YALE ENVIRONMENTAL NEWS

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

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A Landscape of Fear

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LETTER FROM JEFFREY J. PARK, DIRECTOR OF THE YALE INSTITUTE FOR BIOSPHERIC STUDIES

The year 2010 will be remembered for the great drilling-rig blowout off the Louisiana shore. By chance the week of the April 20th disaster, I had prepared diagrams for my spring geology seminar to illustrate the inexorable descent of petroleum drilling into deeper and deeper waters, as we pursue increasingly scarce reserves of underground oil. As I write this, attempts to cap the blown well have so far failed, a possible relief well cannot be completed for a month or more, and environmental impacts within and ashore the Gulf of Mexico are emerging.

Despite the technical sophistication of modern media culture, we nevertheless seek villains and heroes in the disaster. We hope that the crisis can be resolved quickly, leaving lives and livelihoods secure. But this is not a summer action movie. Neither the US President nor the CEO of BP has the power to reach a mile beneath the sea surface and plug the leak. Instead we are treated to a summer inaction movie, repeated each morning on CNN. The seafloor gusher-cam reminds us that the reach of mankind's technology exceeds its grasp.

What can a university do in such a crisis, far from the frontlines of legal judgments, oil-slick remediation and Department of Interior oversight? Options for direct actions are few, but Yale's influence can be felt indirectly. Two distinguished Yale alumni, William Reilly and Francis Beinecke, have been appointed by President Obama to his investigative commission on the Gulf of Mexico oil spill, with former Environmental Protection Agency (EPA) administrator Reilly as co-chair. Both Reilly and Beinecke are members of the Leadership Council of Yale's School of Forestry & Environmental Studies. The spill itself has revealed new physical phenomena that deserve scientific study, such as its plume-like mixtures of oil, methane and chemical dispersants that appear to linger beneath the sea surface. Yale researchers will be assessing environmental impacts and remediation strategies in the coming years, addressing on-the-ground problems while training the next generation of environmental researchers and managers.

Yale's motivation for its new Climate & Energy Institute (YCEI) is reinforced by the Gulf disaster. The search for alternate energy sources is no more urgent today than it was before April 20, but the American public may now feel the urgency more. YIBS co-sponsored one of this year's first group of YCEI postdoctoral awards to Dr. Berat Haznedaroglu, who will work with Associate Professor Jordan Peccia of Environmental Engineering. Yale College students have already started to select more course offerings in energy, environment and climate change. The Environmental Studies (EVST) Program, in concert with allied Yale departments, offered a slate of new seminar courses on topics from wind energy to geographic information systems (GIS) to the politics of river management. The number of EVST majors has nearly doubled, a mark of success for John Wargo and Paul Sabin, chair and DUS of EVST, respectively.

In addition to Dr. Haznedaroglu, YIBS awarded four additional Donnelley and YIBS Postdoctoral Fellowships in research areas ranging from soil-microbe diversity to solar-radiation variations to water-resource management in developing nations. YIBS supported a successful faculty search in the School of Forestry & Environmental Studies in the field of climate-change-impacts research. As a result, Dr. Nadine Unger will join the School in the fall, bringing expertise in atmospheric aerosols and the impacts of energy-resource and pollution-control policy choices. In the next academic year YIBS will support an anthropology faculty search in the field of evolutionary demography, and seek to establish an environmental beachhead within the new Microbial Diversity Institute (MDI) on Yale's West Campus with a possible faculty appointment. Among the YIBS research centers, two will have new directors: Associate Professor David Post will take the helm at the Center for Field Ecology, and Jeffrey Powell will lead ECOSAVE, effective July 1, 2010. I thank the long-serving outgoing directors, Stephen Stearns and Elisabeth Vrba, for their service and achievements.

CONFERENCES, SEMINARS, SYMPOSIA

YIBS/ESC FRIDAY NOON SEMINARS

Yale Institute for Biospheric Studies (YIBS) director Jeffrey Park continues to support the new Yale Climate & Energy Institute (YCEI) by providing dates during the spring 2010 semester of YIBS/ESC Friday Noon seminars to include YCEI seminar speakers. The schedule proved to serve both audiences of YIBS and YCEI with an outstanding speaker line-up.

YIBS/ESC seminars, which took place in the Class of 1954 Environmental Science Center room 110 were as follows:

Henry Wilson, YIBS Postdoctoral Associate at the Yale School of Forestry & Environmental Studies–*Altered Dissolved Organic Matter Structure in Rivers with Agricultural Land Use: Patterns, Potential Causes, and Implications for Ecosystem Function* ■ **Donald Worster**, Joyce and Elizabeth Hall Professor of U.S. History and Environmental Studies at the University of Kansas and the Dr. Strachan Donnelley Distinguished Visiting Environmental Scholar at the Yale School of Forestry & Environmental Studies: *Darwin in the Grasslands: Evolution, Adaptation, and Environmental History* ■ **Ellen Thomas**, Lecturer, Department of Geology & Geophysics, Yale University**:** *Lessons About the Oceanic Carbon Cycle from the End Cretaceous Mass Extinction* ■ **David Watts**, Professor, Department of Anthropology, Yale University: *Behavioral Ecology and Conservation of Chimpanzees at Ngogo, Kibale National Park, Uganda* ■ **David Fox**, Associate Professor of Geology & Geophysics, University of Minnesota; Edward P. Bass Distinguished Visiting Environmental Scholar: *Contrasting Latitudinal Gradients in Mammalian Species Richness and Climate During the Middle Paleocene in Western North America* ■ **Mary Louise Timmermans**, Assistant Professor, Department of Geology & Geophysics, Yale University: *Exploring the Arctic Ocean* ■ **Karen Hebert**, Assistant Professor, School of Forestry & Environmental Studies: *The Social Life of Sustainable Salmon: Paradox and Possibility in a Southwest Alaskan Fishery.*

YCEI Seminars, which took place in Kroon Burke Auditorium and Sage Auditorium at the School of Forestry & Environmental Studies, were as follows:

William Nordhaus, Sterling Professor of Economics, Yale University**:** *Climate Change: An Economic Perspective* ■ Richard Birdsey, Project Leader for the Climate, Fire and Carbon Cycle Sciences, USDA Forest Service: *Forests and Climate Change* ■ Howard Frumkin, Special Assistant to the Director for Climate Change and Health, Centers for Disease Control and Prevention: *Climate Change and Public Health* ■ John Roemer, Elizabeth S. and A. Verick Stout Professor of Political Science and Economics, Department of Political Science, Yale University**:** *Intergenerational and International Equity in a Warming Planet* ■ Ken Caldeira, Professor Department of Global Ecology, Carnegie Institution of Washington: *Intentional and Unintentional Climate Change: Using Global Models to Inform Public Policy* ■ Ernest Moniz, Professor of Physics and Cecil & Ida Green Distinguished Professor, Massachusetts Institute of Technology: *Energy Technology for a Low Carbon World* ■ Thomas Meyer, Arey Distinguished Professor of Chemistry, University of North Carolina, Chapel Hill: *Our Energy Future: Science and Technology Challenges for the 21st Century.*

YIBS and YCEI will again combine their offerings in the fall of 2010. Please visit the YIBS Web site for the schedule of dates and speakers with their topics at *www.yale.edu/yibs/events_yibsesc.html*

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B

C

A and **C** Sifakas (*Propithecus verrauxi*), Beza Mahafaly, Madagascar.

B Richard Bribiescas, Professor and Chair of Anthropology, presents Marion Schwartz of the Schwartz Family Foundation, the primary sponsor of the symposium, with a framed copy of the symposium poster." The photographer was Gary Aronsen.

A Look at Lemur Longevity: Evolution and Senescence in a Unique Primate

On April 30th, leading researchers in the field of primate behavior and life history gathered at the Yale University Department of Anthropology to discuss the evolutionary biology of lemur senescence.

Presenters and discussants for the Department of Anthropolgy's symposium "A Look at Lemur Longevity: Evolution and Senescence in a Unique Primate." First row: Diane Brockman, Patricia Whitten, Marion Schwartz, Laurie Godfrey, Stephanie Anestis. Second row: Stephen King, Monica Wakefield. Third row: Richard Lawler, Chris Gilbert, Andrea Baden, Marina Blanco, Richard Bribiescas. Last row: Jason Kamilar, David Watts, Emily Goble, Stacey Tecot, Tim Webster, Emilienne Rasoazanabary.

The symposium, sponsored by the Schwartz Family Foundation, the YIBS Center for Human and Primate Reproductive Ecology (CHaPRE), and the Department of Anthropology, took a long-overdue look at lemur senescence from multiple perspectives: phylogenetic, demographic, endocrinological, and life historical. Both extinct and extant taxa were represented, and the presentations and an in-depth discussion revealed incredible diversity in this primate group, on both the species and individual level. As summarized by co-organizer Professor Richard Bribiescas, "Understanding the evolutionary biology of aging in ecologically sensitive species such as lemurs provides much needed insight into the evolution of primate life histories as well as crucial information on the conservation biology of endangered Malagasy wildife." Presenters at the all-day event were (in alphabetical order): **Andrea Baden** (SUNY, Stony Brook), **Richard Bribiescas** (Yale University), **Diane Brockman** (University of North Carolina), **Laurie Godfrey** (University of Massachusetts), **Stephen King** (SUNY, Stony Brook), **Richard Lawler** (James Madison University), **Marion Schwartz** (Yale University), and **Patricia Whitten** (Emory University). Discussants included **Stephanie Anestis** (Yale University), **Marina Blanco** (University of Massachusetts), **Brenda Bradley** (Yale University), **Christopher Gilbert** (Yale University), **Jason Kamilar** (Yale University), **Emilienne Rasoazanabary** (University of Massachusetts), **Stacey Tecot** (SUNY, Stony Brook), and **David Watts** (Yale University).

YIBS CENTER FOR THE STUDY OF GLOBAL CHANGE WEEKLY SEMINARS

The YIBS Center for the Study of Global Change continued its weekly Global Change Seminars during the spring 2010 semester. Talks were presented with an emphasis on deep time—environmental changes of the geologic past and the impact on ideas about future climate change. Speakers and their topics were:

Karl K. Turekian, Department of Geology & Geophysics, Yale University: M*ultiple factors in the meteorite caused extinctions at the Cretaceous-Tertiary boundary* ■ **Mark Pagani**, Department of Geology & Geophysics, Yale University: *Estimates of climate sensitivity from the geologic record* ■ **Dennis Kent**, Department of Earth & Planetary Science, Rutgers University: *Paleogeographic control of sources and sinks of CO_2 during the Mesozoic and Cenozoic* ■ **Nicholas Longrich**, Postdoctoral Associate in the Department of Geology & Geophysics, Yale University: *The Cretaceous-Tertiary mass extinction: Using patterns in the North American vertebrate fossil record to understand extinction processe* ■ **Robert DeConto**, University of Massachusetts, Amherst: *A revised view of the Cenozoic evolution of the cryosphere* ■ **Lee Kump**, Pennsylvania State University Institutes of Energy and the Environment: *For Peat's sake: Ins and outs of carbon cycling at the PETM* ■ **Kate Freeman**, Department of Earth and Mineral Sciences, Pennsylvania State University: *Plio-Pleistocene lake deposits in Olduvai Gorge: Implications for the hydro-climate of the region* ■ **Thomas Algeo**, Department of Geology, University of Cincinnati: *Advances in the use of trace-metal proxies for paleoceanographic research* ■ **David Fox**, University of Minnesota and Edward P. Bass Distinguished Visiting Scholar, Yale University: *Origin of the grassland ecosystem in the Great Plains; C_4 grass biomass, ecosystem structure, and climate during the Neogene* ■ **Isabel Montanez**, University of California, Davis: *Reconstructing ancient CO_2-glaciation-climate linkages in deep-time* ■ **Christina Ravelo**, Ocean Sciences Department, University of California, Santa Cruz: *Global climate change of the last five million years: A view from the Bering Sea* ■ **Boaz Luz**, Hebrew University: *The isotopic composition of atmospheric oxygen: Explaining the mystery of the Dole effect.*

Please visit the Center for the Study of Global Changes Web site for future seminars at *www.yale.edu/yibs/research/CSGC.html*

YALE SYMPOSIUM ON AEROSOLS AND CLIMATE

A symposium on aerosol effects on climate, currently one of the hottest topics in climate research, took place at the Yale Department of Geology & Geophysics on March 26 and 27. The symposium was presented by the Yale Institute for Biospheric Studies (YIBS) Center for the Study of Global Change. Some of the very best scientists within the research field of aerosol effects on climate visited Yale and presented their latest research and pointed to future directions and challenges.

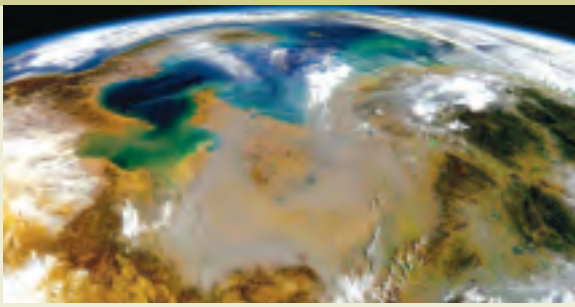
The Forum was organized by Karl K. Turekian, Yale Sterling professor of Geology & Geophysics, Inez Fung, professor at the University of California, Berkeley, and YIBS Edward P. Bass Distinguished Visiting Environmental Scholar at Yale, Dorothy Koch, NASA Goddard Institute for Space Studies (GISS), Research Affiliate, Yale Department of Geology & Geophysics, and Trude Storelvmo, Assistant Professor, Yale Department of Geology & Geophysics.

Prominent speakers with diverse expertise and views gave the audience an intriguing tour through the exciting field of aerosol-climate interactions, with presentations ranging in scale from laboratory studies of single aerosol particles, to the role of aerosols in coupled atmosphere-ocean climate simulations.

