YALE ENVIRONMENTAL NEWS

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

spring 2004
vol. 9, no. 2

Transnational Management Preserves Lowlands

A team of scientists led by a Yale professor is calling for the immediate transnational management of an Indonesian rain forest to halt illegal logging that is destroying protected lowlands.

"Failure to institute transparent and equitable land-use solutions will lead to the irreversible ecological degradation of Borneo's terrestrial ecosystems," according to a research article that appeared in the February 13 issue of *Science*.

"Stemming the flow of illegal wood from Borneo requires international efforts to document a legitimate chain-of-custody from the forest stand to consumers through independent monitoring. Indonesia's wood-based industries must demonstrate sufficient timber concession stock or reduce capacity. Timber and plantation operations must be closely monitored with annual satellite-based assessments [and] strictly enforced penalties to prevent further incursions in the protected areas."

Based on remote sensing satellite and field-based analyses, Lisa Curran, associate professor of tropical resources at the Yale School of Forestry & Environmental Studies (F&ES), and scientists from the University of Maryland and Indonesia, observed that protected lowland forests in both Indonesian Borneo and Kalimantan in southeastern Asia declined by an average of 56 percent from 1985 to 2001. In the province of West Kalimantan alone, lowland protected areas were reduced by 63 percent. Protected forests have become increasingly isolated and deforested by commercial loggers and wildfires and by their conversion, primarily to oil palm plantations.

Thirty-eight percent of lowlands in Gunung Palung National Park (GPNP) in West Kalimantan were deforested from 1988 to 2002. Lowland protected areas, such as the GPNP, are critical to maintaining Borneo's biodiversity. More than 420 resident bird species and 222 mammal species exist on Borneo, and 61 percent of these birds and 52 to 81 percent of the mammals are confined to lowland forests. This park contains 17 percent of Borneo's population of endangered orangutans.

The logging of dipterocarp trees, which are used to make plywood and Formica, is depleting the number of orangutans and pigs that live within Borneo's lowlands and depend on the fruit that the trees produce. The populations of threatened nomadic and large vertebrates with extensive lowland ranges, including the Malayan sun bear, bearded pig and orangutan, are predicted to decline precipitously if logging continues.

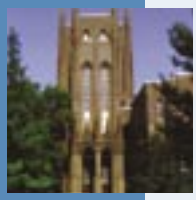
Over the past two decades, the volume in cubic meters of dipterocarp timber exports from the Kalimantan, Sarawak and Sabah provinces of Borneo exceeded all tropical-wood exports from Africa and Latin America combined. Logging within protected areas is expected to increase because of state regulations passed in 2001 that allow for uncontrolled logging of remaining accessible lowland, and because of widespread conversion of forest to oil palm plantations outside of protected areas.

"Even uninhabited frontier parks become susceptible to market forces without an active civil society, institutions and effective governance," Curran said.

Top: Bearded pigs, *Sus barbatus*, are nomadic 150 kg vertebrates that move across the landscape and eat the seeds of the main timber trees removed. They are the major source of protein/wildgame for indigenous peoples. Commercial logging is disrupting wildlife, ecological dynamics and local rural livelihoods

Bottom: An illegal industrial logging camp within a "protected forest area" logging the park

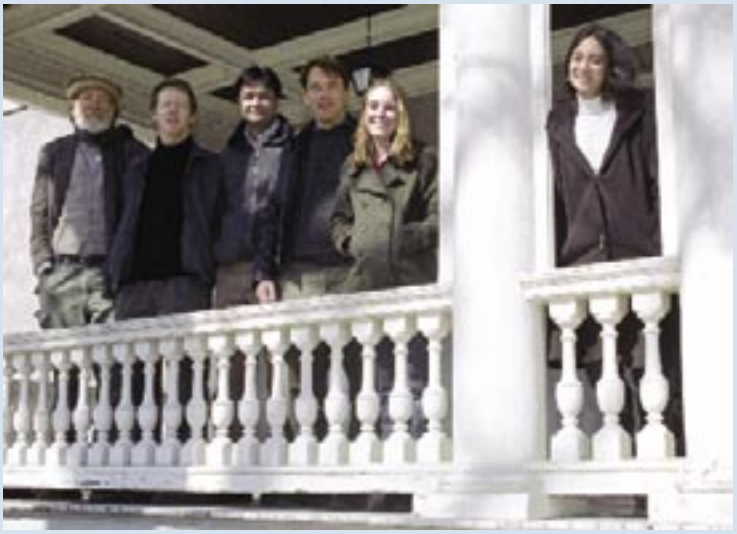
INSIDE THIS ISSUE



Combined F&ES/Anthropology Degree Program Formalized

by Michael Dove

Michael Doolittle



Michael Dove, left, director of the combined-degree program, with students in the program, left to right, Andrew Mathews, Shafqat Hussain, Jonathan Padwe, Anne Rademacher and Julie Velasquez Runk.

In 2003 the Yale Graduate School formalized a unique combined doctoral degree program, involving the Department of Anthropology and the School of Forestry & Environmental Studies (F&ES). The program was launched some years ago by former Yale Provost Alison Richard, with the aim of enabling doctoral students in biological anthropology to draw on the resources of both F&ES and Anthropology. The arrival in late 1997 of anthropologist Michael Dove at F&ES, with a joint appointment in Anthropology, stimulated new interest in the program. It has since grown with every passing year, culminating in the drawing up of a formal course of study last year.

The stated purpose of the new degree program is to (1) combine the interdisciplinary character and possibilities of F&ES, especially in terms of bridging the social and natural sciences, with the disciplinary identity and strengths of the Anthropology Department; (2) combine the strengths in ecological and environmental studies of F&ES with the social science strengths of the Anthropology Department; and (3) combine the emphasis within F&ES on linking theory with policy and practice with the Anthropology Department's strengths in theory. The combined doctoral degree offers its graduates great flexibility when entering the marketplace: they can represent themselves as anthropologists and/or environmental scientists and as theoreticians and/or practitioners. They have the credentials for policy-oriented positions with international institutions as well as academic positions in teaching and research.

There are currently eight students in the program. The first two graduates—Pamela McElwee and Andrew Mathews, its first graduates in recent years—will receive their Ph.D.s this May. Their dissertations, "'Lost Worlds' or 'Lost Causes'? Biodiversity Conservation, Forest Management, and Rural Life in Vietnam" and "Forestry Culture: Knowledge, Institutions and Power in Mexican Forestry, 1926–2001," respectively, reflect the richness of subjects tackled by students in the program.

The countries where the students have done field research—in many cases for two to three years—include Vietnam, Indonesia, Mexico, Nepal, Panama, Cambodia, Pakistan and India. Students in the program have been very successful in winning major outside grants to support field research, including multiple awards from the National Science Foundation, the Environmental Protection Agency and the Fulbright program, in addition to a number of private foundations. The Yale Center for International and Area Studies has also been a valued supporter through its area study councils. Students in the program have drawn their committees from more than a dozen different faculty members in F&ES, Anthropology, other Yale departments and the New York Botanical Garden. The resources available to students in the combined-degree program give Yale an unrivaled advantage in doctoral-level training at the intersection of society and environment.

The recent growth of the combined-degree program is partly explained by its synergy with important institutional developments at Yale. Within F&ES, these include Dean Gus Speth's dual goals of building bridges to the rest of the Yale campus and making F&ES into a global school of the environment; within the wider university, the combined degree builds on the growing interest in environmental studies and President Levin's call for the development of greater international presence and expertise.

The intellectual content of the combined-degree program follows in the Yale tradition of giving students the theoretical and methodological tools to think critically in novel and unexpected situations. Past paradigms of conservation and development have largely failed; so doing more and better offers no promise for the future. The road to healthy societies and environments depends upon thinking outside the box. The greatest environmental challenge of the 21st century may well be a conceptual one. The hybrid character of the combined F&ES/Anthropology degree offers an unique opportunity to meet this challenge.

CONFERENCES, SEMINARS, SYMPOSIA

F&ES Lecture Series Addresses Environment in the 2004 Elections

by Heather Kaplan, M.E.M. '04

How are environmental issues playing out in the 2004 election year? What is the future role of the environment in U.S. politics? Why does the environment seem to be a low-priority issue to voters? Such questions were explored this semester by students at the Yale School of Forestry & Environmental Studies (F&ES) as part of a course and associated lecture series titled "Politics and the Environment in the 2004 Election Year." Key speakers in the series include Deb Callahan, president of the League of Conservation Voters; former Vice President Al Gore; Bob Semple, associate editor of the editorial page for the *New York Times*; Bobby Kennedy Jr.; Congressman Christopher Shays (R-CT); John Podesta, chief of staff for former President Bill Clinton; as well as prominent Democratic and Republican pollsters.

