The Yale Institute for

Biospheric Studies

YIBS 1999-2000 Annual Report

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I. APPOINTMENTS

FACULTY APPOINTMENTS

Ruth Blake
Assistant Professor of Geology and Geophysics

Michael Donoghue
Edward P. Bass Professor of Ecology and Evolutionary Biology

Roger Ely
Assistant Professor of Chemical and Environmental Engineering

Stephen Stearns
G. Evelyn Hutchinson Professor of Ecology and Evolutionary Biology

GAYLORD DONNELLEY ENVIRONMENTAL FELLOWS APPOINTED IN THE SPRING - 2000

Claudio Ciofi
Gaylord Donnelley Environmental Fellow working in the Department of Ecology and Evolutionary Biology Conservation Genetics Labor atory

Campbell Webb
Gaylord Donnelley Environmental Fellow working at the Yale School of Forestry and Environmental Studies and the Department of Ecology and Evolutionary Biology

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II. STUDENT PROGRAMS

A. - Studies in the Environment Program - Supported by the Donnelley Studies in the Environment Endowment Fund

Professor Mary Helen Goldsmith, Chair
Assistant Professor Steven Stoll, Director of Undergraduate Studies (on leave during 1999/2000 Academic Year)
Gordon T. Geballe, F&ES Lecturer, DUS for 1999/2000 Academic Year

The Studies in the Environment Double-Major Program provides undergraduate students with the skills and depth of knowledge required to pursue an environmental career in government or in the private sector. The program also prepares students to continue their education in graduate and professional programs in business, law, or management of natural resources, and to become effective, informed citizens and stewards of the environment in their communities. Studies in the Environment emphasizes an interdisciplinary approach built on a strong foundation in the natural sciences, especially geology and ecology, subjects that also require a basic background in chemistry, physics, and biology. In the social sciences, courses in economics, political science and policy analysis, and in the humanities, history and literature, are essential components of the Studies in the Environment core curriculum. Regardless of their primary major, students in the program acquire basic scientific knowledge and practical skills to become aware, inquiring, and observant, capable of formulating hypotheses and designing experiments, capable of analyzing data and determining its statistical significance, analyzing risk to reach decisions on the basis of present knowledge, and to be able to monitor and adjust course in response to unanticipated outcomes. Students in the program who are majoring in one of the humanities or social sciences receive a better education in natural sciences than do most of their peers.

Since the establishment of the environmental summer internship program in 1992 which is associated with the Studies in the Environment Program but not limited to just Studies in the

Environment majors, approximately 104 undergraduates from various Yale undergraduate disciplines have taken advantage of the funds available to work on a variety of environmentally-focused projects during the summer months. These experiences have enhanced their understanding and commitment to the many environmental issues that they face in our world today .

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B. - Support for Undergraduate Summer Internships - Summer 2000 - Funded by the Bingham Foundation Studies in the Environment Endowment Fund, the Montgomery Family Studies in the Environment Endowment Fund, and the Department of Ecology and Evolutionary Biology

Double Major Students:

Susan Brown	Majors: Studies in the Environment and American Studies Project: To gain first hand experience with the European approach to organic farming on an Italian organic farm.

Viviann Chui	Majors: Studies in the Environment and Political Science Project: Internship with Winrock International Kathmandu, Nepal to work on the campaign to transform Nepal into a “clean energy country.”
Rebecca Kolsky	Majors: Studies in the Environment and Anthropology Project: Internship at the National Environmental Education and Training Foundation (NEETF) in Washington, DC.
Josh Mukhopadhyay	Majors: Studies in the Environment and Biology Project: Environmental factors favoring the development of bamboo-dominated forests in the Tambopata-Candamo reserved zone in southeastern Peru.
Abigail Ryder	Majors: Studies in the Environment and Anthropology Project: Social dynamics associated with economic change of women in the Sangha River region.
Joanne Sum-Ping	Majors: Ethics, Politics and Economics, and Ecology and Evolutionary Biology Project: Internship with the US Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, Office of Policy Coordinating and Initiatives, Washington, DC.
Nicholas Stucky	Majors: Studies in the Environment and Biomedical Engineering Project: Assessment of remote sensing of ecosystem change affecting salmon and steelhead habitat in the Puget Sound region.

Single Major Students:

Matthew Nicotra	Major: Ecology and Evolutionary Biology Project: Transmission genetics of polyp fusibility in Hydractinia symbiologngicarpus.
Anahid Powell	Major: Ecology and Evolutionary Biology Project: Constructing a genetic map of Hydractinia symbiolongicarpus using microsatellites and AFLP markers.
Elizabeth Saunders	Major: Ecology and Evolutionary Biology Project: Study of complexation of heavy metals by sulfur compounds.
Rajni Sethi	Major: Ecology and Evolutionary Biology Project: Project at the Hubbard Brook Experimental Forest in New Hampshire’s White Mountains.
Margaret Sherriffs	Major: Ecology and Evolutionary Biology Project: Investigation of how the exotic parasitoid wasp Allorhogas pyralophagus assess

	the size of its host when the host is concealed within plant tissue.
Lauge Sokol-Hessner	Major: Ecology and Evolutionary Biology Project: Effects of intraguild predation among three spider species on grasshopper populations in an old-field interaction web.
Megann Young	Major: Ecology and Evolutionary Biology Project: Effects of food-web complexity on the appearance of tropic cascades.
Fleming Terrell	Major: Ecology and Evolutionary Biology Project: Internship with Dr. Dan Brunbaugh in the Center for Biodiversity and Conservation at the American Museum of Natural History to work on the project "Molecular Studies of Dispersal and Speciation in Bryozoans."

Gaylord Donnelley Prize

Susan Brown, American Studies and Studies in the Environment
Senior Essay: *The Silent Leader: Rachel Carson's Role in the Emergence of the Modern Environmental Movement.*

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C. - D. G. Evelyn Hutchinson – YIBS Graduate Student Support

Department of Ecology and Evolutionary Biology

Homayoun Bagheri	*Evolution of Variation in Biochemical Systems.* Advisor, Günter Wagner
Luis Cadavid	*Genetic and Molecular Characterization of Hydractinia Symbiolongicarpus Allorecognition Locus.* Advisor, Leo Buss
Kyle Cole	*In Vitro Selection of E. Coli Rnase P.* Advisor, Robert Dorit.
Jeff Huckaby	*In Vivo Evolution of RNase PRNA.* Advisor, Robert Dorit
Julia Kreychman	*Structure of Protein Energy Landscapes, Symmetries of 3 Dimensional Structures and Functional Diversification as Key Factors Governing the Patterns of Protein Diversification.* Advisor, Junhyong Kim
Jason Mezey	*Pattern and Evolution of Pleiotropic Effects: Analysis of QTL Data and an Epistatic Model.* Advisor, Günter Wagner
Kristin Saltonstall	*Genetic Variation in Phragites Australis.* Advisor, Jeffrey Powell
Maxim Shopak	*Aggregation of Variables and Decomposability of Mutation-Selection on Fitness Landscapes.* Advisor, Günter Wagner

Michel Slotman	*The Genetics of Postmating Reproductive Isolation and the Nature of Introgression Between Anopheles Gambiae and Anopheles Grabiensis.* Advisor, Jeffrey Powell
Elizabeth Suatoni	*Patterns of Hybrid Breakdown in an Alternative System, the Rotifer Species Complex, Brachionus Plicatilis.* Advisor, Sean Rice

Environmental Engineering

Jeffrey Chen	*Colloidal Transport Phenomena in Aquatic Systems.*
Eric Vrijenhoek	*Improving the Understanding of Optimal Use of Membrane Processes for Water Quality Control.*

Yale School of Forestry and Environmental Studies

Michael Booth	*Material Flows Across Ectomycorrhizal Networks and Plant Competition in Temperate Forests.*
Robert Klee	*Measuring Sustainability Through Material Flow Analysis of Industrial Systems in Antarctica: A Case Study of the British Antarctic Survey.*
Laly Lichtenfeld	*The Meta-Physical King of Beasts: Exploring Biological and Socio-Cultural Relationships to the Lion in Northern Tanzania.*
David Pinney	*Farming on the Urban Fringe: Public Interests, Private Decisions.*
Anne Rademacher	*"Culturing" Urban Ecology: Strategic Linkages of Environment and Cultural Identity in Discourses of Urban River Restoration, the Upper Bagmati Basin, Kathmandu, Nepal.*
Shane Rosenthal	*Pro-poor Policies for the Provision of Urban Water and Sanitation Services.*
Leigh Shemitz	*Understanding the Health of Cities: An Analysis of the Changing Patterns of Poverty, Health, Land and People in an Urban Ecosystem.*
Terry Terhaar	*Values of the Heart and Soul and How They Influence Forest Policy and Management Decisions: Where Do People Think They Fit In Nature?*
John Tuxill	*Examining the Effects of Agrarian Change on Mayan Agrodiversity in Yucatan State, Mexico: Implications for In Situ Conservation.*
David Neidel	*Insiders and Outsiders: Village Conservation Agreements and the Politics of Property in Kerinci, Indonesia.*

Department of Geology and Geophysics

Cynthia Marshall	*Comparative Analysis of Developmental Anatomy and Growth Patterns in Embryonic Paleognathes; with Comparisons to Embryonic Neognathes, Archosaurs and Non-avian Theorpods.*
Jessica Maisano	*Patterns and Postnatal Ossification in*

	Squamates: Their Phylogenetic Informativeness and Relationship to Life History Characters and Climate Change.
Alan Gishlick	*Theropod Predatory Behavior and the Origin of Flight.*
Daniel Brinkman	*Taxonomic Implications of Osteological Variability in the Ornithopod Dinosaur Tenontosaurus.*
Rebecca Masters	*Metamorphic Fluid Flow and the Development of Barrow's Index Mineral Zones, Stonehaven, Scotland.*

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D. - Yale Student Environmental Coalition (YSEC) 1999-2000 YIBS Support

YSEC Speaker Series - Spring 2000
Spring Fling and EarthDay Participation - Spring 2000
Campus Green Vote Training - Spring 2000

With funding support from the Yale Institute for Biospheric Studies, the

Yale Student Environmental Coalition (YSEC):

- Hosted Robert Massie, Executive Director of the Center for Environmentally Responsible Economies (CERES) as their guest speaker on March 23, 2000. His talk focused on: "Corporations exert an influence over human decisions and behaviors that is often more profound than that of schools, governments or religious communities. What are you gonna do about it?"
- Contributed money to the Spring Fling Organizing Committee to use for general expenses for this event. During the Spring Fling, YSEC members staffed a table and served ice cream to students who signed a global warming petition. This petition was part of YSEC's Kyoto Now Campaign, which educates students about climate change and urges the Yale administration to set an environmental example by reducing campus carbon dioxide emissions.
- Held a Campus Green Vote training that taught attendees general organizing and media skills. After the training, the Campus Green Vote representatives helped with YSEC's Kyoto Now Campaign.

