

# YALE ENVIRONMENTAL NEWS

The Peabody Museum of Natural History, the School of Forestry & Environmental Studies, and the Yale Institute for Biospheric Studies

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## Rita Colwell Named First Edward P. Bass Distinguished Visiting Environmental Scholar

*The Edward P. Bass Distinguished Visiting Environmental Scholar program was created in July 2002 with a generous endowment gift by its namesake to the Yale Institute for Biospheric Studies (YIBS). The program was set up to bring scholars who are active researchers in the broad area of the environment to Yale for an extended period. Scholars are nominated through the YIBS Faculty Council.*

YIBS Director Derek Briggs is pleased to announce the appointment of Dr. Rita Colwell as the first Bass Distinguished Environmental Visiting Scholar, and she will be in residence at Yale from January 15, 2005 through April 2005.

Dr. Colwell is currently chairman of Canon US Life Sciences, Incorporated and Distinguished University Professor both at the University of Maryland at College Park and at Johns Hopkins University Bloomberg School of Public Health. She served as the eleventh Director of the National Science Foundation, 1998–2004, and in that capacity served as Co-chair of the Committee on Science of the National Science and Technology Council. Her major interests include K–12 science and mathematics education, graduate science and engineering education and the increased participation of women and minorities in science and engineering. She is also interested in global infectious diseases, water and health, and is currently developing an international network to address emerging infectious diseases and water issues, including safe drinking water for both the developed and developing world.

Dr. Colwell bridges the disciplines of environmental science and medical epidemiology, establishing this special role through her landmark discovery of the role of marine plankton as natural reservoirs of *Vibrio cholerae*, the agent of epidemic cholera. She has tracked the global distribution of cholera and associated outbreaks with climatic events that influence sea surface temperature and plankton blooms, and coupled fieldwork with the power of remote sensing. Her investigations were among the first to demonstrate the application of remote sensing technologies to epidemiology. This rapidly developing field



of study is being pursued at Yale through the YIBS Center for Earth Observation.

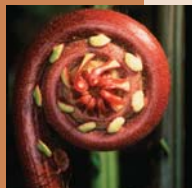
The announcement of Dr. Colwell's visit to Yale as a Bass Distinguished Scholar has already generated great interest among faculty and students in the Department of Ecology & Evolutionary Biology, the School of Engineering, the School of Epidemiology and Public Health, and the Department of Geology & Geophysics, who are familiar with her work as a landmark in interdisciplinary research. Her visit will also assist the effort to further interdisciplinary ties between medical epidemiology and environmental science at Yale. During her time here, Dr. Colwell will give seminars, interact with students and research groups, and participate in the life of several academic departments.

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# FACULTY NEWS



## New Faculty

### Dr. Alexey Fedorov Joins Geology & Geophysics Faculty

Dr. Alexey Fedorov joined Yale in July 2004 as Assistant Professor of Geology & Geophysics. His research interests are centered on the role of ocean in climate both today and in the past. Dr. Fedorov's scientific career began with studying small-scale air-sea interactions essential in controlling the physical properties of the ocean surface. For his Ph.D. dissertation at Scripps Institution of Oceanography, he developed a model description of breaking surface waves forced by wind. He defended his thesis, *Nonlinear Effects in Surface and Internal Waves*, in 1997, and a year later, came to work at Princeton University, at the Program in Atmospheric and Oceanic Sciences. There he became interested in large-scale climate problems such as decadal changes of El Niño or climate feedbacks leading to the Ice Ages. Fedorov says that coming to Yale gives him the opportunity to join a vibrant group of researchers with diverse interests looking to solve fundamental problems in earth, oceanic, and atmospheric sciences.

Currently Fedorov's research is focused on dynamical processes in the ocean and atmosphere that are relevant to phenomena ranging from oceanic general circulation to large-scale climate fluctuations caused by ocean-atmosphere interactions. The same phenomena are likely to contribute to seasonal, interannual, and decadal climate variability, and to oceanic response to global warming. Applying a hierarchy of models extending from idealized dynamical systems to comprehensive numerical

General Circulation Models, Fedorov strives to combine theoretical and numerical approaches with the analysis of data from observations.

We know that ocean is important for anything from day-to-day weather (remember hurricanes) to interannual climate changes (El Niño), but what are the long-term global effects of the ocean-atmosphere interactions, on the timescale of thousands of years? Fedorov has been involved in testing a hypothesis that unstable ocean-atmosphere interaction may play a role in slow climate fluctuations, such as those leading to glacial cycles. Because of the vast area of the tropics, any tropical cooling/warming may lead to changes in the globally averaged surface temperature by changing the net heat fluxes, as well as by influencing the earth's cloud cover and albedo, i.e., the reflectivity of the earth's surface. A surprising conclusion of this study is that in order to explain why ice grows in high latitudes, we may need to understand the low-latitude processes first.

### Dr. Suzanne Alonzo Joins Ecology & Evolutionary Biology Faculty

Dr. Suzanne Alonzo joined Yale in July 2004 as Assistant Professor in the Department of Ecology and Evolutionary Biology. She studies the evolution and ecology of mating systems and reproductive strategies using a combination of field studies, laboratory research, and mathematical models. Her research interests include the evolution of alternative reproductive strategies, conflict between the sexes over mating and parental care, the effect of interactions between species on evolution within species, and the importance of behavior and life history patterns on the management and conservation of species. Before arriving at Yale, she was a researcher at the Institute of Marine Sciences at the University of California, Santa Cruz, where she also spent three years as a National Science Foundation postdoctoral Fellow in the Department of Environmental Studies. Dr. Alonzo received her Ph.D. in 1998 from the Department of Ecology, Evolution, and Marine Biology at the University of California, Santa Barbara, and her bachelor's degree from the Department of Integrative Biology at the University of California, Berkeley.

Dr. Alonzo's research combines mathematical models and empirical studies to consider the effect of interactions within and between the sexes on observed reproductive behaviors. Using game theoretical models, she predicts how competition within a sex and interactions between the sexes are expected to affect the distribution of mating success among individuals, and thus the potential for selection on reproductive traits such as mate choice, territoriality, and sperm production. The predictions of these models are then tested in empirical systems, including a Mediterranean species of fish and the side-blotched lizard found in North America.

Dr. Alonzo has also used her understanding of animal behavior to develop theory and make management recommendations for species that are commercially exploited. In the Antarctic, krill are the main food source for many predators, including seals, penguins, and whales. Recent increases in the exploitation of krill has led to the concern that local depletion may impact the survival and reproduction of the many predators that depend on krill. With colleagues, Dr. Alonzo developed a theory to understand the conditions under which land-based predators might experience a local depletion of krill. Dr. Alonzo also recently led a team of researchers from the University of California, Santa Cruz; the National Marine Fisheries Service; and the California Department of Fish and Game in conducting an assessment of a commercially exploited fish, California sheephead, that changes sex from female to male as it grows and ages. This stock assessment was the first to consider sex change explicitly and indicated it is necessary to consider behavior and life history patterns when managing species.

Dr. Alonzo is building a research group at the Osborn Memorial Laboratories to address a variety of questions about the ecology and evolution of mating systems and reproductive patterns. She will be teaching an undergraduate course in animal behavior as well as a graduate course on mathematical models in ecology and evolution over the next academic year.

# MARSH BOTANIC GARDEN



View of the gently sloping hillside below Marsh Hall in spring ca. 1940. Historic photograph from the Marsh Botanic Garden collection.

## Poised for the Future The Marsh Botanic Garden (1899–2004)

by Mary Helen M. Goldsmith

*Professor, Department of Molecular, Cellular & Developmental Biology; Director, Marsh Botanic Garden, 1986–2002*

One of Yale's lesser known assets—its botanic garden—is currently receiving renewed attention for its multiple roles in the research, teaching, and appreciation of plants by faculty, students, and the wider community. Othniel C. Marsh, Yale alumnus and professor responsible for the Peabody Museum of Natural History's (YPM) world-renowned collection of dinosaurs, also collected plants during his travels, displaying them in the gardens and greenhouses surrounding his home at the crest of the hill north of the campus. On his death in 1899, he bequeathed to Yale this tract

of nearly eight acres, bordered by Prospect Street, Hillside Terrace, and Mansfield Street, stipulating that it should be “used as a University Botanic Garden and for no other use or purpose.” In 1900, the Marsh mansion became the home of the fledgling Yale School of Forestry (now the Yale School of Forestry & Environmental Studies [F&ES]). Since then F&ES and Botanic Garden have shared the same grounds.

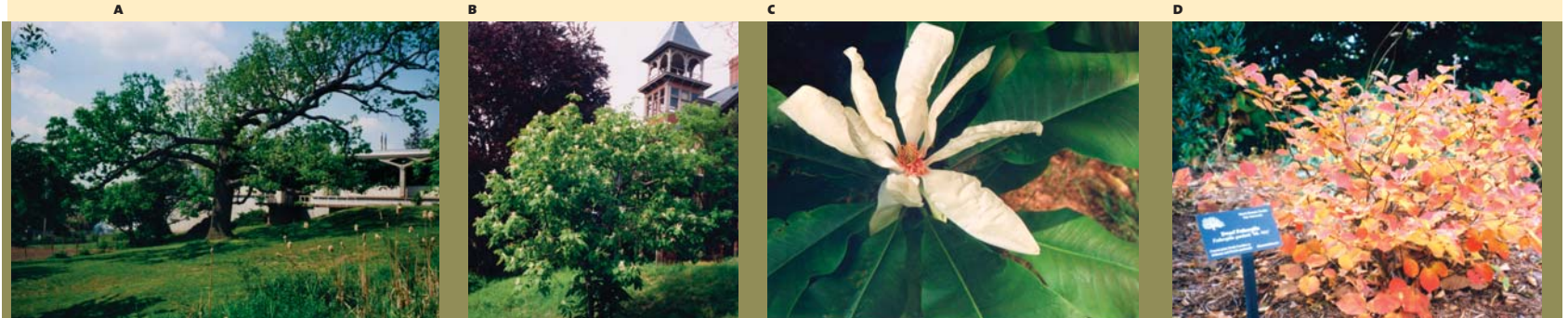
For most of the first two decades of the garden's existence, Dean of Forestry Henry

Graves served as its director. During this period, the gardener John Murray planted several systematically arranged beds with labels that enabled the forestry students to study plants and their relationships. Students also received instruction in propagating trees and shrubs. Thousands of white pines and other conifers were started and eventually transplanted throughout the state to reforest and protect the watersheds of public reservoirs.

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## MARSH BOTANIC GARDEN

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Above, from left to right:

A. The ancient white oak *Quercus alba* saved by Nichols and Graves nearly eighty years ago. The tree survived severe damage inflicted by a tornado in 1989 and two more recent storms.

B. Recent view of the hillside on the preceding page. Bigleaf Magnolia *Magnolia macrophylla* in bloom. Of the trees and flowering shrubs seen in the earlier photograph, only the European beech with copper foliage in the background remains.

C. Leaves and flower of Bigleaf Magnolia.

D. Dwarf fothergilla *Fothergilla gardenii* 'Mt Airy' is located in the border south of Marsh Hall. This native of the southeastern coastal plain from North Carolina to Alabama grows along edges of ponds and wetlands. The addition of botanical labels is a recent improvement.

E. Franklin's tree *Franklinia alatamaha* flowers in the fall. This species, named for Benjamin Franklin and now extinct in the wild, is one of a few American representatives of the mostly Asian family Theaceae of tea and camillas.

F. Witchhazel *Hamamelis virginiana* blooms in the fall. It grows in a moist area of the rock garden. This species along with many others in the garden are being used by Professors Michael Donoghue, Vivian Irish, Leo Hickey, and their students in studies of the evolution of early groups of flowering plants.

G. While most hydrangeas are native to Asia, oakleaf hydrangea *Hydrangea quercifolia* is a handsome shrub native to southeastern United States and the Gulf Coast. Along with viburnums and winterberry, it screens the fence surrounding the experimental garden plots. Oakleaf hydrangea blooms in late summer.

H. The showy outer florets of doublefile viburnum *Viburnum plicatum* var. *tomentosum* 'mariesii' flowers are sterile; the smaller inner ones are fertile.

The year 1922 was important for the garden. To recognize Marsh's generosity and perpetuate his memory, the Yale Corporation agreed to add his name to the botanic garden. A plan for its reorganization was finally presented, with the goal that "the Botanic Garden will be an institute for research in plant life also containing a systematic display of plants as an educational feature for students and the general public".<sup>1</sup> Also in this year, the highly regarded landscape architect Beatrix Farrand was appointed Consulting Landscape Gardener to the university. In 1923 when the Forestry School moved down Prospect Street to newly completed Sage Hall, the Botany Department took charge of the Marsh garden. Shortly thereafter botany professor George Nichols became director of the garden.

Nichol's interest in plant ecology on the succession and formation of plant communities in nature led him to experiments in the Marsh garden on the conditions for germination of seeds and growth of native plants. In time he focused on a simpler question more suitable to a botanic garden: Could native species adapt to cultivation in conditions that local gardeners could duplicate? In 1927, Nichols inaugurated a seed exchange program and was soon sending seeds of 340 different species of native American plants, amounting to over 1,500 packets annually, to 37 different botanical gardens in 20 different countries. This enormous effort continued until his death.