The student-initiated course was developed in response to concerns about the absence of environmental issues in mainstream political discourse. Recent polls suggest that although the majority of Americans consider themselves to be environmentalists, most consider the environment a low priority. According to Dan Glickman, former U.S. secretary of agriculture and current director of the Institute of Politics at Harvard, environmentalists are partly to blame for the low priority given to the environment by Americans. "National environmental groups," he said in January, "have gotten fat, lazy and comfortable."

Representative Shays, who spoke in February, also noted that efforts to restore and protect a clean and healthy environment must cross party lines. "We must reach beyond the Democratic caucus. Success in the past has come when there [have been] substantial number[s] on both sides who want environmental progress."

YIBS/ESC FRIDAY LUNCHEON SEMINAR SERIES

In the Fall of 2002, Yale Institute for Biospheric Studies (YIBS) Director Karl Turekian organized the first series of YIBS/ESC Friday Noon Seminars featuring as speakers occupants of the Class of 1954 Environmental Science Center (ESC) in keeping with the intention of the building's use as a locus of interdisciplinary activities in environmental sciences. Seminars, scheduled each Friday during the fall and spring semesters, successfully continue, hosting faculty from the various disciplines on Science Hill as speakers. Under the direction of the current YIBS director, Professor Derek Briggs, the following speakers were featured in the spring of 2004: Jeffrey Park, professor of geology & geophysics (G&G) and chair of the Environmental Studies Program; Jay Ague, professor of G&G; Benedict Kiernan, A. Whitney Griswold Professor of History and director of the Genocide Studies Program; Richard Prum, newly appointed professor of ecology & evolutionary biology (EEB) and curator of ornithology in the Peabody Museum of Natural History (YPM); Dr. Theodora Pinou, Niarchos project coordinator for the YPM; Dr. Eric Lazo-Wasem, invertebrate zoology senior collections manager at the YPM; Dr. Amy Russell, Gaylord Donnelley Environmental Postdoctoral Fellow in EEB; Dr. Stephen Meyer, Gaylord Donnelley Environmental Postdoctoral Fellow in G&G; Dr. Benjamin Twining, Gaylord Donnelley Environmental Postdoctoral Fellow in the School of Forestry & Environmental Studies (F&ES); William Mitch, assistant professor of chemical & environmental engineering; and Oswald Schmitz, professor and director of doctoral studies in F&ES.

The fall 2004 seminar schedule begins on Friday, September 10 and continues through the fall semester. Speakers will include Gaboury Benoit, F&ES professor of environmental chemistry and environmental engineering; David Evans, assistant professor of G&G; Hong Yang, visiting professor in G&G; Jeffrey Powell, professor in EEB and F&ES; Danny Rye, professor of G&G; John Wargo, F&ES professor of environmental risk analysis & policy, political science and director of undergraduate studies for the Environmental Studies Program; Melinda Smith, assistant professor of EEB; J. Rimas Vaisnys, professor of electrical engineering and EEB; David Watts, professor and director of undergraduate studies in anthropology;

continued on page 4

PEABODY MUSEUM OF NATURAL HISTORY

continued from page 3

and Harvey Weiss, professor of Near Eastern archaeology, language and civilization and anthropology.

The audience for the seminars is primarily composed of faculty, research staff and students involved in environmental research and education. Topics focus on current research and are presented in a way that is comprehensible to the diverse audience who attend. Seminars are in Room 110 of the Class of 1954 Environmental Science Center (ESC), 21 Sachem Street. For information on dates and topics, please visit the following website: *www.yale.edu/yibs/ESC_Seminar.html*

F&ES SPONSORS PROFESSIONAL ETHICS WORKSHOP

A professional ethics workshop, held last November, focused on codes and ethics in forestry. The annual workshop was sponsored by the School of Forestry & Environmental Studies' (F&ES) master of forestry program. Chad Oliver, Pinchot Professor of Forestry & Environmental Studies and director of the Global Institute of Sustainable Forestry, discussed advocacy in science and the ethical challenges that it presents. Lisa Newton, professor of applied ethics at Fairfield University, facilitated a discussion of business ethics in the workplace and provided insight into the role of individuals in shaping an ethical profession as a whole. Lloyd Irland, lecturer in forest finance and senior research scientist at F&ES, discussed the meaning of professionalism in forestry. Curtis Rand, Connecticut consulting forester and an F&ES alumnus, emphasized the importance of working for what and whom he believes in and educating his clients as a part of that process. Twelve F&ES students attended the workshop.

EVENTS

SOURCE TO SOUND CLEANUP
May 8

With the Quinnipiac River Watershed Association

BIOZONE! THE PEABODY MUSEUM SUMMER YOUTH INSTITUTE

July 12–23

A fun and educational program for children focusing on biodiversity, including behind-the-scenes tours and field trips.

see *www.peabody.yale.edu* for details

Ornithologist Joins the Department of Ecology & Evolutionary Biology and the Peabody Museum of Natural History

Richard O. Prum has been appointed to the Department of Ecology & Evolutionary Biology (EEB) as the William Robertson Coe Professor of Ornithology, and to the Peabody Museum of Natural History (YPM) as curator of ornithology. He received his bachelor's degree from Harvard University (1982) and his doctorate from the University of Michigan (1989). After a Chapman Fellowship at the American Museum of Natural History in New York, Prum served 12 years as a professor and curator at the University of Kansas. He was awarded a Fulbright Fellowship for research and teaching in Brazil in 2001, and has served on the editorial board of *The Auk*, a quarterly journal of ornithology published by the American Ornithologists' Union, the leading international journal and professional organization in his field, and also serves on the board of this organization.

An enthusiastic bird watcher since childhood, Prum has researched a wide variety of questions in avian biology and has conducted fieldwork in many countries and continents. At Harvard, he first combined his love of avian diversity with the exciting developments in phylogenetics to conduct studies of the relationships of toucans and the barbets (Ramphastidae) and reconstruct the biogeographic history of tropical Central and South America. As a graduate student, Prum pioneered the phylogenetic analysis of behavior evolution in his comparative analysis of the elaborate courtship displays in a family of Neotropical birds, the manakins (Pipridae). Because of his interest in display ornamentation and sexual selection, Prum began to investigate the poorly understood structural colors of bird feathers and skin. Over the past

RICE: FROM INDIGENOUS CULTURES TO DNA

October 9–11

During this three-day event Museum visitors will be able to use interactive, fun activities to explore this extremely important plant, from recent advances in the study of its genome to its cultivation and use over the last 7,000 years. Sponsored by the NSF Plant Genome Program.

EXHIBITIONS

In Search of the Giant Squid

September 25, 2004 through January 2, 2005

A Smithsonian Institution exhibition that tells the story of these amazing animals. Specimens from the Peabody's own extensive collections will be included in the exhibition. Visitors will examine the myths surrounding giant squid, compare them with other squids and mollusks, and explore what is known about how they hunt, move, mate, and defend themselves.

Line drawing of *Architeuthis princeps* by A.E. Verrill.

An enthusiastic bird watcher since childhood, Prum has researched a wide variety of questions in avian biology, and has conducted fieldwork in many countries and continents.

decade, he has been studying the anatomy and physics of blue and other structural colors in birds, mammals and other animals.

While teaching ornithology, Prum became fascinated with everything to do with feathers and particularly how branched feathers grow. "Over the years, I developed a nearly messianic interest in communicating how feathers grow to my students, but I never expected that this overlooked subject would become central to my research," he reports. In 1999, however, Prum began to apply the details of this growth to create a new developmental theory of how feathers evolved. In combination with an explosion of new fossils of feathered dinosaurs from China over the last five years, Prum's theory has led to revolutionary advances in our understanding of the origin and diversification

continued on page 6

continued from page 5

of feathers. Prum remarks that "feathers have always been thought of as quintessentially avian, but now we know they originated and diversified in terrestrial dinosaurs before the origin of birds. After centuries of being considered among the most distinct of all animal groups, it has become difficult in the last few years to distinguish birds from dinosaurs by anything more than a few minor anatomical details."

Even though his work has led to an erosion of the special status of birds as a distinct class of vertebrates, Prum remains a hard-core avian enthusiast. "My main challenge as a scientist has been to take the details of avian biology that I find fascinating and turn them into 'Big Science'." In particular, Prum is a fan of the suboscine perching birds, a group that includes North American flycatchers that are tremendously diverse in South America. Although he no longer keeps an updated Life List (a birder's list of all bird species ever seen), Prum estimates that he has seen somewhere between a quarter and a third of the nearly 10,000 biological species of birds. "Birding has really added to my appreciation of avian diversity and can only contribute to the scientific study of bird biology. I don't know of any scientific opportunities that have been missed by spending a morning watching birds, but I can think of many that might never have happened if the opposite had never happened."

