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Layers of history are revealed as traditions realign in the Philippine highlands.

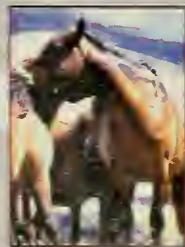
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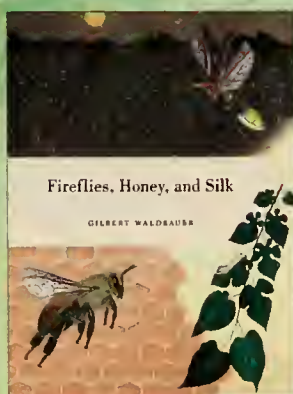
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ON THE COVER: Staghorn beetle (*Cyclommatus pulchellus*) atop leaf litter in New Guinea
Image by Mark Moffett/Minden Pictures

UNCOVERING NATURE



Fireflies, Honey, and Silk

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DOUGLAS PALMER

Illustrated by Peter Barrett

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Arachnids

JAN BECCALONI

With around 11 distinctive lineages and over 38,000 species of spiders alone, arachnids are amazingly diverse. Most books about arachnids focus on spiders, neglecting scorpions, ticks, mites, and other fascinating yet poorly understood groups. Beccaloni summarizes existing knowledge about each major type of arachnid.

Rewilding the West

Restoration in a Prairie Landscape

RICHARD MANNING

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—Candace Savage, author of *Prairie*



The Great Dinosaur Discoveries

DARREN NAISH

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Dinosaur Odyssey

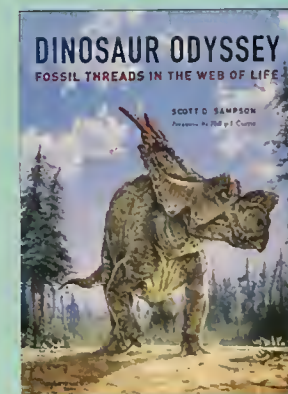
Fossil Threads in the Web of Life

SCOTT D. SAMPSON

Foreword by Philip J. Currie

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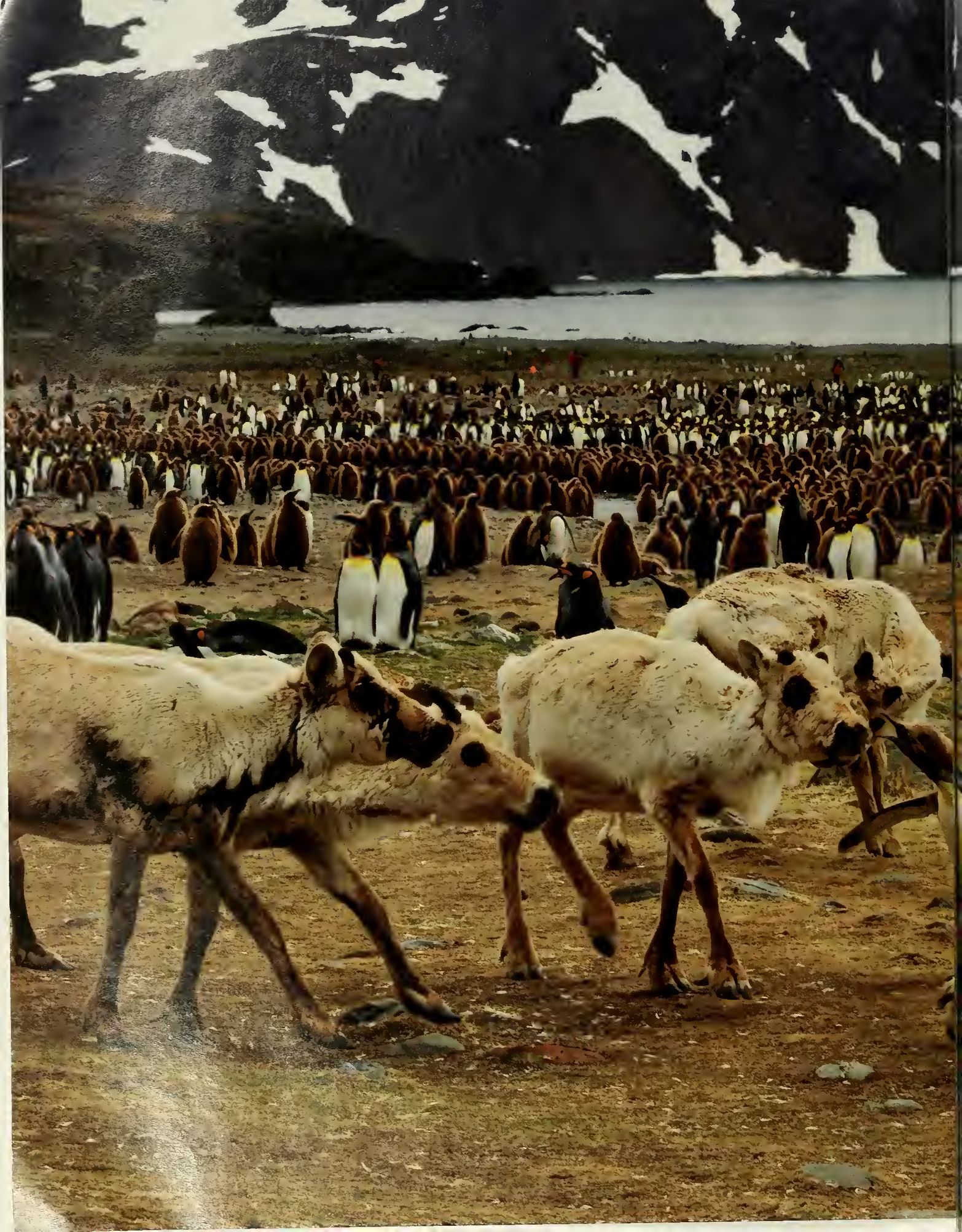
—Peter Dodson, author of
The Horned Dinosaurs



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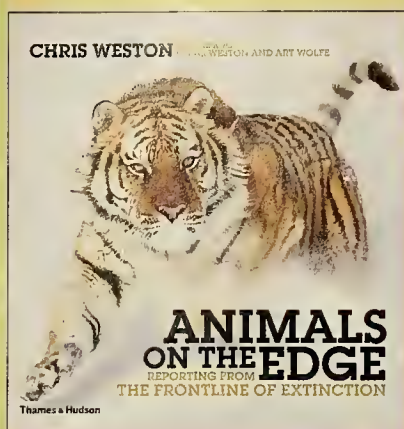
A photograph capturing a dramatic moment in nature. In the foreground, a reindeer with light brown fur and small antlers is running towards the right. The ground is a mix of dirt, grass, and rocks. In the middle ground, a vast colony of penguins, mostly with brown downy feathers, is spread across the landscape. A few adult penguins with black and white plumage are also visible. In the background, a large, rugged mountain with patches of snow rises under a clear sky.

THE NATURAL MOMENT

NIPPED IN THE BUCK

Photograph by Art Wolfe

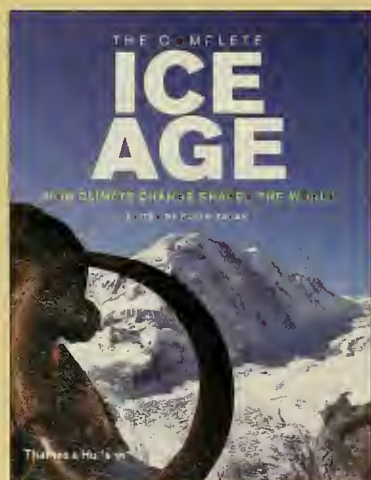
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THE NATURAL EXPLANATION BY ERIN ESPELIE

Just as no man is an island, no island touched by man can be an island entirely of itself. Think of Hawaii and New Zealand, if not Mindanao, Majorca, and the Isle of Man. Even the remote and icy landmass of South Georgia, a British territory in the South Atlantic Ocean, bears the mark of people. Exhibit A: Ancestors of the reindeer pictured here arrived aboard Norwegian whaling vessels in the early twentieth century—and thrived . . . mostly.

South Georgia, situated roughly 1,300 miles east-southeast of South America, first felt the tread of man-made soles in 1775, when Captain James Cook came ashore. Not long after, sealers and whalers began stopping, and brought the pitter-patter of brown rats' feet (Exhibit B).

Relocating reindeer was a more deliberate effort, an attempt to establish a permanent supply of home-style grub for wayfaring Nordic seamen. The hoofed pilgrims came in three waves—ten animals in 1911, five in 1912, and seven in 1925. Each boatload was put out to graze in a separate and isolated locale. In 1918 an avalanche wiped out one herd, but the other two, in Husvik and Ocean Harbor, now total 2,000 individuals.

Photographer Art Wolfe, who says his absolutely favorite place on the planet to photograph is South Georgia, visited King Edward Point and the one-time whaling hub of Gryt-viken three Decembers ago. Nearby he saw a reindeer, of the Ocean Harbor herd, steer a little too close to the rookery of a feisty juvenile king penguin. The penguin, secure



Juvenile king penguins

in the thick of a colony numbering in the hundreds of thousands, prevailed; the reindeer swerved and moved on to feed with its herd.

Although reindeer don't seem to faze king penguins, they do affect other birds. They vacuum up vegetation, promote erosion, and tromp upon birds' nests. British Antarctic Survey scientist Anthony R. Martin recently completed a study of how white-chinned petrels fare under the reindeer's reign. He found that reindeer thin out native tussac grass, forcing the white-chins from their preferred nesting sites.

As for how the island's varied vegetation might rebound without reindeer, another 2009 study offers a hint. Near the other pole, on St. Matthew Island in the Bering Sea, where nonnative reindeer once roamed, munched, and multiplied, botanists looked at lichen regrowth. Even though more than forty years have passed since winter starvation killed off the reindeer, lichen biomass lags about 88 percent behind that on an adjacent island that has always been reindeer free.

By Martin's estimate, "literally millions more seabirds are likely to breed on South Georgia if introduced mammals are removed."

Over the course of his thirty-year career, photographer **Art Wolfe** has worked on every continent and snapped an estimated one million images. Some of those have appeared in his sixty-plus books. In 2009 two new ones have been released: *Travels to the Edge: A Photo Odyssey* (The Mountaineers Books) and *Caribou Crossing* (Sasquatch Books). Wolfe maintains his gallery, production company, and digital photography school in the SoDo district of Seattle. Visit www.artwolfestock.com for more information.



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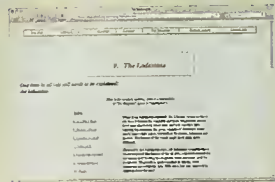
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nature.net by robert anderson

MAGNETIC MINERALS



COUNTING ALL THE MAGNETS in my house would be a real challenge: there are magnets in electric motors, magnets in speakers, magnets holding cupboards shut, magnets in toys, magnets on the fridge. We are surrounded by magnets. But that's nothing new; Earth is littered with magnetic minerals. Some organisms have even evolved to make use of them. In ancient times, lodestones were humanity's introduction to the mysterious force. On the Internet, retired NASA scientist David P. Stern ponders the course of civilization without those rare stones (www.phy6.org/earthmag/lodestone.htm), and describes a colleague's research that suggests lodestones may be the result of lightning striking the right kind of iron ore. For my guide to Web sites exploring magnetic minerals and the many secrets they reveal, please visit the magazine online (www.naturalhistorymag.com).

ROBERT ANDERSON is a freelance science writer who lives in Los Angeles.

WORD EXCHANGE

His Land

Twenty-five years ago we introduced a new columnist to our readers: botanist Robert H. Mohlenbrock, who celebrates the anniversary this month with his 226th installment. It is the first "This Land" he's done on Delaware; his first on Maryland is waiting in the wings. "That leaves only three states I have not written about," he tells me, "Connecticut, Rhode Island, and North Dakota." For sure, he will remedy that before too long. I've had the privilege of working with Bob beginning with his first column, back in November 1984, and I count myself among his many fans. Thank you, Bob, for teaching us about Our Land.

Vittorio Maestro
Editor in Chief

NATURAL HISTORY welcomes correspondence from readers. Letters should be sent via e-mail to nhmag@naturalhistorymag.com or by fax to 646-356-6511. All letters should include a daytime telephone number, and all letters may be edited for length and clarity.

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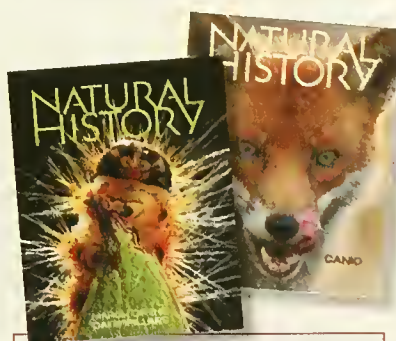
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— EST. 1900 —



Spider's No Dummy

Orb spiders of the genus *Cyclosa* have a flair for home decor. They adorn their webs with prey remains or egg sacs wrapped in silk, positioning those packets in a vertical line above and below their own central waiting place. But the ornaments are no product of feng shui. In fact, a new study shows, they're decoys—and the orb spider is thus the first animal proven to build body doubles for fooling predators.

Studying *C. mulmeinensis* in Taiwan, on a tropical island off the coast, Ling Tseng and her graduate adviser at the time, I-Min Tso of Tunghai University in Taichung City, confirmed that the decorations match the web owner's body in size and color. Then they set up video cameras in front of webs to record the behavior of wasps, the spiders' main predators.

