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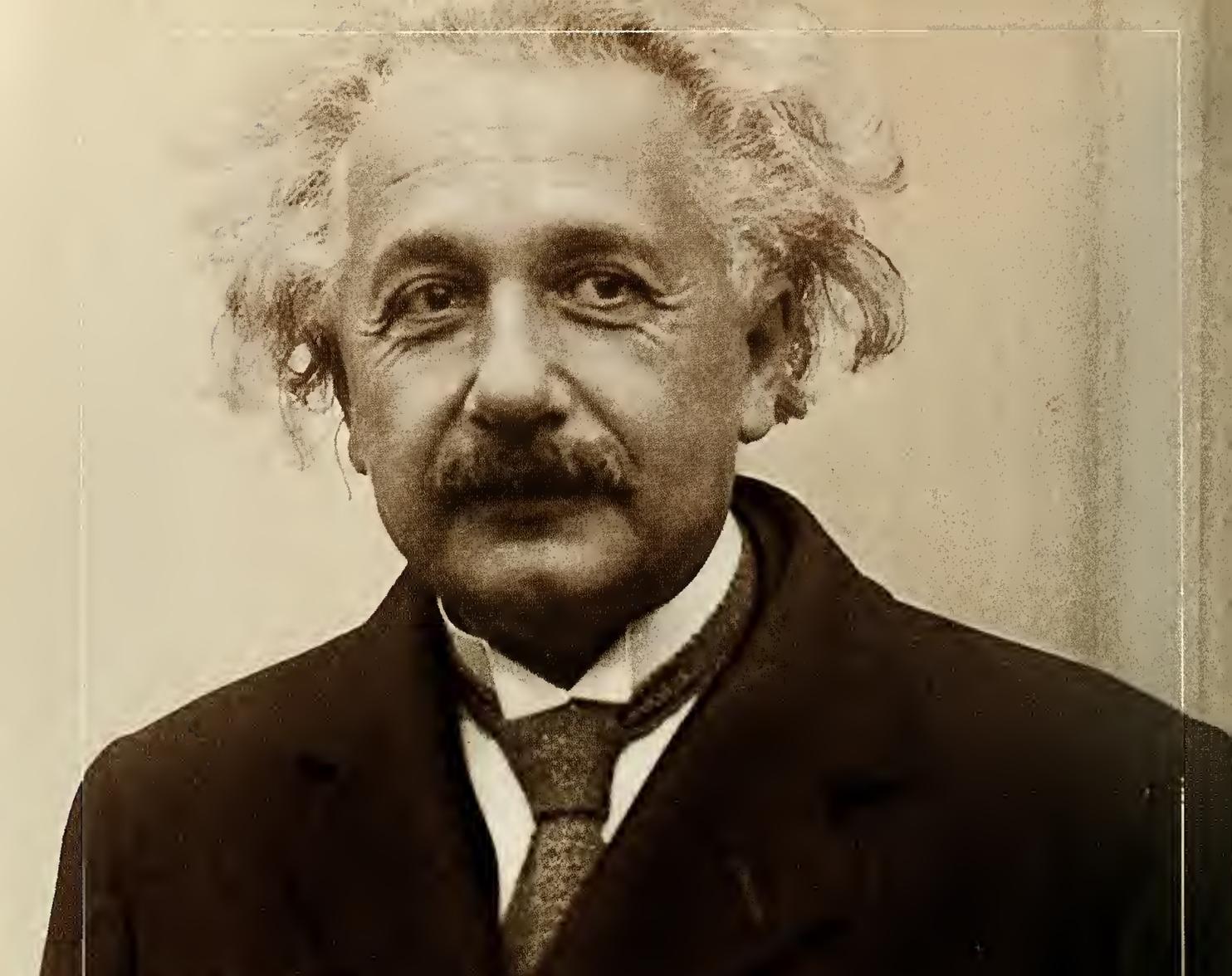
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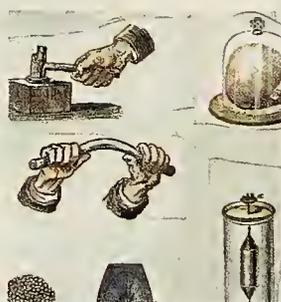
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# This Stop Is Vietnam

Isn't it odd, really, that so much of what we outsiders know about Vietnam is colored by the memory of the war? As someone who came of age in the late 1960s, I still find it hard to put aside the terrible associations some of the names conjure: Mekong River, Gulf of Tonkin, Ho Chi Minh trail (soon to be a major superhighway), even the description "mountains and jungles of Vietnam." Yet behind those names from ten thousand wartime dispatches is a land that is home to an incredible diversity of life-forms, including literally hundreds of species new to science that were hidden by decades of conflict.

Vietnam lies at the center of a tectonic traffic jam. Mountains and rivers arose from collisions of three tectonic plates, creating an immense variety of ecosystems in the country as well as some formidable barriers to species migration. Swings of climate—hot and cold, wet and dry—buffeted the landscape. During ice ages long ago, sea levels plunged and the continental shelf off the shores of Vietnam turned into dry land. Some species roamed across the newly exposed land. Then, when the climate warmed and sea levels rose again, populations became trapped and isolated on newly created islands. Other species, which once ranged freely across cool valleys, were chased up to cooler mountains as the lowland climate began to warm; eventually they became isolated by altitude instead of by seawater. With time, the isolated populations evolved and diverged, then remixed when the barriers to their spread eventually receded once more.

With this issue the editors of *Natural History* invite you back to Vietnam, a country that has become both a hot tourist destination and an ecologist's dream. Join Nguyen Thi Dao as she recalls running as a child through the forests of Cuc Phuong National Park, Vietnam's oldest national park (see "My Life as a Forest Creature," page 70). Marvel at photographer Mark Moffett's glorious image of a caterpillar native to the rainforests of Vietnam (see "Pretty Poison," page 10). Enjoy the reminiscences of Le Anh Tu Packard, as she recalls the aromatic dishes her grandmother flavored with the sublime extract of the *ca cuong*, the water bug that for the Vietnamese is practically a symbol of the highest culinary art (see "Bug Juice," page 63). Finally, take a field trip with Eleanor J. Sterling, Martha M. Hurley, and Raoul H. Bain (see "Vietnam's Secret Life," page 50) to discover how the nation's rich biodiversity, coupled with the crazy-quilt complexity of its ecosystems, arose directly from the pushes and pulls of its turbulent climatic and geologic history.

Thus informed, you won't want to miss the new exhibit at New York City's American Museum of Natural History, "Vietnam: Journeys of Body, Mind, and Spirit," opening March 15.

As this issue of *Natural History* goes to press, we have just begun to mourn the loss of the seven astronauts who perished in the breakup of the space shuttle *Columbia*. Our hearts go out to their families, to their extended family at NASA, and to all our readers who share in the sadness of this tragedy.

—PETER BROWN

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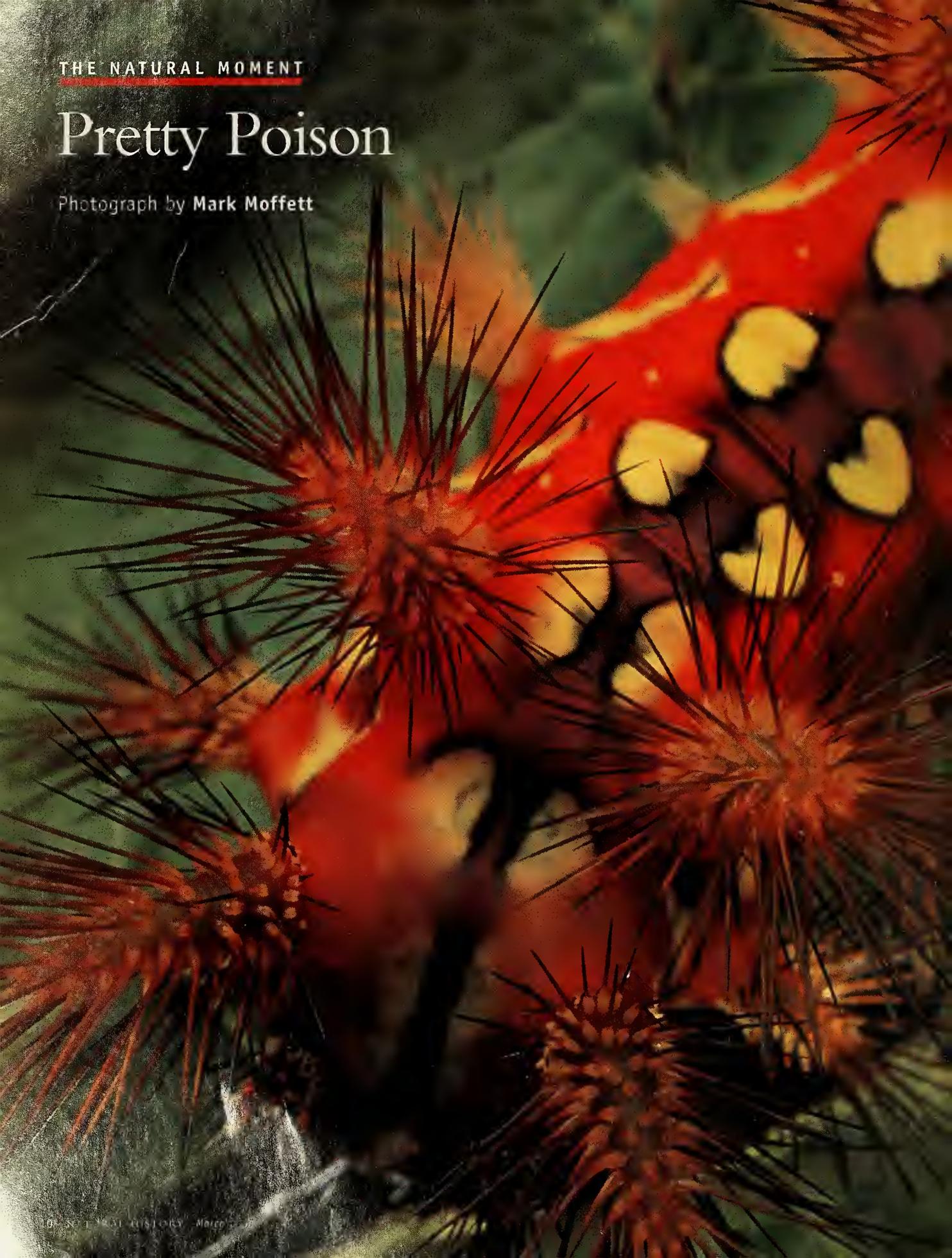
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THE NATURAL MOMENT

# Pretty Poison

Photograph by Mark Moffett





← See preceding pages



To be seen or not to be seen? Most slug caterpillars survive their vulnerable youth by making a visual statement. Orange-tinted skin, black body rings, and piercing yellow eyespots mark the Vietnamese larva of *Setora fletcheri* pictured here. But this brazen display fades away with adolescence. First the flashy spikes collapse. Then a spherical cocoon is spun. The brown, mature moth finally emerges with a more conservative strategy: to blend in.

Not all of the slug caterpillar's decoration is just for show. At any sign of danger, each cluster of spines blooms into a bristly sphere. Glands at the base of the spines produce venom rich in histamines—liquid peril for any would-be attacker.

Photographer Mark Moffett stealthily approached this *S. fletcheri* in Tam Dao National Park, north of Hanoi, where the mountains rise from the fertile Red River Delta as “islands in a sea of clouds.” The description well suits the numerous and distinct niches that isolate the residents of Tam Dao, making it a kind of untapped, continental Galápagos, teeming with exotic organisms. Trekking at twilight in the park, Moffett spotted this larva shining on the path. Even in the dark, he notes, it glowed “like a marine creature”—much too extravagant to resist.

—Erin Espelie

## LETTERS

## All in the Family?

In his search for differences between Neanderthals and modern humans, Juan Luis Arsuaga [“Requiem for a Heavyweight,” 12/02–1/03] may have missed the importance of similarities. He thinks no Neanderthal genes have reached us, but why should we even assume genes specific to Neanderthals existed? Even though today we can readily distinguish, say, Europeans from Aboriginal Australians, their distinctive characteristics do not reflect unique genes. Different human groups simply have different proportions of certain genetic variations (such as blood types A, B, AB, or O). So some other kind of evidence of Neanderthal ancestry is needed.

Studying Pleistocene Europeans, my colleagues and I found a long history of gene flow between various populations, including Neanderthals. And in a study of anatomical similarities, we could not dismiss the possibility that half the ancestors of early modern Europeans were Neanderthals. Of course, evolution has continued to modify genes and anatomy, and there are no Neanderthals left. But Mr. Arsuaga might indeed be carrying that drop of Neanderthal blood.

Would a Neanderthal pass unrecognized on a New York subway? Probably. The artist Karen Harvey built up muscle and flesh around a cast of the skull of the 70,000-year-old La Ferrassie

Neanderthal [see illustration below]. I wonder how many men as good looking as this fellow were



straphanging this morning on the A train.

Milford H. Wolpoff  
University of Michigan  
Ann Arbor, Michigan

In my view, modern humans evolved in situ from Neanderthals in Europe, as they did from robust forms elsewhere. Furthermore, the two manifestations of human form could never have encountered each other, because only one existed at any given time.

Abundant archaeological research has shown that the in-situ refinement of late Mousterian tools gave rise to the toolmaking traditions of the subsequent Upper Paleolithic. The late so-called Neanderthals who made those tools were almost indistinguishable from the early “moderns”—the Cro-Magnons—who succeeded them. Moreover, Cro-Magnon teeth and degrees of robustness are exact equivalents of late Neanderthal teeth and degrees of robustness.

C. Loring Brace  
Museum of Anthropology  
University of Michigan  
Ann Arbor, Michigan

JUAN LUIS ARSUAGA  
REPLIES: Neanderthals and

modern humans were two morphologically different types. Their skeletal differentiation was substantially greater than that of closely related present-day species such as lions and tigers, which can interbreed in captivity but don't usually mix in nature. But even substantial morphological differences between two populations do not necessarily imply the populations are genetically isolated (unable to interbreed).

Neanderthals evolved in Europe from their Middle Pleistocene ancestors. Modern humans appear later in the European fossil record; either they evolved locally from the Neanderthals (as Mr. Brace states), or they came from elsewhere and replaced the Neanderthal “aborigines.” I think the second scenario is the more likely. Nevertheless, Neanderthals and modern humans could have interbred locally on a small scale, and Neanderthals could thereby have contributed to the gene pool of the earliest modern human population in Europe. If the gene contribution was small, though, those rare Neanderthal genes would probably have disappeared in a few millennia, long before the present—unless the Neanderthal genes gave their bearers greater fitness. If the morphological differences between Neanderthals and contemporary humans resulted from different frequencies of the same genes, as Mr. Wolpoff

states, those unique Neanderthal gene combinations have been lost.

But my two colleagues and I agree on something quite important: Neanderthals had a human mind. They had self-consciousness and language, engaged in rituals, made long-term plans. Some investigators divide all past and present beings into just two categories: they (creatures without a mind) and we (the present-day human species). I say Neanderthals were on our side of the line.

#### Central Questions

Neil deGrasse Tyson's "Delusions of Centrality" [12/02-1/03] comes close to saying what I would put this way: Because every-

thing in the observable universe began expanding from the same point, wherever one happens to be is, for all practical purposes, the center of everything. What to us appears to be a faint proto-galaxy near the edge of the universe is, to its inhabitants, the center of their own expanding and uniformly distributed universe. It is as correct for each of us to say "I am at the center of everything" as it is to say there is no center. One is entitled to feel as important or as humbled as one's temperament dictates.  
*Robin C. Chapman  
Virginia Beach, Virginia*

I take exception to Neil Tyson's version of the history of science. He accepts the pandemic presumption

that Earth's centrality in the Ptolemaic system implied our specialness. On the contrary, for medieval writers "central" implied "low," and the very center was the very lowest. That's why Dante placed Hell dead center in his universe. That's why Pico said we Earth-dwellers inhabit "the excrementary and filthy parts of the lower world."

Copernicus's removal of the Earth from that cosmic pit was not a demotion but a promotion. Galileo thus exulted that, in the new cosmology, Earth was no longer "the sump where the universe's filth and ephemera collect" but was now free to join "the dance of the stars."  
*Dennis Danielson  
University of British Columbia  
Vancouver, Canada*

NEIL DEGRASSE TYSON REPLIES: Mr. Danielson implies that I and my 6,000 astrophysicist colleagues around the world are all deluded. Perhaps so. But not without good cause. If the center of the universe were indeed a cosmic slag heap and not a special place, why did everybody get so upset when they learned it might not be occupied by Earth? Why was Copernicus afraid to publish his heliocentric system? Why was Galileo subjected to the Holy Inquisition? The psychology of human behavior argues differently from the phantasmagoria of Dante and Pico.

Natural History's e-mail address is [nhmag@amnh.org](mailto:nhmag@amnh.org).

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## CONTRIBUTORS

**Mark Moffett** (“The Natural Moment,” page 10) made his first foray into tropical rainforest research at the age of seventeen, catching snakes for a Costa Rican expedition led by naturalist Max Nickerson. Moffett continued to explore rainforest habitats as a graduate student at Harvard, where he studied under the evolutionary biologist E.O. Wilson. While doing his dissertation in biology, Moffett traveled for more than two years in Asia, teaching himself photography in his spare time. He has won international awards for his pictures, some of which were exhibited in twenty-five countries as part of the 1992 World Press Photo exhibition. He photographed the brilliantly colored slug caterpillar in northern Vietnam.



Conservation biologist **Eleanor J. Sterling** (*far left*) (“Vietnam’s Secret Life,” page 50) is the director of the Center for Biodiversity and Conservation (CBC) at the American Museum of Natural History in New York City. She has spent the past fifteen years engaged in field research, studying threats to biodiversity. Coauthor **Martha M. Hurley** (*center left*) is a postdoctoral research fellow at CBC. She is part of the team analyzing data from the CBC’s biotic survey in Vietnam, under way since the late 1990s. Together with Sterling and their colleague Minh

Duc Le, Hurley is also coauthor of a forthcoming book that will highlight Vietnam’s remarkable biodiversity. Coauthor **Raoul H. Bain** is a herpetologist who earned an M.Sc. in zoology from the University of Toronto, with a focus on the diversity of Southeast Asian amphibians. He began doing scientific fieldwork in British Columbia as a technician in paleontology and has since worked in Alberta, Tennessee, and the Bolivian Andes. Bain has made four field trips to Vietnam since 1995. The publication of Sterling, Hurley, and Bain’s article coincides with the exhibition “Vietnam: Journeys of Body, Mind, and Spirit,” which will open at the American Museum of Natural History on March 15.

**Robert L. Smith** (“On the Scent,” page 60) has been sorting out the paternal behavior of water bugs for more than two decades. When he read **Le Anh Tu Packard**’s reminiscences of the aromatic condiment derived from one water bug’s species, *Lethocerus indicus* (“Bug Juice,” page 63), he was charmed and also eager to supply the scientific side of the story. Smith is an associate professor of entomology at the University of Arizona in Tucson. He recently collaborated with the zoologist Arja Kaitala to tell *Natural History* readers about another critter, “The Bug That Lays the Golden Eggs” (March 2002). Packard was born in Thailand of ethnic Vietnamese parents, and raised mainly in Bangkok, Yangon (Rangoon), and New York City, but as a child she also lived for more than half a year in Vietnam. She now appreciates many cuisines, but the flavors she grew up with still call to her. An economist based in Pennsylvania, Packard often returns to Vietnam on missions for the United Nations and the World Bank. She is a technical advisor to Vietnam’s finance ministry and an academic advisor to a nonprofit Vietnamese research organization.



An art enthusiast as well as an astrophysicist—and thus well versed in mathematics—**Mario Livio** (“The Golden Number,” page 64) recently combined his passions to delve into the mysteries of a number that pops up repeatedly in both nature and human creativity. The result was his recent book, *The Golden Ratio: The Story of Phi, the World’s Most Astonishing Number* (Broadway Books, 2002). Born in Romania, Livio holds a doctorate in theoretical astrophysics from Tel Aviv University and is now head of the science division at the Space Telescope Science Institute in Baltimore, Maryland—the organization responsible for the scientific program of the Hubble Space Telescope. Livio is also the author of *The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos* (John Wiley & Sons, 2000).

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**DRINKING IN THE DARK** Far from city lights, with only the Moon and stars to guide them, people see in shades of gray. That's because our eyes have just two kinds of photoreceptors—rods and cones—and the rods, the only receptors that work well in dim light, do not detect color. Until recently, biologists had assumed that all animals shared the same visual limitation. But the animal world has a knack for coming up with species whose sensory powers surpass our own. This time, a humble nocturnal moth is our superior.

The elephant hawkmoth (*Deilephila elpenor*) locates flowers in the dark of night and feeds on their nectar. When the moth's cousins, the butterflies, seek nectar in the daytime, they rely on color to distinguish and remember flowers particularly rich in nectar. Almut Kelber, Anna Balkenius, and Eric J. Warrant, all biologists at Lund University in Sweden, thought that having color vision would be just as useful for the nocturnal hawkmoth. So they set out to prove for the first time ever that at least one animal can perceive color at night.

Under limited light, similar to that of



Elephant hawkmoth (actual size), foraging by color

late dusk, Kelber and her colleagues trained sixteen hawkmoths to find the sugar solution placed in the centers of artificial flowers. Some hawkmoths were trained to seek the blue flowers, others the yellow ones. Then the biologists dimmed the room to the level of starlight and presented the moths with a display of variously colored circles (minus the sugar solution). One circle was the animal's training hue (blue or yellow); the rest were

various shades of gray. Almost unfailingly the moths chose—that is, touched first—the color to which they had been trained. By contrast, six people asked to discriminate among the disks under the same low light failed miserably. Once again, it seems, we are bested—though we do have the brains to prove this fact to ourselves. ("Scotopic colour vision in nocturnal hawkmoths," *Nature* 419:922–25, October 31, 2002)

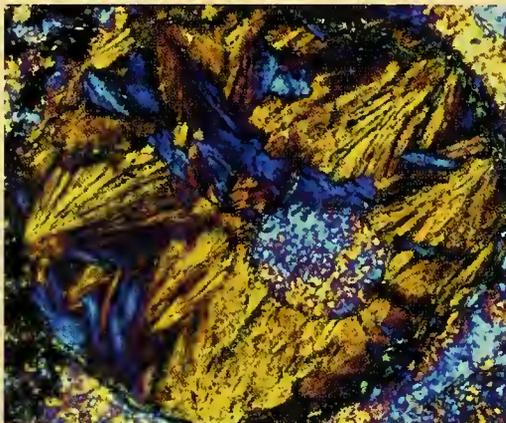
**AFTERMATH OF A CATAclysm** Most scientists agree that about 65 million years ago a catastrophic meteor impact wiped out the dinosaurs. That collision, however, is dwarfed by events that took place billions of years earlier, when the Earth was only a billion years old.

According to Gary R. Byerly, a geologist at Louisiana State University in Baton Rouge, and his colleagues, during the Earth's early history four meteors slammed into the planet with such force that they vaporized rocks for hundreds of miles around. The clouds of rock vapor quickly condensed and fell back to Earth as a rain of small rounded particles called spherules.

Spherules occur in what are now South Africa and western Australia, embedded in layers of sedimentary rock that contain unusually abundant, and thus demonstrably extraterrestrial, chromium isotopes and iridium. The spherules are mixed up with inorganic detritus, perhaps because of a tsunami—also generated

by the collision—that sloshed back and forth across the Earth. Some of the spherule beds are as much as a foot thick, so the impacts that created them must have been enormous. By comparison, the impact layer left by the meteor that did in the dinos is less than an inch thick.

