Miller Institute News

The Miller Institute is "dedicated to the encouragement of creative thought and the conduct of research and investigation in the field of pure science and investigation in the field of applied science in so far as such research and investigation are deemed by the Advisory Board to offer a promising approach to fundamental problems."

Miller Fellow Focus: Anne Pringle

"Understanding the evolution of mutualism: parasitism, migration, and the ecology of sex"

Mutualisms are cooperative associations between individuals of different species. A common mutualism is the association between plants and arbuscular mycorrhizal (AM) fungi; in this mutualism the plant trades photosynthetically derived carbon for phosphorous. Mutualisms involve apparently altruistic behaviors and for this reason are difficult to relate to paradigms of ecology and evolution. (Sir Robert May dismissed the associations as "orgies of mutual benefaction".) But mutualisms involve costs as well as benefits, and a current view of mutualisms posits that these associations are reciprocal exploitations, in which costs are usually less then benefits. However, in some cases costs can be greater than benefits, because an individual may abuse a mutualism; in these cases mutualism becomes parasitism. How do mutualisms persist in the face of these "cheaters", or parasites?

I have collected data on the costs and benefits exchanged between plants and AM fungi, and also between plants and nitrogen-fixing bacteria, in collaboration with Jim Bever (Indiana University) and Ellen Simms (UC Berkeley). In the second mutualism carbon is shunted to bacteria that capture nitrogen from the atmosphere for plants. In both cases I found that benefits were correlated, so that plants that grew well were associated with fungi or bacteria that also grew well. Plants that grew poorly were associated with fungi or bacteria that grew poorly. The correlation suggests that cheating is a poor strategy, as individuals derive a benefit that is proportional to the investment made in a mutualism, and may help to explain why mutualisms are successful in spite of cheating.

Mutualisms are often symbioses between plants and microbes, including fungi. Fungi are perceived as intractable laboratory organisms, and this is a barrier to the understanding of mutualism. For example, although measures of fitness are a common currency of comparative biology, there are no standard measures of fungal fitness. Without an understanding of fitness, hypotheses about the adaptive significance of phenotypes or basic mechanisms of evolution, for example natural selection, remain speculative. In collaboration with my sponsor John Taylor (UC Berkeley, Department of Plant and Microbial Biology) I have been exploring how fungal fitness

DEADLINES TO NOTE

Miller Professorship Applications: September 23, 2002
Miller Fellow Nominations: October 3, 2002
Visiting Miller Professor Nominations:
October 7, 2002 and February 10, 2003

Continued Miller Fellow Focus: Anne Pringle

can be measured and understood. We argue that focusing on a single aspect of fitness is appropriate if that measure is chosen carefully. Choosing which aspect of fitness to measure may be facilitated by an understanding of how fitness measures are correlated. Choices may also be based on the ecology of a species, for example if a fungus is semelparous and reproduces once, or iteroparous and reproduces multiple times. This work will be published in Trends in Microbiology.

I am also interested in how organisms travel without their symbionts. Invasive species may devastate a habitat (Kudzu is a famous example of an invasive plant species), but invasive species also provide a unique opportunity to study the effects of mutualism on species dispersal. Invasive species must either carry their mutualists along or be flexible enough to associate with whatever mutualists are available in a new habitat. *Amanita phalloides*, commonly known as the death cap mushroom, is hypothesized to be an invasive species of fungus. *A. phalloides* is a mutualist of oak trees and cannot "carry" its host. Mycologists believe that it has successfully established in urban centers of California, where it may grow with native species of oak, but although it has been introduced to Australia, where there are no native species of oak, it has not established there. I am using historical records to track the migration and naturalization of *A. phalloides* in the United States and Australia, and I hope to show that invasion by *A. phalloides* is facilitated or limited by the distribution of its mutualist. Finally, thinking about how individuals travel with or without their mutualists has motivated me to explore asexual and sexual reproduction in lichens. Lichens are symbioses of fungi and either algae or cyanobacteria. Species of lichenized fungi are either asexual or sexual, and rarely both. Asexuality is hypothesized to be advantageous because asexual propagules are made up of both the fungus and alga, whereas sexual propagules are made up of the fungus, which must reestablish the symbiosis with a free-living alga upon germination. But this hypothesis assumes that free-living algae are rare. Could sexual reproduction be advantageous when algal symbionts are abundant? I am excited about exploring this and other questions related to the ecology of sex.

