THE UNIVERSITY OF ARIZONA®

Desert News and Views:

An EEB Alumni Newsletter

ECOLOGY & EVOLUTIONARY BIOLOGY

Issue 2, Winter 2004

Graduate student Katy Prudic shot this photo of the Arizona Sister (*Adelpha brewdowii eulalia)* while chasing butterflies in the Pinaleno Mountains. The species is a common resident of oak woodlands and riparian corridors throughout Arizona.

With this newsletter we hope to build a better EEB community through improved communication about our program and mission. Founded in 1975, EEB was the first department of its kind in the world and our way of studying biology is increasingly being used as a model for the organization of biology at universities. We have grown into one of the leading EEB programs in the world and our goal is to maintain our excellence both in terms of research and in terms of undergraduate and graduate education.

Our teaching and research missions are mutually supportive; good teachers must be good learners and research is how we learn. We study the diversity of life in an integrative ecological and evolutionary framework, considering all levels in the biological hierarchy, including genes, cells, organisms, populations, communities and whole ecosystems. Our methods involve mathematical and computer models, lab work, field work, comparative analyses, and the use of museums and collections.

We study a range of habitats, including deserts (especially the local Sonoran desert), oceans, islands, and mountains. We also study a range of taxonomic groups, including microbes, protists, fungi, plants, and animals. Our program is organized around the core areas of genetics and ecology in an evolutionary context, but we are a diverse group and appreciate diverse approaches to biological problems.

Creative and vibrant faculty are the best way to build a program and we have welcomed a number of them into the department in recent years, including Regis Ferriere, Carlos Machado, John Pepper and Michael Worobey, all featured in this newsletter.

Our graduate students continue to amaze us. Past graduate students occupy key positions in EEB science around the country and are making fundamental contributions to the field. In our current students, through their many accomplishments and awards, we can see a bright future for EEB. In this newsletter we feature Asher Cutter and Jake Russell for receiving the Hoshaw Award.

We are supported in our mission by a talented and eager staff. This month we feature in Multiple Loci another side of Kate Riley, the EEB Business Manager. We also introduce the Winfree Memorial Lecture series in honor of Art Winfree, whose untimely death stunned us several years ago. We still miss him. We also feature in this issue the Conservation Internship and the CATTS fellowship.

These are just a few of the many things that have been going on. As you can see it is an exciting time to be in EEB. I hope this newsletter will serve EEB by expanding and better integrating our diverse community. If you have suggestions for the content and format of this newsletter, please let us know.

-Rick Michod, Department Head

Desert News and Views

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We welcome your input for future issues.
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Hoshaw Award

Two Hoshaw Award Winners this year: Asher Cutter and Jake Russell

Asher Cutter

Reproduction is the primary metric of organismal fitness and, therefore, understanding variation in the mode of reproduction and its effects within and among species is a central theme in evolutionary biology.

The continuing debate over the issue of the origin and maintenance of sexual reproduction attests to the difficulty of fully describing the features involved in the evolution of breeding systems. Different modes of reproduction are expected to perturb population genetic patterns in evolutionarily important ways, so genomic comparisons among organisms that vary in breeding system afford us the opportunity to test predictions from theory.

My research into these issues has concentrated on the nematode *Caenorhabditis elegans* and its relatives as a model by integrating computational, theoretical and experimental approaches. The *C. elegans* breeding system populations are composed of self-fertilizing hermaphrodites and rare outcrossing males, and provide a powerful system for informing our understanding of the evolution of traits relevant to behavior, physiology and ecology.

Asher Cutter

My research has contributed to these issues by (1) evaluating the potential role of deleterious mutations as a force contributing to breeding system evolution through experimental and bioinformatic approaches, (2) describing the meiotic and behavioral factors that control the amount of outcrossing in nematodes, and (3) inferring general features about the process of natural selection from genomic patterns of genetic variation.

About the Hoshaw Award.....

The Hoshaw Memorial Award was established in memory of Robert W. Hoshaw, a longtime EEB faculty member. The Hoshaw family established this award to recognize EEB graduate students that demonstrate excellence in their field. Students are nominated for this award based on their academic record and their potential contribution to the field of ecology and evolutionary biology. Preference is given to those students who show excellence in a particular undertaking, such as outstanding performance in preliminary exams, publishing a manuscript, or preparing a paper for a national or international conference.