In addition to continued research on feather development and evolution, avian phylogeny, behavior and structural coloration, Prum will be teaching ornithology and evolution at the undergraduate and graduate levels. At the YPM, he is the head curator in the Division of Vertebrate Zoology. "We look forward to helping Yale's outstanding vertebrate collections to grow in size and intellectual importance, and to take full advantage of the new collections facilities in the Class of 1954 Environmental Science Center. The YPM collections are a unique feature of Yale's intellectual endowment, and will continue to be an important asset in biodiversity studies in the coming century."

Mesoamerican Archaeologist Canuto Joins Anthropology Department and the Peabody Museum of Natural History

Marcello Canuto has been appointed assistant professor in the Department of Anthropology and assistant curator of anthropology at the Peabody Museum of Natural History (YPM). He received his Ph.D. from the University of Pennsylvania (1989) and brings expertise in Mesoamerican archaeology to the Museum's Division of Anthropology. Canuto has used YPM artifacts for study in a variety of classroom settings, and his appointment will help to further integrate the anthropology collections with the educational mission of the University.

Canuto has conducted research primarily in Mexico, Belize, and Honduras, where he recently completed settlement research in and around the Classic Maya city of Copan. His academic interests include household and community dynamics, the sociopoliticial organization of the prehispanic Maya, the definition of identity through material culture, and the modern social contexts of archaeology in Mesoamerica. Canuto teaches undergraduate courses in introduction to archaeology, field techniques, and Mesoamerican cultures and archaeology for the Department of Anthropology. He also teaches graduate seminars on archaeological theory and on household, community and identity studies. He is the director of undergraduate studies for the Archaeological Studies Program (see *www.yale.edu/archaeology*).

Currently, Canuto is co-directing *Proyecto Arqueológico Regional El Paraíso* (PAREP; see *http://research.yale.edu/parep*), a multidisciplinary research project in Honduras that explores Classic Maya sociopolitical interaction and its role in identity formation. The PAREP project brings together an international multidisciplinary team of archaeologists, geologists, ecologists and enthnographers whose experience ranges from professional to undergraduate. He recently co-edited the book *Understanding Early Classic Copan* (University of Pennsylvania Press, 2004) and is currently working on *Communities of Family and State: The Rise of Classic Maya Socio-political Complexity*.

A Remarkable Fossil Discovery

by Derek Briggs, *Curator of Invertebrate Paleontology, YPM; Professor of Geology & Geophysics; Director, YIBS*

When decay stays on hold and the fossil record delivers more than the usual shells, bones and teeth, those of us with an interest in long-lost soft-part anatomy tend to sit up and take notice. As emphasized in the 2003 Peabody Museum of Natural History (YPM) exhibition on the Cambrian Burgess Shale, *Evolution's Big Bang,* exceptionally preserved fossils allow us to glimpse what life—rather than death—was really like millions of years ago. Without deposits like the Burgess Shale, extraordinary animals such as *Anomalocaris*, *Opabinia* and *Hallucigenia* would be unknown. Therefore it is no surprise that newly discovered soft-bodied fossils from 425-million-year-old Silurian rocks are causing a stir, not least because they represent an interval of geologic time that, unlike the Cambrian, boasts very few examples of exceptional preservation.

These Silurian fossils were found in a layer of volcanic ash in Herefordshire, England. The deposit has yielded a variety of sponges, a worm-like mollusk, a bristle worm, a starfish, and a diversity of arthropods, including an early representative of modern lobsters and crabs. Found in small concretions, most of the animals are just a few millimeters long. After the animals were buried, and before the carcasses had time to decay and collapse, the ash surrounding them stiffened and hardened. Even though internal organs are rarely evident, the external forms of the animals are exquisitely preserved. However, the specimens are far too tiny and delicate to be extracted using needles or a dental drill, and acid is not an option as both fossils and sediment would dissolve! High resolution computer-aided tomography (CAT scanning) has so far proved unsuccessful because of the lack of contrast between fossil and surrounding sediment. The best method is to grind away the fossils 30 microns at a time (increments just over one thousandth of an inch thick). An exact three-dimensional electronic reconstruction—a virtual fossil—can then be generated from digital images taken after each grind. This reconstruction can be rotated and "dissected" to allow all the features to be observed (Fig. 1).

Experience shows that the Herefordshire fossils cannot be identified with confidence before the specimens are ground. The random sections that result when the concretions are cracked open can be misleading, which is why a large number of specimens remain to be determined, and why grinding a new one is always exciting and occasionally yields a real surprise.

And so it proved in the case of an outline with two shells (Fig. 2) that turned out to be a perfectly preserved ostracode. Ostracodes, bean-shaped crustaceans common in a variety of environments today, are much beloved by paleontologists because they have a long evolutionary history and can often be used to determine the age of rocks. But we were not sure that the oldest examples of these shells were really ostracodes until our Herefordshire discovery revealed details of the limbs. The fossil is so similar to examples found today that it can be placed in a living family! Some of these tiny crustaceans clearly evolved at a remarkably slow rate.

The Herefordshire specimen is by far the oldest ostracode to preserve anything other than the shell. Its discovery was published in *Science* last December, but this diminutive fossil attracted unprecedented worldwide press attention, from Chile to Russia, for just one reason—it has the oldest preserved male copulatory organ. It is 25 million years older than the previous record held by a fossil harvestman ("daddy longlegs") from Scotland, described just two months earlier in the rival publication *Nature*. But after all, as *New York Times* correspondent Nicholas Wade wrote in the paper's Sunday, December 7, 2004 issue, "in paleontology, age matters"!

The Herefordshire Project is a collaboration between Derek Briggs (Yale University), Derek Siveter (University of Oxford), David Siveter (University of Leicester) and Mark Sutton (University of Oxford).

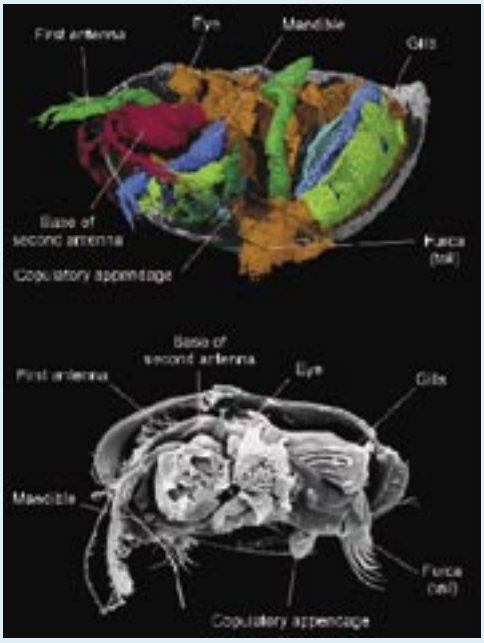


Figure 1

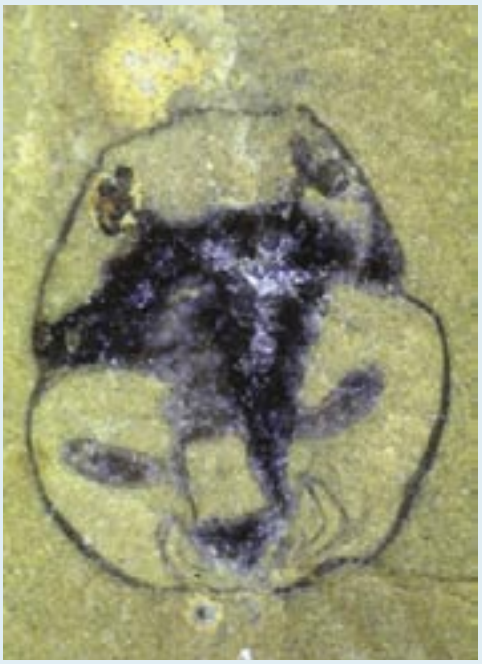


Figure 2

Figure 1. Virtual reconstruction of ostracode *Colymbosathon* (top) from the Silurian of Herefordshire (5 mm long) compared with the modern ostracode *Xenoleberis* (bottom) from the Japan Sea (2 mm long). In both cases the left half of the shell has been removed to show the features inside.