The biologists found that wasps were twice as likely to attack webs with at least two packets as to attack webs with one or fewer—the ornamentation being rather conspicuous. Yet on the well-festooned webs, wasps tended to attack the decoys rather than the spider, and spiders there suffered only 40 percent as many bodily attacks as did spiders on plain webs. The odds indicate that building decoys gives spiders only a slight advantage—but Tseng and Tso assert it's enough for natural selection to maintain the behavior. (*Animal Behaviour*)

—Stéphan Reeb

Orb spider, *Cyclosa mulmeinensis*, waits amid its decoys.

Herp Hatcheries

Some species of reptiles nest communally; that is, females lay their eggs together in the same spot around the same time. Some? Maybe that should be “many,” says J. Sean Doody, an ecologist now at the Australian National University in Canberra.

Along with two colleagues, Doody performed an exhaustive literature review of the egg-laying habits of reptiles (and amphibians). It turned out that communal nesting had been reported in 345 reptile species—four times more than previously realized. (Even some dinosaurs may have laid eggs together, but Doody sensibly restricted his survey to living species.)

The numbers represent only a minority of known reptile species, but the egg-laying behaviors of many have yet to be observed. In certain families of Australian lizards, the team points out, communal nesters represent no more than 9 percent of all the species, but more than 73 percent of the species whose nesting habits are known.

Why a female reptile should lay eggs in another's nest has been little studied. She would probably save the time and effort of searching for an appropriate site and digging a nest. And a larger, many-mom clutch may dilute her offspring's risk of predation. But she might incur the reproductive costs of her hatchlings competing and exchanging diseases with their peers. Striking a balance could account for the persistence in many species of females that nest sometimes together, sometimes alone. (*Quarterly Review of Biology*)

—S.R.

Communal nest, glued to the wall of a cave, holds the eggs of at least twenty Sri Lankan golden geckos.

Play It Again, Sakura

Love of music is universal among people, but when did that taste evolve? Do other primates share our preference for consonant rather than dissonant chords? Cotton-top tamarins do not, according to past research. Our closest cousins, chimpanzees, had never been tested, however—until now.

It's hard for researchers to find a subject of any species that has never been exposed to music (we like it so much we blast it everywhere, nowadays). But Kazuhide Hashiya of Kyushu University in Fukuoka, Japan, learned of one such rarity living at a zoological park. A seventeen-week-old female chimp named Sakura, rejected by her mother, had been reared by humans away from radio, TV, CD players, and other music sources.

Hashiya, graduate student Tasuko Sugimoto, and several colleagues gave Sakura a string to pull that enabled her to replay classical minuets after hearing bits of them. Some of the minuets they'd made dissonant by computer—for example, by changing all



the G notes to G-flat. Sakura replayed the original, consonant versions 55 percent more often than their dissonant alterations.

It's not clear why humans feel pleasure when we hear harmonious combinations of sounds, but whatever goes on in our brains, we may very well share the mechanism with at least one chimp. Perhaps our common evolutionary ancestor would have enjoyed a good tune, too. (*Primates*)

—S.R.



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SAMPLINGS

Young and Hungry

Black holes are gluttons, sucking in everything nearby with their immense gravitational fields. In the early stages of the universe, however, black holes had slim pickings on which to feed, a new study suggests. What's more, they had only themselves to blame.

Not everyone realizes that black holes emit copious radiation. The rays don't come from the holes themselves, of course, but from the heated and compressed matter hurtling toward them. The radiation heats other nearby ordinary matter, which typically falls into the black hole like all the rest. But in the early universe, say Marcelo A. Alvarez and two colleagues at Stanford University, the halos of dark matter that surround black

holes were quite skimpy compared with the halos around modern black holes. The holes and their halos weren't sufficiently massive to gravitationally entrap the extra radiation-heated matter, and it simply diffused away, depriving the beasts of further fodder. The three astrophysicists ran a computer simulation of that effect and found that as a result, early black holes grew much more slowly than previously thought—by less than 1 percent during their first 200 million years.

Computer simulation shows radiation (white) produced by a black hole in the early universe, and its effect on nearby gas (blue).

But today some black holes are huge; how did they get so big? One possibility, Alvarez's team says, is that dozens of the early black holes eventually came together in clusters. In each one, radiation from the holes may have enabled enormous gas clouds to build up, then collapse under their own weight to form a giant black hole. (*Astrophysical Journal*) —S.R.

Ghost of Predation Past

Talk about bearing a grudge! Even though wolves were extirpated from Colorado in the 1930s, yellow-bellied marmots there still fear them, a recent study shows.

Foxes, coyotes, and mountain lions all think marmots make a nice meal. But each predator represents a different threat: foxes, for example, usually attack pups, whereas coyotes are adept at catching marmots of all ages. Belying their name, adult yellow-bellies sometimes actually chase foxes, but they turn tail and scamper to their burrows when a coyote shows up. The rodents react appropriately to the danger level.

Daniel T. Blumstein, a behavioral ecologist at the University of California, Los Angeles, and two colleagues were curious to see if the Colorado marmots would still respond defensively to wolves—a major menace way back when. They sprinkled horse feed in a field to attract marmots, and erected life-size photographs of a fox, coyote, mountain

lion, wolf, or African antelope (as a control) nearby. When the researchers suddenly unveiled one of the pictures, foraging marmots were most likely to flee in response to the wolf.

Blumstein says the marmots' reaction supports the "multipredator hypothesis," the notion that prey maintain their fear of extinct predators so long as similar enemies—probably coyotes, in the marmots' case—remain in play to keep them on their toes. (*Animal Behaviour*) —S.R.

Sweet Spot of the Glyptodont

When Alex Rodriguez swings for the fences or Venus Williams tries to ace her serve, they do well to connect at the "sweet spot" of their bat or racket. That aim was apparently shared by some unlikely contenders: glyptodonts, armored mammals with clublike tails that roamed the Americas until about 10,000 years ago.

The sweet spot, or center of percussion, is the point on a tool where powerful blows should be landed to maximize impact and minimize the risk of injury to the user. For the largest glyptodonts, which could reach the size and weight of a compact car, dealing a blow at their tail's sweet spot minimized risk to the joint at the base of the tail, while inflicting maximum damage on an opponent. So conclude R. Ernesto Blanco of the University of the Republic in Montevideo, Uruguay, and colleagues, who

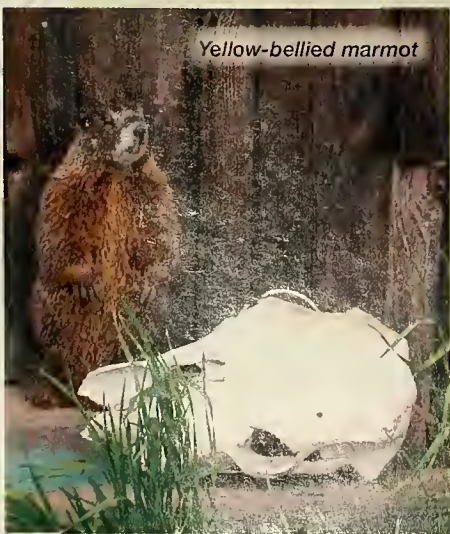
mathematically modeled the fossilized tails of several species of glyptodonts.

The largest glyptodont species, such as *Doedicurus clavicaudatus*, had elliptical depressions on their tails that many researchers think bore spikes—the most menacing of which, Blanco's team found, would have sprouted close to the center of percussion. Giant glyptodonts were probably limited to wielding their tails in clumsy, ritualized encounters with same-species rivals, the team says, whereas smaller, nimbler species had flexible tails they could have used to ward off predators and other unpredictable adversaries. (*Proceedings of the Royal Society B*) —Harvey Leifert

Doedicurus clavicaudatus



Yellow-bellied marmot



Every year, maternal and neonatal tetanus (MNT) claims the lives of almost 180,000 infants and 30,000 mothers.¹ MNT has been eliminated in most of the developed world – but it remains a deadly public health threat in 47 developing countries.

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¹ WHO/UNICEF, 2004 data

² FORTUNE, March 2008

³ Ethics, Inc.[®] Magazine, April 2007

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SAMPLINGS



Wild mares socialize in New Zealand's Kaimanawa Mountains.

COURTESY OF ELISSA Z. CAMERON

Neigh-Neigh Sisterhood

Wild mares that form strong social bonds with other mares produce more foals than those that don't, researchers have found, in what may be the first documented link between "friendship" and reproductive success outside of primates.

The study followed bands of feral horses in the Kaimanawa Mountains of New Zealand over the course of three years. Elissa Z. Cameron, now at the University of Pretoria in South Africa, and two colleagues computed sociality scores for fifty-six mares, based on parameters such as the proportion of time each animal spent near other mares and the amount of social grooming she did. The team found that the scores correlated well with foaling rate: more sociable mares had more foals. They also suffered slightly less harassment by the bands' few males.

Such correlational studies are notoriously tricky to interpret, and they do not prove cause and effect. But Cameron's data are certainly consistent with the idea that bonds between females—even unrelated ones, as in horse bands—help them fend off pestering males, thus reducing stress and promoting healthy pregnancies. Other studies of various primate species (baboons, most notably) support that notion. (PNAS) —S.R.



THE WARMING EARTH

Heat Shrink

Australia's average surface temperature has risen more than 1 Fahrenheit degree since 1900. During roughly the same period, the body size of Australian passerine (perching) birds has declined by as much as 3.6 percent. Zoologist Janet L. Gardner of the Australian National University in Canberra and colleagues, who detected

the shrinking trend in birds, suspect the two changes are no coincidence.

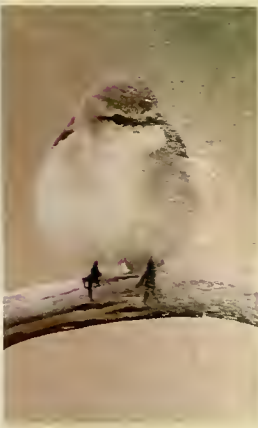
Gardner's team measured 517 specimens of eight insectivorous passerine species collected in southeastern Australia over the past 100

years. Half the species showed significant reductions in size; the other half showed smaller declines or no change.

Within a given animal species, individuals living at high latitudes, toward a pole, are usually larger than those living nearer the equator, probably because greater body mass helps ward off the cold. In keeping with that principle, the researchers calculated that southern populations of four Aussie bird species now have body sizes typical of populations that lived 7 degrees of latitude (about 483 miles) closer to the equator before 1950. In a nutshell, smaller birds now live somewhat closer to the South Pole.

Analyzing subtle banding on the birds' feathers, Gardner's team found no change over time in their growth rate, so nutritional deficiencies resulting from environmental degradation are unlikely to have caused the birds' shrinking. Rising temperatures due to climate change best explain the trend, they say. (Proceedings of the Royal Society B) —H.L.

Jacky winter, an Australian species whose average body size has shrunk



COURTESY OF JANET L. GARDNER

Ants, All for One!

Helpful acts, such as grooming or foster parenting, are common throughout the animal kingdom, but accounts of animals rescuing one another from danger are exceedingly rare, having been reported in the scientific literature only for dolphins, capuchin monkeys, and ants. [See "Save the Seal!" on page 48 for a recent observation of altruistic whales.] New research shows that in the ant *Cataglyphis cursor*, the behavior is surprisingly sophisticated.

Elise Nowbahari of the University of Paris North, Karen L. Hollis of Mount Holyoke College in South Hadley, Massachusetts, and two colleagues mimicked a natural situation—an ant restrained by collapsing sand and debris. But hidden beneath the sand was a nylon snare holding the ant firmly in place. The ant's nestmates consistently responded by digging around the victim and tugging at its limbs until they found the trap, then biting at the nylon strand. Potential rescuers did not, however, do the same for unrelated ants or insects of other species.

The ants' ability to discern and then tackle the unfamiliar nylon snare demonstrates cognitive and behavioral complexity, unlike such simple actions as digging or limb pulling, which could arguably be elicited by a chemical distress signal. Nowbahari and Hollis distinguish rescue behavior from other cooperative acts in that both participants risk physical harm (rescuing ants could themselves be trapped under falling sand), with no possibility of reward for the rescuer aside from the benefits of kin selection. (PLoS ONE) —Lindsey Konkel

Ant bites a nylon thread, attempting to free its lassoed nestmate.



ELISE NOWBAHARI

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In the Santa Cruz Valley on the Tohono O'odham reservation, **Mission San Xavier del Bac** stands as one of the finest examples of Spanish colonial architecture in the United States. Listed on the National Register of Historic Places, San Xavier was built in 1783 by the followers of famed Jesuit missionary and explorer Father Eusebio Francisco Kino. A self-guided tour of the mission's domes, enclaves and colorful artwork will open a window to Tucson's Spanish and Native American heritage.

On your next stop, step farther back in time to the earliest days of Tucson's Native American tribes with a tour of the Smithsonian Institution-affiliated **Arizona State Museum**. Catch a glimpse of the world's largest Southwest

Indian pottery collection, along with more than 150,000 archaeological artifacts and a quarter-million prints and photo negatives highlighting the histories of ancient O'odham, Hohokam and Mogollon cultures.

For a taste of Tucson's pioneer past, stop by the **Arizona Historical Society**, which houses the largest collection of Arizona's artifacts, photos and documents in the world. The museum has conserved more than a half-million relics on Arizona's mining, ranching and urban histories, and it also operates two other important historical museums in Tucson—the **Fort Lowell Museum** and the **Sosa-Carrillo Fremont House**.

Last stop: The newly built **Tohono O'odham Nation Cultural Center & Museum**—a 90-minute drive southwest of Tucson. This \$15 million hidden treasure can be found near Sells, Arizona, and features artifacts and displays meant to help visitors understand the culture and traditions of the O'odham people, in addition to how the tribe has contributed to U.S. history. Built within sight of the nation's sacred mountain, **Baboquivari Peak**, the museum will guide new generations to appreciate the O'odham traditions.