Nine presentations, in addition to a dinner talk by Professor Fung followed by lively discussion, left participants with the impression of a very active research field with sufficient remaining open questions to challenge the scientific community in years to come. For the interested reader, all presentations are available at *www.yale.edu/yibs/research/CSGC.html.*

Presenters and their topics were:

Peter Buseck, Arizona State University: *Aerosol particles as viewed using transmission electron microscopy* ■ **Allen Goldstein**, University of California, Berkeley: *Known and unexplored organic constituents in Earth's atmosphere: How well do we understand organic aerosols and their role in the climate system?* ■ **Athanasios Nenes**, Georgia Tech: *Impacts of aerosols on clouds and climate* ■ **V. Ramaswamy**, Geophysical Fluid Dynamics Laboratory (GFDL), National Oceanic and Atmospheric Administration (NOAA): *The imprint of aerosol microphysics on climate* ■ **Daniel Rosenfeld**, Hebrew University: *From expanding marine stratocumulus to suppressing hurricanes: climate forcing through aerosol impact on precipitation* ■ **V. Ramaswamy**, Geophysical Fluid Dynamics Laboratory (GFDL), National Oceanic and Atmospheric Administration (NOAA): *The imprint of aerosol microphysics on climate* ■ **Bjorn Stevens**, Max-Planck-Institut Meteorologie, Hamburg: *Untangling the effects of aerosols on clouds, precipitation and climate* ■ **Lynn Russell**, Scripps Institution of Oceanography: *Tracking the contributions of organic particles and some possible implications for aerosol forcing* ■ **Joseph McConnell**, Desert Research Institute, University of Nevada: *Aerosols in the polar regions during the past millennium from ice core measurements* ■ **Dorothy Koch**, Goddard Institute for Space Studies (GISS), National Aeronautics and Space Administration (NASA) and Yale University: *Aerosol-climate interactions during the 20th Century in the GISS model*



Mineral dust aerosols observed from space. The image is taken from the presentation by Inez Fung on the Great Plains Dust Bowl Event of the 1930s.

FACULTY NEWS


RAYMOND


POST


ALONZO


SMITH


PAGANI

SCHOOL OF FORESTRY & ENVIRONMENTAL STUDIES

Dr. Peter Raymond has been promoted to professor at the School of Forestry & Environmental Studies. Professor Raymond received his BS from Marist College and his PhD from the College of William and Mary/ Virginia Institute of Marine Science. A professor of ecosystem ecology, his lab's research focuses on biogeochemistry of natural systems. In particular, they are interested in the carbon and nitrogen cycles within aquatic systems. Current research topics include the landscape controls on the watershed export of carbon, biogeochemical transformations in estuaries, the physics of air-sea CO_2 exchange, nitrogen cycling in temperate watersheds, and determining the age and composition of carbon being transported from land to the ocean. This research often utilizes the watershed approach and natural isotopes to determine major sources, sinks, and ages of various carbon and nitrogen pools in the natural environment. Professor Raymond is also the director of the Long Island Sound Project within the YIBS Field Ecology Center. See page 26 for more on this project.

DEPARTMENT OF ECOLOGY & EVOLUTIONARY BIOLOGY

Dr. David M. Post

David M. Post was promoted to associate professor with tenure in the Department of Ecology & Evolutionary Biology. He received his BS and MS from the University of Wisconsin-Madison and his PhD from Cornell University. Post uses stable isotope techniques to test long-standing questions about food web structure and dynamics, and uses experimental and comparative approaches to study feedbacks between contem-

A Meditation on Tsunamis

By Stephen Stearns, Edward P. Bass Professor of Ecology & Evolutionary Biology
Written on Saturday, February 27, 2010.

Six weeks ago in Port-au-Prince an earthquake killed two hundred thousand people. Today the people of Chile took very serious damage from a major earthquake; many lives were lost. And Hawaii dodged the tsunami bullet ... this time.

I spent the day pinned to the news, waiting for the wave to strike, relieved that when it did, it was small, for I was born in Kohala on the Island of Hawaii eight months after the tsunami of April 1, 1946. That one was launched by an 8.6 earthquake near Unimak, Alaska. Warnings went out by radio, but the most popular morning show in Honolulu had a DJ, Hal Lewis, a.k.a. J. Akuhead Pupule—Crazy Tuna Head in Hawaiian Pidgin—whose audience—most of the population of Hawaii—had gotten used to his kidding around. On April 1st his warnings were ignored, written off as an April Fool's joke. At 7:30 that Monday morning the tsunami hit the Big Island, and the school buses were just pulling into the parking lot at Laupahoehoe Elementary School, on the coast north of Hilo. As the children got off, they could see the ocean receding and fish flopping about in tide pools that had never been there before. Not knowing what was happening, they rushed down onto the exposed rocks to look at the fish. They were caught by the incoming wave and swept out to sea, along with pieces of their school.

Some of the children from Laupahoehoe climbed onto broken pieces of wooden buildings and were swept thirty miles up the coast past Kohala. Obed Keawe and Pierre Bowman, both experienced watermen, were watching the aftermath of the tsunami when they saw the Laupahoehoe children going by offshore, clinging to a roof that was riding the current, heading for certain death in the Central Pacific. Obed and Pierre jumped into the water on surfboards, paddled out through the chaotic post-tsunami waves and currents, and brought eleven children ashore.

The tsunami killed 159 people and destroyed the Hilo waterfront.

The lesson was not lost. I grew up with a strong message often repeated: when a tsunami strikes, the first sign is that the water recedes, and you must then run as fast as you can for high ground. We did not forget the children of Laupahoehoe, most of whom were not saved.

In 1960 a volcanic eruption southeast of Hilo destroyed the town of Kapoho. By the light of its 1500-foot fountains we could dive at night two miles away. Shortly after that eruption stopped in March, the largest recorded earthquake in history, 9.5 on the Richter scale, occurred in Chile on May 22, 1960. It launched a huge tsunami that again destroyed the Hilo waterfront. Striking at night, it killed 61 people, many of whom were spectators drawn to the ocean to watch the spectacle and surprised by the size and speed of the wave, which went right over the top of the bridge on which they were standing. Humans cannot run 35 miles per hour.

My father went up in a small plane a day later to view the aftermath. He saw large mats of vegetation, one with a goat clinging to it, miles out to sea, large sharks circling, and a human corpse floating on the surface.

After that experience, Hilo converted its waterfront from businesses and stores to parks and sport fields.

The only tsunami that I have seen up close

porary evolution and ecological interactions. He works with fish and food webs primarily in lakes and streams in New England. He received the 2002 Raymond L. Lindeman Award and 2003 IRPE Prize for his work on food chain length. Post is an editor for the journal *Ecology Letters*.

Dr. Suzanne H. Alonzo

Suzanne H. Alonzo was promoted to associate professor on term in the Department of Ecology & Evolutionary Biology. She received her BA from the University of California, Berkeley, and her PhD from the University of California, Santa Barbara. Alonzo studies the evolution and ecology of reproductive traits using mathematical models and empirical studies of fish. She conducts fieldwork in Corsica on the ocellated wrasse and in Connecticut on the tessellated darter. Alonzo is an editor for the journals the *Proceedings of the Royal Society of London Series B*, the *American Naturalist, Evolutionary Ecology*, and *Ethology*.

Dr. Melinda D. Smith

Melinda D. Smith was promoted to associate professor on term in the Department of Ecology & Evolutionary Biology. She received her BA from the University of Colorado and her MS and PhD from Kansas State University. Smith uses large-scale experiments and comparative studies to test how climate change and biological invasions influence biodiversity and ecosystem function. She works in grassland ecosystems in North America and South Africa, and salt marsh communities in New England. Smith is an editor for the journal *Oecologia*.

DEPARTMENT OF GEOLOGY & GEOPHYSICS

Mark Pagani, a geochemist in the Department of Geology & Geophysics, was promoted to professor with tenure effective January 2010. Professor Pagani received his BA at Colorado University, Department of Geology & Geophysics, and his PhD from Pennsylvania State University. He joined the faculty at Yale in 2002. His research interests encompass the fields of biogeochemistry, paleoceanography, and paleoclimatology, with a focus on understanding the factors driving climate during the Cenozoic era. His approach applies the isotopic compositions and abundances of organic molecules (biomarkers), and records of stable isotope- and trace-element compositions of species-specific foraminifera to constrain the physical and environmental conditions of ancient oceans, terrestrial systems, and the atmosphere.

was launched by an 8.6 earthquake in the Aleutians on March 9, 1957. We viewed it on the North Kohala Coast at Kapanaia, a bay shaped like a capital omega, walled in by steep cliffs, with a narrow entrance facing the sea. First the bay drained dry, to a depth of 20-30 feet, leaving a huge wall of water at the entrance. Then the sea came in, not as a breaking wave but as a rapid, potent, lasting surge that pushed the level of the bay 35 feet above high tide and rushed half a mile back into the valley whose stream drained into the bay. When the water withdrew, there was a thunderous roar from the huge rocks it pulled with it, rocks that had withstood the heaviest floods of decades, rocks whose bouncing, bounding turbulence no swimmer could conceivably survive.

The surges came several times, at 15-20 minute intervals. At the low point of one interval my father ran out to the center of the stream to photograph the wall of water towering again at the front of the bay. My mother thought he was a blockhead. I was rooting for him. He got the shot.

It was a relatively small tsunami.

Such catastrophes are natural. They have often changed the course of human history and the shape of human culture. The explosion of Santorini (Thera) ca. 1600 BC launched a tsunami 80-150 feet high onto the north shore of Crete. It appears to have critically weakened the Minoan civilization and contributed to its collapse. Major earthquakes in China were interpreted as signals that the government had lost the Mandate of Heaven and helped to justify regime change. The Lisbon earthquake in 1755, which may have killed a hundred thousand people, turned Voltaire from a skeptical believer to a convinced atheist and shaped the course of the Enlightenment. The earthquake in Valparaiso shortly before Darwin arrived on the *HMS Beagle* lifted the harbor by about 50 feet and convinced him that normal processes, operating in the present, could have raised the Andes, helping him to accept Lyell's geological ideas and preparing him for his theory of evolution.

These events, while they do change the course of history, are smaller by many orders of magnitude than some catastrophes of the past. The end-Cretaceous meteorite impact 65 million years ago in the Yucatan launched tsunamis that were probably still nearly a kilometer high when they met on the opposite side of the globe. Gigantic Miocene eruptions in the Cascades and in the Phlegrean Fields near Naples sent deadly clouds of volcanic ash thousands of miles, putting down deposits many meters deep in Nebraska and near Kiev, now laden with fossils of the animals that died. Many more could be mentioned.

To scale up from merely planetary catastrophes, what would happen if a nearby supernova hit the cosmic reset button and turned us all into plasma? The good news is that it would be over quickly, and for the first 5 or 10 billion years we would not even notice, for we would not yet have re-evolved consciousness. When we did, we would probably reconstruct a cosmic history very much like the one we have produced this time around, since the last supernova in the neighborhood gave us all our heavy elements. For a long time, not yet having encountered local catastrophes, we would put ourselves at the center of that story. Then, schooled by the local catastrophes of a dynamic planet, we would again learn better.

Humans and their civilizations, their nations and their histories, their hopes and their dreams, are small and young. Nature is very big and very old. Some natural catastrophes are so large that nothing that we can do will protect us. They have no meaning. They do not happen because we did anything wrong or anything right. They just happen.

YALE PEABODY MUSEUM OF NATURAL HISTORY

EVENTS

COFFEE: THE WORLD IN YOUR CUP
On view May 29 to September 19, 2010

The Yale Peabody Museum's latest temporary exhibition explores the powerful influence of the $60-billion-a-year global coffee industry on the environment, human culture and economies worldwide—from coffee cultivation in Africa and South America to coffee culture in the United States—and illuminates the fascinating stories behind the coffee we drink, enabling us to become informed consumers.

Presenting sponsor, New Haven's own Willoughby's Coffee & Tea. Exhibition organized by the Burke Museum of Natural History and Culture at the University of Washington, Seattle, with major sponsorship provided by The Boeing Company, Microsoft Corporation, Starbucks Coffee Company, and the University of Washington.

PEABODY SUMMER YOUTH PROGRAMS
July and August 2010

Added to the fun of its regular week-long summer camp programs at the Museum for students entering 1st to 9th grade—on topics as diverse as biodiversity, astronomy, natural science illustration, ancient survival skills, ancient cultures and archaeology—this year the Peabody was pleased to announce four additional summer camp offerings at Yale's West Campus. The new camp programs take advantage of acres of woods, walking trails and a segment of the Oyster River that flows through the property on its way to Long Island Sound.

FIESTA LATINA!
October 2, 2010

Our annual celebration of Latin American cultures! This day-long festival features performances of traditional and contemporary Latin American music and dances, along with storytelling, face painting and mask making.

BIOBLITZ
October 8–9, 2010

Peabody scientists and volunteers team up once again with Connecticut's Beardsley Zoo in Bridgeport for another BioBlitz covering the town of Stratford—a 24-hour race to identify as many living organisms as possible in a specific area. Visit *www.peabody.yale.edu/explore/bioblitz/* for details.

BLACK HOLES: SPACE WARPS & TIME TWISTS
On view October 9, 2010 through May 1, 2011

The Peabody's next temporary exhibition explores the modern search for real black holes—the most mysterious and powerful objects in the universe. Featuring hands-on models, computer-based investigations, immersive experiences, and a technology-assisted learning environment, the exhibition lets visitors make sense of the weird ideas behind black holes and examine the evidence for themselves—science fiction or reality?

HOW TO SEE A BLACK HOLE
October 22, 2010

Although they emit no observable radiation of any kind, during the past 16 years dozens of celestial objects have been positively identified as black holes. Charles Bailyn, Thomas E. Donnelley Professor of Astronomy and Physics and winner of the Rossi Prize from the American Astronomical Society for research on this topic, will describe how black holes can be studied and what we know about these enigmatic objects.

A PEABODY HALLOWEEN
October 30, 2010

Join us for our annual celebration of the animals and nature-based traditions associated with Halloween.