Byerly and his coworkers have analyzed the lead isotopes in small zircons extracted from the lowest (hence the oldest) spherule-studded layer. The relative abundance of those isotopes, which reflect the slow decay of uranium over the millions of millennia since the spherules were formed, has enabled the geologists to calculate the age of the layer: nearly 3.5 billion years. That makes it the earliest evidence discovered so far of an asteroid impact. In those days, bacteria were the Earth's principal life-forms, and they've turned out to be a lot tougher than the dinosaurs. After all, they're still with us. ("An archean impact layer from the Pilbara and Kaapvaal cratons," *Science* 297: 1325–27, August 23, 2002)



Spherule—a raindrop made of rock

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**FROZEN DINNERS** One September afternoon a dozen years ago, two hikers came across a mummified man at the edge of an alpine glacier in northern Italy. Now known as the Tyrolean Iceman, or Ötzi (after the Ötztal Alps, where he was discovered), the 5,200-year-old corpse has been the subject of much analysis and discussion, including conflicting assertions about his diet.

Now, adding to earlier investigations into Ötzi's diet, the molecular anthropologist Franco Rollo and his colleagues, all of the University of Camerino in Italy, have extracted intact DNA fragments from the mummy's intestinal contents and compared the DNA with known sequences from modern plants and animals. Their analysis shows that Ötzi's second-to-last meal (the remains lower down in the intestinal tract) included the meat of an ibex (a wild goat), cereals (grains of the grass family, possibly cultivated), and various other plants. His last meal was red deer meat.

Today the red deer (*Cervus elaphus*) is at the periphery of human affairs. Five thousand years ago, however, Europeans relied heavily on the animal. Carvings depicting red deer occur prominently at Neolithic alpine archaeological sites. Some of the equipment Ötzi carried (a curved spike, an



Ötzi the Iceman

edge sharpener for stone tools, a quiver) was made from the red deer's skin or antlers. And some historians maintain that people deforested Europe during the Mesolithic period to favor the growth of red deer herds. The creature is thus thought to have been on early continental menus—an inference that Rollo and his colleagues have now directly confirmed. ("Ötzi's last meals: DNA analysis of the intestinal content of the Neolithic glacier mummy from the Alps," *Proceedings of the National Academy of Sciences* 99:12594–99, October 1, 2002)

**EXPERIMENT OF THE MONTH** Any runner knows that if you want to cover a long distance, you shouldn't start too fast. And that may be a sound rule of thumb for a runner's entire lifetime. Experiments with people as well as with laboratory animals continually demonstrate that rapid growth leads to early death. Now it appears that the same trend holds for some wild animals, too.

Mats Olsson, now at Göteborg University in Sweden, and Richard Shine of the University of Sydney in Australia captured pregnant southern snow skinks (*Niveoscincus microlepidotus*) at the summit of Mount Wellington on Tasmania and then placed their newborns in pens on the same mountain. The pens encompassed the skinks' natural habitat, and the baby animals were individually marked and given plenty of extra worms to eat. Four times during the first three months of their lives, the little reptiles were caught and weighed to establish their growth rate. Then they were released into the wilderness at the mountain's summit.



Southern snow skink (adult version)

Twice in the next four years the investigators recaptured the skinks across an area that far exceeded the animals' capacity for travel. Individuals that weren't recaptured were thus presumed to have perished. As the biologists expected, skinks that had grown fast as youngsters—raised, one might say, with a silver spoon—figured prominently in the group of missing individuals. That silver spoon, say the authors, "may sometimes be tarnished."

The physiological reason for the link between fast growth and lower life expectancy is still unclear, but the implication for evolutionary studies is important. Although fast growers generally outcompete their rivals during any given reproductive season, in the course of a lifetime they may not leave more offspring in the next generation, contrary to what has commonly been assumed. Olsson and Shine say the slow starters may compensate for their languid pace by living longer and getting more chances to breed. ("Growth to death in lizards," *Evolution* 56:1867–70, September 2002)

**CORE VALUES** Besides preserving the occasional frozen mummy, glaciers and ice fields contain evidence of the climates of long ago. As ice is consolidated from the annual snowfall, the quantities and composition of dust and atmospheric gases trapped in the ice signal spells of wet and dry, hot and cold. For glaciologists, examining an ice core extracted from the depths of a glacier is like reading the table of contents of a history book.

Ice cores recently extracted from the top of Mount Kilimanjaro, the highest peak in Africa, have now yielded a picture of tropical climate change for the past 12,000 years. Glaciologist Lonnie G. Thompson of Ohio State University in Columbus and an international team of geoscientists drilled down to the bedrock to extract cores as long as 167 feet. Analysis has shown that major

droughts took place about 8,300, 5,200, and 4,000 years ago; the latter two dates coincide with known societal upheavals in Africa and the Middle East. Overall, however, Africa's climate was relatively warm and wet from about 11,000 to 4,000 years ago, becoming drier and cooler thereafter.

But the cool phase is over. In the past 100 years, Kilimanjaro's ice fields have shrunk 80 percent. At current warming rates the frozen fields, which have survived for aeons just south of the equator, are expected to vanish by the year 2020. ("Kilimanjaro ice core records: evidence of Holocene climate change in tropical Africa," *Science* 298:589–93, October 18, 2002)

*Stéphan Reeb* is a professor of biology at the University of Moncton in New Brunswick, Canada, and the author of *Fish Behavior in the Aquarium and in the Wild* (Cornell University Press).



# SPRING BREAKS

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Conserving a delicate  
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Eco-Centre, La Dune de  
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# NEW BRUNSWICK

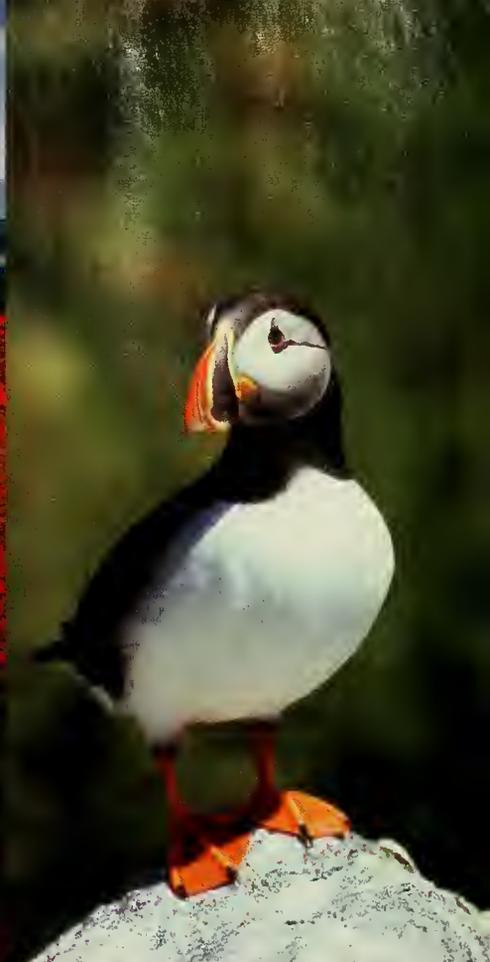
**N**EW BRUNSWICK'S BAY of Fundy, One of the Marine Wonders of the World, is a prime feeding ground for migrating birds. **Campobello Island** and **Grand Manan Archipelago** (one of Thayer's Top 100 Birding Hot Spots) are located at the mouth of the bay and are home to more than 390 species of birds. John James Audubon, author of *Birds of America*, discovered and sketched some entirely new bird species here. Nearby **Machias Seal Island** is one of the few Puffin colonies in the world where visitors can go ashore and view them in their natural habitat.

Welcome to New Brunswick, Canada...where bird-watchers answer the call of Sandpipers, Plovers, Bald Eagles, Puffins and rare waterfowl! From island retreats to protected marshes and preserved habitats, this is an ecological haven for millions of winged creatures.

Farther along the Fundy Coast, make sure you stop and tour the gleaming mud flats of the **Irving Nature Park** in Saint John, a 600-acre estuary acclaimed for its amazing bird staging area. And visit the interpretative centre of nearby **Fundy National Park** to discover why Fundy's ecosystem is so

important to many of North America's rare birds. The park is also home to a network of coastal trails where you can catch sight of shorebirds reeling in the tidal wake.

Over on the Acadian Coast, you'd better bring your binoculars to the wildlife reserve at **Cape Jourimain Nature Centre**...over 170 different species of birds are protected here by the Canadian Wildlife Service! In Sackville, visit the **Tantramar Marshes**. Situated on one of North America's major migratory bird routes, they offer prime nesting and feeding grounds for Marsh Hawks and countless waterfowl. Constructed over 200 years ago, the marshes are the largest man-made



agricultural land mass in Canada and home to the **Sackville Waterfowl Park**. This 55-acre park has a network of boardwalks and walkways which allows species such as the Common Snipe and the Tree Swallow to be observed without harming the lush grasses and wetlands in which they thrive.

Continuing up the coast you'll discover a provincial eco-treasure...the **Irving Eco-Centre, La Dune de Bouctouche**. "The Dunes," as they are known locally, also offer an extensive boardwalk system along one of the last remaining white sand dunes on the northeastern coast of the continent. Here you will see rare plants as well

as spot the Tern and endangered Piping Plovers as they nest in the fragile marshes.

Head up to the northeastern tip of the province to the serene **Miscou Island**, the site of the Oldest Lighthouse in Eastern Canada and home to a burgeoning bird sanctuary. You'll find Yellowlegs, Sandpipers, Northern Gannets and many more on Miscou's spectacular coast. You should see the island in the fall...the thick brush that covers the bogs for miles on up to the lighthouse turns an amazing fire red. It makes for an incredible birding backdrop!

It's all part of the wonder of bird-watching...and it's waiting for you next door in New Brunswick, Canada!



Above left: One of many exquisite, pristine waterfalls at Fundy National Park; above center: Autumn Ablaze - the spectacular red peat bogs of Miscou Island; top right: the colorful Atlantic Puffin; bottom right: A bird-watcher's paradise, Cape Jourimain Nature Centre.

# Walk on the Ocean Floor...

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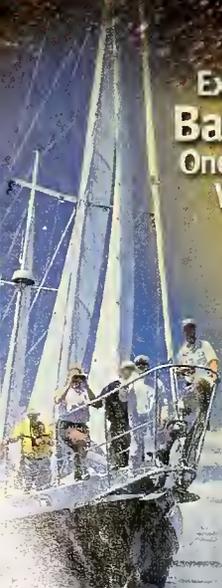
Visit the Irving Eco-Centre, La Dune de Bouctouche, and tour the botany and biology of one of the last sand dunes on the northeastern coast of the continent. Search for fossils and sea shells on our Discovery Beaches... the undiscovered treasures of New Brunswick's over 2,065 kilometres (1,200 miles) of coastline.

Irving Eco-Centre,  
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Grand Manan Island



Grand Falls Gorge

## Tour Miles of the Maritimes' Most Spectacular Rivers.

The St. John River reaches from the Bay of Fundy up beyond the breathtaking Grand Falls Gorge! The legendary Miramichi calls fly fishers from around the world to challenge miles of salmon fishing paradise. On the Restigouche, you can canoe through the unspoiled wilderness for days on end.

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Lameque Island



Atlantic Puffin

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Discover the bird sanctuary in Lameque as well as Miscou Island's spectacular coast where Yellowlegs, Sandpipers, Northern Gannets, and others come to spread their wings. Experience the spectacular view at Cape Jourmain Nature Centre and spot a Bald Eagle's nest. At the Irving Eco-Centre, La Dune de Bouctouche, see where Great Blue Herons and the endangered Piping Plovers thrive.



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# CAYMAN ISLANDS

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in the Caymans (the other subspecies are in Cuba and the Bahamas).

You can spot this native bird along the National Trust's Mastic Trail, a restored 200-year-old footpath through a 2-million-year-old woodland area located in the dense interior of Grand Cayman Island. The picturesque trail winds from swamplands tangled with black mangroves to forests; past mango, tamarind, and calabash trees and delicate wild banana orchids to grassy glades dotted with palm trees. The best time to see the Cayman parrot is February through May; you'll often find it nesting in the hollow tops of dead royal palms during March and April. Be on the lookout for Caribbean dove, West Indian woodpecker, Cuban bullfinch, and smooth-billed ani. Book a guided tour at (809) 949-1996.



Patricia Bradley

The Cayman Islands are known for their pristine beaches, but they are also home to over 220 bird species such as the brown booby (below).

Established in 1990, the 180-acre National Trust Brac Parrot Reserve protects the nesting area of the endemic, endangered Cayman Brac parrot *Amazona leucocephala hesternus*. The latest census estimates about 400 of these lovely, iridescent emerald green parrots on the Brac. This endangered subspecies of the Cuban Amazon parrot can be seen in this unspoiled tropical woodland from February through May. The noisy parrots nest during March and April, loudly announcing the beginning of spring. Book guided tours at 345-948-2222.

Booby Pond Nature Reserve on Little Cayman, a 204-acre site comprising a saltwater pond and surrounding mangrove habitat, is a natural rookery, home to an estimated 5,000 nesting pairs of red-footed boobies (one of the largest breeding colonies in the Western Hemisphere). Boobies mate for life and nest from February through July in the mangrove trees within the sanctuary. You'll also find 200 pairs of magnificent frigate birds. While on Little Cayman, keep an eye out for migratory shorebirds, which are seen frequently here. You're likely to see waders as well as a variety of herons, stilts, and even the endangered West Indian whistling duck. You may also see the whistler in the North Side district of Grand Cayman at the Willie Ebanks Farm (located at the end of Hutland Road). The farm is also home to blue-winged teals, coots, grebes, and an occasional osprey or peregrine falcon.



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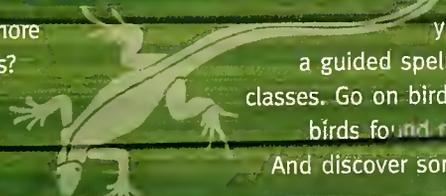
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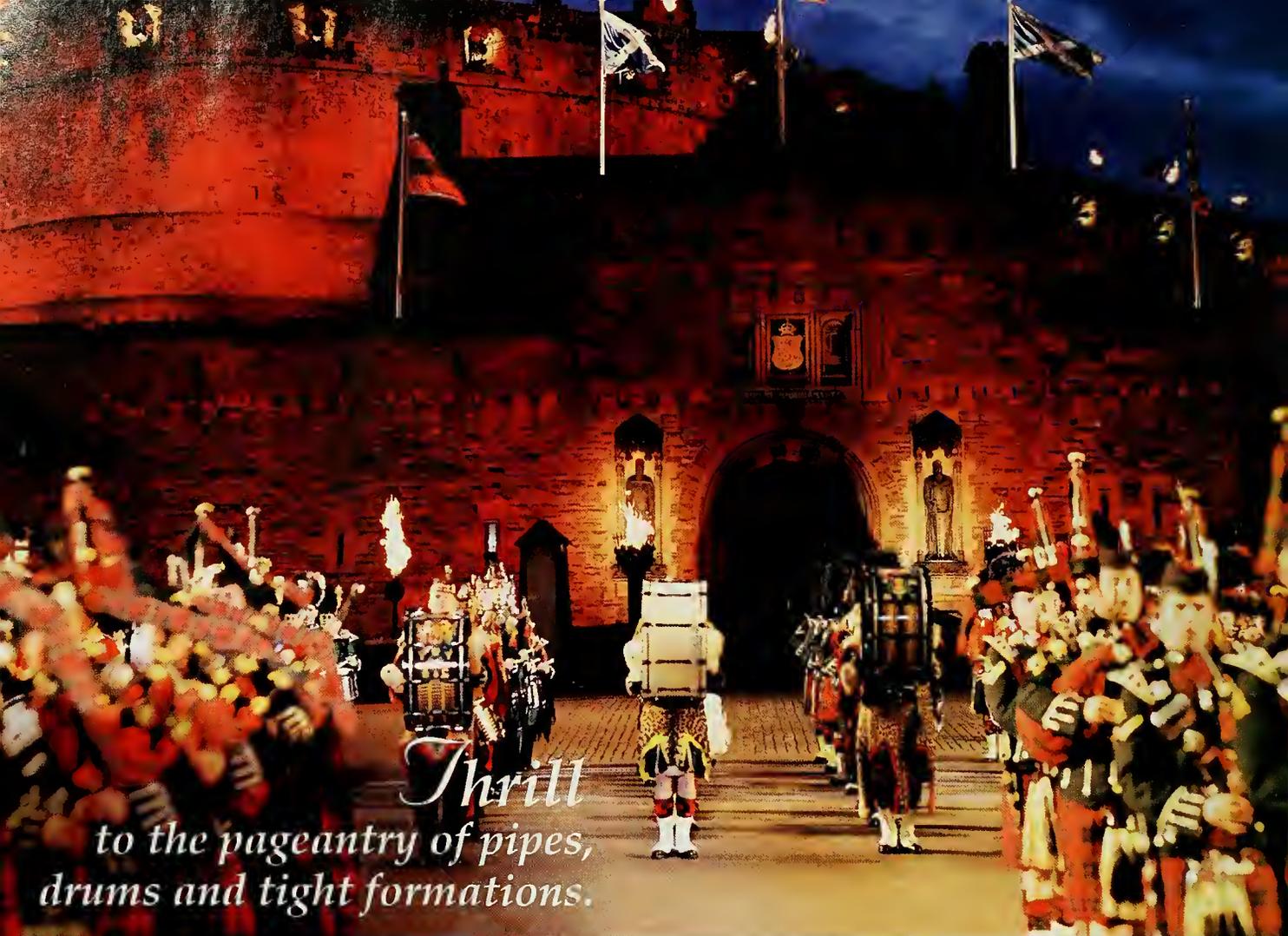


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# SCOTLAND

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Scottish Viewpoint

## Taking flight over the Highlands

fifth of the total puffin population of Scotland, approximately 125,000 pairs, breeds in Shetland. Throughout the isles you'll come across throngs of Arctic terns and both species of skuas, as well as black guillemots, gannets, shags, and Storm and Leach's petrels. Rare birds turn up on all the islands, but the best areas to spot them are in the central and south mainland. Print out a checklist at <http://www.wildlife.shetland.co.uk> before you venture out to these wild northern areas.

At Isle of May National Nature Reserve, in the mouth of the Firth of Forth, you'll see thousands of puffins in May and June. But if you don't have enough time for a northern adventure, visit Bass Rock, a dramatic volcanic plug only one hour from Edinburgh. Take a boat trip here and gaze at the

gannets nesting on cliffs a thousand feet high. For a one-of-a-kind "arm-chair birding" experience, visit the National Seabird Centre in North Berwick. Here, you can watch seabirds such as gannets and puffins up close—or stay inside and watch live videos, using remote control television cameras, from the nearby seabird colonies.

The estuaries and salt marshes of the Solway Firth, in southwest Scotland, are feeding and roosting grounds for many thousands of wintering wildfowl. Visit the Caerlaverock National Nature Reserve, south of Dumfries, a site for wintering waterfowl and waders. And on the coast north of Aberdeen, stop at the Forvie National Nature Reserve, a smaller estuary that is home to the largest breeding population of eider duck in Britain.



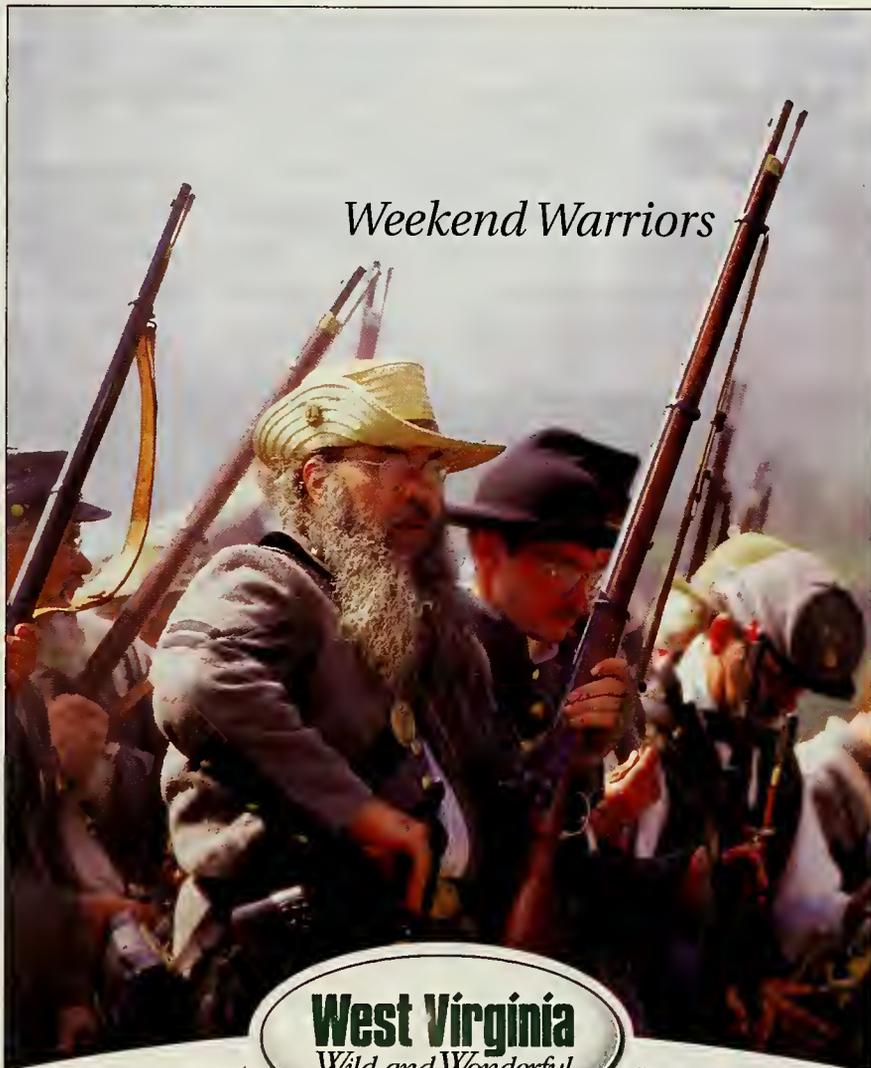
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# Stick-in-the-Mud Science

*You'll need your brain and plenty of patience—but not much more—to take the measure of the Earth and its motions.*

*By Neil deGrasse Tyson*

**F**or a century or so, various blends of high technology and clever thinking have driven cosmic discovery. But suppose you have no technology. Suppose all you have in your backyard laboratory is a stick. What can you learn? Plenty.

With patience and careful measurement, you and your stick can glean an outrageous amount of information about our place in the cosmos. It doesn't matter what the stick is made of. And it doesn't matter what color it is. The stick just has to be straight.

Hammer the stick firmly into the ground where you have a clear view of the horizon. Since you're going low-tech, you might as well use a rock for a hammer. Make sure the stick isn't floppy and that it stands up straight. Your cave-man laboratory is now ready.

On a clear morning, track the length of the stick's shadow as the Sun rises, crosses the sky, and finally sets. The shadow will start long, get shorter and shorter until the Sun reaches its highest point in the sky, and finally lengthen again until sunset. Collecting data for this experiment is about as exciting as watching the hour hand move on a clock. But since you have no technology, not much else is competing for your attention. Notice that when the shadow is shortest, half the day has passed. At that moment—called local



Steve Irvine, *Analemma above Keppel Henge*, May 2000 to May 2001

noon—the shadow points due north or due south, depending which side of the equator you're on.