From off-the-beaten-path exhibits to unexpected adventures, once you decide to open your mind and really explore, Tucson will surprise you. You don't have to seek out new discoveries on your own. Help is available at the **Tucson Visitors Center** at 100 S. Church Avenue, or by consulting the Metropolitan Tucson Convention & Visitors Bureau's information specialists at 800-638-8350. Visit us online at www.visitTucson.org.

Left: Mission San Xavier del Bac; above: Southwest Indian pottery at the Arizona State Museum; petroglyphs



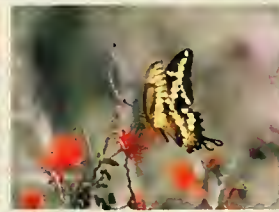
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The Matrix

Papua New Guineans are mystified by a million-dollar insect census. But then, who wouldn't be?

BY VOJTECH NOVOTNY

Translated from the Czech by David Short

Illustrations by Benson Avea Bego



Uljaj is the respected headman of the Didipa clan, a great fount of knowledge of the plants, animals, and traditions of the clan. He remembers the days of the Japanese occupation, the Australian trusteeship, and the whole lifetime of

independent Papua New Guinea. For fifteen years one of the Didipa clan's neighbors has been a biological research station, so Ulaj has had plenty of experience helping numerous researchers. Some of them would catch bats, attach transmitters to their backs, then run about the jungle all night with a radio antenna to map where the bats flew. Others would spend long hours combing the stony beds of forest streams until they found the whitish maggot they were looking for. Yet others would net birds in order to band them. Others caught beetles on sticky stuff, moths lured by lights, and flies in pheromone traps. There were those who would pin termites to the leaves of trees, then come back and count how many

of them had been discovered and devoured by ants. Others would catch butterflies, mark their wings with numbers, let them go, and try to catch them again the following day. Or measure the trees in the forest. Or spend long months collecting falling leaves and fruit in traps and then weighing them. Nothing can surprise Ulaj now.

The scientists all explained to him the purposes of their particular performances—discovering the population structure of bats, estimating the numbers of butterflies in the jungle, measuring the calcium cycle, et cetera, et cetera. Such explanations explain nothing—least of all why apparently intelligent people spare no cost and effort to such pointless ends.

Over ten years, our own project, concerned with a detailed survey of utterly useless insects that eat the leaves of useless species of trees, also involved a number of New Guineans, including Ulaj, as lab and field





technicians. For all the years of explaining, they remain unclear about the idea of basic research, though they have no problem understanding its techniques and immediate objectives, such as measuring the diversity of herbivorous insect species in a tropical forest. The mystery remains of why we had turned up here and erected a field station; equipped it with computers, microscopes, off-road vehicles, and other costly items; and then spent years of hard work on such a patently absurd project, which, after all that effort, only produces seventy cubic feet of cardboard boxes per year, full of pin-mounted beetles and other insects, all of them unprepossessing.

If we exclude the possibility that this might all conceal some profitable enterprise, such as the apparently futile activity of panning for gold once proved to be, the only other explanation is that it is some magic ritual. Those most obsessed with research are Europeans and Americans, the very people who brought so many miracles of technology. How the one leads to the other is by no means clear, but there must be a connection. Thus New Guinean public opinion on basic research accords with the view of the European or American public,



which funds basic research in the hope that glaringly absurd projects will be transformed cabalistically into social gains and technological progress. And somehow that does happen (though no one knows how), as history teaches us.

So if less-developed countries wish to catch up and overtake their technologically more advanced and prosperous competitors, the best thing is to get better at catching bats and affixing transmitters on their backs, sifting stony stream beds for whitish grubs, pinning termites to foliage, writing numbers on butterflies' wings, and weighing falling leaves. In our laboratories in New Guinea and far away from there in southern Bohemia, we are doing what we can. After all, that's why we white magicians are here.

I am sitting before my computer screen as our just-completed Grand Matrix scrolls before me. It is a gigantic table of 1,583 lines, each one for a species of herbivorous insect, and 62 columns, each one for a species of woody plant in the rain forest on the north coast of New Guinea. The figures in the 98,146 fields indicate how many individuals of each species of insect were found feeding on this or that tree or shrub, and so provide a quantitative account of the food relationship between insects and plants. The insect side of the matrix includes everything from seven-inch-long stick insects through large and small grasshoppers, and the caterpillars of many families of butterflies and moths, to all manner of beetles—from giant long-horned beetles to tiny little leaf beetles and weevils. The plant world is represented by eighteen families and forty genera. Although this is only a small selection of the several hundred woody species in the forest, they still represent a range of lifestyles—from the tall species reaching to the top of the canopy, through shrubs on the



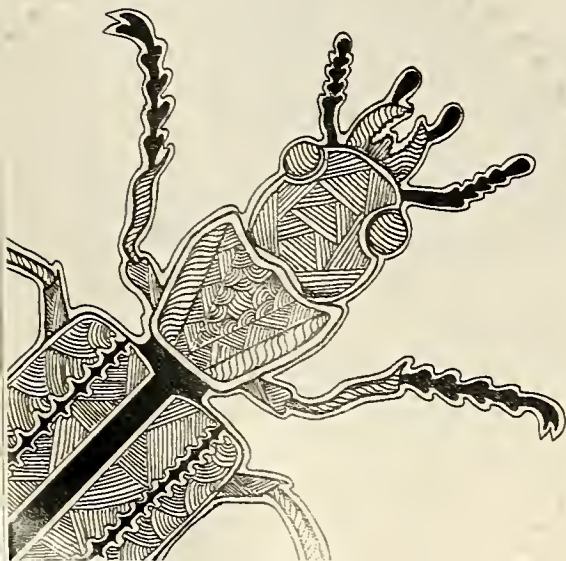
forest floor and pioneer species making inroads on recent clearings, down to specialists that populate the often inundated lands adjacent to forest streams. There are, among others, fifteen fig species, a palm, latex-rich spurges, the broad-leaved gymnosperm *Gnetum*, an *Endospermum* that lives symbiotically with ants, and a breadfruit tree with edible fruit.

What did making the Grand Matrix cost? Five years' work by a fifteen-strong team speaking seven different mother tongues, 11,000 working days spent in New Guinea, 13,000 miles on foot through the jungle, 40,000 miles by off-roader, 28 intercontinental flights, 35,000 e-mails, 29 bouts of malaria, 18,000 ship's biscuits and 8,000 portions of instant noodles, 22,000 betel nuts and 1,500 coconuts, 38 machetes, 35 checkbooks, 6 computers, 4 stereo-microscopes, 1 charge of witchcraft, and 1 armed hold-up; plus: the construction of an entomological laboratory on a coconut plantation, the introduction of electricity and the Internet in places where no one had ever dreamed of them, the economic advancement of three villages, fourteen mothers-to-be transported urgently to the hospital, and the experimental study of the food preferences of 120,000 insects.

I travel through our Grand Matrix as through an alien landscape behind the looking glass. The fig tree area teems with giant long-horned beetles and poisonous milkweed butterflies; tree species of the coffee family are awash in stick insects and hawk moths; the spurges

have tiny leaf beetles, and huge urania moths, while the monocotyledonous plants are an insect desert, with just the odd skipper butterfly visiting. The simple matrix reflects the complex evolutionary history of the relations between plants and the insects that eat them, as well as the ecological conditions prevailing in today's tropical forests. Deciphering it will not be simple, and the purport of the results arrived at can barely be guessed in advance. But these are concerns for the morrow. Today I have my Grand Matrix, the key that will open up myriad mysteries, a key found at the end of a long and adventurous journey, a key costing almost a million dollars.

Postscript after three years: The Grand Matrix ultimately found a use as the starting point for estimating the number of insect species living on Planet Earth. Entomologists have so far described and named around 850,000 species. The consensus is that, even after 250 years, work on the complete catalogue of insect species has not reached the halfway point, though there are widely differing views on how many remain to be discovered. The great unknown is how many species inhabit the tropical rain forests, that most species-rich and least investigated of ecosystems.



In the 1980s the debate was reignited by a new method of insect collection, in which forest trees are misted with a rapid-action pyrethroid insecticide. The dead insects then rain down from the barely accessible canopy onto the heads of biologists waiting in the understory. The method's trailblazer, the American biologist Terry Erwin, had an incredible 955 species of herbivorous beetles land on him from nineteen trees of a single species in Panama. Erwin estimated that around one-fifth of them specialized on that particular species of tree. Multiplying the number of those specialists by 50,000—that is, by the number of tropical tree species—and adding in all the predatory and parasitic species, and species living in the soil, Erwin arrived at an estimate of at least 30 million species of insects. That was several times higher than most previous estimates.

Biologists and conservationists adore species, so the new 30 million estimate became very popular. The nongovernmental organization Conservation International promptly made it into a slogan: "Save Tropical Forests. 30 Million Insects Can't All Be Wrong." The insects may not be wrong, but biologists certainly are. As our studies of twenty years later have shown, mere dozens of the hundreds of herbivorous insect species present on any tropical tree are truly dependent on it as their food source: the rest are just tourists who can dine on a wide variety of trees. A new calculation based on our Grand Matrix has led to the mass extinction of hypo-



thetical species, since by this reckoning we share the planet not with 30 million, but with no more than 4 to 6 million species of insects.

VOJTECH NOVOTNY is Professor of Ecology at the University of South Bohemia and the Head of the Department of Ecology and Conservation Biology at the Biology Center of the Academy of Sciences of the Czech Republic. He is leading an international team of researchers studying relationships between plants and insects in tropical rain forests. Novotny directs the New Guinea Binatang Research Center in Papua New Guinea, which unites Western scientists and the tribal peoples of the New Guinea rain forests in the pursuit of world-recognized ecological research.

*DAVID SHORT is a senior teaching fellow in the Czech and Slovak languages at University College London, and a freelance translator. Among his recent translations of literature are Vítězslav Nezval's *Valerie* and her *Week of Wonders* (2005) and Bohumil Hrabal's *Pirouettes on a Postage Stamp* (2008). He is also the author of the widely used textbook *Teach Yourself Czech* (updated edition, 2005).*



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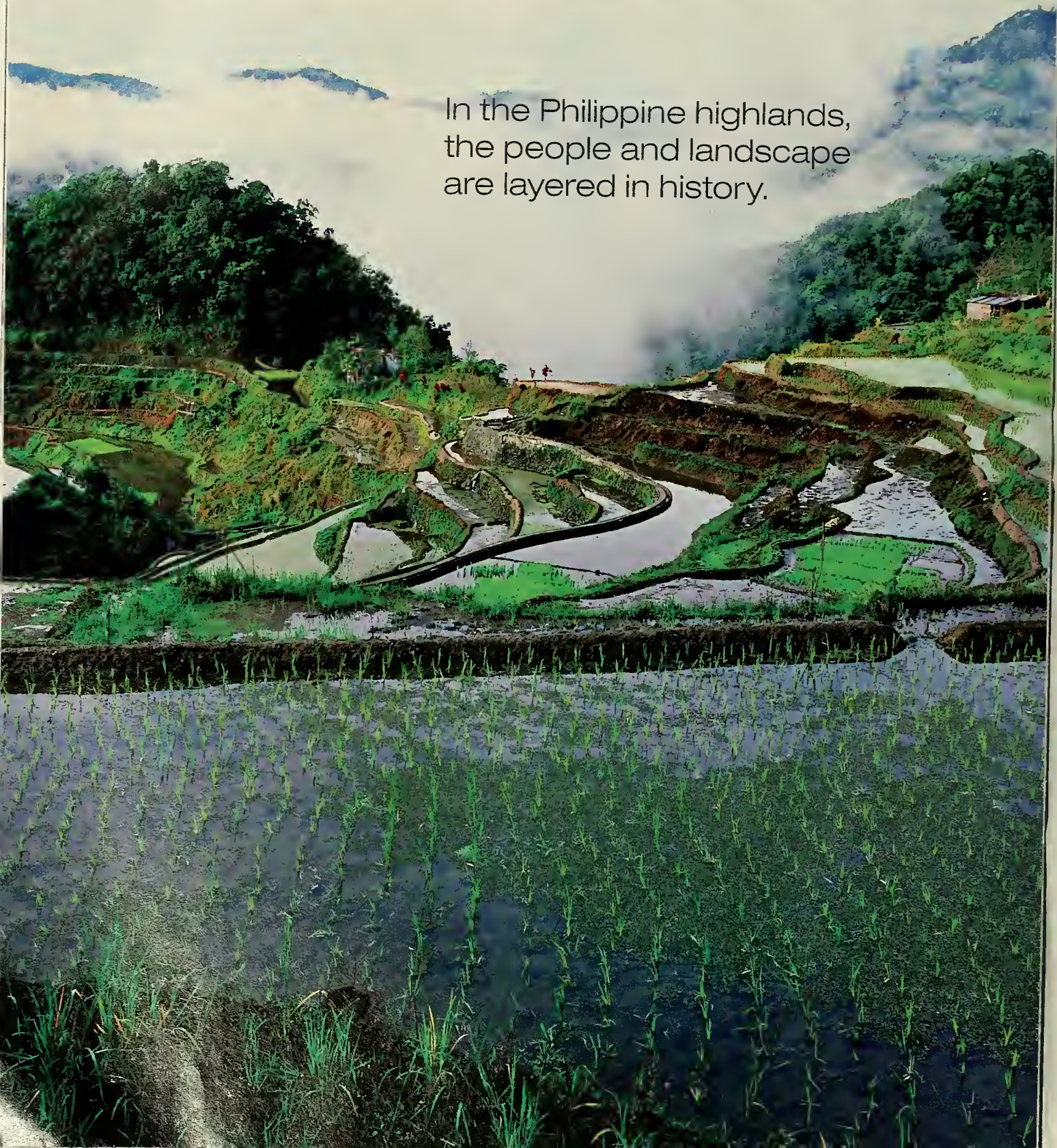
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Fields of Dreams

In the Philippine highlands,
the people and landscape
are layered in history.