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E. - Yale Chapter - Society for Conservation Biology (SCB) 1999-2000 YIBS Support

SCB Environmental Seminar Series at Yale

September 20, 1999	Laurie Marker, Cheetah Conservation Fund, Namibia presented cheetah conservation.
February 29, 2000	Mark Ritchie, Department of Fisheries and Wildlife, Utah State University presented Spatial Scaling Laws Yield a Synthetic Theory of Biodiversity.
March 2, 2000	Peter Seligmann, Chairman and CEO of Conservation International presented issues in international conservation.
March 22, 2000	David Olson, Senior Scientist and Director of the Conservation Science Program at World Wildlife Fund presented Ecoregion-Based Conservation Approaches.
April 13, 2000	George Woodwell, Founder and Director of Woods Hole Research Center presented his past work on important environmental issues.

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III. GAYLORD DONNELLEY ENVIRONMENTAL FELLOWSHIP

Donnelley Environmental Fellows Appointed 1999 - 2000

Dr. Douglas Gollin
Term: August 1999 through July 2001
Sponsor: *Professor Robert Evenson*
Economic Growth Center
Research: *Agricultural development, economic growth, and sustainable resource use*

Over the past year, several research projects have come to fruition. Most notably, Dr. Gollin expects to complete a book manuscript edited jointly with Yale Economics Professor Robert E. Evenson in January 2001. This manuscript summarizes the results of a two-year effort by a group of economists from around the world to examine the impact of international agricultural research on the sustainable production of crops. Their findings have been presented at the World Bank and in numerous other forums, and it is anticipated that the book itself will receive considerable attention within the international community. A major finding of this research is the overwhelming success of international research in developing improved crop varieties over the past 40 years. These varieties have played a substantial and important role in contributing to unprecedented increases in per capita availability of food. They have also helped to alleviate stress on land and forest resources by allowing for increased human populations to be fed at least partly through intensification of agriculture on existing crop land, rather than through clearing of new land.

It is believed that this work will play a significant role in shaping attitudes within the international policy community. The study was commissioned by the Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), the umbrella organization that supports some 16 international agricultural research centers. The study comes at a time when donors have been reluctant to allocate funds for further agricultural research, at least in part based on some misconceptions about the continued impacts of such

work.

Drawing on this research, Professor Evenson and Dr. Gollin are organizing a session at this year's annual meetings of the American Association for the Advancement of Science (AAAS). This session will address the appropriate role for the public sector in the further development of biotechnology for agriculture. In addition to organizing the session, they are also preparing one of the papers, which Dr. Gollin will present. The main message of the paper is that public sector research will remain the predominant source of technical change for agriculture in developing countries. For most major crops, we see little evidence that the private sector will carry out much research relevant to the needs of poor countries.

Another accomplishment during the past year was the publication of a paper on the management of materials in agricultural gene banks. For most cultivated crops, genetic diversity is collected and conserved ex situ in gene banks – typically cold storage facilities designed to maintain the viability of seeds for 50 to 100 years. Along with colleagues from CIMMYT, the International Center for Maize and Wheat Improvement in Mexico, Dr. Gollin wrote a paper that addressed some

practical questions relating to the use of gene banks for breeding improved varieties. This paper, recently published in the American Journal of Agricultural Economics, has been well received by plant breeders and gene bank managers, as well as by economists.

Dr. Gollin has also continued to explore theoretical models of the relationship between agricultural development and economic growth. Along with several colleagues at Yale and elsewhere, he is working on papers that focus on the theoretical and empirical relationships between technical change in agriculture and economic growth.

Outside of his research, he has taken advantage of many intellectual resources at Yale and has enjoyed the chance to interact with students and faculty in the Economics Department, the School of Forestry and Environmental Studies, and the Yale Center for International and Area Studies. His experience at Yale has been both productive and enjoyable and he thanks the Donnelley family and the Yale Institute for Biospheric Studies for their kind and generous support.

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Dr. Ofer Ovadia
Term: September 1999 through August 2001
Sponsor: *Professor Oswald Schmitz*
School of Forestry and Environmental Studies
Research: *Testing the effect of state dependent decision-making of individual herbivores on food web dynamics.*

Scientific Background:

Understanding the origin and maintenance of global patterns of biodiversity is one of the monumental problems of biology (Ricklefs and Schluter 1993). Ecological studies of the past thirty years tended to

focus on population level processes in order to explain community structure. However, this approach failed to explain global biodiversity patterns (Ricklefs and Schluter 1993). These studies as many others at the population and community levels were based only on numerical effects and did not take into account the possible behavioral effects. Recently, it has been shown that individual behavior may stabilize population dynamic (Mangel and Roitberg 1992), drive trophic cascades (Schmitz et. al. 1997), and be critical to persistence of populations in the landscape (Lima and Zollner 1996; Roitberg and Mangel 1997). These studies as some others have led ecologists to the conclusion that one should not ignore the role of individual behavior when studying the structure and the function of complex ecological entities (e.g., Sutherland 1996; Fryxell and Lundberg 1998).

Dr. Ovadia's research aim is to incorporate state dependent decision making by individual herbivores into a model of food web dynamics, and to test this model experimentally in the field.

The Model:

Dr. Ovadia uses the Gecko (Booth 1997; Schmitz and Booth 1997; Schmitz 2000) as a tool for studying the effect of state dependent decision-making by individual herbivores on food web dynamics. The Gecko is a spatially explicit individual based model developed at the CCE (Center of Computational Ecology) to explore the effect of individual behavior on food web dynamic (Booth 1997; Schmitz and Booth 1997; Schmitz 2000). He has modified the Gecko to include state dependent foraging decisions by individual herbivores and ran simulations and used the results to design and to generate predictions for the field study.

The Empirical Study:

The study is located in an old-field located at the Yale-Myers Research Forest in northeastern Connecticut. The food web includes three-trophic levels, spider predators, grasshopper herbivores and herbaceous plants.

The field study is divided into two major parts: behavioral experiments and food web experiments. During the behavioral experiments Dr. Ovadia monitors the foraging behavior of grasshoppers with different internal Body State exposed to different levels of predation risk. During the food web experiments, he tests the effect of different

During the food web experiments, he tests the effect of different levels of chronic internal Body State of grasshoppers on community dynamic.

Research Plan:

September 1999 – April 2000:
Theoretical study which includes three parts: 1) Modifying the Gecko to include state dependent decision making by herbivores, 2) Running simulations to test the effect of herbivores state on food web dynamic, and 3) Using the simulations results to design and to generate predictions for the field study.

April 2000 – September 2000:
Field study that includes two major parts: 1) Behavioral experiments, and 2) Food web experiments.

September 2000 – April 2001:
Analyzing the results from the empirical study. Using the first year results to enhance the development of the theoretical study.

April 2001 – September 2001:
Field study testing the predictions generated by the Gecko during the theoretical study of the second year.

The progress done since Dr. Ovadia's arrival at the Yale University:

1) Dr. Ovadia is working in collaboration with Ginger Booth from the CCE. They have modified the Gecko to include state dependent foraging decision by the herbivores in the model. He ran simulations and used the results to design and to generate predictions for the field study.

2) Dr. Ovadia did a large field experiment during the summer and is currently analyzing the data.

3) Dr. Ovadia is working on his PhD publications and has submitted two papers, one accepted for publication in Behavioral Ecology and the other currently is in review.

4) Dr. Ovadia is working on two papers: the first manuscript is a theoretical state dependent Gecko paper and the second one is an empirical paper that is based on the results of field study.

References:

1) Booth, G. 1997. Gecko: A continuous 2D world for ecological modeling. Artificial Life. 3: 147-163.

2) Fryxell, J.M. and Lundberg, P. 1998. Individual Behavior and Community Dynamics. Chapman and Hall, London.

3) Lima, S.L. and Zollner, P.A. 1996. Towards a behavioral ecology of ecological landscapes. Trends in Ecology and Evolution. 11(3):131-135.

4) Mangel, M. and Roitberg, B.D. 1992. Behavioral stabilization of host-parasite population dynamics. Theoretical Population Biology. 42:308-320.

5) Ricklefs, R.E. and Schluter, D. 1993. Species Diversity in Ecological Communities, Historical and Geographical Perspectives. The University of Chicago Press, Chicago.

6) Roitberg, B.D. and Mangel, M. 1997. Individuals on the landscape: behavior can mitigate landscape differences among habitats. Oikos. 80:234-240.

7) Schmitz, O.J. 2000. Combining field experiments and individual-based modeling to identify the dynamically-relevant organizational scale in a field system. Oikos. In Press.

8) Schmitz, O.J., Beckerman, A.P. and O'Brien, K.M. 1997. Behaviorally mediated trophic cascades: effects of predation risk on food web interactions. Ecology. 78(5):1388-1399.

9) Schmitz, O.J. and Booth, G. 1997. Modeling food web complexity: The consequences of individual-based, spatially explicit behavioural ecology on trophic interactions. Evolutionary Ecology. 11: 379-398.

10) Sutherland, W.J. 1996. From Individual Behaviour to Population Ecology. Oxford University Press. Oxford.