You've just made a rudimentary sundial. And if you want to sound erudite, you can now call the stick a gnomon (I still prefer "stick"). Note that in the Northern Hemisphere, where civilization began, the stick's shadow will revolve clockwise around the base of the stick as the Sun moves across the sky. Indeed, that's why the hands of a clock turn "clockwise" in the first place.

**I**f you have enough patience and cloudless skies to repeat the exercise 365 times in a row, you will notice that the Sun doesn't rise from day to day at

the same spot on the horizon. And on two days a year the shadow of the stick at sunrise points exactly opposite the shadow of the stick at sunset. When that happens, the Sun is rising due east, setting due west, and daylight lasts as long as night. Those two days are the spring and fall equinoxes (from the Latin for "equal night"). On all other days of the year the Sun rises and sets elsewhere on the horizon. So the adage that the Sun always rises in the east and sets in the west was invented by somebody who never paid attention to the sky.

If you're in the Northern Hemisphere while you're tracking the points on the horizon where the Sun rises and sets, you'll see that those spots inch north of the east-west line after the spring equinox, eventually stop, and then inch south for a while. After they cross the east-west line again, the southward inching eventually slows down, stops, and gives way to the northward inching once again. The entire cycle repeats annually.

All the while, the Sun's trajectory is changing. On the summer solstice (Latin for "stationary Sun"), the Sun rises and sets at its northernmost point along the horizon, tracing its highest path across the sky. That makes the solstice the year's longest day, and the stick's noontime shadow on that day the shortest. When the Sun rises and sets at its southernmost point along



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the horizon, its trajectory across the sky is the lowest, creating the year's longest noontime shadow. What else to call that day but the winter solstice?

For 60 percent of the Earth's surface and about 75 percent of its human inhabitants, the Sun is never, ever directly overhead. For the rest of our planet, a 3,200-mile-wide belt around the equator, the Sun climbs to the zenith only two days a year (OK, just one day a year if you're smack on the tropic of Cancer or the tropic of Capricorn). I'd bet the same person who professed to know where the Sun rises and sets on the horizon also started the adage about the Sun always being directly overhead at high noon.

So far, with a single stick and herculean patience, you have identified the cardinal points on the compass and the four days of the year that mark the change of seasons. Now you need to invent some way

to time the interval between one day's local noon and the next. An expensive chronometer would help here, but one or more well-made hourglasses will also do just fine. Either timer will enable you to determine, with great accuracy, how long it takes for the Sun to revolve around the Earth: the solar day. Averaged over the entire year, that time interval is equal to twenty-four hours—exactly—though this doesn't include the leap second added now and then to account for the slowing of the Earth's rotation by the Moon's gravitational tug on Earth's oceans.

Back to you and your stick. We're not done yet. Establish a line of sight from its tip to a spot on the sky, and use your trusty timer to mark the moment a familiar star from a familiar constellation passes by. Then, still using your timer, record how long it takes for the star to realign with the stick from one night to the next. That interval, the sidereal day, lasts twenty-three hours, fifty-six minutes, and

four seconds. The almost-four-minute mismatch between the sidereal and solar days forces the Sun to migrate across the patterns of background stars, creating the impression that the Sun visits the stars in one constellation after another throughout the year.

Of course, you can't see stars in the daytime—other than the Sun. But the ones visible near the horizon just after sunset or just before sunrise flank the Sun's position on the sky, and so a sharp observer with a good memory for star patterns can interpolate what patterns lie behind the Sun itself.

Once again taking advantage of your timing device, you can try something different with your stick in the ground. Each day for an entire year, mark where the tip of the stick's shadow falls at noon, as indicated by

*The Sun seldom rises due east,  
and—for most of Earth's inhabitants—  
it's never, ever directly overhead.*

your timer. It turns out that each day's mark will be in a different spot, and by the end of the year you will have traced a figure eight, known to the erudite as an "analemma" [see photograph on page 32].

Why? Earth is tilted on its axis by 23.5 degrees from the plane of the solar system. This tilt not only gives rise to the familiar seasons and the wide-ranging daily path of the Sun across the sky, it's also the dominant cause of the figure eight that emerges as the Sun migrates back and forth across the celestial equator throughout the year. Moreover, the Earth's orbit about the Sun is not a perfect circle. According to Kepler's laws of planetary motion, its orbital speed must vary, increasing as we near the Sun and slowing down as we recede. Because the rate of the Earth's rotation remains rock-steady, something has to give: the Sun does not always reach its highest point on the sky at "clock noon." Although the shift is

slow from day to day, the Sun gets there as much as fourteen minutes late at certain times of year. At other times it's as much as sixteen minutes early. On only four days a year—corresponding to the top, the bottom, and the middle crossing of the figure eight—is clock time equal to Sun time. As it happens, the days fall on or about April 15 (no relation to taxes), June 14 (no relation to flags), September 2 (no relation to labor), and December 25 (no relation to Jesus).

**N**ext up, clone yourself and your stick and send your twin due south to a preselected spot far beyond your horizon. Agree in advance that you will both measure the length of your stick shadows at the same time on the same day. If the shadows are the same length, you live on a flat—or a supergigantic—Earth. If the shadows have different lengths, you can use simple geometry to calculate the Earth's circumference.

The astronomer and mathematician Eratosthenes of Cyrene (276–194 B.C.) did just that. Comparing shadow lengths at noon in two Egyptian cities—Syene (now called Aswan) and Alexandria, which he overestimated to be 5,000 stadia apart—Eratosthenes derived a value for Earth's circumference that was within 15 percent of being correct. The word “geometry,” in fact, comes from the Greek for “earth measurement.”

Although you've now been occupied with sticks and stones for several years, the next experiment will take only about a minute. Use a stone to pound your stick into the ground at an angle other than vertical, so that it resembles a typical stick in the mud. Tie a stone to the end of a thin string and dangle it from the stick's tip. Now you've got a pendulum. Measure the length of the string and then tap the bob to set the pendulum in motion. Count how many times the bob swings in sixty seconds.

The number, you'll find, depends very little on the width of the pendulum's arc, and not at all on the mass of

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the bob. The only things that matter are the length of the string and what planet you're on. Working with a relatively simple equation, you can deduce the acceleration of gravity on Earth's surface—which is a direct measure of your weight. On the Moon, with only one-sixth the gravity of Earth, the same pendulum will move much more slowly, executing fewer swings per minute. There's no better way to take the pulse of a planet.

Until now your stick has offered no proof that the Earth itself rotates—only that the Sun and the nighttime stars revolve at regular, pre-

equator, the plane still rotates, but more and more slowly as you move from the Poles toward the equator. At the equator the plane of the pendulum does not move at all. Not only does this experiment demonstrate that it's the Earth, not the Sun, that moves, but with the help of a little trigonometry you can also turn the question around and use the time needed for one rotation of the pendulum's plane to determine your latitude on our planet.

The first person to use a pendulum to demonstrate the Earth's rotation was Jean-Bernard-Léon Foucault, a French physicist who surely conducted the last of the truly cheap lab-

extreme rising and setting points of the Moon. Begun in about 3100 B.C. and altered during the next two millennia, Stonehenge incorporates outsize monoliths quarried far from its site on Salisbury Plain in southern England. Eighty or so bluestone pillars, each weighing several tons, came from the Preseli Mountains, roughly 240 miles away. The so-called sarsen stones, each weighing as much as fifty tons, came from Marlborough Downs, twenty miles away.

Much has been written about the cultural and scientific significance of Stonehenge. Historians and casual observers alike are impressed by the astronomical knowledge of these ancient people, as well as by their ability to transport such obdurate materials such long distances. Some fantasy-prone observers are so impressed that they even credit extraterrestrial intervention at the time of construction.

Why the ancient civilizations that built the place did not use the easy, nearby rocks remains a mystery. But the skills and knowledge on display at Stonehenge are not. The major phases of construction took a few hundred years in toto. Perhaps the preplanning took another hundred or so. You can build anything in half a millennium—I don't care how far you have to drag your bricks. Furthermore, the astronomy embodied in Stonehenge is not fundamentally deeper than what can be discovered with a stick in the ground.

Perhaps these ancient observatories perennially impress modern people because modern people have no idea how the Sun, Moon, or stars move. We are too busy watching evening television to care what's going on in the sky. To us, a simple rock alignment based on cosmic patterns looks like an Einsteinian feat. But a truly mysterious civilization would be one that made no cultural or architectural reference to the sky at all.

*Astrophysicist Neil deGrasse Tyson is the Frederick P. Rose Director of the Hayden Planetarium in New York City and a visiting research scientist at Princeton University.*



Thomas Kellner, *Stonehenge*, 33#34, 2002

dictable intervals. For the next experiment, find a stick more than ten yards long and, once again, pound it into the ground at a tilt. Tie a heavy stone to the end of a long, thin string, and dangle it from the tip. Now, just like last time, set it in motion. The long, thin string and the heavy bob will enable the pendulum to swing unencumbered for hours and hours and hours.

If you carefully track the direction the pendulum swings, and if you're extremely patient, you will notice that the plane of its swing slowly rotates. The most pedagogically useful place to do this experiment is at the geographic North (or, equivalently, South) Pole. At the Poles, the plane of the pendulum's swing makes one full rotation in twenty-four hours—a direct measure of the direction and rotational speed of the Earth beneath it. For all other positions on Earth, except along the

oratory experiments. In 1851 he invited his colleagues to “come and see the Earth turn” at the Panthéon in Paris. Today there's a Foucault pendulum in practically every science and technology museum in the world.

Given all that one can learn from a simple stick in the ground, what are we to make of the world's famous prehistoric observatories? From Europe and Asia to Africa and Latin America, a survey of ancient cultures turns up stone monuments that served as low-tech astronomy centers, though it's likely they also doubled as places of worship or embodied other deeply cultural meanings.

On the morning of the summer solstice at Stonehenge, for instance, several of the stones in its concentric circles align precisely with sunrise. Certain other stones align with the



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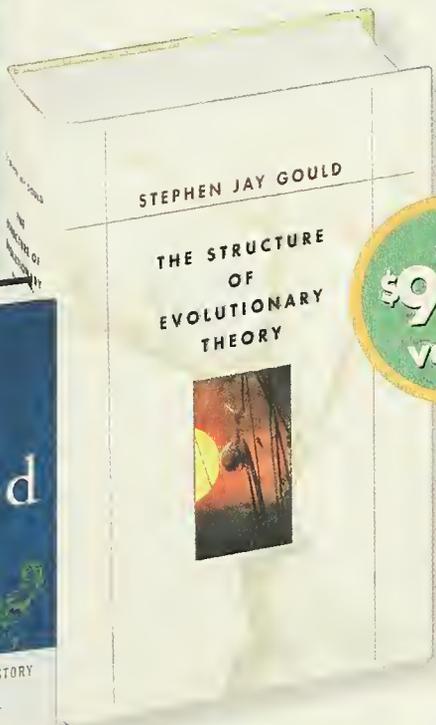
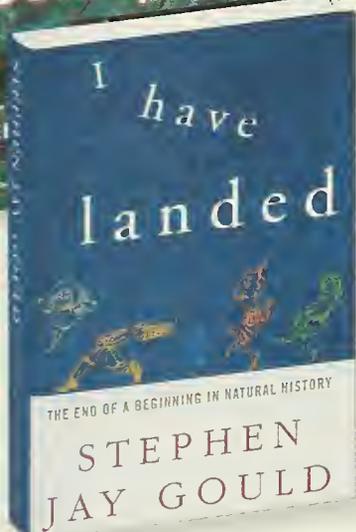
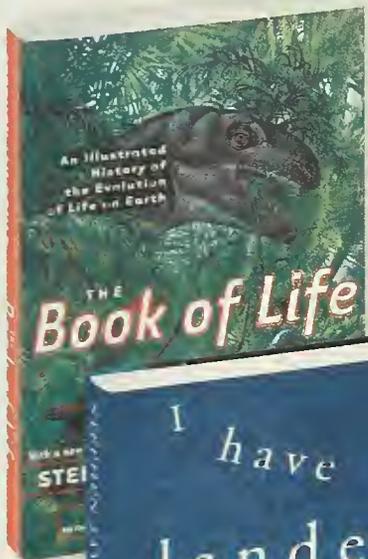
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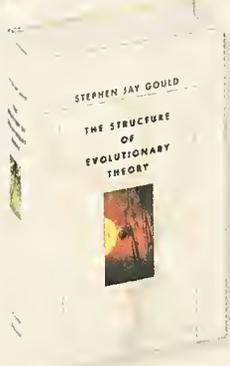




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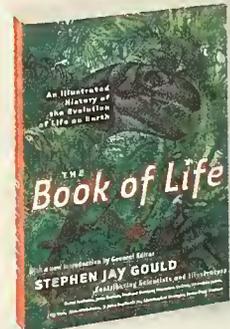
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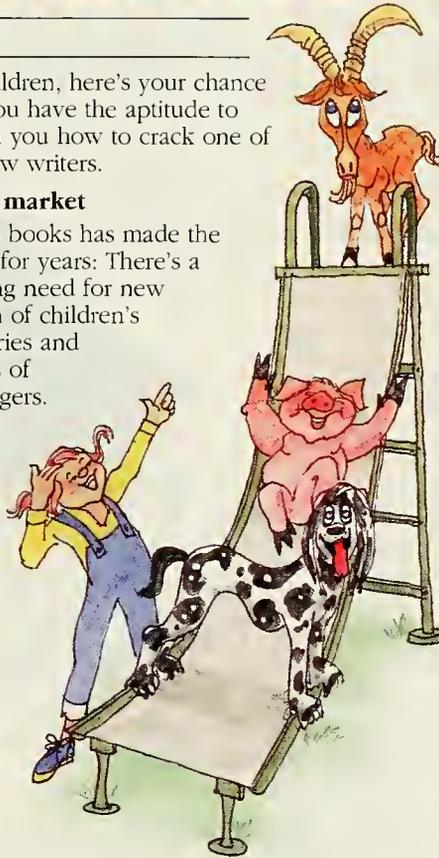
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My fellow instructors—all of them professional writers or editors—work with their students the same way I work with mine: When you've completed an assignment on your own schedule, at your own pace, you send it to me. I read it and reread it to make sure I get everything out of it that you've put into it. Then I edit it line-by-line and send you a detailed letter explaining my

Kristi Holl, a graduate of our course, has published 24 books and more than 100 stories and articles. She is now an instructor at the Institute.



you require an aptitude test," says Nikki Arko, Raton, NM. "Other schools sign you up as long as you have the money to pay, regardless of talent or potential."

### "I'd take the course again in a heartbeat!"

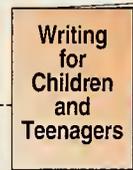
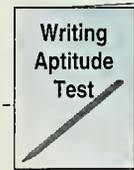
"My most recent success has been the publication of the novel I started for my last Institute assignment," writes Jennifer Jones, Homer, NY. "Thank you for giving me the life I longed for."

"I'd take the course again in a heartbeat!", says Tonya Tingey, Woodruff, UT. "It made my dream a reality."

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edits. I point out your strengths and show you how to shore up your weaknesses. Between your pushing and my pulling, you learn how to write—and how to market what you write.

### I am the living proof

What I got from my instructor at the Institute changed me from a "wannabe" into a nationally published writer. While there's no guarantee that every student will have the same success, we're showered with letters like these from current and former students.

"Since graduating from your course," says Heather Klassen, Edmonds, WA, "I've sold 125 stories to magazines for children and teenagers."

"Before this, I didn't know if my work was typical or bland, or if there was even a spark of life in it," writes Kate Spanks, Maple Ridge, BC. "I now have over 30 articles published. . ."

### "... a little bird. . . has just been given freedom"

This course has helped me more than I can say," says Jody Drueding, Boston, MA. "It's as if a little bird that was locked up inside of me has just been given the freedom of the garden."

" . . . I was attracted by the fact that

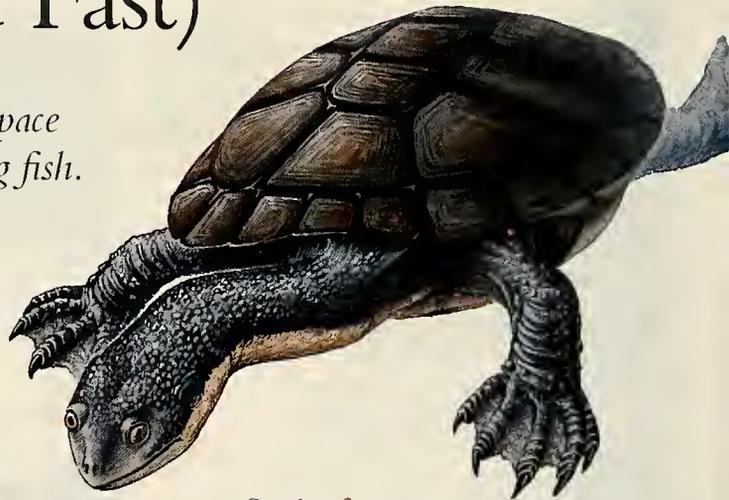
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# Open Wide (and Fast)

*The law of physics that propels rockets into space enables an Australian turtle to catch a darting fish.*

By Adam Summers

Illustrations by Shawn Gould



Slow and steady might win races for tortoises, but it's not clear that the same strategy would work for a pond turtle ambushing its prey. Imagine one of these torpid reptiles trying to hide its awkward shell from a school of minnows: The turtle crouches warily behind a tuft of vegetation. Suddenly . . . long pause . . . the creature lumbers out from its blind, racing along at inches per second in hot (but clumsy) pursuit of its meal. Favorable comparisons between the turtle and, say, a cheetah lying in wait for a Thomson's gazelle do not spring to mind.

Yet—who'd have thunk it?—several turtles make fine ambush predators. The massive alligator snapper, for one, lures fish into its gaping mouth by twitching the tip of its tongue. Another, the Australian snake-necked turtle, grabs its prey with a quick, serpentine strike. The basic mechanics of its strike are both surprising and surprisingly effective.

The Australian snake-necked turtle (*Chelodina longicollis*) is a member of the suborder Pleurodira, a group of turtles limited to the Southern Hemisphere. Many, the Australian snake-neck included, have far longer necks than their cousins, the Cryptodira. One consequence is that a pleurodire cannot retract its head into its shell by bending its neck up and back; instead, the animal must

fold its neck sideways into a deep hollow at the front of the shell.

But the long neck also enables the turtle to ambush fishes and tadpoles by shooting its head far forward, almost as far as the entire length of its body.

The turtle's head lies at the end of eight neck vertebrae, which are connected to the body by more than fifty muscles. Given such a complex anatomy, one might think that making a high-speed stab at a fish would call for neuromuscular coordination worthy of Barry Bonds hitting a slider. Not so. In fact, as Peter Aerts, a biologist at the University of Antwerp in Belgium and his colleagues have found, the turtle's rapid capture of prey paradoxically requires far less motor control than does a slow, deliberate bite.

How can the stimulation of dozens of muscles in the complicated multijoint system that constitutes the turtle's neck be coordinated in just the right sequence and with just the right timing for the turtle to get its head to its quarry? Consider, as Aerts did, a folding carpenter's rule with ten segments (representing the head, the eight vertebrae, and the body).

Starting from a relaxed S-bend, similar to the usual starting position for the turtle, imagine extending the "head" of the rule in a straight line towards a target by adjusting each of the hinges a bit at a time. Impossible? No, but certainly extremely tedious.

A turtle relying on vertebral muscles to extend its neck confronts the same problem—and being methodical is no way to catch a darting little fish. But, as Aerts points out, the rule can be quickly and accurately extended to the target if the head is grasped and yanked in the desired direction. The joints move where they will; perhaps they each follow different bending patterns with each new extension. But the head gets where it's going without wavering off course.

What a handy solution to the problem of extending the carpenter's rule! Yet, at first blush, it appears irrelevant to the case of the turtle. After all, why would a hunted fish yank a turtle's head anywhere—when it probably wouldn't want to touch that head with a ten-foot pole? But nature has other ways to get the job done, as Aerts and his colleagues Johan van Damme and Anthony Herrel realized. With a little help from Sir Isaac Newton, a turtle can actually *pull* its own head towards its prey.

If that action seems about as likely as a fish committing suicide, recall Newton's third law: for every action there is an equal and opposite reaction. Here the action is a sudden suction, caused when the turtle floods its mouth and throat with a large volume of water. The linchpin of the system for controlling this action is a bony structure called the hyoid apparatus. In most vertebrates the hyoid supports the tongue, as it does in the snake-necked turtle. But in the snake-neck, it also pushes down a bone called the hypoglossum (which, as its name suggests, is situated beneath the tongue), thereby expanding the turtle's mouth. The hyoid also moves bones known as branchial arches, which expand its throat.

The change in the width of the neck is twofold. Expanding the neck downward and to the sides

causes water to rush into the mouth and flow down the throat. The Newtonian reaction to the rearward-rushing water then snaps the head forward almost instantaneously (the acceleration of the head can be more than four times the acceleration of gravity). The effect is

almost exactly the opposite of what happens when an unattended garden hose is turned on: the straight hose, reacting like a rocket to the water shooting out its end, writhes into S-curves. In the case of the turtle, an S-curved neck straightens when water is sucked inside.

To bolster their hypothesis, the Belgian biologists developed a mathematical model that derives the rearward-rushing volume of water from

the observed expansion of the neck. From the mass and speed of the moving water, they could calculate the resultant forward motion of the head and neck needed to offset the momentum of the water. Although the predictions of the model break down as the distance between the head and prey becomes minuscule, they closely match the movements observed during much of the turtle's strike. (When the head is close to the prey, the model tends to overestimate head movement because it does not compensate for the neck's connective tissue and muscles, which absorb some of the kinetic energy as they stretch.)

To further rule out the possibility that vertebral muscles might be con-

trolling the strike, the biologists implanted fine wire electrodes into the animal's neck muscles to detect the activity of each muscle. Sure enough, as one would expect if the Newtonian explanation is correct, the vertebral muscles were largely quiet during extension, whereas the muscles of the hyoid were firing.

One consequence of the "head pull" mechanism is that the turtle must aim its head at the target in the water before opening its mouth and throat. Indeed, early in the strike, before the turtle's head accelerates, the turtle takes aim at the prey animal—using its vertebral muscles. It turns out that the muscles of the vertebral column are

well suited for that task.

The Australian snake-necked turtle is a popular pet on its native continent.

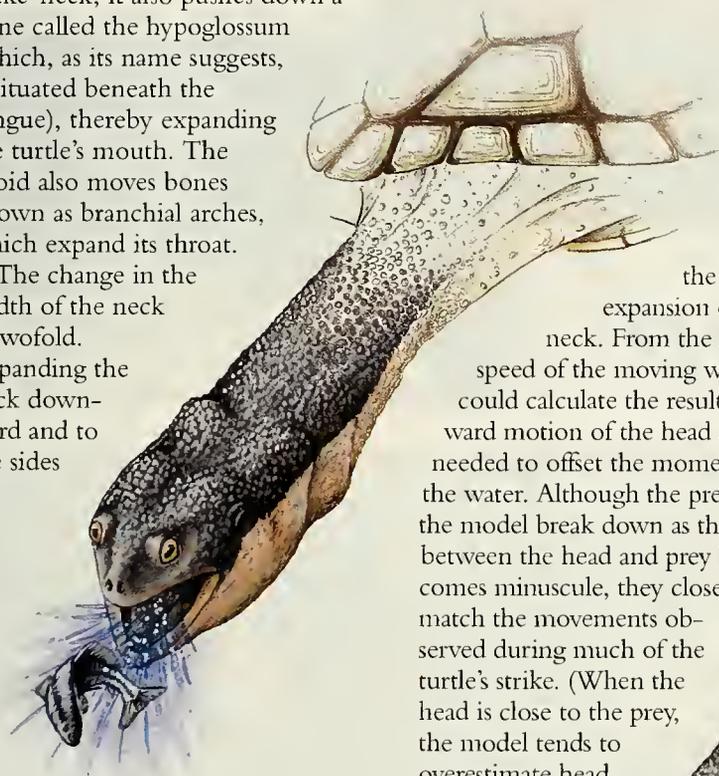
Fortunately for its owners, the animal's rapid strike capability works only in water; the mass of a mouthful of air is not enough to draw the head forward.