The work of Beatrix Farrand and George Nichols is the principal reason for considering the Marsh Botanic Garden a historically

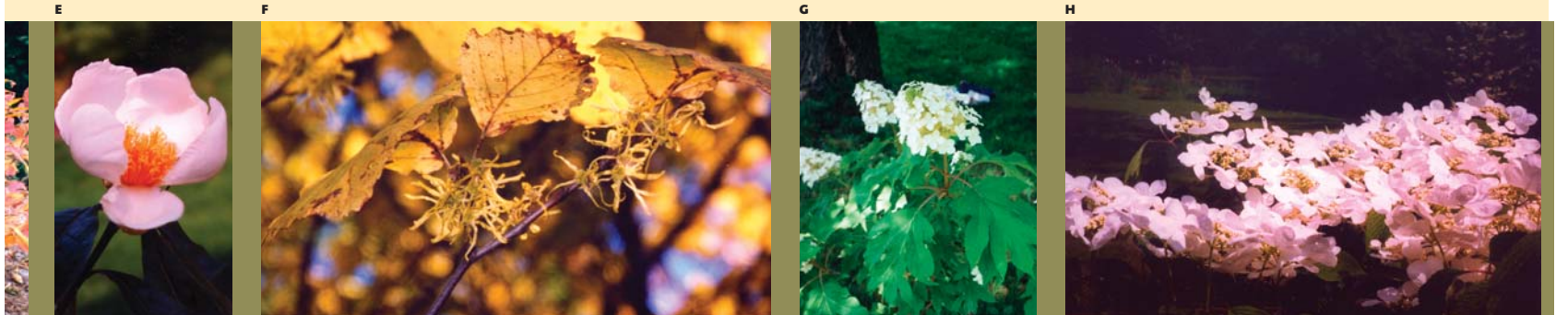
significant botanic garden. Farrand trained with Charles Sprague Sargent at Harvard's Arnold Arboretum and traveled widely, schooling herself in European gardens. In 1899, she had been the only woman among eleven founders of the American Society of Landscape Architects. When she began to design the Yale landscape, the campus was a sea of construction.

Beatrix Farrand was ahead of her time in advocating the use of native American trees, shrubs, and perennials on the campus. She strove to group plants as they might be found in natural communities. Species were chosen for their fall foliage, the winter interest of their architecture, shape and color of bark, and persistence of colorful fruits attractive to birds and wildlife. She created settings for the new buildings—surrounding the YPM with dogwoods, maples, witch hazels, and deciduous hollies, and Sage Hall with viburnums and blueberries. She conceived of the whole campus as an arboretum, an outdoor museum of trees and shrubs.

Marsh was Farrand's first commission for the design of a botanical garden, and she struggled to reconcile the requirement for a public display of diverse species of plants and their systematic relationships with an artistic vision that unified the whole site. Her proposed resolution was to replicate the first botanic garden, built for display of medicinal plants at Padua in 1545, as the centerpiece for the formal gardens on the level ground at Marsh.

The first two quadrants of the Padua design covered half an acre and were filled with native American species collected by Nichols, the new director. But Nichols and Graves halted completion of the remaining

<sup>1</sup> from the Graves' Report 23 Nov. 1922 YU/TR Series III Box 256, Folder 1462 cited by Catherine Phillips (2000) in "The Marsh Botanic Garden, 1900–1939: A History".



quadrants by refusing to allow removal of the venerable white oak on the hillside and rerouting of the brook. Overruled, Farrand turned her attention to working the natural features of the spring, wetland, and vernal pool into the rock garden. The rock garden took over six years to complete. Rocks, some weighing half a ton and hauled in from the Yale Natural Preserve in Westville, were placed to appear as natural outcrops, and more than a thousand native North American and exotic plants were arranged among them and along the brook and paths. Some 700 native herbaceous perennials were tested in the formal beds, of which 400 to 500 survived, prospered, and demonstrated their ornamental qualities. These included 30 species of goldenrods, 18 of asters, and numerous phlox, cacti, and ferns.

During the late 1920s through the 1930s, some 10,000 visitors a year were coming to the Marsh Botanic Garden to view the seasonal displays. In spring, tulips, narcissi, and iris bloomed in the formal gardens and viburnums, azaleas, rhododendrons, mountain laurel, and lilacs on the hillside. In summer, roses, phlox, dahlias, gladioli, and asters were the attractions, and in fall, the foliage. Each fall thousands of bulbs and hundreds of iris were planted, carefully arranged by color. The showy, giant, bearded irises were the gift of the American Iris Society that each year sent new introductions to be evaluated. By any measure, the Marsh Botanic Garden and its public displays were a stunning success.

George Nichols died in 1939 and Beatrix Farrand did her last work at Yale, the Silliman College courtyard, in the early 1940s before retiring to California. Budgets were tight during the Depression and the war. Perhaps more important, subsequent directors and the fac-

ulty of the Botany Department were working in new research areas in development and physiology and had little interest in the educational and public aspects of the garden. Within two years of his death, all of Nichol's valuable collection of native plants had been dug up and given to Connecticut College. Years later, when I became director and wanted to learn more about designing gardens with native flora, I attended seminars on the subject offered by the Connecticut College Arboretum and frequented plant sales at Connecticut College in order to purchase trees and shrubs for the Marsh Gardens.

Without the interest of the faculty during much of the latter half of the 20th century, the grounds and their plantings were neglected. Grounds Maintenance took over the upkeep of the lawns as well as the garden's garage and parking area for storage and maintenance of their garbage trucks and equipment. With the contraction of the staff, the duties of the garden's manager and horticulturalist inevitably became limited to growing the plants needed in research and teaching. Despite Marsh's stipulation that the site be used only for the university's botanic garden, Greeley Laboratory, designed by Paul Rudolph, was built in 1958. Now the only remaining traces of Marsh's original garden and Farrand's later work are the magnolias, laurels, and rhododendrons found along Hillside Terrace east of the rock garden.

Along with Farrand's lists of perennials, we are fortunate to have a copy of her 1927 plan for the Marsh Botanic Garden. Following a tornado in 1989, I revived the advisory committee and consulted with interested faculty in (Faculty of Arts and Sciences) and F&ES about the garden's future direction. The advi-

sory committee agreed on a plan to restore the grounds in a manner consistent with the spirit of Farrand's 1927 plan but requiring less maintenance. Provost Alison Richard provided funds specifically for this restoration.

We began clearing overgrown areas of invasive exotics with minimal use of herbicides. Catherine Phillips and Michael Doherty spent the summer of 1998 carefully excavating the rock garden. To stabilize the opened areas, we quickly replanted with native shrubs—azaleas, buttonbush, elderberry, and sweet pepper bush—appropriate to a shaded wetland, along with six different species of ferns. Some native perennials, Jack-in-the-pulpit, Solomon's seal, false Solomon's seal, and Canada mayflower, have reappeared in profusion. Columbines, cardinal flower, and great lobelia were grown from seed in the greenhouse and planted.

On the hillside above the rock garden, brambles were removed, and a planting of the both high- and low-bush blueberries was established in the understory. Freed from competition, a stand of the delightful shrub bottlebrush buckeye sprang up. Arrowwood, viburnums, and blueberries were planted to provide a screen along the fence on Hillside Terrace.

On the steep banks that were left ungraded when Greeley was built, red osier dogwood, a wetland species, along with clumps of switch, Indian, and big and little bluestem grasses were introduced to reduce runoff and flooding. Bayberry and sweet fern, two woody species that fix nitrogen with the soil bacterium *Frankia* harbored in their roots, help improve the nutrient-poor glacial till that covers the hillside.

Collections are only useful for study if the plants are identified. Over the past decade, stu-

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## MARSH BOTANIC GARDEN

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Left to right:

A. A small stand of native cattails *Typha latifolia* grows intertwined with the invasive, exotic purple loosestrife *Lythrum salicaria*. Each of the dry, brown fruiting stalks of loosestrife produces as many as a million seeds.

B. Blue flag *Iris versicolor* blooms along the brook.

C. Native shrubs planted following renovations to Greeley provide a display of fall foliage

All photographs by M. H. M. Goldsmith

dents in Terrestrial Ecosystems, Environmental Studies, and Biology of Plants have assisted me in preparing an inventory and computerized data base of the significant woody trees and shrubs, herbaceous perennials, grasses, and ferns present in the garden. In celebration of the centennial of both the garden and the F&ES, we installed several hundred sturdy metal labels that provide the common and scientific names, the family, and the distribution of the specimen. Now staff and students in F&ES's Urban Resources Initiative find inspiration in the garden for trees, shrubs, and perennials to use in helping local neighborhoods create green spaces.

Today, the Marsh Botanic Garden includes not only outdoor gardens and greenhouses at Marsh and Osborn Memorial Laboratories, but also controlled environmental facilities. The greenhouses contain collections of tropical and economically useful plants, lower vascular plants, insectivorous plants, cacti, and succulents. The collection of tropical plants—tree ferns, cycads, palms, bromeliads, and orchids—includes economically important species: coffee, cocoa, bananas, pineapple, cinnamon, ginger, and vanilla orchid. These plants, tended by horticulturalist David Garinger, are used for teaching and demonstration, but by arrangement may also be available for experimentation and research.

In 2002, Timothy Nelson, Professor of Molecular, Cellular & Developmental Biology (MCDB), was appointed director of the garden and with the advisory committee is revisiting the ever vexing balance between education and research at the garden. Almost immediately

Nelson and the advisory committee had the opportunity of appointing a new manager for the garden. Eric Larson arrived in the spring of 2003. Previously, Larson served as a working supervisor of Haverford College's 200-acre historic campus. He has increased our visibility in the university and wider community by introducing an online newsletter, Liquid Sunshine, and inviting small groups for garden tours along with tea, concerts, or picnics. Throughout the year, several undergraduate and graduate work-study students receive training in best horticultural practices under his direction. Other welcome innovations are the colorful borders of diverse annuals and perennials in the experimental garden, and this year's wildflower meadow below the north entrance to Greeley Laboratory. Two dozen young trees have been planted, including apples and other fruit trees, European beeches, bald cypress, and tupelo (sour gum).

In 2004, the faculty created two new courses that depend on the garden's outside and greenhouse collections. Although space is limited, Dianella Howarth, lecturer and postdoctoral fellow in the Department of Ecology & Evolutionary Biology (EEB), teaches the weekly laboratory for the E&EB course *Plant Diversity & Evolution* at Marsh. I use the collections in the Environmental Studies/MCDB/F&ES course *Plants and Agriculture in Temperate and Tropical Ecosystems*. For this course, we raise historic species of wheat and its wild relatives from seed obtained from the Wheat Genetics Resource Center at Kansas State University in order to demonstrate the hybridization and polyploidy involved in the evolution and domestication of wheat.

Once again, as in the 1920s, new construction is occurring on campus. With the restoration of Betts Hall for the Yale Center for the Study of Globalization and the Divinity School, more people come to the north end of campus. Aware of Beatrix Farrand's legacy, Yale's landscapers have endorsed the creation of a green space with Marsh Botanic Garden at the center of a continuous park including Sachem's Woods, William Farnam Memorial Garden, and the wetland lying north of Ingalls Rink and the proposed parking garage.

Botanical gardens, unlike museums of natural history, enable learning by observing living organisms. This is all the more important in a world where so many children and students grow up in an urban environment unconnected to and uninterested in the natural world. We are unlikely to be able to save what we do not know, value, and love. This is the foremost reason that Yale University should again honor Marsh's wish for a great living museum of plants in the Marsh Botanic Garden.

*During the time she was a special horticultural assistant to the garden's director in 1998–2000, Catherine Phillips undertook a careful study of Farrand's role at the garden, using sources in the Marsh Botanic Garden files, the archives and manuscripts collection of the Yale University Library, and the Beatrix Farrand archive in the library of the Environmental School of Design, University of California, Berkeley. I am grateful to Catherine Phillips for permission to quote her manuscript, The Marsh Botanic Garden 1900–1939: A History prior to publication.*

# CONFERENCES, SEMINARS, SYMPOSIA

## Forum on Global Climate Change Components

The YIBS Center for the Study of Global Change received a gift of \$50,000 from Exxon Mobil to support a forum on climate change. A forum was held on October 29th and 30th in the Class of 1954 Environmental Science Center that discussed the certainties, uncertainties, and social, political, and economic responses to these putative causes of change in climate. The schedule of speakers and discussion leaders was the result of deliberations of the organizing committee composed of Karl K. Turekian (Chair), Mark Pagani and Steven Sherwood from the Department of Geology & Geophysics, and Robert Mendelsohn from the School of Forestry & Environmental Studies. Haroon Kheshgi of Exxon Mobil provided advice to the organizing committee.

The forum focused on climate change as being clearly observed on a variety of time scales. Most recently global warming and the role of human activity in exacerbating it has been one of the most compelling global issues for discussion and action. Although there is no fundamental disagreement on the simple physical linear relationship between the increase in the radiatively important gases, such as carbon dioxide, in the atmosphere and the expected increase in temperature, there are fundamental uncertainties on how this simple relationship is confounded by feedback effects and external forcings. Feedback can be both positive and negative and the external forcings can be terrestrial or solar. These issues are directly involved in discussions on what actions are necessary or prudent to mitigate the inferred consequences of human exacerbated climate change.

Speakers and their topics were: William Nordhaus, Yale University—*Human Effects*; Drew Shindell, Goddard Institute for Space Studies (GISS), NASA—*Current Understanding of the Effects of Solar Variability on Climate*; Joyce Penner, University of Michigan—*Aerosols and Climate*; Isaac Held, Geophysical Fluid Dynamics Laboratory, NOAA, Princeton, N.J.—*The Response of the Hydrological Cycle to Global Warming*; and Wallace Broecker, Columbia University Lamont-Doherty Earth Observatory—*Grand Strategies*.



### YIBS/ESC FRIDAY NOON SEMINARS

The Yale Institute for Biospheric Studies (YIBS) and Class of 1954 Environmental Science Center (ESC) Friday Luncheon Seminar Series continues to attract enthusiastic audiences of faculty, students and outside interested guests. Seminars are held each week during the fall and spring semesters in the Class of 1954 Environmental Science Center. Fall 2004 seminars featured the following list of speakers and topics: Jeffrey Powell, Professor, Department of Ecology & Evolutionary Biology (EEB)—topic: *Evolutionary Genetics of African Malaria Vectors*; Gaboury Benoit, Professor of Environmental Chemistry, Yale School of Forestry & Environmental Studies (F&ES)—topic: *Aquatic Trace Metals: Good or Evil?*; David Evans, Assistant Professor, Department of Geology & Geophysics (G&G)—topic: *Global Environmental Changes at the Dawn of Animal Life*; Hong Yang, Visiting Professor, G&G—topic: *Metasequoia (Dawn Redwood) as a Modern and Ancient Environmental Archive*; Marian Chertow, Assistant Professor of Industrial Environmental Management, F&ES—topic: *Industrial Environmental Management: Reorganizing Industry Ecologically*; Durland Fish, Professor of Epidemiology, Yale School of Public Health—topic: *Lyme Disease and Other Vector-Borne Diseases: Medical Problems with Environmental Solutions*; Bruce Lieberman, Visiting Professor, G&G—topic: *Biogeography in Deep Time: Evolution in*

*the Fossil Record*; John Wargo, Professor of Environmental Risk Analysis and Policy, F&ES, and Professor, Department of Political Science—topic: *Environmental Threats to Children's Health: Challenges in Science and Law*; Melinda Smith, Assistant Professor, EEB—topic: *Dominant Species and the Functioning of Ecosystems*; Rimantas Vaisnys, Professor, Department of Electrical Engineering and Professor, EEB—topic: *How Many X Ought Y Support?*; David Watts, Professor, Department of Anthropology—topic: *Cooperation, Hunting, and Intergroup Aggression in Chimpanzees*; Harvey Weiss, Professor, Department of Near Eastern Languages and Civilizations; Professor, Department of Anthropology—topic: *What Happened in the Holocene? Social Responses to Abrupt Climate Changes at 8.2, 4.2, and 5.2kaBP*.