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Donnelley Fellows Appointed for 2000 – 2002

Dr. Claudio Ciofi
Term: July 2000 through June 2002
Sponsors: *Dr. Gisella Caccone and Professor Jeffrey Powell*
ECOSAVE Conservation Genetics Laboratory
Research: *"Research in Molecular Ecology"*

Dr. Claudio Ciofi arrived at Yale on July 1, 2000 as a Gaylord Donnelley Environmental Fellow. Dr. Ciofi received his Ph.D. in Conservation Biology from the University of Kent in England in 1998. His dissertation was on the spectacular Komodo dragon and is one of the finest studies done on the Komodo dragon in the last 20 years. He conducted arduous fieldwork in an effort to understand these lizards, including tagging them and determining range size. He also collected blood from about 150 animals and conducted microsatellite DNA studies. Finally, he analyzed the genetic data using sophisticated techniques that allowed him, among other things, to draw conclusions about the relative isolation among the remaining populations. Thus he has demonstrated all the skills required in modern conservation biology: fieldwork, ecological studies, laboratory genetic studies, and sophisticated computer-based analysis. In addition, he has been working with and training local Indonesians, not only to give them skills, but also to raise their appreciation for these endangered animals with the hopes of affecting public policy.

After his arrival at Yale University as a Donnelley Post-Doctoral Fellow, he has been involved in a number of very productive research and educational activities, both at Yale and abroad, all part of the two main wildlife conservation projects that he has been involved in. The giant Galápagos tortoise and the Komodo dragon projects are well-established studies where molecular genetic techniques are employed to better define the distinctiveness of natural populations, to obtain information on demographic parameters, and to provide recommendations on the amount of effort that should be devoted to conservation. This is a fast evolving discipline, which is being integrated with ecological and demographic studies, to formulate appropriate management strategies for endangered species.

In the first three months of his appointment, he has participated in scientific expeditions in Ecuador and Indonesia to collect samples for

genetic analysis from giant tortoises and Komodo dragons respectively. The Ecuadorian expedition was carried out in the Galápagos archipelago, about 1,500 km off the coast of Ecuador in the Pacific Ocean. The fieldwork was conducted on Isabela, the largest and geologically youngest of a set of 15 volcanic islands. The study, organized at Yale, included four researchers of different nationalities. Its purpose was to collect blood samples of giant tortoises inhabiting the slopes of two volcanoes on the north part of the island. The group identified, measured, sexed, and sampled 93 tortoises of up to 200 kg in weight. Samples were collected from the brachial vein located on one of the forelimbs. During the work, Dr. Ciofi had the opportunity of training two Ecuadorian undergraduate students in the collection and storage of reptile blood.

The Indonesian expedition was conducted at Komodo National Park in the southeast part of the country. The goal of the study was to collect blood samples from adult females once the location of their nests was identified. Subsequent collection of samples from the hatchlings will allow a DNA fingerprinting analysis to assess single or multiple paternity. This will help to clarify the mating system of the species. Dr. Ciofi collected blood samples from five females. As for his previous studies on the Komodo dragon, specimens were caught in baited traps (300x50x50 cm). Young females were first restrained, and 500 micro liters of blood were collected from the caudal vein using a 5 ml syringe and a spinal needle (0.70x90 mm), while large specimens were kept in the trap and bled by nail-clipping.

Whole genomic DNA was extracted from blood samples soon after fieldwork. Genetic analysis is now conducted by assessing allelic differences among individuals at nine microsatellite loci.

Microsatellites are short, tandemly repeated simple sequences of nuclear DNA. Genetic differences between individuals are determined by identifying variation in the number of repeats. Microsatellite loci are first amplified by polymerase chain reaction (a technique to obtain sizable specific DNA sequences from minute amounts of whole DNA), and individual genotypes are then obtained. Differences in allele sizes between individuals as little as one DNA base pair can be detected, allowing the maximum degree of resolution. Yale undergraduate students are currently working on the above techniques under Dr. Ciofi's supervision. During their training period, they will become proficient in DNA extraction and analysis methods and will gain knowledge of how the data obtained can be used to design and implement wildlife management plans.

The Komodo dragon study is part of a wider project Dr. Ciofi set up during his Ph.D. work. At Yale, he has had the opportunity to continue and expand the work he initiated using genetics to obtain quantitative information on population divergence, reproductive biology, and demography of the species.

In addition, he has submitted a number of applications for funding to US Institutions to support his ongoing research. In January 2001, three grants have been awarded by private Zoological foundations, and additional support has been confirmed by the Smithsonian Institution, Washington D.C. These funds will allow Dr. Ciofi to continue his studies in the laboratory and in the field, and will also afford him the opportunity to continue his collaboration with Indonesian universities and support undergraduate short-term field studies on the biology and management of the Komodo dragon.

Dr. Ciofi is also collaborating with the Zoological Society of San Diego and they have begun to fund a capacity building project at the University of Bali and Komodo National Park. He produced a memorandum of understanding with the Indonesian Department of Nature Protection and Conservation, Udayana University (Bali, Indonesia) and the Zoological Society of San Diego, to set up a molecular biology laboratory in the department of Basic Science at Udayana, and a field research station in Komodo National Park. In 2001 Dr. Ciofi will be directly involved in setting up the administrative, logistic and scientific part of this initiative. Funds will be provided for capacity building, one Post-Doctoral position, and stipends for a local member staff person, and scholarships for Indonesian graduate students.

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Dr. Campbell Webb
Term: September 2000 through August 2002
Sponsors: *Professor Mark Ashton*,
School of Forestry and Environmental Studies
Professor Michael Donoghue,
Dept. of Ecology and Evolutionary Biology
Research: *"Study of the Phylogenetic Structure of Forest Tree Communities in Indonesian Borneo and at Selected Comparative Sites in Asia and Central America"*

Dr. Campbell Webb arrived at Yale on September 1, 2000 as a Gaylord Donnelley Environmental Fellow. He received his Ph.D. from Dartmouth College in Ecology and Evolutionary Biology and studied the regeneration ecology of the tree community at the Gunung Palung National Park, Kalimantan, Indonesia, and its role in the maintenance of species diversity for his doctoral work. In a study of 150 species, he found that seedlings of common species generally suffer high mortality than those of rare species, an exciting discovery that implies the existence of a 'balance of nature' in these economically valuable forests.

Before arriving at Yale, Dr. Webb spent the last two years as a research fellow of the Arnold Arboretum, Harvard University, working on regional-scale patterns of tree species diversity in Borneo and developing methods to investigate the phylogenetic structure of sympartric plant communities. He also gained experience in 'alpha-taxonomy', describing several new plant species from Borneo.

His research explores the origin and maintenance of tree species

diversity in tropical forests. He has assessed a number of hypotheses for the contemporary coexistence of tree species, and found evidence that there exists a `balance of nature' in Bornean forests, in that regeneration of common species is less successful than that of rare species. Recently, he has started to examine the potential for modern phylogenetic analyses to be used in our investigation of ecological community structure. Since he has come to Yale, Michael Donoghue and he have begun to develop the tools and theories needed for this new approach. Mark Ashton was on sabbatical for most of the Fall of 2000, and Dr. Webb looks forward to working with him in 2001.

While his primary research focus is on the theory of forest community structure, he has long been active in rain forest conservation, particularly in the inventory and mapping of threatened forest areas. As described below, he has made progress in these areas. The general program of seminars at the Yale School of Forestry and Environmental Studies has been a great resource. The country that he has been most involved in is Indonesia, and a pleasant surprise for him at Yale has been the existence of a sizable body of Indonesian graduate students, many of who work on environmental issues back home.

Overall, he finds Yale to be an excellent home for his research and conservation activities, and he expresses his deep gratitude to the Yale Institute for Biospheric Studies, and especially to the Donnelley family for supporting his fellowship.

Activities, July - December 2000

Main Research

1) Any analysis of the phylogenetic structure of communities will depend upon having phylogenies for the taxa in the communities. However, very few of these taxa will have ever been the subject of detailed molecular analysis. We must depend therefore on constructing `supertrees' of the communities, using published phylogenies of closely related species. Dr. Webb has developed a system for assembling these supertrees that includes a frequently-updated `backbone' phylogeny for the higher plants. See the project website at http://pantheon.yale.edu/~cw252/ttp.

2) The analyses of community phylogenetic structure that is planned depends upon specialized software. This software is based on code that Dr. Webb wrote before arriving at Yale, but it must be continually modified and upgraded. The package of software now includes measures of the tree-balance of community phylogenies.

Proposals and Grants

1) Professor Michael Donoghue and Dr. Webb were awarded a grant from the Biotic Surveys and Inventory panel of NSF to develop methods for biodiversity surveys using wireless technology.

2) Professor Michael Donoghue and Dr. Webb also submitted a proposal to Annual Review of Ecology and Systematics for a review paper

entitled ``Phylogenies and Community Ecology," to be written with David Ackerly, Mark McPeek and Michael Donoghue. The proposal was successful and the paper is due January 2002.

3) A proposal was also submitted to the National Center for Ecological Analysis and Synthesis to organize a 15-person working group, also under the title, ``Phylogenies and Community Ecology."

Visits and Meetings

1) Dr. Webb attended the Ecological Society of America meetings in Snowbird, Utah. Discussed wireless biology techniques at a special session of the Long-Term Ecological Research meeting and presented a talk entitled, “Seed dispersal determines local seedling species diversity in Bornean rain forest” at the General Annual Meeting.

2) Dr. Webb visited Steve Hubbell at University of Georgia to collaborate on analysis of the phylogenetic structure of the 50-ha forest research plot on Barro Colorado Island, Panama.

3) Dr. Webb visited David Ackerly and Miguel Martinez-Ramos at Stanford University, to begin collaboration on a simulation model of community assembly and phylogenetic structure.

Biological Inventory

1) With the NSF grant (above), Dr. Webb has started to assemble a wireless system that links a field collector with the global systematics and education community. This will enable the collector to more efficiently inventory taxa outside their area of expertise, and will also be a powerful tool for engaging students in biodiversity studies. The current setup comprises a PalmPilot with PalmPix camera connected to a laptop computer up to 20 miles away, via a FreeWave spread-spectrum radio. The laptop will eventually be positioned at a base-camp, and will transmit data to a web-server, via a cell- or satellite telephone. The web-server will post images and messages on the Internet, and route replies back to the user. He will test the setup in Borneo during a field trip in March and April 2001.

2) Computer-based identification keys provide a powerful tool for anyone trying to identify unknown taxa. However, even laptops are too cumbersome to carry to the field, where identification is most needed. However, 'palm-tops' are small enough, and Dr. Webb developed a simple identification application for the PalmPilot, called 'PalmKey.' The tool can be downloaded from his website: www.herbaria.harvard.edu/~cwebb/PalmKey.