Anyone carrying a snake-necked turtle is safe from a speedy bite.

That's not to say that slow and steady can't still win a race—or deliver a bite. If you're handling such a turtle, keep a wary eye on its slow-moving head. Like the careless hare, you'd surely hate to be caught napping.

Adam Summers ([asummers@uci.edu](mailto:asummers@uci.edu)) is an assistant professor of ecology and evolutionary biology at the University of California, Irvine.

*If the airplane won't come to the hangar, bring the hangar to the airplane. The Australian snake-necked turtle catches its prey by opening its mouth—the movement of muscles and bones in its head and neck rapidly expands its throat, which instantaneously fills with water. The momentum of inrushing fluid, by virtue of the third law of motion, jerks the turtle's head forward and, assuming the turtle has aimed correctly, directly at the fish.*





Left: Blackwater National Wildlife Refuge; below: Calvert Cliffs; bottom left: Clustered spires in Frederick

Middleton Evans



Dan Breitenbach

# Maryland

## *The Land Between Tide and Time*

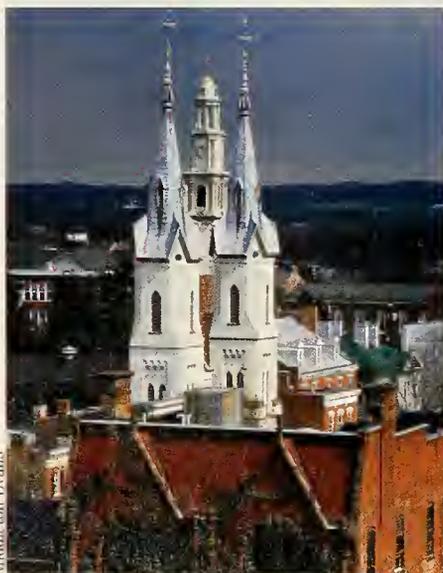
From the shores of the Chesapeake Bay and the Atlantic Ocean to the peaks of the majestic Allegheny Mountains, Maryland is a state of natural wonders.

**P**ADDLE THROUGH THE FER-  
tile marshes of the lower  
Chesapeake as ducks, geese,  
eagles, and a swirl of birds soar above  
you. Bicycle on trails that meander  
through the unspoiled forests of western  
Maryland, or hike on the Appalachian  
Trail itself. Cast a line for blue marlin,  
brook trout, smallmouth bass, or striped  
bass ("rockfish" to the locals). Hunt for  
fossils along a shoreline of towering  
cliffs or prowl for owls on a night hike.

Looking for an adventure in the great outdoors? Visit Maryland's Western Region, nestled in the Appalachian Mountains. Here, you may climb the state's highest mountain, swim in Deep

Creek Lake, discover a waterfall, do a little fishing, or brave whitewater rapids.

If you're a history buff, head to the Capital Region, where you'll find Frederick, Montgomery, and Prince George's Counties. Just outside the nation's capital, these counties offer the best of urban sophistication and the tranquility of rural life. Rolling farmlands, covered bridges, and vineyards mark the countryside. And you'll find a wealth of historic sites—from Civil War battlefields to the spectacular Chesapeake and Ohio Canal to fine colonial homes. Visit an aviation museum that celebrates the nation's beginning of aviation, then soar above of the ground



Middleton Evans

at a state-of-the art amusement park, before heading to the Goddard Space Center for an out of this world view of space.

In Central Maryland, colonial history complements maritime heritage. Annapolis, America's sailing capital, hasn't changed much since it became Maryland's capital city in 1695. Today it has more eighteenth-century buildings than any other city in the U.S. It's also home to the U.S. Naval Academy and a center of boating and water sports, including fishing, crabbing, sailing, and swimming.

Historic fishing villages, picturesque small towns, first-class boating, a traditional lifestyle anchored in the Tidewater...the banks of the Patuxent and Potomac Rivers and the shores of



Middleton Evans

the Chesapeake Bay....In Calvert, Charles, and St. Mary's Counties, you'll discover first-hand why Southern Maryland Is Fun. Birders flock to this region to gaze at bald eagles, great blue herons, and more than 300 other species of birds. And after a satisfying day of bird-watching, treat yourself to a scrumptious meal of Maryland's famous blue crabs, oysters, or a freshly caught fish.

On the Eastern Shore, enjoy the splen-

dors of the Chesapeake Bay in the counties of Dorchester, Worcester, Talbot, and Queen Anne's. On the fringes of the bay, fragile marshes and winding waterways are teeming with birds and wildlife. Three of the nation's endangered species are here: the bald eagle, the Delmarva fox squirrel, and the peregrine falcon. Canoe through creeks and rivers, explore historic towns, hike through marshes and woodlands, fish and crab on the Bay—the unspoiled beauty of the area is all around you. Don't miss the natural barrier island of Assateague, one of the state's treasures, and its legendary ponies.

Wherever you decide to go, Maryland will amaze you with all there is to see and do.

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## Annapolis/Anne Arundel County

**A**NNAPOLIS/ANNE ARUNDEL County brings you the best of Maryland's colonial history and maritime heritage. Fronting the shores of the Chesapeake Bay, the county is a center of boating and water sports, including fishing, crabbing, sailing, and swimming. Annapolis, Maryland's capital city and America's sailing capital, has more eighteenth-century buildings and houses than any other city in the U.S. It's also the home of the U.S. Naval Academy (410-263-6933), founded in 1845. Stop at the Armel-Leftwich Visitor Center for a map of the facilities, and don't miss the model ships and history exhibits at the Academy's Museum. If you prefer the countryside, drive along the rural western shore of the Chesapeake Bay, past fishing villages and farms dating from the colonial era, to the "lost" town of London, unearthed in the 1990s.



The State Capitol at Annapolis

AAAGCVB

## Charles County

**L**ESS THAN AN HOUR FROM Washington, D.C. and Annapolis, Charles County is a haven for nature lovers and history buffs on southern Maryland's coastal plain. Enjoy first-class fishing, 150 miles of spectacular shoreline, beautiful forests, and many lakes, ponds, and extensive wetlands.

The county's abundant undeveloped areas support a dense population of bald eagles and 321 other bird species. Every spring for the past fifty years, nearly 1,500 great blue herons have nested in the treetops of Nanjemoy Creek Great Blue Heron Sanctuary. This creek, popular with fishermen, also is a good spot to sight ospreys and bald eagles.

The Chicamuxen Wildlife Management Area (301-743-5161), tucked away on a peninsula, harbors rare and endangered species, such as the Louisiana thrush, on about twenty acres of wetlands. Purse State Park (301-743-7613), a ninety-acre reserve of gently rolling hills, woods, and marshlands, is the perfect site for fossil hunting. And Cobb Island, bordered by the Potomac and Wicomico Rivers, lures birdwatchers as well as fishing, boating, and seafood lovers.

History buffs won't want to miss the Dr. Samuel A. Mudd House (301-645-6870) in Waldorf, home to the country doctor who set the leg of John Wilkes Booth, President Lincoln's assassin, unwittingly helping him to escape to Virginia. Costumed guides now take visitors around the early Victorian frame farmhouse, dating to about 1754 and furnished with original pieces. Also a must-see is the small town of Benedict, the only spot in the United States where foreign troops have invaded our shores. During the War of 1812, British forces landed in Benedict, marched to Washington, D.C., and burned the city.

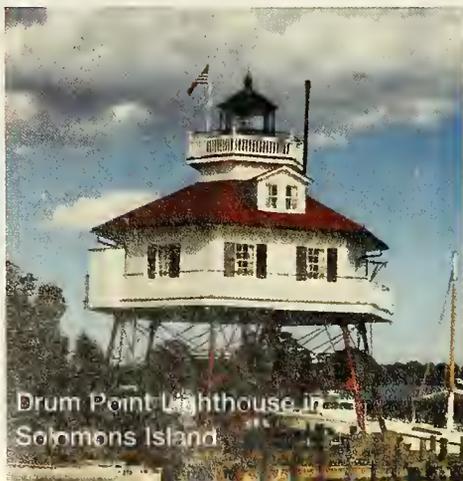
## Calvert County

**I**N THIS SOUTHERN MARYLAND county, you can take a cruise around Solomons Island, a historic fishing village where the Patuxent River meets the Chesapeake Bay. You can hunt for more than 600 species of fossils on the open beaches at Calvert Cliffs State Park—majestic cliffs, formed more than 15 million years ago, that dominate the Chesapeake Bay. Walk on the elevated boardwalk through the primeval beauty of Battle Creek Cypress Swamp in Prince Frederick, the northernmost naturally occurring stand of bald cypress in America. Visit the picturesque towns of Chesapeake Beach and North Beach. Here you'll find the Chesapeake Beach Railway Museum and the largest fleet of charterboats in the state. When you visit Calvert County, you'll discover why Southern Maryland Is Fun.



Historic London Town and Gardens

AAAGCVB



Drum Point Lighthouse in Solomons Island

## Dorchester County

**D**ORCHESTER COUNTY IS THE Heart of Chesapeake Country. Marshes and waterways are filled with wildlife and birds, and quaint watermen's villages are sprinkled through the "Cape Cod of the South." The port town of Cambridge, founded in 1684, is lined with historic homes and museums, including the Brannock Maritime Museum, with exhibits on Chesapeake Bay history. Outside of Cambridge, the Dorchester Heritage Museum has exhibits on aviation, archaeology, and local history,

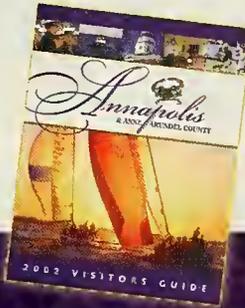


Bald Eagle

and the Richardson Museum focuses on the Bay's long heritage of wooden boat building. Also nearby is the Spocott Windmill, the only post windmill in Maryland, which still grinds flour on special occasions. Blackwater National Wildlife Refuge, just south of Cambridge, is an important nesting and leeding area for three of the nation's endangered species: the bald eagle, the Delmarva fox squirrel, and the peregrine falcon. And at the Harriet Tubman Museum, learn about the famous woman who helped slaves escape to freedom on the Underground Railroad.

# Annapolis

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## Frederick County

**N**ESTLED IN THE APPALACHIAN Mountains and Piedmont Plateau, Frederick County has more farms than any other county in Maryland. Vineyards and covered bridges dot this county, and the largest water garden in the U.S., the Lilypons Water Gardens, is in Buckeystown. The county also is a center of Civil War history sites, including the Monocacy National Battlefield, the site of the 1864 battle that played a pivotal role in defending Washington D.C. The Barbara Fritchie House and Museum is a replica of the house where 96-year-old Fritchie reportedly confronted General Stonewall Jackson when Confederate forces marched into Frederick in early September 1862.



Tourism Council of Frederick Co.

## Garrett County

**I**N THE MOUNTAINS OF WESTERN Maryland, the Deep Creek Lake Area offers visitors recreation and relaxation in 90,000 acres of lakes, forests, rivers, and parkland.

From the high adventure of whitewater sports on the Youghiogheny and Savage rivers to peaceful paddling on lakes and reservoirs, there is something for everyone.

Eco-tourism and nature tourism opportunities abound, with guided excursions



The natural beauty of Garrett County

Credie Calhoun Photo courtesy www.campearth.org

and rental equipment available for hiking, birding, mountain biking, canoeing, rafting, or kayaking.

This rural area is sparsely populated—only thirteen traffic signals in the entire county. The small towns reflect a quieter time: neighbors still gather in community parks for picnics on the 4th of July and caroling at Christmas. Shops and festivals feature the craftsmanship of Allegheny Mountain artisans and the elegant simplicity of Amish woodworking.

## Deep Creek Lake Area Western Maryland



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DORCHESTER COUNTY, MARYLAND

Seneca Creek State Park in  
Montgomery County



Montgomery County

**J**UST OUTSIDE OF WASHINGTON, D.C., Montgomery County is not your ordinary suburb. It offers visitors the best of urban sophistication and country leisure, from museums and galleries to theaters, historic sites, and pristine parks. Start your exploration with a visit to Glen Echo, a former amusement park that now is a year-round center of dance, theater, and the arts. The park includes the Clara Barton National Historic Site (301-492-

6245), which commemorates the life of the founder of the American Red Cross. Then explore the nearby Chesapeake and Ohio (C & O) Canal National Historic Park, near the Potomac River. The canal was operated from 1828 to 1924, primarily for hauling coal, and hundreds of original structures, including locks, lock houses, and aqueducts, remain. Plan a hike or bike tour along the canal's towpath, which provides a nearly level, continuous trail through the spectacular scenery of the Potomac River Valley.

If you'd rather be fishing, head to Little Seneca Lake in Black Hill Regional Park, just north of Germantown, where you might hook some largemouth bass, tiger musky, crappie, catfish, and several types of sunfish. Rent a rowboat or canoe, take a ride on a pontoon boat, or find a spot in the fishing pier. Hike,

Where the National Road crossed the northern part of the county in the 1800s, inns and taverns were built to accommodate travelers. Some of these still welcome visitors seeking lodging or a home-cooked meal.

At the end of the nineteenth century, the B&O railroad brought the wealthy and powerful from "down east" to vacation in the cool mountain summers. Many ornate Victorian "cottages" remain in the Mountain Lake Park area.



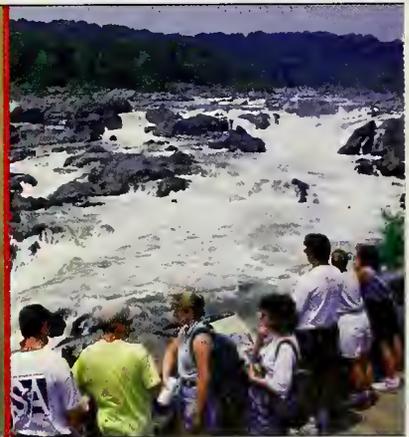
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## Prince George's County

Right: Brighton in Montgomery County; below: Maryland's famous crabs



horseback, or mountain bike through the miles of trails that meander through the quiet forests of this vast park. After a day in the outdoors, treat yourself to a feature at the Olney Theatre Center (301-924-3400), presenting the musical satire *Mainstage* through March 30th.



**B**ORDERING WASHINGTON, D.C. and a mere thirty-seven miles from Baltimore, Prince George's County offers a range of historic, cultural, and popular tourist sites.

Tour historic homes such as Darnall's Chance House Museum (301-952-8010) in Upper Marlboro, one of Maryland's oldest buildings, dating to 1704; the Montpelier Mansion and Cultural Arts Center (301-953-1376) in Laurel, a fine eighteenth-century Georgian house that was a haunt of George and Martha Washington's; the Marietta House Museum (301-464-5291) in Glenn Dale, a plantation home from circa 1813; and Riversdale (301-864-0420) in Riverdale Park, built between 1801 and 1807 and patterned after an eighteenth-century Belgian mansion.

Aviation fans won't want to miss the free tour of the Paul E. Garber Preservation, Restoration, and Storage Facility (reserve a tour at 202-357-1400), where aircraft are restored before they are displayed at the Smithsonian's Air and Space Museum; the College Park Aviation Museum (301-864-6029); or the Airmen Memorial Museum (800-638-0594) in Suitland, honoring leaders in aviation.

Schedule a visit at NASA's Goddard Space Flight Center and Museum (301-286-8981) in Greenbelt, the major U.S. laboratory for developing and operating unmanned scientific spacecraft. On March 18th, you can participate in *Goddard's Sun-Earth Day 2003: Live From the Aurora*, and learn about the sun, its structure, and processes.

If you have children, don't miss Prince George's most popular tourist attraction: Six Flags America (301-249-1500). The theme park features an exciting collection of roller coasters, including the new Batwing, where you fly face down through corkscrews and twists.

## Natural Beauty

... Comes in many forms

Discover scenic habitats, wildlife exhibits and educational experiences, all just minutes from Washington, D.C., Annapolis and Baltimore. Prince George's County offers natural beauty in all its forms.

- Cedarville State Forest
- Merkle Wildlife Sanctuary & Visitor Center
- National Colonial Farm
- National Visitor Center at Agricultural Research Center
- National Wildlife Visitor Center
- Watkins Nature Center
- Patuxent River Park

For additional information, contact:  
**Prince George's County  
 Conference & Visitors Bureau**  
 301-925-8300 (or 888-925-8300)  
[www.visitprincegeorges.com](http://www.visitprincegeorges.com)



## Queen Anne's County

**I**N LOVELY QUEEN ANNE'S COUNTY, on the scenic Eastern Shore of the Chesapeake Bay, enjoy a succulent crab or oyster dinner beside a bustling marina, fish and crab on the Bay, boat through wandering rivers, bicycle through historic and picturesque small towns, and hike through marshes and woodlands on the Cross Island Trail.

Start your visit on Kent Island, just across the Chesapeake Bay Bridge. Established as a trading post in 1631, the island is the oldest settlement in Maryland. In Stevensville, the island's largest town, visit the restored Stevensville Train Depot and Christ Church, home to Maryland's oldest congregation, founded in 1631.

Matapeake State Park, on the island's western shore, offers views of the Bay Bridge, boat ramps, and a 900-foot-long fishing pier. Terrapin Beach Nature Park, off MD 18, includes a one-mile nature trail, pond, two observation blinds, and a boardwalk to the Chesapeake Bay.

Just east of the island, in Grasonville, the Chesapeake Bay Environmental Center, operated by the Wildfowl Trust of North America, is a 500-acre sanctuary with trails around six waterfowl ponds, each representing a different wetland habitat. You may see deer, red fox, herons, swans, turtles, geese, and many species of ducks and other migratory birds traveling north and south on the Atlantic Flyway. The visitor center has a large picture window overlooking a waterfowl pond, hands-on exhibits for children, and an aquarium featuring creatures from the Chesapeake Bay.

The sixty-acre lake at Tuckahoe State Park, six miles north of the town of Queen Anne, is a haven for boaters and anglers. Tuckahoe Creek meanders through the park's wooded marshlands, and the Adkins Arboretum is home to native Maryland trees and plants.

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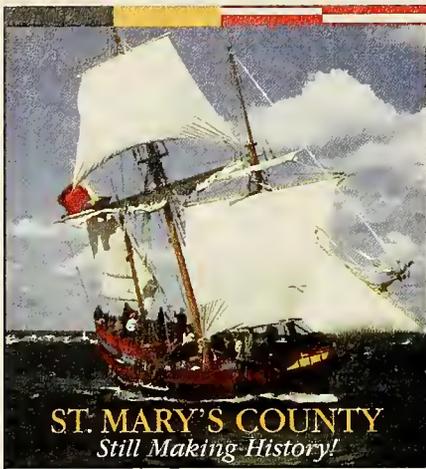
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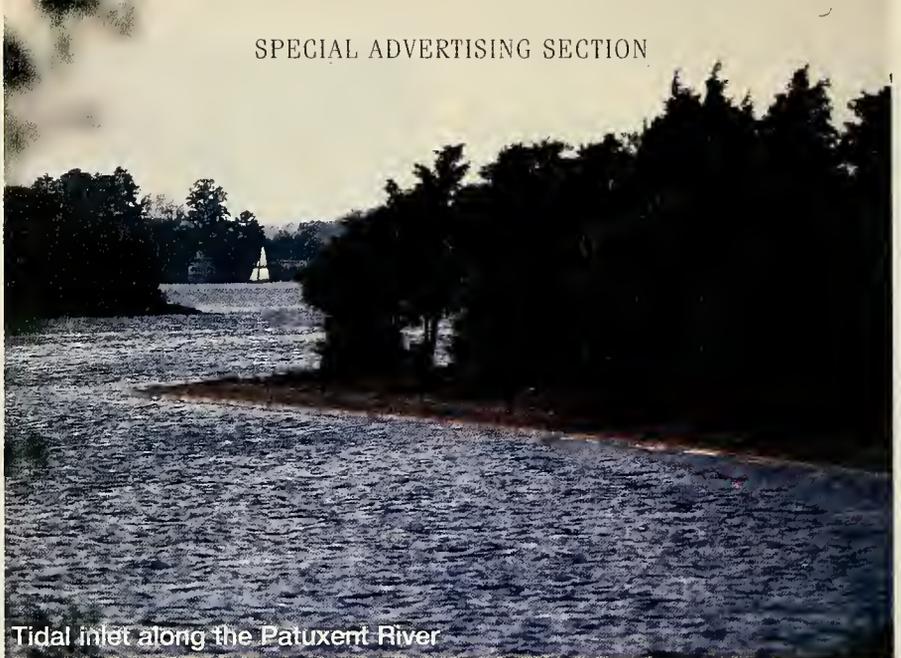
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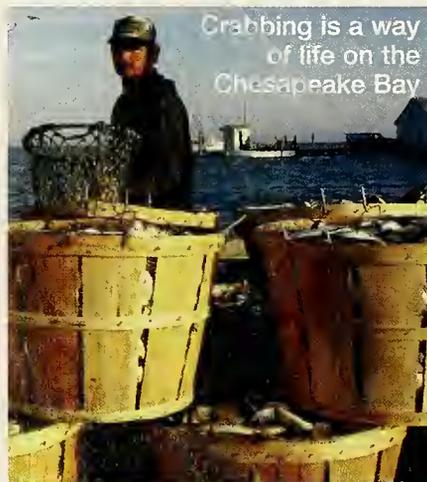
Tidal inlet along the Patuxent River

*St. Mary's County*

**S**HAPED BY THE CHESAPEAKE BAY and its mighty tributaries, the Patuxent and Potomac Rivers, St. Mary's County lies on a verdant peninsula that has fostered a traditional lifestyle anchored in the natural bounty of the Tidewater. Historic sites abound, including St. Mary's City, the state's colonial capital and its premier outdoor living history museum and archaeological park. The tidal landscape of creeks and tributaries offers great opportunities for canoeing and kayaking, and here, the waterman's way of life still centers on the seasonal harvest of crabs and oysters—available for sampling at crabhouses and waterside eateries throughout the county.

*Talbot County*

**I**N TALBOT COUNTY, EXPLORE the unspoiled beauty and historic lore of Maryland's Eastern Shore. Start your tour of this county's charming and historic small towns in the waterfront village of St. Michaels, called "the town that fooled the British" because during the War of 1812 the townspeople hung lanterns in the trees and the British cannons overshoot the houses. Here, the Chesapeake Bay Maritime Museum features exhibits on boat building, Chesapeake Bay craft, steamships, and decoy carving. Easton, rated among the Top Ten Best Small Towns in America, is a nostalgic All-American hometown, and Tilghman Island, surrounded by the Chesapeake Bay, is a working watermen's village with excellent fishing (it's home to the last commercial sailing fleet in North America) and fresh seafood.



Crabbing is a way of life on the Chesapeake Bay

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## Worcester County

**Y**EAR AFTER YEAR, VISITORS return to the untouched wilderness of Worcester County, where they sail, canoe past majestic cypresses along the Pocomoke River, catch crabs, and fish on the bays, rivers, ocean, and inlets.

Situated on Maryland's lower eastern shore, Worcester was not connected to the mainland until 1952, and it's retained much of its natural beauty. Bald eagles, snowy egrets, great blue herons, otters, muskrat, and deer inhabit the banks of the Pocomoke River. The county is home to the year-round beach resort of Ocean City, the pristine marshlands of Assateague, a natural barrier island, and the quaint historic town of Berlin, with its clusters of charming bed-and-breakfasts, historic inns, and antique stores.