Jake Russell

My interests lie in the ecology and evolution of symbiotic interactions. I am currently using aphids and some of their bacterial symbionts as a model to address several questions:

1. *What are the coevolutionary histories of the interactions between aphids and their secondary symbionts (i.e. those not required for aphid growth or reproduction)?* Phylogenetic analyses suggest that these symbionts have jumped between host species on a number of occasions, with little evidence for long-term persistence in a single host lineage.

2. *What factors play a role in shaping the host ranges of secondary symbionts of aphids?* My data suggest that the efficiency of symbiont transmission as well as the effects of symbionts on host fitness may be significant. Interestingly, some symbionts appear capable of persisting in multiple host species, suggesting that they are generalists to some extent.

3. *How are secondary symbionts maintained within host populations?* I have examined the fitness effects of symbionts on their aphid hosts. My data suggest that several of these bacteria have rather negligible effects on host fitness at permissive temperatures, but may confer benefits under hotter conditions. These benefits likely play a role in maintaining symbiont-infected individuals within aphid populations.

Jake Russell

4. *How might secondary symbionts benefit their aphid hosts?* Given previous findings suggesting that secondaries can supplement the function of *Buchnera*, the obligate symbiont of aphids, I have attempted to partially describe the genomic coding capacity of several of these microbes. My results indicate that some secondary symbionts of aphids possess genes involved in the synthesis of essential amino acids. This may be important for the aphid hosts, which typically rely on *Buchnera* for the synthesis of amino acids. Thus, we have identified a possible mechanism by which secondary symbionts can supplement *Buchnera* function.

Profiles of New Faculty

Regis Ferrière

Regis Ferrière

Regis joined the EEB faculty as an Associate Professor in January 2002

The week of April 1992 changed my life. Steve Stearns was chairing a Jacques Monod conference on life-history evolution. The cream of evolutionary biologists worldwide had been invited. Robert Barbault, the head of the Ecology department in Paris (where I had started my PhD studies a few years earlier) was expected there, but he could not make it. His collaborator could not replace him; he was already committed elsewhere.

Barbault eventually proposed that Stearns take me on board; I had a couple of published papers on life-history evolution in non-equilibrium populations, and perhaps a few decent things to tell this honorable assembly.

No question, I felt honored by the invitation. But the timing was bad for me, too. I had spent the year training for one of the most difficult degrees you can take in a French university: the so-called aggregation of mathematics, a kind of certification of broad expertise in the field. The written part of the exam (three 6-hour tests on three consecutive days) was scheduled that very week, Tuesday to Thursday! Dr. Stearns would have to comply with a couple of requests…that I would attend just one day of the conference (whereas it was mandatory for participants to be present for the whole week), and consequently that my talk be scheduled on that day. What an arrogant frog! It was a tight squeeze, though: I would have to leave the last exam early, and rush to the station to catch the last TGV to reach the conference, in a secluded village in the Alps.

I guess people liked my talk, in spite of some fierce questions from the chairman that I handled with a degree of calm which, I think, mostly reflected how tired I was…anyway, Rick Michod liked it. In my work, I had run across Michod's 1978 influential paper on life-history evolution several times. And there he was.

Rick, affiliated with EEB for a number of years already, had just been awarded a substantial NIH grant to work on kin selection and the evolution of sex, and was chasing potential PhD students and postdocs to fill up his lab. He encouraged me to apply right away. A few months later, I knew I was one of the happy few to be accepted.

I tremendously enjoyed my two-year stay at EEB, working with Rick and his lab crew, in the fabulous intellectual environment set by the other faculty members, and the friendly atmosphere created by a most dedicated staff.

In 1995 I returned to Paris, where I became professor of mathematical ecology two years ago. Simultaneously, a half-time position opened at EEB. This time, no chance, no hassles for me to apply! Nowadays, I share my time between the Ecole Normale Superieure in Paris (where I lead the group of Mathematical Evolutionary Biology) and UA in Tucson. A great life…

Many reasons could have brought me to Arizona anyway. A strong taste for mineralogy and copper species. A passion for astronomy and astrophysics. A deep interest in bees and wasps and their pollination services, and in desert plants and fungi...or an irrepressible attraction for roads with unlimited horizons to ride my bike…in the Sonoran, I feel like I'm in heaven.