Activities Planned for 2001

1) Continued work on phylogenetic structure of forest communities: compiling datasets, developing software, publishing findings.

2) NCEAS meetings (2 x) for working group entitled: "Life-history variation and community structure in neotropical rainforest communities: ecological and phylogenetic influences."

3) Possible NCEAS meeting for working group entitled "Phylogenies and community ecology."

4) Ecological Society of America meeting, Madison WI. Invited symposium speaker.

5) Association of Tropical Biology meeting, Bangalore, India.

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IV. YIBS RESEARCH CENTERS

A. The Center for Biological Transformation Report, 1999 - 2000

Center Director, L. Nicholas Ornston

Plasticity In Environmental Microorganisms

The plasticity of microorganisms has long been a source of fascination for biologists. Half a century ago, bacteria offered models for understanding how the expression of genes responds to environmental fluctuations and, after a few good shakes, these models still help to shape thinking in developmental biology. Such thoughts tend to be focused upon how the genome of a single cell can give rise to the complexity a multicellular organism. As the world continues to be shaped for us by the biological activity of diverse unicellular organisms, questions shift to how their complexity can be combined to achieve the overall constancy of a single biosphere. The complexity is staggering, and sophisticated techniques for identifying environmental microorganisms and their activities increase our awareness of our ignorance. Whatever bliss this ignorance might afford must be overcome by the certainty that microorganisms are the biological reservoir of opportunities for maintaining balance in the environment.

Chemical communication between plants and bacteria is an environmental interaction that has been going on for a very long time. Survival of plants depends upon their ability to ward off pathogens and to enter into beneficial nutrient exchanges with microbial symbionts. The relationship extends to animals for whom some of plant products are indigestible, toxic or both. Removal of plant products from the environment is achieved by microorganisms, and the process requires physiological versatility. One challenge is how to grow at the expense of a toxic compound. A second is how to digest a compound designed to endure. A third is how to achieve the genetic fluidity essential for adaptation to a constantly shifting environment.

Activities in the Center for Biological Transformation have focused upon a bacterial strain that offers singular advantages for genetic analysis through natural transformation. The organism, a representative of the genus Acinetobacter, grows at the expense of a wide range of plant products, and many of these are metabolized through a single intermediate, protocatechuate. Genetic sleight-of-hand makes it possible to select mutants with defects in these metabolic systems. The mutations have revealed a cluster of about 40 genes that achieve the overall mineralization of complex plant products. Notable among the newly discovered genes is one that encodes an enzyme that acts upon chlorogenate, a material that presents problems in stockyard feeds because it is remarkably resistant to metabolism by animals. The bacteria may be able to help out on this one.

Ongoing research continues to elucidate a panoply of transporters, transcriptional regulators and enzymes that contribute to catabolism of protocatechuate, a compound that can be toxic when supplied in high concentrations. It has been possible to design a system that allows secrets of genes from other organisms to be unraveled by the joy of Acinetobacter genetics. Extraordinary genetic fluidity was revealed by investigation of Acinetobacter genes for conversion of vanillate to protocatechuate. Nevertheless, it was possible to use a novel

technique to identify amino acid residues essential for the activity of the proteins that are involved. Study of spontaneous mutations revealed deletion mutations that are guided by nucleotide sequences. This finding emphasizes that DNA has a voice in its own destiny, and present studies are designed to explore mechanisms that allow this to take place. Of particular value for future research will be the recently determined crystal structure of Acinetobacter protocatechuate 3,4-dioxygenase. This allows interpretation of known mutations and permits design of experiments designed to explore the physical and chemical flexibility of the enzyme.

Publications of the Center for Biological Transformation, 1999-2000:

1. Kok, R. G., D. M. Young, and L. N. Ornston. 1999. Phenotypic expression of PCR-generated random mutations in a Pseudomonas putida gene after its introduction into an Acinetobacter chromosome by natural transformation. Appl. Env. Microbiol. 65: 1675-1680.

2. Segura, A., P. V. Bünz, D. A. D'Argenio, and L. N. Ornston. 1999. Genetic analysis of a chromosomal region containing vanA and vanB, genes required for conversion of either ferulate or vanillate to protocatechuate in Acinetobacter. J. Bacteriol. 181:3494-3504.

3. D'Argenio, D.A., A. Segura, W. M. Coco, P. V. Bünz, and L. N. Ornston. 1999. The physiological contribution of Acinetobacter PcaK, a transport system that acts upon protocatechuate, can be masked by the overlapping specificity of VanK. J. Bacteriol. 181:3505-3515.

4. D'Argenio, D.A., M. W. Vetting, D. H. Ohlendorf, and L. N. Ornston. 1999. Substitution, insertion, deletion, suppression, and altered substrate-specificity in functional protocatechuate 3,4-dioxygenases. J. Bacteriol. 181:6478-6487.

5. Parke, D., D. A. D'Argenio, and L. N. Ornston. 2000. Bacteria are not what they eat: that is why they are so diverse. J. Bacteriol. 182:257-263.

6. Morawski, B., A. Segura, and L. N. Ornston. 2000. Substrate range and genetic analysis of Acinetobacter vanillate demethylase. J. Bacteriol. 182:1383-1389

7. Morawski, B., A. Segura, and L. N. Ornston. 2000. Repression of Acinetobacter vanillate demethylase synthesis by VanR, a member of the GntR family of transcriptional regulators. FEMS Microbiol. Lett. 187: 65-68.

8. Vetting, M.W., D.A. D'Argenio, L.N. Ornston, and D.H. Ohlendorf. 2000. Structure of Acinetobacter strain ADP1 protocatechuate 3,4-dioxygenase at 2.2 Å resolution: implications for the mechanism of an intradiol dioxygenase. Biochemistry 39:7943-7955.

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B. The Center for Computational Ecology Report, 1999 - 2000
Center Director, Oswald Schmitz

Given that many of our research initiatives, aimed at linking computational modeling with field experimentation, are well underway, the Center for Computational Ecology (CCE) is now shifting more emphasis toward its teaching mission.

In 1998, CCE programmer Ginger Booth developed software (called CourseWare) that would facilitate creating interactive science labs that could be served over the Internet. A prototype lab course was developed for FES 563b/EEB 340b, Community Ecology, taught by Oswald Schmitz. The intent was to offer students a way of learning mathematical principles taught in lecture, in a setting in which they could interact with computational-based exercises that could be accessed at their leisure outside of normal lab meeting times. There were five electronic labs designed to complement various themes presented in lectures. The electronic labs appeared to serve a valuable role - student grades improved by 10-15% on the first mid-term exam relative to years when such teaching software was unavailable.

Building on the success of this pilot project, CCE applied for and

Building on the success of this pilot project, CCE applied for and received funding from Yale ITS and from Howard Hughes to develop course modules for other undergraduate courses. CCE is now actively developing computer-based learning modules for EEB 110, Introduction to Environmental Science (R. Dorit, enrollment 300 students). These modules will again complement lecture material and allow students the freedom to explore different lecture concepts (e.g., human population growth, risk and spread of infectious diseases, biodiversity and the stability of ecosystems) within and outside of normal weekly discussion sections. These modules will be designed to be completely interactive such that students can explore concepts in far greater depth than can be covered during lecture. We have also developed several modules for EEB Conservation Biology (J. Powell, O. Schmitz and A. Caccone, enrollment 50 students), which aids students in understanding the concepts and measures of biodiversity.

The effort to engage CCE in a more active teaching role is a major Center priority for the next one and a half years.

For more detailed information on the Center for Computational Ecology, visit our web site at http://peaplant.biology.yale.edu:8001/

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C. The Center for Earth Observation Report, 1999 - 2000
Center Director, Ronald Smith

The goals and organization of the Center for Earth Observation (CEO) are unchanged from previous years. In this annual report, we focus on events of the recent year and plans for the future.

Infrastructure:
In 1999 the Center moved to temporary quarters in the Kline Geology Laboratory. The space provided by the Department of Geology &Geophysics (G&G) in KGL is excellent and this has allowed us to continue our work unabated. Current plans are to move to the Environmental Science Facility (ESF) in the summer or fall of 2001.

The Silicon Graphics (SGI) computer systems purchased in 1997 with NASA "Center of Excellence" funds are continuing to provide excellent performance. We have added considerable disk space, using base CEO funds, to keep up with our growing archive and the increasing demands of users for disk storage.

The SGI systems are starting to approach their expected lifetime as a leading edge scientific computer system (about 4 years). Discussions at CEO have begun about replacing the entire system in the year 2001 or 2002. Ideally, the changeover would occur at the same time as the move to ESF, so that we do not have to move and reinstall an outdated computer system. The funds for this purchase have been requested from General ReInsurance through YIBS, but the outcome of this request is not yet known.

Governance:
The CEO steering committee includes representatives from G&G, Ron Smith; Anthropology, Frank Hole; School of Forestry and Environmental Studies (F&ES), Xuhui Lee; and Epidemiology and Public Health, Durland Fish. The idea of adding a member from the Department of Ecology and Evolutionary Biology is under consideration, in connection with new initiatives in biodiversity.

Staff:
The CEO has two full time Masters-level staff members. Laurent Bonneau provides day-to-day management of the Center, assists users and instructors, and works with others around campus on issues of spatial analysis and geographical information systems. Jie Zhang assists users and instructors, organizes the CEO data archives and works on high-level research projects. This staff has brought a high standard of professionalism to their positions. They have established a reputation on campus for knowledge, enthusiasm and efficiency.

Archive:
In 1999, CEO began an effort to expand its archive of Landsat images. With the help of falling prices and ample research funding, the archive has quickly grown to exceed 500 images. These images are maintained in a CD cabinet and can be browsed on the revamped CEO web page

in a CD cabinet and can be browsed on the revamped CEO web page. We have concentrated our growth in areas with active projects at Yale: the Middle East, west Africa, southeast Asia, Amazon basin, and New England.

With the launch of NASA's Terra and other satellites last year, the flow of image data has accelerated rapidly. The Center is gaining experience using some of these new products, especially MODIS, ASTER and IKONOS. Because of our small size however, we cannot keep fully abreast of all the new products.

The larger archive has been especially helpful for students seeking projects. Although our coverage is not global, students can often find images of relevance to their interests. On other occasions, we can assist in purchasing needed images.