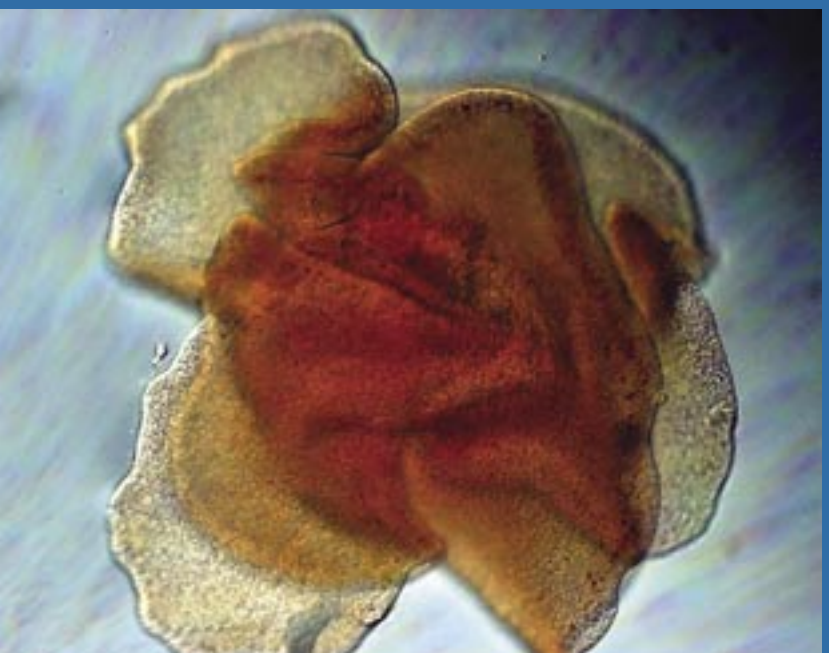
Figure 2. Specimen of *Colymbosathon* as it was when the concretion was cracked open (maximum width 3 mm), showing an inclined transverse section that passes through the eyes at the front and the gills at the rear.

The Peabody Museum Home to the *Trichoplax* Genome Project

While Yale University has been a prominent player in the emerging new science of genomics, it may come as a surprise to many that the home of Yale's first genome project is the Peabody Museum of Natural History (YPM). A collaboration of Curator of Invertebrate Zoology and Department of Ecology & Evolutionary (EEB) Biology Professor Leo Buss and Professor Steve Dellaporta in the Department of Molecular, Cellular and Developmental Biology (MCDB) has landed Yale funding for genomics-related research and a commitment to sequence the entire genome of a little-known and still largely enigmatic invertebrate, the placozoan *Trichoplax adhaerens*.

The Placozoa are free-living metazoans, characterized by a unique body plan. *Trichoplax* looks superficially like a giant multicellular amoeba, but is in fact a proper multicellular animal with a multinucleate syncytium sandwiched between differentiated dorsal and ventral epithelia. Only four distinct cell types exist: monociliated dorsal and ventral epithelial cells, ventral gland cells and syncytial fiber cells. Nerves, sensory cells and muscles are absent and the epithelia lack either a basal membrane or gap junctions. With a top and a bottom, but having neither right and left nor front and back, the Placozoa are without obvious parallel.

Trichoplax was discovered growing on the walls of an aquarium in 1883 by F. E. Schulze, a German scientist who provided a thorough morphological description. While *Trichoplax* was recognized as distinctive when first described, its status as an outlier became increasingly clear as the bounds of metazoan morphological diversity came to be well known. However, early in the 20th century Schulze's work was submerged and erroneous reinterpretations of *Trichoplax* as a hydroid, or even a sponge larva, made their way into textbooks and journal articles. This recasting of Schulze's results was possible only because no further discovery of the animal itself was reported for over 70 years. Then, in 1969, the noted German protozoologist Karl Grell rediscovered *Trichoplax* in Red Sea algal samples. Over the next two decades Grell and his colleagues systematically investigated several features of the animal's biology. In the years since, various invertebrate zoologists have collected *Trichoplax*, but with the exception of the original Grell isolate, there has been no systematic effort to collect and establish new clones in laboratory culture.



The enigmatic placozoan *Trichoplax adhaerens*.

Two years ago, Yale students Casey Dunn, Nathan Havill, Ana Signorovitch, Rafe Rosengarten, Melissa Garcia Rice and Professor Leo Buss collected *Trichoplax* from diverse locations throughout the Caribbean. Signorovitch, Rosengarten and Buss developed a series of new techniques to establish the animal in routine laboratory cultures, and clones from Grenada, Jamaica, Panama and Belize are now maintained continuously. Specimens from these cultures are being accessioned to the YPM collections. To our knowledge, they are the first specimens of the phylum to be made available for study at any major museum. Working with Dellaporta and Maria Moreno, associate research scientist in MCDB, Buss's group used these animals to generate both small and large insert genomic libraries, which are in turn the raw material from which the entire genome will be characterized. Buss, Dellaporta and Marino have received additional funding to generate the full-length cDNA libraries necessary to produce gene chips for application of *Trichoplax* to problems of environmental genomics.

Why should such a little-known and curious organism attract the interest of federal genome efforts? What justifies an effort certain to cost many millions of dollars? The reasons are twofold. First, *Trichoplax* has the smallest genome of any animal yet measured—and by a wide margin. Not only is sequencing relatively inexpensive as a consequence (and the cost-to-benefit ratio correspondingly low), but this tiny genome promises to define, to the extent living organisms allow, the minimal animal gene complement. Second, and most compelling, is the recent demonstration by Dellaporta, using animals produced by Buss's group, that *Trichoplax* is unambiguously the most primitive of all animals. Only by sequencing the most primitive animals can we discover those genes that are uniquely "animal" and provide an outgroup for an analysis of their evolution.

Niarchos Program Takes Yale Students and Researchers to Crete to Study Turtles

by Theodora Pinou, *Niarchos Project Coordinator*

Thanks to a generous grant from the Stavros S. Niarchos Foundation, during June 2003 the Peabody Museum of Natural History (YPM) and the Natural History Museum of Crete (NHMC) participated in their first summer study program at the University of Crete. Part of the collaboration initiative between YPM and NHMC, this summer study program has dual objectives: to train undergraduate and graduate students in ecology and biodiversity, and to nurture cultural exchanges among people with common scientific objectives. Through this program, six Yale researchers and 12 Yale students were given the opportunity to travel to Crete, collect specimens, and experience the geology and biodiversity of this Mediterranean island through NHMC collections and field trips.

One of the research projects being supported through this collaboration involves the monitoring of the turtle *Mauremys rivulata* in wetlands throughout the island. This past summer, research teams from YPM and NHMC came together to capture, mark and release *M. rivulata* as part of a long-term monitoring program by the two institutions. Teams focused on collecting tissue (nails, to be used to isolate DNA) and life history data for turtles living in Pombia, a wetland associated with a sewage treatment plant, and in the Almyros River, which empties into the Mediterranean Sea. Data for this species were collected and incorporated into the NHMC's database. Students were trained in field techniques used to trap, measure, mark and then release turtles. They also were taught how to navigate the NHMC database, and as a result learned much about specimen and data management in museums.

Participating students included Yale College student Linda Shi, Wellesley College senior Catrina Huynh from the anthropology lab of Dr. Anastasia Karakasidou, University of Crete graduate student Georgia Mantziou, and undergraduate student Ioanna Kaftatzi. Collaborating researchers are YPM's Theodora Pinou and Petros Lymberakis from the NHMC. For more information on the Niarchos Collaboration Initiative visit *www.peabody.yale.edu/exhibits/nhmcypm/*.

Top: Petros Lymberakis and Georgia Mantziou teaching students to use hoop nets for capturing turtles.

Middle: Collaborating teams working at the NHMC Vertebrate Zoology Laboratory.

Bottom: Georgia Mantziou measuring the length of a turtle plastron at Pombia.

Peabody Acquires Deep Sea Fauna from New England Seamounts

by Eric Lazo-Wasem, *Invertebrate Zoology Senior Collections Manager*

The New England Seamount Chain (NES) originates at the edge of Georges Bank in the Atlantic Ocean off Massachusetts and extends southeast to the Bermuda Rise, a distance of over 1,000 kilometers. Composed of more than 20 named extinct volcanic peaks, these seamounts have recently caught the interest of biologists investigating deep sea faunal communities. Although scientists have been aware of the seamounts for decades, earlier investigations have focused solely on their geologic makeup. In December 2000 a team of scientists aboard the National Oceanographic and Atmospheric Administration (NOAA) research ship R/V *Delaware II* collected fish and invertebrates at Bear Seamount, the peak closest to the edge of Georges Bank. Of the 20 trawls made at Bear, almost half contacted the bottom at about 1,100 to 2,500 meters below the sea surface, collecting for the first time living benthos of the NES, many to be deposited in the collections at the Peabody Museum of Natural History (YPM).

Accompanying this first survey cruise to Bear Seamount was Jon Moore (Yale Ph.D. 1993, Biology). Moore first became interested in deep sea fishes while researching the phylogeny of beryciform fishes (a deep sea group that includes orange roughy) and working part-time in the ichthyology section of YPM's Division of Vertebrate Zoology. After earning his doctorate, Moore spent a year as a curatorial assistant in the Division of Invertebrate Zoology before accepting a lecturer position at Yale teaching organismal biology courses. During his work in the Invertebrate Zoology Division, he and Senior Collections Manager Eric Lazo-Wasem developed a collaborative interest in deepwater invertebrates, and laid plans for acquiring new material for YPM's collections. While at the Woods Hole Oceanographic Institution in the late 1990s, Moore was instrumental in acquiring new deepwater material for the Peabody, and encouraged agencies there, especially from cruises undertaken by the National Marine Fisheries Service, to deposit voucher material at YPM.