But it was the great science done at EEB that got me here. My research focuses on the adaptive evolution of cooperation and mutualisms, mathematical approaches to the notion of fitness, models of speciation, and evolutionary conservation biology. Also this year, I will chair the EEB committee for admissions to our graduate studies. I shall do my best to convince our prospects of what I feel is obvious: that EEB in Tucson is one of the greatest places worldwide to develop the science of ecology and evolution! Hopefully they won't find me either too arrogant or too froggy.

Carlos Machado

Carlos joined the EEB faculty as an Assistant Professor in January 2003.

I am an evolutionary biologist interested in understanding how genetic variation is generated and maintained in natural populations, and in how that variation is transformed into adaptive divergence and phylogenetic diversity.

I grew up in Santiago, Chile, and in Medellín and Bogotá, Colombia. Despite growing up in large cities I was exposed to the natural richness of Colombia from an early age, spending several months a year in a small town in the countryside where my parents had grown up. The town is located in a transition zone between the western Andean mountain range and the Chocó region, one of the wettest places in the world, and was thus suited for exploring a diverse array of ecosystems (from paramo to rain forest). My most memorable field and hiking trips happened at that time. Although my love for biological diversity started back then, I only became seriously interested in biology by the time I had to choose what to study in college.

Profiles of New Faculty

Carlos Machado

I did my undergraduate work at the Universidad Nacional de Colombia in Bogotá, where I had "old-fashioned" biology training, with extensive courses in taxonomy, systematics, morphology, physiology, descriptive ecology, and few courses in genetics.

For my bachelor's thesis, I decided to try something different and tested the waters working in a molecular parasitology laboratory on the molecular biology of *Plasmodium falciparum*, the agent of malaria. After realizing that hard-core molecular biology was not for me, I was truly resolved to become an evolutionary biologist, and decided to explore options abroad.

After finishing college, I went to work as a research assistant at the Smithsonian Tropical Research Institute (STRI) in Panamá in the lab of Eldredge Bermingham. I initially worked on the phylogeography of tropical coral reef fishes, but later initiated molecular phylogenetic studies in figs and fig wasps in collaboration with Allen Herre, who introduced me to this extraordinary mutualism, which constitutes a major subject of my current research.

After working at STRI, I came to the U.S. to enroll in a PhD program at the University of California at Irvine, working in the lab of Francisco Ayala. For my PhD I conducted work on the molecular natural history of fig wasps, as well as a molecular evolution study in *Trypanosoma cruzi*, the parasite that causes Chagas disease in Latin America.

For my postdoc (with Jody Hey, Rutgers University) I used empirical and theoretical tools to test models of speciation and infer the history of three recently diverged species of a classic group of *Drosophila (D. pseudoobscura, D. persimilis* and *D. p. bogotana*) using multilocus sequence data. In my last year of postdoctoral training I started developing genomic resources (microarrays) to study the evolution of gene expression differences and the genetic basis of hybrid dysfunction in these species of *Drosophila*. These studies constitute a major focus of current research in my lab.

In addition, I have continued studying the fig/fig wasp mutualism. Current work and interests in this system include studying the population genetic consequences of evolution in highly subdivided populations, the fitness effects of *Wolbachia* infections in fig wasps, the evolution of parasitic non-pollinating fig wasps, and the extent of cospeciation in Neotropical figs and their pollinators.

John Pepper

John joined the EEB faculty as an Assistant Professor in August 2003.

My love of the natural world was nurtured by a family of committed bird-banders and backpackers. As a young boy, I crammed twenty snakes and various sundry creatures into my bedroom and took my volunteer position at the zoo very seriously. On the other hand, school was not a good fit for me and I left high school as soon as I could. However, my first job selling encyclopedias was not much fun and I quickly lost interest in cleaning up at the local movie theater despite the free shows. So I went back to college. Although I completed a degree in computer science, I found myself working as an assistant field biologist in California and then as a lab technician at Stanford sequencing DNA before it became obvious to me I should combine my interests with an academic career in biology. My daughter Delia has inherited the family interests in critters and we enjoy capturing and studying reptiles and insects.