Courses:
As in past years, the course "Observing the Earth from Space" was taught in the spring term 2000. Approximately 31 students enrolled in the course, mostly from F&ES, but with significant numbers from G&G, Studies in the Environment, Anthropology,Epidemiology. The student projects in the course were impressive in their diversity and quality (see Appendix A). This course will be offered again in the spring of 2001.

Discussion continues concerning expanding the course size limit or offering a follow-on course at a more advanced level. While desirable, these options are not feasible because of limited faculty at Yale in the area of remote sensing. Appointments in the departments or professional schools would be necessary to expand this teaching program. The recent growth in the teaching of GIS at Yale is a step forward however. Students who have taken GIS can take fuller advantage of the remote sensing data sets.

The Center has provided some support for other courses at Yale (Appendix B). Additionally we have been asked to assist in undergraduate recruiting activities.

Supporting users:
The Center assists students, staff, and faculty to carry out remote sensing projects. This is a continuing activity throughout the year. We receive no reimbursement for most of these small projects, especially for student thesis projects. A common request is to provide image analysis support in the grant-writing stage. A list of current projects is given in Appendix C.

Outreach:
The CEO participates is several activities which might be termed "outreach". We have assisted the Peabody Museum in a remote sensing demonstration for Martin Luther King Day. The Tweed Airport Commission has used our images of the New Haven region in their presentations. We made a remote sensing presentation to the F&ES Pingree workshop concerning monitoring of forest easement land in Maine. We have worked with the University of Connecticut on a joint EPSCoR proposal to NASA.

Support from YIBS:
The stable support from YIBS since the founding of the Center has allowed CEO to develop a high-quality basic infrastructure and an experienced staff. With fluctuating research funding, and considerable teaching and student project responsibilities, YIBS support has been a key to CEO's success.

Funded research:
The Center has experienced an unprecedented growth in its funded research this year. Two major NASA awards were announced in December 1999 and the research began in March 2000. These grants total about 1.6 million dollars over three years. They are specifically oriented towards remote sensing and could not have been won without the existence of the CEO. The Southwest Asia Project (SWAP) examines the changing landscape, hydrology and agriculture in the Middle East. The P.I.s are Frank Hole from Anthropology, and Ron Smith from G&G. The Characterization of Eco Regions in Africa (CERA) project examines the changes in forest and agriculture in west central Africa. The P.I.s are Mark Ashton from F&ES and Dr. Prasad Thenkabail from CEO. These grants support an expanded research staff during the

duration of the funded projects. The overhead funds from these grants go to Yale and F&ES respectively, and not to CEO.

The future of CEO

The rapid growth in satellite technology and the increased understanding that land use, landscape change, and habitat destruction are fundamental issues in environmental research suggest that the Center's resources will be increasingly in demand. The growth of Yale's effort in this area is mostly in the hands of the Departments and Schools. Strong faculty appointments in the areas of remote sensing, spatial analysis, and large scale environmental monitoring are needed to bring Yale to the first rank.

The CEO is in contact with other groups at Yale concerning a coordinated effort to strengthen Yale's geographical resources. Other players include the Map Library, the Science Library, the GIS lab at F&ES, and the Statistics Laboratory. For the future, we envision a "Geography Center" that encompasses all of these activities.

APPENDIX A – Observing Earth From Space Class Projects

Section 1: Oceans

Deborah Liptzin - Primary productivity cycles Amazon and Orinoco River regions

Erika Schaub - Ocean productivity changes in the Gulf of Maine

Neel Kamath - Remote sensing and applicability to coral reef ecosystem mapping

Section 2: Forests

Sue Barnes - Forest changes in southern Maine

Michael Beman - Correlating landcover change to carbon sequestration of forests

Silvia Benitez - Carbon cycle analysis in the Great Mountain Forest

Valerie Bodet - Temporal changes in an industrial forest in Georgia

Adriana Casas - Landcover changes in the Brazilian Amazon 1986 to 1996

Sarah Chamberlin - Deforestation in the southern Congo between 1984 and 1994

Victoria Chow - Examining easement monitoring techniques in Maine forests

Tiffany Lin - Agro-forest changes over time in northern Congo

Juan Zou - Quantify and qualify tropical deforestation in the Amazon

John McKenna - Changes in the Dzanga-Sangha Reserve in the Central African Republic

Section 3: Arid Lands

Wenbo Cao - Estimating desert water use from evaporative cooling

Sara Chen - Fallow cycle changes over time in Syria

Eden Enclona - Examine changes in irrigated agriculture in Syria

Melissa Droller - Land cover changes in Israel west of the Sea of Galilee

Section 4: Ecosystems/Geology/Other

Sean Gray - The physics of reflectance in glaciated alpine terrain

Lisa Max - Using the thermal band to improve classification of Cape Cod

Ben Piper - Habitat destruction over time near national parks in southern Brazil

Robert Rosenswig - Landcover issues in Belize

Mark Wishnie - Vegetation classification of sub-basins of the Panama Canal watershed

Heather McGray - Landuse patterns in the buffer zones around the La Amistad Biosphere Reserve in Costa Rica

Section 5: Epidemiology

John Brownstein - Tick borne encephalitis risk map of Europe

Hilary Rosen - West Nile Virus mosquito breeding sites in New York City

Section 6: New Haven and Connecticut Land Classification

William Caldicott - Measuring the ex-urban sprawl in the Greater Hartford area

Stacey Kingsbury - Rattlesnake habitat in Marlborough, CT

Greg Serenbetz - Landcover classification and change in the Mill River watershed

Matthew Morrison - Comparison of land cover classifications of the Naugatuck River watershed

Greg Socha - Multi-temporal landcover classification of northwestern Connecticut

Navis Bermudez - Quantify the amount of impervious surfaces in the Greater New Haven

APPENDIX B - Lectures presented by the CEO staff to support the following courses

Environmental Studies course taught by Mary Helen Goldsmith - lecture on an introduction to remote sensing with a focus on natural resource applications.

Introduction to Archeology course taught by Lucinda McWeeney - lecture on an introduction to remote sensing with a focus on archeological applications.

G&G Surveying course taught by Robert Gordon - lecture on GPS & GIS (with lab exercise)

Geology course taught by Jonathan Lees - lecture on an introduction to remote sensing.

APPENDIX C - Individual Student and Faculty Projects

Hydrological Modeling of the Levantine
Jeff Albert, F&ES

RS and GIS used to Identify, Map, and Predict Regions of Risk for Lyme Disease
John Brownstein, EPH

Field and numerical studies of glacier Engabreen in Northern Norway
Denis Cohen, G&G

Temperature, Rainfall and Settlement in the Near East
Ben Diebold, Anthropology

Cambodia Genocide Project
Matthew Fladelan, F&ES

Identification of Livingstone's Fruit Bat Roosting Sites in the Comoros Islands
Elise Granek, F&ES

Yale Meyers Forest Model
Anders Halverson, F&ES

Forest Stand Dynamics and Carbon Cycle
Huei-An Chu, F&ES

Mountain Induced Rainfall in the Southern Alps of New Zealand
Juan Zou, G&G

Bamboo-Dominated Forests of the Amazon
Bronson Griscom, F&ES

Investigation Of Paleoanthropological Sites Associated With The East African Rift Valley
John Kingston, G&G

Statistical Analysis of Image Classification Techniques
Olaf Kuegler, FES

Yale Glacier Analysis
Deb Liptzin, G&G

Land Use in Buffer Zones of La Amistad International Biosphere Reserve, Costa Rica
Heather McGray, F&ES

Landcover Classification of the Naugatuck River
Matthew Morrison, F&ES

Temporal Investigation of Cultivation Within and Bordering Araguaia National Park, Brazil
Ben Piper, F&ES/EPH

Northern Belize Landuse Project
Robert Rosenswig, Archeology

Land Cover Type Characterization and Change from AVIRIS Data

Land Cover Type Characterization and Change from AVIRIS Data
Georgia Silvera, F&ES

The Mastadon Project
Jim Wallis, Civil Engineering/F&ES

Mathematical Analysis of Hyperspectral Data
Fred Warner, Math

Analysis of Evaporative Cooling from Vegetation
Wenbo Cao, G&G

Characterization of Riparian Vegetation in Sub-Basins of the Panama Canal Watershed
Mark Wishnie, F&ES

Forest Stand Dynamics and Carbon Cycle
Xuhui Lee, F&ES

Forest Stand Dynamics and Carbon Cycle
Huaiyu Yuan, G&G

Regional Climate Model Simulations of the Middle East
Zav Kothavala, G&G

Major research projects at CEO:

SWAP - SouthWest Asia Project
http://www.yale.edu/ceo/Projects/swap.html

Ron Smith, G&G
Frank Hole, Anthropology
Roland Geerken, CEO
Jennifer Arz, Anthropology
Andrea Mautner, CEO
Eric Hole, CEO
Nicholas Kouchoukos, U of Chicago
Jane Foster, U of W. Virginia
Kirk Maaech, U of Maine
Robert Oglesby, Purdue/NASA
Jason Evans, ANU/G&G

MAP - Mesoscale Alpine Programme
http://www.geology.yale.edu/~smith/yale_map.html

Ron Smith, G&G
Qingfang Jiang, G&G
Sean Gray, G&G
Steve Skubis, SUNY
Matthew Fearon, G&G

CERA - Characterization of Eco Regions in Africa
http://www.geology.yale.edu/~smith/africa_project.html

Prasad Thenkabail, CEO
Tiffany Lin, F&ES
Eden Enclona, F&ES
Mark Ashton, F&ES

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YIBS 1999-2000 Annual Report

IV. YIBS RESEARCH CENTERS

D. Center for Ecology and Systematics of Animals on the Verge of Extinction (ECOSAVE) 1999-2000 Annual Report

Center Director, Elisabeth Vrba

Faculty Members:
Jacques Gauthier
Jeffrey Powell
Elisabeth Vrba

Senior Research Scientist:
Adalgisa, Director
ECOSAVE Conservation Genetics Laboratory

Major accomplishments in Jacques Gauthier's laboratory included reorganization of the Divisions of Vertebrate Zoology (VZ) and Vertebrate Paleontology (VP) in the Peabody Museum (PM) to better meet research and teaching needs of the Departments of Ecology and Evolutionary Biology (EEB), Geology and Geophysics (G&G), and Anthropology, as well as the Environmental Sciences Facility (ESF), Yale Institute for Biospherics (YIBS) and the School of Forestry and Environmental Studies (F&ES). The greater part of the reorganization plan has been realized in the past year: Mary Ann Turner has assumed the new Registrar position; Lyndon Murray, the new VP Collections Manager (CM), has arrived; and we are in the process of securing a new CM for "Dry" collections and a new Curatorial Assistant for VP. Jacques's analyses of lizard embryology, phylogeny, ecology and paleontology continued, resulting in the addition of new specimens to the PM collections through fieldwork in the Mojave Desert. Jacques also provided partial support for Skip Lazell and Greg Watkins-Colwell to collect amphibians and lizards from China, which specimens are now in the PM collections.