During the spring 2005 semester, speakers will include Dr. Rita Colwell, the Edward P. Bass Distinguished Visiting Scholar for the spring of 2005; the two newly appointed Gaylord Donnelley Environmental Fellows, Dr. Craig Layman and Dr. Gregory Dietl; and newly appointed faculty member in EEB Assistant Professor Suzanne Alonzo. A full listing of speakers and dates can be found on the YIBS Web site [www.yale.edu/yibs](http://www.yale.edu/yibs).

**INTERNATIONAL SYMPOSIUM  
EXPLORES CHALLENGES FACING  
FOREST CERTIFICATION IN  
DEVELOPING SOCIETIES**

The Yale Program on Forest Certification, in cooperation with the Rainforest Alliance, the University of Tasmania, and the State University of New York at Buffalo, hosted a collaborative symposium exploring the social, ecological, and economic effects of forest certification on developing and transitioning societies in June at the Yale School of Forestry & Environmental Studies (F&ES).

“This event represents a truly outstanding achievement in global-scale collaboration,” said Dean Gus Speth, who delivered an address to the audience of over 100 experts from 36 countries in attendance on the second day.

Symposium participants evaluated cutting-edge research from local experts, presenting case studies from 16 developing countries throughout Asia, Eastern Europe, Latin America, and Africa. To complement case-study presentations, Forest Trends, a Washington, D.C.-based nongovernmental organization, organized a panel on local land rights, traditional land use, local economies, and governance, and presentations were followed by commentator analyses and discussion.

Forest certification is a unique nongovernmental policy tool originally developed to address problems of deforestation and forest degradation in the tropics. The goal of certification is to create market-based incentives for responsible forest management by providing market recognition for products originating from forests managed according to a specified set of environmental, economic, and social standards. The purpose of the symposium was to assess the successes and challenges faced in the implementation of forest certification in developing countries.

“Forest certification was created, in large part, to address tropical-forest degradation. However, the greatest interest and support have occurred in Europe and North America, raising important questions regarding the pathways certification might follow to pro-

mote improved forest practices in developing and transitioning countries,” said Benjamin Cashore, Associate Professor of Sustainable Forest Policy and Director of the Program on Forest Certification.

Conference participants identified numerous challenges to the growth of certification in developing countries, including rampant rates of illegal logging, inadequate domestic or regional demand for certified forest products, inadequate government capacity to enforce environmental regulations, disputed land tenure, and lack of access to research and technology addressing sustainable forest management and economic growth.

Participants in the symposium included a diverse group of practitioners, donor agency representatives, nongovernmental organizations, the academic community, and the private sector. The professional, as well as geographic, diversity of attendees provided an excellent opportunity to compare the forest certification experiences of different actors in the certification process across a wide range of countries and regions, and to identify common themes and priorities for further research.

Following the symposium, the case study researchers, editors, and commentators participated in a two-day workshop to revise the case studies and incorporate comments received throughout the symposium. F&ES will publish a book presenting the case studies, as well as regional and overarching themes.

The event was sponsored by Deutsche Gesellschaft für Technische Zusammenarbeit, Forest Trends, International Tropical Timber Organization, Rainforest Alliance, South Cone Trading Company, US Forest Service International Programs, World Bank, World Wide Fund for Nature, Yale Center for the Study of Globalization, Yale Program on Forest Certification, and Yale University Council on Southeast Asia Studies.

**TOPICS IN GLOBAL CHANGE  
SEMINAR SERIES**

The major activity of the Yale Institute for Biospheric Studies (YIBS) Center for the Study of Global Change is to provide a forum to discuss the mechanisms of global change involv-

ing climate and changes on the Earth’s surface that have occurred on different time scales. The major instrument for this approach is a weekly seminar series known as Topics in Global Change.

Under the direction of Karl K. Turekian, Sterling Professor of Geology & Geophysics and Director for the YIBS Center for the Study of Global Change, the weekly seminar series continues. Speakers and topics for the Fall 2004 series were Alexey Fedorov, Yale University—*A Tropical Perspective on the Ice Ages and Global Warming*; Jorge Sarmiento, Princeton University—*The Role of the Southern Ocean in Global Productivity and its Bearing on Climate*; Charles Wohlforth, Freelance writer—*The Whale and the Supercomputer: On the Northern Front of Climate Change*; Stephen Meyers, Yale University—*Reconstructing Interdecadal to Centennial-Scale Climate Teleconnections Using Tree Ring Chronologies*; Chris E Forest, Massachusetts Institute of Technology—*Uncertainty in Climate Sensitivity: How Well Does the Historical Climate Record Constrain It or Future Climate?*; Michael Bender, Princeton University—*Atmospheric Oxygen and Oxygen Isotopes Reflect Climate Change*; Adina Paytan, Stanford University—*High Productivity During Cretaceous Ocean Anoxic Events*; Pierre Biscaye, Lamont-Doherty Earth Observatory—*Provenance of Atmospheric Dust in Ice Cores as a Constraint on the Modeling of Atmospheric Circulation and Transport*; Alan Thorndike, University of Puget Sound—*In Search of a Qualitative Dynamics: Some Thoughts about Interactions, Feedbacks, and Correlations*; Eli Tziperman, Harvard University—*Rapid Past Climate Change: It’s the Sea Ice*; Ted Moore, University of Michigan—*Long Term Paleooceanographic Changes in the Paleogene*.

Professor Turekian is active on the national scene through membership in committees of the National Research Council dealing with issues of climate change. He also presents lectures at universities on issues of atmospheric chemistry, and was co-Executive Editor for the Treatise on Geochemistry that is composed of 10 volumes, four of which deal with matters of environmental geochemistry and biogeochemistry.



# PEABODY MUSEUM OF NATURAL HISTORY



## EVENTS

### ELEPHANTS!

February 12–July 31, 2005

An exciting, hands-on exhibition that focuses on the evolutionary history of these animals. It contains many spectacular exhibits, including a life-sized model of a woolly mammoth as well as a tiny dwarf elephant from the Mediterranean.

### THE MUSEUM'S ANNUAL DR. MARTIN LUTHER KING JR.'S LEGACY OF ENVIRONMENTAL & SOCIAL JUSTICE FESTIVAL

January 16 & 17, 2005

One of the largest MLK day celebrations in Connecticut, the festival will feature a poetry slam, musical performances, storytelling, and Jim Lucas's dramatic one-man presentation of Dr. King's famous speeches.



## Recent Acquisitions in the Peabody's Division of Invertebrate Paleontology

by Susan Butts, Collections Manager, Invertebrate Paleontology

The Division of Invertebrate Paleontology at the Yale Peabody Museum of Natural History (YPM) recently obtained rare specimens of fossilized scyphozoan medusae (jellyfish). These Cambrian fossils (over 500 million years old) were found in north central Wisconsin's Krukowski Flagstone Quarry. In the quarry, jellyfish fossils occur on bedding planes of rippled, medium-grained quartz sandstones, where several planar surfaces have impressions preserved in convex and concave relief. The rock type and presence of ripple marks indicate deposition on a beach or in a shallow, subtidal marine environment.

The geologic evidence suggests the medusae were washed ashore and stranded on the Cambrian beach. Mass strandings of hundreds of jellyfish are not uncommon on modern beaches. Strandings generally occur after large storms, or when high densities of jellyfish gather in shallow waters for breeding or feeding and are blown ashore or trapped in ebbing waters. "Beached" jellyfish may pulse, as they

do when suspended in the water column, and so can worsen their predicament by taking wet sand into their gut, effectively anchoring themselves. The remains of stranded jellyfish are scavenged by beach-dwelling organisms such as crabs and birds, but such scavengers were absent in the Cambrian.

Jellyfish are rarely preserved as fossils because they lack "hard parts," mineralized skeletal materials that do not decay. In these specimens the soft bodies were pressed into the sandy beach and covered with fine-grained material. The impressions left behind preserve details of the stomach and bell margin, the "floating skirt" of the jellyfish. Jellyfish have always become stranded like this, but only in Cambrian sandstones were they preserved as impressions. This "preservation window" is probably due to microbial films that protected the sand surface from erosion in the next flood. Krukowski Quarry is also known for the trace fossil *Climactichnites*, which bears a remarkable resemblance to a motorbike track and



A rippled bedding plane in Krukowski Quarry showing numerous jellyfish impressions up to 1 meter in diameter. Broom for scale.

likely represents the trail left by a large slug-like organism. The YPM has several exceptional *Climactichnites* specimens.

The jellyfish specimens were collected by Dan Damrow of Mosinee, Wisconsin, and were acquired by Adjunct Curator Adolf Seilacher of the YPM's Division of Invertebrate Paleontology through J. W. Hagadorn, assistant professor at Amherst College, who conducted research at the site.

For more information, see "Stranded on a Late Cambrian Shoreline: Medusae from Central Wisconsin," by J. W. Hagadorn, R. H. Dott Jr., and D. Damrow, 2002, in *Geology* 30(2):147–50.

J. W. Hagadorn

*The Age of Reptiles*, a mural by Rudolph F. Zallinger. ©1966, 1975, 1985, 1989, Peabody Museum of Natural History, Yale University, New Haven, Connecticut USA. All rights reserved.



## Peabody Scientists Assemble the Tree of Life

Two years ago the US National Science Foundation created a new program entitled “Assembling the Tree of Life,” or AToL for short. The aim of this program is to stimulate and coordinate the assembly of knowledge about the phylogeny of all of the major lineages of life. Peabody Museum scientists have been very active in this effort, as evidenced by the several recent NSF awards and the new book featured here. The overall effort is advancing very rapidly and a solid outline of the entire Tree of Life should soon become a reality.

### The Evolution of Green Plants

Humans rely on green plants for food, shelter, clothing, and oxygen! As one of the oldest and most diverse branches of the Tree of Life, plants provide unparalleled opportunities to address a host of fundamental evolutionary questions, such as the transition from single celled to multicellular body plans, the colonization of land, and the derivation of a wide array of different life cycles.

Michael Donoghue (Peabody Museum of Natural History Director and Curator of Botany) is the principle investigator on the Yale portion of a collaborative green plant AToL award that involves five other institutions. This project is focused on resolving phylogenetic relationships among the major green plant lineages, including various green algae, the mosses and their relatives, ferns, conifers, and flowering plants. Donoghue and several Yale graduate students are exploring the implications of the new findings for the movement of plants onto land. Specifically, they hope to identify those “key innovations” that served to increase the rate at which plants diversified.

the phylogeny of the angiosperms, or flowering plants. This five-year grant is part of a collaborative effort involving six other institutions. The primary Peabody Museum of Natural History (YPM) participants are Michael Donoghue, Leo Hickey (Curator of Paleobotany), Nico Cellinese (Botany Collections Manager), and Reed Beaman (Head of Museum Informatics).

Flowering plants are by far the largest clade of green plants, with over 270,000 described species. Although angiosperm systematists have made enormous progress in clarifying phylogenetic relationships, many major clades are still not confidently resolved. The aim of the angiosperm AToL project is to use plastid and mitochondrial genome sequences and morphological characters to elucidate relationships within twelve especially problematic branches. The Yale team is responsible for resolving relationships among the *Asterales* (daisies and relatives), the *Apiaceae* (carrots and relatives), and the *Dipsacales* (honeysuckles and relatives). The YPM effort also entails the analysis of leaf architectural characters and the development of new informatics tools to integrate information from disparate databases.

### Resolving the Angiosperm Tree

Yale has been awarded over \$1 million by the National Science Foundation to help resolve



Top to bottom: Water Lily; Scabiosa (Photos by Michael J. Donoghue); Squamate (Photo by Jesse Maisano)

### Reconstructing Squamate Phylogeny

Squamates, the lizards and snakes, are the second largest group of tetrapod vertebrates after the birds. Despite their great interest to ecologists and evolutionary biologists, relationships among the major squamate lineages are still poorly known. Many fundamental questions remain unresolved, such as the placement of snakes among the various lizard lineages.

Jacques Gauthier (Peabody Museum of Natural History Curator of Vertebrate Paleontology and Vertebrate Zoology) is collaborating with colleagues at seven other institutions to clarify squamate relationships using a combination of molecular and morphological data, and incorporating fossil along with extant organisms. One major product will be a Web-accessible morphological database that includes a digital image illustrating each character in every taxon, as well as links to high-resolution X-ray CTscans of skulls. The study will resolve the origin and relationships of the major lineages of venomous snakes, and plans to develop a multilingual Web site to facilitate venomous snake identification for medical workers and the lay public.