During my graduate studies, I studied creatures including beetles, intertidal limpets, naked mole-rats, chimpanzees, dolphins, and parrots, culminating in a PhD thesis on the behavioral ecology of the Glossy Black Cockatoo (an endemic parrot) on Kangaroo Island in Australia. A short way into my thesis field work, I realized that I was, in fact, studying the demise of the Glossy Black Cockatoo and felt compelled to prepare a population recovery plan, which was funded by the Australian federal government for $1 million. Today, the cockatoos are recovering steadily.

While continuing to study the social behavior of dolphins and parrots, I've also recently taken up studies in evolutionary theory using both mathematical and computer models. My current research

John Pepper

focuses on the dynamics of multilevel selection, or systems in which natural selection acts simultaneously at more than one level in a biological hierarchy.

Multilevel selection theory can be a useful tool for studying the evolution of any trait involving cooperation or conflict. I typically study multilevel selection using agent-based computer models to generate the dynamics of interest, and mathematical models to analyze and interpret those dynamics. In addition to refining multilevel selection theory, I am also working on applying it to several specific problems. Some examples of current problems are:

1. *What are the evolutionary dynamics of cancer?*
In collaboration with Carlo Maley at the Fred Hutchinson Cancer Research Center in Seattle, I am using computer models to investigate the interplay between two levels of selection – the gradual accumulation of somatic cell mutations during an individual's lifetime, and the selection of developmental patterns among individuals that limit the potential for harmful somatic evolution.

2. *How do genetic systems evolve to become more evolvable?*
I am interested in the issue of "evolvability", or why some systems readily evolve adaptation while others do not and whether living organisms' proficiency at adaptation may itself have evolved. Results from computational models show that linkage patterns affect how well a population can adapt. More importantly, they also show that over long time scales evolution can reorganize chromosomes into a more evolvable architecture.

3. *How can cooperation evolve among unrelated organisms?*
Most existing theory for the evolution of cooperation involves either kin selection or reciprocal altruism. In nature though, cooperation is common among unrelated organisms with little or none of the cognitive ability required for reciprocal altruism to operate. Together with several collaborators, I am studying a mechanism for the evolution of cooperation under such conditions, in which feedback between an altruistic behavior and the local quality of a structured environment leads to spatial clustering of cooperators. Results from computer and mathematical models suggest that this could be a fairly general mechanism for the evolution of cooperation in nature.

In the future I am also interested in returning to the field to study Arizona's thick-billed parrot and am hoping to recruit some colleagues from our old field site in Western Australia to resume our research on acoustic communication in bottlenose dolphins at what we might dub the "Sonoran Dolphin Research Center"!

Michael Worobey

Michael Worobey

Michael joined the EEB faculty as an Assistant Professor in August 2003.

I'm a biologist with an interest in the evolution of viruses, particularly rapidly evolving RNA viruses like HIV and influenza. I use the tool kit of molecular phylogenetics to investigate basic questions about how different viruses evolve, and to make inferences from viral gene trees about such things as when, where, and how particular lineages crossed into the human population, and how some viruses manage to stay one step ahead of their hosts in a relentless evolutionary arms race.

Although much of my research is driven by empirical questions about specific viruses, a good portion of my work does involve using viral data as convenient and powerful means to study evolution in a broader context. The processes that shape the evolution of viruses are surprisingly similar to those that act in higher organisms, and often the signal of interest is so much louder and clearer in viral populations that it pays to give them a close look. You're rarely at a loss for a polymorphic site in the world of RNA viruses.

I studied biology as an undergraduate at Simon Fraser University in Burnaby, BC, breaking up the academic year with four months of forest-fire fighting each summer. At SFU, I applied for a job in Bernie Crespi's lab and got a good grounding in phylogenetics with a project (which formed my Honors thesis) that showed how the morphology of the galls of Australian thrips tracks the phylogeny of the insects.