Sanderling

Worcester also offers visitors a unique glimpse into the lives of early African-American pioneers, who settled the county in the mid-1600s. In the Berlin community of Germantown, visit two of the oldest structures from this period: the Comlort Powell House and, right next door, the New Bethel Methodist Church. The Julia A. Purnell Museum in Snow Hill displays the memorabilia of William Julius "Judy" Johnson, who enjoyed a professional baseball career from 1918 to 1939. In Pocomoke City, the Sturgis One Room School Museum, built about one hundred years ago, is an African-American schoolhouse.

## Johns Hopkins University Press



Heron wading in a marsh

**F**OUNDED IN 1878 IN BALTIMORE, Johns Hopkins is the oldest university press in continuous operation in North America. Three recent publications are of special interest to naturalists. *Birds of the Mid-Atlantic and Where to Find Them*, by John Rappole, is a comprehensive field guide to bird life in this area, with lists of the best sites to spot specific birds. It provides extensive information about every species: description, identification details, habitat, vocalization, range, seasonal occurrence, and distribution. Each entry is accompanied by a color photograph. *Rock Creek Park*, by Gail Spilisbury, celebrates Rock Creek Park, a resplendent wilderness retreat in Washington, D.C. Spilisbury tells the riveting story of the park's formation and preservation, focusing on how Frederick Law Olmsted Jr. and other visionaries laid down precedents for its preservation. In *The Great Marsh: An Intimate Journey into a Chesapeake Wetland*, David W. Harp's stunning photography and Tom Horton's graceful prose capture the beauty and essence of the disappearing marshland of Blackwater National Wildlife Refuge in Dorchester County. The fertile waters and soggy vegetation are home to ducks, geese, eagles, and dozens of other species. Essays discuss how the endangered marsh functions as a refuge for migrating butterflies and the bogs yield archaeological treasures.

## Birds of the Mid-Atlantic Region

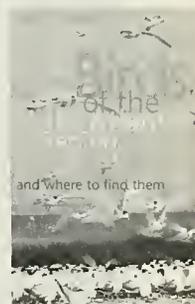
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John H. Rappole

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# Vietnam's Secret Life

*Naturalists exploring the country's mountains and forests are finding that the keys to its extraordinary biodiversity may lie deep in the past.*

*By Eleanor J. Sterling, Martha M. Hurley, and Raoul H. Bain*

**A**long Vietnam's border with Laos runs the Truong Son range, known to the Laotians as Saiphou Louang and to much of the rest of the world as the Annamites. But the mountains are becoming known—to conservation biologists as well as to everyone else concerned with preserving the world's species—as a region of exceptional biodiversity. In the early 1990s investigators began visiting

Vietnam's natural areas in greater numbers than at any time since the beginning of what is known to the people of the region as the Second Indochina War. And the investigators—ecologists, evolutionary biologists, and specialists in a broad spectrum of life-forms—soon confirmed what the local peoples had long known: an astounding array of organisms dwell in the country. For many biologists to this day, entering Vietnam is like entering uncharted territory, an area of vast biological abundance, where new species, it seems, can turn up virtually anywhere you look.

Biologists exploring the Truong Son have discovered—or, importantly, re-discovered—three previously unrecognized species of muntjac, or barking deer; one species of pig; and one species of rabbit [see illustrations of the latter two animals on page 53]. Those findings alone are remarkable; after hundreds of years of systematic biol-

ogy, who would have thought that large or medium-size mammals would remain to be described? And that list doesn't even include the saola, the sole member of *Pseudoryx*, a genus entirely new to the cattle family. Weighing in at about 220 pounds, the saola is the largest land-dwelling mammal introduced to science since the kouprey, or gray ox, was described in 1937. (That animal ranged through northern Cambodia and adjacent areas of Thailand, Laos, and Vietnam, but may now be extinct.)

But Vietnam promises more to biologists than just the windfall that is the Truong Son range. Ever since the mid-nineteenth century, up until the beginning of the Second World War, forays by Vietnamese and visiting naturalists had sketched a spotty but telling portrait of the country's biodiversity. More recently, since peace came to Vietnam, further hints of biological abundance have come from collaborations between Vietnamese and foreign investigators.

But only in the past ten years have biologists understood that the newly recognized charismatic megafauna are only the tip of an iceberg of heretofore unknown species that live in the Truong Son as well as in other, primarily montane, areas of Vietnam. Among the organisms new to science (though, again, not to natives of the area) are three



*The Sichuan whipping frog has been assigned to the species *Polypedates dugritei*—but herpetologists are now realizing that these frogs actually form a group of species, not just one. The several species probably arose when climate change stranded ancestral frog populations on separate mountaintops; the confusion for zoology arose when the climate changed again, first warming and then cooling, enabling the new (but similar-looking) frog species to disperse before they were isolated once more.*



*The male red-shanked dauc langur (Pygathrix nemaeus nemaeus)—a stunning arborealist endemic to Southeast Asia—lives in the forests of the northern end of Vietnam's Truong Son Mountains and adjoining lowlands. Because it rarely leaves the trees, climatic change affecting the range of its rainforest home could have forced the monkey into moist, albeit restricted "refuges," leading to the divergence of today's three subspecies of dauc: black-, red-, and gray-shanked.*



The green pricklenape lizard (*Acanthosaura capra*) is endemic to Indochina. The genus ranges across mainland Southeast Asia as well as on the island of Sumatra, perhaps indicating dispersal during dry periods when the Sunda shelf was exposed; the foothills of the Himalaya prevent the creature from spreading to the west. The lizard prominently displays its dewlap, or fold of loose skin, both to ward off predators and to threaten competitors during courtship.



*Megalaima franklinii auricularis*, a subspecies of the golden-throated barbet, has been observed in only a few parts of the central Truong Son and in southern Laos—a region that has proved a veritable oviary of recently discovered endemic species. As a result, the area is now the focus of conservation efforts.



The rhinoceros snake (*Rhynchophis boulengeri*) ranges across northeastern Vietnam and its small offshore islands, through China's Guangxi region, to the northeast of Vietnam, and China's Hainan Island, but it cannot be found in China's Yunnan Province, northwest of Vietnam. Depressed sea levels during ice ages would have opened the islands to colonization, and the return of warmer weather would have isolated them there, but the inland mountains are still too dry and too cold to be hospitable to these arboreal snakes.

species of birds, nineteen species of amphibians, sixteen species of reptiles, and, just since the year 2000, at least twenty-nine species of fish and 516 species of invertebrates. And—perhaps just as intriguing—many of the species native to Vietnam do not occur anywhere else: a phenomenon known as endemism.

The ferment of scientific activity in Vietnam in the past decade is a result of several historical developments: the restoration of political stability after decades of war; the recent opening of strategic border areas to scientists; and the reopening of the country to foreign scientific collaborators, such as our group from New York's American Museum of Natural History. Of course, Vietnam's turbulent political history can only explain why so many discoveries are emerging just now. History and politics (aside from the destruction they wreak) have little to say about the country's biodiversity—particularly about why so much of that biodiversity is endemic to it.

The real roots of the region's biodiversity lie in the dynamic interplay over time of geographic, geological, and climatic forces. The heaving of

mountains, the shifting courses of rivers, and the expansion and contraction of seas and forests have successively isolated and reunited populations of plants and animals. As new habitats arise and old ones shift, existing organisms can disperse, adapt, or die. Those three options have largely created the unusually complex mosaic of life that exists in the region today.

Mountains and hills wrinkle the vast majority of Vietnam's 127,000 square miles. Major mountain blocks include the highlands in the northeast, the Hoang Lien Son in the northwest (the southeasternmost extension of the Himalaya), and the Truong Son along the border with Laos. A range of forest habitats, each adapted to a different amount of yearly rainfall, blanket the slopes of these mountains.

The seasonality of the rainfall is, in part, a consequence of the monsoon circulation pattern, the dominant climatic feature of southern and eastern Asia for at least the past seven million years. In the winter, strong northeast monsoon winds blow, as air flows from cold, high-pressure areas in Asia along the eastern edge of the Tibetan Plateau toward a hot, low-pressure zone over Australia—a process that brings cold, dry winds to Vietnam. In the summer, air masses move in from the opposite direction, from Australia and the Indian Ocean; passing over Vietnam the air releases moisture picked up along the way, hence the country's summer rains. Those dynamic circulation patterns interact with the terrain and the surrounding ocean to expose Vietnam to widely varying amounts of rainfall.

Temperature and humidity vary with topography; in general, the higher the elevation, the cooler and wetter the climate. The interaction of upland areas with moisture-laden moving air masses creates a "rain shadow": windward slopes wring most of the moisture from the clouds and remain substantially wetter than the leeward slopes. In the Truong Son, for example, the coastal-facing eastern slopes are wetter than those facing west.

Meanwhile, a variety of climates dot Vietnam's interior. Regions without prolonged dry periods support moist evergreen forests; seasonally dry forests—mixtures of evergreen and deciduous trees—grow in areas of more mixed dry and wet periods; and dry deciduous forests range across southwestern regions with expanded dry seasons. In addition, Vietnam also hosts ecosystems as diverse as temperate coniferous forests, mangrove forests, grasslands, and coral reefs.

Geologically speaking, Southeast Asia lies at the interface of three converging continental plates: the Eurasian, Indo-Australian, and Philippine Sea. Continental plates, which are formed

from Earth's rigid, brittle lithosphere, or crust, move gradually across the planet, buoyed by movements from below, in the Earth's mantle. Sometimes the plates break into pieces; an aggregation of continental fragments broke off from the prehistoric supercontinent called Gondwanaland about 400 million years ago. Over the course of the ensuing 200 million years, some pieces of the broken continent migrated north to collide and fuse with Asia at higher latitudes, in the process creating much of what is now Vietnam. The Truong Son range arose during collisions that took place between the late Paleozoic and early Mesozoic Eras, between 340 million and 255 million years ago.

Later, between 55 million and 40 million years ago, what is now the subcontinent of India broke off from Gondwanaland and migrated north, colliding with Eurasia. The fusion of the two landmasses led to a major influx of new species, which dispersed through India and into Southeast Asia. As the collision of India with Asia continued—and it continues to this day—the rising Himalaya and the Tibetan Plateau essentially isolated Southeast Asia from invasions by species from the north and west [see “*The Anguid Odyssey*,” page 55].

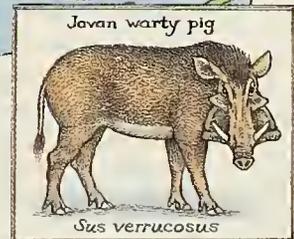
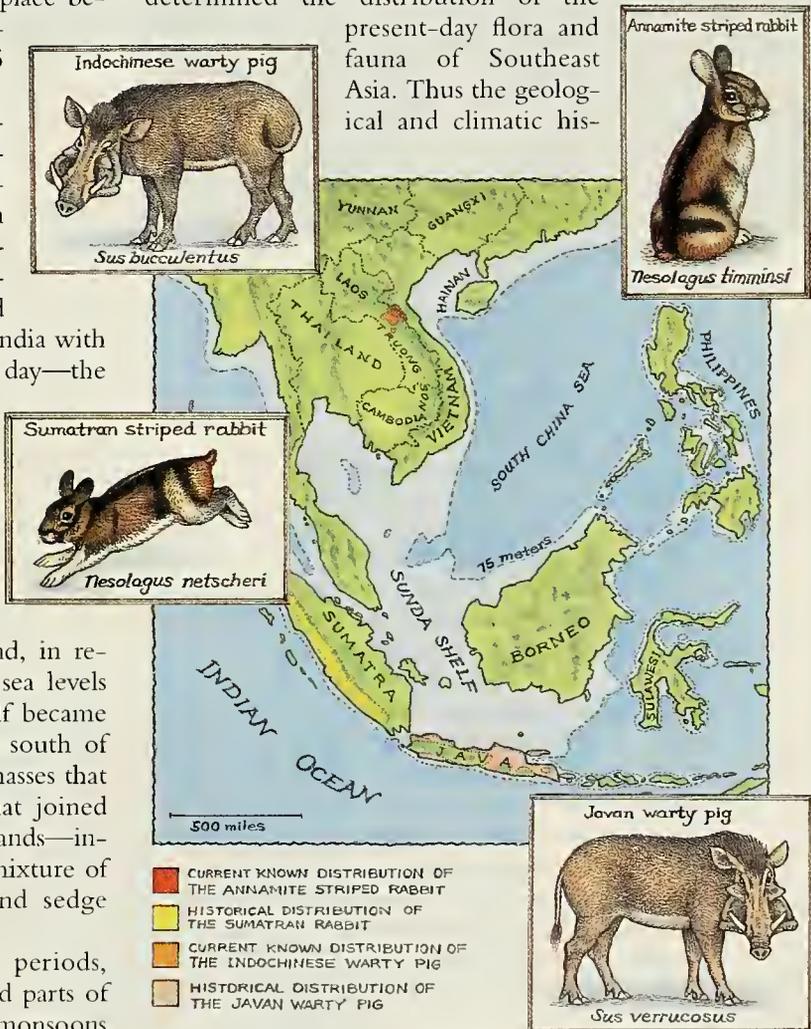
While the Himalaya were rising, Earth's climate began to fluctuate between cool and warm phases. Continental glaciers formed and retreated and, in response, sea levels fell and rose. When sea levels fell, the shallow Sunda continental shelf became exposed (today it lies beneath the seas south of Vietnam). The Sunda shelf linked landmasses that are now separated, forming bridges that joined mainland Southeast Asia to the Sunda Islands—including Borneo, Java, and Sumatra. A mixture of rainforest and grassland, woodland and sedge blanketed the emergent land.

During such glacier-forming cold periods, when much of the Gulf of Thailand and parts of the South China Sea disappeared, the monsoons picked up substantially less moisture than they do today. Seasons became more distinct. Forests previously limited to mountain elevations descended to lower levels, and grasslands proliferated, pushing out lowland evergreen rainforests. The most recent cold period took place about 18,000 years ago, the climax of the last ice age.

In contrast, during the warmer periods between glacial advances the climate became wetter and less seasonal, and the evergreen rainforests expanded,

reaching into the higher elevations and latitudes. Sea levels rose, covering the continental shelves and land bridges, splitting up and isolating populations and individual species. Those processes have continued throughout the Cenozoic Era up until what is, geologically speaking, the present day. In Southeast Asia, long-term cycles of isolation and recolonization have been the evolutionary norm.

Those cycles fueled the rise of new species, led to the extinction of others, and, in general, determined the distribution of the present-day flora and fauna of Southeast Asia. Thus the geological and climatic his-



Both the recently described Annamite striped rabbit and the Indochinese warty pig (rediscovered after more than 100 years) are known to range in only a small stretch of the northern Truong Son. Their closest likely relatives, however—the Sumatran striped rabbit and the Javan warty pig, respectively—range more than 1,500 miles away, on the islands for which they are named. Fluctuating sea levels and changing habitats could have spurred multiple cycles of isolation and recolonization across land bridges, eventually leading to the evolution of distinct species. Genetic analyses of the striped rabbits indicate that they became separate species some eight million years ago. (The drawings here are an artist's interpretation of field observations.)



The Cat Ba langur (*Trachypithecus poliocephalus*) lives only on Cat Ba, a small rocky island not far off the coast of Vietnam—just the sort of environment to promote the evolution of an endemic species, whether through environmental influences or even through a process such as the founder effect, by which a small group of organisms become distinct from ancestral populations because of the isolation of a limited gene pool. The monkey's numbers were never large, and it is thought to be seriously threatened by the encroachments of tourism. Ironically, tourists could also prove to be its saving grace: they often pay top dollar to see rare primates on minute islands.

tory of the region can serve biologists as a kind of Rosetta stone, helping them to decode and disentangle the patterns of Vietnam's biodiversity as well as to pinpoint where new species might be found.

Consider, for example, some of the distribution patterns of Vietnamese amphibians and reptiles. Northeastern Vietnam shares more than twenty of these species with China's Hainan Island and Guangxi autonomous region. China's Yunnan Province, however, which borders both Vietnam and Guangxi, shares none of them. Sea-level changes, in concert with climate, help explain the patterns. Low sea levels during the Pleistocene Epoch, beginning 1.8 million years ago, enabled

flora and fauna to migrate back and forth from the mainland to Hainan Island. But the drier, cooler climate of Yunnan Province limited the westward dispersal of at least some of the species.

Sea levels far lower than they are today also enabled amphibians and reptiles to travel freely back and forth between the Greater Sunda Islands and mainland Southeast Asia. As a result, the two areas share roughly a fifth of their amphibian and reptile species. In fact, investigators comparing present-day species distributions with measurements of contemporary ocean depths can demonstrate how low sea levels must have fallen during some geological periods. Moving across the sea would have been hard for reptiles and practically impossible for amphibians, whose permeable skin does not tolerate saltwater.

Inland, away from the seas, climate and geography can also play a role in the rise of new species as well as in endemism. Here, however, Vietnam's climatic cycles drove organisms up and down mountains rather than back and forth across land bridges that were later flooded.

For example, when the climate warmed, montane forest communities contracted and moved up the mountain slopes, where the climate was relatively cool. Those contractions could keep forest populations living on separate slopes isolated for substantial periods of time—in some cases, long enough to differentiate into distinct species. Later, when the climate cooled again and the forests expanded downslope, those now-distinct species could disperse throughout the lowlands. If further warming phases pushed the new species back up to high elevations, many might end up populating new, or more widespread, areas than the ones where they originated. The effect, of course, is virtually identical to that of rising and falling sea levels, which led to island endemism. But the mixing of evolutionary lineages and the resultant diversity means zoologists are faced with a tangle that they are only now sorting out.

Bird endemism also seems to follow such a tangled pattern. Montane forests above about 3,000 feet in the Truong Son are rich in songbird diversity, notably in the flycatchers and Old World warblers and related species. Two of the three new bird species described in the central

The male crested argus (*Rheinardia ocellata*) has the longest tail feathers of any bird in the world, reaching a maximum length of nearly seventy inches. Two separate regions host the birds: the Truong Son of Vietnam and Laos, and montane areas on the Malay Peninsula. The disjunct range could be a consequence of sea-level changes and variations in forest cover in recent geological times, leaving the species in only these evergreen forest refuges. This photograph was taken using a "camera trap"—a camera attached to a motion detector that can do field-work when no one is around.



Truong Son (the black-crowned barwing, the golden-winged laughingthrush, and the chestnut-eared laughingthrush) are endemic to the area.

Biologists have recognized eleven endemic subspecies of babblers there as well. These discoveries have led the conservation organization Bird-Life International to designate this region of the Truong Son a high priority for bird conservation.

The patterns of endemism and speciation observed in Vietnam are set in motion when the separated populations become trapped by some kind of barrier that develops between them. But that barrier need not be elevation, or a land bridge that has been flooded. In the Truong Son another kind of barrier has arisen, in the form of a moist refuge surrounded by a drier environment.

As we noted earlier, the Truong Son act as a barrier to the monsoon winds, giving rise to high rainfall and a reduced dry season on the eastern slopes. As a result, moist evergreen forests have grown historically at all elevations to the east of the main ridge (though today much of the land at lower elevations is deforested). In contrast, on the western slopes drier semi-evergreen forests are more common.

The moist evergreen forest may have been able to persist on the eastern slopes of the Truong Son despite increasingly dramatic climate fluctuations during the past three million years. Those tropical rainforests may have provided a refuge for forest-dependent species during colder, drier, more distinctly seasonal periods. Such an extra dimension, along

which habitat may have expanded or shrunk with time, could help explain why, even in such an Eden of biodiversity as Vietnam, the Truong Son

range outshines the rest of the country. (Indeed, in addition to the species we mentioned earlier, the rainforests of the Truong Son harbor about a dozen endemic species of frogs.)



### The Anguid Odyssey

*Pictured above is a limbless glass lizard of the family Anguidae, genus Ophisaurus. (These animals may look like snakes, but their ears and movable eyelids are telltale distinguishing features.) Several species of glass lizards are endemic to Southeast Asia, but the story of how they got there (and where they went afterward) is no less interesting than endemism. Originating in North America, the ancestors of limbless glass lizards probably migrated to western Europe between 40 million and 50 million years ago, across a land bridge (not shown in this contemporary map). They then expanded into northern Africa and western Asia. As species radiated throughout eastern Asia, the uplift of the Tibetan Plateau between 10 million and 25 million years ago isolated the new species from populations to the west. At roughly the same time, one eastern lineage returned to North America via the Bering land bridge. The result: Vietnam's three species of glass lizards count different North American species as their distant ancestors and closest relatives.*



Unfortunately, some patterns of endemism are not so easily explained. Vietnam is host to several principal kinds of primates: gibbons (lesser apes), langurs and macaques (which are both monkeys), and lorises (which are prosimians). The ranges of many of those animals are clearly restricted, yet strangely, for many of them, no discernible geographic barrier has been identified.

Several but not all of Vietnam's primate species live only east of the Mekong River, even though there is no apparent reason that they could not raft across. Even more strangely, the ranges of all but two of Vietnam's primates—the lesser slow loris and the bear macaque—are restricted to either the north or the south of the country. A 195-mile-wide transition zone, between 14 and 17 degrees north latitude, serves as a barrier between north and south, but no climatic or geographic reasons have been identified for the existence of this barrier.

Ecologists, confronted with such a checkerboard distribution, have speculated that competition for food or other resources might limit the expansion of one species into another one's range. Although that explanation sounds plausible, it is undermined by the observation

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The golden Vietnamese cypress (*Xanthocyparis vietnamensis*), a conifer that inhabits the northern reaches of Vietnam, was first described by scientists in 2001. Mature trees bear both needles (left) and scales (right)—a highly unusual condition for a mature tree. (It is much more common for a conifer to have one kind of leaf when young and the other kind when mature.) The “discovery” was no surprise, of course, to the region’s indigenous people; they have long sought out the tree’s fragrant wood, leaving the species’ survival in serious question.



that species such as the Assamese macaque and the pigtailed macaque, whose ranges do not overlap in Vietnam, live side by side in Laos and China. Interspecific competition cannot be the only answer.

Other investigators have speculated that glaciation during the Pleistocene Epoch—accompanied by colder temperatures, depressed rainfall, and increased seasonality—might have forced primates into ecological refuges. Species that ended up in the northern areas were presumably better able to manage the cooler weather year-round than were the species that favored the south.

have a solid picture of primate evolution in Vietnam. Biodiversity, it seems, is not merely a result of geographical and climatic obstacles and effects. The irony is that, although geographic ranges are better known for primates than for any other group of organisms in the region, those ranges are perhaps the ones biologists are least able to explain.

In seeking to understand the origins of Vietnam’s biodiversity, biologists have to be wary of snap judgments. Particularly for species identified only in the past decade, it is virtually impossible to de-

## WHERE ON EARTH IS THE *KHTING VOR*?

Species are often described from remains; such work is the obvious domain of paleontology. But sometimes zoologists hoping to find extant organisms begin by doing the same thing. In 1994 a new ox-like species was described solely on the basis of horns that had been sold as hunting trophies at markets in south-central Vietnam and eastern Cambodia in the early twentieth century. The animal was given the scientific name *Pseudonovibos spiralis*, and it was expected to be similar to other wild cattle found in the same area, including the gaur and the kouprey, or gray ox. Supposedly it inhabited the deciduous and semi-deciduous forests of southern Indochina. Its horns, shaped like a lyre, were ringed with knobs and twisted at the tips: a combination unique among mammals.