Papers (appeared or in press) by Jacques Gauthier during 1999-2000:

Wagner, G.P. and J.A. Gauthier. 1999. 1,2,3 = 2,3,4: A solution to the problem of the homology of the digits in the avian hand. Proceedings of the National Academy of Sciences 96:5111-5116.

Gauthier, J. and G. Wagner. 1999. 1-2-3 or 2-3-4 or both?: A solution to the problem of avian digit homology. Abstract In: American Society of Ichthyologists and Herpetologists (79th). Pennsylvania State University, State College.

Nydam, R.L., J.A. Gauthier, and J.J. Chiment, 2000. The mammal-like teeth of the late Cretaceous lizard Peneteius aquilonius Estes 1969 (Squamata, Teiidae). Journal of Vertebrate Paleontology 20(3):628-631.

Laurin, M. and J.A. Gauthier, 2000. In Maddison, D. and Maddison, W. (eds), The Tree of Life, entries on : Amniota; Amniote phylogeny; Autapomorphies of amniote clades; Diapsida; Diapsid phylogeny; Autapomorphies of diapsid clades.

Jeff Powell's group continued to focus their major conservation efforts on giant Galapagos tortoises. Two important events occurred this past year. They published their first paper on these tortoises and it garnered considerable attention, including the public press (New York

Times, British Broadcasting Corporation, among others). Second, this past summer the team made a successful collecting trip, partly funded by YIBS in the form of ECOSAVE funds, to sample the two remaining subspecies not previously sampled. They returned with about 200 blood samples, and now have about 2,400 blood samples, which are being analyzed, in the laboratory.

Papers (appeared or in press) by Jeff Powell during 1999-2000:

Caccone, A., G. Amato, O. C. Gratry, J. Behler, J.R. Powell. 1999. A molecular phylogeny of four endangered Madagascar tortoises based on mtDNA sequences. Molecular Phylogenetics and Evolution,12: 1-9.

Caccone A, J.P. Gibbs, V. Ketmaier, El. Suatoni, J. R. Powell. 1999. Origin and evolutionary relationships of giant Gálapagos tortoises. Proceedings National Academy of Sciences (PNAS) USA, 96: 13223-13228.

Powell, J. R., A. Caccone, V. Petrarca, A. della Torre, and M. Coluzzi. 1999. Population structure, speciation, and introgression in the Anopheles gambiae complex. Parassitologia 41:101-113.

Gentile G., M. Slotman, V. Ketmaier, J.R. Powell, and A. Caccone. 2000. Attempts to molecularly distinguish cryptic taxa in Anopheles gambiae s.s. Insect Molecular Biology (in press).

In Elisabeth Vrba's ECOSAVE program, a paper on the causes of macroevolution in African Neogene biota and hominids was completed and published by the end of 1999 (Vrba, 1999). Continuing collaboration with other members of the Middle Awash Research Program on new fossil finds from Late Neogene Ethiopian fossil strata resulted in publication de Heinzelin et al. (1999) in Science on the environment and behavior of the new hominid species Australopithecus garhi. The year 1999-2000 marked the final preparation and publication of the volume "Antelopes, Deer, and Relatives: Fossil Record, Behavioral Ecology, Systematics and Conservation" (eds Vrba, E.S. and Schaller, G.B.) with chapters from 22 international contributors, sponsored by YIBS and the Wildlife Conservation Society, New York. New systematic analyses of living and extinct antelopes (Bovidae) culminated in the first cladistic analysis of bovids that combines behavior and ecology with soft and hard anatomy (Vrba and Schaller, 2000.) A preliminary report on a comprehensive new analysis of the all-African fossil record of larger mammals over the past 22 million years was completed and used to test hypotheses of macroevolution (Vrba in press, in Cenozoic Geology of Southern Africa). A new statistical method was developed for calculation of the expected frequencies of first and last appearances of species in the fossil record under the null hypothesis of underlying constant probabilities of origination and extinction. This method takes into account the observed changes in fossil preservation over time and geography, and adjusts expected turnover frequencies accordingly. It allows statistical testing, by use of the hypergeometric distribution, of observed frequencies of first and last appearances of species in the fossil record against the frequencies expected under the null hypothesis. The results, which point out intervals of significantly high speciation, migration, and/or extinction, are then compared with independent evidence of climatic change. A detailed analysis by these methods of the African mammal record is in progress.

Papers (appeared or in press) by Elisabeth Vrba during 1999-2000:

de Heinzelin, J., Clark, J.D., White, T., Hart, W., Renne, P., WoldeGabriel, G., Beyene, Y. and Vrba, E.S. 1999. Environment and behavior of 2.5-million-year-old Bouri hominids. Science 284 : 625-629.

Vrba, E.S. 1999. Habitat theory in relation to the evolution in African Neogene biota and hominids. In T.G. Bromage and F. Schrenk (eds.), African Biogeography, Climate Change, and Early Hominid Evolution, pp. 19-34. Part of New Series on Human Evolution (Series Eds Wood, B. and Ciochon, R.). Oxford University Press, Oxford, United Kingdom.

Vrba, E.S. and Schaller, G.B. (eds.) 2000. Antelopes, Deer, and Relatives: Fossil Record, Behavioral Ecology, Systematics, and Conservation. Yale University Press, New Haven, Connecticut.

Conservation. Yale University Press, New Haven, Connecticut.

Vrba, E.S. and Schaller, G.B. 2000. Introduction. In Vrba, E.S. and Schaller, G.B. (eds.) Antelopes, Deer, and Relatives : Fossil Record, Behavioral Ecology, Systematics, and Conservation. Yale University Press, New Haven, Connecticut.

Vrba, E.S. and Schaller, G.B. 2000. Phylogeny of Bovidae (Mammalia) based on behavior, glands and skull morphology. In Vrba, E.S. and Schaller, G.B. (eds.) Antelopes, Deer, and Relatives : Fossil Record, Behavioral Ecology, Systematics, and Conservation. Yale University Press, New Haven, Connecticut.

Vrba, E.S. In press. Major features of Neogene Mammalian Evolution in Africa. In T.C. Partridge and R. Maud (eds.), Cenozoic Geology of Southern Africa. Oxford University Press, Oxford, United Kingdom.

Vrba, E.S., In press. Comments on Stephen Jay Gould. Natural History.

Vrba, E.S. In press. Expatiation. In Pagel, M. Encyclopedia of Evolution. Oxford University Press, Oxford, United Kingdom.

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The ECOSAVE Conservation Genetics Laboratory Annual Report 1999-2000

Laboratory Director, Adalgisa Caccone

FORMAL COURSES:

Spring

Molecular Approaches to Systematics, Conservation Genetics, and Behavioral
Ecology (EEB 375b/535b and F&ES 578)
This course had twelve students enrolled for credit and five graduate students and post docs auditing it. People who attended were from the Department of Ecology and Evolutionary Biology, the Department of Molecular, Cellular, and Developmental Biology, Anthropology, the Department of Geology and Geophysics, the School of Forestry and Environmental Studies, and the Department of Epidemiology and Public Health.

Fall

Laboratory in Molecular Systematics (EEB315La, cross-listed in F&ES)
Last year this course had an enrollment of eight students. This year the enrollment is ten students (the maximum number accepted). Students are both undergraduates and graduate students from the School of Forestry and Environmental Studies.

Conservation biology (EEB115)
This is the first year for this course, which is team-taught by Jeff Powell, Oswald Schmitz, and Gisella Caccone. The course has an attendance of approximately 100 students.

Laboratory Training

During the past year, Dr. Caccone has been supervising the research of five graduate students (four from the Department of Ecology and Evolutionary Biology and two from the School of Forestry and Environmental Studies, and six undergraduate students who are Organismal Biology majors. Several other graduate students have utilized the equipment and computer facilities of the ECOSAVE Conservation Genetics Laboratory (approximately five to six graduate and undergraduates).

Publicizing YIBS and the ECOSAVE Conservation Genetics Laboratory outside of Yale

Invited talks:

Symposium on Endangered Species" sponsored by the America Type Culture Association (Orlando 19 April, 1999)

Symposium on "Museum, Universities, and Biodiversity in the 21st Century" (San Francisco 7-10 May 1999)

Symposium on "Evolutionary Significance of Colonization" (European

Evolutionary Society meeting, Barcelona 23-28 August 1999).

Evolutionary Society Meeting, Barcelona 25-28 August 1999).

In the first two Symposia, Gisella Caccone talked about the ECOSAVE Conservation Genetics Laboratory as part of the efforts by YIBS and Yale to address the need for formal training in the emerging field of conservation genetics and the study and preservation of biodiversity.

Organizing a Symposium on "Molecular Approaches to Conservation ": Together with George Amato Wildlife Conservation Society (WCS), Gisella Caccone organized a symposium within the meeting of the Society for Molecular Biology and Evolution, Yale University, New Haven, CT June 17-20, 2000. Invited speakers included: Oliver Ryder, Zoological Society of San Diego; Robert Fleischer, Smithsonian institution; Rob De Salle, American Museum of Natural History. The scope of the Symposium was to discuss the role of genetics in conservation biology among a group of molecular evolutionists to look in depth at the issue of what molecules can and cannot do in conservation biology. Usually these topics are debated in conservation biology meetings, where expertise in genetics is limited.

