FEB 13** **Daniel Bisaccio**, Director of Science, Department of Education. HabitatNet: A global biological diversity project.
- FEB 20** **Lindsay Brin**, Graduate Student. Estuaries in flux: coastal nitrogen cycling in the face of anthropogenic and environmental change.
- FEB 27** **Andrew Altieri**, Postdoctoral Research Associate. Allies, enemies, and the invasion of New England beaches.
- MAR 6** **Jonathan Waage**, Professor. Turning waste water into recreation - Florida style or how to justify showing lots of bird pictures for Doug.
- MAR 13** **Jorn Cheney**, Graduate Student. A comparison of the adhesive capabilities of five species of Gekkonidae.
- MAR 20** **Nicholas Gidmark**, Graduate Student. On the mechanical significance of a derived snout morphology: new bones to pick in a fish skull.
- APR 3** **Joshua Idjadi**, Visiting Faculty. Keeping your friends far and your enemies farther: the role of spatial arrangement in promoting coral species diversity.
- APR 10** **Stephen Porder**, Assistant Professor. Mountains and dust: determining the age of the world's ecosystems.
- APR 17** **Gregory Sawicki**, Postdoctoral Research Associate. Neuromotor control of compliant muscle-tendon during cyclic contractions: implications for steady-speed terrestrial locomotion.

## Monday Colloquia

- FEB 2** **Jason Neff**, University of Colorado, Boulder. Manifest Dust: a history of land use change, wind erosion and dust deposition in the western U.S.
- FEB 9** **Gunter Wagner**, Yale University. Genetics and the origin of mammals: transposable elements and transcription factor evolution.
- FEB 23** **Jonathan Levine '95**, University of California, Santa Barbara. Niche and neutral controls over coexistence among annual plants.
- MAR 2** **Craig Packer**, University of Minnesota. Science, poverty and lion conservation in Africa.
- MAR 9** **Ann Burke**, Wesleyan University. Evolutionary morphology in the 21st century.
- MAR 16** **Carl Zimmer**, Science writer & contributor for the New York Times. Science meets talk.
- MAR 30** **Michael Benton**, University of Bristol. Investigating evolutionary radiations.
- APR 6** **Gonzalo Giribet**, Harvard University. Elucidating global biogeographical patterns of terrestrial animals: examples from arthropods and related animals.
- APR 13** **Douglas Altshuler**, University of California, Riverside. Biomechanics and neural control of flight through the lens of evolution.
- APR 20** **Chris Harley '94**, University of British Columbia. Global warming, ocean acidification and the ecology of rocky shores.
- APR 27** **Mike Alfaro**, University of California, Los Angeles. Integrating fossils, trees and taxonomy in macroevolutionary studies.
- MAY 4** **Charles Davis**, Harvard University. Insights from the flowering plant Tree of Life: from climate change to horizontal gene transfer.
- MAY 11** **William Bradshaw**, University of Oregon. Evolutionary response to rapid climate change: you snooze, you lose.

# New Publications



**Altieri, A. H.** 2008. Dead zones enhance key fisheries species by providing predation refuge. *Ecology* 89:2808-2818.

Bassarova, M., **C. M. Janis** & M. Archer 2009. The calcaneum – on the heel of marsupial locomotion. *Journal of Mammalian Evolution* 16:1-23.

**Bromberg Gedan, K., C.M. Crain & M.D. Bertness.** 2009. Small mammal herbivore control of secondary succession in New England tidal marshes. *Ecology* 90: 430-440.

**Bromberg Gedan, K., B.R. Silliman & M. D. Bertness.** 2009. Centuries of human-driven change in salt marsh ecosystems. *Annual Reviews of Marine Science* 1: 117-141.

Farina JM, BR Silliman & **MD Bertness.** Can conservation biologists rely on established community structure rules to manage novel systems? ... Not in salt marshes. *Ecological Applications* 19:413-422.

**Gedan, K.B.** & B.R. Silliman. 2009. Using Facilitation theory to enhance mangrove restoration. *Ambio* 38: 109.

Germer, S., C. Neill, T. Vetter, **J. Chaves,** A. V. Krusche & H. Elsenbeer. 2009. Implications of long-term land-use change for the hydrology and solute budgets of small catchments in Amazonia. *Journal of Hydrology* 364:349-363.

Hopkins, R., **J. Schmitt** & J.R. Stinchcombe. 2008. A latitudinal cline and response to vernalization in leaf angle and morphology in *Arabidopsis thaliana* (Brassicaceae). *New Phytologist* 179: 155-164.

Howarth, R.W., S. Bringezu, L. Martinelli, R. Santoro, D. Messem, & **O. E. Sala.** 2009. Introduction: Biofuels and the environment in the 21st Century. Pp. 15-36 in R. W. Howarth & S. Bringezu, eds. *Biofuels: environmental consequences and interactions with changing land use.* Cornell University Press, Ithaca.

**Janis, C. M.** 2009. Artiodactyl 'success' over perissodactyls in the late Palaeogene unlikely to be related to the carotid rete: a commentary on Mitchell & Lust (2008). *Biology Letters* 5: 97-98.