Photographs by Ellen Kaplowitz
Story by Henry N. Beyer

For two millennia, people have planted rice on sculpted terraces covering 4,000 steep square miles of the Cordillera Central, the Philippines' largest mountain range, on Luzon, the country's principal island. My grandfather Henry Otley Beyer (1883–1966) spent much of his life studying the culture and history of the various ethnic groups inhabiting that region. Born in Iowa, he earned a master's degree in chemistry, but, inspired to pursue anthropology, came to Luzon in July 1905 to join an ethnological survey. (The Philippines was then an American possession.) Within a decade he had cofounded the anthropology department at the University of the Philippines in Manila. In the nation's academic circles he is still remembered as the Father of Philippine Anthropology and Archaeology. Growing up, I always listened closely to him. And in the last five years of his life, when I became his ears and eyes in his discussions with colleagues and friends—repeating what he had missed—I continued to learn from him.

Although the earliest evidence of a human presence in the Cordillera dates back roughly 40,000 years, the first big influx of settlers likely arrived 3,000 years ago, from mainland Asia. They originally practiced dry farming with millet, rice, and tubers such as taro and yam. My grandfather believed that the early terrace-builders, who cultivated rice in wet fields, came much later, from Southeast Asia. They may have followed river valleys, gorges, and canyons to find the ideal altitude for their agricultural practices. Other requirements were a continuous supply of water for irrigation, from a natural spring, river, or stream, and level fields that could be kept flooded to serve the crop's growth cycle—hence the terracing.

The highest terraces, rising like steps as much as 5,000 feet above sea level, are in Ifugao, a province in north central Luzon. They are the best preserved of the existing ancient structures, and in 1995 the UNESCO World Heritage Committee declared them an official site. They are also prized as a source of organically grown rice. No pesticides or chemical fertilizers are used in cultivating those terraces, and in keeping with current concerns, in 2009 they were declared to be free of genetically modified organisms. For those reasons,

people pay as much as four times the cost of ordinary commercial rice to obtain the highland product. The primary threat to the fields, at this time, is lack of labor. The educated inhabitants, at least the college graduates,

Below (and opposite page): Terraces in the Philippine Cordillera Central provide level fields that can be flooded for rice cultivation. Water buffalo, the rural source of animal power, cannot work the steep slopes, so women and men must till, plant, and harvest everything by hand.





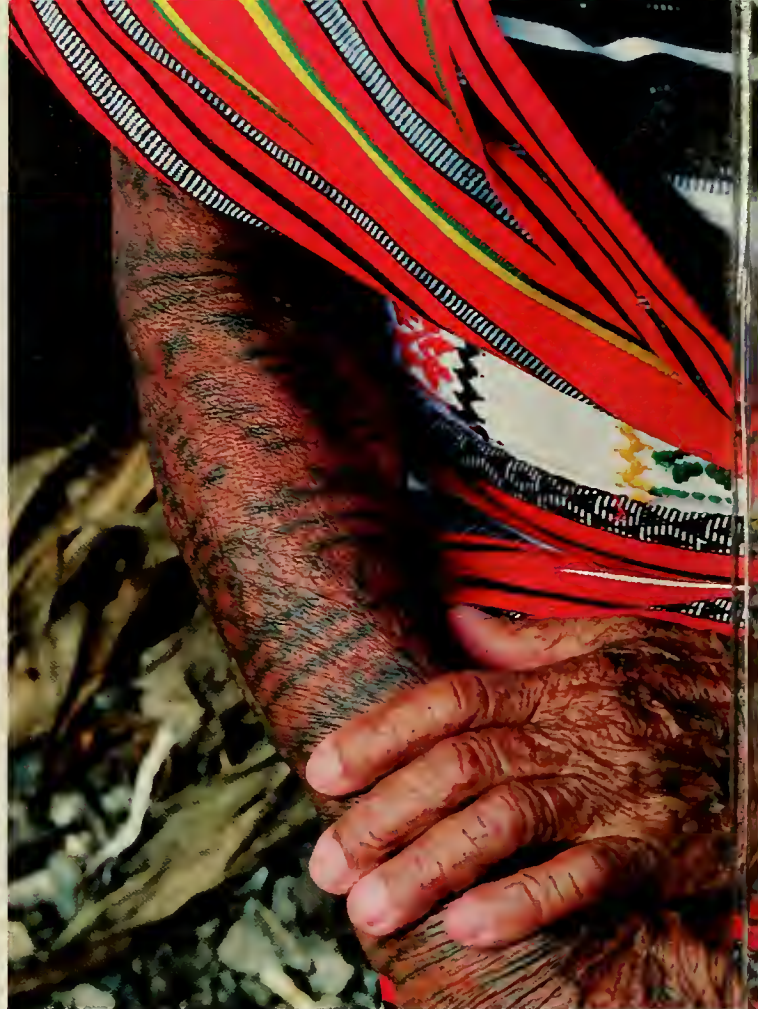


Above (and top left of opposite page): Stone walls around the paddies in the Cordillera are often used as pathways and as steps to ascend and descend the slopes. The variety of rice usually planted in the highlands requires 180 days to grow, in contrast with the 90-day variety prevalent in the lowlands. Terrace owners don't use pesticides or commercial fertilizers. Maintenance includes clearing away grass and weeds to prevent rats from nesting near the terraces.

Left: Farmers harvest rice by cutting individual stems and pushing the base of the stalk back under the mud to decompose—thus preserving nutrients. After the rice is harvested, owners catch fish and shellfish, such as snails, for food from the paddies.

seldom choose to farm. Perhaps the premium prices will help keep the farming alive.

Ninety-eight million people currently live in the Philippines, embracing a diversity of ethnic groups. The majority of the population in the lowlands speaks Filipino (Tagalog) and a few primary Luzon dialects; on the Visayan Islands and on Mindanao most people speak Cebuano. However, more than 170 native languages are spoken nationwide. Among the terrace-farming peoples living in the Cordillera are the Ifugaos and Bontocs, who were known for—among other things—their art of tattooing. Women traditionally wore elaborate lines of tattoos on their arms only, whereas men bore ink on their chests and heads as signs of their strength as warriors [*see photographs on following two pages*]. Beginning in the late 1940s, after World War II, teachers at missionary schools discouraged the practice, so most women in the area under the age of



Above left (and far right of opposite page): Mummified body of Apo Anno has been preserved for 400 years. Oral tradition throughout the Cordilleran province of Benguet (inhabited by the Kankanai people) records his prowess as a hunter and warrior, as do the elaborate tattoos from the top of his forehead to the soles of his feet. It is said that the mummy was stolen for a time by a Christian missionary, who hoped that the people of the village that cared for it, Nabalikong, might then be easier to convert. Later, in the 1920s, it passed through the hands of the author's grandfather Henry Otley Beyer, who determined that the preservative used was a plant called *sabut* in the legume family. Anno was returned to his home village, near the Agno River, by the National Museum of the Philippines in the 1990s—after an absence of about ninety years.

Above: Tattooed arms of an older woman reflect a traditional practice thought to enhance beauty and thus improve chances of landing a husband. In the days when headhunting was common and men were scarce, mothers often forced daughters to be tattooed lest they become spinsters. Teachers at missionary schools discouraged the art, and most women in the Cordillera under the age of sixty lack such tattoos.

Left: Tomb in Lumiang Cave in the town of Sagada showcases an increasingly rare style of coffin that is circular and hand carved out of pine.



sixty are not tattooed. As wars among tribes waned, the men stopped getting tattoos as well.

Another group in the vicinity, living along the Chico River, whose waters irrigate many of the rice terraces, is the Kankanaï. One of their towns, Sagada, shares an ongoing Cordilleran tradition of burying the dead in nearby caves and niches. One cave, called Lumiang, about a half mile from the center of Sagada, still has several layers of coffins stacked in piles in the cool recesses. (Other burial sites have been looted.) Among the coffins there is an unusual circular kind, hollowed out from a good-size pine tree [see photograph on opposite page]. Such log coffins are now being phased out, since the government has banned the cutting of pine trees, which were overlogged.

Typically, upon death among the highlanders, the body is seated and tied to a “death chair” (*sangadel* or *hangdel*) for the duration of the wake, which lasts one or two days for the poorest people but up to eight days for the wealthiest. With a fellow young American named Roy Franklin Barton, my grandfather described that and other practices in a 1911 article titled “An Ifugao Burial Ceremony,” in the *Philippine Journal of Science*.

Such traditional burial practices are increasingly rare, and are usually found only in isolated areas. Indeed,

many aspects of Philippine culture have changed since my grandfather’s arrival. Most changes were brought about by the influence of missionaries and educators, and by central government control. Traditional religious beliefs slowly gave way to Christianity. Head-hunting and tribal wars slowed. The list of what has changed is long. Yet the beautiful terraces remain.

Ellen Kaplowitz’s images have appeared at a number of museums, including the Field Museum in Chicago and the American Museum of Natural History in New York City. Her most recent book is *A World of Decent Dreams: Vietnam Images* (Weatherhill, 2003). For more information visit www.ellenkaplowitzphotography.com.



Henry N. Beyer is an antiques dealer specializing in Philippine traditional and primitive arts. He lives in the southwest of Luzon’s Cordillera Central, in Baguio City, which celebrated its centennial on September 1, 2009.

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Slippery **Business**

Scientists race to understand the reproductive biology of freshwater eels, as populations decline worldwide.

BY RICHARD SCHWEID





TIM VATTIS

The first time I tried to grip a freshwater eel was during an interview with a North Carolina eel dealer, who reached into a concrete-lined pool in his warehouse and tossed one of his captives to the floor in a quick movement. “Pick it up,” he said, with a slightly nasty smile and a challenge in his voice. He nodded his head toward the eel, an adult a yard long and as thick as a baseball bat. It was already making good time squirming across the concrete floor, looking unnervingly like a big snake. Still, I knew that eels are fish and that they don’t have much of a bite, and the task sounded easy enough, so I stooped to scoop the eel off the floor, putting both hands around its body and squeezing. It was like trying to hold a handful of water. In a flash, it slid through my fingers back to the floor, leaving a smear of slime drying on my hands.

Then the dealer showed me the trick. It’s no secret; it was aptly described in an anonymously authored book called *Athletic Sports for Boys: A Repository of Graceful Recreations for Youth*, published in 1866 in New York. The book included eel fishing as one of those graceful recreations for American boys, and taught them how to handle their catch: “Place the second finger on one side of him, and the first and third on the other, about an inch and a half from his neck. Then by pressing the fingers together he cannot move.” It works.

The idea of an afternoon spent fishing for and handling eels has long since fallen out of favor in the United States. Likewise, eels themselves have disappeared from North American cuisine, where for a long time they held a high place. A handful of eel dealers still buy eels on the U.S. east coast for sale to Europe and Asia, but a significant North American market no longer exists.

Even though people around the world have been eating freshwater eels, and researchers (beginning with Aristotle) have been studying them, for thousands of years, much about the animals remains unknown. Spurred by global population declines, however, scientists are beginning to unlock some of the freshwater eels’ millennial mysteries. And they are closing in on the long-standing goal of breeding eels and raising them to

adulthood in captivity on a commercial scale, in hopes of freeing the aquaculture industry from the need to gather young eels from the wild.

More than 700 species of true eels, in the order Anguilliformes, have been identified around the world. Fourteen families of exclusively marine eels include morays and congers; one family of freshwater eels, the Anguillidae, consists of sixteen species, all in the genus *Anguilla*. Among them, the American eel (*A. rostrata*), European eel (*A. anguilla*), Japanese eel (*A. japonica*), and Australian or shortfin eel (*A. australis*) have each sustained humans for thousands of years. Paleolithic cave dwellers in what are now France and Spain left European eel bones in their trash middens. Australian aborigines and Native Americans consumed their local species, as did the Greeks. “Fear death,” wrote the Greek comic poet Philetaerus in the fourth century B.C., “for when you’re dead, you cannot then eat eels.”

Members of the Anguillidae are catadromous: they are born and die in salt water, but mainly pass their lives in fresh, a life cycle opposite that of salmon and other anadromous fishes. Every ordinary-looking eel resting in the mud of a North American or European lake, pond, river, or creek has made an astonishing journey from its birthplace in the depths of the Atlantic Ocean’s Sargasso Sea—an approximately two-million-square-mile zone between Bermuda and the Azores. The Sargasso is bounded by strong clockwise currents, which carry the thin, leaf-shaped eel larvae, called “leptocephali,” hundreds or thousands of miles northwest to North America and then northeast to Europe. The two species, American and European, are distinguished by the number of their vertebrae, as well as genetically. American eel larvae also grow faster; they’re ready to hop off the ocean current and head for shore in a year or less, whereas the European larvae continue to go and grow with the flow, possibly for as long as three years.