### Yale in CIPRes

Last fall the NSF's Information Technology Research (ITR) program awarded \$11.6 million to a research consortium of 13 US institutions to build computational tools for constructing a "family tree" of all species on Earth. Such a tree would provide a better picture of how life evolved, a better understanding of where humans fit in, and a better interpretation of the forces underlying the adaptation and diversification of species. But, with 1.7 million described species, and probably more than ten times that many yet to be discovered, this is a monumental task. The Computational

*continued on page 12*

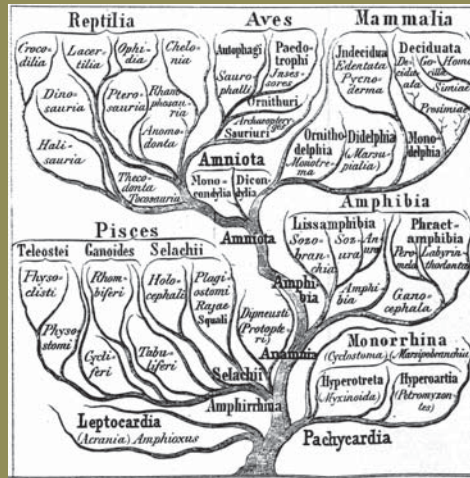


Darlene Murawski

Fiddle Head

Infrastructure for Phylogenetic Research consortium, or CIPRes for short, is developing new analytical techniques, setting up large repositories of evolutionary data, and harnessing the power of supercomputers to enable the reconstruction of the Tree of Life.

The lead Yale scientists in CIPRes are Michael Donoghue and Paul Turner, both faculty members in the Department of Ecology and Evolutionary Biology. Donoghue is focusing on the development of a database for storing and synthesizing information about phylogenetic relationships, while Turner is evolving a known virus phylogeny in his laboratory, which will then be used to test the efficacy of new tree inference methods. The YPM will also be developing an interactive exhibit on the Tree of Life and the associated computational issues.



Haeckel Tree

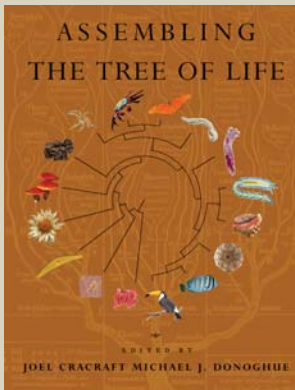
## The Peabody Awarded NSF Grant for the Care of Fossil Vertebrate Collection



Among the most significant of the many important fossil vertebrate collections in the Division of Vertebrate Paleontology at the Yale Peabody Museum of Natural History is the Princeton University Collection, with its exquisite examples of North and South American

dinosaurs and mammals. Moved almost in its entirety from Princeton University in 1985, this collection is currently stored separately from other collections in the basement of the Museum.

Curator of Vertebrate Paleontology Jacques Gauthier and preparator Marilyn Fox recently received a National Science Foundation grant that will fund the conservation of these important fossils and support their integration into the remaining Yale University collections. Specimens will be properly stored in acid-free containers and will be carefully labeled to avoid any potential confusion with similarly numbered Yale specimens. Large fossils, such as dinosaur bones and mammal skulls, will be placed in plaster support jackets. This NSF grant supports the hiring of skilled preparator Vicki Fitzgerald for this project over the next three years.



*Assembling the Tree of Life represents the most exciting moment in organic evolution...because it helps us understand who we are and of what we are a part... fundamentally important for the future of humanity...destined to be a classic.*

—Thomas E. Lovejoy, President, Heinz Center for Science, Economics, and the Environment

*Assembling the Tree of Life*, edited by Joel Cracraft of the American Museum of Natural History and the Peabody Museum of Natural History's Michael Donoghue, is designed to be the most authoritative synthesis of knowledge on the evolutionary history of life. Calling upon the international expertise of almost 100 systematic biologists, the book summarizes our current understanding of phylogenetic relationships within and among the major branches of the Tree of Life, and includes commentary on the significance of phylogenetic knowledge for science and society. Information on phylogeny has exploded over the past decade owing to the availability of molecular data and new analytical tools. *Assembling the Tree of Life* brings these advances together for the first time in one volume.



Dr. Jay Ague explaining Connecticut's geology at Hammonasset State Park.

## Niarchos Summer Study Program Brings University of Crete Scholars to Yale

From June 13 to June 18, 2004, the Yale Peabody Museum hosted its second summer exchange program with the Natural History Museum of Crete (NHMC). This program complements last year's summer study program in Crete, where Yale researchers and students were able to meet their collaborators in person and explore the natural history of the island and its Mediterranean environment.

The 2004 summer program at the Peabody Museum provided visiting scholars from NHMC and the University of Crete an opportunity to become acquainted with North American biodiversity by working on museum specimens with their Yale collaborators. The program included a tour of the Peabody, a lecture on Native American cultures, and a series of talks highlighting conservation genetics and Connecticut's biodiversity. This was followed

by presentations of works-in-progress, where collaborators and students discussed their mutual findings and interests in an informal setting. The Peabody's Informatics Director Reed Beaman presented a full-day workshop on the value of satellite imagery as complementary tools for analyzing biodiversity in an area.

Visitors, Yale students and colleagues traveled to the Yale-Myers Forest, where they were introduced to various strategies of forest management and conservation by Mark Ashton and Dave Ellum from the Yale School of Forestry. After a night in Sturbridge Village, the group visited Dinosaur State Park and Hammonasset State Park to learn about the geologic processes that contributed to the biological history of the area.

This summer study program is only one component of a multi-faceted collaborative initiative between the Yale Peabody Museum and the NHMC funded by the Stavros S. Niarchos Foundation. The initiative is also supporting the exchange of biodiversity exhibitions and related educational materials between the two institutions, and has provided funding for six collaborative research programs. The completion of the Niarchos Experimental Classroom at the Peabody with its videoconferencing capability has gone beyond the limits of e-mail to allow students and educators to build educational bridges across great geographic distances, fostering better communication between workers. For more information visit [www.nhmc.uoc.gr/nhmcypm/html/index.html](http://www.nhmc.uoc.gr/nhmcypm/html/index.html).

## Early Evolution of the Cacti

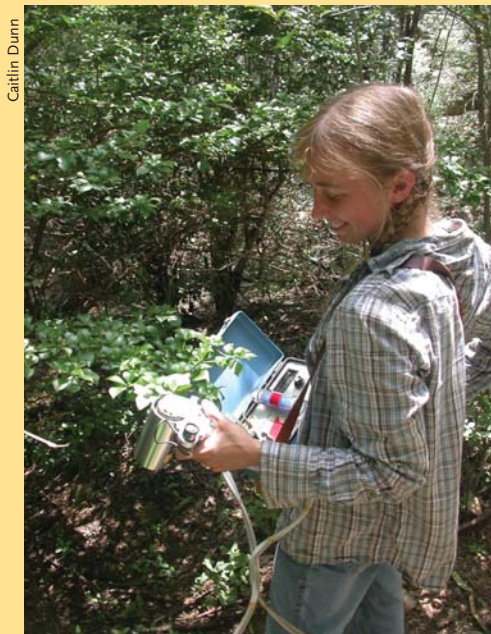
by Erika Edwards,  
Research in Evolutionary Biology at the Yale Peabody Museum

The leafless, stem-succulent cacti are important elements of the New World flora, especially in arid and semi-arid ecosystems. Their specialized morphology and physiology are well known. By using the short-lived opportunities provided by infrequent rains to gather water from the soil, and simultaneously increasing tissue water storage and photosynthetic water use efficiency, cacti manage to function in some of the harshest environments while maintaining tissues that are well hydrated.

*Pereskia*, a group of 17 species of shrubs and trees in the Cactaceae with normal leaf development and function, is often considered a “missing link” between the highly specialized cacti and the rest of the plant world. However, phylogenetic placement of *Pereskia* within the cacti has remained uncertain, and little is known about *Pereskia* ecology and physiology. With her dissertation research, Erika Edwards, a doctoral student in the lab of Peabody Museum of Natural History Director Michael Donoghue, is focused on improving knowledge in both of these areas.

To resolve phylogenetic relationships within Cactaceae, she has sequenced multiple gene regions from all *Pereskia* species and other cacti. Erika is using these data to infer new hypotheses about early cactus evolution. Her extensive fieldwork in Venezuela, the Dominican Republic, and (in 2005) Bolivia focuses on understanding how *Pereskia* species regulate water loss, and whether their ecological “strategy” is similar to that of more specialized leafless, succulent cacti.

Erika spent June and July of 2004 in the Dominican Republic working with the three species of *Pereskia* endemic to the island of Hispaniola. By monitoring various aspects of their daily water use she concluded that although these *Pereskia* species lack many of the anatomical adaptations that later evolved in the cacti to restrict water loss, they are also very conservative in their water use, maintaining well-hydrated leaves in the face of drought



Erika Edwards measuring stomatal conductance of *Pereskia marcanoi*, Dominican Republic.

conditions by tightly regulating the timing and degree of stomatal opening.

Another discovery was that all three species have photosynthetic fruits. This becomes more meaningful when you consider that the outer wall of the cactus fruit is derived from stem tissue. In a sense, then, these species of cacti that have been thought of as lacking stem-based photosynthesis actually do perform it—in the fruit. This suggests that stem photosynthesis in cacti evolved first in the fruit, and was later transferred to the vegetative stem tissue. Erika is following up these initial observations with more studies to confirm this possibility.

## ORNIS

by Reed Beaman,  
Director of the Informatics Program

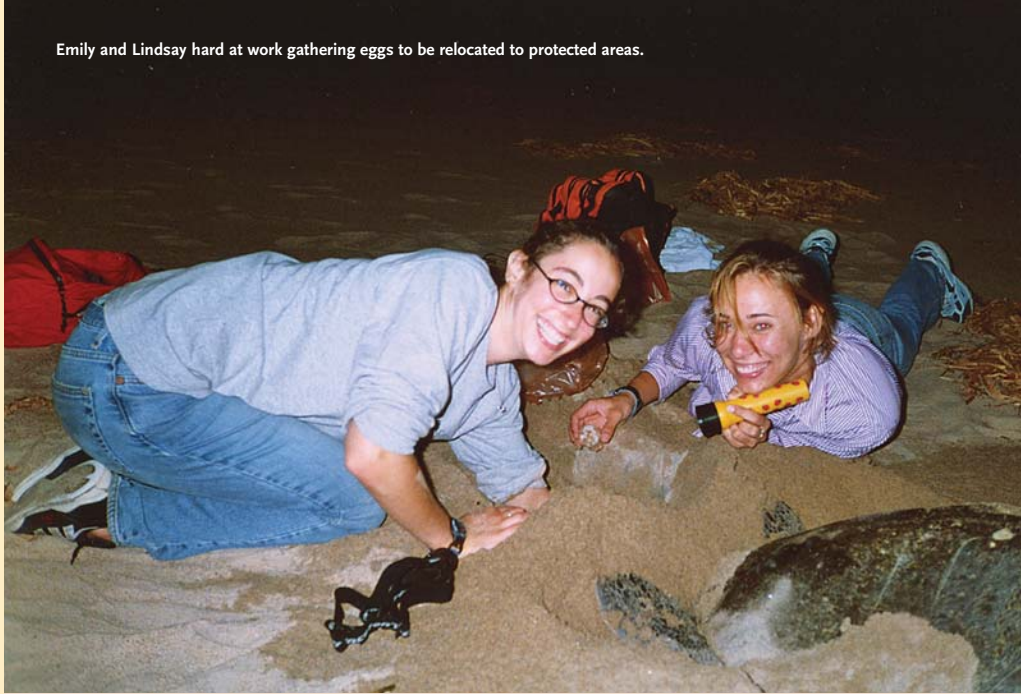
The ORNithological Information System (ORNIS) will provide digital biodiversity information on 3.9 million specimens from 29 museum collections representing over 10,000 avian species. The Yale Peabody Museum of Natural History (YPM) has partnered with the University of Kansas Biodiversity Research Center (the project leader), UC Berkeley Museum of Vertebrate Zoology, and 26 other collaborating institutions to provide informatics technology for ORNIS through recent funding provided by the National Science Foundation. ORNIS is a collaborative community solution that will address the enormous challenge of transforming museum specimen information into georeferenced digital data. The distributed data network, combined with a spatial analysis workbench, will enable biodiversity researchers to query ORNIS partner collections through one or more portals, spatially validate biocollections against other biotic and abiotic spatial data sets, and perform ecological modeling operations. The YPM will contribute automated georeferencing solutions through continued development of BioGeomancer ([www.biogeomancer.org](http://www.biogeomancer.org)), an automated georeferencing service for collectors, curators, and users of natural history specimens.



A sampling of the more than 100,000 bird specimens in the Yale Peabody Museum of Natural History.



Emily and Lindsay hard at work gathering eggs to be relocated to protected areas.



## Yale Undergrads Contribute to Invertebrate Zoology at the Peabody Museum

Yale undergraduates Lindsay Demaree, the recipient of a 2004 summer Silliman College Grant, and Emily Schenker, awarded a Yale College Dean's Research Fellowship, had the opportunity to travel to Jalisco, Mexico, to participate in Dr. Theodora Pinou's grassroots Sea Turtle Conservation Program. This program is in partnership with the National University of Mexico and the University of Guadalajara, institutions which, in collaboration with naturalist Alejandro Peña and local private foundations, have been protecting this coastal area for the last 15 years.

Emily and Lindsay spent their summer learning about sea turtle biology and gaining hands-on experience monitoring sea turtle nesting, such as helping to relocate freshly laid eggs to protected areas on the beach. Through this program both students developed an invaluable connection with the Mexican scholars and students with whom they worked side by side each night toward a common goal. Most importantly, Emily and Lindsay experienced the strength of third-world conservation efforts that integrate citizens into local conservation activities.

While monitoring nesting turtles, the students had the added responsibility of collecting shell epibionts (organisms that live on turtle shells) for their independent study projects. Lindsay and Emily will work with Dr. Pinou and senior collections manager Eric Lazo-Wasem, contributing to their long-term study of epibiont diversity and the impact of these organisms on sea turtle health. Emily will be analyzing epibionts collected during an entire nesting season, comparing her results to data compiled over the past two years. Lindsay will be examining the success of the Sea Turtle Conservation Program over 10 years by comparing the number of eggs laid to the number hatched.

Theodora Pinou is a curatorial affiliate at the Yale Peabody Museum of Natural History, and an assistant professor in the Department of Biological and Environmental Sciences at Western Connecticut State University. She can be reached at (203) 837-8793 or pinout@wcsu.edu. Eric Lazo-Wasem is the senior collections manager in the YPM's Division of Invertebrate Zoology. He can be reached at 203.432.3784 or eric.lazo-wasem@yale.edu.