Information and updates at (203) 432-5050 and *www.peabody.yale.edu*

Yale Anthropologist Honored by AAAS

Andrew Hill, the J. Clayton Stephenson Professor of Anthropology and Curator of Anthropology in the Yale Peabody Museum of Natural History, has been elected a Fellow of the American Association for the Advancement of Science (AAAS) for his distinguished contributions "to the field of human evolution, and particularly the relationship of hominins to the changing ecosystems of which they were a part."

In November 2009, the AAAS Council elected 531 members as Fellows, an honor bestowed on members by their peers in recognition of meritorious efforts to advance science or its applications and for their contributions to science and technology. These individuals were recognized in February 2010 during the AAAS annual meeting in San Diego.

Founded in 1848, the AAAS is an international non-profit organization dedicated to advancing science around the world. The AAAS publishes the journal *Science* and spearheads programs that raise the bar of understanding for science worldwide.

The Birds that Call West Campus Home

By Lynn A. Jones and Susan Hochgraf,
Museum Assistants, Yale Peabody Museum of Natural History

The Yale Peabody Museum of Natural History (YPM) was one of the first departments to occupy Yale's new 143-acre West Campus in West Haven and Orange. Several of us on the staff have been taking advantage of our lunch hours in the park-like setting to observe the wildlife that calls West Campus home. Along with Museum Assistant Nicholas Drew, we three birders took our observations to a new level by organizing the first West Campus Christmas bird count.

The National Audubon Society's national Christmas bird count, which dates back to 1900, collects baseline data by recording the bird populations present during the winter months. This 24-hour survey counts both the number of species and individual birds sighted in a pre-defined geographic location. Our efforts, while not included in the national census, were recorded for comparison with future surveys.

We began on a cold Wednesday morning during the Yale winter recess break. Lynn began before sunrise by playing audio recordings of owls. Previous owl sightings there had raised our expectations of a vocal response from these birds, but the cold, strong winds seemed to keep the owls quiet. Nicholas and Susan continued the count around daybreak.

First light brought a unique experience that few have the opportunity to witness—the emptying of an overnight winter crow roost, which was located across the road from the Yale property. We counted an estimated 1,500 American Crows, with Fish Crows mixed in among them, as they all took off at sunrise and flew over campus. Another hotspot revealed a flush of birds along the banks of the Oyster River where it flows underneath the main road through West Campus.

We all walked the entire campus, stopping at locations with habitat desirable to birds. Near the main entrance a large open field, overgrown with invasive Multiflora Rose, offers a unique habitat with an abundant winter food source for many wildlife species. This field yielded some of the highest counts of the day. A highlight was a Brown Thrasher first spotted by Nicholas. Although fairly common, this species usually migrates farther south during the colder months of the year.

The count offered us a great day. Our six-hour survey resulted in a grand total of 2,009 individual birds seen either on land or flying over West Campus. We identified a total of 33 species, from the Herring Gull to the Carolina Wren, and got unusually close looks at a Sharp-shinned Hawk hunting Black-capped Chickadees, several warm-weather birds still lingering behind, and Red-winged Blackbirds migrating south. Four species were new to the West Campus bird list Susan has been maintaining: Carolina Wren, Brown Thrasher, Hairy Woodpecker and Fish Crow.

The Christmas bird count does not end the birding season, but rather creates a reference point for other activities. Already YPM's West Campus Education Coordinator Tom Parlapiano has led an evening "owl prowl" for families through West Campus. Though unsuccessful in seeing live owls, both children and adults had the chance for an up-close look at mounted owls from the YPM ornithology collections. We also continue our lunchtime bird walks, which are always open to other West Campus staff. The West Campus bird list will continue to grow as spring sets in and many migrants stop in the area.

For information on the birds already spotted and to follow along with our birding efforts, visit Susan Hochgraf's blog at *www.birdingwestcampus.blogspot.com.*

Lynn Jones

A

Rebekah DeAngelo

B

Ann Prum

C

Lynn Jones

D

A Nicholas Drew and Susan Hochgraf get a closer look at the birds of West Campus.

B The birders who braved the cold: Nicholas Drew, Lynn Jones and Susan Hochgraf (left to right).

C Tom Parlapiano shows Peabody specimens at the owl prowl class.

D Nicholas and Susan examine an American Crow that did not survive the winter.

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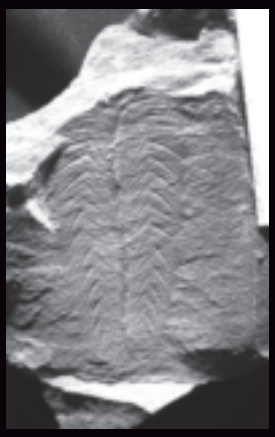

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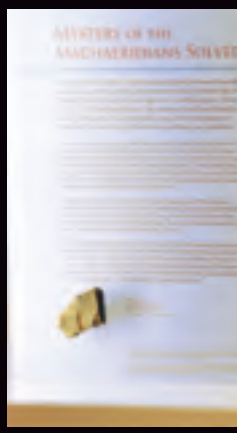


D

An Ancient Armored Worm Brought to Life

By Jakob Vinther (PhD '11), Yale Department of Geology & Geophysics

An oversized reconstruction of a remarkable fossil creature occupies one of the display cases at the Sachem Street entrance of the Class of 1954 Environmental Science Center: an armored worm, called a machaeridian, from the Ordovician seas of about 480 million years ago. Until recently we had no clear idea where to look for relatives of this worm among modern animals.

The plates that make up the armor of machaeridians have been known since 1857 and were originally interpreted as the isolated plates of barnacles, those ubiquitous denizens of rocky shorelines. Others suggested that the shelly remains might be part of an echinoderm. Subsequent discoveries from around the world of rare articulated skeletons showed that machaeridians were elongate slug-like or worm-like animals not more than a few to about 10 centimeters long (about four inches). The debate about their place in the tree of life focused on either mollusks (such as chitons) or annelids.

A major aim of my research is to understand the mollusks that diversified during the Cambrian explosion around 520 million years ago. Many of these had multiple plates on their back, and I was quite convinced that machaeridians were part of this story. The difficulty was that, with the total absence of any evidence of the soft tissues of machaeridians, only their calcareous armor was known.

As 2007 began—coincidentally the 150th anniversary of the first report of machaeridians—I met Peter Van Roy (now a post-doctoral researcher in the Yale lab of YPM director and the Frederick William Beinecke Professor of Geology & Geophysics Derek Briggs), who had discovered remarkably preserved soft-bodied fossils in rocks from the Ordovician of Morocco. Peter still travels to the desert of the Anti-Atlas region to collect fossils with the local Berbers every year. That year he brought back a fossil that just a handful of paleontologists could only fantasize about (after several pints of beer): a machaeridian fossil with soft parts. The discovery would resolve one of the biggest mysteries in paleontology.

My research with Peter Van Roy and Derek Briggs (see "Machaeridians are Palaeozoic armoured annelids," *Nature* 451:185-188, January 10, 2008) revealed that the newly discovered fossil specimen preserves most of the plates, but also has underneath it a series of stubby appendages with projecting bundles of bristles. Machaeridians turn out to be annelid worms, the group that also includes earthworms, leeches and bristle worms. They seem to be close relatives of modern scale worms, but machaeridians developed a distinctive armor—no modern annelid worm carries mineralized plates on its back. The Moroccan machaeridian was a surface crawler. Other forms that resemble a string of clam shells attached to an earthworm were clearly burrowers. Machaeridians were abundant for more than 200 million years in the Paleozoic oceans, but fizzled out in the Permian period.

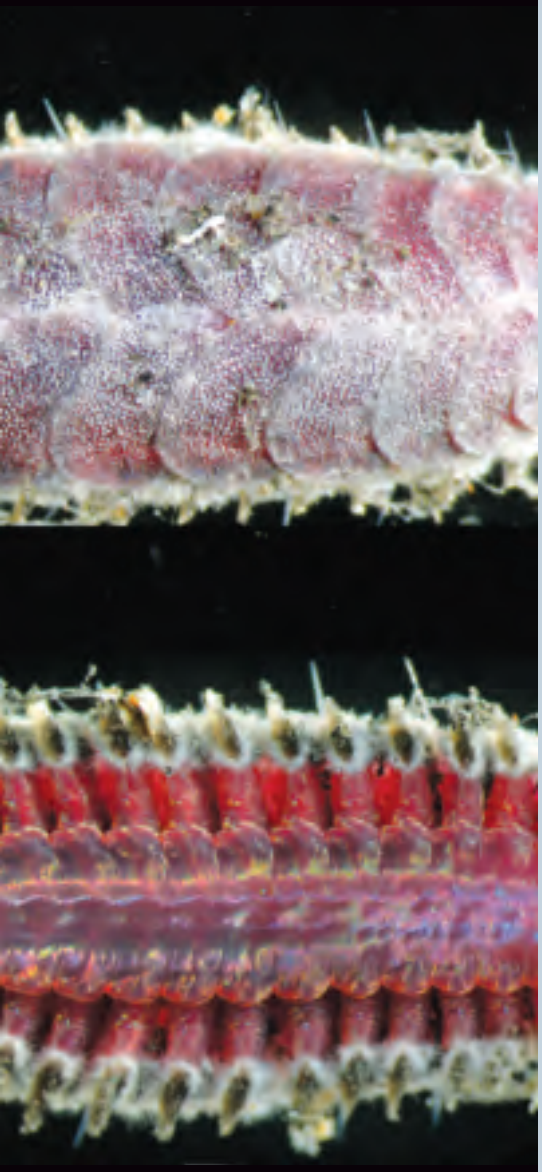
Now that we knew what was underneath the armor plates, it was worth bringing the machaeridian back to life. Esben Horn, a Danish model-maker (see his work at www.10tons.dk), heard about this bizarre creature and was enthusiastic to reconstruct it. After a long correspondence and several refinements, he created a giant machaeridian based on Van Roy's discovery, with insights from modern annelid scale worms and inspiration from the color patterns of living mussels. Horn generously donated his model of the 480-million-year-old creature to the Yale Peabody Museum. Several other remarkably preserved soft-bodied fossils from the Ordovician of Morocco now in the YPM collections are also waiting to be brought back to life by scientists, artists and model-makers.

A This drawing of the soft body parts of the adjacent fossilized machaeridian (*Plumulites bengtsoni,* YPM 221134) highlights the walking limbs (red), the bristles (blue-gray) and the gut (purple). Modified from Vinther et al. 2008; drawing and photograph by Peter Van Roy. Reprinted by permission from Macmillan Publishers, Ltd., from "Machaeridians are Palaeozoic armoured annelids," by Jakob Vinther, Peter Van Roy and Derek E. G. Briggs, *Nature* 451(7175):185–188, Figure 1. © 2008.

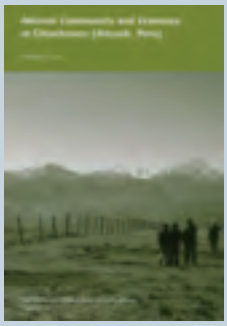
B A complete fossilized machaeridian skeleton. Photo by Jakob Vinther.

C Model-maker Esben Horn, Jakob Vinther and exhibit designer Laura Friedman at the installation of the machaeridian model. Photo by Sally Pallatto.

D The finished exhibit case with the model in place. A mirror allows the viewer to see the underside of the animal. Photo by Jakob Vinther.



The soft flaps on the back of this modern scale worm are very similar to the structures that carried the mineralized plates on the machaeridians.
Photograph courtesy of Greg Rouse/ Scripps.



NEW TITLES IN THE YALE UNIVERSITY PUBLICATIONS IN ANTHROPOLOGY SERIES

Volumes in the Yale University Publications in Anthropology monograph series, published by the Yale University Department of Anthropology and the Yale Peabody Museum of Natural History, embody the results of research directly conducted or sponsored by the department and the YPM Division of Anthropology. Publication 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.

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Settlement, Nesting Territories and Conflicting Legal Systems in a Micmac Community by Daniel P. Strouthes

Yale University Publications in Anthropology 89
ISBN 978-0-913516-25-6

Anthropologist Daniel P. Strouthes, associate professor in the Department of Geography & Anthropology, and American Indian Studies Program, University of Wisconsin–Eau Claire, an expert on indigenous law systems and North American Indian societies and cultures, has studied the Eskasoni band of the Micmac Indians of Cape Breton, Nova Scotia, over thirty years. In this pioneering book he describes the novel means of conflict control involving territorial defense they invented. His book is the first study of an indigenous land tenure system of a settling people as well as the first detailed account of the legal history of a Native American society.

Strouthes learned the Micmac language and conducted extensive interviews with community members to uncover their novel system of law and unorthodox means for conflict resolution regarding territorial defense. He offers a thoroughgoing analysis of the effects of settlement on the Eskasoni band, then applies his findings to current discussions of cultural change. In the case of the Eskasoni people, he observes, a choice was made not to maintain an established legal tradition, nor to borrow one from the dominant European–North American culture, but to invent something new. Despite the common perception that virtually all culture change in today's world can be traced to diffusion and globalization, this imaginative Micmac band demonstrates that in some instances culture change is the result of a conscious desire for improvement.

Ancient Community and Economy at Chinchawas (Ancash, Peru) by George F. Lau

Yale University Publications in Anthropology 90
ISBN 978-0-913516-26-3

In this groundbreaking study of ancient Chinchawas, a small agropastoral community in the North Central Highlands of Peru, George F. Lau, University Lecturer in the Sainsbury Research Unit for the Arts of Africa, Oceania & the Americas, School of World Art Studies and Museology, University of East Anglia, Norwich, England, provides the first full archaeological investigation of a site of the Recuay culture. Departing from the traditional focus on large regional centers in Andean archaeology, the author investigates the rise, history and demise of groups at Chinchawas (AD 300–900), emphasizing the importance and character of rural communities in complex societies.