**Janis, C.** 2009. Mammals. Pp. 704-709. in M. Ruse & J. Travis eds. *Evolution: the first four billion years.* Harvard University Press, Cambridge, MA.

Jenkins, F.A., Jr., N.H. Shubin, **S.M. Gatesy** & A. Warren. 2008. *Gerrothorax pulcherrimus* from the Upper Triassic Fleming Fjord Formation of East Greenland and a reassessment of the contribution of head lifting to feeding in temnospondyls. *Journal of Vertebrate Paleontology* 28: 935-950.

**Knies JL,** JG Kingsolver & CL Burch. 2009. Hotter is better and broader: Adaptation to higher temperatures results in greater maximum intrinsic growth rate and broader temperature ranges in a natural phage population. *American Naturalist* 173: 419-430.

Kunz T.H., S. A. Gauthreaux, Jr, **N. I. Hristov,** J. W. Horn, G. Jones, E. K. V. Kalko, R. P. Larkin, G. F. McCracken, **S. M. Swartz,** R. B. Srygley, R. Dudley, J. K. Westbrook, & M. Wikelski. 2008. Aeroecology: probing and modeling the aerosphere. *Integrative and Comparative Biology*. 48: 1-11.

Lauenroth, W. K., D. G. Milchunas, **O.E. Sala,** I. Burke & J. A. Morgan. 2008. Net primary production in the shortgrass steppe. Pp. 270-305 in W. K. Lauenroth & I. Burke, eds. *Ecology of the shortgrass steppe.* Oxford University Press, Oxford.

McGeoch, L., I. Gordon & **J. Schmitt.** 2008. Impacts of land use, anthropogenic disturbance, and harvesting on a medicinal liana, *Mondia whytei*, in Kakamega Forest, Kenya. *Biological Conservation* 141:2218-2229.

**Morse, D. H.** 2009. Post-reproductive changes in female crab spiders (*Misumena vatia*) exposed to a rich prey source. *Journal of Arachnology* 37:72-77.

**Morse, D. H.** 2009. Four-level interactions: herbivore use of ferns and consequent parasitoid hyperparasitoid performance. *Ecological Entomology* 34:246-253.

**Ogburn, R.M. & E.J. Edwards.** 2009. Anatomical variation in Cactaceae and relatives: trait-lability and evolutionary innovation. *American Journal of Botany* 96: 391-408.

Ojima, D., C. Field, P. Leadley, **O. E. Sala,** D. Messem, J. Petersen, J. Born, L. VanWey, & M. Wright. 2009. Mitigation strategies: biofuel development considerations to minimize impacts on the socio-environmental system. Pp. 287-302 in R. W. Howarth & S. Bringezu, eds. *Biofuels: environmental consequences and interactions with changing land use.* Cornell University Press, Ithaca.

**Porder, S.** & O.A. Chadwick. 2009. Climate and soil-age constraints on nutrient uplift and retention by plants. *Ecology* 90: 623-636.

**Porder, S.,** A. Bento, A. Leip, L.A. Martinelli, J. Samseth & T. Simpson. 2009. Toward an integrated assessment of biofuel technologies. Pp. 227 – 242 in R.W. Howarth & S. Bringezu eds. *Biofuels: environmental consequences and interactions with Changing land use.* Cornell University Press, Ithaca.

**Riskin, D. K., J. W. Bahlman,** T. Y. Hubel, J. M. Ratcliffe, T. H. Kunz & **S. M. Swartz.** 2009. Bats go head-under-heels: the biomechanics of landing on a ceiling. *Journal of Experimental Biology*. 212:945-953.

**Sala, O. E., D. Sax & H. Leslie.** 2009. Biodiversity consequences of increased biofuel production. Pp. 127-137 in R. W. Howarth & S. Bringezu, eds. *Biofuels: environmental consequences and interactions with changing land Use.* Cornell University Press, Ithaca, NY.

**Swartz, S. M.** & K.M. Middleton. 2007. Biomechanics of the bat limb skeleton: Scaling, material properties and mechanics. *Cells Tissues Organs* 187:59-84.

**Swartz, S. M.,** D.J. Willis & K. S. Breuer. 2008. Aeromechanics in aeroecology: flight biology in the aerosphere. *Integrative and Comparative Biology* 48: 85-98.

Von Wettberg, E.J., D.L. Remington & **J. Schmitt.** 2008. Partitioning adaptive variation across a patchy landscape: shade avoidance traits in *Impatiens capensis*. *Evolution* 62:654-667.

Waldman, R. M., A. Song, **D. K. Riskin,** **S. M. Swartz** & K. S. Breuer. 2008. Aerodynamic behavior of compliant membranes as related to bat flight. *American Institute of Aeronautics and Astronautics Journal: AIAA* no. 2008-3716.

**Wilczek, A.,** J. Roe, M. Knapp, **M. Cooper,** C.M. Lopez-Gallego, L. Martin, C. Muir, S. Sim, A. Walker, J. Anderson, J.F. Egan, B. Moyers, R. Petipas, A. Giakountis, E. Charbit, G. Coupland, S.M. Welch & **J. Schmitt.** 2009. Effects of genetic perturbation on seasonal life history plasticity. *Science* 323:930-934.



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