As they near land, having reached about two and a half inches in length, the leptocephali metamorphose into “glass eels,” their bodies adapting to freshwater and rounding out in cross section [see diagram on next page]. At that stage hundreds of millions of juvenile eels are netted—legally and illegally—out of estuaries each year, mostly to supply the Asian aquaculture industry. Stronger swimmers now, many glass eels that escape the nets enter

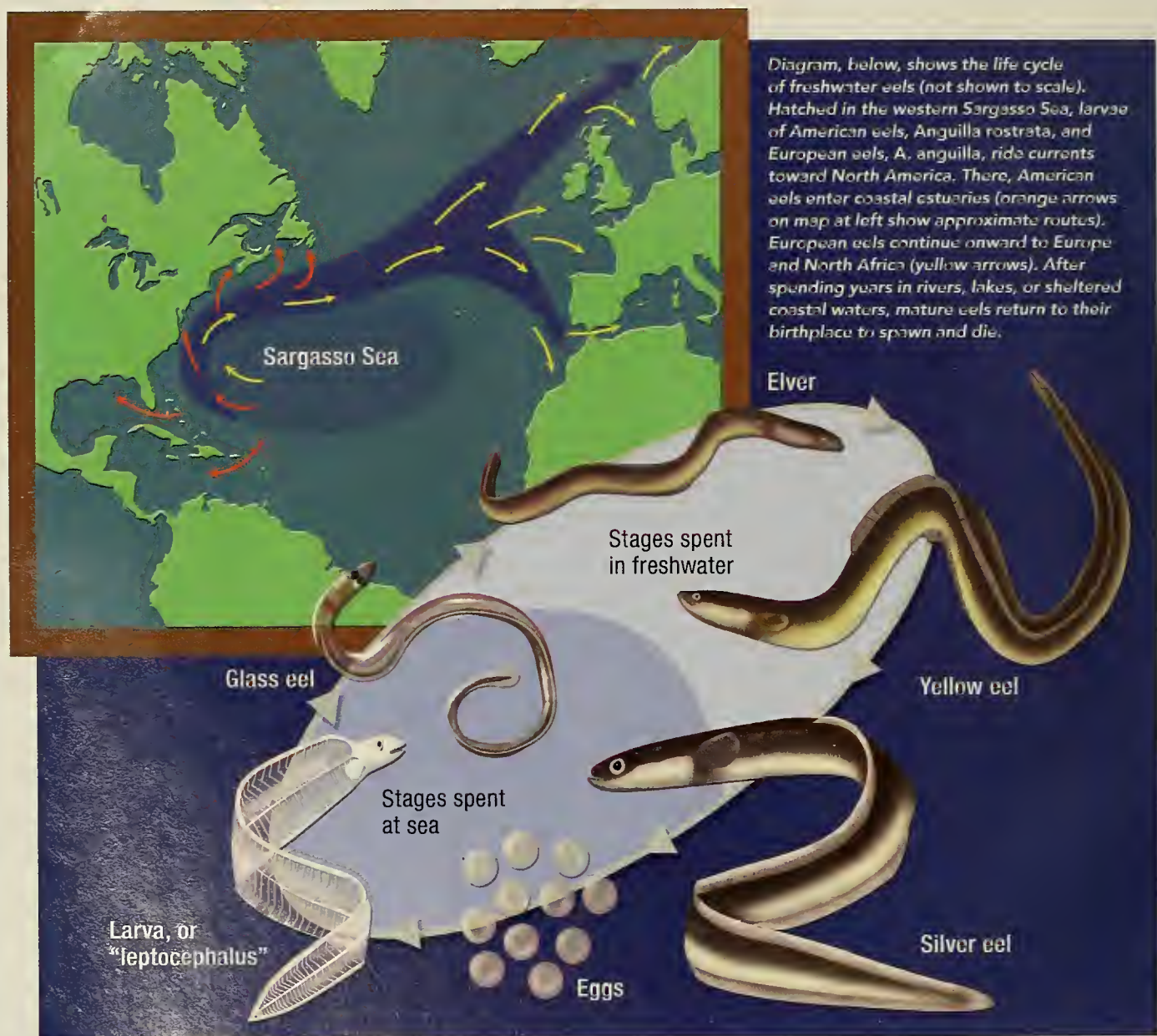
Mature, or “silver,” American eels, opposite page, held in a tank before shipment to European fish markets. Above: Young eels gather in a Massachusetts river.

a river and swim upstream in search of a freshwater body to call home. (Some stay behind in coastal waters.) As the glass eels grow they develop pigmentation, at which point they are called “elvers.” Once they exceed six inches in length and darken to their characteristic muddy yellow-brown-green color, they are called “yellow eels.” When they find a home they like—some females forge as far inland as South Dakota—they stay there for years, passing their days resting in the mud and their nights hunting.

When they are somewhere between five and twenty-five years old, having grown as long as five feet, yellow eels mature sexually and enter the “silver-eel” phase of their lives. Their backs darken and their bellies whiten for oceanic camouflage from predators above and below; their eyes enlarge and change pigmentation for improved

vision deep in the ocean. They head back downriver, on a long return swim to the Sargasso. Their digestive systems atrophy, and they fast during the entire trip. They have no need to hunt; they have only to swim, arriving with just enough energy left to spawn before they die.

That description of an eel's life cycle has been accepted since 1923, when a Danish researcher, Johannes Schmidt, published data from eighteen years of trawling for eel larvae in the Atlantic Ocean. He showed that larvae caught in the Sargasso Sea were so small that they must have hatched nearby. But though adult eels are frequently taken during their downriver journeys to the sea, none have ever been captured in the Atlantic, and it was not until 2008 that the first were found in *any* ocean.



That's when a crew of researchers from Japan netted three freshwater eels—two Japanese eels and a giant mottled eel (*A. marmorata*)—about eighty miles off a seamount in the western North Pacific. Dissection revealed the eels to be sexually mature males, and a few days later a different ship found recently hatched larvae nearby. Scientists had been zeroing in on the area as the Japanese eels' spawning grounds, and here, at last, was proof.

The trawling expedition's leader was Seinen Chow, a marine biologist with the National Research Institute of Fisheries Science in the city of Yokosuka. Dubious about the project's chances of finding an eel, he'd initially declined to participate. "I thought it would be a waste of time," he says. The team dutifully developed protocols for what to do if they did capture an eel, but they were thoroughly surprised when, on the tenth night of trawling, they actually netted one. "It was panic on board," says Chow. "We forgot all our protocols for the moment." The crew couldn't do anything at first but stare at the eel.

In June 2009, the same team netted another eight Japanese eels, males and females, in three weeks of trawling. The eels are thought to swim deep below the surface, at some 600 yards, during the day and to rise quickly at sunset to 200 yards. Indeed, Chow's team netted their eels at night.

Starting in 1974, scientists have made numerous attempts to track silver American and European eels on their way to the Sargasso—without much success. "Pop-up satellite tags" are the latest in tracking technology. Would-be eel



Author holds wild-caught glass eels at a processing plant in Spain, where they are considered a delicacy.

trackers can attach one to an anesthetized eel with a wire pierced through the animal's dorsal muscle. The eel is released, and after a certain pre-programmed time, or at a certain depth, the tag pops off. It then floats to the surface, where it transmits stored data about its journey with the eel to a satellite.

In October and November 2008, scientists from the Eeliad project, a consortium of European research groups, released forty satellite-tagged silver *A. anguilla* eels in Ireland's Galway Bay, and forty more from the mouth of the Loire

River in France. Eighty more are scheduled for release in autumn 2010. Additional eels are being let go with older-style data-storage tags implanted in their bodies. Eventually, the researchers hope, the tags will provide information about migratory behavior that will be useful not only in capturing elusive adults on the spawning grounds, but also in managing stocks, which are in trouble.

By July 2009, sixty-two tags had floated to the surface and transmitted data, the farthest from about 950 miles off the Irish coast, well short of the Sargasso Sea. Still, with funding secured through 2012, the Eeliad's director, David Righton, a marine biologist with the United Kingdom's Centre for Environment, Fisheries and Aquaculture Science in Lowestoft, England, is optimistic the project will succeed. "We didn't expect to reach the Sargasso the first time," he says.

The Eeliad project is a component of the European Union's response to a dramatic drop in eel populations—and Europe is not alone. Over the past decade eels have declined around the world. Nowhere have falling numbers caused more alarm than in Japan, which has the world's largest per capita consumption, and where eels represent a \$1 billion annual market. The Japanese consume

Eelers assemble near the base of a Massachusetts river dam. Many die trying to surmount the dam on their way upriver, and again years later, on their return to the sea as adults. Dams have contributed to a global decline in freshwater eels.





Silver European eel wears a pop-up satellite tag so researchers can track it as it sets out for the Sargasso Sea.

enough *A. japonica* is captured each year to feed the national appetite, so the Japanese depend on glass eels captured in Europe, or to a lesser extent in North America, and raised to eating size on farms in China or Japan. The EU is placing increasingly stringent regulations on that commerce, however, which lends urgency to research into captive eel reproduction. Recent breakthroughs have been major, but the work has not been easy or rapid.

Japanese researchers made a giant step forward in eel reproduction in 1973, when, building on earlier work, they induced fertility in males and females with hormonal injections and produced larvae from the fertilized eggs. The larvae lived for the five or six days it took them to consume their yolk sacs, and then died. Later researchers tried a variety of diets, from egg yolk to rotifers, but the larvae grew poorly, if at all, and did not live much past two weeks. (Exactly what larvae eat in the wild is not well understood.) It was not until 1998 that a team led by Hideki Tanaka, a fish biologist at the National Research Institute of Aquaculture, discovered that larvae in tanks would consume a slurry with a base of shark-egg powder.

Chefs work the grills at the annual eel festival in Comacchio, Italy. Eel is popular among Europeans, but has fallen out of favor with Americans.



some 200 million pounds of eel a year, most of it prepared as *kabayaki*—slices of eel that are butterflied, skewered, marinated in a soy-based sweet sauce, steamed, and grilled for a smoky flavor. Not nearly

The larvae still only survived for thirty days, but they grew to one-third of an inch before dying.

Continual refinement of the diet extended survival and growth to the two-inch, 250-day mark, when larvae transform into glass eels, ready for freshwater. By 2004 Tanaka's group had blown past that milestone, too, raising yellow eels of an edible size from birth in captivity. But shark-egg powder is not cheap, and with many shark populations in trouble, it is obviously not a workable or responsible commercial solution. In addition, most of the fertilized eggs still do not produce viable larvae. For now, Tanaka says, mass production on a commercial scale remains out of reach.

Although Europeans don't consume as much eel as the Japanese, they hold the fish in high regard all over the continent: jellied or stewed in the United Kingdom; smoked in Germany, the Netherlands, and Scandinavia; cooked in a red-wine sauce in France; grilled in Italy—the list goes on. The drop in the European eel population has spurred concern and research activity in recent years. Danish researchers, aiming, like the Japanese, for commercial aquaculture production, have induced sexual maturation and spawning in European eels, and have kept the resulting larvae alive for as long as eighteen days, but not without a struggle. The project's lead researcher, Jonna Tomkiewicz, an aquatic biologist at the Technical University of Denmark in Charlottenlund, told me, "Right now, we're where the Japanese were thirty years ago. Their research has received a lot of funding because eels form such a large part of their diet."

Nevertheless, Tomkiewicz is confident that European eels will eventually be mass-produced. The EU and Denmark recently infused several million euros into her project. Should it succeed, the capacity to breed eels would not only be commercially important, but would also help relieve pressure on the wild stock, she says.

In the U.S., researchers at the University of Massachusetts Dartmouth have bred American eels and sustained the larvae for six days. The program is young—just entering its fourth year—and focuses on understanding the eels' decline, not on aquaculture. That, no doubt, reflects the economic insignificance of the domestic eel market. Some Asian communities carry on a small trade in eels, and a few Italian-Americans still incorporate them into a traditional Christmas Eve supper. But most Americans will live and die without tasting eel flesh. Quite a comedown in popularity for the fish that was a staple of Native American tribes along the

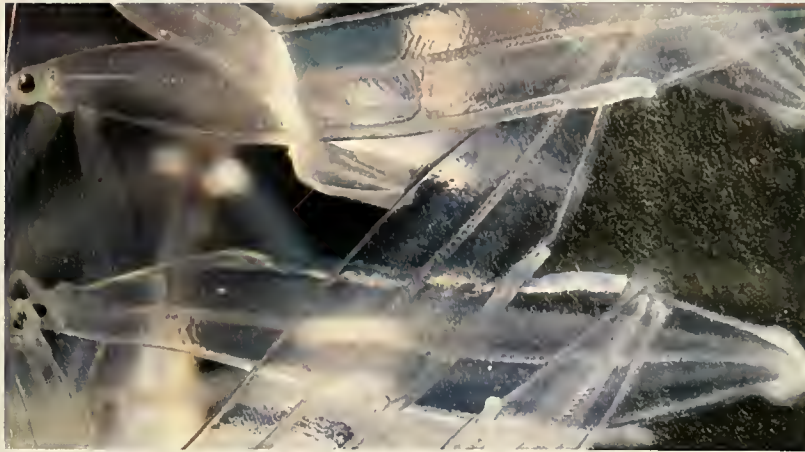
East Coast and its rivers, and that virtually saved the *Mayflower* pilgrims from starvation their first spring in Massachusetts, in 1621. Eel was avidly consumed as a readily available, inexpensive fish in the U.S. until after World War

I, when its presence dwindled, then disappeared from the national table—a change often attributed to modern squeamishness about its snakelike appearance and slime coating. It is hard to think of another food that has fallen so far out of favor in just a century.