The horns, it was thought, might represent the remains of an elusive animal known in the Khmer language of Cambodia as the *khting vor*, a name describing the shape of the horns (from *khting*, meaning gaur, and *vor*, a liana, or creeping vine). In the traditional folklore of the region, the *khting vor* is a snake-eating wild ox. Its horns are held to protect people and their homes against snakes, and are also ground into a powder for treating venomous bites.

DNA was recovered from the horns, but considerable doubt arose from its analysis. Confusingly, it suggested the animal belonged to not one but three quite different

subcategories within the family Bovidae: the goats and sheep; the oxen, bison, and buffaloes; and the common domesticated cattle.

Not surprisingly, then, a debate erupted about whether or not the *khting vor* ever existed. Were the horns in fact creations of local craftsmen, prized for their value as ritual objects or in traditional medicine? Further molecular work has shown that the specimens are actually from common cattle, and sophisticated examination of the horns themselves indicates that their unique ringing patterns and torsion were created by carving, heating, and twisting. Given the limited number of horns collected to date (between sixty and seventy), the problems of contamination associated with the recovery of “ancient” DNA, and the extremely limited data on its possible geographical habitats, the question of the *khting vor*’s legitimacy has become extremely difficult to resolve in its favor.

Still, a recent camera-trapping survey of Cambodia, in which cameras activated by tripwires were left in forests, could have finally removed such uncharitable skepticism. Unfortunately, though, no pictures of the animal were obtained. Either the *khting vor* is expert at avoiding zoological paparazzi, or, as with the unicorn before it, its only proper place is in the pages of Jorge Luis Borges’s *Book of Imaginary Beings*.

—M.M.H.

termine whether their ranges are restricted by long-term geological or climatic factors, or simply because of habitat loss or degradation. Some species may be “bastard endemics”—occupying only a subset of a formerly larger geographic range—simply because they have retreated, say, to mountain-top islands in a sea of cultivated or seriously degraded land.

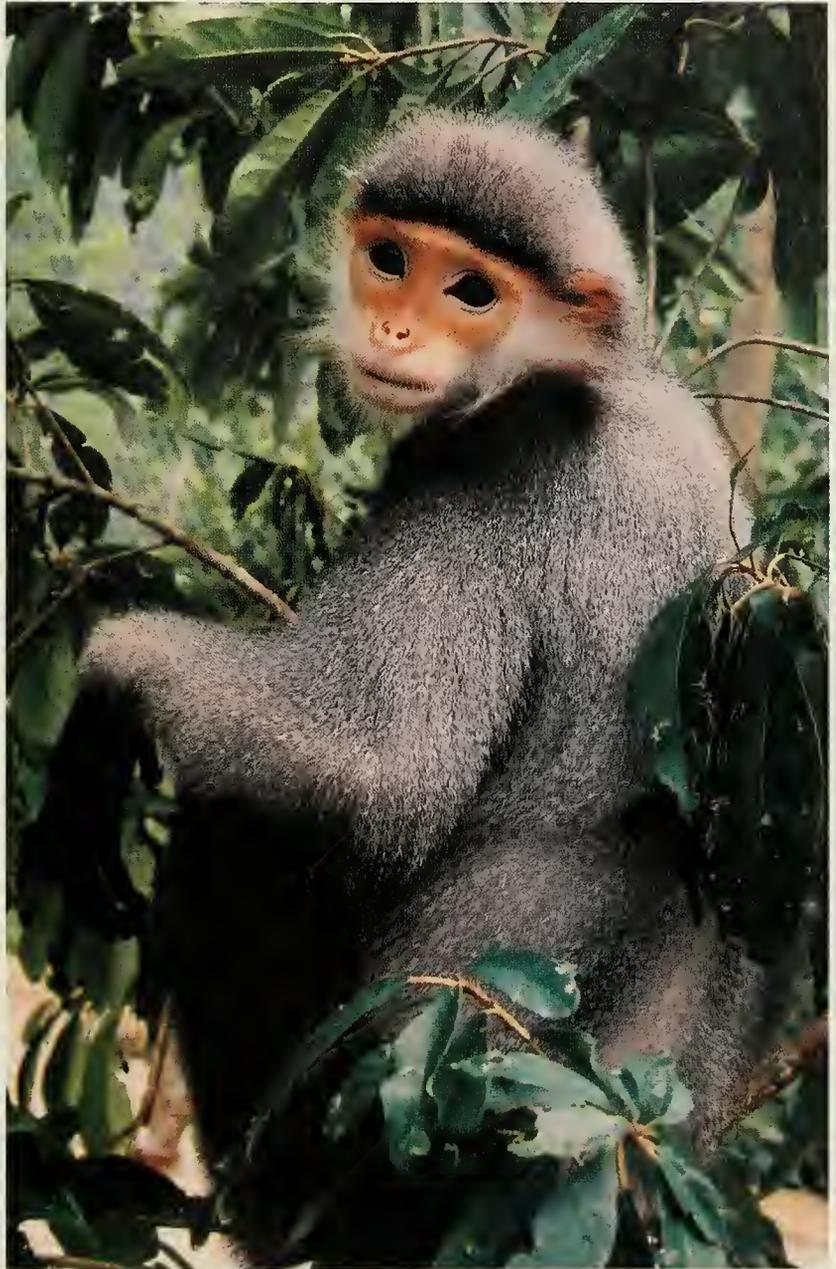
Acknowledging the ability of environmental degradation to create endemism brings a practical urgency to the theoretical study of the factors that create endemic species. In short, the study of endemism is not just a pursuit for evolutionary biologists; it is an issue for conservationists and environmentalists to consider as well.

Vietnam has a relatively long history of seeking to redress environmental degradation. As far back as 1962, Ho Chi Minh, the revolutionary general and president of North Vietnam from 1945 until 1969, established the country’s first protected area, Cuc Phuong National Park [see “This Land,” by Nguyen Thi Dao, page 70]. By 1990 more than ninety reserves, covering some 4 percent of the country (or about 3.2 million acres), had been placed under government protection. The Vietnamese government still has plans to roughly double that protected area, but in the region’s second most populous nation, the demands of economic development must compete for land with efforts to conserve biodiversity.

In that context, the study of endemism can help governments and others set priorities about what to protect. Certainly it makes sense to determine those priorities, as conservationists have done in the past, on the basis of which species are endemic. After all, if a local population of a widespread species were to go extinct, at least there would still be other populations in the world, but endemic species have much more restricted ranges. The loss of a single population, or a couple of populations of such species, could easily lead to the species’ extinction.

The trick, then, is to identify areas of endemism preemptively, without waiting for some remarkable discovery to send everyone scrambling to save a rare and obviously threatened organism. By applying the study of endemism, rooted in the slow

passage of deep time, to the problem of conservation—which strives to match the double-time pace of economic development—we might be able to protect areas before they’ve been thoroughly explored, perhaps leaving some of Vietnam’s diversity for the future to discover. □



*The gray-shanked dauc langur (P. n. cinereus) was first described by biologists in 1997. It shares the Truong Son with red- and black-shanked dauc langur subspecies, which live to its north and south, respectively. This animal, however, was found not in the forest but far sale in a market, and it currently lives in a center for rescued primates. Only a handful of these animals have been seen in the wild. Considerable debate exists as to whether these subspecies ought to be lumped into one species or split into three. For now, the lumpers hold the upper hand.*



Rubbing of a ca cuong water bug, from an urn in Mieu Temple, Hue, Vietnam

## On the Scent

*The trail of a giant water bug leads from Arizona to Vietnam.*

By Robert L. Smith

Many years ago, as a graduate student drawn to behavioral ecology and aquatic insects, I encountered my first water bug in the mountain streams of southern Arizona. The species was *Abedus herberti*, a member of one subfamily of giant water bugs, the Belostomatinae. This bug has a remarkable behavior: the male often carries the eggs of its progeny on its back. That same behavior, rarely seen in other groups of insects, has been observed or inferred in more than a hundred species belonging to five genera of the same water bug subfamily. At the time, however, no one had adequately explained it. That's when I knew these bugs were the ones for me.

In my subsequent investigations I learned that the male acquires the eggs while mating repeatedly—sometimes more than a hundred times—with the female. His possessiveness ensures that his sperm alone are responsible for fertilizing all of the eggs she lays on his back. The male then carries the eggs until they hatch, keeping them wet and making sure they can breathe [see “Daddy Water Bugs,” February 1980].

Sometimes while studying my bugs in mountain streams, I came across another species of water bug, *Lethocerus medius*. That one belongs to another subfamily of giant water bugs, the Lethocerinae, which don't carry eggs on their backs. Instead, the female attaches large clutches of eggs in the open air, to vegetation and other material that emerges above the water's surface. I kept my eye out for her deposits but never saw any, nor did I find any immature bugs. The reason was that these bugs usually live in the still waters of ponds and lakes, not in streams. Arnold Menke, a specialist in water bug systematics, then at the Smithsonian Institution in Washington, D.C., suggested I look for them in the desert, in so-called cattle tanks.

Cattle tanks are natural depressions in the ground. They are usually bone dry in May and June, when surface temperatures can exceed 140 degrees, but they rapidly fill with runoff during the southern Arizona “monsoons”—thunderstorms that arrive soon after the human-made fireworks of the Fourth of July. The ponds begin to teem with algae and other life that has lain dor-

mant, and, summoned by the rains, some insect species in the mountain streams fly to the desert below to gorge on the bounty.

Among the opportunistic migrants is *L. medius*, the largest giant water bug in Arizona. Adults can measure nearly three inches long, and they come equipped with piercing, sucking mouthparts and clawed raptorial front legs. They are big enough to ambush tadpoles too chunky for any other insect predators. The female water bugs use most of their nutrient bounty to produce eggs, whereas the males expend energy on grabbing and defending home bases on the emergent vegetation, from which they court females ready to lay eggs.

In the mid-1980s, in the company of my friend Eric Larsen, then a graduate student working on other water bugs known as back swimmers (he now teaches at the University of Chicago), I began studying the reproductive behavior of *L. medius*. We noted early on that the bugs laid their eggs on sticklike objects extending two feet or more above the water. Mesquite branches, steel and wooden fence posts, and partly submerged cocklebur plants were all popular.

In the second year of work I tried an experiment. I stripped several ponds of their potential egg-laying sites and substituted new ones, sticking several dozen flat wooden stakes into the mud. After several weeks I was pleased to find that eggs had been laid on a number of my stakes. After another week I captured bugs in nets as they were resting underwater on the stakes. Talk about instant gratification! Every stake with eggs also harbored a bug, and every bug was a male! Moreover, stakes without eggs rarely harbored a bug of either sex.

I learned that male bugs not only hang out on the objects that bear their eggs but also brood the eggs by bringing them water. That finding was confirmed independently by Noritaka Ichikawa, a biologist at the Himeji City Aquarium in Japan, working with *L. deyrollei*, a Japanese water bug species. His laboratory studies show that underwater, a brooding bug both imbibes water and saturates its body. The wet insect then quickly crawls up to the eggs and positions himself head down over them, dripping and regurgitating water into the clutch. Ichikawa and I have proved that the eggs of the species we study desiccate and die if left unattended in open air, and that they drown within hours if submerged.

Early in my field research I witnessed my first mating pair of *L. medius*. While the female laid eggs at the lower edge of the clutch, the male demonstrated his commitment by irrigating the

eggs from above. But the male also acted just like the males among my “back brooders,” regularly interrupting both egg laying and watering to insist on another bout of sex. When the female finally finished laying all her eggs, she swam off, while the male remained behind for about a week, tending the eggs until they hatched.

By lucky accident I discovered that the males were also valiant at defense. One day I tapped several times on the top of an egg-bearing stake with my pocketknife, to seat the stake more firmly in the mud. The resident bug, which had been resting head-down below the water’s surface, rushed up to the eggs, covered them with his body, spread his raptorial front legs, and extended his beak. I was so startled that I dropped my knife into the water.

In the minute it took me to retrieve my knife, a possible explanation for such a formidable display occurred to me. Birds might threaten eggs that were suspended above the water (though I had never seen that happen). A charging giant water bug could be a good deterrent, and such behavior would be favored by natural selection. I tested how other bugs reacted to a “pecking bird simulation” and discovered that the bugs’ responses were consistent with my hypothesis.

During several years of observing I was amazed by other feats of the brooding males. If a person (or perhaps a cow) abruptly approached a male positioned on his eggs, the bug would usually jump into the water and swim several yards away. The first few times that happened, I despaired that the dad would ever find his eggs again—but every bug always did, and quickly, even at night. Indeed, male bugs could find the right stake in the midst of a forest of stakes, even if I added extras nearby just to sow confusion. Sometimes, too, a female laid eggs on a dead cocklebur plant. I watched in awe as, even in the dark, the



A female *L. medius* lays her eggs, while the male above her keeps them moistened with water.



Among the largest of the giant water bugs, *L. medius* dines regularly on small vertebrates such as fish fry and tadpoles.

male repeatedly ascended the maze of branches, nearly flawlessly making the correct choices at as many as five branching points. How did he do it?

I began to focus on an anatomical feature that had been recognized in *L. indicus*, an Asian water bug species. *L. indicus* possesses a gland with an outlet on the underside of its thorax. Asian biologists have taken a special interest in the gland, because its fragrant exudate is a highly valued flavoring among gourmet

chefs, particularly in Vietnam but also in other regions of Southeast Asia and southern China [see "Bug Juice," opposite page]. Curiously, the gland occurs in both males and females, but the gland in the male is reported to be as much as twenty-five times larger than the one in the female.

In fact, that organ, called the metathoracic scent gland, is a basic feature of Heteroptera, the insect order to which giant water bugs belong. The organ commonly releases a noxious chemical used in defense (in the stink bug, for instance) or a pheromone used in courtship. Mysteriously, though, the gland is absent in back-brooding giant water bugs such as *A. herberti*. Moreover, though it is present in emergent-brooders such as *L. medius*, biologists had not determined what function it or its products might fulfill for the bug.

With the help of

William S. Bowers and Philip Evans, chemical ecologists in the department of entomology at the University of Arizona in Tucson, I analyzed the contents of glands from *L. medius* as well as from another North American species, *L. americanus*. Both species contained the same chemical—*trans*-hex-2-enyl acetate—that occurs in *L. indicus*, and both sexes produced it, though the males carried more than ten times as much as the females did. In fact, it now seems that all two dozen species in the genus *Lethocerus* produce the same chemical.

Could the gland be used for defense? Not likely. In handling hundreds of the bugs, I have never had one discharge its scent gland on me (though distressed bugs regularly evacuated the stinky contents of their guts). Besides, the gland product is not noxious or foul smelling; on the contrary, it is very pleasant. Might the gland manufacture sexual pheromones? That, too, is a non-starter. Such attractants are usually produced by only one sex, and typically they are complex chemical blends that differ sharply, even among closely related species. The water bug product is basically made up of one fairly simple compound.

Instead, I think, in emergent-brooding water bugs the gland functions to lay down a chemical trail that can be followed during egg laying and egg brooding. The opening for the gland's secretion is directly between the hind legs, perfect for marking vegetation. If I am right, the gland enables male bugs to find their eggs both day and night. And this explanation accounts for the absence of the gland among back-brooders, whose behavior is thought to have evolved later than that of emergent brooders: they simply don't need it.

Why do both sexes possess the gland when only the males brood? While laying her eggs, the mother water bug periodically returns to the water to re-

fresh herself. Furthermore, she can be knocked off the egg-laying site by her mate's insistent attempts to copulate. The gland may be useful to her in finding her way back to her eggs for the few hours it takes her to finish laying them. But the males apparently need larger glands; they have to find the eggs many times each day for a week or more, not just for a few hours. □



A male *L. medius* returning from a dip has to navigate to the top of a maze of branches to return to his eggs.

My earliest memories of the *ca cuong* water bug can't be separated from the pleasures of eating. My grandmother, who lived with us in Bangkok, would prepare her traditional Vietnamese dish of noodles in a glorious chicken broth topped with thin slivers of omelet, steamed chicken breast, and a smooth-textured paté. It was served with *nuoc mam*, a fish sauce mixed with lemon juice, minced ginger, garlic, and just one drop of the essence extracted from the *ca cuong*'s scent glands. That one drop suffused the dish with an indescribable fragrance, enough for the entire family.

Even at the age of five I knew that the *ca cuong* was a wonderful, precious creature. In times of war and social turmoil, vials of its aromatic essence were literally a liquid asset, more valuable (and more portable) than gold. My mother told of families that escaped from Laos to Thailand in 1946, driven out by the terror of French bombs. Vials of the sublime essence they brought with them provided the capital they needed to start a new life.

Even after coming to America in 1960, I never stopped yearning for the *ca cuong*. Miniature vials contributed by visiting relatives were gratefully received and sparingly used. Then, in the late 1980s, an uncle who traveled frequently to Vietnam told me that my beloved *ca cuong* was hardly to be seen anymore. I was shocked, and resolved to learn more about the fate of this gastronomic delight.

I invited a dear friend who lives in Paris to share his memories of the *ca cuong*. Noting that their season came in late spring and early summer, he said his images were of bugs caught, cooked whole, and then mashed in a bowl with some *nuoc mam* fish sauce. The family would gather round, dipping boiled cabbage leaves in the shared bowl. For him, the *ca cuong* evoked not so much physical or olfactory sensations as the promise of changing seasons. He also

# Bug Juice

By Le Anh Tu Packard

recalled an earthy proverb: *Ca cuong chet den dit con cay* (the *ca cuong*, dead, on reaching the anus remains intense). It is a variant of the adage that no one can change the basic nature of things. That the *ca cuong* is widely believed to be an aphrodisiac adds further ambiguity to the proverb.

Other friends have offered depictions of the bug—rubbings from a temple in Hue, Vietnam's former imperial capital [see illustration below and on page 60]—and recounted stories about the *ca cuong* in ancient times.



David Marr, a historian at the Australian National University in Canberra, forwarded me a 1928 article on the region's edible insects that includes the story, perhaps apocryphal, of how the bug got its name. Legend has it that Trieu Da (207–137 B.C.), a Chinese general who became ruler of central Vietnam, sent the Chinese emperor a tribute of precious objects, including a number of the insects. The emperor then wrote to ask the insect's name. To inflate the bug's value, Da called it a cinnamon-tree weevil. But the emperor sent back an artfully worded, reproachful reply, that no one in that region would call it by that name, and Trieu Da ought not assume that his betters would be so easily fooled. As a result, the insect came to be called *ca cuong*, a mangling of the phrase *Da cuong*, meaning "Da embarrassed."

On my first trip back to Vietnam, in 1990, I asked about procuring *ca cuong* essence. One of my indulgent

aunts, who lived in the old quarter of Hanoi, scoured the city, but alas, no luck! The market seemed to have been cornered by people who planned to leave the country.

On my second trip, in 1992, I met Vu Quang Manh, a zoologist and an authority on the *ca cuong*. (He is currently an associate professor at Hanoi National Pedagogic University and head of the Vietnam Soil Ecology Society.) He told me that the bug, which inhabits ponds and waterlogged fields, subsists mainly on a diet of small fish, tadpoles, large aquatic insects, and snails. According to Manh, even the carcasses of some large waterfowl show signs of the insect's deadly bite.

In the 1980s *ca cuong* could still be seen flying around Hanoi's Ba Dinh Square, attracted by the lampposts and by the spotlights illuminating the mausoleum of Ho Chi Minh. They were also common near Ho Tay (West Lake). Now they are gone from both places, driven away by chemical fertilizers and pesticides. Manh reports more recent sightings of the bugs in Van Long Wetland Nature Reserve in Ninh Binh Province, south of Hanoi, a pesticide-free riverine wetland.

That this fabulous creature may disappear from Vietnam would be a tragedy for our culture and cuisine—the rough equivalent of abolishing truffles from French cuisine. Fortunately, Manh is leading a project to create a hospitable habitat for the water bug—one free of chemical fertilizers and pesticides. An effort to save the *ca cuong* is an important component of a wider effort to promote sustainable organic agriculture and to protect Vietnam's environment.

Cultivating the *ca cuong* and exporting its essence could help poor farmers increase their income and generate hard currency revenues for the nation. Even non-Vietnamese epicures, on tasting the flavor of the *ca cuong*, may fall under its spell. And why not? Whoever thought, after all, that Westerners would develop such a passion for raw fish? □

# The Golden Number

*Nature seems to have a sense of proportion.*

By Mario Livio



Olivia Parker, *Equinox*, 1992

What do:

- the arrangements of sunflower seeds;
- the branching of leaves on a stem;
- the flight path of a diving falcon;
- the breeding of rabbits;
- the spiral shapes of nautilus shells and other mollusks;
- the shapes of spiral galaxies; and
- the way black holes change from one “phase” to another

all have in common? What shared thread connects the petal arrangement in a red rose with the art of Salvador Dalí and the architecture of Frank Lloyd Wright? The answer is, all these phenomena share a close association with a single, extraordinary number. No wonder the number in question has earned the name “golden ratio.”

The golden ratio—aka “golden section,” “golden number,” and even “divine proportion”—is hardly, by itself, a novel concept. The systematizer of Greek geometry, Euclid, who taught in Alexandria around 300 B.C., defined the number in *Elements*, his famous work on geometry and number theory. But Euclid’s definition was entirely geometric and betrayed not the slightest acquaintance with the role of the golden ratio in the natural world. In fact, it was nothing more than a modestly amusing way for geometers to divide a line into two unequal parts. Little did Euclid know that his innocent-looking division would preoccupy mathematicians, physicists, botanists, psychologists, and artists for the next few millennia.

Euclid’s number (the name “golden ratio” was applied centuries later) emerges from geometry in the following way: Take any line segment and divide it into two parts, in such a way that the longer part of the line segment is in the same proportion to the shorter part as the entire line segment is to the longer part. The ratio in question is the golden ratio [see diagram below]. (You don’t need to follow the mathematics to understand the rest of this article, but for readers who are interested, here’s how to figure

out the value of Euclid’s number: Suppose the length of the shorter part is 1 and

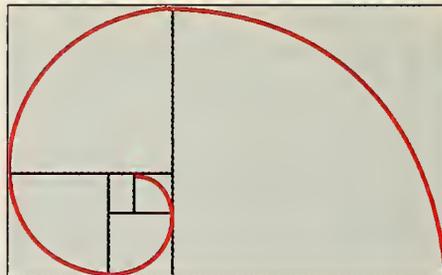


the length of the longer part is  $x$ . That makes the length of the original line segment equal to  $x + 1$ . According to Euclid’s definition, then, the value of the golden ratio is  $x/1$ , the ratio of the longer part to the shorter part. But that ratio must also be equal to  $(x + 1)/x$ , or the ratio of the original line to the longer part. The solution for  $x$  is then a straightforward, albeit technical, matter of high school algebra.)

Turn the crank, and the number that solves the equation for  $x$  is equal to the never-ending, never-repeating number 1.6180339887 . . . , commonly denoted by the Greek letter phi, or  $\phi$ . Phi is not to be confused with the Greek letter pi, or  $\pi$ , which stands for a more familiar never-ending, nonrepeating number also present throughout Euclid’s work. Pi, whose decimal value is 3.1415926535 . . . , is simply the ratio of the circumference of a circle to its diameter. But pi also makes guest appearances in the most diverse parts of natural science. In that respect phi is like pi: its original definition can be understood by virtually anyone, but it reappears in a remarkable variety of arcane and mysterious guises.

Also like pi, the number phi is an irrational number, one that cannot be expressed as a ratio of two whole numbers, such as  $3/1$ ,  $3/2$ ,  $5/7$ , or  $23/39$ . In fact, phi is mathematically the “most irrational” number, in the sense that, if you try to approximate it as what is known as a continued fraction (one in which fractions are added in the denominator ad infinitum), you find that the approximation converges on it more slowly than continued-fraction approximations do for any other irrational number.