I am married to David Johnson, currently teaching economics at Stanford, and we have a daughter, Zoe Charlotte. We love to be outdoors, whether we are identifying lichens, building sand towers at Point Reyes National Seashore, or riding on the miniature steam train at Tilden Park.

Stephen Zatman (1971-2002)

The Miller Institute mourns the loss of our friend and colleague, Prof. Stephen Zatman, who was killed in an automobile crash on July 9. He was 30. "Stephen was one of the premier young geodynamicists in the country who had tremendous potential to be an outstanding teacher and mentor," said Raymond E. Arvidson, Chair of the Department of Earth and Planetary Sciences at Washington University, where Stephen had been on the faculty since July 2001. He earned a bachelor's with honors from Cambridge University and a master's and PhD from Harvard University. He was a Miller Fellow from 1998-2001. A funeral was held July 12, in Detroit, Mich. Zatman is survived by his wife Dana, and his daughter Molly, both of University City, Missouri.

Miller Fellowships

The Miller Institute is pleased to introduce the 2002-2005 Miller Research Fellows. These twelve Miller Fellows were awarded a three-year term, generally beginning August 1, 2002.

Astronomy	**Saurabh Jha,** (Harvard University) will be hosted by Professor Alex Filippenko
Chemistry	**YounJoon Jung,** (Massachusetts Institute of Technology) will be hosted by Professor Graham Fleming & Professor David Chandler
	Raghuveer Parthasarathy, (University of Chicago) will be hosted by Professor Jay T. Groves
Earth & Planetary Science	**Michael Zach,** (University of California, Irvine) will be hosted by Professor Jill Banfield
Electrical Engineering & Computer Sciences & Statistics	**Elchanan Mossel,** (Hebrew University, Jerusalem) will be hosted by Professor Alistair Sinclair & Professor Yuval Peres
Environmental Science, Policy, & Management	**Alison Galvani,** (University of Oxford) will be hosted by Professor Wayne Getz
Integrative Biology	**Mark Hauber,** (Cornell University) will be hosted by Professor Eileen Lacey
Mathematics	**Carlos D'Andrea,** (University of Buenos Aires, Argentina) will be hosted by Professor Bernd Sturmfels
	Elena Mantovan, (Harvard University) will be hosted by Professor Kenneth Ribet
Molecular and Cell Biology	**Stéphane Bodin,** (Paul Sabatier University, Toulouse, France) will be hosted by Professor Matthew Welch
Physics	**Huan T. Tran,** (Princeton University) will be hosted by Professor Adrian Lee
Plant & Microbial Biology	**Jeffrey Townsend,** (Harvard University) will be hosted by Professor John Taylor & Professor Louise Glass

Please refer to our website: http://socrates.berkeley.edu/~4mibrs for additional information.

Recent Publications

Miller Professor Walter Alvarez ('01-'02) published one paper during his Miller Professorship;"Geomorphological evidence bearing on the paired compressional-extensional fronts of the Northern Apennines," Eos, v. 82, p. 1247

Miller Fellow Tamás Hausel ('99-'01) published four papers during his term with the Miller Institute; "Examples of mirror partners arising from integrable systems," with M. Thaddeus, Comptes Rendus des Séances del l'Académie des Sciences. Série I. Mathématique, 333 (4) (2001) 313-318, arXiv:math.AG/0106140, "Geometric interpretation of Schwarzschild instantons," with G. Estesi, Journal of Geometry and Physics 37 (2001) 126-136 arXiv:hep-th/0003239, and "Geometric construction of new Yang-Mills instantons over Taub-NUT space," with G. Estesi, Physics Letters B514 (1-2) (2001), 189-199 arXiv:hep-th/0105118.

Miller Fellow Mark Jellinek ('99-'01) published two papers during his fellowship: "Dynamics and longevity of an initially stratified mantle," with H. M. Gonnermann and M. Manga, Geophys. Res. Lett., 29, paper number 10.1029/2002GL01485, and "The influence of interior mantle temperature on the structure of plumes: Heads for Venus, Tails for the Earth," with A. Lenardic and M. Manga, Geophys. Res. Lett., 29, paper number 10.1029/2001GL014624.