Now an assistant professor at Florida Atlantic University, Moore has been a participant on several research cruises to the NES, including one sponsored by the National Science Foundation, and another by NOAA this past summer, both of which used the deep submersible *Alvin* to investigate the seamount fauna to depths greater than 2,100 meters. From these expeditions, Moore was able to secure for Yale a major portion of the invertebrates and fishes; the rest were divided among several other institutions, including Harvard University's Museum of Comparative Zoology and the National Museum of Natural History, Smithsonian Institution.

Specimens collected during these investigations are allowing scientists to sketch a preliminary picture of the faunal communities inhabiting these isolated undersea mountaintops. Although the precise identity of most of the invertebrates is as yet unknown, the number of recognized morphotypes is staggering, especially considering the traditional viewpoint that the cold, deep ocean bottom of the Atlantic is largely uninhabited. Corals, echinoderms and crustaceans dominate the list of invertebrates; some of these animals are quite rare in museum collections and have been collected in the Atlantic only a few times before. For example, one small, solitary coral collected at Bear Seamount has been seen for the first time since it was originally described over 100 years ago. Although most people associate coral reefs with the tropics, vast coral communities of species such as *Lophelia, Metallogorgia* and *Paragorgia* have arisen on the seamounts.

Jon Moore in front of the deep submersible *Alvin* aboard the *Atlantis*

These attract a broad array of invertebrates and fish; the overall diversity so far encountered exceeds 600 species and will probably rise to more than 1,000 as more specimens are identified.

While diving at the NES aboard the *Alvin* this past summer, Moore focused his collecting, in part, on xenophyophores, large single-celled protists found only in the deep sea environment. These organisms are a current research interest of Moore's wife and collaborator, Susan Richardson (Yale Ph.D. 2000, EEB), currently a research associate at the National Museum of Natural History, Smithsonian Institution. Xenophyophores create an agglutinated shell, or "test," consisting of a secreted organic adhesive that binds together fine sediments and the tiny shells of other single-celled protists. Known as the giants of the protozoan world, some xenophyophores, such as *Syringammina fragilissima,* can

continued on page 12

Deep submersible *Alvin* hanging from A-frame

Specimens collected during these investigations are allowing scientists to sketch a preliminary picture of the faunal communities inhabiting these isolated undersea mountaintops. Although the precise identity of most of the invertebrates is as yet unknown, the number of recognized morphotypes is staggering, especially considering the traditional viewpoint that the cold, deep ocean bottom of the Atlantic is largely uninhabited.

Deepwater bamboo coral

An amphipod crustacean, *Eurythenes gryllus*, from near Bear Seamount

Large branch of the deepwater coral *Paragorgia* aboard the *R/V Atlantis.*

A lophogastrid mysid shrimp, *Gnathophausia*

continued from page 11

have tests exceeding 10 centimeters in diameter. Richardson is currently working to identify the xenophyophores collected at the NES. Also of interest is a crustacean, the amphipod *Liljeborgia* sp., unexpectedly found associated with the xenophyophores; the relationship of this amphipod to the protist is unknown.

The acquisition of deep sea collections is not a new endeavor for the YPM. In the late 19th century, the United States Fish Commission began surveying the coastal waters from Newfoundland to the Carolinas. Addison E. Verrill, Yale's first professor of zoology and one of the original curators of the YPM, was for many years in charge of the U. S. Fish Commission's dredging operations and the person primarily responsible for identifying the collected fauna. Many of the collecting stations were in deepwater, some at depths exceeding 4,000 meters. Ultimately, Verrill produced dozens of papers on the Atlantic coast invertebrates, and described hundreds of new species from U.S. Fish Commission samples. As part of his arrangement with the U.S. Fish Commission, Verrill was able to retain a major portion of this material, and today it forms a core historical collection of the Division of Invertebrate Zoology.

Currently more than two dozen specialists are identifying or otherwise studying the NES fauna. Long-term goals include describing any new species and mapping the distribution of the deepwater coral communities. Of particular interest are questions of genetic isolation in the invertebrates inhabiting the seamounts. Because some of the benthic invertebrates do not have planktonic larvae for dispersal, it is expected that several species in these groups could be restricted in their distribution to just these seamounts. This limited distribution is particularly true for those invertebrates nestled in the bottom substrate, and which do not spend much time in the water column subjected to dispersing currents.

In this regard, historical collections, such as those housed at the YPM, are being surveyed for comparative material. Scientists such as Les Watling at the University of Maine, another alumnus of this past summer's *Alvin* dives, are beginning to investigate the potential negative impact that commercial fishing may have on deepwater coral communities. Recent studies have indicated that the corals *Paragorgia* and *Lophelia*, which both occur in dense underwater "forests," are slow growing and provide crucial habitat for associated invertebrates. When commercial trawlers drag nets through these fragile habitats, they essentially "clear-cut" the reefs; the resulting loss of habitat forces many animals to move elsewhere. The scars from these activities can take years to heal. One proposal under consideration is to establish some of these seamounts as protected areas to conserve their unique habitats and faunas. While the lack of commercial fishery species and the geographical

A multi-armed brisingid starfish from the New England Seamounts

isolation of these seamounts means they are currently not a focus for commercial fishing, the discovery of a commercially important deepwater fishery (such as orange roughy) could encourage trawlers to venture out to these areas.

For now, Moore, Richardson, Watling and other scientists will continue their explorations of these deep sea mountains to further our understanding of the biodiversity and ecology of the faunal communities and provide information on what animals live in these pristine habitats. Another cruise is planned for the summer of 2004, and if the past is any indication, it will likely yield even more new and exciting discoveries.

NEW PUBLICATIONS FROM THE YALE PEABODY MUSEUM

The Yale University Publications in Anthropology (YUPA) series publishes research conducted or sponsored by the Yale Peabody Museum of Natural History's (YPM) Division of Anthropology and the Yale Department of Anthropology. YUPA is supported by the Theodore and Ruth Wilmanns Lidz Endowment Fund for Excellence in Scholarly Publications, dedicated to the dissemination of scholarly research and study of the world and its cultures.

The YPM also publishes monographs as the *Bulletin of the Peabody Museum of Natural History*, and short papers in the Postilla series, on research in the Peabody's collections, as well as Special Publications related to its exhibitions, special events, and other areas of interest.

In 2003 the YPM published two new YUPA titles:

YUPA 85,
The 1912 Yale Peruvian Scientific Expedition Collections from Machu Picchu: Human and Animal Remains
Richard L. Burger and Lucy C. Salazar, Editors

This collection of three essays focuses on the human and animal bones recovered from excavations at Machu Picchu early in the 20th century, and incorporates recent efforts to wrest knowledge from these materials. The Machu Picchu collections, recovered by Yale University's Hiram Bingham and housed for almost a century at the YPM, constitute a unique record of this famous Inca site. The book includes:

- "Food for the Dead, Tools for the Afterlife: Zooarchaeology at Machu Picchu" by George R. Miller, California State University, Hayward
- "Human Skeletal Remains from Machu Picchu: A Reexamination of the Yale Peabody Museum's Collections" by John W. Verano, Tulane University
- "Rite and Crop in the Inca State Revisited: An Isotopic Perspective from Machu Picchu and Beyond" by Richard L. Burger, Yale University, and Julia A. Lee-Thorp and Nikolaas J. van der Merwe, University of Cape Town

YUPA 86,
The Quinnipiac: Cultural Conflict in Southern New England
John Menta

By 1638 the first permanent English settlement in Connecticut, New Haven, existed within the territory of the Quinnipiac. During those first years after contact, the Quinnipiac proved useful to the newcomers, but following this brief accommodation, cultural tensions developed. Although land disputes were the most frequent source of conflict, no aspect of life was too insignificant to lead to problems. The tensions grew steadily until the surviving Quinnipiac, in about 1750, began to leave. Their diaspora is a complicated and unhappy tale. Yet even at the turn of the 21st century, descendants of the tribe endure among the Native Americans of Wisconsin. This narrative of the Quinnipiac and their contacts over the last several centuries with Euro-American culture is taken from primary and secondary sources.

For more information visit *www.peabody.yale.edu/publications* or contact the Publications Office at peabody.publications@yale.edu or (203) 432-3786.