### THE PEABODY WELCOMES NEW NSF TEACHING FELLOWS

by Laura Fawcett,  
Science Education Coordinator

In the spring of 2004, the Yale Peabody Museum of Natural History offered fellowships to a second cohort of Yale students in the sciences through the National Science Foundation's Graduate Teaching Fellows in K-12 Education program. These new K-12 Fellows were integrated into the YPM's biodiversity education initiative in local school districts. In May, after an orientation led by Museum scientists and educators, these five graduate students and one undergraduate began working in middle school classrooms. They also led workshops at the Peabody's seventh annual Biodiversity and Human Health Institute, funded by the Institute of Museum and Library Services.

This NSF program is designed to benefit both the Fellows and the classrooms in which they teach. In addition to offering teachers scientific expertise and access to Museum resources, the Fellows are role models for students, sharing the excitement of scientific discovery and sparking a sense of wonder about the natural world. Through their work, the Fellows hone their communication and teaching skills.

This year's Fellows represent a diversity of scientific interests and backgrounds. Angie Torres (Anthropology, Ph.D. '09) taught ecology and conservation at an elementary school in Panama. In collaboration with the American Museum of Natural History, Alex Hovani, School of Forestry & Environmental Studies (F&ES), M.E.M. '06, developed a high school science course on evolution and Charles Darwin's process of discovery. Sara Royce (Biomedical Engineering, Ph.D. '10), as a mentor with the New Haven Science Fair, tutored a 10th grader through her biotechnology project on plant DNA. Peter Coe (Mathematics, B.S. '05) volunteered with two Yale undergraduate programs, teaching math and science to local elementary and middle school students.

Kellie Heckman (Ecology & Evolutionary Biology, Ph.D. '05), continuing in the program

*continued on page 16*

PEABODY MUSEUM OF NATURAL HISTORY

continued from page 15

for a second year, conducted field research on lemurs in Madagascar. She believes that “introducing science early with an engaging, interactive approach encourages students to remain interested in it throughout their lives.” She adds, “Science also provides a structure for critical thinking through hypothesis testing.” Finally, research by Derek Snyder (Neuroscience, Ph.D. '05) focuses on genetic variation in the human sense of taste. Addressing a major focus of this NSF program, he is concerned about “the proliferation of scientific misinformation, as well as the public tendency to view scientific knowledge as a set of immutable answers, rather than an ongoing evaluation of conclusions based on existing data and subject to change. At best, these problems suggest that the public may be unaware of the process of scientific inquiry; at worst, they actively breed mistrust in science. Early science education experiences may promote long-term scientific literacy.”

L. Fawcett (2)



Left: Lex Hovani (F&ES, '06) works with teacher Jennifer DeWallace during the Summer Institute. Right: Sara Royce (Biomedical Eng, '10) works with teachers from New Haven's Edgewood Magnet School.



BUTTS

JOYCE

## The Peabody Museum Welcomes New Divisional Staff

### Susan Butts Division of Invertebrate Paleontology

Invertebrate Paleontology collections manager Susan Butts received her doctorate from the University of Idaho. As a postdoctoral associate at Yale, Susan worked in Professor and Curator Derek Briggs's lab, and at the Museum, reorganizing and moving the world-renowned Charles Schuchert Brachiopod Collection to the Class of 1954 Environmental Science Center. Susan's research interests include Carboniferous brachiopods and brachiopod paleoecology; the use of brachiopod paleocommunities in a sequence stratigraphic framework to detect global climate change (for example, the transition from greenhouse to icehouse climates); and taphonomy, particularly silicification, the replacement of calcareous shells by silica during fossilization. As collections manager, Susan follows Tim White, who is now Assistant Director of Collections and Operations at the Museum.

### Walter Joyce Division of Vertebrate Paleontology

Vertebrate Paleontology collections manager Walter Joyce received his education in paleontology and geology from several institutions, including the University of Erlangen-Nuremberg and the University of Bonn in Germany, the University of Kansas, Louisiana State University, and the University of Texas at Austin. He graduated with a Ph.D. from Yale University in May 2004. Walter will focus his efforts on reorganizing the Peabody Museum of Natural History's expansive vertebrate fossil collections and leading field expeditions in search of new fossils. He is also interested in making the collections more accessible to researchers around the world through Web-based resources. Walter's research focus is on the origins, morphology, phylogenetic relationships, ecology, and nomenclature of fossil and recent turtles. He is one of the two primary coordinators of the *Fossil Turtle Newsletter*, an international bulletin of fossil turtle research.



# The Complexities of Siphonophores

by Casey Dunn

Research in Evolutionary Biology at the Yale Peabody Museum

Much of evolutionary biology is concerned with understanding the diversity of cellular and multicellular organisms. There are, however, other levels of biological organization that to date have been almost entirely neglected. One of these is colonial organization. Among some animals that can reproduce asexually through budding the process can be incomplete, leaving the animals attached and physiologically integrated throughout their lives, thus forming a colony.

The siphonophores are arguably the most complex of all animals that live in such colonies, and differ from most other colonial animals in two key respects. First, all budding is localized to well-defined growth zones and is highly regulated. Second, there is a high degree of functional specialization across the members of the colony, which fall into discrete classes dedicated to tasks such as feeding, defense, reproduction, and locomotion. These are arranged into a very specific pattern. So, just as humans are complex organisms with a high division of labor among cells with organization of these cells into precise patterns, siphonophores have become highly complex through the division of labor of physiologically integrated animals with organization of these animals into precise patterns at the level of the colony. Siphonophores have, then, acquired a well-defined individuality at the level of the colony, in a sense becoming “super organisms.”

Understanding how siphonophores acquired this individuality, and how a diversity of forms has been realized within the group, will give us insight into how individuality arises and how it has been shaped at other levels of biological organization, such as at the transition from unicellularity to multicellularity.

Despite intense interest in siphonophores in the past, we still know virtually nothing about how their colonies are actually organized and how their budding process generates such complex, regular patterns. This is because siphonophores are extremely fragile and found

exclusively in the waters of the open ocean. Active swimmers, they are among the most abundant organisms in the open ocean. Siphonophores are the longest animals in the world, with some species exceeding 100 feet (30 meters) in length. But the nets used to collect them tear them apart, leaving only disassociated animals and partial fragments, if that.

Casey Dunn, a graduate student in Yale's Department of Ecology and Evolutionary Biology, has collected intact siphonophores using manned submarines and remotely operated underwater vehicles, as well as by SCUBA diving from oceanic research ships. He has used these specimens to describe the organization of about 15 species, and has described the budding process that produces this precise organization in several of these species. Preliminary findings indicate that the complexity of siphonophore colonies arises sequentially during development, with primary budding generating a simple repeating pattern

that is modified as other types of functionally specialized animals are added. This primary pattern is maintained across siphonophores, with most of the differences in colonial organization resulting from modifications in the last stages of budding.

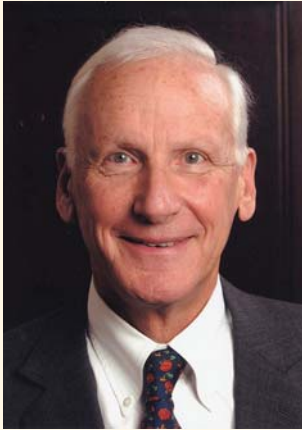
So little is known about siphonophores that many of the species collected during this work are novel. Casey and his collaborators have recently described one new species so fragile that it has never been found in nets, disintegrating almost completely when exposed to the lights of submarines. The type specimen for this species has been deposited in the Yale Peabody Museum of Natural History, as will most of the other siphonophore material used for this work.

A new species of deep-sea siphonophore described by Casey Dunn, Phil Pugh, and Steve Haddock in a forthcoming issue of the *Bulletin of Marine Science*. This is the type specimen, photographed shortly before collection, deposited at the YPM. It was collected at a depth of 1,190 meters (more than 3,900 feet) by the *Tiburón*, one of the Monterey Bay Aquarium Research Institute's remotely operated vehicles. Photo by Casey Dunn.



# FUNDING AND AWARDS

Color Reflections



GERALD GRINSTEIN

Jeannie Claudio



RICHARD KROON

## Donors Put New F&ES Home on Fast Track

by David Taylor

Four Yale alumni from varied backgrounds, recognizing the magnitude and urgency of the environmental challenges that face the world in the coming decades, have come forward with generous gifts to help the Yale School of Forestry & Environmental Studies (F&ES) cultivate leadership to address those challenges. The gifts respond to goals laid out by Dean Speth for the School: creating a model, new “green” building, attracting and supporting the best students, and strengthening the faculty.

Leading the way is Richard Kroon, Yale Class of 1964, who with the support of his family has committed a multimillion-dollar gift for the new building that will bear his name. Joining Kroon are Gerald Grinstein, Yale Class of 1954, who has pledged to fund an endowed professorship at F&ES, and two anonymous donors who have committed gifts to support, respectively, the Kroon building and student financial aid.

These recent gifts represent an extraordinary investment in the School and a foundation for its future. According to Fred Regan, director of the capital campaign and chief development officer, the campaign had raised \$52 million by the end of the 2003–2004 academic year—which includes these recent gifts—against a minimum goal of \$62 million in support of the campaign’s core needs, which are endowment and the new building. (Overall fund-raising, including all pledges,

gifts, and grants for all purposes, topped \$68 million at the end of the last academic year.)

The dramatic and timely support of Kroon, Grinstein, and the two anonymous donors has given the F&ES campaign a powerful boost and confidence that its minimum objectives can be met when the campaign formally concludes in fall 2005. The challenges ahead, however, remain significant and will require continuing strong support from a broader group of donors. “This endeavor needs help from as many people as possible,” noted Kroon. “All of the school’s alumni, other Yale alums, and friends need to support the school and Dean Speth.”

### New Home on Science Hill

The new green building will embody the School’s commitment to sustainable design, renewable materials, and resource efficiency. “My family and I believe deeply in the objectives Dean Speth has set out,” said Kroon, “and in the urgency with which our global environmental problems must be addressed.”

Before retiring in 2001 from the investment brokerage firm Donaldson, Lufkin and Jenrette, Kroon served for 20 years as the managing partner of that firm’s venture capital fund, the Sprout Group. His Yale undergraduate studies were in economics, but he was moved to make his contribution to F&ES after conversations

with his son, Andrew, a Yale student, and Dean Speth, an undergraduate classmate of Kroon’s.

The gift expands Kroon’s previous strong support for F&ES. In 2002 he established a scholarship for graduates of Yale College who go on to pursue studies at F&ES and who can demonstrate financial need.

“I’m just so impressed with the School’s commitment to train people to be leaders when we really need that leadership in this field,” Kroon explained. “We’re going to need clear-thinking people to guide us in this so-important area over the next several decades.” The environmental challenges he feels most strongly about include water quality; curbing greenhouse gas emissions, which have been identified as a primary source of climate change; and managing economic development in a way that sustains forests.

Of course, Kroon doesn’t expect the new building to resolve those issues directly. For him, the focus is on the people who teach, learn, and interact within the building and the leadership that emerges from F&ES.

Furthermore, the green elements of the building’s design will help the school highlight its environmental principles in a tangible form, he explained. Just as the School’s programs have grown beyond forestry over its history, its new home will embody ideas about the environment and energy use that were unknown when Sage Hall was built in 1923.

The Kroon building is expected to cost approximately \$27 million and take four years to build. The structure will bring together elements of the School that are presently scattered among eight buildings. It will house classrooms, a library, faculty and administrative offices, and the Yale Environment Center, which will consist of an auditorium, breakout rooms, and exhibit areas.

Kroon’s gift also honors the School’s diversity and his own student experience at Yale. “I have been so impressed with the continuing high level of academic excellence and broad cultural experience,” Kroon said. “I feel so blessed to have been a Yale undergraduate and a recipient of other people’s generosity. I could not have gone to Yale without the very substantial help I got [through Yale scholarships]. I’m very happy to have an opportunity to give some back and help others.”



### Major Support for Green Design

A donation from an anonymous Yale graduate also will support the School's plan for an environmentally sustainable structure. Like Kroon, this donor sees the new building as an opportunity to extend F&ES leadership into the field of design. The building will, besides showcasing applied principles of green design, also energize the School with exciting aesthetic appeal and comfortable spaces.

The donor explained that environmentally responsible design involves features of a building's "hardware"—its physical materials—as well as "software," or how it is used. In terms of hardware, a building should employ, to the extent feasible, materials made or harvested locally and sustainably (for example, woods certified by the Forest Stewardship Council). The design also should maximize healthy elements, including fresh air, daylight, and natural materials, for those who use the building.

In its "software," the building can incorporate an awareness of what makes a comfortable and inspiring environment through principles of biophilia, which suggests that humans possess a deep and biologically based urge to connect with the natural world. The new building can use innovative architecture and a biophilic awareness of space to foster an atmosphere of community.

"The new building will be an inspirational and instructional model of sustainable design," agreed Stephen Kellert, Ph.D. '72, chair of the building committee and the Tweedy/Ordway Professor of Social Ecology.

### Endowed Professorship

In addition to leading the effort to transform the School's physical plant, Dean Speth has helped guide a major faculty initiative that has resulted in a refocusing of the School's teaching and research on nine focal areas. A complementary campaign priority has been to expand faculty resources. To date, five new endowed professorships have been established through major campaign gifts. The most recent endowed professorship will be funded by Gerald Grinstein and his wife, Lyn. The gift marks and celebrates Grinstein's 50th reunion, arose from several discussions between Grinstein and Dean Speth about the School's future and strategic priorities, and

builds on Grinstein's strong relationship with Yale University President Richard Levin. In addition, Grinstein's appreciation for F&ES is underscored by his membership on the School's Leadership Council.

Grinstein, former CEO of Western Airlines and of the Burlington Northern railroad, made headlines in January 2004 when he became CEO of Delta Airlines. He also is on the board of a number of companies, including PACCAR, a multinational technology company.

Grinstein has been a leading supporter of institutions that undergird a healthy society, from education to culture and the arts. He and Lyn helped to build the Seattle Symphony's striking new home at Benaroya Hall with a generous gift. Besides the symphony, Grinstein's other loves are the Seattle Mariners baseball team, art collecting, and fly-fishing.