For the first time, the book presents a site-level investigation of highland community organization and social life in first-millennium Recuay culture. With detailed attention to the record of local economy, residential and ceremonial practices, and trade, Lau reveals a more comprehensive account of early lifeways in the high Andes than has been seen before. Through analysis of the site's distinctive ceramics and material culture, he establishes a new sequence for the region that charts the rise and fall of a long-vanished Andean people.

A

Art Show and Display Highlight Birds of Prey

From January through June 2010, the most recent art display at Yale's Class of 1954 Environmental Science Center (ESC), "Birds of Prey of the Eastern United States," showcased 40 original works by 26 members of the Greater New York Chapter of the Guild of Natural Science Illustrators.

B

A A comparison of the skulls of a Bald Eagle (Accipitridae: *Haliaeetus leucocephalus,* YPM 105523), a Great-horned Owl (Strigidae: *Bubo virginianus,* YPM 109152) and a Brown Falcon (Falconidae: *Falco berigora,* YPM 104779) from the YPM collections. Photo by Sally Pallatto.

B Harriers are similar to owls and unique among diurnal raptors in having unusually large ear openings and a facial disc, a ruff of stiff, movable feathers around the face that helps the bird detect prey by collecting sound. Both the Northern Harrier (*Circus cyaneus*), top, and the Short-eared Owl (*Asio flammeus*), bottom, can be seen patrolling coastal marshes of New England (such as at Hammonasset or Stratford in Connecticut). Both hunt mostly by listening and can detect prey (usually small rodents) even completely hidden in vegetation. Photo by Sally Pallatto.

The ESC is an ideal location to showcase works of natural history art and scientific illustration in the natural sciences. For submission guidelines visit www.peabody.yale.edu/collections/esc/esc_art.html

Each work was accompanied by an explanation of its subject written by the artist. Birds of prey have always occupied a special place in the human imagination and have been represented in the symbolism of the mythology, art and literature of many cultures and civilizations throughout history. Eagles have long been equated with nobility and power, falcons with speed and freedom and owls with wisdom, darkness and death. Curated by Guild member Dick Rauh, this juried show of works in a variety of media—including oil, watercolor, acrylic, pastel, graphite and even the techniques of silverpoint and linoleum block print—interprets these magnificent wild raptors as they really are and communicates the wonder and awe that can be found in their world.

Many of the participating artists have had their art featured in solo and group exhibitions in museums and galleries throughout the United States and abroad. The Guild of Natural Science Illustrators (www.gnsi.org) is a professional nonprofit educational organization that encourages high standards of competence and professional ethics in the field of scientific illustration. The work of Guild members can be seen at www.science-art.com.

To accompany the Guild show, the ESC rotunda features a small exhibit case on "Monophyly or Convergence? Uncertain Evolutionary Origins of Birds of Prey." Developed by ornithologist Kristof Zyskowski, collections manager of the Division of Vertebrate Zoology at the Yale Peabody Museum of Natural History, the case asks whether raptorial features evolved independently as an adaptation to a similar lifestyle or resulted from close relationships in these groups. The exhibit uses taxidermy mounts of a Northern Harrier (*Circus cyaneus*) and Short-eared Owl (*Asio flammeus*) and comparison of skulls of a Bald Eagle (Accipitridae: *Haliaeetus leucocephalus,* YPM 105523), a Great-horned Owl (Strigidae: *Bubo virginianus,* YPM 109152) and a Brown Falcon (Falconidae: *Falco berigora,* YPM 104779) to tell this story.

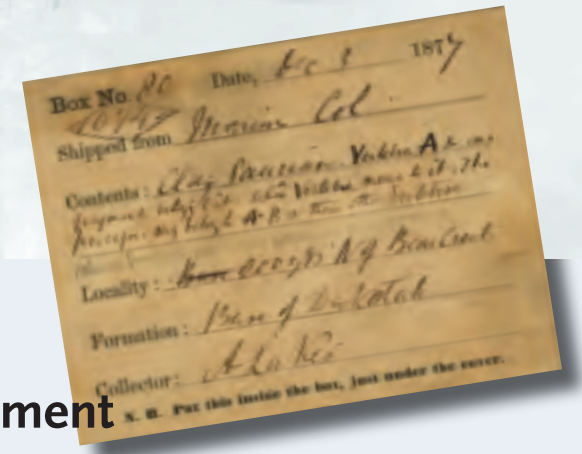
C

D

C Golden Eagle with Rat
Aquila chrysaetos and *Rattus norvegieus*
Watercolor on paper
The Golden Eagle hunts along the Hudson River singly and in teams. Several groups can be observed through the seasons as one commutes along the river by train or when hiking nearby trails. This particular bird is captive at New York's Bronx Zoo. With feathers in quill, the bird was a more stationary subject well suited to close study of his treatment of the prey provided to him. Painting by Chris Sanders. © 2009 Chris Sanders

D Great Horned Owl with Her Babies
Bubo virginianus
Watercolor on paper
What is most intriguing about the Great Horned Owl is its face. The large, yellow, front-facing eyes, partially covered by "brow" feathers, give it an intense, piercing and stern expression. The large "ear tufts" that give the bird its name are neither ears nor horns but feathers, of course, and are not related to hearing at all. Theories as to the purpose of the ear tufts include providing species recognition, camouflage and non-verbal communication in dense woodlands. This owl can live in forests, deserts, plains and parks, where it feeds on rodents, birds, amphibians, fish, large insects and road kill. Painting by Judy Aronow. © Judy Aronow

Barn Owl
Tyto alba
Watercolor and gouache on paper
This medium-sized nocturnal raptor, one of the most widely distributed birds in the world, is found on all continents except Antarctica and is most recognizable by its lovely heart-shaped face. Even with a 43-inch wingspan, the Barn Owl's flight is stunningly silent, due to soft, fringe-edge feathers. With its excellent low-light vision, it hunts mostly at night and its ability to hunt by sound alone is the best of any animal tested. It nests in hollow trees and cliff cavities, but will also use nest boxes and buildings, especially barns, of course. This raptor eats small mammals, preferring rodents as its meal of choice. When the rodent population goes up, so does the population of Barn Owls! Painting by Judy Aronow. © Judy Aronow



New Discoveries Among Old Fossils: "Collecting" Dinosaurs in the Peabody Basement

by Daniel Brinkman, Museum Assistant II, and Nicholas Drew, Museum Assistant, Division of Vertebrate Paleontology

According to his former graduate student George Gaylord Simpson, the late Richard Swann Lull, Yale's first Sterling Professor of Geology and a past director of the Yale Peabody Museum of Natural History (YPM), often remarked "that the best [fossil] collecting he knew was in the basement of the Peabody Museum, where reposed much of the great Marsh Collection, including innumerable undescribed specimens and some that Marsh, himself, had never laid eyes on." Made more than 50 years ago, Lull's observation remains true today—new specimens are still being discovered among the many dinosaur fossils in the YPM basement.

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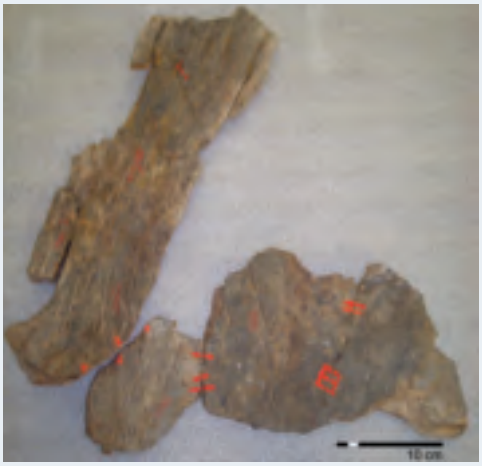

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In March 1877, English missionary, teacher and self-trained artist Arthur Lakes, who would later become one of Colorado's most accomplished geologists, discovered some fossilized teeth and massive bones while prospecting with a friend in the foothills of the Rocky Mountains near Morrison, Colorado. Lakes sent letters and sketches announcing these discoveries to the two most prominent American vertebrate paleontologists of the day: Othniel C. Marsh at Yale and Edward D. Cope at the Academy of Natural Sciences in Philadelphia.

Marsh was Yale's first professor of paleontology and Cope was his main scientific rival and, later, his most despised antagonist. In sending letters and specimens to both men, Lakes unwittingly helped trigger the great dinosaur bone rush in the American West that soon followed. During the next two decades both Marsh and Cope employed teams of workmen to collect dinosaur fossils for them out West. The rapid pace of new discoveries was fueled by the intense personal and professional rivalry between Marsh and Cope. The two would independently name more than 140 new dinosaur species between them, of which 37 (31 named by Marsh and 6 by Cope) are still considered valid today.

A The pencil-shaped teeth of the type specimen of *Diplodocus lacustris* (YPM 1922). Photo by Nicholas Drew.

B Partial bony plate of the type specimen of *Stegosaurus armatus* (YPM 1850). Photo by Nicholas Drew.

C O. C. Marsh's first full skeletal reconstruction for *Stegosaurus* published in 1891. From *The Dinosaurs of North America*, by O. C. Marsh, 1896. Sixteenth Annual Report of the U.S. Geological Survey, Washington, D.C. Photo courtesy of YPM Archives.

Lakes was eventually hired in June 1877 to continue collecting specimens exclusively for Marsh. Lakes and his crews collected fossils near Morrison intermittently for more than two years, excavating 10 major quarries and a few other, less extensive sites. The material from one excavation, Quarry 5, was the focus of our "collecting" efforts in the YPM basement. The rock at Quarry 5 consisted of very hard sandstone that was especially difficult to break. Removing fossils from such hard rock proved frustrating and Lakes and his men resorted to using sledgehammers. Unfortunately, the brittle, fossilized bones and teeth were indiscriminately broken along with the rock, creating a complex, three-dimensional jigsaw puzzle of shattered pieces for YPM preparators to contend with today. (Fossil preparators are the highly skilled scientific technicians who remove fossils from their rock matrix and glue the pieces together for study and display.)

Lakes and his crews sent tons of excavated Quarry 5 material to Marsh, who identified, among the other skeletal remains, fragments of a large bony plate and long pencil-shaped teeth that he attributed to a new kind of large plated reptile. In November 1877, he created the order Stegosauria for this newly discovered reptile and the fossil designated YPM 1850 became the holotype (or name-bearing) specimen of the first species recognized for this new order, *Stegosaurus armatus*. Marsh named several other species of stegosaur over the next few years (all from Wyoming), including *Stegosaurus ungulatus,* the first stegosaur for which he had a full skeletal reconstruction drawn.

Shipping label from a crate of dinosaur bones collected from Lakes' Quarry 10 and shipped by Arthur Lakes from Morrison, CO, to New Haven, CT, by rail in December 1877. Photo courtesy of YPM Division of Vertebrate Paleontology.

Although Marsh initially believed that the long, pencil-shaped teeth from Quarry 5 (now catalogued as YPM 1922) belonged to *Stegosaurus armatus,* he realized later, after the discovery of more dinosaur remains in Wyoming, that they actually belonged to a new kind of sauropod (a giant, long-necked, long-tailed, big-bellied, plant-eating dinosaur) that he named *Diplodocus lacustris* in February 1884. Marsh went to his grave in 1899 thinking that only two kinds of dinosaur had been collected from Lakes' Quarry 5: *Stegosaurus armatus* and *Diplodocus lacustris.*

Although only a fraction of the fossils from Quarry 5 has ever been prepared, this has not prevented generations of paleontologists from poking around in this unprepared material looking not only for other recognizable skeletal elements, but for additional kinds of fossil animals in it as well. In 1998, Colorado paleontologist Kenneth Carpenter found a *Diplodocus* -like tail vertebra mixed in with material attributed to stegosaur YPM 1850.

Then in 2001, also in this material, he and YPM Curatorial Affiliate Peter Galton reported finding a possible shinbone of the large, meat-eating dinosaur *Allosaurus* and the fragmentary limb bones of a *Diplodocus*-like sauropod. Recent work both at YPM and in the reopened Quarry 5 near Morrison has since added to the list of specimens and kinds of fossil animals now known from that quarry.

We began our fossil "collecting" in the YPM basement early in fall 2009 when a major air-handling-system renovation in the Kline Geology Laboratory building necessitated not only the reshuffling of Division of Vertebrate Paleontology collections within the YPM–KGL complex, but also the relocation of some holdings to Yale's West Campus, including tons of the unprepared material from Lakes' Quarry 5 originally catalogued as *Stegosaurus armatus* YPM 1850. Museum assistants Nicholas Drew and Scott Poglitsch were assigned the task of packing and moving this unprepared material to West Campus.

This meant that each chunk of sandstone had to be individually examined for the presence of fossilized bone or tooth fragments and then bagged and labeled, resulting in the first piece-by-piece examination of this material in more than a century (if ever). Fossils thought to belong to animals other than *Stegosaurus* were turned over to Museum Assistant II


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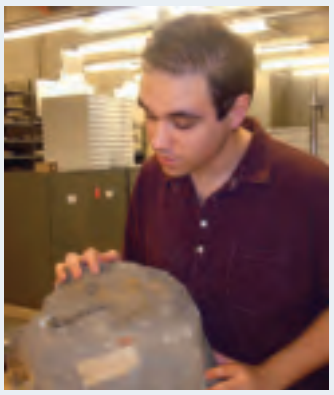
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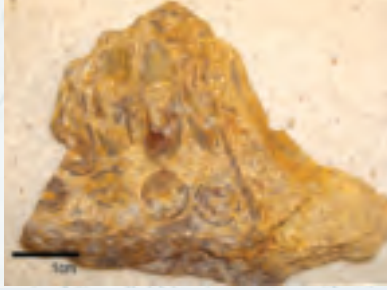
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D A recently discovered tooth fragment probably attributable to *Camarasaurus.* Credit: Nicholas Drew

E This recently discovered tooth fragment belonged to a large meat-eating dinosaur, possibly *Allosaurus.* Credit: Nicholas Drew

F Museum Assistant Nicholas Drew examines a large block of sandstone excavated from Lakes' Quarry 5 that contains probable *Camarasaurus* tooth fragments. Credit: Daniel Brinkman

G A newly discovered jaw fragment probably attributable to *Diplodocus lacustris.* Credit: Nicholas Drew

H Newly discovered tooth fragment probably attributable to *Diplodocus lacustris.* Credit: Nicholas Drew

I Arthur Lakes' watercolor painting of his crew excavating *Apatosaurus* bones at Quarry 10 near Morrison, ca. 1877. Credit: YPM Archives

Daniel Brinkman for identification.