PUBLICATIONS

HerbIS Is the Erudite Recorded Botanical Information Synthesizer

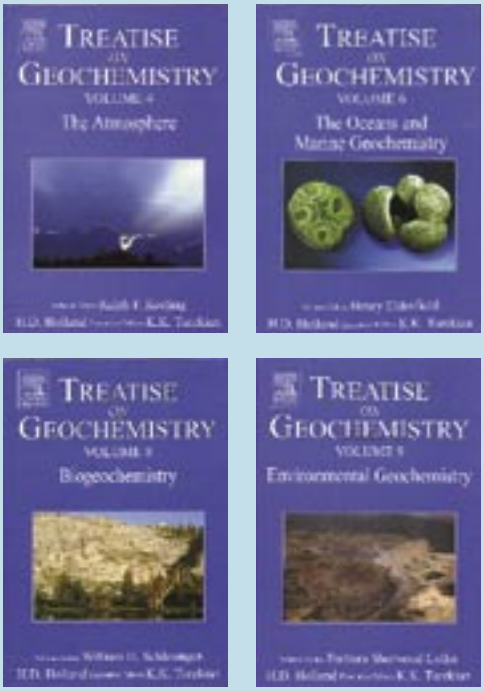
by Reed S. Beaman, *Informatics Director;* Nico Cellinese, *Botany Collections Manager; and* Michael J. Donoghue, *Director, Peabody Museum*

Specimen of *Aesculus hippocastanum* from the Yale Herbarium. Plants are pressed, dried and mounted on acid-free sheets. The label at the bottom right provides the scientific data.

The Peabody Museum of Natural History (YPM) was recently awarded a National Science Foundation grant for $850,000 through the Biological Databases and Informatics Program to inaugurate the HerbIS project (*www.herbis.org*), an informatics-based collaboration of the YPM, the University of Illinois at Urbana-Champaign and the New York Botanical Garden, with YPM as lead partner. HerbIS will allow for rapid and automated digital capture of botanical specimen images and data from herbarium specimens. YPM's Division of Botany houses approximately 350,000 herbarium specimens in the Yale Herbarium, including several historically important collections, and has excellent holdings of bryophytes and pteridophytes. Only about 1,100 specimens in the Division have so far been digitally catalogued, and HerbIS will help redress this disparity.

The HerbIS project teams will digitize specimen sheets with high resolution digital cameras and optical character recognition, natural handwriting recognition, and natural language processing software using machine learning. This minimizes the time spent on image and data capture for individual specimens by reducing the manual data entry required. The project's data capture tools will be available as web services, ultimately to be made available to other institutions.

One of the main goals of HerbIS is to improve the rate at which biological specimen data can be made available to researchers, educators, policymakers, and the general public. Currently, a bottleneck in data capture efficiency continues to limit access to information about museum specimens. The bottleneck is enormous—more than a billion specimens are curated in natural history museums around the world, but less than 5 percent of these are accessible electronically in a database, and far fewer still are available as digital images. Finding ways around this bottleneck is critical, since specimens are the link to the organisms themselves, the names we give them, and our taxonomic classifications. All biological researchers are ultimately dependent on museum collections for knowledge of the organisms they study.



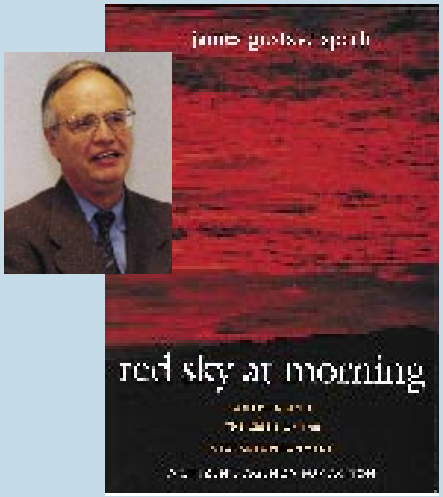
TREATISE ON GEOCHEMISTRY PUBLISHED

The publication of the ten volume *Treatise on Geochemistry* (Elsevier-Pergamon Press, Publisher) in December 2003 was the culmination of four years of work by a large group of international geochemists under the executive editorship of H.D. Holland of Harvard and Karl K. Turekian of Yale. Turekian is the director of the Center for the Study of Global Change of the Yale Institute for Biospheric Studies. One volume of the *Treatise* is dedicated to environmental geochemistry and another to biogeochemistry. The importance of these two fields has grown and the breadth of topics covered in each volume shows the development of the fields. Two additional volumes on the atmosphere and the oceans and marine geochemistry also cover environmental subjects. An integrated index volume brings all the disciplines encompassed by geochemistry together for easy identification of association and cross-referencing.

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. 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 Publications Series editor Jane Coppock at jane.coppock@yale.edu.



YALE BOOK SAYS NEW APPROACHES TO GLOBAL ENVIRONMENTAL THREATS URGENTLY NEEDED

The international community must take urgent action to address global-scale environmental threats or face an era of unprecedented environmental decline, argues *Red Sky at Morning: America and the Crisis of the Global Environment*.

"Time is running out," says author James Gustave Speth, dean of the Yale School of Forestry & Environmental Studies and former chair of the Council on Environmental Quality (CEQ) in the Carter Administration. "We are on the verge of reaping an appalling deterioration of our natural assets. Only unprecedented action taken with a profound sense of urgency can forestall these consequences."

Surveying 10 major concerns, Speth says some progress has been made on reversing ozone depletion, stabilizing world population and curbing acid rain, but weak international environmental treaties and lack of U.S. leadership have failed to slow climate disruption, desertification, deforestation, extinction of species, freshwater shortages, fisheries depletion and the buildup of highly dangerous chemicals, despite the fact that these issues were brought forcefully to public attention a quarter-century ago.

Published in March 2004 by Yale University Press, the book outlines steps in eight areas that, taken together, would comprise the needed transition to sustainability. "These tran-

continued on page 16

continued from page 15

sitions require genuine partnership between countries of the North and South, as well as actions far outside the traditional areas of environmental policy," Speth says. "Collectively, they will do three things of immense importance. They will directly attack the underlying drivers of deterioration. They will greatly enhance the prospects for success of treaties and other agreements by altering the context in which the agreements are operating. And they will facilitate a very different, more hopeful and powerful way of doing the business of global environmental governance."

After reviewing the trends in global environmental deterioration—biotic impoverishment, climate disruption and toxification—*Red Sky at Morning* analyzes why the initiatives taken over the past two decades have not worked thus far and will not work in the future. "Lured on by the success of domestic environmental law and some early international efforts, we freighted international environmental law with virtually the whole burden of dealing with increasingly complex global issues," Speth said in an interview.

He added, "And then we left the treaty-making to outmoded procedures and weak institutions, where the public is largely excluded and where sovereignty ensures that every country essential to a worthwhile agreement has a veto. The result has been toothless treaties."

The result, *Red Sky at Morning* notes, is that tropical forests continue to disappear at an acre a second, water shortages are mounting, species losses are occurring at 100 to 1,000 times the normal rate, ocean fisheries are declining rapidly, and the emissions of the principal climate-altering gas continue to grow, increasing 22 percent between 1980 and 2000.

Still, Speth says there are hopeful signs and encouraging developments, among them improved scientific understanding, slowed population growth rates, reductions in world poverty, development of technologies in energy and elsewhere that can bring major environmental improvement, increased use of market forces to achieve environmentally honest prices, greater knowledge of what's required for effective treaties, and remarkable new capacities in civil society. Most impressive, Speth notes, is the surge in "green jazz," the bottom-up, improvisational, unscripted initiatives being taken by business, NGOs, cities and states, and religious and other associations.

"It has been said that people act out of love or fear—to realize a positive vision or to avoid disaster," Speth says. "This volume focuses on the looming disaster and how to avoid it. And the positive vision? You do not need me to provide it. You have seen it at Yellowstone, Yosemite and the Smokies; when fishing for trout or spotting a bird or hiking the woodlands; in the salt marsh, the blackwater swamp, the grassland prairie, the urban park. You have seen it in the crisp air and clear water, the children playing in the stream, the sunset at the beach, the monarch butterflies on their way to Mexico, the birds newly arrived at the feeder, even the deer eating your sedum. It is part of you, and me, and we are part of it. And it will be there for our children and their children and so on, forever, if we have the wisdom to protect it."

The book includes a chapter on "Resources for Citizens," which contains an inventory of web-based and other resources for individuals and groups interested in promoting the transition to sustainability as voters, consumers, investors, workers, association members and activists.

To purchase *Red Sky at Morning*, contact Liz Pelton (410-467-0989, lizpelton@aol.com) or visit *www.redskyatmorning.com*.

Class of 1964 Making a Difference in Environmental Education

A summer travel fellowship established by the Yale College Class of 1964 enabled two Yale College architecture students last year to study how extreme climates affect the design of buildings in the Australian outback, Fiji and Iceland.

Kent Gould and Lisa Rothman, both seniors, were recipients in 2003 of the Class of 1964 Environmental Summer Fellowship. For the past three years the Class of 1964 has provided funding to sponsor summer travel fellowships for Yale College juniors who have an interest in exploring an environmental

"The fellowship is important to the extent that it succeeds in adding to the pool of committed environmental leaders," said Frank Basler, a member of the Class of 1964 who is in charge of the fellowship program.

project or activity. The 2001 Class of 1964 fellow was Leah Zimmerman '02, who traveled to Lake Baikal, Russia, and Abi Sud '03 studied urban agriculture in Bangladore in the summer of 2002. The fellowship is administered by the School of Forestry & Environmental Studies (F&ES).