Ongoing Research Projects:

Molecular Biogeography Of Cave Life: A Study Using MtDNA From Bathysciine Beetl>
This study focuses on phylogenetic relationships in two distinct species assemblages of cave-dwelling beetles with similar disjunct distributions in the Pyrenees and Sardinia. One assemblage contains six species in the genera Ovobathysciola (four species) and Patriziella (two species) on Sardinia and one species of Anillochlamys in the Pyrenees. Species within the two Sardinian genera co-occur in the same karst area. Although, they are believed to be each other's closest relative, they have very different body types (globular body with short appendages in Ovobathysciola; elongated body with long appendages in Patriziella), which are believed to reflect different degrees of adaptation to cave life. The other assemblage of Bathysciine beetles includes three species in the genus Speonomus in the Pyrenees and one on Sardinia. All the species are rare and many are endangered. One issue of particular interest was whether Ovobathysciola and Patriziella are reciprocally monophyletic, or whether each of the Patriziella species evolved independently from the co-occurring Ovobathysciola species, as the similar morphology of the Patriziella species might be due to convergence rather than common descent. Based on DNA sequences of the COI region of the

mtDNA, neither scenario was supported. Rather the two Patriziella species are sister taxa embedded within the Ovobathysciola radiation. In addition, the well-dated geological history of this region allowed us to calibrate absolute rates of COI evolution, the first such estimates for any insect. Finally this study suggests that the evolutionary acquisition of typical cave adaptations (e.g., elongated body and appendages) may occur at about the same rate as loss of traits (e.g., eyes and pigmentation) associated with cave life.

Conservation Genetics of Galapagos tortoises
In collaboration with Jeffrey Powell (EEB) we are carrying out an extensive survey of the genetic divergence within and between the eleven extant sub species of the Galápagos giant tortoises, Geochelone nigra. These tortoises are the largest living tortoises and one of the two remaining species of giant tortoises in the world. Within the archipelago, only eleven of the subspecies survive to the present. Most of the subspecies are endangered. The decline of the populations is primarily due to human impact. Buccaneers and whalers began in the 17th century to remove tortoises from the islands and use them as a source of fresh meat. Introduced animals such as feral goats, pigs, dogs, rats and continued poaching represent more threats to the surviving populations. Although these tortoises have become a symbol of the conservation efforts to preserve the unique fauna of the Galápagos Islands, little is known about the levels of genetic divergence between the different subspecies.

Previous work on several mtDNA genes has produced the first DNA based phylogeny of the group and shown the presence of fixed

nucleotide differences between most of the 11 surviving subspecies. This year we concentrated on:

- analyzing patterns and levels of genetic divergence on fast evolving nuclear DNA regions
- using the fixed DNA differences found in the mtDNA to assign individuals of unknown origin to a particular island and sub-species. The information gathered from this study is helping in the management of breeding programs of both wild and captive individuals.
- Conservation genetics of the Aldabra Giant Tortoises

With funds generated from a gift from Coleman Burke to YIBS, we have recently begun a genetic study of the Aldabra and Seychelles tortoises (Geochelone gigantea), a group of highly endangered giant tortoises. We want to produce relevant data that will aid in understanding the phylogeny and taxonomy of the group, and to help in designing in situ conservation programs for this group. Gisella Caccone is collaborating with Justin Gerlach from Cambridge, England, who will provide blood from wild caught animals from all the extant newly described species, and with several Zoos in the

USA to obtain blood samples from the Aldabra and Seychelles tortoises in captivity. To date we have blood from thirty animals and we were successful in amplifying and sequencing one mitochondrial gene (cytochrome b). Future work will concentrate on assaying for genetic variation other DNA regions, producing a phylogeny for the group, and finding DNA markers that will help in the management of breeding programs for this species.

Attempts to Molecularly Distinguish Cryptic Taxa in the Anopheles gambiae s.s. mosquitoes
The Anopheles gambiae complex contains the most important vectors of malaria in sub-Saharan Africa, and hence the world. Despite decades of research on this complex, it continues to reveal novel complexity. Until about 1960, it was considered a single species; between 1965 and about 1985, it was considered six species. In the last 15 years, the systematic status of the complex has again been thrown into turmoil, especially centered on the most important taxon, An. gambiae s.s. It is now clear from analyses of frequencies of chromosomal inversions, that this "species" is subdivided into distinct genetic units, i.e., An. gambiae s.s. is not a single panmictic unit. This has great practical significance: it impacts such important processes such as the spread of insecticide resistance genes as well as impact the outcome of any attempts to genetically manipulate populations. In addition, these chromosomally defined "forms" are ecologically distinct which determines their spatial and temporal distributions, e.g., the Mopti form can breed in the dry season, thus allowing transmission of malaria year round. To date these forms have largely been defined by inversions in the right arm of the second chromosome. Considerable effort has been expended in searching for DNA-based markers that would both confirm the reality of the forms as genetically distinct, as well as provide a diagnostic procedure to identify the forms in both sexes at all developmental stages, a great benefit to field research. Such attempts have been only partially successful. We have been applying a relatively new approach, which combines advantages of previous approaches without the drawbacks; it is called AFLP (Anonymous Fragment Length Polymorphism). Moreover, we have modified it to further increase its usefulness as a diagnostic tool in epidemiology. This technique allows a rapid screen to detect DNA differences between large numbers of mosquitoes simultaneously; many sequences are simultaneously compared.

Phylogenetic relationships of the relict snakes in North America
Theodora Pinou, a lecturer in the EEB, is collaborating with Jeff Powell on a project attempting to resolve one of the last remaining questions regarding the origin and relationships of Nearctic snakes. This will be accomplished by reconstructing the phylogeny of eight enigmatic species of North American snakes called Relicts, whose affinities to one another, and to other snakes are poorly

understood. The two hypotheses that will be tested are that all

eight of the North American Relict snakes form a monophyletic group, and that these North American Relicts are most closely related to a South American clade of xenodontine snakes. The project entails:

I. To isolate DNA from several individuals of each Relict species;

II. To sequence mitochondrial and nuclear gene regions for each Relict species;

III. To combine these 12s and 16s mitochondrial sequences into an existing database of aligned snake sequences;

IV. To employ methods of phylogenetic reconstruction of the mitochondrial and nuclear gene regions.

The results of this work provide several valuable contributions to the field of Systematic Zoology. First, this study will provide an evolutionary framework for studying the biodiversity and biogeography of the Nearctic fauna. Second, this study will provide a comprehensive phylogenetic framework from which to examine the evolution of morphological characters in snakes. Third, this study will contribute to our understanding of the differences in the pattern and rate of molecular evolution between nuclear and mitochondrial genes in another vertebrate group (i.e., snakes). Fourth, this work offers the opportunity to train two undergraduate students in the fields of molecular systematics and taxonomy, and to expose them to scientific meetings, good habits in museum science, and manuscript preparation.

Determining phylogenetic relationships between extant prairie chicken populations and the extinct heath hen based on mitochondrial DNA sequences
Eric Palkovacs, a master student from the School of Forestry and Environmental Studies, is engaged in a study of the genetic differentiation of extant and extinct prairie chickens. The Eastern prairie chicken subspecies, the heath hen (Tympanuchus cupido), once roamed the fields and scrub oak lands of New England. The heath hen clung precariously to existence for sixty years as a small population limited to the island of Martha's Vineyard until it was driven to extinction in 1932. Greater prairie chicken populations are declining across most of their range, and the Attwater's prairie chicken (Tympanuchus cupido attwateri), which is limited to a small population on the Gulf Coast of Texas, is critically endangered and may soon join the heath hen if current population trends do not change. We are using mitochondrial DNA sequence analysis to assess levels and patterns of genetic variation within and between populations and subspecies of North American prairie chickens (Tympanuchus cupido), including the extinct heath hen. We are analyzing field-collected blood and feather samples from range-wide greater prairie chicken populations and from the single Attwater's prairie chicken population. We are also examining genetic material from museum skin heath hen specimens from Yale University's

Peabody Museum, the American Museum of Natural History in New York, and private collections on Martha's Vineyard. The resulting molecular phylogeny will have important conservation implications. First, The Nature Conservancy has shown considerable interest regarding the re-establishment of a population of prairie chickens on Martha's Vineyard to replace the heath hen, and one role of this project is to identify the closest extant relative of the extinct heath hen for this potential introduction. Second, this project will elucidate the genetic distinctiveness of the Attwater's prairie chicken population and other greater prairie chicken populations, thereby providing valuable information for determining whether supplementing declining populations is a desirable conservation strategy.

Mate recognition Systems in Rotifers
Lisa Suatoni, an EEB graduate students, is studying the role of mate recognition divergence in speciation in the marine rotifer Brachionus plicatilis. This entails looking for large-scale and small-

scale patterns of divergence in the mate recognition system within this species complex. She is quantifying and mapping degrees of mate recognition onto a phylogeny of populations from around the world. Imbedded in a branch of this phylogeny will be a smaller scale phylogeny of populations in a local and regional area. This will help to ascertain what evolutionary forces (drift, selection) are playing the largest role in the divergence of this mate recognition system.

Genetic differentiation of European populations of roe deer
Saverio Vicario, a graduate student from EEB is collaborating with Gisella Caccone and Frederika Kaestle from Anthropology, to analyze levels of genetic variation in extant and extinct populations of Italian populations of roe deer. Roe deer are distributed in the Palaearctic and in continental Asia. The European roe deer (Capreolus capreolus) show wide morphological, ethological, and ecological variability. Roe deer populations in southwest Europe have been relatively disturbed as a consequence of habitat fragmentation and restocking for hunting purposes. Roe deer populations of the western Italian Alps have been extirpated by over-hunting during the last 30 years, and then restored using stocks from the eastern Alps, central Europe and the Balkans. In contrast, roe deer of the eastern Italian Alps have been preserved and still represent the autochthonous Alpine populations. Isolated roe-deer populations in central-southern Italy have been recognized as an endemic subspecies, named C.c. italicus. The levels of genetic diversity and the phyleogeographic relationships among roe deer populations are poorly known. Therefore, the eventual genetic consequences of human disturbances are still unknown. For these reasons, roe deer provide a case study to evaluate the genetic effects of fragmentation and human disturbances on managed populations. We are analyzing historical (pre-dating the restocking of the natural populations) and fossil samples (from the Pleistocene)

to study the genetic structure in undisturbed vs., disturbed roe deer populations. The comparison of historical and fossil samples from southern Italy with modern samples will be important in assessing if the southern Italian subspecies (now reduced to few animals in a protected area) is genetically distinct from the other Italian populations. This will also provide valuable information for determining whether supplementing the declining population is a desirable conservation strategy and eventually suggesting from which populations the restocking should occur.