Lyn Grinstein shares her husband's interest in F&ES and his support of its growing role at Yale, and continues to be deeply involved with the Yale Art Gallery's programs. Lyn Grinstein joined the Gallery's board in 1999. "She's been a very generous supporter of the Gallery's exhibits and publications," noted Jock Reynolds, the Gallery's director, "and is a very vital presence on the board." The Grinsteins' support for Yale, Reynolds added, is a "perfect intersection of their interest in the environment, education, and art."

Said Dean Speth: "A great school is built on great scholars, and I am delighted and grateful that one of our scholars will be called the Grinstein Professor at the School of Forestry & Environmental Studies."

### Leadership Scholarships

A second anonymous donor's gift has established a new endowed scholarship fund for outstanding F&ES master's degree students. The gift, from a dedicated alumna of F&ES, is intended to foster the spirit of leadership and to support outstanding students who demonstrate financial need. The new Leadership Scholars Fund will be flexible, providing either deep support for one or two exceptional students or broad support for more students, depending on the pool of applicants and their needs in a given year.

"The goal is to have a scholarship that establishes a spirit of teaching by example," the donor noted, highlighting the values of integrity, generosity, and reciprocity. Students will be invited to interpret the goal of reciprocity in creative ways. They may decide to honor the spirit of the fund through teaching, mentoring, and advocacy or through innovations in the private sector. From the business sphere come examples like Ben & Jerry's Phish Food, the ice-cream flavor; a portion of profits from Phish Food sales helped to clean up Lake Champlain. Also exemplifying this vision are William McDonough, a designer who embraces the "cradle-to-cradle" concept of continuously recycled products that eliminate waste, and Karl-Henrik Robert, whose program, The Natural Step, which incorporates the principles of environmental sustainability, is being adopted by major companies such as McDonalds, IKEA, and Home Depot.

"Wherever you find yourself, ask yourself how you can make the planet a better place," the donor explained. "There are many ways you can interpret that."

While the donor's primary aim is to provide major financial support to outstanding individual students, she also is deeply committed to strengthening financial support for students in other ways. Recognizing that her own fund can offer generous, but only limited, support, she is hopeful that gift support such as hers will be supplemented by much larger low-interest loan initiatives aimed at financially disadvantaged students at Yale. The donor believes that both paths (that is, direct scholarship support as well as loan support) are essential to meet the leadership needs of the future.

"It's about creating opportunities for master's students to enroll at the School without regard for their ability to pay," the donor explained.

If anything, the gifts are a reminder that one of the School's greatest resources is its students, a recognition that is close to the dean's heart. In lighter moments, Dean Speth has said that when he has a bad day, he goes and talks to the students to replenish his own inspiration. "They always have creative approaches and energy to bring to an issue," the donor recalled Speth saying.





## F&ES Community Praises Selection of Kenyan Nobel Winner

When Wangari Maathai recently received the Nobel Peace Prize, the School of Forestry & Environmental Studies (F&ES) community reacted to the news as if a member of the family and her cause—the environment—had won. “Needless to say, everyone is very excited,” said Dean Speth. “We feel like she is part of the family. It was a great treat to have her here.”

Maathai, who was the McCluskey Visiting Fellow in Conservation at F&ES in 2002, received the Nobel Peace Prize for her work on reforestation and forest development in Africa. While at F&ES, she co-taught a course on sustainable development in developing countries, and returned to Yale last May to receive an honorary degree.

Dean Speth said Maathai’s achievement takes on special significance because it is the first time that the prize has recognized work to preserve the environment. “The more profound issue that the Nobel group in Norway is presenting is people learning not to do violence against our natural setting, our natural environment that sustains us,” he said.

Gary Dunning, executive director of Yale’s Forests Dialogue, who worked with Maathai when she was at F&ES, said Maathai represents a connection between environmental security and human rights. “I think this award has recognized a great leader and a great human being,” he said.

Born in Nyeri, Kenya, Maathai earned her undergraduate degree in biological sciences at Mount St. Scholastica College, Kansas, in 1964, and two years later obtained a master’s degree in biological sciences from the University of Pittsburgh. In 1971, she earned a Ph.D. in anatomy at the University of Nairobi, becoming the first East and Central African woman ever to get a doctorate. In 1976, she became the first female to chair the Department of Veterinary Anatomy at the University of Nairobi, and the following year became the first female associate professor of that department and then founded the Green Belt Movement, which has mobilized poor women to plant millions of trees. She ran for the presidency of Kenya in 1997, but lost to Daniel Arap Moi.

In 2003, Maathai was appointed deputy minister of Environment, Natural Resources, and Wildlife in Kenyan President Mwai Kibaki’s cabinet, and in a recent interview for a United Nations Environment Programme documentary, Maathai said, “I love the trees, I love the color. To me they represent life, and they represent hope. I think it is the green color. I tell people I think heaven is green.”

*“I love the trees, I love the color. To me they represent life, and they represent hope. I think it is the green color. I tell people I think heaven is green.”*



## GE Foundation Grant Enables F&ES to Attract Diverse Talent

*The Yale School of Forestry & Environmental Studies (F&ES) has received another \$100,000 two-year grant from the GE Foundation to offer full financial support for up to five students from historically underrepresented US communities. This is the third consecutive year that the GE Foundation has funded the Environmental Scholars Program.*

“The School of Forestry & Environmental Studies is a recognized center of excellence on environmental and natural resources issues. It develops the leaders needed to manage these important issues for the years ahead,” said Steve Ramsey, GE vice president for corporate environmental programs. “This GE Foundation grant will help attract more diverse talent into the program and ultimately to industry and the nonprofit sector.”

The goal of the scholars program is to increase the number of applicants and matriculating master’s students from historically underrepresented communities in the United States, which comprise urban and rural poor and ethnic and racial groups, including Native Americans. When matched with Yale and other funding sources, the students will have full financial support for both years of their master’s program.

The current GE Foundation Scholars are first-year students **Stephanie Horn** of Lower Peach Tree, Ala., **Christopher Hudak** of New Sharon, Maine, and **Evelyn Silva** of Flushing, N.Y. Second-year students are **Drena Howard** of Charlotte, N.C., and **Lisa Botero** of Orlando, Fla., both master’s candidates in environmental management, and **Jacqueline Guzman** of Houston, Texas, a candidate for a master’s degree in environmental science.

“The scholarship is very important to me. Without it I would not be studying at Yale,” said Howard, who will pursue a career in environmental health education after she graduates in 2005. Said Botero, “The GE scholarship is a priceless benefit to me and I am grateful to those who honored me as a recipient. The scholarship has granted me a certain degree of independence by lessening the financial burden and related stresses associated with earning a master’s degree, which will be the first of its kind earned by anyone in my family since coming to this country.”

Dean James Gustave Speth said that the School’s success relies on its ability to attract the best and brightest students with high leadership potential. “While the School has an outstanding track record in preparing students to become environmental leaders, it has been less successful in attracting students from underrepresented communities in the United States. Rising tuition costs, coupled with modest permanent sources of scholarship funding for master’s students, complicate the effort,” he said. “The GE Foundation’s generous grant will help us achieve the School’s strategic goal of educating a new, more diverse generation of environmental professionals.”

The cost of tuition is \$23,850 annually to obtain a two-year master’s degree in either environmental management, environmental

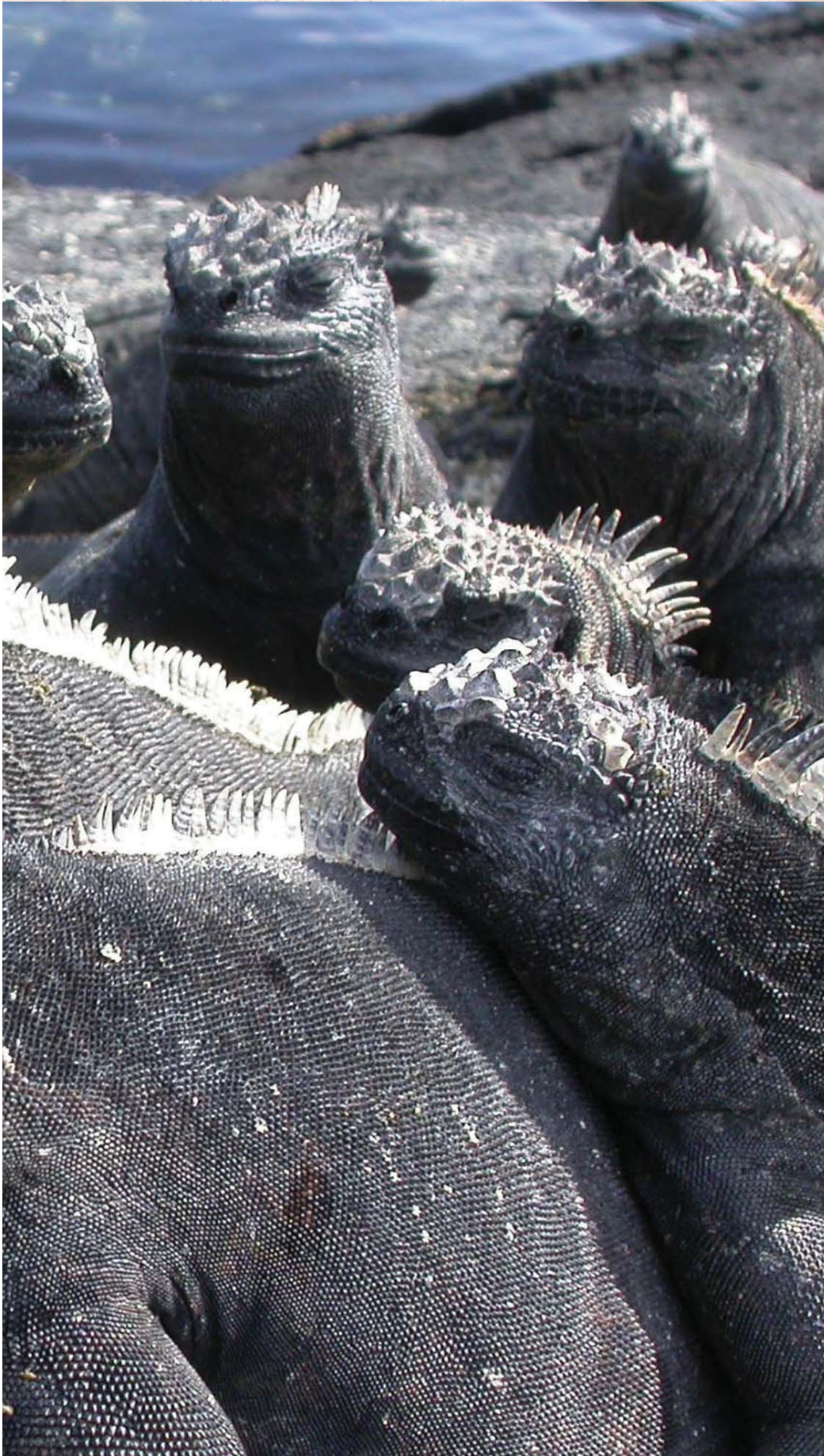
science, forestry, or forest science. F&ES provides \$2.1 million a year in scholarship aid to its 261 master’s students, 26 percent of whom come from outside the United States. Seventy-five percent of master’s students receive grants or loans. Admission to F&ES master’s programs is not based on financial need.

The GE Foundation, the philanthropic organization of the General Electric Company, works to strengthen educational access, equity, and quality for disadvantaged youth, and supports GE employee and retiree giving and involvement in GE communities around the world. In 2003 the GE family contributed \$140 million to community and educational programs, including \$50 million from the GE Foundation. For information, visit [www.gefoundation.com](http://www.gefoundation.com).

The Yale School of Forestry & Environmental Studies ([www.yale.edu/environment](http://www.yale.edu/environment)), founded over 100 years ago, is the oldest school in the country devoted to professional training in the area of the environment and natural resources. In addition to its four two-year master’s programs, F&ES offers a doctor of philosophy (Ph.D.), which is jointly administered with the Yale Graduate School of Arts and Sciences. For more information, contact the F&ES admissions office at 203.432.5942.

**RESEARCH AND  
PROGRAM HIGHLIGHTS**





## Galápagos Marine Iguana and Oil Pollution



*Amblyrhynchus cristatus* is the only species of marine iguana worldwide. It occurs only in Galápagos, where it feeds on green and red algal species along the rocky island shores. Digestive efficiency is maintained for the most part by the presence of an indigenous microbial flora, which is part of a sensitive and unique digestion system. Despite the apparent great phylogenetic age of these reptiles (they diverged from their closest relative, the Galápagos land iguana, more than 10 millions year ago), preliminary genetic studies on a small set of samples suggest that levels of inter-island differentiation are low. Yet morphological and chromatic differentiation among island populations is remarkable, with as much as a ten fold difference in body size between full-grown individuals from different islands. In January 2001 the oil tanker Jessica spilled more than three million liters of oil on the shores of several Galápagos islands with dramatic consequences for the marine Galápagos fauna (see Fig. 1 on the next page for the geographic impact of the oil-spill). At least 60% of the affected island populations of marine iguana died from starvation because

*continued on page 24*

*Top:* Some of the Yale expedition members: Gisella Caccone, Sebastian Steinfartz, Michael Russello, and Scott Glaberman (San Cristobal, Galápagos).

*Left:* A group of marine iguanas sunning themselves on lava rocks on the island of Fernandina.

RESEARCH AND PROGRAM HIGHLIGHTS

continued from page 23

the oil poisoned their vital hindgut microsym-bionts.

In June–July 2004 Dr. Gisella Caccone (Director YIBS Molecular Systematics and Conservation Genetics Laboratory) led a team of scientists from the USA, Belgium, Ecuador, Germany, and Italy, on a trip to the Galápagos to collect blood samples and morphological measurements from populations of marine iguana on all the major islands in the archipelago. The goal of the project was to understand patterns and levels of genetic differentiation within and between populations of marine iguana, and to evaluate the evolutionary impact of the oil spill. The trip was successful, and the team collected morphological data and blood samples from 50–100 individuals from 16 different locations, including all the populations that were affected by the oil spill. For the same populations, the team already had blood samples for 30–50 individuals collected on a previous expedition (1993; see Fig. 1 for sampling sizes and locations). These earlier samples represent the pre-oil spill conditions

for the study. Museum samples from the same populations will also be included in the genetic and morphological analyses in an attempt to evaluate the effect of human-induced events (oil spills, urbanization, and the introduction of alien predators, etc.) and climatic changes like El Niño/Southern Oscillation (ENSO) in shaping levels and patterns of genetic and morphological evolution.