Recognizing the importance of environmental education at Yale and in honor of classmate F&ES Dean Gus Speth, the Class

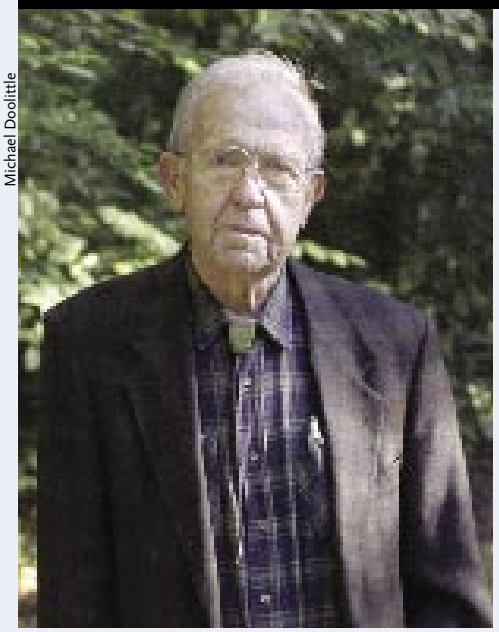
of 1964 has been instrumental in contributing to the successful training of the next generation of environmental leaders and citizens. The Class of 1964 has also created the Class of 1964 Environmental Initiative, which provides financial assistance to F&ES students, as well as funds that supplement F&ES teaching in the Yale College major in environmental studies.

Gould and Rothman used the fellowship to complement their academic study of architectural design in extreme climates and the work of Finnish architect Alvar Aalto. Their examination of the ways that arctic, desert and rain forest climates affect the architectural design of buildings and homes resulted in a report titled "Environmental Design in Extreme Climates," and presented to the Class of 1964 class council on Feb. 7.

Gould and Rothman observed that in Reykjavik, Iceland, many of the city's structures are designed to deal with long periods of little or no sunlight. Buildings are not tightly spaced, to allow light into as many openings as possible. On the country's south coast, mud, grass and stone are the primary building materials, as well as insulators, for old turf huts embedded into the earth and roofed with sod. Lumber is in short supply because the country's terrain is hostile to trees. In humid Fiji, homes sit on stilts or cement pillars above ground to take advantage of breezes. Wind shafts, created by arranging corridors as uninterrupted linear paths, encourage ventilation and circulation. If architectural design in tropical Fiji places buildings above ground, desert architecture takes the opposite approach. In the Australian town of Coober Pedy, many homes are built into the desert rock, which keeps interiors cool during the day and warm during the evenings. The homes are ventilated by air shafts, sometimes 99 feet in length.

While architectural design is a result of practical necessity in locales with extreme weather conditions, "green" design, according to Gould and Rothman, has become more popular in temperate zones due to notions of land conservation, bio-degradability, environmental efficiency, energy efficiency, air quality and the desire to save money.

Michael Doolittle



David Smith, the Morris K. Jessup Professor Emeritus of Silviculture at F&ES.

Scholarship Honors David Smith, Who Taught Generations of Students the Inner Life of Forests

by Richard Conniff

In the parking lot of an assisted living center, a frail, diminutive man sits on a bench at the end of a long garage. He has his cane propped upside down in front of him, one foot up on the crook, his hands folded over the rubber end piece, his chin resting on his hands. His eyesight is impaired, and the effects of a stroke keep him from venturing out into the forests where, not so long ago, he led students much younger than he to a point somewhere between exhaustion and illumination. But even at a distance, even in a parking lot, he still has a characteristic way of closely observing what other people scarcely notice.

"You see that little ridge off to the right there?" asks the man, whose name is David Smith, Morris K. Jessup Professor Emeritus of Silviculture at the School of Forestry & Environmental Studies (F&ES). "That's a remnant of the kame terrace. A huge chunk of ice got deposited over there as the last glacier retreated 15,000 years ago, and a river of melt water raged around it, dumping sand and glacial till to form the ridge."

"How do you know all that?" asks a visitor, who has assumed until that moment that the whole thing was put there by a developer in the 1970s.

"There's a kettle pond formed by the ice over there," says Smith, "and that tree, the one growing just beyond the dumpster, that's a scarlet oak. It likes to grow in dry soils."

Smith, now 82 and recently honored with the establishment of the David M. Smith Scholarship Fund at F&ES, has spent a lifetime observing such details, beginning on his great-grandfather's woodlot in western Massachusetts. When he announced his intention to become a forester, he recalls, his father allowed that *he* had gone to college to get *out* of the woods, then packed him off to the Yale School of Forestry. After earning his doctorate, Smith went on to become one of the most revered and beloved professors in the history of the school, teaching generations of students how to ferret out for themselves the secret details of how forests grow. Through his textbook, *The Practice of Silviculture*, "every forester in the world" also came to know Smith's methods, says a colleague, with only slight exaggeration. Originally published in 1921 by one of Smith's mentors at Yale, Ralph Hawley, the book has sold about 125,000 copies, not counting pirated editions in China and elsewhere. It has shaped the management of forests in areas as distant as Tasmania.

This last thought makes Smith proud and, since he is very much a New Englander, also rueful. His book (which he has handed down in turn to be written by students he once mentored) is explicitly about North American forests, and his chief argument is that every forest, and every stand within a forest, is different and deserves its own carefully considered style of management. *The Practice of Silviculture* was never meant to be a cookbook. He is quietly scathing on the topic of forests he has visited in Canada, where the clear-cutting was done according to actuarial yield tables, and

continued on page 18

continued from page 17

the replanting regimen called for 500 seedlings per hectare, whether on rich Pacific coastland or the edge of treeless tundra. "There is no one way to do these things, no dogma," he says.

On the contrary, Smith's students describe him as a sort of Sherlock Holmes of the forest, able to analyze a stand of trees and figure out from seemingly trivial clues exactly what it has been through over the past few centuries, what it is likely to do next and what sort of help it could use to get there. A hummock of dirt tells him that the 1938 hurricane uprooted a tree here. A bend in the stem of a spruce records the passing of an ice storm 20 years back. He sees each stand as a unique product of its soils, its microclimate and the animals that live there.

Sitting on the bench in the parking lot, for instance, Smith points to the fork high up in the trunk of a white pine tree, and recounts the life history of a weevil that specializes in eating the terminal shoots of the tallest pines, a diet that seems to him as exotic as "eating hummingbird tongues." The weevils overwinter in the litter on the ground. "They look like tiny elephants. They have a snout, not that they use it for breathing." When the weevil larvae devour the six inches of new growth at the top of the pine, the trunk forks and begins to grow again. A careful forester cuts the tallest and most vigorous white pines first, Smith suggests, to put the growth on slower trees that are less susceptible to weevils. The unfashionable economic value of the forest still matters to him, as he thinks it should in a world that gets two-thirds of its energy and much of its housing from wood. Another pine in the parking lot catches his attention because someone years ago trimmed the lower branches, to yield a straight and relatively knot-free 16-foot length of lumber. The senior center could sell that tree now for $50, he thinks. But wait another 30 years until the trunk thickens to two feet, and it could be worth $1,000.

Smith passes on his encyclopedic knowledge of the forest in a slow, soft voice, without the slightest hint of showiness. He has a knack for the quaint Yankee turn of phrase. "We'd sit around tearing apart some paper," says Matt Kelty, a former student who now heads the Department of Natural Resources Conservation at the University of Massachusetts. "Then he'd say, 'Well, we've learned that we can smell a rotten egg. Now we have to see if we can learn to lay a good one.'" Chad Oliver, Pinchot Professor of Forestry & Environmental Studies at F&ES, recalls Smith's description of a colleague who ventured opinions too quickly: "He has a mind like a 10-cent mousetrap. He'll snap at anything." Apart from the quaint phrasing, Smith also fit the New England image by being notably frugal, fueling his field trips on Dinty Moore stew, among other practical economies. But Kelty also recalls one time on a field trip when a student stricken with flu was mortified at having to stay back at the camp. At the end of the day, Smith forbore with Dinty Moore, and brought him chicken soup instead. "He worried about people," says Kelty, who also recalls that the day he arrived at Yale for his graduate teaching fellowship, Smith wanted to write him a personal check to tide him and his bride over until his teaching stipend arrived. E.H. Harriman Professor of Forest Management Graeme Berlyn, who taught a course with Smith, adds: "He unerringly did the right thing for people, provided good counsel, believed in treating everybody fairly. People always felt they could trust the guy, both students and faculty."

...he led students much younger than he to a point somewhere between exhaustion and illumination.