Eels may be on the verge of disappearing from tables everywhere. Japanese, European, and American eels share an alarming reduction in the numbers both of elvers navigating upriver and of adults returning downriver. (Eels are far more easily monitored in freshwater than at sea.) In the mid-1990s, the number of elvers in Japan fell precipitously. Although they have since recovered somewhat, they haven't returned to former levels, and adult-eel catches have steadily declined. The number of elvers entering European rivers is estimated to have fallen more than 95 percent over the past decade, and authorities have declared the European eel population to be "outside of safe biological limits." As for American eels, Canadian researchers voiced concern about them as early as the mid-1990s, and their numbers have continued to dwindle. In 1982, a daily mean of more than 25,000 eels used an eel ladder at a dam on the upper Saint Lawrence River, in Cornwall, Ontario. By 2005, that number was down to around 200.

The easy part is counting them. The hard part is figuring out why their numbers are declining. Adverse conditions could be affecting the eel at any of the phases in its wide-ranging and uncharted life cycle. Researchers have proposed various causes: habitat destruction in the form of dams and other barriers to upstream migration; disease or parasites; freshwater pollution; climate change, affecting the water temperature or the ocean currents that carry the leptocephali landward; or any combination thereof. Alternatively, the diminishing numbers of elvers and eels could simply reflect a natural cycle that will reverse itself in time.

Europe has reacted in a stronger fashion than Japan, the U.S., or Canada. New restrictions on the capture and trade of adult and glass eels go into force in the EU during 2009. Some member nations have even temporarily banned eel fishing outright. And this past March, listing of the European eel under Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and



Japanese eel larvae, *A. japonica*, cultured in an aquaculture laboratory

Fauna (a.k.a. CITES) took effect, placing additional substantive restrictions on the fishery. In Japan, fishing for adult eels is unrestricted but insignificant; the capture of glass eels and elvers for aquaculture purposes is generally

prohibited, with some local exceptions.

For its part, Canada has listed the American eel as a "species of special concern," but not as threatened or endangered. Its capture is legal in all of its home provinces except Ontario. And after a two-year review, the U.S. Fish and Wildlife Service (USFWS) likewise concluded that the American eel is not an endangered or threatened species. So most of the states it lives in continue to permit the harvest of eels longer than six inches, or past the glass-eel stage. "The American eel has experienced declines due to various causes in parts of its range, but we looked closely at the situation and there are millions and millions of them out there," says David Perkins, a fisheries manager with the USFWS's Northeast Region who participated in the review. "The species is not in danger of disappearing."

Still, it's probably a good thing that Americans have all but stopped eating eel, or their numbers would undoubtedly be lower. Even though most Americans may never lay eyes on an eel—alive or butterflied—the nation would be a poorer place without them. Eels have coexisted with humans for millennia. Their life of transformations makes our own cradle-to-grave journey in the same aging body seem monotonous. The eel is one of those animals that inspires enduring wonder in people who study it. "I used to work with cod, and when I switched to eels I was surprised by the passionate feelings that surround them," says David Righton of the Eeliad project. "Now I understand it. They are truly marvelous creatures. In Europe, they have not been very fundable and are only now beginning to receive the attention they should have had a long time ago. We'll see if it's soon enough."

Richard Schweid, a Nashville native, lives and writes in Barcelona, Spain, where he is a founding editor of the magazine *Barcelona Metropolitan*. He has published nonfiction books on a number of subjects, including eels (*Eel*, Reaktion Books, 2009, and *Consider The Eel: A Natural And Gastronomic History*, University of North Carolina Press, 2002), cockroaches, American cars in Cuba, and catfish farming in the Mississippi Delta.



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BOOKSHELF BY LAURENCE A. MARSCHALL



Crow Planet: Essential Wisdom from the Urban Wilderness

by Lyanda Lynn Haupt
Little, Brown and Company, 2009;
229 pages, \$23.99

Much has been written of late about the interaction between animals and humans at the boundaries of our cities, where tendrils of suburban development intrude ever farther into previously uninhabited forests and open fields. But the dynamic works the other way, too: wild animals have been moving deep into

our cities at an accelerating pace. Peregrine falcons, for instance, now regard the ledges of skyscrapers, high-rises, and bridges as natural nesting places. And then, of course, there are crows, which have long regarded urban landscapes as fine places to carry on their business.

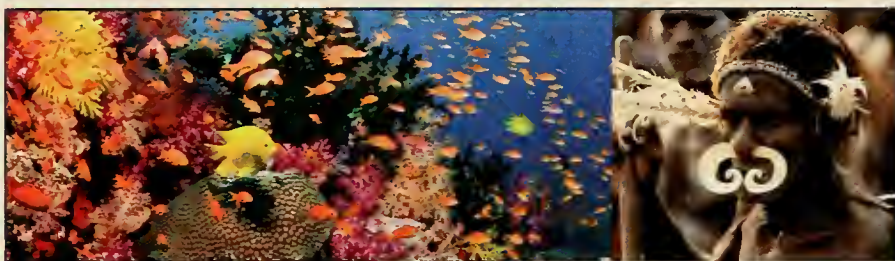
Naturalist and essayist Lyanda Lynn Haupt wants us to realize what the crows have known for so long: that “there is a continuum from a pure, undefiled wilderness to a trampled, concrete industrial area,” and that “there is no place that the wild does not. In some small way, proclaim itself.” And so, through a series of well-crafted and perceptive meditations on urban crows, she invites us to see nature on the wing, right outside our townhouse doors.

Crows have adapted so well to our cities, of course, because they are

among the cleverest of birds. Recent studies have classed their cognitive skills as comparable in many ways to those of apes. They seem to be able to reason causally, as when they poke holes in a plastic grocery bag to see whether there is food inside. One well-documented stratagem of urban crows worldwide is dropping nuts onto busy city streets so that cars will break the shells. In David Attenborough’s 1998 documentary *The Life of Birds*, crows in Tokyo can be seen taking the trick a step further. Realizing that the cars could flatten them as well as the acorns and chestnuts, those Japanese crows wait at curbside for the walk signal before hopping onto the pavement with the human pedestrians and strolling over to claim their bounty.

Haupt wants us to realize that crow behavior is no less remarkable in the city than it would be out in the woods. Much of the birds’ behavior, in any case, would be the same no matter where they lived. Following Haupt’s lead, we can watch crows raise their young in nests built in streetside or backyard trees (she cautions readers on how not to disturb them). If you observe from a distance you may be able to catch sight of the hatchlings as they learn to hang their little tails over the edge of the nest to avoid soiling the nursery. Later, you may be treated to the slapstick routines of the young as they learn to fly, jumping clumsily from the nests or nearby twigs—and sometimes crash landing on the pavement below.

According to Haupt, urbanites who love the wild should consider themselves fortunate, for the modern city is by no means a hermetic exclusion of nature. It is rather what she terms a zoöpolis, “an overlap of human and animal geographies,” where a keen-eyed and patient naturalist can find endless opportunities to stimulate the mind and feed the soul. That’s what the crows taught Lyanda Lynn Haupt, and that’s what her book can teach us all.



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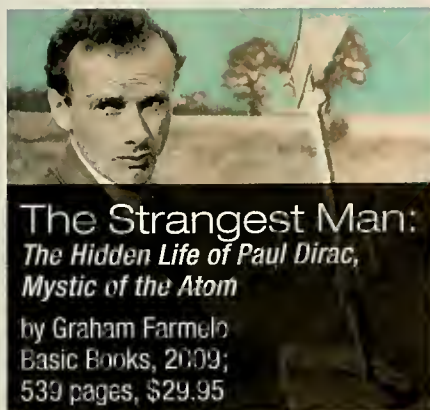
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It was as if Paul Dirac were made of antimatter. Other physicists of the generation that created quantum mechanics appeared normal by comparison: they were sociable creatures whose quirks (and there were many) only made them seem more human. Niels Bohr liked to entertain his associates in his lavish mansion on the grounds of a Carlsberg brewery. Erwin Schrödinger *really* liked

women (he lived openly with both his wife and his mistress). Albert Einstein played his violin in chamber ensembles.

But Dirac did none of those things. He was legendary for his inability to appreciate the give-and-take of normal conversation. In a typical Dirac story, recounted in this book, which I also heard as a graduate student in the 1960s, Dirac stands at the blackboard after giving a lecture. Someone in the audience raises his hand and says, "I don't understand the equation on the top right-hand corner of the blackboard." The room is silent, the seconds ticking by uncomfortably, until at last the uneasy moderator asks for a reply to the question. "That was not a question," says Dirac without emotion, "it was a comment."

Graham Farmelo, a senior research fellow at the Science Museum, London, has taken on the challenge of examining the significance of

Dirac's life and work with thoroughness and obvious sympathy. Dirac's greatest accomplishment was an equation that predicted the existence of antimatter even before there was experimental proof that the weird stuff existed. He also wrote an influential textbook on quantum mechanics, so lucid in its insights that it has never gone out of print.

Farmelo's eloquent and empathetic examination of Dirac's life raises this book above the level of workmanlike popularization. Using personal interviews, scientific archives, and newly released documents and letters, he's managed—as much as anyone could—to dispel the impression of the physicist as a real-life Mr. Spock, the half Vulcan of *Star Trek*. Dirac was certainly oddly self-absorbed, "childlike but never childish," as a colleague once described him, but as Farmelo's narrative unfolds, you see that it was just because

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BOOKSHELF

Dirac's humanity was hidden by a profound reserve.

Perhaps that wasn't so much an abnormality (though Farmelo ventures a diagnosis of autism) as a consuming passion for science that satisfied the young Dirac far more than the messiness of interpersonal relations. The older Dirac, married and with family responsibilities, took canoe trips with a friend and found amusement in the Sunday comics (he especially liked *Prince Valiant* and *Blondie*). Reading Farmelo's biography, the enigma grows less strange. Or perhaps, as with the quantum mechanics Dirac helped develop, we just grow more accepting of the strangeness as it becomes more familiar to us.



Dazzled and Deceived: Mimicry and Camouflage

by Peter Forbes
Yale University Press, 2009;
300 pages, \$27.50

Have you ever noticed that field mice have dark-colored backs and light-colored bellies? It's the same with a great many animals, from brook trout to beagles. It was a New England artist, Abbott H. Thayer, who first figured out why. In 1896, he submitted an article to the natural history journal *The Auk* in which he proposed that the pattern is a form of camouflage. The bellies of animals, which are usually shaded by their bodies, would appear darker than their backs if not light-colored or white to compensate for daytime

Continued on page 42

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THIS LAND BY ROBERT H. MOHLENBROCK

Bald Heads and Bare Knees

Delaware plays host to a deciduous member of the cypress family.

Mention "bald cypress" and one thinks of the vast swamps of Georgia, Florida, Louisiana, and other states in the Southeast. But the trees naturally range northward up the Mississippi River basin and along the Atlantic coastal plain. Recently I wrote of the "northernmost bald cypress swamps in the nation's heartland," not far from my home in southern Illinois ["On Heron Pond," May 2009]. But to see the most northerly stand on the continent, I traveled to Delaware's Trap Pond State Park.

Bald cypress (*Taxodium distichum*) is so named because it is deciduous, unlike most members of the cypress family, which includes, among other trees, cedars, cypresses, junipers, redwoods, and sequoias. Some botanists classify all three living members of the genus *Taxodium* as variants of *T. distichum*, but I recognize the two others as distinct species: pond cypress (*T. ascendens*) and Montezuma bald cypress (*T. mucronatum*). Pond cypress is also deciduous, losing its leaves during the winter; *T. mucronatum*, a native of Mexico, is semievergreen, shedding its leaves only where there's a distinctly cooler season. Two Asian species, the Chinese swamp cypress, *Glyptostrobus pensilis*, and the dawn redwood, *Metasequoia glyptostroboides*, also lose their leaves in winter.

Since bald cypress trees have rot-resistant wood and are highly valued

as timber, they were extensively cut in the Trap Pond area during the late 1700s. Indeed, a dam that was built to power a local sawmill created the pond. By the early 1800s, most of the large bald cypress trees had been logged. Farmers then ditched and drained much of the area to dry it out for agricultural purposes. In the 1930s, the United States government purchased Trap Pond and the area around it, and in 1951 it became one of Delaware's first state parks. Today it encompasses more than 3,500 acres.

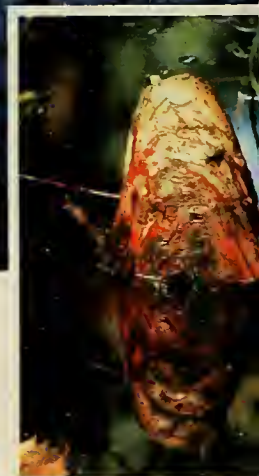
The bald cypress trees border the park's 107-acre Trap Pond and its tributaries, growing on the swampy banks and in the water. They may be reached from the water (by park-operated pontoon boat and a variety of watercraft for rent) or by hiking the Cypress Point Trail. The approach by boat affords an unbeatable view, but the trail, which begins in dry upland woods and passes through mesic (moist) woods, provides the opportunity to examine other trees as well as understory plants.

All three species of *Taxodium* have many small leaves borne on branchlets. The leaves, which are less than one inch long, may fall off individually, but the more northerly trees really go bald when they shed many of their branchlets for the



Bald cypress reflects in Trap Pond on a winter day. Right: A bald cypress pneumatophore, or "knee," emerges from a swamp.

MITCHELL LE SAGE



winter. Round male and female cones grow on the same tree at about the same time in early spring. Pollen is pro-

HABITATS

Dry woods are dominated by blackjack oak, chinquapin oak, downy serviceberry, northern red oak, red hickory, sassafras, southern red oak, Virginia pine, and white oak. Deerberry, a type of

highbush blueberry, is a common shrub or small tree. Blue Ridge blueberry is a low-growing shrub. Broomsedge bluestem and poverty oat grass are common on the forest floor.