The expedition was funded by the National Geographic Society and by YIBS–ECOSAVE Center. Logistic support was provided by the Charles Darwin research Station and the Galápagos National Park. Upon completion of the genetic work, the samples will be deposited in a permanent blood and DNA collection housed in the newly established cryogenic facility located in the Peabody Museum of Natural History at Yale. Each blood sample will be associated with morphological and ecological measures, with digitized images of each individual. This collection will be available to the whole research community.

## Three Students Receive Switzer Fellowships

Three master's candidates at the Yale School of Forestry & Environmental Studies (F&ES) have received \$13,000 fellowships from the Robert and Patricia Switzer Foundation for their dedication to environmental change. The foundation, based in Maine, awards 20 fellowships annually to emerging environmental leaders who are pursuing graduate degrees at universities in New England and California.



FIGURE 1

Map of the Galápagos. The site of the oil spill is marked by X. Shores of polluted islands are in red. Dots represent sampling sites visited in 1993. Numbers in brackets (males, females) indicate sampled individuals at these sites.



Peter Otis, director of the Career Development Office, said, "The highly competitive Switzer program selects master's and doctoral students who it believes will make an immediate and direct impact on critical environmental issues. Recipients benefit from the scholarships, but they also are supported by a mentoring program, join an impressive network of other recipients whose activities include an annual retreat, and are eligible to apply for Switzer Leadership Grants that could link them with employers."

The F&ES recipients of the Switzer Environmental Fellowships are Ann Grodnik and Radha Kuppalli, both joint-degree candidates at F&ES and the Yale School of Management, and Andrea Johnson, a candi-

date for a master's degree in environmental science.

Grodnik is pursuing joint master's degrees in environmental science and business administration. Her research focuses on the economics of climate change and how corporate strategy and national economies are affected by climate-change mitigation policy. She is particularly interested in how corporations can achieve competitive advantage through superior environmental and social performance.

Kuppalli specializes in environmental finance, focusing on issues related to emissions trading, markets for ecosystem services, and corporate environmental responsibility. After graduate school, she plans to work in the private sector to develop market-based mecha-

nisms that can help improve the environment.

Johnson's work focuses on the linkages between conservation problems and solutions, linkages between financial flows and environmental impacts, international markets and rural communities, and academics and the public with particular emphasis on the developing world. Her thesis research last summer focused on the contested Camisea natural gas pipeline development project in Peru, where she is investigating the role of civil-society participation in holding the project's funding sources (Inter-American Development Bank, among others) and implementers (a transnational energy consortium) accountable to social and environmental standards.

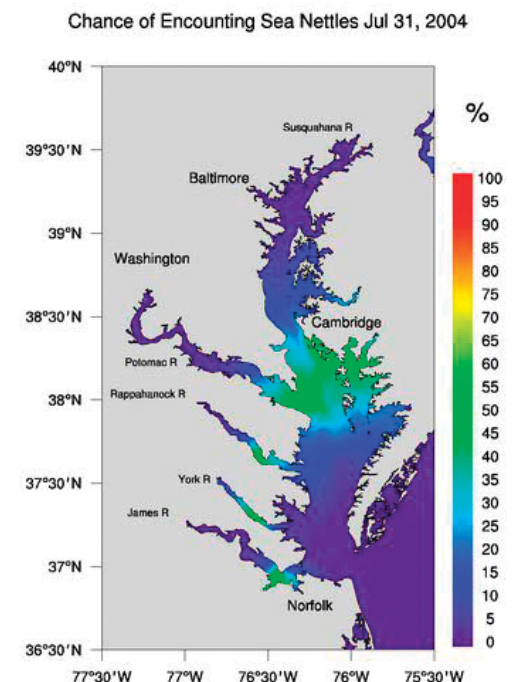
## Forecasting System Predicts Presence of Jellyfish in Chesapeake Bay

A team of scientists led by Yale associate research scientist Mary Beth Decker of the Department of Ecology and Evolutionary Biology (EEB) was recently awarded funds from the National Oceanic and Atmospheric Administration (NOAA) to develop an operational model for predicting the near-real time distribution and abundance of a stinging jellyfish (*Chrysaora quinquecirrha*) in Chesapeake Bay. Jellyfish blooms influence plankton dynamics in coastal waters worldwide. These blooms can reduce food available to higher trophic levels and fish, and they negatively impact tourism in the coastal eastern USA, yet factors that affect bloom development and distribution are not well understood. *Chrysaora quinquecirrha* has the potential to control the flow of energy and nutrients through the food web due to its seasonally high abundance and consumption rates. The impact of *Chrysaora* on the Chesapeake ecosystem and fisheries might be better understood if their presence could be predicted. *Chrysaora* is an ideal target species for ecological forecasting because abundant distribution data have been collected over many years and the primary factors that control its occurrence can be predicted with models.

*Chrysaora* abundance, temperature, and salinity were collected from the bay and its tributaries during 1987–2000, and these data were used to develop a model that describes the preferred habitat of the medusan form of *Chrysaora*. This empirically derived model predicts the probability of *Chrysaora* encounter as a function of surface temperature and salinity. The habitat model can be applied to near-real time estimates of temperature and salinity derived from hydrodynamic models. This method (currently operating in demonstration mode; can be linked through Dr. Decker's Web site [www.yale.edu/decker](http://www.yale.edu/decker)) allows nowcasts to be generated in order to predict the distribution and likelihood of *Chrysaora* occurrence in Chesapeake Bay by identifying locations where ambient conditions coincide with *Chrysaora*'s preferred habitat.

During the next three years, Decker and her associates will operationalize the *Chrysaora* nowcast system. This goal will be accomplished by refining and validating the habitat model in order to more accurately forecast the distribution of *Chrysaora* in the bay and to expand the use of nowcasting capability. This research will synthesize information on factors that influence the distribution and abundance

of *Chrysaora* in order to understand better how this top predator affects energy flow through the Chesapeake Bay system, focusing in particular on potential impacts on other top predators (i.e., fish). This project represents an exciting step toward developing general approaches that combine real-time data derived from disparate sources, such as numerical circulation models, operational satellites, and moored sensor systems, to generate nowcasts and forecasts of bloom development and distribution patterns of noxious marine biota.



## Chinese Environmental Officials Participate in Executive Program



A delegation of 21 high-level officials from China participated this past summer in an executive program developed for them by the Yale School of Forestry & Environmental Studies (F&ES).

The 10-day program last July focused primarily on industrial ecology, ecosystem management, environmental leadership, economics, and environmental law and policy for 8 of the 11 directors-general at the Chinese State Environmental Protection Administration (SEPA) and 13 commissioners of the provincial-level Environmental Protection Bureaus. The goal was to acquaint the Chinese officials with environmental management theory and practices in the United States that will help China achieve environmentally sound development.

The delegation was accompanied by Yujun Zhang '01, chief of staff to Jianxin Li, SEPA director and leader of the delegation, and Qian Wang, deputy division chief of international organization at SEPA and member of the Yale Class of 2002. Zhang and Wang served as translators and program coordinators.

Highlights of the officials' stay included field trips to a state-of-the-art fuel cell installation and the EPA Region 2 office in New York to meet with the delegation's U.S. counterparts and a visit with General Electric (GE) environment and innovation officials. They also took a tour of the New York Harbor, from the tip of Manhattan to Elizabeth, N.J., conducted by the US Army Corps of Engineers and the Port Authority of New York and New Jersey.

In addition, the delegation was honored at a reception hosted by Linda Koch Lorimer, Vice President and Secretary of Yale University, and by a proclamation from Connecticut Governor Jodi Rell, designating July 15 as Environmental Protection Day to commemorate their visit.

Marian Chertow, Assistant Professor of Industrial Environmental Management, and Daniel Esty, Professor of Environmental Law and Policy, were co-chairs of the program, and Assistant Dean Jane Coppock helped plan and organize the program. Many F&ES faculty also participated, including Michelle Bell, Assistant Professor of Environmental Health;

Brad Gentry, Senior Lecturer in Sustainable Investments and Research Scholar; Thomas Graedel, Clifton R. Musser Professor of Industrial Ecology; Xuhui Lee, Professor of Meteorology and Micrometeorology; Sheila Olmstead, Assistant Professor of Environmental Economics; and David Skelly, Professor of Ecology, as well as former F&ES Dean John Gordon and Epidemiology & Public Health Dean Michael Merson. Gretchen Rings, coordinator of the Center for Industrial Ecology, managed logistics, and four students—Shi Han, Woon Kwong Liew, Juan Espinosa, and Xue Wang—worked to implement the program.

Chertow, Graedel, and Gordon plan to meet again with SEPA leaders in China in November 2004. The SEPA Executive Program is the first time SEPA collaborated with a private organization outside China, and is the latest China-related F&ES program. F&ES faculty have taught recently in executive programs in Shanghai, Nanjing, and Beijing. In May, the Environment and Sustainable Development Leadership Program began a three-year program for jointly sponsored short courses between Yale and Tsinghua University.



Class of 2004, Environmental Studies Program. From left, Sparsh Khandeshi, Christine Pham, Livia DeMarchis, Michael Renda, Rachel Wasser, John Wargo (DUS of EVST), Linda Shi, Todd Montgomery, Marina Spitkovskaya, Christopher McPhee. (Not pictured: Anna Gross)

## The Environmental Studies Program Graduates Its First Class of Majors

by Jeffrey Park, EVST Chairman

Through the support and hard work of Yale alumni, professors, and staff, the Environmental Studies Program has created a stimulating interdisciplinary major for Yale undergraduates. The year 2004 saw the graduation of our first class of seniors, a cohort of ten young women and men whose senior research essays ranged from wildlife conservation to government fuel-economy policy. A photo album of the senior presentations can be found linked to the Environmental Studies Web page at [www.yale.edu/evst](http://www.yale.edu/evst).

An important factor in our success thus far has been the efforts of Professor John Wargo of the School of Forestry & Environmental Studies (F&ES). Jointly appointed in the Political Science Department, Professor Wargo is the program's Director of Undergraduate Studies (DUS). Professor Wargo is taking a well-deserved sabbatical leave in fall 2004, during which time Professor Steven Stoll of the History Department is serving as DUS of Environmental Studies (EVST).

John Wargo and I co-taught the EVST junior seminar in spring 2004, a course where our majors are exposed to interdisciplinary research methods in the environment. As part

of this course the class took a weekend field trip to Cape Cod in late March. On the first day of the field trip, students were given tours by contractors for the groundwater remediation project beneath Otis Air Force Base. On the second day, the students were guided by park rangers who manage public use of the Cape Cod National Seashore. A photo album of the Cape Cod field trip is posted on the EVST Web site.

In the 2003–2004 school year our program hosted the second year of Dr. Richard Marcus's term as a postdoctoral associate and lecturer. Through the funding support of Yale's Center for the Study of Globalization, Dr. Marcus taught two courses, *Global Issues in African Conservation and Development*, and *Comparative Politics of Water Resources*, both cross-listed with the Political Science Department. Between teaching and advising research projects in both Yale College and F&ES, Dr. Marcus initiated a book project on comparative water-resource politics. Dr. Marcus departed Yale this fall to become an assistant professor of political science at the University of Alabama, Huntsville.

### FIVE STUDENTS NAMED HEINZ SCHOLARS

Five students from the School of Forestry & Environmental Studies (F&ES) will receive grants to study pressing environmental challenges as Teresa Heinz Scholars for Environmental Research.

"It is quite an honor for our School to have 5 of the 16 fellowship recipients," said Dean Gus Speth.

The fellowship recipients were selected by a committee of environmental experts. Two F&ES Ph.D. candidates and three master's candidates will receive \$10,000 and \$5,000 awards, respectively, to pursue environmental research.

The students and their projects are doctoral candidates **Alissa Hamilton**, *Fabricating Fresh: The Growth of Florida's Orange Juice Industry and the Transformation of Taste, Tradition, and Territory*; and **Anastasia O'Rourke**, *Innovations in Finance and Policy for High-Growth Environmental Ventures*; and master's candidates (Environmental Science) **David Kneas**, *Assessing the Assessments: Environmental Impact Assessments and Community Relations with Multinational Mining Companies*; **Ann Grodnik**, *The Clean Development Mechanism as an Instrument for Carbon Mitigation and Sustainable Development: Early Lessons from Two Case Studies*; and **Andrea Johnson**, *Researching the Researchers: A Comparative Case Study Exploring Linkages between Institutional Structure, Stakeholder Perceptions, and Conservation Activities at Indonesian Ecological Research Stations*.

For more information about the Heinz Fellowships, contact Peter Otis, director of the Career Development Office, at 203.432.8920.

## STUDENT NEWS



Left to right: Eric Palkovacs, Oliver Balmer, Maria DeAngelo, Casey Dunn

### ECOLOGY & EVOLUTIONARY BIOLOGY STUDENTS RECEIVE AWARDS

Maria DeAngelo, a 2nd-year Ecology & Evolutionary Biology (EEB) graduate student in Professor Anne Yoder's laboratory in the Class of '54 Environmental Science Center, along with the nonprofit group Finding Species and the Mindo Biological Station, is organizing a meeting of biologists working in Ecuador. The 2nd Annual Conference

on Tropical Forest Research in Ecuador was held in Mindo, Ecuador, in October 2004, and focused on Yasuni National Park and the increased amount of oil exploration occurring in the lowlands of Ecuador. Maria was a moderator and also presented a talk titled: "Diversity and Speciation of small Mammals of the Amazon: The Importance of Maintaining Intact Ecosystems". This meeting included biologists from Ecuador and the United States, and from such universities as Universidad San Francisco de Quito, Pontifica

Universidad Catolica de Ecuador, New York University, SUNY Stony Brook, University of California at Davis, Boston University, University of North Carolina at Chapel Hill, as well as groups such as Conservation International, TADPOLE (tropical amphibian distribution and population operation for life-saving efforts), and EcoEcuador. Maria received a Fulbright Fellowship for her research work in Ecuador and is fulfilling the mission of the Fulbright Program, which is mutual understanding between people of the United States

### ENVIRONMENTAL SUMMER INTERNSHIPS—2004

With the generous support of the Gaylord and Dorothy Donnelley Foundation, the William Bingham Foundation, the Montgomery Family Fund and Yale's Department of Ecology and Evolutionary Biology, the Environmental Studies Program in 2004 awarded 27 Environmental Summer Internships totaling \$63,501 to Yale undergraduates. The breadth of these internships expresses the remarkable diversity of student interest in environmental issues. Topics ranged from malaria-vector abatement in Africa to efforts by multinational corporations to reduce environmental degradation in China, to field work in the Yale–Myers Forest to study species dispersal among microscopic aquatic organisms.