Smith's New England background was the key that enabled him to open up what he calls in his book "the little world of the stand." A gypsy moth infestation had ravaged the family woodlot, and in 1946 Smith went up to Massachusetts to organize a salvage sale. It was a "typical seemingly incomprehensible mixed forest," he says, a layer cake of white pine, oak, maple and hemlock. Foresters then operated on the simplistic premise that big trees were old trees, and small trees young. But Smith knew this stand too well to accept that. He knew, for instance, that the chestnuts had been cut down after being killed by blight in 1915, a salvage sale that paid his mother's college tuition. He also knew that his great-grandfather had run a sawmill there through much of the 19th century, and that the family house had eaten up the rest of the forest for firewood. So everything he was looking at had grown up since about 1880. Big trees and small alike were roughly the same age. The variation among them was a product not of age but of other less obvious factors, the hidden patterns of growth and shade tolerance of different species. This epiphany helped Smith develop the field now known as "forest stand dynamics," a major contribution to forestry.

In 1949, the Yale faculty expressed its trust in Smith with the dubious honor of asking him to apply his thinking to the school's own forests, or as one of them put it: "See what you can do about the mess up in Union." The 7,800-acre Yale-Myers Forest in Union, Conn., was so hopeless the faculty wanted to get rid of it. Most of it was derelict pasture scooped up by George Myers, a wealthy F&ES alumnus, who prided himself on never paying more than $15 an acre. The new forest that had sprung up there had also been decimated by the 1938 hurricane. Smith and a small staff of foresters had the unlikely job of restoring Myers and the school's other New England forests to health and making them pay for themselves in the process.

Smith's students describe him as a sort of Sherlock Holmes of the forest...

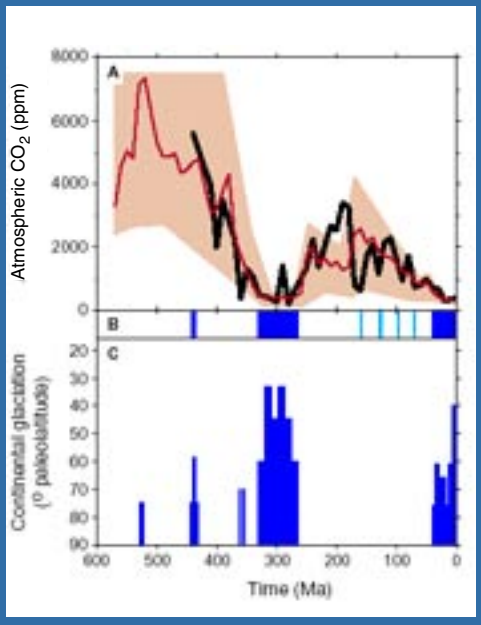
"We'd walk around looking for something we could harvest without sacrificing the future, and we didn't have much success," Smith recalls. "We got a lot of exercise. For the next 10 years, I just sort of stalled around." At Yale-Tuomey Forest in New Hampshire, his ability to thin out branchy, weevil-damaged "cabbage pines" was limited by demand from a local factory making wooden buckets, the only market for such short lengths of useful lumber.

While he was thinning the forests and slowly improving the stands of old-field pines, Smith also oversaw the development of research in the forest to help create a more scientific basis for forest management. The Yale forests became self-supporting by 1965, and at about the same time, Smith began advising the Baskahegan Company on management of its 100,000-acre commercial forest in northern Maine.

"He taught us to pay attention to how the forest naturally develops and to adapt our management to the forest, instead of the other way around," says Roger Milliken Jr., president of Baskahegan. "He told us that in forestry, the trees are both the product and the factory. The key is to keep the trees that are capable of being factories for high-quality stands. It's the opposite of short-term thinking, where you take the best and leave the rest. You really had the feeling when you were in the woods with Dave that he thought like a tree. He really understood what the trees wanted to do and how we could work with that for both economic and ecological rewards." Baskahegan is now widely regarded as one of the best forests in Maine.

He told us that in forestry, the trees are both the product and the factory.

Good forestry demands patience of its practitioners, and an abiding sense of how small steps can produce profound change over time. At Yale-Myers Forest, the restoration plan now stretches out to 2070, when Smith, his students and even many of his students' students will be long gone. The thought does not seem to discourage Smith—just the opposite. He points to a hybrid American-Chinese chestnut tree in the parking lot. The trunk bears healed-over lesions, a sign of partial resistance to chestnut blight. He knows the researcher who planted the tree and he talks with her from time to time about making new cross-pollinations in pursuit of even greater resistance. This past fall, Smith took a dozen nuts from the tree on the chance that they could be scattered around Yale-Myers, so they will grow there and give some future teacher a chance to talk about chestnut blight. It will be a little lesson, amid a thousand other possible lessons, many of them devised and passed on by a man named Smith, who took time to know the inner life of the New England forests he loved so well.



Plots of the concentration of atmospheric CO_2 and climate vs time for the past 550 million years (Phanerozoic time).
A. The red line and shaded region represent the results of computer modeling of the carbon cycle; the black line represents a running five point average of all other methods for estimating CO_2 and is based on 372 separate measurements.
B. Cold periods (dark blue) and cool periods (light blue)
C. Extent of glaciation, in time and space, as recorded by glacial deposits. The two largest glaciations correlate well with low CO_2 levels.

Courtesy of Royer, D. L., Berner, R.A., Montanez, I.P.,Tabor, N.J. and Beerling, D.J., 2004, CO_2 as a primary driver of Phanerozoic climate. GSA Today, v. 14(3), p. 4–10.

Carbon Dioxide and Climate over Geologic Time

by Robert Berner

Carbon dioxide has long been accepted as a greenhouse gas capable of having a major impact on the climate of planet Earth. This basic tenet of climate science has been challenged recently by researchers who suggest that variations in cosmic ray flux impose a more direct control on climate. In order to test the control by CO_2, Dr. Dana Royer, former Yale graduate student, and Robert A. Berner, Alan M. Bateman Professor of Geology and Geophysics (G&G), examined the geological record for variations in carbon dioxide over the last 500 million years of Earth history and compared these with direct indications of ancient climate such as glacial deposits. Royer, along with co-workers from the University of California, Southern Methodist University, and the University of Sheffield, compiled more than 370 geological estimates of ancient CO_2 levels using indicators such as the structure in fossil leaves, chemical composition of calcite in ancient soils, and chemical composition of fossils. The result is a reconstruction of atmospheric levels of CO_2 over the last 500 million years. To further complement the observed changes, the results of a mathematical model that quantifies how CO_2 varies over time as part of the global carbon cycle was compared to the results of the other methods. Royer and Berner also developed a novel approach that considers the effects of variations in pH of the oceans over time on estimates of sea surface temperatures, derived from the composition of ancient limestones. The combined observational and modeling approaches, as reported in the March 2004 issue of *GSA Today*, show a close correlation between CO_2 and temperature (see figure). This reinforces the conclusion that CO_2 exerts a first-order control on the climate of Earth and suggests that variations in cosmic ray fluxes are of secondary importance.

Lisa Curran

CURRAN SELECTED AS A 2004 ALDO LEOPOLD LEADERSHIP FELLOW

Lisa Curran, associate professor of tropical resources and John Musser Director of the Tropical Resources Institute at the School of Forestry & Environmental Studies (F&ES), has been selected as a 2004 Aldo Leopold Leadership Fellow *(www.leopoldleadership.org)*. She also received an American Association for Advancement in Science and National Science Foundation award for Women's International Science Collaboration. In 2003–2004, she presented the annual Marsh Lecture at Clark University in Worcester, Mass., was the plenary speaker at the National Science Foundation's biocomplexity grantees meeting in Washington, D.C., and the keynote speaker at Duke University for the symposium on "Global Trade and Local Environments." Curran also was elected to serve a three-year term (2003–2006) as an external faculty member of the Santa Fe Institute (SFI). Curran and J.S. Lansing (SFI and University of Arizona) co-edited the book *Robustness of Coupled Natural and Human Systems*, which will be published by Oxford University Press in the fall.

Yale Environmental News
Yale University
P.O. Box 208105
New Haven, Connecticut 06520-8105

Address Service Requested

Non Profit Org.
U.S. Postage
PAID
New Haven, CT
Permit No. 526

Yale Environmental News offers information on environmental research, teaching, and outreach at Yale University. It is produced by the Yale Peabody Museum of Natural History (YPM), the Yale School of Forestry & Environmental Studies (F&ES), and the Yale Institute for Biospheric Studies (YIBS).

We welcome submissions from faculty, staff, and students.

To submit an item, please contact:
Rose Rita Riccitelli, Editor.
Tel: 203.432.9856
Fax: 203.432.9927
E-mail: roserita.riccitelli@yale.edu

Graphic Design: Yale RIS, Maura Gianakos

Submission Deadline for Next Issue
Fall 2004: October 8, 2004

printed on recycled paper