Mesic woods lie between the upland and the swamp. Principal trees are American beech, American holly, black cherry, flowering dogwood, loblolly pine, red maple, sweetgum, and tulip tree.

Several prickly greenbrier vines grow in this habitat; poison ivy and Virginia creeper are common. A common shrub or small tree is devil's walkingstick, named for its spiny stem.

duced in the tiny male cones, which cluster by the hundreds on elongated sprays called “panicles” that hang from the ends of persistent branchlets formed the preceding year. The female cones, which are larger (up to one inch in diameter), arise at the ends of branches. One or two seeds develop on each scale of a female cone and are mature by autumn. To be fully primed, the seeds require a month of immersion in water, though they will not germinate underwater.

The bald cypress, which can grow more than 100 feet tall, has needlelike leaves arranged on two sides of each branchlet in a herringbone pattern. It is a common inhabitant of deep swamps and the floodplains of rivers, habitats where silt accumulates. It often grows in permanently standing water, which promotes a swollen, or buttressed, base. It



ranges from the southeastern United States west to Texas and north as far as southern Illinois, southern Indiana, and southern Delaware.

Pond cypress leaves differ in that they grow on fine, erect branchlets, and they are scalelike, often “appressed”—lying flat along the branchlets. The species, whose maximum height is about 80 feet, prefers swamps that do not have an accumulation of silt. It also occurs along blackwater streams. It is found from North Carolina south to Florida and west to eastern Louisiana.

Montezuma bald cypress leaves are similar to those of bald cypress, but the panicles that bear the male cones are longer and less crowded. The species is mostly native to Mexico, where it grows along the banks of rivers, but it extends into Texas, particularly along the Rio Grande. In the southern parts of its range, it is usually evergreen. One specimen in the Mexican village of Santa Maria del Tule, about five miles east of the city of Oaxaca, is among the largest trees in the world. The famous Tule Tree has a circumference of approximately 110 feet, a diameter of 25 to 50 feet (greater than that of any sequoia), and an estimated height of 140 feet. Because of its multiple trunks, some botanists have suggested it is actually several trees growing together, but recent DNA studies by a group of Mexican botanists prove it is a single tree.

Bald cypress, pond cypress, and Chinese swamp cypress (but not Montezuma bald cypress) all may form pneumatophores, or “knees.” Those woody, columnar structures may grow several feet tall. I have seen some nearly nine feet tall at the



Top: Needlelike bald cypress leaves, growing on branchlets, form a herringbone pattern. Above: Tiny pond cypress leaves clinging tightly to upright branchlets.

Guillard Lake Scenic and Research Natural Area in South Carolina’s Francis Marion National Forest, and in the Cypress Creek National Wildlife Refuge in southern Illinois. The knees give added anchorage to trees that live in the swampy environment. Trees grown as ornamentals in drier soil usually do not form them. Although some botanists and many textbooks state that the pneumatophores facilitate the passage of carbon dioxide and oxygen to and from the plant, experiments do not bear that out. The knees do, however, store food in the form of starch.

ROBERT H. MOHLENBROCK is a distinguished professor emeritus of plant biology at Southern Illinois University Carbondale.

Cypress swamp Bald cypress grows on the banks or a short distance from them in standing water up to four feet deep. Other trees include mountain laurel, red maple, swamp tupelo,

water oak, and willow oak. Shrubs in standing water beneath the bald cypresses are buttonbush and swamp loosestrife. Among the shrubs growing in muddy soil beneath the trees are

American black elderberry, coastal pepperbush, common winterberry (a type of holly that loses its leaves during the winter), northern spicebush, possumhaw, and purple chokeberry.

Nonwoody species growing in the swamp’s wet soil are arrow arum, Canadian clearweed, smallspike false nettle, and several sedge species, including *Carex bromoides*, *C. crinata*, and *C. interior*.

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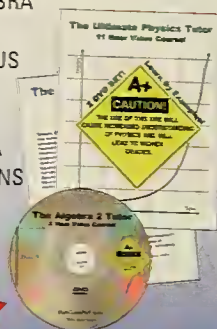
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SKYLOG BY JOE RAO

November welcomes the return of the Leonid meteor shower, so named because it seems to emanate from within the constellation Leo, the Lion. The meteoroids that cause the display were once part of Comet Tempel-Tuttle, which orbits the Sun every thirty-three years (its last close approach to the Sun, the perihelion, was in 1998). The comet's periodic nature was first established and its orbit plotted following its observation in the winter of 1865–1866 by both the German astronomer Wilhelm Tempel and the American astronomer Horace Parnell Tuttle.

On each visit to the inner solar system, Comet Tempel-Tuttle crosses Earth's orbit, and there its dusty debris hits our atmosphere at nearly forty-five miles per second. Typically only about ten Leonids flash by per hour at the shower's peak, but 2009 promises to be a banner year. Our planet is projected to pass near the center of a dense trail of debris left behind in the year 1466. In 2008, Earth's passage through the outer edges of that debris trail briefly produced up to a hundred Leonids per hour for viewers in Europe.

NOVEMBER NIGHTS OUT

- 1 Clocks "fall back" one hour as daylight saving time gives way to standard time. Tonight and all through November, you'll find Jupiter standing high in the south at nightfall (south-southwest by month's end).
- 2 The Moon is full at 2:14 P.M. eastern standard time (EST).
- 3 Venus rises just south of east about ninety minutes before sunup. Forty-five minutes later look for the blue star Spica sparkling about 3.5 degrees to the right of and slightly below the planet.
- 9 After midnight (in the wee morning hours), Mars appears as a bright, yellow-orange "star" several degrees above and to the left of the Moon. The Moon wanes to last quarter at 10:56 A.M. EST.
- 10 During the predawn hours the blue



Leonid meteor, November 17, 1998, Monteromano, Italy

The greatest activity should come on November 17, but unfortunately for North Americans, it will be during their daytime hours. Viewers across Central Asia will have the best seats. Jérémie Vaubaillon of Caltech predicts the peak should come at 21:43 Greenwich mean time (4:43 P.M. eastern standard time), and be characterized by rates of up to five hundred meteors per hour! For North America, the predawn hours of the 17th seem to offer the most promise: perhaps twenty to thirty Leonids per hour (or even more). Set a lounge chair in a dark place with a clear view of the sky. Don't stare at any one place, but keep your eyes moving over the sky. Begin watching soon after midnight; the shower should gradually intensify as dawn approaches.

JOE RAO is a broadcast meteorologist and an associate and lecturer at the Hayden Planetarium in New York City (www.haydenplanetarium.org).

star Regulus sits several degrees above and to the left of the Moon.

12 Low in the east, about four hours before sunrise, yellowish-white Saturn shines a little below and ten degrees to the left of the crescent Moon.

15 About an hour before sunrise, look for a very thin crescent Moon, with Venus slightly higher and about seven degrees to the left.

16 The Moon is new at 2:14 P.M. EST.

17 The Leonid meteor shower peaks (see story above).

23 To the south, soon after sundown, the crescent Moon hovers a few degrees directly above Jupiter.

24 The Moon waxes to first quarter at 4:39 P.M. EST.

BOOKSHELF

Continued from page 37

illumination. Pale bellies and darker backs thus help animals appear more uniform in sunlight, and make it harder for predators to spot them. Thayer claimed to have become aware of that protective coloration because of his own difficulties in sketching animals in the wild.

In a revealing and entertaining review of mimicry and camouflage in nature, art, and war, journalist Peter Forbes explores a wide range of eye-fooling strategies, such as the one discovered by Thayer. There are fish called sea dragons that masquerade as fronds of seaweed, spiders that resemble bird droppings, and leaf butterflies that, when perched on a branch, are indistinguishable from foliage.

Not all protective strategies involve hiding in plain sight, however. The larva of the elephant hawk moth, when threatened, contracts its body to resemble the head of a large snake, an effective deterrent to a hungry bird. And what's fair for prey is also fair for predators: the Malayan praying mantis (*Hymenopus bicornis*), to give one example, is a dead ringer for a local flower (*Melastoma polyanthum*) that is frequented by bees. All a mantis has to do is sit quietly on an *M. polyanthum* bush, and dinner will come buzzing right into its clutches.

Animals don't adopt disguises consciously, of course, the way a hunter dons camos on the first day of deer season. Forbes rightly portrays camouflage and mimicry as examples of how natural selection can act in subtle and surprising ways. His book will open your eyes to aspects of the natural world that may have passed you by, unnoticed.

LAURENCE A. MARSCHALL is W.K.T. Salm Professor of Physics at Gettysburg College in Pennsylvania and coauthor, with Stephen P. Maran, of *Pluto Confidential: An Insider Account of the Ongoing Battles over the Status of Pluto*, published by BenBella Books.

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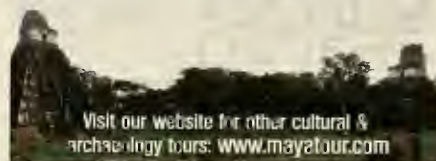
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AN ENCHANTING JOURNEY:

Traveling the Silk Road Opens November 14

It's December 21 in AD 1000 in the heart of Baghdad. You're a scholar making an entry in your journal, and you need to know the time. If the sun were up, you could make a fair guess, but it's night. So you reach for an ingenious device perfected by Islamic astronomers: an astrolabe that can pinpoint the hour by the position of the stars. Problem solved!

Welcome to just one of the many engaging hands-on experiences in the Museum's new exhibition *Traveling the Silk Road: Ancient Pathway to the Modern World*, an exploration of the golden age of one of the greatest trading routes of all time. Opening November 14, this captivating exhibition transports visitors to four storied cities: Xi'an, the capital of China's Tang Dynasty; Turfan, a verdant trading outpost; Samarkand, home of merchants who thrived on the caravan trade; and, finally, ancient Baghdad, a fertile hub of commerce and scholarship that became the intellectual center of the era.

Despite its name, the Silk Road was not one road but a network of routes that connected broad regions and facilitated trade between China and the empires of Central and West Asia. In addition to serving as a conduit for commerce, it was the information highway of its time, helping to disseminate science, folklore, art, and religious beliefs.

"No single person traveled the entire extent of the Silk Road, but trade goods did, and, more importantly, so did ideas," explains Mark Norell, Chairman and Curator-in-Charge of the Division of Paleontology at the Museum. "Paper, which helped spread literacy and Islam throughout the world, was a major invention from China. Buddhism, which came out of India, went north." Norell co-curated *Traveling the Silk Road* with guest co-curator William Honeychurch, assistant professor at Yale University's Department of Anthropology, and consultant Denise Leidy, curator of the Department of Asian Art at the Metropolitan Museum of Art.

Adults are sure to enjoy inspecting the goods at a grape-bordered night market in Turfan, delving deep into geography on an interactive tabletop map, or walking through a cross-section of an Arab sailing ship, or dhow. But there is also much to capture the imagination of children, includ-



A member of the exhibition department prepares a caravan camel for the Silk Road.

ing individual "passports" that are stamped at each stop of the journey, a live-animal display of silk worms (*Bombyx mori*), several life-sized resin camels, and a musical interactive in which children can activate the sounds of ancient instruments. In Samarkand, an ongoing story hour uses computer animation to recreate timeless tales from lands traversed by the Silk Road.

Elsewhere, a video lays out the process of sericulture—raising worms to make silk—while text and images offer step-by-step explanations of glass blowing and making paper, the breakthrough communications technology of its time.

—Joan Kelly Bernard

The Presenting Sponsor of *Traveling the Silk Road: Ancient Pathway to the Modern World* is MetLife Foundation.

Additional support has been provided by Mary and David Solomon.

Every Sunday Afternoon, Sounds of the Silk Road

"Lands that were once considered distant are no longer thought to be so—we are all becoming neighbors," says Yo-Yo Ma, founder and artistic director of the Silk Road Project. Since 1998, the initiative has looked to the ancient Silk Road as a modern metaphor for the exchange of art, music, and ideas between far-flung places. Joining past and modern traditions, the Silk Road Ensemble, a group of renowned musicians, composers, arrangers, visual artists and storytellers, has visited more than 100 venues in 25 countries.

This fall the Silk Road Project comes to AMNH, curating a series of concerts as part of the exhibition *Traveling the Silk Road*. Every Sunday afternoon, live performances—including traditional music and storytelling—will be held at the far end of the gallery, bringing to life yet another lasting legacy of this legendary trade route.

—Jessica Ulrich

The Silk Road Project residency is generously supported by Rosalind P. Walter.



Silk Road Ensemble members

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33rd Annual Margaret Mead Film & Video Festival Opens November 12

In the Bedouin village of El-Sayed, it's not uncommon for children to grow up with five hearing siblings and four who are deaf. Deafness has long been part of life in this community, shaping its unique sign language and social conventions. Enter city doctors, who extol the virtues of an implant that can make deaf children hear. Will the new technology threaten the culture of this desert hamlet?

That tension lies at the core of *Voices From El-Sayed*, a remarkable documentary that follows the progress of one deaf boy whose family risks the implant. The film will be screened this month at the American Museum of Natural History as part of the 33rd Annual Margaret Mead Film & Video Festival. The longest-running such showcase in the United States, the festival is renowned for engaging audiences in dynamic post-screening discussions with filmmakers, experts, and subjects.

In a nod to the new exhibition *Traveling the Silk Road*, several of the festival's selections will also explore the movement of goods and ideas. Capitalism and religion collide in *Hair India*,

which traces the booming trade in human hair from a temple that auctions off sacred hair offerings to a posh Mumbai salon whose clients pay top dollar for high-end extensions.