Through our meticulous "collecting" efforts, we discovered several more fragmentary teeth and a couple of jaw fragments probably attributable to *Diplodocus lacustris,* three fragmentary teeth of a large meat-eating dinosaur (possibly *Allosaurus*), and as many as seven fragmentary teeth probably belonging to the blunt-faced sauropod dinosaur *Camarasaurus* (an animal not previously reported from any of Lakes' excavations near Morrison). All of these specimens were heavily damaged when excavated, thereby making their precise taxonomic identifications difficult.

In addition to our "collecting" efforts in the YPM basement, the Morrison Natural History Museum in Colorado has recently reopened Quarry 5 hoping to find even more fossils. So far, according to its director and chief curator Matthew Mossbrucker, their excavations have produced the tooth plate of a new species of lungfish, dozens of stegosaur tracks, including those of juveniles, and the claw bone of the "brontosaur" *Apatosaurus.* Although *Apatosaurus* has not been reported before from Quarry 5 proper, YPM Curatorial Affiliate John McIntosh has recognized probable *Apatosaurus ajax* skeletal elements (the end of a thigh bone and some tail vertebrae catalogued together as YPM 4833) from a smaller Lakes' site near Quarry 5. Moreover, *Apatosaurus* bones are known from Lakes' nearby Quarry 8 and are especially abundant at his extensive Quarry 10, about 9,000 feet (almost 2 miles) from Quarry 5.

Recent discoveries in the YPM basement and at the reopened Quarry 5 have substantially increased both the number of specimens and kinds of fossil animals known from this quarry, making it the richest one of the ten that Arthur Lakes and his crews worked near Morrison (though Lakes' expansive Quarry 10, which yielded so many *Apatosaurus* bones, still holds the local record for the most skeletal elements recovered in a single quarry near Morrison). Given the results of our recent "collecting" activities, it seems that Professor Lull was right: the best fossil collecting for some of us really does take place in the basement of the Peabody.

Peabody Receives Grant for Care of Fossil Fish Collection

By Marilyn Fox, Preparator, Vertebrate Paleontology Preparation Laboratory

Fossils of tiny Eocene fish (VP.004005) from the Green River Formation in Wyoming. Photo by Vicki Fitzgerald.

The Yale Peabody Museum of Natural History (YPM) Division of Vertebrate Paleontology has received a grant for the conservation of its fossil fish collection, approximately 7,600 specimens ranging in age from Devonian to the Tertiary. The $149,282 award from the Institute of Museum and Library Services (IMLS) will allow the division to clean the specimens, place them in new acid-free trays, and eventually rehouse the entire collection together in 53 new museum-quality cabinets provided by Yale for storage in a recently renovated storeroom that will provide appropriate environmental conditions for fossil materials.

These fossil fish specimens include large holdings from the Devonian Cleveland Shale of Ohio, the Triassic–Jurassic Newark Supergroup in Connecticut and New Jersey, and the Cretaceous Niobrara Chalks of Kansas. The collection dates back to some of the earliest collecting done in the American West in the 1870s, with additional significant contributions made in the 1960s and the 1980s. Taxa represented include both jawless and jawed fishes, and bony and cartilaginous fishes.

Every specimen treated during the project is digitally photographed. The images will be made available through YPM's searchable online catalog. Researchers will then be able to see our holdings of a particular animal without having to travel to the division.

Museum Assistant Vicki Fitzgerald and the Vertebrate Paleontology Preparation Lab's crew of experienced volunteers are performing this work. Fitzgerald was also responsible for supervising both of our previous grant-funded projects: the conservation of the large dinosaurs collected in the 19th century under the direction of O.C. Marsh and the conservation of the fossil vertebrate specimens obtained from Princeton University when it ended its paleontology program.

We have made some interesting discoveries during this project. Some of the specimens collected in the 1870s from the Cretaceous Niobrara Chalks of Kansas had never been

An example of the specimens within this collection, this fish fossil from the Green River Eocene deposits in Wyoming was prepared by Preparation Lab volunteer Mary Weigand. Photo by Marilyn Fox.

unwrapped and were still in their original newspaper, wood and string packages; some were even in candy or cigar boxes, others were stored in old fruit boxes stacked on top of cabinets. We left some of these specimens wrapped, to be kept for possible future exhibits or historical research. All the newspaper wrapping removed from the specimens were archivally sealed.

We also discovered a map to localities where fossils were collected, drawn on a railroad station map. Locality maps are rare from these expeditions, so this one could provide clues to finding the sites where the specimens were collected.

This IMLS-funded project will raise the conservation and storage of these specimens to the highest conservation standard, bringing the YPM Division of Vertebrate Paleontology one step closer to achieving its overarching goal of preserving and making every specimen in its collections instantly available for study.

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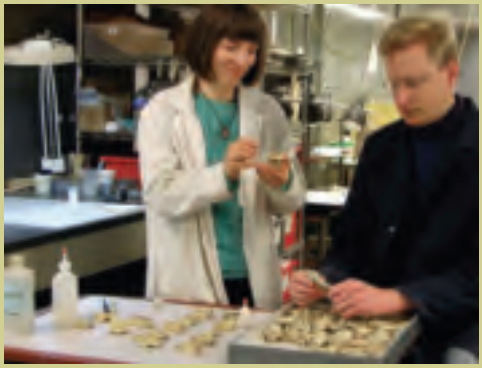

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A All the fossils are stored in foam-lined acid-free specimen trays. With the catalog number and YPM prefix clearly written on each bone, researchers will be able to identify every bone as belonging to a specific individual specimen.

B These boxes hold specimens collected in 1873, still in their original newspaper wrappings. All wrappings were encapsulated in archival enclosures and will be kept in the Division's collections where they will be available for future study. Photo by Marilyn Fox.

C Vicki Fitzgerald and Curatorial Affiliate Alan Gishlick (PhD '02) examine specimens in the collection. Photo by Marilyn Fox.

D and **E** Teeth of the Miocene sharks *Heptranchias primigenius* (top) and *Odontaspis taurus* (bottom). Photo by Vicki Fitzgerald.

RESEARCH AND PROGRAM HIGHLIGHTS

Prescribed Burning at the Yale School Forests

Brent Frey, Yale School Forests Research Coordinator

Dr. Ann Camp, Yale FES (3)

A

The prescribed burn program at Yale-Myers Forest is an excellent manifestation of the School Forest's research, management, and educational mandate. Depending upon the vagaries of New England weather, prescribed fires are attempted each spring on our forestland in northeastern Connecticut. This spring the weather cooperated splendidly and, bolstered by the help of fire officers from the Connecticut Department of Environmental Protection and a keen band of Yale School of Forestry & Environmental Studies graduate students, we carried out several controlled burns. The fires were successful in top killing woody regeneration and thus helping to maintain meadow habitat.

These burns contribute to our larger goal of promoting early successional shrub and grassland habitat favorable to early seral wildlife, habitats that have become less prevalent on the landscape due to changing land-use patterns. Spring burns are rotated annually among several different forest patches within an area of the forest known as the Red Front Lot. Habitats promoted by the prescribed burns include several open forest meadows and an oak-savanna. Ongoing research compares floristic patterns and soil development between burned areas and protected reserve patches within. The prescribed fire program also serves as a valuable teaching tool, providing students hands-on experience in fire ecology. Students of Dr. Ann Camp's Fire Ecology course as well as interested students from the school community participate. Additionally, these sites form an important part of our demonstration trail network, with the Red Front Trail focused on wildlife habitat management.

A Flames engulf some downed wood and a snag within the forest meadow.

B Our newly minted band of prescribed burners stands proudly in the smoldering meadow.

C Guided by a forest officer from the CT DEP, William Lynam (FES'10) uses a drip torch to start the fire line in the oak savanna.

Microbial Diversity Institute

Looking at the smoke billowing from a power plant or the aftermath of a catastrophic flood, it is hard to believe that tiny microbes are responsible for many of the major events that occurred in Earth's history, and in the formation and destruction of our physical and biological environments. As a cause of human mortality, infectious diseases are second only to heart disease, and the three biggest killers—HIV, tuberculosis and malaria—result from a virus, a bacterium, and a eukaryote, respectively, all of which are microbes, and each infecting and killing humans in its unique fashion. And let's not forget smallpox, typhoid, diphtheria, hepatitis, West Nile, Swine Flu, Lyme disease, polio, measles, herpes, and the plague. Even your glass of pasteurized milk—recognizing that pasteurization eliminates more than 99.99% of all microorganisms—still contains a number of bacterial cells equivalent to the population of Mexico City.

But the problems and questions extend far beyond those relating to human disease. Microorganisms recycle the elements that make up all living systems and make them available as nutrients and metabolites for other life forms. The generation of atmospheric oxygen—microbes; the broad-scale global distribution of plants—microbes; and without the ancient symbiotic association between bacterial and eukaryotic microbes, animals would not be able to respire nor would plants photosynthesize.

The Microbial Diversity Institute (MDI) was formed to investigate such diverse microbe-mediated processes. Its three broad focus areas concern the role of microbes in ecology and the environment, the molecular and genomic diversity of microbes, and the interactions between microbes and their hosts. Members of at least ten departments at Yale already conduct research in these areas, and the MDI will serve to link researchers on Science Hill, the Yale School of Medicine and West Campus. With an initial target size of ten new faculty, each member of the MDI will maintain a research lab on West Campus but also have their primary appointment in an existing department, an arrangement that will foster the broader goal of extending interactions among researchers spanning the entire Yale community.

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So far, two new faculty have been hired to the MDI: Nancy Moran, who studies the genetic and ecological interactions of bacterial symbionts and their hosts, and Howard Ochman, whose research investigates the forces operating on the evolution of bacterial genomes. In Fall 2010, they will be joined by Eduardo Groisman, a Howard Hughes Medical Institute (HHMI) investigator whose work explores the mechanisms by which pathogenic and commensal bacteria modify their gene expression patterns so that they can survive and proliferate within host tissues. And there is presently a search for junior faculty members whose research explores new areas of microbial diversity. We envision the MDI to be unlike any other institute or department in the world in fostering innovative approaches to the study of microbes—and this is just the formula when studying the diversity, relationships, functions and interactions of the most ancient group of organisms on the planet.

Microbes Contributing Less to Climate Warming

The physiology of microbes living underground could determine the amount of carbon dioxide emitted from soils on a warmer Earth, according to a study published in *Nature Geoscience*.

Researchers at the University of California at Irvine, Colorado State University and the Yale School of Forestry & Environmental Studies have found that as global temperatures increase, microbes in soil become less efficient over time in converting carbon in soil into carbon dioxide, which is a key contributor to climate warming.

Microbes, in the form of bacteria and fungi, use carbon for energy to breathe, or respire, and to grow in size and in number. A model developed by the researchers shows microbes exhaling carbon dioxide furiously for a short period of time in a warmer environment, leaving less carbon for growth. As warmer temperatures persist, the less-efficient use of carbon by the microbes causes them to decrease in number, eventually resulting in less carbon dioxide being emitted into the atmosphere.

"Microbes aren't the destructive agents of global warming that scientists had previously believed," said Steven Allison, lead author of the study and assistant professor of ecology and evolutionary biology at UC Irvine. "Microbes function like humans; they take in carbon-based fuel and breathe out carbon dioxide. They are the engines that drive carbon cycling in soils. In a balanced environment, plants store carbon in the soil and microbes use that carbon to grow. The microbes then produce enzymes that convert soil carbon into atmospheric carbon dioxide."

The study, "Soil-Carbon Response to Warming Dependent on Microbial Physiology," contradicts the results of older models that assume microbes will continue to spew ever-increasing amounts of carbon dioxide into the atmosphere as the climate continues to warm.

The new simulations suggest that if microbial efficiency declines in a warmer world, carbon dioxide emissions will fall back to pre-warming levels, a pattern seen in field experiments. But if microbes manage to adapt to the warmth—for instance through increases in enzyme activity—emissions could intensify.

"When we developed a model based on the actual biology of soil microbes, we found that soil carbon may not be lost to the atmosphere as the climate warms," said Matthew Wallenstein, of the Natural Resource Ecology Laboratory at Colorado State University. "Conventional ecosystem models that didn't include enzymes did not make the same predictions."

Mark Bradford, assistant professor of terrestrial ecosystem ecology at the Yale School of Forestry & Environmental Studies, said there is intense debate in the scientific community over whether the loss of soil carbon will contribute to global warming. "The challenge we have in predicting this is that the microbial processes causing this loss are poorly understood," he said. "More research in this area will help reduce uncertainties in climate prediction."

Kroon Hall Achieves LEED's Highest Rating

A view of Kroon Hall's top floor from the Knobloch Environment Center. Photo by Robert Benson Photography.

Kroon Hall has been awarded LEED platinum certification by the U.S. Green Building Council. Under the LEED (Leadership in Energy and Environmental Design) rating system for new construction, Kroon Hall was awarded 59 points, seven more than required for the top rating of platinum.

"The faculty and students of our environment school are working in a setting that superbly embodies their aspirations," said President Richard Levin.

The 58,200-square-foot Kroon Hall, which opened in January 2009, was designed to use 81 percent less water and 58 percent less energy than a building of comparable size and to generate 25 percent of its electricity onsite from renewable sources. Designed by Hopkins Architects, in collaboration with Centerbrook Architects and Planners and Atelier Ten, Kroon Hall incorporates a wide range of sustainable strategies and design features reflected in its LEED rating.