Use of molecular techniques to study levels of fungal diversity on root tips
Michael Booth, a Ph.D. student in the School of Forestry and Environmental Studies, is working on using molecular techniques to study levels of fungal diversity on root tips. Many recent papers have documented the potential for many species of ectomycorrhizal fungi to form extensive belowground networks that connect the roots of co-occurring trees, often including a diversity of tree species. To gain an initial estimate of fungal "host-generality" (or "host-inspecificity") Michael is collecting several seedlings each of the five or six dominant forest species where they co-occur and are growing underneath a similarly diverse forest overstory. He samples root tips from each seedling and will sort them initially by morphotype. Then he will extract DNA from them, and Gisella Caccone will amplify the ITS region of the fungal DNA and study the pattern of genetic variation at that locus.

Individuality and Multilevel selection in the Colonial Rotifer Sinantherina socialis
Melissa Garcia, an EEB graduate student, is using the colonial rotifer, Sinantheria socialis to study multilevel selection and individuality. S. socialis colonies are suitable for this study because they have characteristics which are more typical of individuals rather than of colonies. For example, a juvenile colony is produced as a unit, it matures as a unit, it reproduces fully formed juvenile colonies as a unit, and it senesces as a unit. An additional trait of S.socialis colonies, which is important to this study, is that, under some circumstances juvenile colonies fuse. Colonies consist of zooids (colony members). For a given heritable colony trait, that

zooids (colony members). For a given heritable colony trait, that trait's evolution can be influenced by the effects of colony level selection and zooid level selection. When there is only colony level selection with no zooid level selection, then the colony itself begins to take on characteristics of an individual. In order to study the degree of individuality in S.socialis colonies, various laboratory lines of S. socialis colonies are used to analyze the levels of selection for given traits, the heritability of these traits, the mechanism of colony reproduction, and the effects of colony fusions on individuality. An important part of this project is verifying that the different laboratory lines of S.socialis are genetically distinct and that the results gathered are not particular to a single clone. This is especially important for the colony fusion studies. Preliminary evidence, such as the fact that the different lines have different pH tolerances, suggests that the laboratory lines are genetically distinct. This will be verified using molecular methods; DNA will be isolated and PCR will be used to amplify highly variable regions to look for differences between lines. This method has been used with success on other rotifer species.

PUBLICATIONS 1999-2000

Caccone, A., G. Amato, O. C. Gratry, J. Behler, J.R. Powell. 1999. A molecular phylogeny of four endangered Madagascar tortoises based on mtDNA sequences. Molecular Phylogenetics and Evolution,12: 1-9.

Allegrucci G., A. CACCONE, V. Sbordoni. 1999. Cytochrome b sequence divergence in the European Sea Bass (Dicentrarchus labrax) and phylogenetic relationships among some Perciformes species. J. of Zool. Syst. and Evol. Res. , 37:149-156.

Caccone A, J.P. Gibbs, V. Ketmaier, El. Suatoni, J. R. Powell. 1999. Origin and evolutionary relationships of giant Gálapagos tortoises. Proceedings National Academy of Sciences (PNAS) USA, 96: 13223-13228.

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Caccone A and V. Sbordoni. 2000. Molecular Biogeography Of Cave Life: A Study Using MtDNA From Bathysciine Beetles. Evolution (in press).

Gentile G., M. Slotman, V. Ketmaier, J.R. Powell, and A. Caccone. 2000. Attempts to molecularly distinguish cryptic taxa in Anopheles gambiae s.s. Insect Molecular Biology (in press).

Pinou T. and A. Caccone. A method of obtaining mitochondrial DNA from snake bone. Herpetological Review (submitted).

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E. The Center for the Study of Global Change 1999-2000 Annual Report

The Center for the Study of Global Change, under the directorship of Karl K. Turekian, offers a fall and spring seminar series of “Topics in Global Change.”

TOPICS IN GLOBAL CHANGE, Fall, 1999

Monday, 2:00 - 3:30 PM, Room 102 Kline Geology Laboratory

September 13	Karl K. Turekian, Department of Geology & Geophysics, Yale University: “Geochemistry and global change”
September 20	John Mak, SUNY, Stony Brook: “Assessment of tropospheric OH levels using 14CO”
September 27	Roger Summons, Australian Geological Survey: “Molecular evidence bearing on the presence of molecular oxygen in the Precambrian Earth's ocean

	in the Precambrian Earth's ocean-atmosphere system"
October 4	Steven Stanley, Johns Hopkins University: "On the cause (and possible end) of the modern ice age"
October 11 123 KGL	Susan Solomon (Zucker Fellow), Environmental Research Laboratories, Boulder, NOAA: "Ozone depletion from pole to pole"
October 14 Thursday	Wallace Broecker, Lamont-Doherty Earth Observatoryof Columbia University "Reconstruction past deep ocean carbonate concentrations"
October 18	Steven Goldstein, Lamont-Doherty Earth Observatory of Columbia University "What do Nd and Sr isotopes in marine sediments tell us about glacial-interglacial changes in the 'great ocean conveyer'?"
October 25	*No session Geological Society of America meeting*
November 8	David Beerling, Department of Plant and Animal Science, Sheffield University (UK); "Plants in an ancient greenhouse world"
November 15	Special Seminar of the regional National Academy of Sciences
November 18 thursday	Henry Fricke, Department of Paleobiology, Smithsonian Institution and Geophysical Laboratory "Oxygen isotope evidence for warm blooded dinosaurs and its importance to the study of terrestrial environments during the Mesozic"
November 29	Ken Caldeira, Lawrence Livermore National Laboratory: "Geoengineering Earth's radiation balance to mitigate anthropogenic climate change"

TOPICS IN GLOBAL CHANGE, Spring, 2000

Monday, 2:00 - 3:30 PM, Room 102 Kline Geology Laboratory

January 24	Steven D'Hondt, Graduate School of Oceanography, University of Rhode Island: "Organic fluxes and ecological recovery from the Cretaceous/Tertiary mass extinction"
January 31	Jean Lynch-Stieglitz, Lamont-Doherty Earth Observatory at Columbia University: "Reconstructing upper-ocean density structure and circulation during the last Glacial Maximum"
February 2 Wednesday	Boaz Luz, Hebrew University: "A new approach to the assessment of oceanic production"
February 14	Martin Stute, Lamont-Doherty Earth Observatory of Columbia University: "Climate signals of the last Ice Age in groundwater"
February 21	Peter Reiners, Washington State University: "Measuring the timing, rates and styles of orogenic exhumation and topographic development with (U-Th)/He

	thermochronometry”
February 28	Peter Buseck, Arizona State University: “Minerals in the air: an environmental perspective”
March 20	Michael Ghil, UCLA: “Ice ages and global warming: What are we doing that the climate isn’t?”
March 27	Dorothy Peteet, Lamont-Doherty Earth Observatory of Columbia University: “Rapid vegetional changes in coastal North America the response to climate since the last maximum”
April 3	Timothy Herbert, Brown University: “Regional patterns of ocean cooling and warming during the last Ice Age cycle”
April 10	Edouard Bard, University of Marseille-Ais: “The penultimate glaciation as viewed from the geochemistry of deep-sea ediments and submerged stalagmites”
April 17	Richard Alley, Pennsylvania State University: “Crazy climate: ice-core records of large, rapid and widespread climate changes”
April 24	Robert Oglesby, Purdue University: “Modeling the glacial and climatic history of Antarctica”

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V. SPONSORED PROGRAMS AND SEMINARS

The Society for Conservation Biology
1999-2000 YIBS Support for Spring Seminar Series

Speaker: David Olson	World Wide Fund for Nature
Speaker: Peter Seligmann	Conservation International
Speaker: James Leape	World Wide Fund for Nature
Speaker: George Hall	Woods Hole Oceanographic Research Center

Symposium on "Molecular Approaches to Conservation"
Presented at the Society for Molecular Biology and Evolution meeting in June - 2000

This symposium was sponsored by the Yale Institute for Biospheric Studies and the World Wildlife Conservation Society and was organized by Dr. Gisella Caccone, Director of the ECOSAVE Conservation Genetics Laboratory and by Dr. George Amato of the World Wildlife Conservation Society.
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VI. COURSES

STEV 110b/EEB 110b, Environmental Studies - Rob Dorit
An introduction to environmental studies. Concepts include demography, complexity, risk assessment, and interaction. Case studies include emerging infectious disease, the design of conservation areas, and global warming. Emphasis on interdisciplinary approaches to environmental issues.

STEV 205b^{G}/MCDB 150 b^{G}, Global Problems of Population Growth - Robert Wyman
The worldwide population explosion in its human, environmental, and economic dimensions. Sociobiological bases of reproductive behavior. Population history and the cause of demographic change. Interactions of population growth with economic development and environmental alteration. Political, religious, and ethical issues surrounding fertility; human rights and the status of women.

STEV 466b, Multidisciplinary Approaches to Managing Earth and Its Resources. Gordon Geballe, Mary Helen Goldsmith (in charge)
An introduction to the techniques, methods of analysis, and interpretation of data that different disciplines apply to investigating global environmental concerns. In preparation for designing their senior research projects, students work on cooperative projects during the term.

STEV 496a or b, Senior Research Project and Colloquium - Steven Stoll and Staff
Research projects under the supervision of members of the faculty. Students are encouraged to undertake projects that not only meet the requirements of their primary majors, but that provide substantial opportunity for multidisciplinary work on environmental problems.

Throughout the year, students meet at intervals to discuss their progress with their peers and the faculty. During the spring term of their junior year, Studies in the Environment majors must submit a written proposal for their senior project for approval. Prior to this, students should consult with the adviser of their research project and the directors of undergraduate studies in both majors about the design of the project.

G&G 362b[G], Observing the Earth From Space – Ronald Smith
A practical introduction to satellite image analysis of the Earth's surface. Topics include the spectrum of electromagnetic radiation, satellite-borne radiometers, data transmission and storage, computer image analysis, the merging of satellite imagery with GIS and applications to weather and climate, oceanography, surficial geology, ecology and epidemiology, forestry, agriculture, archaeology, and watershed management. Preference to undergraduates in Geology and Geophysics, Anthropology, and Studies in the Environment.

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