From SFU I moved on to the Department of Zoology at the University of Oxford on a Rhodes scholarship, landing in Paul Harvey's group. At this point I set off in a new direction, combining my interest in phylogenetics, an active research area in the department, with the study of infectious disease, another Oxford specialty. Eddie Holmes took me under his wing and together we set about showing that dengue virus, which was supposed to be a paragon of clonality, in fact sometimes undergoes recombination.

This empirical finding opened up a host of questions about the role of recombination in viral evolution, and I spent much of my time as a graduate student investigating these questions in one way or another. My DPhil thesis includes several empirical investigations of recombination in viruses such as dengue and HIV, as well some theoretical and methodological work developing new recombination detection tests and exploring how failing to account for recombination can bias phylogenetic inference.

In 2000, I violated the prime directive of the Harvey group and started collecting my own data. Bill Hamilton and I shared a common interest in the origins of HIV, and he asked me to accompany him to the Democratic Republic of the Congo to collect specimens from wild

chimpanzees there who might harbor viruses related to HIV. I have now established a solid research program there to study SIV, HIV, and other viruses on their home turf. My lab here in EEB will be equipped for working with level 1, 2, and 3 pathogens, and I'm looking forward to turning on the fieldwork-labwork-computation pipeline.

In the meantime, some of the questions I'm investigating in an overall phylogenetic framework include: (1) What facilitates cross-species transmission to human populations of viruses like HIV-2 from West African monkeys, HIV-1 from chimpanzees, or influenza from birds? (2) Can relatively "ancient" genetic material help solve the riddle of RNA virus origins by reconciling the apparently fast rate of evolution in many groups with patterns of co-divergence with hosts that suggest much deeper evolutionary roots? (3) How can molecular phylogenetics inference improve HIV vaccine development?

Winfree Memorial Lecture Series

Art Winfree left a powerful legacy of highly creative mathematical modeling and outstanding and innovative teaching. To both celebrate and continue this legacy, the Department of Ecology and Evolutionary Biology and the Graduate Program on Applied Mathematics have jointly funded the Winfree Memorial lecture, starting in the Spring of 2004. Each year an outstanding speaker at the interface of biology and mathematics will be hosted, with the host department rotating in adjacent years between EEB and Applied math.

We are especially pleased that the inaugural Winfree speaker, hosted by Applied mathematics, is Art's Son, Erik Winfree from Caltech. Erik and Art are the only father-son pair to have jointly held McArthur Awards at the same time. Erik works on a variety of problems at the interface of molecular biology and biocomputing.

-Bruce Walsh

Multiple Loci

Many of us have interests and talents completely outside of the lab and the field. This new column will allow a glimpse at other facets of our faculty and students. This second contribution was written by Emily Langdorf about Kate Riley, our outstanding Business Manager.

When you walk into our EEB business manager's office, you will find Kate Riley amidst piles of proposals, grants, and financial reports. You can hardly imagine she has time for anything unrelated to maintaining the efficiency of the department yet you may catch sight of a violin in the corner of that same office, an inconspicuous indicator of Kate's extensive musical background.

Kate Riley

Kate's love and appreciation for music were cultivated at a young age. Her earliest musical memories center around her mother's Steinway grand. As soon as she could climb up on the piano bench, she was playing. As Kate grew, so did her talent. She accompanied for both church services and school choirs and took one of the Bach two-part inventions to contest when she was in high school. However, Kate was always in competition with her mother's students for quality time on the piano, and so, at age 9, Kate began to study the violin.

Kate's dedication to the violin has allowed her to participate in numerous ensembles in addition to her school orchestras. Kate was accepted into the Columbus Symphony Youth Orchestra and had the opportunity to tour with the group several times. During this same period, she formed a string trio, *Les Trois*, with two other high school friends and "turned professional." Playing outside in the snow with gloves on for a wedding reception soon ended that promising career!

Kate's participation in ensembles continues today. She manages to find time in her busy schedule to play with The Foothills Phil, a quintet at Rancho Vistoso. Recently, she hammed it up for a benefit with a violin duet adaptation of Joplin's "The Entertainer," and participated in the annual performance of the holiday classic, Handel's "Messiah."