The festival opens November 12 with *Cooking History*, a compelling look at the food customs of last century's bloodiest conflicts. "Talking about war through food is a really unique way to examine war's devastating effects," says Festival Director Ariella Ben-Dov, and the film serves up striking stories from a Russian cafeteria worker who prepared blinis during the Nazi siege of Leningrad, a Hungarian butcher who made sausages for Soviet occu-



The cochlear implant is a controversial arrival in El-Sayed.

ers a decade later, and more. Through the eyes of the cooks who fed the troops, *Cooking History* offers a rare glimpse of military cuisine lore.

For a complete schedule of the festival, which runs through November 15, as well as for details about opening night, visit amnh.org/mead.

—Eugenia Levenson

The Ancient Silk Road: Travel with the Curator

Imagine yourself in the Gobi Desert, following in the footsteps of the legendary AMNH fossil hunter Roy Chapman Andrews, gazing in awe at the Qin Dynasty terra-cotta warriors, and visiting the Caves of The Thousand Buddhas—all with Mark Norell, Chairman and Curator-in-Charge of the AMNH Division of Paleontology, by your side to share his insights.

That's just part of the amazing itinerary of an AMNH Expeditions private jet program planned for spring 2010, which allows travelers to trace the paths of ancient Silk Road caravans accompanied by Norell, co-curator of the exhibition *Traveling the Silk Road: Ancient Pathway to the Modern World*, which opens this month.

The 15-day trip, which runs April 20 through May 4, 2010, begins in Xi'an, the gateway to the ancient Silk Road, and takes travelers to historic sites in China, Mongolia, Uzbekistan, Armenia, and Turkey before concluding in Istanbul or London. The expedition is limited to 72 travelers, and ticket prices start at \$29,950. For more information, visit amnhexpeditions.org or call 1-800-454-4149.



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At the Museum

AMERICAN MUSEUM OF NATURAL HISTORY 

www.amnh.org

EXHIBITIONS

*Traveling the Silk Road:
Ancient Pathway to the
Modern World*

Opens November 14

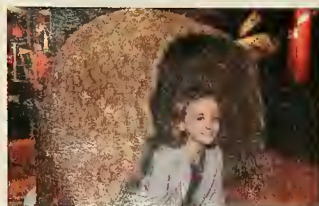
This intriguing exhibition transports visitors to one of the greatest trading routes of all time, showcasing the goods, technologies, and cultures from four storied cities: Xi'an, China's Tang Dynasty capital; Turfan, a verdant oasis; Samarkand, home of prosperous merchants; and ancient Baghdad. Explore commerce, communication, and cultural exchange from AD 600 to 1200. Don't miss live performances, produced by the Silk Road Project, every Sunday.

Traveling the Silk Road is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with Azienda Speciale Palaexpo, Roma, Italy and Codice. Idée per la cultura srl, Torino, Italy; the National Museum of Australia, Canberra, Australia and Art Exhibitions Australia; the National Museum of Natural Science, Taichung, Taiwan and United Daily News, Taipei, Taiwan.

The Presenting Sponsor of *Traveling the Silk Road: Ancient Pathway to the Modern World* is MetLife Foundation.

Additional support has been provided by Mary and David Solomon.

The Silk Road Project residency is generously supported by Rosalind P. Walter.



A visitor tries out an *Extreme Mammal* adaptation.

Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time
Through January 3, 2010
Featuring fossils and modern

mammals from the Museum's world-class collection, this exhibition reveals the distinctive qualities and shared ancestry that unite this diverse class of animals.

Extreme Mammals is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with the California Academy of Sciences, San Francisco; Canadian Museum of Nature, Ottawa, Canada; and Cleveland Museum of Natural History.

Major funding for *Extreme Mammals* has been provided by the Lila Wallace-Reader's Digest Endowment Fund.

Additional generous support for *Extreme Mammals* has been provided by the Bill and Ann Ziff Foundation, the Eileen P. Bernard Exhibition Fund, and Harlan B. Levine, M.D. and Marshall P. Levine.

Frogs: A Chorus of Colors

Through January 3, 2010

This delightful exhibition features more than 200 live frogs in re-created habitats.

This exhibition is presented with appreciation to Clyde Peeling's Reptiland.

*The Butterfly Conservatory:
Tropical Butterflies Alive in Winter*

A perennial favorite, this exhibition lets visitors mingle with up to 500 live, free-flying tropical butterflies.

*Highway of An Empire:
The Great Inca Road*

The Inca Empire owed its reach and power to an extensive network of roads, the focus of this stunning new photo exhibition.

Courtesy of the Consulate General of Peru in New York.

The presentation of *Highway of An Empire* at the American Museum of Natural History is made possible by the generosity of the Arthur Ross Foundation.



Al Gore

SPECIAL EVENTS

*A Night With Al Gore:
Our Choice*

Tuesday, 11/3, 7:30 pm

Former Vice President Al Gore will discuss his new book *Our Choice*, an inspiring call to action in the face of the climate crisis. Book signing will follow. For tickets, visit amnh.org.

SciCafe

Wednesday, 11/4, 7 pm

Cocktails, conversation, and cutting-edge science are all on tap at the second installment of this exciting new monthly series. See amnh.org/scicafe for a complete schedule.

Proudly sponsored by Judy and Josh Weston.

Media Partner for SciCafe is *Seed Magazine*.

*33rd Annual Margaret Mead
Film & Video Festival*

Thursday, 11/12–Sunday, 11/15

See the best in documentary filmmaking at the Margaret Mead Film & Video Festival, the longest-running showcase of documentary film in the U.S. For the line-up and details about opening night,

visit amnh.org/mead.

Made possible, in part, with public funds from the New York State Council on the Arts.



DJ Spooky

*Art/Sci Collision:
DJ Spooky and The Science of Terra Nova*

Sunday, 11/15, 4 pm

The Margaret Mead Film & Video Festival presents *The Science of Terra Nova*, an exploration of the science and history behind *Terra Nova: Sinfonia Antarctica*, a new multimedia performance by Paul D. Miller (aka DJ Spooky).

Origami Tree

Monday, 11/23–Friday,
1/4/2010

A beloved Museum tradition, the Origami Tree marks the start of the holiday season when it returns to the Theodore Roosevelt Memorial Hall this month. This year's decorative theme—**Origami, A to Z**—will feature an alphabetical menagerie, including *Extreme Mammals*-inspired ornaments.



Last year's Origami Tree included ornaments of dinosaurs, African mammals, and more.

HAYDEN PLANETARIUM PROGRAMS

TUESDAYS IN THE DOME
Virtual Universe: What is a Star? What is a Planet?

Tuesday, 11/10, 6:30 pm

Celestial Highlights: From Cygnus to Orion with Ted Williams

Tuesday, 11/24, 6:30 pm

These programs are supported, in part, by the Schaffner family.

LECTURE

Peter Ward on the Medea Hypothesis

Monday, 11/16, 7:30 pm

Renowned paleontologist Peter Ward discusses a provocative vision of life's relationship with Earth's biosphere.

Journey to the Stars

This spectacular new Space Show launches visitors through time and space to



Glimpse a red giant in *Journey to the Stars*.

experience the life cycle of the stars in our night sky. Tour stellar formations explore celestial mysteries, and discover the fascinating, unfolding story that connects us to the stars.

Journey to the Stars was developed by the American Museum of Natural History, New York (www.amnh.org), in collaboration with the California Academy of Sciences, San Francisco; GOTO INC, Tokyo, Japan; Papalote • Museo del Niño, Mexico City, Mexico; and Smithsonian National Air and Space Museum, Washington, D.C.

Journey to the Stars was created by the American Museum of Natural History, with the major support and partnership of NASA, Science Mission Directorate, Heliophysics Division.

Made possible through the generous sponsorship of Lockheed Martin Corporation.

And proudly sponsored by Accenture.

Super-computing resources provided by The Texas Advanced computing center (TACC) at the University of Texas at Austin through the TeraGrid, a project of the National Science Foundation.

IMAX MOVIES

Beavers

Follow a family of beavers on a series of adventures in a rare, up-close look at these industrious creatures.



Young men net sardines on Umzumbe Beach.

Wild Ocean

Experience the frenzy that takes place each year in the waters off the coast of South Africa as billions of fish migrate up the KwaZulu-Natal Wild Coast.

INFORMATION

Call 212-769-5100 or visit www.amnh.org.

TICKETS AND REGISTRATION

Call 212-769-5200, Monday–Friday, 9 am–5 pm, or visit www.amnh.org. A service charge may apply. All programs are subject to change.

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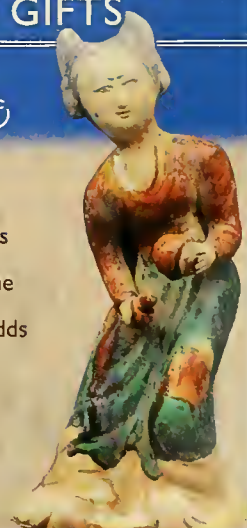
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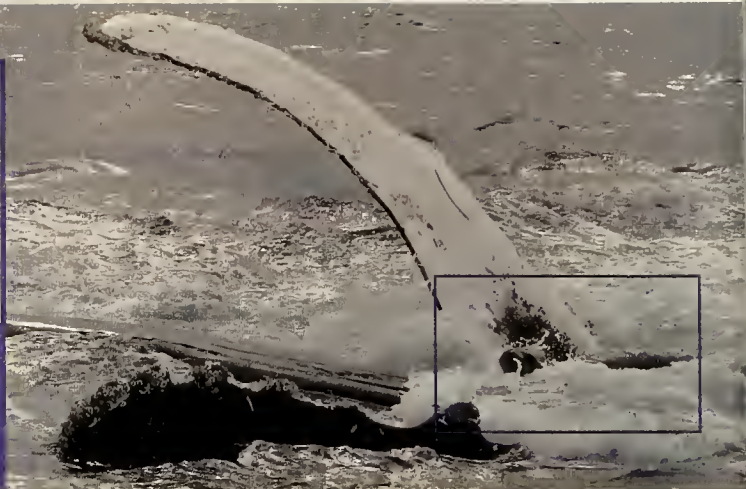
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Save the Seal!

By Robert L. Pitman and John W. Durban



Last January we sailed from the tip of South America to the Antarctic Peninsula on the sixty-five-foot yacht *Golden Fleece*, in search of killer whales. The kind we were looking for—which potentially constitute a new species—prey on seals that live on and around the sea ice. We hoped to document one of their remarkable hunting techniques: sometimes as many as seven whales swim side by side to make a wave that washes a seal off an ice floe. The journey brought some surprises.

Early one morning, we located a pod of ten killer whales that we had previously tagged for satellite tracking, and found they had a pair of agitated, adult-size humpback whales in their midst. The humpbacks were bellowing loudly through their blowholes and slapping the water with their tails and fifteen-foot flippers. At first we thought that the humpbacks were under attack, but we saw no overt signs of aggression, so we concluded that they were probably just being harassed. Killer whales often test larger whales, perhaps to check for weaknesses that they might be able to exploit. We ducked below deck to quickly review some video footage of the event, however, and noticed a Weddell seal between the humpbacks—perhaps that's what the killer whales were after.

The killer whales moved on, and fifteen minutes later they spotted a crabeater seal on an ice floe. They created a wave that broke up the floe and left the distraught seal on a piece of ice not much bigger than it was. Just when it seemed the killers were

about to have their way, the same pair of humpbacks charged in, swimming around the floe, bellowing and thrashing the water. The killer whales seemed annoyed and finally left the seal alone, still safe on the floe. We concluded that perhaps this deliberate intrusion by the humpbacks was some jumbo-size form of mobbing behavior, comparable to the way songbirds pester birds of prey to drive them off.

A week later we witnessed a similar event that suggested a somewhat different interpretation. Another group of killer whales was attacking a Weddell seal on an ice floe, and a different pair of large humpbacks had inserted themselves into the fray. At one point, the predators succeeded in washing the seal off the floe. Exposed to lethal attack in the open water, the seal swam frantically toward the humpbacks, seeming to seek shelter, perhaps not even aware that they were living animals. (We have known fur seals in the North Pacific to use our vessel as a refuge against attacking killer whales.)

Just as the seal got to the closest humpback, the huge animal rolled over on its back—and the 400-pound seal was swept up onto the humpback's chest between its massive flippers. Then, as the killer whales moved in closer, the humpback arched its chest, lifting the seal out of the water. The water rushing off that safe platform started to wash the seal back into the sea, but then the humpback gave the seal a gentle nudge with its flipper, back to the middle of its chest [see photo-

graph above]. Moments later the seal scrambled off and swam to the safety of a nearby ice floe.

It occurred to us that in all three of these encounters, the menacing behavior of the killer whales may have triggered a protective maternal response in the humpback whales. Even though they did not have calves that were at risk, they acted immediately and instinctively to counter the threat posed to a smaller animal.

When an animal provides maternal care to another that is not its own offspring, it is termed *allomaternal* care [see "Meet the Alloparents," April 2009]. Maternal behavior may even cross species boundaries. Perhaps the most common example of that is when humans raise pets, but there are plenty of cases of domestic cats and dogs adopting orphaned animals. Such behavior has been documented less frequently in undomesticated animals—though in 1996 a mother gorilla at the Brookfield Zoo near Chicago made headlines when she gently picked up a three-year-old boy who had fallen into the gorillas' enclosure and carried him to the zookeepers' door.

When a human protects an imperiled individual of another species, we call it compassion. If a humpback whale does so, we call it instinct. But sometimes the distinction isn't all that clear.

ROBERT L. PITMAN and JOHN W. DURBAN are research biologists for the Protected Resources Division of the NOAA Fisheries Service, Southwest Fisheries Science Center, La Jolla, California. The events described here occurred on an expedition in collaboration with a BBC documentary film crew.



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