Kroon Hall earned 12 out of 14 possible points in LEED's Sustainable Sites category through environmental sensitivity to the building landscape design and the promotion of public transportation.

It earned all five points for Water Efficiency by incorporating many innovative water-saving and water-reusing features. Stormwater is collected from the roof and courtyards, filtered through native aquatic plants and used for all nonpotable needs such as toilets and irrigation. Water demand is further reduced by low-flow plumbing and irrigation fixtures.

The building earned all 17 points in the Energy and Atmosphere category for building commissioning, which is the process of ensuring that the building is operating as intended; reducing the use of harmful refrigerants; onsite renewable energy production; building energy performance; and measurement and verification of operational performance. The rating was achieved through passive design, optimized lighting and incorporation of renewable energy sources onsite, which includes a 100-kilowatt rooftop array of photovoltaic panels.

Kroon Hall achieved 6 points out of 13 in the Materials and Resources category. Credit is given to the selection of architectural, structural and landscape materials used in the building and for recycling. Points are awarded for the percentage of materials that were purchased from within a radius of 500 miles from the building or are made of recycled materials. The project purchased 16 percent of the materials with recycled content and 34 percent from regional sources. Almost 80 percent of the timber purchased for the building is certified by the Forest Stewardship Council.

The maximum 15 points was awarded for Indoor Environmental Quality. Points are achieved for projects that maximize daylight and have views to the outdoors, use high-efficiency filtration for air ventilation, give occupants control of their visual and thermal environment and utilize finished products with low concentrations of volatile organic compounds.

The building achieved 4 out of 5 points for Innovation and Design. The project achieved points for its green education program, green housekeeping plan and exemplary performance for potable water savings.

In addition to achieving LEED platinum status, Kroon Hall received the following recognition:

- **Excellence in Design Award**
  Environmental Design + Construction Magazine
- **Building of the Year**
  Architects' Journal 100 Awards
- **International Design Award**
  Royal Institute of British Architects
- **Silver Award**
  American Council of Engineering Companies of Massachusetts Excellence Awards, Connecticut
- **Judges Award for Innovation in Sustainability**
  American Council of Engineering Companies of Massachusetts Excellence Awards, Connecticut
- **Most Intriguing Green Building**
  Connecticut Green Building Council
- **Top Ten Award**
  Committee on the Environment, American Institute of Architects
- **Honor Award for Design Excellence**
  American Institute of Architects New England
- **Design Award**
  American Institute of Architects Connecticut
- **Citation for Integrated Design Process**
  Beyond Green High-Performance Building Awards, Sustainable Buildings Industry Council
- **Tucker Design Award**
  Building Stone Institute
- **Wood Design Citation Award**
  Wood Design & Building Magazine
- **Award of Merit for New Construction**
  Project Team Awards, Connecticut Building Congress
- **Winner, Build Connecticut Award**
  Associated General Contractors of Connecticut
- **Winner, Smart Environments Award**
  International Interior Design Association and Metropolis Magazine

YALE ENVIRONMENT 360 VIDEO WINS NATIONAL MAGAZINE AWARD

Yale Environment 360 has won the 2010 National Magazine Award for Digital Media for best video for an original report that it produced and posted on the site about mountaintop removal coal mining in Appalachia.

The video, *Leveling Appalachia: The Legacy of Mountaintop Removal Mining*, was one of five finalists in the video category that included videos produced by *National Geographic* and *The New York Times* style magazine. Directed by Chad Stevens and produced by *Yale Environment 360* and the multimedia company MediaStorm, the 20-minute video depicts the enormous environmental and human costs of mountaintop removal mining. The practice, which involves blasting the tops off mountains to get at the coal seams below, has destroyed or severely damaged more than a million acres of Appalachian forest, buried nearly 2,000 miles of streams in mining debris, contaminated water supplies and driven some local residents from their homes.

"We are extremely proud of this award and I hope it helps shed even more light on the issue of mountaintop removal mining and its effects on the people and environment of Appalachia," said Roger Cohn, editor of *Yale Environment 360*.

Yale Environment 360, an online magazine launched in June 2008, was one of just six online-only magazines to receive a nomination as a finalist for this year's National Magazine Awards, which are regarded as the most prestigious awards in magazine publishing. This is the first year that the American Society of Magazine Editors has sponsored National Magazine Awards for digital journalism. *Leveling Appalachia* was the first video produced by *Yale Environment 360*.

Published at the Yale School of Forestry & Environmental Studies, *Yale Environment 360* features reporting, commentary and analysis on global environmental issues. It has been recognized for digital and editorial excellence, winning a 2009 Online Journalism Award for Best Specialty Site Journalism.

Amphibians as Environmental Omen Disputed

Amphibians, for years considered a leading indicator of environmental degradation, are not uniquely susceptible to pollution, according to a meta-analysis published in *Ecology Letters*.

After a review of over 28,000 toxicological tests, researchers from Yale, the University of South Dakota and Washington State University are challenging the prevailing view that amphibians, with their permeable skin and aquatic environment, are particularly sensitive to chemical threats and, as such, are "canaries," or predictors of environmental decline.

"The very simple message is that for most of the classes of chemical compounds we looked at, frogs range from being moderately susceptible to being bullet proof," said David Skelly, professor of ecology and a member of the research team. "There are other kinds of environmental threats that have led to their decline, including habitat conversion, being harvested for food and the global spread of the chytrid fungus, which is mowing down these species in its path."

The team, led by Jacob Kerby, an assistant professor of biology at the University of South Dakota, based its analysis on information gleaned from the US Environmental Protection Agency's (EPA) Aquatic Toxicity Information Retrieval database, examining 1,279 species, among them segmented worms, fish and bivalves, such as clams, insects and snails. Those species were exposed in water to various concentrations of 107 chemical agents, including inorganic chemicals, pesticides, heavy metals and phenols, a class of organic chemical compound.

"What our results suggest is that all animals are susceptible to chemical stressors and that amphibians are potentially good indicators," said Kerby. "But there isn't any evidence that they're a uniquely leading indicator. We tried to be comprehensive in the types of chemicals and organisms that we examined."

The paper, "An Examination of Amphibian Sensitivity to Environmental Contaminants: Are Amphibians Poor Canaries?," is available at *www.interscience.wiley.com/cgi-bin/fulltext/122658158/PDFSTART.*

A Landscape of Fear

By Bruce Fellman
Originally published in Environment:Yale magazine

Picture yourself in a meadow in high summer. Tall downy grasses, amid a colorful patchwork of buttercups, knapweed, Indian paintbrush and butterfly weed, sway languidly under a sultry sun. Monarch butterflies, hummingbird moths and droning bumblebees skitter atop the flowers in jittery haste for nectar. Thoreau, you fancy, could have been inspired in that meadow to write "The Inward Morning": How could the patient pine have known / The morning breeze would come, / Or humble flowers anticipate / The insect's noonday hum... .
It is the picture of peace. Don't believe it. Just below the brilliant spatter of green, yellow, purple and orange are scenes of wanton violence that often end in sudden death. A spider, its eyes glinting in the light, feels movement and gnashes its jaws in anticipation, waiting to ambush a meal. A nearby grasshopper inches along, calmly munching on grass and a wildflower, unaware of its fate.

It won't be long.

Or maybe it will. The grasshopper feels something, too, and stops its forward progress. Like a human being about to confront a predator of the same species from around the corner, the insect starts behaving in a way we'd find very familiar. Inwardly and outwardly, the grasshopper seems to be afraid.

Dror Hawlena, a Gaylord Donnelley Environmental Postdoctoral Associate at the School of Forestry & Environmental Studies (F&ES), is piecing together how grasshoppers react to spiders, arachnid "monsters" intent on making a meal of insect prey. The grasshopper's physiological response to potential doom is, perhaps surprisingly, "quite similar to our own," says Hawlena. "Grasshoppers may have different glands, but their stress reaction involves the same hormones and endocrine mechanisms found in humans. In fact, you see this in all vertebrates—and we're now finding it in invertebrates, too. It's one of the most fundamental responses, and the most critical. If you can't respond quickly in an emergency, you die."

That response, it turns out, is critical in another way. "How a grasshopper avoids a predator can lead to the transformation of an ecosystem," says Oswald Schmitz, Oastler Professor of Population and Community Ecology. Schmitz, who oversees Hawlena's research, along with that of numerous graduate students and undergraduates, is a pioneer in an effort to understand how fear and other so-called nonconsumptive effects (NCEs) help determine the species composition, functioning and structure of the natural world.

At its most basic, Schmitz's work, now in its 17th year in the meadows of the Yale-Myers Forest, involves monitoring and recording what happens during the summer in a series of screened-in cages, each roughly one square meter in area and one meter high. Inside these microcosms, various combinations of spiders, grasshoppers and plants go about their business.

"This is a wonderful model system," says Schmitz. But, he quickly adds, the research is about much more than the natural history of the organisms that he and his colleagues have had under consideration since 1993. "What we're getting out of these small enclosures are broad conceptual insights that we can apply to much larger systems."

Natural resource managers and policymakers alike can use fear factors and other NCEs to predict, with a much greater degree of accuracy than has previously been possible, what our impact on the planet might be. Taking these fundamental but, until recently, overlooked processes into account can, says Schmitz, lead to better ways of carrying out such seemingly unrelated projects as the management of timber harvests in the boreal forests of Canada, the reintroduction of wolves and other top predators to the national parks and the implementation of biological control programs in agriculture.

"You want to avoid unintended consequences," says Schmitz. For example, when wolves were brought back to Yellowstone, one impetus, besides the restoration of a missing part of the ecosystem, was to put the brakes on an overabundance of elk. However, things didn't work out quite as planned. To be sure, the wolves killed prey, but in short order the elk dealt with their newfound fear of predation by changing their feeding patterns and moving away from the more open range areas.

"Elk are important for maintaining the species diversity and productivity of grasslands," says Schmitz. "There's evidence that both declined after the wolves were brought back."

That evidence was clearly present in the enclosures in the Yale-Myers meadows. But instead of wolves, which were in short supply in Connecticut, Schmitz worked with *Pisaurina mira*, the nursery web spider and a dominant predator in the meadows. There were other spiders haunting the grasses, but *P. mira*, which employs a sit-and-wait hunting strategy, was simply the one he encountered first when he began his work. "Choosing it turned out to be pure serendipity," he recalls.

The most common grasshopper in the field, and the one Schmitz used in the research, was a red-legged species known as *Melanoplus femurrubrum*. Its favorite food is Kentucky bluegrass (*Poa pratensis*). The insect was less inclined to eat goldenrod, which was also very common, or a variety of wildflowers, such as Queen Anne's lace, that flourished in the area and were well-represented in the enclosures.

When he started tallying up his initial results, he noticed something odd. "The spiders had no net effect on prey density," Schmitz explains.

If the predators weren't eating many of the herbivores, then there shouldn't have been much difference between the enclosures that contained spiders and grasshoppers and those with grasshoppers alone. But he found measurable changes in prey behavior when spiders were present, and, by the end of the season, there were significant differences in the diversity and abundance of grassland plants between the two kinds of enclosures. The spiders, he said, were leaving a "predation signature."

Schmitz had stumbled upon the unexpected ecological consequences of a landscape of fear.

"Many biologists grew up viewing prey simply as animals waiting to be eaten, and if you didn't get eaten, you were fine," says Evan Preisser '98, an assistant professor in the Department of Biological Sciences at the University of Rhode Island and a co-editor of a 32-page special feature on NCEs in the September 2008 issue of the journal *Ecology*. "But that's akin to saying that if you were in a mall when a fight broke out and someone got shot, you were okay as long as you weren't hit. In reality, even though this had no direct impact on you, it probably would have terrified

Left to themselves, the grasshoppers would rather spend their time munching on nitrogen-rich grass that stimulates their own growth and reproduction, as well as results in high-quality fertilizer. But with spiders in the picture, their stress increases and their diet changes.

Bob Handelman

you and, as a result, caused you to make all sorts of changes in your life. And if everyone present that day reacted the same way, even small changes in behavior manifested over a large population could have profound and unexpected effects. NCEs are, in essence, the wages of fear. The genius of Os' work is that it gives us a much more nuanced view of reality."

In the enclosures that had spiders, the grasshoppers changed both what they ate and when and where they ate it. *P. mira* is typically most active early in the day, but when the spiders and the grasshoppers were together in the cages, the potential prey shifted its peak activity and feeding period from morning to midday. The grasshoppers also tended to congregate in the relative safety of the upper reaches of the goldenrod. These tactics helped the insects avoid their predators, but at a cost—the increased risk of stress, sometimes fatal, from the heat. In addition, the spider-confronted grasshoppers ate considerably less of the bluegrass they preferred and turned more to the goldenrod and the wildflowers.

By the end of the summer, the minimeadows without spiders had different plant communities than those with resident arachnid predators. In the former, goldenrod, which can dominate its competition, held down the abundance and diversity of the grasses and wildflowers, such as clover, black-eyed Susan and wild strawberry. But where the nursery web spiders sat patiently and waited for a grasshopper meal, there was less goldenrod and a greater variety of the other plants.

This pattern held even in enclosures that contained spiders whose jaws had been glued shut by the researchers so that they could no longer hunt. The fear they continued to strike in their prey was enough to push the stressed grasshoppers into predator-avoidance mode—and the plant community into an altered state. (The operation, by the way, requires a gentle touch—the spider is held between two soft sponges while a dab of super glue is squirted between the jaws. This experimental strategy is possible only because nursery web spiders can go as long as two months between meals without starving to death.)

Schmitz looked at results he called "counterintuitive" and scratched his head. "If you're not losing grasshoppers to predation, how can the spiders be affecting the plants?" he asked.

Then came an "Aha!" moment—the result, ironically enough, of a graduate school research project in behavioral ecology—and a bitter disappointment. A Canadian by birth, Schmitz started his research career in the late 1970s at the University of Guelph, where he studied the foraging behavior of deer and evaluated whether supplemental feeding programs were cost-effective. As a doctoral student at the University of Michigan, he examined deer foraging from an economics viewpoint, using a then-promising analysis tool called portfolio theory, to see whether deer were maximizing their returns by "investing" in a broad portfolio of food items that would minimize the risk of starvation.