And if piano and violin weren't impressive enough, Kate is also an avid singer. Her chorus experience began early. In middle school, she performed in the hit musical "Hello Dolly" as the front end of the dancing horse (she is quick to reiterate that "it was the front end of the horse!").

Kate continued to sing through college with the Ohio State University Chorus and currently sings with the UA University Community Chorus and the Tucson Masterworks Chorale. Her highlight vocal experience occurred just this May when she and several other members of TMC were invited to perform two Jackson Berkey works as part of a larger ensemble at New York City's Carnegie Hall. As the saying goes, "if you haven't played it, you haven't made it."

Clearly, music is a central part of Kate's life and means a great deal to her. She has made the comment that without her music, she couldn't be the person she is. Music grounds her but also allows for a creative escape from the daily routine. While she once considered a professional career in music, she quickly came to the conclusion that she loved that part of her life far too much to allow it to become little more than a paycheck. So, as long as the fingers are moving and the voice is willing, she will be found contributing to the local musical community.

Outreach News

Conservation Biology Internship

Conservation Interns in action

Students want to save the world. When they start college, they are drawn to the life sciences because of a passion for conservation. Since 1998, the Conservation Biology Internship Program (CBIP), led by Robert Robichaux and Cheryl Craddock, and funded by the National Science Foundation, has capitalized on this creative and intellectual energy to provide students with an enriched academic experience for undergraduates.

It has been clear for over 100 years that to educate students to be scientists, students must do science. But how can you do this with conservation biology, which is a mixture of basic and applied science? Conservation biology combines academic fields such as genetics, ecology, ecosystems science, and ecophysiology. But conservation takes place in a social context, responding to the needs of a variety of stakeholders. Conservation biology is thus the purview of academe, government and non-government agencies, which don't necessarily do a good job talking to each other. CBIP provides students with conservation biology research experience by bridging this gap.

In CBIP, students benefit from two mentoring scientists, one from the University of Arizona and the other from an organization or agency with conservation goals (such as The Nature Conservancy, Saguaro National Park, and Fort Huachuca). Students have the opportunity to conduct paid, supervised, independent research on questions with a direct bearing on management or conservation issues. For example, one student, working with the Arboretum at Flagstaff, investigated whether increased fuel load during prescribed burns would cause heat to penetrate at depth to eradicate smooth brome, a noxious weed.

Rather than disconnect the research from course work, in CBIP, students also take seminars book-ending their summer research project. During these seminars, students review the primary literature, discuss experimental design, analyze data, and write up their results. Students present their results at a fall CBIP symposium. This fall, we will learn the results of research as varied as whether the Huachuca Springtail should be federally listed to the efficacy of using DNA derived from scat to survey mammalian populations in Tucson Mountain Park.

Does it sound a little like graduate school? One CBIP alumni, while working with Zion National Park this summer, excitedly described how she was able to discuss science with the seasoned biologists. Not bad for an undergraduate returning for her senior year.

At this writing, we are recruiting for next year's cohort. At the top of our flier it reads, "Want to save the world?" It could just as easily read, "This is why you came to school in the first place."

- Cheryl Craddock

The CATTS Fellowship

CATTS (Collaboration to Advance Teaching Science and Technology) is a partnership between the University of Arizona and local K-12 schools that aims to enrich teaching in science, technology and math.

The NSF-funded program provides graduate and undergraduate fellowships that partner students with local teachers during the school year. Students prepare for their fellowship with training in inquiry-based teaching techniques, then follow up with actual classroom experience. CATTS hopes that these experiences will foster a career-long commitment to science outreach.

The CATTS program has funded a number of current and past EEB graduate students. Along with working directly in classrooms, fellows participate in diverse outreach activities, including arranging on-campus visits to research labs and exhibits, judging science fairs, and individual mentoring of older students that show a strong interest in science.

Keep us posted:

Name _____ Other degrees _____

Change of address? (Circle which you prefer as a mailing address)

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_____	_____
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e-mail _____	

Employer and job Title _____

New job? Married? Kids? Take a trip? Retired? See a classmate? Send us your news for future newsletters:

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In future issues, we will use this space to report on additional alumni, faculty, and graduate student news.

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