Miller Fellow Thomas Juenger ('99-'01) published five papers during his term: "Genotype-by-environment interaction for fitness and the spatial scale of selective heterogeneity in *Ipomopsis laxiflora*," with J. Bergelson, International Journal of Plant Science 163 (4): 613-618, 2002, "The evolution of tolerance to browsing in *Gentianellacampetris*: natural selection and the quantitative genetics of tolerance," with T. Lennartsson and J. Tuomi, Evolutionary 14: 393-419, 2000, "Tolerance to herbviory: toward a more unified theory of plant-herbivore interactions," with T. Lennartsson, Evolutionary Ecology 14: 283-287, 2000, "Quantitative trait loci for floral morphology in *Arabidopsis thaliana*," with M. Puruggana and T. F. C. Mackay, Genetics 156 (3), 1379-1392, 2000, and "The evolution of compensation to herbivory in scarlet gilia *Ipomopsis aggregata*: herbivore-imposed natural selection and the quantitative genetics of tolerance," with J. Bergelson, Evolution 54; 764-777, 2000.

Miller Fellow Philip Starks ('99-'01) published eight papers during his fellowship: "Genetic support for the evolutionary theory of reproductive transactions in social wasps," with H.K. Reeve, J.M. Peters, and P. Nonacs, P Roy Soc Lond B Bio 267 (1438): 75-79, 2000, " Fever in honeybee colonies," with C. A. Blackie and T.D. Seeley, Naturwissenschaften 87 (5): 229-231, 2000, "The relationship between serial monogamy and rape in the United States(1960-1995)," with C.A. Blackie, P Roy Soc Lond B Bio 267 (1449): 1259-1263, 2000, "The effect of HIV infection on human sexual behavior," with C.A. Blackie and W.M. Getz, AIDS 2000 A7109/C/1996, "Alternative reproduction tactics in the paper wasps *Polistes dominulus* with specific focus on the sit-and-wait tactic," Ann. Zool. Fennici 38 (3-4): 189-199, 2001, " Semi-nondestructive genetic sampling from live eusocial wasps, *Polistes dominulus* and *Polistes fuscatus*," with J.M. Peters, insect Soc 49(1): 20-22, 2002, "Special Double Issue: A Tribute to William Donald Hamilton (1936-2000)," with W. M. Getz and R.E. Page, Ann. Zool. Fennici, 38 (3-4), 187-330, 2001, and "Conflicts around a study of Mexican crops," with A.V. Suarez, M. Bernard, T.A. Blackledge, K. Copren, E.M. Sarnat, A.L. Wild, W.M. Getz, K. Will, P.J. Palsboll, M.E. Hauber, C. Moritz, and A.D. Richman, Nature 417 (6892): 897-897 Jun 27 2002.

Miller Institute News
Fall 2002
2536 Channing Way #5190
Berkeley, CA 94720-5190
Phone: (510) 642-4088
Fax: (510) 643-7393
http://socrates.berkeley.edu/~4mibrs

Please send address corrections to the Miller Institute

Check our website for upcoming Deadlines

Awards & Honors

Recent Executive Committe member Vaughan Jones, Miller Professor (Fall '92), of the Department of Mathematics was honored by Queen Elizabeth II in her Golden Jubilee celebration. Professor Jones was named a Distinguished Companion of the New Zealand Order of Merit. The honor is the functional equivalent of a knighthood. Professor Jones was recognized for his work being used to understand the complex 'knotted' configuration of DNA.

Former Miller Professor Gareth Thomas ('64-'65) of the Department of Material Science and Engineering, was awarded the Gold Medal for 2003 by Acta Materialia. This award honors contributions and leadership in materials research.

Former Miller Fellow ('74-'76) Professor Richard Van Sluyters of the Department of Optometry, was the 2002 recipient of the Biomedical Leadership Award. He was honored "for his stewardship of organizations that support and defend biomedical research" and for his support for science education in California, and his leadership of the California Biomedical Research Association.