"Unfortunately, by the time I finished my doctorate in 1989, this approach had been eclipsed by people interested in how avoiding the risk of predation shaped the behavior of animals," says Schmitz. "I vowed to get out of behavioral ecology."

But a landmark 1989 paper in *Ecology* by Thomas Schoener, a University of California at Davis community ecologist, changed his mind. Schoener, whom Schmitz calls his "academic grandfather," and his colleague David Spiller looked at what happened to the animal and plant life on small islands in the Bahamas when the researchers manipulated the number of lizards present in experimental enclosures. The lizards preyed on web-building spiders, which, in turn, preyed on insects. Changing the number of lizards present not only had a direct impact on the spiders, but it also had an indirect effect on prey insects and the plants they consumed.

"The Schoener paper showed the value of looking at predators not just in terms of their interactions with prey, but also in terms of the myriad effects they could have in ecological communities of carnivores, herbivores and plants," says Schmitz. "It offered me a way toward a more holistic perspective of entire systems."

Aquatic biologists such as Bobbi Peckarsky, then at Cornell University, had documented various aspects of these so-called "trophic cascades" in streams while investigating the interactions of trout, stoneflies and mayflies. But in the early 1990s, Peckarsky explained that her work and other aquatic studies like it weren't commonly on the radar screens of terrestrial ecologists, who were still enmeshed in research about the direct effects of predation. "Os was the exception," she says.

Schoener's findings in the Bahamas and Schmitz's conversations with Peckarsky and others provided "the impetus to get into food web work," Schmitz says. Still, when he came to Yale in 1992, there was considerable doubt that indirect effects played a significant role in shaping terrestrial systems. "But no one had really looked," he says.

The more Schmitz pondered his early results, the more he realized that the changes he observed in the grassland plants were not the direct result of prey being consumed and, thus, of there being fewer hungry herbivores in the meadow. Rather, he had documented an indirect effect: a predator causing a shift in prey behavior that, in turn, cascaded through the plants, as the grasshoppers switched to a less nutritious, but safer, diet.

This discovery and years of subsequent refinements of the key role played by what are now known as "trait-mediated interactions"—think, fear—almost didn't happen. And here's where serendipity came in. There's another common spider in the meadow: *Phidippus rimator*. This jumping spider is an active predator, always on the hunt, and, unlike its sit-and-wait co-conspirator, never lingers in the same place for long.

When Schmitz examined this hunter's impact in the enclosures on grasshoppers and in grasslands alike, he got different results. *P. rimator* knocked down prey numbers considerably, so there were fewer grazers to munch down the bluegrass. But because it was impossible for the grasshoppers to determine where this predator was, the prey didn't shift its behavior and diet toward the goldenrod and wildflowers.

Goldenrod is the dominant competitor in the meadow, and without herbivores to keep it somewhat in check, it eventually overshadowed its fellow plants. Paradoxically, fewer grazers resulted in lower species diversity.

"Had I started working with the jumping spiders, I might never have encountered the behavior-shift story," says Schmitz.

And he and Hawlena might never have become interested in looking at fear factors. The researchers already knew that grasshop-

If there's no escape from a spider—Schmitz and Hawlena modeled this in field and laboratory setups, but it could easily happen in nature if spiders or any other predator, for that matter, were especially abundant—the grasshoppers do something else familiar. They crave carbs.

pers reacted to the presence of a sit-and-wait spider by changing their behavior and moving elsewhere. The situation is very similar to what a human would do when walking down a dark street in a less-than-sterling neighborhood—first chance you get, you cross over to a seemingly safer and lighter location rather than stroll by that creepy-looking character hanging out on the corner.

"We don't understand how grasshoppers detect the location of the spider," says Hawlena, "but when we subject them to the risk of chronic predation, they react just like we would."

Hawlena placed each overwrought insect inside a metabolic chamber—a transparent cylinder about 3.5 inches long and three-quarters of an inch in diameter—used to measure carbon dioxide output. "They breathe faster and their metabolism increases," he explains.

If there's no escape from a spider—Schmitz and Hawlena modeled this in field and laboratory setups, but it could easily happen in nature if spiders or any other predator, for that matter, were especially abundant—the grasshoppers do something else familiar. They crave carbs.

"Stressed grasshoppers need more energy," says Hawlena, "and they get it from eating more goldenrod."

Left to themselves, the grasshoppers would rather spend their time munching on nitrogen-rich grass that stimulates their own growth and reproduction, as well as results in high-quality fertilizer. But with spiders in the picture, their stress increases and their diet changes. "Their immediate needs become more important than the future," says Hawlena.

They head for the goldenrod, whose chemistry—the carbon-to-nitrogen ratio is tilted toward carbon—provides the grasshoppers with the increased carbohydrates they require. So the insects cope with the metabolic demands of stress, but, according to research currently being reviewed for publication, there's literally no free lunch. Grasshopper mothers stressed out by chronic predation risk having offspring that are 15 percent smaller than those of mothers living in spider-free zones. Also, mothers in the risk zone produce kids with poorer jumping ability. "This results in offspring that are more vulnerable to predation," says Schmitz.

There's another cost, as well—this one to the meadow. When it comes to fertilization, nitrogen trumps carbon. Compared to their grass-fed, living-is-easy counterparts, grasshoppers on the high-carb, anti-stress diet produce excrement that is harder to break down and less nutritious for plants. Grasshopper bodies even reflect this change in diet; in death, the corpses containing higher carbon don't offer the premium fertilizer benefits of those that had more nitrogen in them.

Schmitz estimates that grasshoppers, living and deceased, contribute between 5 and 10 percent to a grassland's overall nutrient budget. So more spider-induced herbivore pressure on the goldenrod can not only alter the diversity and abundance of plant species in the meadow ecosystem, it can also result in poorer fertilizer. This, along with changes in the composition of the leaf litter and the soil bacteria, may eventually change the kinds and amounts of minerals available in the ground—and the varieties of plants and animals that can thrive.

And so, says Schmitz, "being scared to hell can significantly change an ecosystem's nutrient budget and transform the way it looks and functions."

Schmitz has synthesized nearly two decades of experimental and theoretical work in *Resolving Ecosystem Complexity*, a Princeton University Press book, due out this summer. "The beauty of this work is that with the insights we've gathered, we can predict what an ecosystem will look like if we change it in some important way," he says.

In the vast boreal forests of Canada, one company is already putting these insights into practice. Mistik Management oversees the planting and harvest of softwood trees on the company's nearly 4.5 million acres of land in northwestern Saskatchewan. The typical logging operation, says Schmitz, who has worked with Mistik, involves clear-cutting and then replanting primarily with white spruce saplings. But there's always been a problem with this strategy. "Aspen trees tend to come back first in a clear-cut and choke off spruce growth," he says.

Based on his work in the enclosures, Schmitz had an idea. While moose and deer did a fine job of grazing aspen sprouts, the herbivores largely avoided young spruce, which are filled with noxious chemicals. But with wolves frequenting the clear-cuts, the fear-filled moose and deer stayed far away.

In an experiment, which involved acres instead of meters, Schmitz compared clear-cuts with areas in which Mistik cut most of the timber but left patches of standing trees. "These became refuges for the moose and deer," he says.

The herbivores tended to avoid the open areas, and even when they entered they were ineffective at keeping the aspen out. Not so when there were refuges. "By changing the way we harvested the landscape, we were able to let nature effectively manage for us," says Schmitz. "And at no real cost."

Mistik has since adopted the refuge technique. For this company, looking for a more sustainable way to manage its resources, the landscape of fear has become a landscape of opportunity.

YIBS Center for Field Ecology:

SUPPORTING FIELD BASED RESEARCH AND TEACHING IN ECOLOGY AND THE ENVIRONMENTAL SCIENCES

The Yale Institute for Biospheric Studies (YIBS) Center for Field Ecology (CFE) supports field-based research and teaching in ecology. CFE was founded in 2002 to help Yale become a world leader in ecology. Major initiatives include a Pilot Grant Program to support graduate student research in ecology, initial support for a climate change experiment in Connecticut salt marshes, long-term sampling of Long Island Sound, and efforts to improve the research facilities on Yale University's natural lands. Research supported by CFE bridges five academic units and has addressed topics as diverse as the evolution and ecology of the mosquitoes that spread dengue fever, the responses of mammals to climate change at the Paleocene-Eocene boundary, and the retention of heavy metals in the wetlands of New England. CFE support for teaching has exposed a generation of undergraduate and graduate students to an experiment that tests the influence of climate change on New England's salt marsh ecosystems.

Pilot Research for Graduate Students

The CFE Pilot Research Grants Program was created to help early career PhD students to explore field ecology projects of their own choosing and gather the pilot data required to justify external funding. Research on "field ecology" is defined broadly to include field-based projects that draw from behavior, ecology, evolution, epidemiology, paleontology, and related fields. Since 2002, the Pilot Research Grants' program has supported the research of 94 graduate students from five academic units: Anthropology, Ecology & Evolutionary Biology (EEB), Epidemiology & Public Health (EPH), Geology & Geophysics (G&G), and Forestry & Environmental Studies (F&ES).

The diversity of research funded by Pilot Grants is amazing. The first four cohorts of 48 students funded from 2002–2005 have graduated and many have jobs in academia and resource management. They include: Michael Muehlenbein (Anthropology, PhD 2004), an assistant professor at Indiana University; Erika Edwards and Cassy Dunn (both EEB, PhD 2005), who are assistant professors at Brown University; Mark Urban (F&ES, PhD 2006), an assistant professor at University of Connecticut; Nathan Havill (EEB, PhD 2006), a research scientist with the USDA Forest Service; John Vanden Brooks (G&G, PhD 2006), an assistant professor at John Hopkins University; Eric Palkovacs (EEB, PhD 2007), a visiting assistant professor at Duke University; Manja Holland (F&ES, PhD 2008), the research programs officer for the Graham Institute at the University of Michigan; and Annika Walters (EEB, PhD 2008), a National Research Council postdoctoral fellow with the National Marine Fisheries Service.

In 2009 and 2010, CFE funded 14 graduate student pilot projects. Among them, Elisabeth Forrestel (EEB) is using phylogenetic and functional approaches to test the relationship between biological diversity and ecosystem function in grasslands. Troy Hill (F&ES) is testing how salt marsh deterioration and erosion influences the retention of heavy metals in salt

marshes in Long Island Sound. Andrew Jones (EEB) is testing the effects of intraspecific completion on the niche breadth of juvenile anadromous alewife, a federally listed species of conservation concern. Katy Richards-Hrdlicka (F&ES) is studying genetic variation in a fungal pathogen, Batrachochytrium dendrobatidis, that has been implicated in the decline of amphibians on five continents. Thomas James (F&ES) is studying the influence of climate and fire on forest development in Mongolia. Derek West (EEB) is testing how climate change and nutrients alter the trajectory of ecosystem development in lakes.

Hands-on Experience for Undergraduate Students and Research Platform for Climate Change

In 2005, CFE funded the construction of a rainfall exclusion experiment in a coastal salt marsh located at the Richards Property, Guilford (part of the Yale University natural lands). The experiment was designed by Melinda Smith (EEB) and Peter Raymond (F&ES) to assess the effects of climate change, in particular changes in precipitation amounts, on coastal salt marsh ecosystems. From its inception, the experiment has been maintained as a long-term platform for both research and teaching in EEB and F&ES. Recently, Dr. Smith and colleagues received funding from the Yale Climate and Energy Institute to expand upon this research. They are currently establishing a new experiment at the Richards Property, as well as five other sites along the Connecticut coastline. The experiment will examine the impacts of two aspects of climate change—warming and altered precipitation amounts—on the ability of salt marsh ecosystems to keep pace with sea level rise. Specifically, the experiment will measure how warming and reduced precipitation impacts salt marsh sediment accretion rates and above and below-ground productivity. These two processes are critical for allowing salt marsh ecosystems to increase in elevation over time with rising sea level, and thus prevent their loss via inundation. Understanding of how climate change impacts sediment accretion rates and productivity is poorly understood, and this research will be among the first to examine how climate changes may impact these processes. As with the previous experiment, this new experiment will serve as a long-term platform for research and teaching in EEB and F&ES.

Long Island Sound Project

A YIBS CFE funded team is measuring several key indicators of ecosystem function and marine ecosystem health in Long Island Sound. The research team includes Dr. Raymond, Dr. Mary Beth Decker (EEB), Dr. Paul Turner (EEB), Dr. Ellen Thomas (G&G), graduate students from F&ES, undergraduate students from Yale College, and collaborators from the University of Connecticut. The goal is to build a time series that will provide new insight into short and long-term changes in the health of the Northeast's largest estuary. Sampling is conducted approximately 14 miles southeast of New Haven Harbor at the University of Connecticut's Central Sound Buoy, which is moored to the seafloor in 90 feet (27 meters) of water. Measurements include high-frequency monitoring of nitrate, a critical nutrient, using an in situ optical sensor permanently deployed aboard the Central Sound Buoy; weekly sampling of jellyfish and zooplankton populations; collection of benthic microorganisms (foraminifera) for population studies and paleoceanographic proxy development; and isolating and studying the evolutionary ecology of *Caulobacter crescentus* bacteria. Sampling is also conducted for several other indicators of ecological and biogeochemical importance.

In addition to this research at the Buoy, Decker and Raymond teamed up with Jamie Alonzo and the Yale Peabody Museum's EVOLUTIONS After School Program (EVOking Learning & Understanding Through Investigations Of the Natural Sciences) to produce an interactive museum exhibit focused on the Long Island Sound. For this project, the high school students worked in groups to research topics related to pollution, food webs and fisheries. In collaboration with video game designer Kent Golden and simulator designer Ginger Booth, students helped design an interactive game called "Race to the Lighthouse," in which student-produced videos were used to teach concepts related to the health and conservation of Long Island Sound. In addition, an interactive kiosk equipped with a barcode scanner allowed visitors to scan and learn about items and ani-

Professor Peter Raymond checking equipment on the University of Conneticut MYSound Project Central Long Island Sound Buoy.