In a golden rectangle the ratio of the longer side to the shorter is equal to phi. A square removed from one end leaves a smaller golden rectangle, and that process can be repeated indefinitely. The smooth spiral that passes through the successively smaller squares is called a logarithmic spiral, whose properties give it special prominence in nature.



The number phi would have remained in the relative obscurity of pure mathematics were it not for its propensity to pop up where least expected. Take, for instance, the head of a sunflower. The florets form various clockwise and counterclockwise spiral patterns, intertwined and crisscrossing but otherwise unmistakable to the eye. Each floret arises in the center of the sunflower and gets pushed outward by its successors; the spiral patterning is an outcome of the way the florets are most easily and efficiently packed as they grow. The number of clockwise spirals and the number of counterclockwise spirals vary, depending on the size of the sunflower. Usually you find 55 twisting one way and 34 the other, but you may find 89

and 55, or 144 and 89. Even 233 and 144 has been reported. Amazingly, if you calculate these as ratios (55/34, 89/55, 144/89, 233/144), you find that they get closer and closer to the value of the golden ratio phi!

The patterning of sunflowers is closely related to one of the discoveries made in 1837 by two French brothers, Auguste and Louis Bravais. Auguste, a crystallog-

rapher, and Louis, a botanist, observed that as new leaves are put forth from the tip of many growing plants, each new leaf advances by an angle of roughly 137.5 degrees from the preceding leaf, around the circumference of the stem. That angle is what you get if you divide the number of degrees in a complete circle, 360, by the number phi, and then subtract the result from 360.

But why should the leaves of a plant arrange themselves in a pattern that is based on a number derived from the division of a line? If the angle between the leaves is, say, 90 degrees (which is equal to  $360/4$ ), or any other simple fraction of 360 degrees, the leaves will align one above the other on the stem, leaving large spaces unfilled. (In the case of 90 degrees, they will make four lines along the stem.) Such an arrangement would probably be undesirable for the plant, because overlapping leaves would shield one another from the light they need. By arranging themselves according to an angle determined by phi, the leaves can fill the spaces in the most efficient way possible, with the least amount of overlap.

Botany is hardly the only context in which the golden ratio appears. Take the so-called golden rectangle, in which the ratio of the length to the width is equal to phi. If you snip off a square from the rectangle, the rectangle that remains is also a golden rectangle. You can continue this process of snipping off squares ad infinitum, generating smaller and smaller golden rectangles. No other rectangle gives rise to the same shape as you snip off successive squares. If you then connect the successive points where the whirling squares cut the sides of the rectangles, you get a curve known as a logarithmic spiral [see illustration at top of page].

The name follows from an observation by the seventeenth-century Swiss mathematician Jakob Bernoulli. Bernoulli noted that the logarithm of the distance from the spiral's center at any point along it is proportional to the angle by which you advance. To express the same thing another way, if you follow the spiral through a series of full, 360-degree turns, the distances measured along the rays



Whirlpool Galaxy, in the constellation Canes Venatici

emanating from the center, or “pole,” of the spiral to a point on the curve form a geometric series. In other words, each distance is a constant multiple of the preceding one.

Bernoulli recognized that the logarithmic spiral does not alter its shape as its size increases, a property known as self-similarity. For that reason, Bernoulli noted, the spiral “may be used as a symbol, either of fortitude and constancy in adversity, or of the human body, which after all its changes, even after death, will be restored to its exact and perfect self.” He asked to have the spiral engraved on his tombstone—but, sadly, ignorance prevailed, and the tombstone artist carved only the simple coil (the shape formed by, say, a roll of paper towels) known as the Archimedean spiral.

Another intriguing property of the logarithmic spiral is that it is equiangular: if you draw a straight line from the pole to any point on the spiral curve, the line always cuts the curve at precisely the same angle. Falcons bank on this property when attacking their prey. Vance A. Tucker, a biologist at Duke University in Durham, North Carolina, studied falcons for many years and discovered that they usually follow a slightly curved trajectory to their victims, rather than plummeting in a straight line. Tucker eventually realized that the falcons’ trajectory could be a consequence of keeping the fovea of one or the other eye, the most acute part of their vision, locked onto their target. To make use of the fovea during a straight downward plunge, the falcons would have to cock their heads some forty degrees to one side or the other. But Tucker showed in wind-tunnel experiments that cocking the head would slow the falcons down considerably. By keeping their heads straight while keeping their target in view from the most advantageous angle, the falcons naturally follow the curve of a (highly drawn-out) logarithmic spiral.

Nature just loves logarithmic spirals. You can find them in phenomena ranging from the shell of the chambered nautilus to hurricanes and spiral galaxies. Sometimes, as in the case of the nautilus, they are a natural outcome of a pattern of additive

growth. And it is through that pattern that the golden ratio is intimately related to the Fibonacci sequence, a celebrated series of numbers discov-



Bill Varie, *Rose in Bloom*, 1998

ered by the early thirteenth-century Italian mathematician Leonardo of Pisa, known as Fibonacci.

**I**n his book *Liber abaci* (“Book of the Abacus”), published in 1202, Fibonacci posed the following fanciful problem about the breeding of rabbits:

A certain man put a pair of rabbits in a place surrounded on all sides by a wall. How many rabbits can be produced from that pair in a year if it is supposed that every month each pair begets a new pair, which from the second month on becomes productive?

The solution to the problem is fairly simple. Start with one pair of baby rabbits. After a month you still have only the one pair of rabbits, now nearing maturity. In the third month, however, you have two pairs of rabbits (the original pair, plus their first two babies). Come back in another month and you have three pairs, because the first pair has generated another set of babies. In the fifth month you have five pairs (because the first pair of babies has become old enough to reproduce). And so on.

You end up with the sequence of numbers 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on, in which each term (from the third on) is equal to the sum of the two preceding terms. The sequence was named the Fibonacci sequence by the nine-

teenth-century French mathematician Edouard Lucas. For the sake of historical accuracy, one should note that this sequence of numbers actually appeared even earlier than Fibonacci, in a rule for the construction of meter in a category of Sanskrit poems known as *mātrāvrittas*. Indian poets wrote about the rule in detail before Fibonacci was born, but Western mathematicians were unaware of their contributions until the appearance of a 1985 article by Parmanand Singh, a mathematician then at Raj Narain College in Hajipur, India.

You may have noticed that some of the numbers in the Fibonacci series have already been mentioned: they are the same as the numbers of clockwise and counterclockwise spirals appearing in sunflowers. And recall that the ratios of the numbers of spirals were good approximations of phi. It turns out that if you calculate the ratios of successive Fibonacci numbers [approximated to the sixth decimal place in the table at right], the ratios oscillate about phi but also converge on it as you go farther out along the sequence.

Thus Fibonacci numbers are a kind of golden ratio in disguise, and they, too, pop up in the most unexpected places. One is in the microtubules of an animal cell, which are hollow cylindrical tubes of a protein polymer. Together they make up the cytoskeleton, a structure that gives shape to the cell and also appears to act as a kind of cell “nervous system.” Each mammalian microtubule is typically made up of thirteen columns, arranged in five right-handed and eight left-handed structures (5, 8, and 13 are all Fibonacci numbers). Furthermore, occasionally one finds double microtubules with an outer envelope made up—you guessed it—of 21 columns, the next Fibonacci number. The precise reason that the Fibonacci numbers show up in microtubules is not clear, but some investigators have argued that microtubules structured this way are more efficient than other possible structures are as “information processors.” Because these sets of numbers are so small, however, the apparent connection with the Fibonacci series may be coincidental.

**T**urning from the microscopic to nature on a large scale, one finds that the spiral arms of many disk-shaped galaxies are often close to logarithmic spirals [see photograph on page 66]. The spiral arms stand out because that is where many stars are being born, and younger stars, on aver-

age, are brighter than older ones. But how do such spiral arms retain their shape over long periods of time? The reason this question is an astrophysical puzzler is that a galaxy does not rotate about its center like a disk of solid material, in which all parts simultaneously make a complete circuit. Instead, the closer to the center the stars or other matter lie, the faster they rotate. A spiral arm made up of some fixed group of bright stars should quickly get “wound up”—but that would imply that spiral galaxies were much rarer than they are observed to be.

The explanation is that the spirals are not structures of connected material streaming out from the center of a galaxy, as they might appear. Instead, they are the result of waves of gas compression sweeping through the disk. Where gas is compressed, the birth of new stars is triggered. Because matter is not uniformly distributed throughout the galaxy, the waves sustain a spiral effect as a kind of interference pattern.

The golden ratio makes an unexpected appearance even in the thermodynamics of certain black holes. Black holes can be either nonrotating (in physicists’ terms, they have no angular momentum)

or spinning. Spinning black holes (called Kerr black holes, after the New Zealander physicist Roy Kerr) can exist in two states, one in which they heat up when they lose energy and one in which they cool down. They also can undergo a phase transition from one state to the other. The transition can take place only when the black hole reaches a state in which the square of its mass is precisely equal to phi times the square of its angular momentum (in the appropriate units). This seemingly magical appearance of phi stems from another unique mathematical property of the golden ratio: its square can be obtained simply by adding 1 to phi (you can check that statement with a pocket calculator).

**I**n this and countless other ways, the golden ratio triggers the feeling of amazement that Einstein regarded as essential for all intellectual endeavors. In Einstein’s words:

The fairest thing we can experience is the mysterious. It is the fundamental emotion which stands at the cradle of true art and science. He who knows it not and can no longer wonder, no longer feel amazement, is as good as dead, a snuffed-out candle. □

1/1 = 1.000000
2/1 = 2.000000
3/2 = 1.500000
5/3 = 1.666667
8/5 = 1.600000
13/8 = 1.625000
21/13 = 1.615385
34/21 = 1.619048
55/34 = 1.617647
89/55 = 1.618182
144/89 = 1.617978
233/144 = 1.618056
377/233 = 1.618026
610/377 = 1.618037
987/610 = 1.618033



Carlotta Corpron, *Chambered Nautilus in Space Composition*, c. 1950

# My Life as a Forest Creature

*Growing up with the Cuc Phuong National Park*

*By Nguyen Thi Dao*



*Forest vegetation hugs the rugged karst terrain.*

I was born in a hammock on a forest path in Cuc Phuong National Park. (The health center to which my mother was being carried was just a little too far away.) The path is still used, though it no longer leads back to our home. As a little girl, I was lucky enough to have the forest as a playground, but my family was relocated out of the park in the late 1990s. Unfortunately my favorite litchi trees were not relocated with us.

Declared a protected area by Ho Chi Minh in 1962, Cuc Phuong became Vietnam's first national park in 1966. It was spared the effects of the war, unlike much of the nation's environment. Covering roughly ninety square miles, it encompasses forested limestone karst mountains and one main, central valley. Sometimes we children were caught in restricted areas by the forest rangers, but not often. I remember one ranger gently telling me not to leave my machete—we all carried rusty knives

back then!—stuck in a tree trunk while I played. The machete, he said, could kill the tree.

My friends and I took little-used routes to the outer edges of the valley to graze and mind our cows and water buffalo—the job of most rural kids. Mainly, though, our cows grazed themselves, and we explored the forest and the streams. Adventure was always around the corner. Once, while collecting wild honey from a hive of the large forest bees, I was caught by the angry swarm. I will never forget the panic. Luckily, one of the village elders picked me up, held me tight, and spat chewed rosebud juice at each of the stings, gently dabbing it on. The pain instantly subsided.

On another occasion I was walking through the forest, looking for my cow, when I suddenly felt I was being watched from above. I looked up and saw a green snake as thick as my big toe. I was scared stiff and ran as fast as I could through the dense forest, pay-

ing no heed to the scratching thornbushes. Snakes are common in Cuc Phuong; some, such as the banded krait, are deadly poisonous.

My friends from the local Muong ethnic group told me that if you didn't disturb the snakes and the bees, they wouldn't go out of their way to hurt you. Relocated from their traditional villages in the center of the park, the Muong now occupy shanties in the parched, stony foothills. From their dusty doorways they can hear the thrumming forest and sense the karst mountains towering above, even when the peaks are shrouded in clouds.

The legendary May Bac (“silver cloud”) Peak was the place I thought most of conquering, because it is the highest mountain in the park, about 2,100 feet. Once you are up there, you are enclosed in a cloud of forest mist. Sometimes the cloud creeps into the bottommost corners of the lowest valley.

The forest is never still. Insects, particularly the humming cicadas, are its pulse. Tree frogs that never come down to the ground break into a chorus on some unseen and unfelt cue; land crabs the size of small dogs clatter through the undergrowth.

Butterflies light up the gloom, congregating in sunny spots and above pools. At least 280 species, including birdwings, live in the park. They often land in muddy areas, and when you come near them, they take off and circle around you. In spring and summer I used to swim in a colorful butterfly sea. It felt like being in a fairy world.

It rains a lot in summer. I once got

lost with my friends in a downpour. We thought it would be a good idea to follow a stream out of the forest, because we knew that streams sometimes intersected our usual paths. How disappointed we were when the stream we were following suddenly disappeared underground! (Now I realize that Cuc Phuong has a natural underground drainage system that absorbs all the rainfall.) Luckily, we found our way out after five hours of struggle, soaked and mosquito bitten. A lot of leeches helped themselves to our blood.

There are many caves in the park's limestone terrain. We used to play hide-and-seek in them; they were pleasantly warm in winter and cool in summer. The must-visit exemplar is Nguoi Xua Cave (prehistoric man cave), where human remains as old as 12,000 years have been discovered.

The best season to visit Cuc Phuong is from the beginning of December, when the heavy rains are over, through April. It is often dry and pleasant then. But as children, my friends and I found summer to be the best

season for collecting wild fruits, many of which are similar to their cultivated counterparts. We had to compete with the squirrels and bats.

Cuc Phuong is home to an estimated 2,000 plant species; just last year my brother, a park botanist, discovered a new orchid (*Vietorchid aurea*). The park is also renowned for its big trees. The most famous one is a thousand-

year-old *Terminalia myriocarpa*. It takes seventeen people to encircle it, stretching their arms around its trunk.

About 450 species of mammals, birds, reptiles, and amphibians—38 percent of the known species in Vietnam—live in the park. Many are endemic, such as Delacour's langur, which we Vietnamese often call the white-shorts langur because of its white bottom. It is a hard animal to spot in the forest, because the vegetation is dense and these monkeys are very smart.



*Delacour's langur*



*Young Owston's palm civets*

the forest at night, the bats swooping past my ears or the movement of an unseen animal in the dark would make my hair stand on end. Sometimes it still does. But it is always magical on a summer's eve when the fireflies are out; they make the forest look like a Christmas night, with thousands of little lights blinking in giant Christmas trees.



For visitor information, contact:  
Cuc Phuong National Park  
Nho Quan District  
Ninh Binh Province  
Vietnam  
(84-30) 848-006/-009/-007  
Fax: (84-30) 848-008

## A SAMPLING OF SPECIES

**Mammals** Clouded leopard, Asian golden cat, Owston's palm civet, Asiatic black bear, crested gibbon, Delacour's langur, Phayre's langur, lesser slow loris, Chinese pangolin, Cuc Phuong squirrel, giant flying squirrels, and horseshoe bats.

**Birds** Eurasian tree sparrow, white-rumped munia, scaly-breasted munia, common kingfisher, white-breasted kingfisher, melodious laughing thrush, black-throated laughing thrush, long-tailed shrike, green peafowl, grey peacock pheasant, silver pheasant, great hornbill, Indian pied hornbill, chestnut-necklaced partridge, red-collared woodpecker, and red-vented barbet.

**Other animals** include snakes, such as cobra, king cobra, and banded krait; geckos, turtles, and frogs; fish (among them the Cuc Phuong catfish) and crabs; and countless insects and spiders.

**Trees** *Parashorea chinensis*, *Terminalia myriocarpa*, *Tetrameles nudiflora*, *Cinnamomum balansae*, *Dracontomeium duperreanum*, and Cuc Phuong pear.

*Nguyen Thi Dao is a conservationist with the World Wildlife Fund Indochina Programme.*

# Let's Make a Galaxy

*Astronomers have identified a cosmic infant “nearby”—70 million light-years from Earth.*

*By Charles Liu*

**G**alaxies in the universe are rather like the cells in an animal. Just as cells combine to make an animal's organs and systems, so, too, do galaxies come together to make the superclusters and filaments that define the large-scale structure of the cosmos. Not surprisingly, in much the same way that biologists examine cell development to understand the aging process in animals, astronomers study galaxy formation to decipher the evolution of the cosmos. Hence, the study of the origin of galaxies is one of the most important topics in modern astronomical research.

In this case, though, the biologists have it much easier. Animals reproduce, and so biologists have a steady supply of newborn cellular agglomerations for comparison and scrutiny. But astronomers have only one universe to observe, and it's mighty long in the tooth—13 billion years old, according to the best current estimates (about three times the age of Earth). Worse, according to current thinking, the vast majority of galaxies formed long, long ago. So when we astronomers want to study the earliest moments in galactic “life,” we have to approach our work more like paleontologists than like biologists, seeking to understand an ancient world with only fossilized remains as a guide. To glimpse galaxies in their embryonic stages, astronomers have to look far back in time, across distances amounting to billions of light-years. Of

course, such great distances pose severe challenges even for the most powerful telescopes. Unfortunately, there is no other choice.

Then again, maybe there is. In the past several years, new evidence has suggested that some galaxies may still be forming. Now, according to astronomers Michael R. Corbin of the Space Telescope Science Institute in Baltimore and William D. Vacca, now at the University of California in Berkeley, a smoking gun may be in view—a nearby galaxy, caught in the act of birth.

**W**hat do we astronomers mean by “galaxy”? We usually recognize one when we see one, but ask us for a definition and we have a much tougher time. Here's a reasonable working definition: a galaxy is a vast, contiguous collection of stars,

gas, dust, and other matter, totaling at least a few million times the mass of the Sun, all held together by mutual gravitational attraction. At least our own Milky Way fits the definition pretty well—though it's on the hefty side as galaxies go, made up of about 100 billion stars that stretch across 100,000 light-years.

According to current models, between two and four billion years after the universe began with a (big) bang, clumps of matter had formed in vast numbers. Each clump was larger than a typical cluster of stars, but smaller than a modern-day galaxy. As gravity acted on these subgalactic clumps, pulling them ever closer together, regions of space that were already relatively dense with clumps became even denser, and did so more quickly, than regions where the clumps were initially relatively sparse. Large collections of clumps created deep gravity wells that sucked in smaller groups of clumps, even as those collections coalesced to make single, larger bodies. Today, billions of years later, we observe the resultant hierarchy of cosmic structure: subgalactic clumps that combined to form galaxies, which in turn gathered into groups and clusters, which then collected into filaments and superclusters.

Since all that clumping and clustering started so long ago, cosmologists don't expect, by and large, to find such primordial subgalactic objects in the universe today. Much of the current observational research on galaxy formation therefore focuses on dwarf galaxies, with less than one-hundredth the mass of the Milky Way. Some kinds of dwarfs have many more young stars than do their larger siblings, and offer the possibility of studying present-day galaxy evolution on a manageable scale.

Corbin and Vacca examined a sample of dwarf galaxies chosen for their compact size and the youth of their star populations. One of the dwarfs, called POX 186, caught their eye. (The



*Blue compact dwarf galaxy, POX 186*

## THE SKY IN MARCH

By Joe Rao



nomenclature has nothing to do with skin disease—"POX" is a kind of shorthand for the informal name of the survey that discovered the object in 1981.) With the Hubble Space Telescope, Corbin and Vacca made a high-resolution image of the galaxy—and found a small, apparently newborn minigalaxy just 70 million light-years away and a mere 100 million years old. The shape, size, and age of the dwarf galaxy all seem consistent with the idea that POX 186 is actually made up of two partly coalesced subgalactic clumps, in the act of coming together to make a new galaxy.

**H**ow could such a young galaxy be forming before our eyes? After all, according to conventional wisdom, subgalactic clumps were all swept up long ago into galaxies like our own. The location of POX 186 may provide a critical clue. Nestled between matter-rich filaments and superclusters are "voids" of intergalactic space. Only a sparse smattering of galaxies occurs in these vast, empty volumes of space. POX 186 resides near the edge of such a void, in the direction of the constellation Boötes; Corbin and Vacca found no other galaxies within 15 million light-years of the dwarf. Maybe that's why the two subgalactic clumps survived so long: exiled in the void, they remained undisturbed for more than 10 billion years, never encountering any other clumps—until now.

The discovery that a nearby dwarf galaxy is actually in its infancy is, though fascinating, hardly heretical. In fact, understanding the ancient, distant subgalactic clumps is still essential for unraveling the mysteries of galaxy birth and formation. But POX 186 does open the door to a new line of inquiry, because astronomers now know that it's also worthwhile to look closer to home. More little blobs of matter may be lurking in the voids.

*Charles Liu is an astrophysicist at the Hayden Planetarium and a research scientist at Barnard College in New York City.*

**Mercury**, acting more the lamb than the lion, enters March still lost in the Sun's glare. It reaches superior conjunction—disappearing, from our perspective,

behind our star—on March 21. Thereafter, it begins climbing into the western evening twilight. By month's end, equipped with binoculars, you might see the planet just above the western horizon about half an hour after sunset. Mercury gets higher in the sky with each passing day, on its way to its best showing in 2003, which takes place during the first half of April.

Bright **Venus**, unmistakable at magnitude  $-4$ , rises at about 4:30 A.M. local time all month long. A telescope shows it in gibbous phase, a small replica of the gibbous Moon. At sunrise in early March it is less than 20 degrees above the horizon, as seen from mid-northern latitudes, and each week it sinks lower in the sky, heading toward superior conjunction. The planet is now fleeing ahead of Earth in our race around the Sun, but its seemingly breakaway speed is mostly the effect of having the inside track; its speed, about 22 miles a second, is only slightly greater than Earth's 18.5. Seen from our moving platform in space, Venus will disappear into the glare of the Sun in July and pass behind the Sun in mid-August.

**Mars** ascends about four hours before the Sun, crossing the meridian overhead shortly after sunup. The planet moves rapidly eastward through the constellation Sagittarius in March, appearing as a fairly inconspicuous yellowish orange light near the constellation's teapot pattern. The big Martian show, though, comes in late August, when Mars, having shifted into the

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evening sky, will be more luminous and closer to the Earth (about 34.6 million miles away) than it has been in many millennia. Perhaps in the year 2287, when the two planets again approach within 34.6 million miles of each other, people will be gazing at Earth from the surface of Mars.

**Jupiter** is king of the night sky this month. Visible high in the south during the evening hours, the brightest "star" in the sky after Venus invites inspection the moment you set up a telescope. As seen from Earth, Jupiter is in retrograde motion, moving westward through the dim stars of the constellation Cancer. By month's end it lies less than a degree away from the famous Beehive star cluster, which appears in binoculars as a swarm of points. Jupiter's bright disk against this background should make a pretty sight. On March 14 a waxing gibbous Moon passes about 3.5 degrees above and to the left of Jupiter.

**Saturn** appears high in the constellation Taurus in the south-southwestern sky at dusk. The planet sets shortly after 2:00 A.M. local time on March 1 and about two hours earlier by the end of the month. Even a small telescope reveals Saturn's wonderful rings, tilted almost as far as they ever tilt toward Earth. Saturn will be 90 degrees east of the Sun, or at east quadrature, on March 13. The long shadow the planet casts on its rings is easily seen from Earth, giving the ensemble a greater appearance of depth.