The following students received support for their summer projects by a committee of faculty headed by Mary Helen Goldsmith. The students' descriptions of their experiences can be found on the Web site [www.yale.edu/evst](http://www.yale.edu/evst).

**Aravinda Ananda**, Environmental Studies '05  
Shrimp Aquaculture in Ecuador: NGO Success in Improving Local Environmental Sustainability

**Antasia Azure**, English (writing concentration) '05  
Study of the Culture of the Australian Aborigines and Their Relationship to the Great Barrier Reef of Australia

**Cara Berkowitz**, Environmental Studies '05  
Hands-on Environmental Education: Bridging Deficits in Holistic Educational Methods and Awareness of Environmental Issues

**Bhart-Anjan Bhullar**, Biology (Ecology & Evolutionary Biology Track) '05  
Paleontology and Comparative Anatomy of Squamates: Field Work, CT Data Processing and Descriptions of Gerrhosaurid Skulls

**Deepali Dhar**, Undeclared '07  
Climate Change Internship with Environmental Defense in New York City, N.Y.

**Genevieve Essig**, Psychology '05  
Summer Internship with Environmental Law Institute

**Alexandra Freeman**, History of Science/History of Medicine '05  
The Recent History of Bioprospecting: An Ecological and Medical Investigation in the Republic of Panama

**Shani Harmon**, Environmental Studies/Anthropology '06  
Potato Park Agrobiodiversity: Impact of Globalization on Indigenous People in Peru

**Laura Hess**, Environmental Studies '06  
Internship with CHIRAG (Central Himalayan Resource Action Group)

**Caroline Howe**, Environmental Studies or Environmental Engineering '07  
Study of Sustainable Agriculture on an Organic Farm and Field Research at Yale–Myers Forest

**Laura Jeanty**, Physics '06  
Internship on Electrical Industry with TERI (The Energy and Research Institute) in New Delhi, India

and Ecuador. Her Fulbright award is the first for a Yale Graduate School science student in four years. She is a 3rd-year student and her YIBS Fellowship paid for a season in Ecuador.

Eric Palkovacs, an EEB doctoral student, is the recipient of the Environmental Protection Agency Star Fellowship Award. Eric's research and dissertation is titled "The Evolutionary Origin and Ecological Consequences of Life History Variation in the Alewife." Eric also received a YIBS Field Ecology Award. He is in his 4th year and his adviser is David Post.

EEB doctoral students Oliver Balmer, Siobain Duffy, and Casey Dunn each received a National Science Foundation Doctoral Dissertation Grant to support their research. Oliver is doing field research in Switzerland, at the Swiss Tropical Institute, and in East Africa to test his theory, the role of multiple infections in the epidemiology of East African trypanosomes. Oliver received a YIBS Field Ecology Award to assist his research and is a 4th-year student of Professor Stephen Stearns, EEB Chair. Siobain, a recipient of a Howard

Hughes Medical Institute Fellowship, is pursuing research that will result in a dissertation "Evolution of Generalism and Speciation in the ds RNA Bacteriophage 6". Siobain is a 4th-year student of Professor Paul Turner. Casey Dunn is doing research on siphonophores (see page 17), a large and enigmatic group of pelagic cnidarians (simple two-layered animals related to hydra) and participated in cruises in the eastern Pacific and North Atlantic. In addition, Casey worked with Phil Pugh at Southampton Oceanographic Institute describing a new species of siphonophore, *Marrus claudanielis*; at the Volker Schmid Laboratory at the University of Basel cloning genes involved in siphonophore development; and at the marine station at Villefranche sur mer, France, collecting specimens. Casey, a student of Günter Wagner, is a 5th-year student whose dissertation is titled "The Development and Evolution of Siphonophores".

**Lucas Knowles**, EVST '05  
Case History of the King Salmon Military Dump Site in Alaska

**Beth Kochin**, Biology (Ecology & Evolutionary Biology Track) '07  
Impact of Anadromous and Landlocked Alewife on Inland Water Quality and Food Web Structure

**Maya Kotas**, Biomedical Engineering '05  
Study of Malaria Intervention Techniques at Ifakara Health Research and Development Centre, Ifakara, Tanzania

**Erica Larsen**, Biology (Ecology & Evolutionary Biology Track) '06  
Rotifers in Space: Testing a Spatially Explicit Model of Metacommunity Coexistence

**Danielle Larson**, Environmental Studies '05  
Field Study in Wrangell-St. Elias National Park and Preserve

**Flora Lichtman**, Environmental Studies '05  
Regulating Underwater Sound: A Case Study (Research at SACLANT Undersea Research Center on the Northwest Coast of Italy)

**Melanie Loftus**, Environmental Studies '05  
What Are the Institutional Challenges to Regional Environmental Planning in the Washington, D.C. Metropolitan Area?

**Erica Machlin**, Biology (Ecology & Evolutionary Biology Track) '05  
Speciation in Mouse Lemurs (Working in Yoder Lab at Yale)

**Madeleine Meek**, Anthropology '05  
Assessment of Healthcare Initiatives in Ranomafana Integrated Conservation-Development Project

**Megan O'Connor**, Environmental Studies '05  
Animal Care at The Second Chance Wildlife Center in Gaithersburg, Maryland

**So Yeon Paek**, Molecular Biophysics & Biochemistry '05  
Infectious Eye Diseases and Public Health Initiatives in Humijbre, Ghana

**Vicente Undurraga Perl**, Biology (Ecology & Evolutionary Biology Track) '06  
Landlocked Alewife and Implications of Dam Removal or Fish Ladder Construction in Connecticut

**Sarah Jane Selig**, Environmental Studies and International Studies '06  
Research on Mesoamerican Reef Health in Akumal, Mexico

**Leanna Sudhof**, Environmental Studies and International Studies '06  
Bacterial Larvicides as a Malaria Vector Control Method at International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya

**Mary Elizabeth Young**, Biology '06  
Development of a Non-Invasive Molecular Sexing Protocol for the Endangered Amur Tiger

**Xizhou Zhou**, Environmental Studies '05  
Case Study of Shell/Petro China Pipeline: Environmental and Social Impacts with UNDP

# PUBLICATIONS

## YALE ENVIRONMENTAL JOURNAL TRANSLATED INTO CHINESE

As China's role in the global environment grows, so too does the importance of high-quality scientific research and communication. As the sixth-largest economy and most populous country in the world, China and its development play a crucial role in the future of the global environment.

To help foster increased international dialogue, the *Journal of Industrial Ecology* has translated summaries (abstracts) of all of its articles into Chinese. These translations are available at the journal's Web site: <http://mitpress.mit.edu/jie/translatons>.

The *Journal of Industrial Ecology*, <http://mitpress.mit.edu/JIE>, is the premier journal in the rapidly growing field of industrial ecology, which systematically examines local, regional and global uses and flows of materials and energy in products, processes, industrial sectors and economies. Industrial ecology focuses on the potential role of industry in reducing environmental burdens throughout the product life cycle, from the extraction of raw materials, to the production of goods, to the use of those goods and to the management of the resulting wastes. Owned by Yale University, published by MIT Press, and headquartered at the Yale School of Forestry & Environmental Studies, the journal is a highly regarded peer-

reviewed quarterly, which has been praised for both its readability and timely relevance to key environmental issues. It is the official journal of the International Society for Industrial Ecology.

Funds for this endeavor were provided by the Henry Luce Foundation as part of a larger project, Collaborative Industrial Ecology in Asia, which aims to increase educational and scientific exchange in industrial ecology between Asia, especially China, and Yale University. The project, now drawing to a conclusion, has supported scientific exchange, student scholarships, and the translation of books and summaries of articles into Chinese, as well as library subscriptions to the journal for Asian universities and institutions.

## [www.yale.edu/environment/publications](http://www.yale.edu/environment/publications)



## Yale School of Forestry & Environmental Studies Publication Series

To capture exciting environmental projects at Yale of interest to a broad professional audience, the School publishes selected work by faculty, students and outside colleagues each year. Everything published since 1995 is now available at our new Online Bookstore (web address above). There you can download chapter PDFs at no charge or order print copies using many forms of payment, including credit card or internal Yale charging. Come visit! If you have questions or want further information, please contact F&ES Publication Series editor Jane Coppock at [jane.coppock@yale.edu](mailto:jane.coppock@yale.edu).

"This project is especially timely because the Chinese government has announced the 'circular economy' (*xun huan jing ji*) as a centerpiece of Chinese environmental policy," said Reid Lifset, editor-in-chief of the *Journal of Industrial Ecology*. "The circular economy and industrial ecology—*chan ye* (for industrial), *sheng tai xue* (for ecology)—strongly overlap. Both emphasize loop closing—recycling in the broadest sense—as a means of moving toward an environmentally sustainable economy."

Gus Speth, Dean of the Yale School of Forestry & Environmental Studies, said, "China's economy is growing by leaps and bounds; its environmental performance and role in the world is a central issue in sustainable development. Translating the abstracts of articles in the *Journal of Industrial Ecology* is one of the best things we can do—bring a forward-looking, preventive environmental framework to the attention of the Chinese and engage them as partners in the development of this new field."



#### NEW F&ES BOOK

Environmental issues that have national impact are featured in a recently published F&ES book on the relationship between the environment and politics in the 2004 presidential election.

Jim Lyons, lecturer and researcher at Yale School of Forestry & Environmental Studies (F&ES), and co-editor of *Red, White, Blue, and Green: Politics and the Environment in the 2004 Election*, said the book is an analysis and compilation of lectures given last spring at the environment school.

Examples of issues include the restoration of the Everglades in Florida, the health of forests in Oregon and Washington, water quality and concern for mercury levels in fish in Wisconsin, and the effects of emissions from utility plants on air quality in New Hampshire and Maine.

Lecturers in the series, representing both Republican and Democratic perspectives, included pollsters, journalists, environmental activists, members of Congress, and former officials of the Bush, Clinton, Ford, and Nixon administrations.

In addition to discussing the 2004 election, the book includes provocative reflections on the role the environment played in the 2000 election and on Republican achievements in environmental protection going back to Teddy Roosevelt. As Jim DiPeso, policy director of

Republicans for Environmental Protection, said in his talk, "Conservation is conservative."

Several talks make reference to the Bush administration's pre-9/11 performance on the environment and a policy decision on arsenic levels in drinking water that generated a critical response from many in the public and the press.

Republican Congressman Christopher Shays was critical of this tack during his talk, saying, "Many of the initiatives proposed by the White House exacerbate, rather than improve, the problems they target."

Polling data indicates that Democrats have a clear advantage over Republicans in terms of public perceptions of which party would do a better job of protecting the environment.

Several speakers noted that the environment is a subject with broad appeal. Kellyanne Conway, a leading Republican pollster and strategist, said that the environment "is one of those areas—unlike abortion, guns, gay marriage, or even tax reform—where a reasonable commonsense policy about environmental concerns is able to magnetically attract Republicans, Democrats, and Independents."

Despite the partisan nature of environmental debates today, several speakers made strong appeals for bipartisan cooperation for solving the environmental problems of the future. As Robert F. Kennedy Jr. noted, "I don't think it's good for our country or for the environment if the environment becomes the province of one party, and I don't think there is any such thing as Republican children and Democratic children."

Contributors are: **Deb Callahan**, president of the League of Conservation Voters; **Kathleen Campbell**, who holds a master of environmental science degree from the Yale School of Forestry & Environmental Studies (F&ES); **Kellyanne Conway**, CEO and president of the polling company™; **Jim DiPeso**, policy director of Republicans for Environmental Protection; **Daniel Glickman**, former director of the Institute of Politics at Harvard University and former secretary of agriculture in the Clinton administration; **Chris Henick**, deputy assistant to the president and deputy to the senior adviser in the Bush administration; Vice President **Al Gore**; **Heather Kaplan**,

*continued on back cover*

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who holds a master of environmental management degree from F&ES; **Robert F. Kennedy Jr.**, chief prosecuting attorney for Riverkeeper; **James Lyons**, lecturer and research scholar at F&ES and the executive director of the Casey Trees Endowment Fund in Washington, D.C.; **Chris Marshall**, senior analyst at The Mellman Group; **Eric Pianin**, a national reporter for the *Washington Post*; **John Podesta**, president and CEO of the American Progress Action Fund; **Nathaniel Reed**, assistant secretary of the interior for fish and wildlife and parks from 1971 to 1977 under Presidents Nixon and Ford; **Robert Semple, Jr.**, Pulitzer Prize-winning environmental reporter and associate editor of the editorial page at the *New York Times*; Congressman **Christopher Shays** (R-CT); **Elizabeth Shogren**, environmental

reporter for the *Los Angeles Times* Washington bureau; **James Gustave Speth**, Dean of F&ES; and **Fred Strebeigh**, lecturer at F&ES and Yale University's Department of English.

To purchase bound copies or download free chapter PDFs of *Red, White, Blue, and Green: Politics and the Environment in the 2004 Election*, edited by Jim Lyons, Heather Kaplan, Fred Strebeigh, and Kathleen Campbell, visit the environment school's publication series Web site, [www.yale.edu/environment/publications](http://www.yale.edu/environment/publications). For more information, contact F&ES Publication Series editor Jane Coppock at [jane.coppock@yale.edu](mailto:jane.coppock@yale.edu).

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