Samatha Atwood

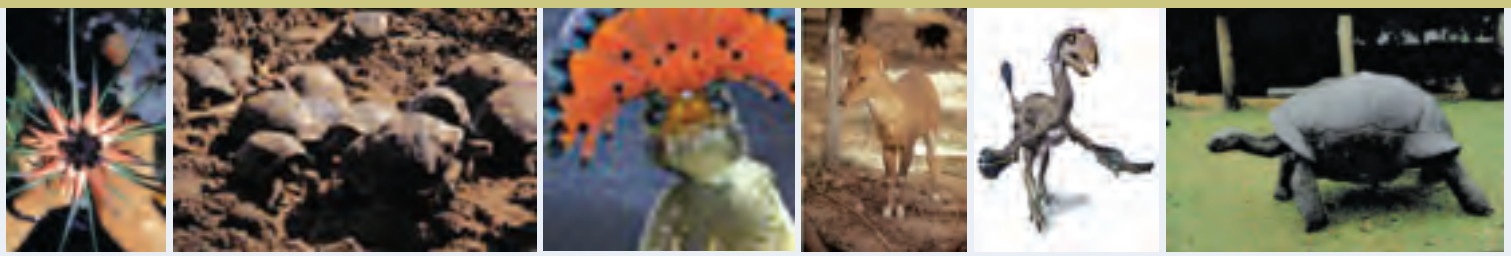
Katy Richards-Hrdlicka, Doctoral Candidate, F&ES, searching for amphibians at the White Memorial Conservation Center in Litchfield, CT.

mals encountered in coastal Connecticut. The kiosk and game are currently on display at the Peabody Museum on the third floor near the Connecticut dioramas.

Yale Natural Lands

Yale University owns natural lands from salt marshes along Long Island Sound to forest land in northern Vermont. CFE administers a number of small parcels of land including property at Linsley Pond, where Yale researchers and students have studied limnology since the 1930s; Bethany Bog, which is a glacial kettle lake with a unique flora that has lain neglected for years and is under some threat from local dumping; and a tract of about 200 acres next to the Yale Golf Course, which is mostly used by locals for recreation. Linsley Pond is used for research by Dr. David Post (EEB), Dr. Peter Raymond and Dr. Gabe Benoit (F&ES); and by Dr. David Skelly (F&ES) for teaching Aquatic Ecology. In recent history, researchers have accessed Linsley Pond from a beach owned by the Linsley Lake Association. In 2008, David Post secured the money to re-establish access to Linsley Pond through Yale University property at the north end of the lake. The Linsely Pond property now has a parking area, storage shed, and a dock which allows greatly improved access to Linsley Pond for research and teaching.

For further information you may contact Professor David M. Post, the director of CFE, or visit the CFE Web site at *www.yale.edu/cfe*



YIBS Center for Ecology and Systematics of Animals on the Verge of Extinction (ECOSAVE)

One of the original Centers supported by the Yale Institute for Biospheric Studies (YIBS) is the Center for ECology and Systematics of Animals on the Verge of Extinction, ECOSAVE. This Center was founded and directed by Professor Elisabeth Vrba (G&G) since its inception in 1992. A new director, Professor Jeffrey R. Powell (EEB) will assume leadership of ECOSAVE on July 1, 2010. This YIBS center has been the major YIBS initiative explicitly centered on conservation of biodiversity, a prime focus of YIBS, as well as being the only conservation research organization based in Yale College.

In the transition of directorship, Powell envisions refocusing ECOSAVE to emphasize international work directed toward conservation biology. Given that the vast majority of endangered biodiversity exists outside the US, this emphasis is only natural. This "internationalization" also fits well with the University's efforts in globalization. Indeed, Powell notes that the science being done in the international arena at Yale is extremely widespread and diverse, but has not yet been particularly highlighted in Yale University's expanding footprint in global and international studies. He hopes this newly re-oriented YIBS center will help emphasize and bring to the fore the global science being done at the University.

Another change in the workings of the Center will be to open it up to all Yale research-

ers with interests in biodiversity studies, especially those centered in Yale College. The plan is to put in place a small granting program to support international biodiversity studies being done by Yale faculty, staff, and students. These funds could be used for students to spend time abroad to initiate a research program, or to bring a colleague from abroad, especially those from biodiversity "hotspot" countries, who want to explore collaboration with a Yale-based laboratory. Shortly, a small committee of interested individuals will be formed to flesh out the new vision and workings of ECOSAVE.

While it is a difficult time financially to undertake new initiatives, YIBS Director Jeffrey J. Park sees the YIBS research centers as important mechanisms for seeding new ideas and new projects, helping to sprout research ideas to develop stronger funding proposals to outside agencies or foundations, or to support fully the kind of research project whose expenses are indeed modest.

Both the YIBS Director Park and new ECOSAVE Director Powell would like to acknowledge the leadership displayed by Professor Vrba for having the imagination and foresight to initiate a conservation-based center at a time when biodiversity studies were in their infancy, as well as her strong leadership over the past 18 years. Several important research projects have been supported by ECOSAVE during this time, including work on African mammals, Galápagos reptiles, South American birds and plants, and Antarctic fish. In addition, ECOSAVE supported the publication of a book (*Deer, Antelopes, Giraffes, and Relatives: Past, Present and Future*), organized a highly successful symposium in 2009, and founded the YIBS Molecular Systematics and Conservation Genetics Laboratory, which has now taken on a life of its own.

EEB STUDENTS AWARDED NSF GRADUATE FELLOWSHIPS

In April 2010, five graduate students in the Department of Ecology & Evolutionary Biology (EEB) were awarded the prestigious and highly competitive National Science Foundation Graduate Research Fellowships. The awards cover full tuition and stipend for three years. The new EEB award winners were:

Karin Burghart, an incoming EEB graduate student from the University of Delaware with an interest in botany and ecology.

April Dinwiddie, first year EEB graduate student from Mount Holyoke College with interests in insect development and evolution.

Teresa Feo, a first year EEB graduate student from the University of California Berkeley with interests in behavioral and morphological evolution of birds.

Andrew Jones, a second year EEB graduate student from Cornell University with interests in fresh water lake ecology.

Jacob Musser, first year EEB graduate student from the University of Minnesota with interests in development, molecular evolution, and the evolution of novelty.

These five awardees will join our current EEB NSF graduate fellows Jerome Weis and Kim LaPierre. An additional NSF Graduate Research Fellowship was awarded to graduating Yale EEB major Sonia Singal '10. Singal also received a two-year Fulbright Fellowship to study viral evolution in Montpellier, France, and will start her NSF fellowship at the Washington University in St. Louis in 2012.

BASS SCHOLARS


de QUEIROZ


OLSON


RICHARDS

THREE BASS DISTINGUISHED VISITING ENVIRONMENTAL SCHOLARS TO SERVE IN THE SPRING 2011

Jeffrey Park, director of the Yale Institute for Biospheric Studies (YIBS), is pleased to announce the appointment of three Edward P. Bass Distinguished Visiting Environmental Scholars during the spring 2011 semester.

DR. KEVIN de QUEIROZ

Dr. Kevin de Queiroz, Curator of Amphibians and Reptiles at the National Museum of Natural History, Smithsonian Institution, will serve as an Edward P. Bass Distinguished Visiting Environmental Scholar in the Department of Geology & Geophysics (G&G) during the spring semester of 2011. He will be in residence from February 1, 2011 to April 30, 2011.

Dr. de Queiroz was nominated by Professor of Geology & Geophysics Jacques Gauthier. He has made exceptional contributions to several areas of evolutionary biology and is a leading figure in the field of systematic biology, having produced diverse and significant works on the theory, methods, history, and philosophy of phylogenetic inference that have altered the landscape of the discipline. For example, he clarified thorny ontological and epistemological issues on the nature of the entities that can participate in the evolutionary process. His influential work on species concepts in particular will be of broad interest to the departments of G&G, Ecology & Evolutionary Biology (EEB), Anthropology, YPM and at the School of Forestry & Environmental Studies (F&ES) and the Yale Peabody Museum of Natural History, as a number of faculty and students at Yale wrestle with the "species problem" on daily basis. To these accomplishments must be added his conceptual and organizational leadership of the PhyloCode project, which promises to revolutionize how biologists communicate the results of their discoveries about biodiversity.

Although often thought of as being primarily a theorist, Dr. de Queiroz's CV speaks no less forcefully to his many and varied empirical contributions. He works with equal facility on fossil and recent vertebrates, but focuses primarily on extant reptile evolution using cutting-edge morphological and molecular techniques. He has even made interesting contributions to the study of amphibian reproductive biology and lizard feeding ecology, ecomorphology, and island biogeography, as well as having produced the standard checklists, dichotomous keys, and species descriptions of the alpha taxonomist. He also has an active field program

Professor Gauthier notes that "Kevin de Queiroz is a world-class curator, systematist, vertebrate morphologist, herpetologist, and evolutionary theorist, and we look forward to having him at Yale as a Bass Scholar."

DR. LINK OLSON

Dr. Link Olson, Curator of Mammals and Acting Curator of Ethnology and History University of Alaska Museum, will serve as an Edward P. Bass Distinguished Visiting Environmental Scholar in the Department of Anthropology, during the spring 2011 semester. Dr. Olson's research on molecular phylogenetics, phylogeography, and biogeography is of interest to several faculty in Biological Anthropology notes Professor Eric Sargis, who nominated Dr. Olson. Dr. Olson will work with Professor Sargis and his colleagues professors Richard Bribiescas, Brenda Bradley, David Watts, and Andrew Hill in Anthropology.

Also, Professors Richard Prum and Thomas Near from EEB are enthusiastic about having Dr. Olson at Yale. In addition, because of his research on systematics, Professor Jacques Gauthier would like him to discuss mammalian molecular phylogenetics in the Systematics Discussion Group (SDG).

While at Yale, Dr. Olson plans to participate in a seminar-reader-tutorial workshop on issues related to phylogeography, taxonomy, species limits, and collections-based research that will be of interest to several students, including those working and volunteering at the Peabody Museum. Dr. Olson will serve as a Bass Scholar from March 14, 2011 to May 7, 2011.

DR. PAUL RICHARDS

Dr. Paul Richards, Professor of Technology and Agrarian Development at Wageningen University, Department of Social Sciences, Technology & Agrarian Development Group, was nominated as a Bass Scholar by William Kelly, Sumitomo Professor of Japanese Studies in the Department of Anthropology. Professor Richards will be in residence in Anthropology from January 1, 2011 to June 30, 2011.

Richards, an anthropological commentator and researcher on agricultural technology and African farming systems, has worked in Sierra Leone for over thirty years, conducting ethnographic studies of Mende village rice farming systems and forest conservation on the Liberian border. After the region became affected by the Sierra Leone civil war (1992–2002), he turned to analysis of that conflict and has written more widely on the anthropology of armed conflicts.

In his work on agriculture, Richards argues, following Durkheim, that human technique and skill underpins human action and institutional change, and began by examining everyday livelihood activities like farming. He coined the term "agriculture as performance" based on years of observing the reflexivity of African farmers and their responses to stress and risks, and drawing on his own skills and interest in musical perfor-

Peter and Rosemary Grant to Serve as Bass Distinguished Visiting Environmental Scholars in The Department of Ecology & Evolutionary Biology

Peter and Rosemary Grant, British evolutionary biologists, will serve as the Edward P. Bass Distinguished Visiting Environmental Scholars during the fall 2010 semester. The Grants are emeritus professors at Princeton University and are noted for their work on Darwin's finches on the Galápagos Island named Daphne Major. They have spent six months of the year each year since 1973 capturing, tagging, taking blood samples, and releasing finches from the islands, and were the subject of the book *The Beak of the Finch: A Story of Evolution in Our Time by Jonathan Weiner* (Alfred A. Knopf, 1994), which won the Pulitzer Prize for General Non-fiction in 1995.

In 2003 the Grants were joint recipients of the Loye and Alden Miller Research Award, and won the 2005 Balzan Prize for Population Biology.

Peter was made a Fellow of the Royal Society in 1987 and Rosemary in 2007. In 2008 both Peter and Rosemary Grant were among the thirteen recipients of the Darwin-Wallace Medal, which is bestowed every 50 years by the Linnean Society of London. In 2009 they were recipients of the annual Kyoto Prize in basic sciences, an international award honoring significant contributions to the scientific, cultural and spiritual betterment of mankind.

They will serve as Bass Scholars from September through December in the Yale Department of Ecology & Evolutionary Biology.

mance. His populist faith in African farmers to survive and prosper, despite the magnitude of the risks they faced, was set out in *Indigenous Agricultural Revolution* (1985).

Fighting for the Rain Forest (1996) showed how the involvement of youth in Sierra Leonean rebel movements had little to do with widely perceived "barbarism" of rebel groups in resource-rich regions. War is, also, part of a "performance" with its origins in history, social orders, and human agency. The widely held "New Barbarism" theories of Robert Kaplan and others had suggested abundant natural resources, like Sierra Leone's diamonds, were a magnet for human greed and civil conflict. Instead, Richards has argued the involvement of youth in the Revolutionary United Front rebel movement was a form of social resistance to patrimonial rule in Sierra Leone, did not appear to have a strong underlying motive of greed (for the diamond revenues), and was a considered response rather than a spontaneous, "barbaric" movement. Grievances were partly responsible for the violence that undoubtedly did afflict Sierra Leone during its civil war and for which the Revolutionary United Front was partly responsible. Richards has advised aid and humanitarian agencies on African post-war reconstruction, demobilization and skills-training.

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

Design: Yale *Printing & Publishing Services*
Maura Gianakos

Assistant Editor
Rosemary Volpe

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