The **Moon** is new at 9:35 P.M. on March 2 and reaches first quarter at 2:15 A.M. on the 11th. It is full at 5:34 A.M. on the 18th. Last quarter comes at 8:51 P.M. on the 24th.

The **vernal equinox** takes place—and spring begins in the Northern Hemisphere, autumn in the Southern—at 8:00 P.M. on March 20.

*Unless otherwise noted, all times are given in Eastern Standard Time.*



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# Table Talk

*Stories of the stuff  
that makes up the world*

*By Hans Christian von Baeyer*

When I was in college nearly half a century ago, we students were entranced by the inimitable campus bard, Tom Lehrer, singing “The Elements.” At a breathtaking pace he rattled them off:

There’s antimony, arsenic, aluminum, selenium, / And hydrogen and oxygen and nitrogen and rhenium / And nickel, neodymium, neptunium, germanium, / And iron, americium, ruthenium, uranium, / Europium, zirconium, lutetium, vanadium / And lanthanum and osmium and astatine and radium / And gold, protactinium and indium and gallium [in-hale] / And iodine and thorium and thulium and thallium.

The song went on to list a total of 102 elements, but Lehrer, then a math instructor at Harvard, was well enough informed to end on a cautious note: “These are the only ones of which the news has come to Harvard, / And there may be many others but they haven’t been discovered.” His caveat turned out to be well advised. The most recent element to be discovered, number 118, was promptly undiscovered again.

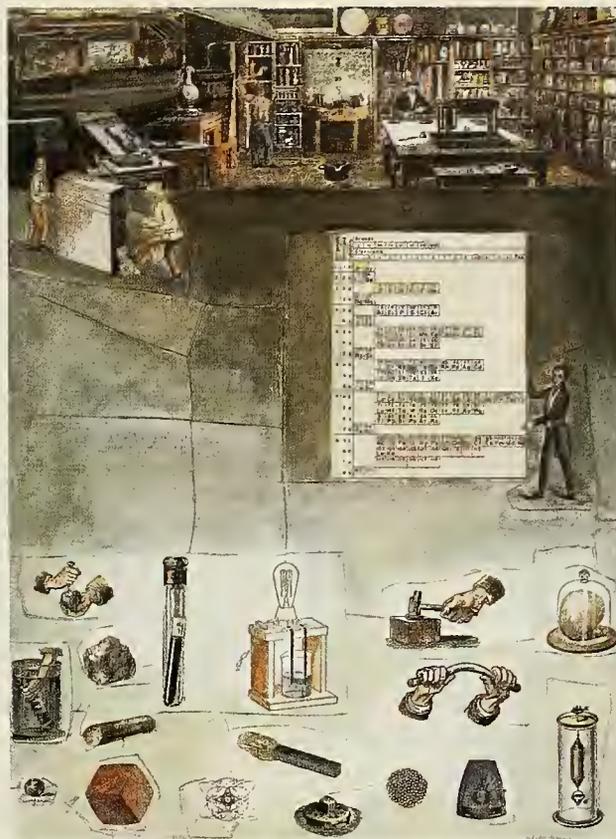
What a world of drama and mystery is evoked by those wonderful names! The occasional familiar one—life-giving oxygen, much-coveted gold—saves the list from academic obscurity and imbues it with an aura of relevance. At the same time, the strange names cry out for more information. What does that one look like? Is it normally a gas, or a solid, or perhaps

even a liquid like mercury? Who discovered it? When? Where? How? What does the name mean? What’s it good for? The lore and lure of the elements—the stuff that we and the rest of the universe are made of—cast their spell far beyond the circle of professional chemists.

For answers to the questions conjured up by Lehrer’s ditty back in the ’50s, I used to turn to my “rubber bible.” We all called it that, rather than *The Handbook of Chemistry and Physics*, because it was published by The Chemical Rubber Publishing Company and printed on thin India paper, like a bible. Now in its eighty-

**The Ingredients:  
A Guided Tour of the Elements**  
by Philip Ball  
Oxford University Press, 2003;  
\$22.00

third edition (my tattered copy is the thirty-eighth), this fat book has been an indispensable reference for four generations of scientists. Before computers, that’s where you looked up stuff like the value of the tangent of 79.7 degrees, the density of sulfur, and all the other grains of information that give physical science its gritty texture.



Vivian Torrence, *The Periodic Table*, 1991

In the middle of the good book, between a list of electronic configurations and the periodic table, there was an essay titled “The Elements”—like the song. It was an alphabetical list of thumbnail sketches, each no longer than a paragraph, of the properties and histories of the elements, from actinium to zirconium. In 3,000 pages, one brief chapter was the only repository in the great reference for anecdotes about people and stories about places of origin, discoveries, applications, and etymologies. This brief section of my bible relieved the tedium of the surrounding pile of dry data, and provided a reassuring reminder that the entire enterprise is of human origin.

Although an alphabetical listing of the elements is more practical than Lehrer’s purely poetic arrangement, it is not much more scientific. The number of ways to shuffle a hundred names is almost unlimited. A historian of science might compile a list

by year of discovery—starting with Aristotle’s element of water, which Antoine-Laurent Lavoisier unmasked as a compound in 1783, and ending with the nameless superheavies that seem to be forever embroiled in controversy. An economist might classify the elements by price, an industrialist by usefulness, a geologist by abundance on Earth, an astronomer by their place in the scheme of nucleosynthesis, a physician by necessity for health. By far the most significant list for scientists is Dmitri Mendeleev’s periodic table of 1869—one of the great triumphs of the human intellect.

But what if you want to conduct a guided tour for the public? How would you choose your itinerary? Which of the possible enumerations of nature’s building blocks would most suit your stroll? The answer, of course, is “none of the above.” The Italian writer Primo Levi’s semi-autobiographical book *The Periodic Table* comprises only twenty-one elemental chapter names.

“Brilliant Light,” the English-American neurologist Oliver Sacks’s reminiscences of his chemical boyhood (published in *The New Yorker* and later expanded in his book *Uncle Tungsten*), pushes the envelope of inclusiveness with mentions of forty-five elements. Sacks recalls how he once drove his parents to distraction with an enraptured chemical monologue until they were forced to exclaim: “Enough about thallium!” List mania, even in the scientific realm, is not a universal passion.

Philip Ball, an English science writer and contributing editor for *Nature*, is far too experienced to become boxed in by the lure of comprehensiveness. He explains his approach in the preface: “No piano tutor would start by instructing a young pupil to play every note on the keyboard. Far better to show how just a few keys suffice for constructing a host of simple tunes.” Accordingly, his little book is divided into just

seven chapters, with the history and explanation of the periodic table taking pride of place in the middle. Leading up to it is a short history of the elements, from Aristotle to the seventeenth-century chemist Robert Boyle, followed by two intimate portraits of individual elements.

The first close-up describes oxygen as “a bridge between the new and the old, between the alchemical roots of Robert Boyle’s ‘chymistry’ and the syntheses of endless wonders in today’s chemical plants.” The second sketch, of gold, begins with the story of King Midas and his golden touch. Here Ball stumbles. His degrees in physics and chemistry establish his authority in things scientific, but like other scientists he can become careless when re-

### *What a world of drama and mystery is evoked by the names of the elements!*

counting myths—as though it didn’t matter, since they are fictitious anyway! He conflates various versions of the Midas tale, moves Midas’s landlocked kingdom of Phrygia from central Anatolia to the distant shores of the Aegean Sea, and, without comment, injects a gruesome nineteenth-century embellishment in which Midas turns his daughter to gold.

The chapter of Ball’s book devoted to the convoluted history of the periodic table describes its profound impact on chemistry and physics. For Sacks, who as a boy was enchanted with chemistry, the table was “the most beautiful thing in the world.” Its explanation in terms of Niels Bohr’s 1913 model of the atom shone like a “brilliant light” of understanding.

Ball’s own youthful experiences with the periodic table were less lyrical but more productive. When he was required to write an examination essay on niobium, for instance, his mere knowledge of its position in the peri-

odic table encoded enough chemical information to enable him to fill several pages. The genius of Mendeleev shines brightly from the pages of Ball’s book, underlining the blatant injustice of his being passed over for a Nobel Prize. (He was a leading candidate in 1905 but was edged out by Adolf von Baeyer, my great-grandfather.)

The final three chapters bring the story up to date. Ball describes nuclear accelerators as atom factories for synthesizing short-lived, heavy elements—atom by expensive atom. He explains the isotopes—chemically identical forms of an element, which differ only in atomic weight—with special emphasis on their usefulness in historical, geological, and even astronomical dating. And he ends the tour with a glimpse at the world of applications, starting with ubiquitous iron and concluding with the noble gas argon which, after a century of haughty celibacy, was finally induced to form a compound in the year 2000.

After I finished reading this charming little book, I felt a bit short-changed: How can a map (the periodic table), two leisurely stops (at oxygen and gold), and four tutorials add up to a “guided tour”? But when I looked for the names of elements in the index, I was astonished to count eighty-four, excluding tabulations. Practically all of them are there! Ball’s achievement is the exact opposite of Lehrer’s: It teaches by seduction, where the latter startles by exhibitionism. By weaving the elements seamlessly into a coherent narrative, the author has given meaning to the entire system without overwhelming the reader with the profusion of its parts. That’s good writing.

*Hans Christian von Baeyer is Chancellor Professor of Physics at the College of William and Mary in Williamsburg, Virginia, and the author of Taming the Atom: The Emergence of the Visible Microworld. His next book, on information, will be published this summer by Weidenfeld & Nicolson.*

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## BOOKSHELF

By Laurence A. Marschall

*A Certain Curve of Horn:  
The Hundred-Year Quest  
for the Giant Sable Antelope  
of Angola*

by John Frederick Walker  
Atlantic Monthly Press, 2002  
\$26.00

Animals can compel our love or admiration. Some amuse us; some annoy us. But only a few can enchant. For some reason—their bearing, their elusiveness, the remoteness of their habitat—such special animals embody an idealized view of nature, becoming the locus of human projections of power, nobility, and sensitivity of near-mythic proportions. The bald eagle, the gray whale, and the snow leopard are three such creatures. And so is the giant sable antelope of Angola, the subject of John Frederick Walker's fascinating account, and a rare and endangered mammal that few people outside its homeland have ever heard of.

Any visitor to a game park in southern Africa can attest to the beauty of the common sable antelope, two races of which (*Hippotragus niger kirkii* and *Hippotragus niger niger*) roam the savannas from South Africa to Zambia. Jet black, with ramrod bearings and large arcs of heavy horn on their equine heads, they are a sight impossible to forget. But the giant sable (*Hippotragus niger variani*), whose horns are almost a foot longer than those of its common relatives—and whose markings are even more striking—has been seen in the wild by only a few naturalists. In the 1800s travelers heard rumors that such animals lived between the Zambezi River and the western coast of Africa, and an enormous horn, more

than five feet long, mysteriously showed up in the University Museum of Natural History in Florence, Italy. But no European had ever seen the antelope in the flesh.

Hunters—and in the early decades of the twentieth century most naturalists were hunters—wanted not only to see the giant sables but to bag them. Following the discovery of a few herds of giant sables in central Angola by a British railway engineer, Frank Varian, just before the First World War, a few heads and hides made it to the trophy rooms and museums of the world, but sightings were sporadic. Until the 1970s, when the behavioral ecologist Richard D. Estes, now head of the International Conservation Union's Antelope Specialist Group, conducted the first (and only) field studies of the giant sable, little was known about its habits, how closely related it was to other species, or even the size of its population.

It didn't help that the homeland of the giant sable was deep in the center of Portuguese West

Africa, one of the most repressive and neglected of the European colonies. Before the last decades of the twentieth century, the region was scarcely touched by modernization; Portugal's chief interest—until Angola achieved independence in 1975—seemed to be extracting as much mineral wealth as possible with the labor of an oppressed population, and then shipping it along the one railway (which Varian had helped build) that connected the frontier with the Atlantic coast.

But independence scarcely made things better. The pre-independence freedom fight degenerated into a civil war that tore the country apart for the rest of the century. By some estimates,



more than a million Angolans died and some 12 million land mines were emplaced. In the ensuing chaos even the few naturalists who study the giant sable lost track of them. There was fear that many of the antelopes had been caught in the crossfire: even though Angolans venerate the giant sable as an icon of their nationhood, the warring armies have been known to slaughter other endangered species for the lucrative profits that the animals' pelts, horns, and ivory bring on the black market—or simply for a bite to eat.

Has the giant sable survived? John Frederick Walker, a journalist who caught the enchantment of the animal in his youth, decided to find out for himself. The resulting book, a riveting account of his research and travels, recalls Peter Matthiessen's tale of a similar search for the snow leopard in the frigid Himalaya. But where Matthiessen struggled against inner ghosts, Walker mainly does battle with bureaucratic bungling and Third World corruption, making his book more a chronicle of the politics of conservation than a search for the meaning of life. It would spoil a wonderfully told story to reveal how it all comes out.

**Coal: A Human History**

by Barbara Freese

Perseus Publishing, 2003; \$20.00

The history of coal, of course, spans time on a geologic scale. Yet Barbara Freese, a former assistant attorney general of Minnesota, brings welcome brevity to that history in this readable book about the black stone Emerson called "a portable climate." The thesis of Freese's book, not startling by any means, is that coal is a mainspring of the modern world: love it or hate it, it is here to stay. It generates most of our nation's electric power, and will continue to do so as other fuels become depleted. But the use of coal poses urgent challenges for the quality of life on our planet.

It was in Great Britain that the use of coal first took hold, perhaps because of



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In addition, an international conference on Vietnamese culture, *Vietnam in the 21st Century: Journeys on the Ground and in the Imagination*, will be held on March 22 and 23. Both conferences coincide with the Museum's new exhibition, *Vietnam: Journeys of Body, Mind & Spirit* and an accompanying photography exhibition that highlights the biodiversity of Vietnam and the CBC's conservation work there.

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its abundance in readily accessible outcrops. As London and other great population centers burgeoned in the fourteenth century, forests began to vanish, and coal became the fuel of choice. Yet as early as the thirteenth century, royal commissions had been set up to deal with pollution from coal burning. Apparently their efforts were to no avail, for in a seventeenth-century book with the apt Latin title *Fumifugium* (from *fumus*, “smoke,” and *fugo*, “to chase away”), a minor government official named John Evelyn described atmospheric contamination that blotted out



Cool seller, c. 1830

the Sun, resulting in a capital city that resembled “the Suburbs of Hell.” Four hundred years of official concern had led only to a worsening of London’s smog problem—and that was before the Industrial Revolution!

Even royal worry could not stop the use of coal, it is clear, because its immediate value as a fuel far outweighed the inconvenience of soot-stained sheets and acrid breezes. And if coal had been essential to the emergence of urban England from the Dark Ages, it was even more important as mercantile and agricultural societies in the West began to transform

themselves into industrial powers. Freese sketches the impressive role of coal in feeding the forges of England and in transforming the virgin continent of North America into a nation of railways and manufacturing centers.

These examples from the great sweep of history highlight the deep and abiding chasm between the power of coal to create wealth and the enormous costs that unleashing such power exacts from society. Although Freese shares the wonder of the Victorians at the accomplishments of industrialized civilization, she doesn’t skimp on describing its dark side. The coal that powers our industries—bringing cheap textiles, central heating, and fresh fruit into our lives—also causes black lung disease, mine disasters, and acid rain. In her penultimate chapter Freese describes a visit to China, which seems to be reprising the Industrial Revolution in fast-forward. There, coal still plays the central role it once played in the West, despite growing competition from nuclear, natural gas, and hydroelectric energy sources. At an accelerating rate—and with a population greater than that of Europe and North America combined—China is making the same mistakes.

But today the stakes are higher, as coal consumption continues to rise. It’s not just London, Pittsburgh, or Beijing anymore; the planet as a whole suffers when fossil forests burn. Cities in the eastern United States feel the stinging breath of Midwest power plants. The smoke from Shanghai wafts over Los Angeles. And global atmospheric concentrations of carbon dioxide threaten to alter the climate in ways that, though still uncertain in their details, will undoubtedly be momentous. As this human history of coal makes clear, there are no easy answers. But books as lucid as Freese’s make a welcome contribution to the search for a sustainable energy economy.

***Measuring America:  
How an Untamed Wilderness  
Shaped the United States  
and Fulfilled the Promise  
of Democracy***

by Andro Linklater  
Walker & Company, 2002; \$26

In January of 1790, addressing the new U.S. Congress for the first time, George Washington set forth three priorities for the fledgling nation: to defend its sovereignty, to strengthen its economy, and to establish a uniform system of weights and measures. In its modern-day guise of “homeland security,” that first imperative continues to preoccupy Washington today, as does the economy. But the integrity of common measuring standards is secure across the land. Grain merchants no longer use larger bushels to buy from the farmer than to sell to the miller, and “a quarter-pounder” weighs the same in Boise as it does in Baltimore. The success of George Washington’s program for reforming weights and measures, Andro Linklater argues, was essential not just to the eventual emergence of a consumer economy, but to the development of the national character of the United States.

What the founding fathers had in mind was not merely to establish fair and uniform measures, but also to create a framework for the general commerce of the nation. The central feature of this vision was to measure, to classify, to rationalize the land itself. Armed with standard English measuring chains (the origin of the twenty-two-yard-long unit), compasses, and transits (surveyor’s instruments with mounted telescopes), the surveyors laid out a rectilinear grid from coast to coast, following imaginary beelines across rugged brush, treacherous mudflats, and precipitous mountainsides.

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success—a reputation that drew immigrants from far and near—has its roots in the uniform survey maps and section markers of these survey parties.

For all the good intentions, though, the measurement of America was neither as systematic nor as rational as its originators might have wished. Linklater cites a good many cases in which judgment was skewed by the inertia of local custom or the expedience of politics. One of his most entertaining and enlightening anecdotes is the story of how the U. S. might well have chosen the metric system from the start, given its clear superiority over pounds, gills, acres, and chains.

Thomas Jefferson led the fight for metric measurement, and was the most influential champion of a system based on decimal multiples of the length of a pendulum that swung through its arc once a second. Not only would the system be easy to manipulate; it also relied on a standard kept not by the government but, in effect, by the immutable laws of physics. By the time Washington addressed the Congress, it was conventional wisdom



*Metric series—length, c. 1880*

that some such scientifically based decimal system ought to guide the new nation, and decimalization of length and weight seemed only a vote away.

But the French Revolution changed all that. In the 1790s the French officially adopted a metric system based on the length of a quadrant of the Earth's meridian. The segment of longitude they chose to measure ran just to the east of Paris—decimal to be sure, but linked, unfortunately, with the geography of continental Europe.

Congress, unable to properly distinguish Jefferson's system from the one tarred by the French Revolution, began to drag its feet, wondering why it should get rid of the familiar inches and yards in favor of a system based on a line through a foreign city.

By the time the system came up for a vote, surveyors had already begun to divide and sell vast tracts of land in the Ohio Valley, using the old English measures. The explosion of land sales settled the issue de facto: Too much time and money had already been invested in the old system. It was too late to change. The U.S. did adopt a decimal coinage. But the great land surveys, the building of the railroads, and the growth of American industrial society itself all took place under a uniform but cumbersome system of units first elaborated in the sixteenth century.

*Laurence A. Marschall, author of The Supernova Story, is W.K.T. Sahn Professor of Physics at Gettysburg College in Pennsylvania, and director of Project CLEA, which produces widely used simulation software for education in astronomy.*

[nature.net](http://nature.net)

## Les Grands Sites

By Robert Anderson

The French Ministry of Culture and Communication has created a tour de force with its "Great Archaeological Sites" ([www.culture.fr/culture/arcnat/en/grsites.htm](http://www.culture.fr/culture/arcnat/en/grsites.htm)), a collection of nine elegantly designed Web pages, conveniently translated into English, that merit your attention as a browser even if you aren't a devotee of French history.

I was first drawn to the collection by a page offering a virtual tour of Chauvet-Pont-d'Arc Cave in southern France. Soon I found myself hopping

around France and across the centuries, traveling back to prehistoric times, Roman Gaul, and the Middle Ages. The tour of Chauvet gave me a good feel for the layout of the cave's subterranean galleries, with their magnificent examples of figures and forms created 31,000 years ago: spotted panthers, engraved horses, a procession of red rhinoceroses, and the ubiquitous hand-print "signatures" of the Paleolithic artists. In the case of Chauvet, virtual viewing is not just a surrogate for visiting in person; it is, lamentably, as close as most people will ever come to seeing those treasures. Like the better known Lascaux Cave (another featured site in the virtual collection), it is sealed to the public because the acidic combination of carbon dioxide and water vapor exhaled by throngs of tourists

would condense on the cool walls and corrode the artwork.

The collection also includes Arago Cave, near France's border with Spain, where the 450,000-year-old Tautavel Man was discovered; a look at the Gallic populations of Provence; and an investigation of a trio of medieval villages northwest of Grenoble settled by "farmer-knights." Finally, from the country that gave the world Jacques Cousteau, the French ministry offers a site dedicated to underwater archaeology. You can spend fascinating hours, all warm and dry, exploring a host of discoveries off the Atlantic and Mediterranean coasts of France, submarine sites in Egypt, and shipwrecks around the world.

*Robert Anderson is a freelance science writer living in Los Angeles.*

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## Unique Collaboration Culminates in Exhibition

When the exhibition *Vietnam: Journeys of Body, Mind & Spirit* opens at the American Museum of Natural History in New York on March 15, 2003, it will be the product of an unprecedented collaboration between the AMNH and the Vietnam Museum of Ethnology in Hanoi. The institutions share a common mission of studying, preserving, and interpreting culture, and their collaboration provides an ideal opportunity to reveal the richness of Vietnamese culture to an American audience.

Vietnam and the United States share a difficult and complex history. Perhaps because the two countries did not resume full diplomatic recognition until 1995, Vietnam is still largely misunderstood by Americans whose knowledge often is limited to memories of the war. Vietnam is, in fact, an incredibly diverse country, with more than 50 ethnic groups. Showcasing Vietnamese culture, with its melding and juxtaposition of the traditional and the contemporary, the exhibition provides American audiences an unprecedented opportunity to experience life in Vietnam in the 21st century. Such an exhibition would not have been possible without the partnership of two museums on opposite sides of the world.

The AMNH has a significant history of scientific and scholarly work in Vietnam, beginning with zoological expeditions in the early 20th century. More recently, in 1997, the AMNH's Center for Biodiversity and Conservation (CBC) initiated a biodiversity project in Vietnam in conjunction with

the Missouri Botanical Garden, the Institute of Ecology and Biological Resources in Hanoi, and the Vietnam National University, Hanoi. As the project developed, it became clear that the study of an ecosystem was incomplete without information about the people who lived and worked there.

The AMNH and the VME had begun a relationship in the early 1990s when Nguyen Van Huy, Director of the VME, and Laurel Kendall, Curator of Asian Ethnographic Collections at the AMNH, traveled to each other's institutions to discuss future projects. In 1998, the VME became the local sponsor of the ethnographic component of the CBC's Vietnam project. In 1999, plans for a major collaborative exhibition on Vietnamese culture took shape, with Drs. Kendall and Huy as co-curators.

As the relationship has developed, each institution has benefited from the experience and expertise of the other. The VME has provided many objects in the exhibition and the scholarly expertise to interpret them. The AMNH has lent its conservation and curatorial expertise and years of experience in developing exhibitions. AMNH staff members have held training workshops in Hanoi on textile and object conservation, ethnographic field meth-



Vietnam Museum of Ethnology intern Hoang Thi To Quyen during her training in the objects conservation lab at the American Museum of Natural History

ods, collection cataloging, and curation, and, in turn, have learned from VME staff about Vietnam and its material culture. As plans for the exhibition have stepped up, five professionals from the VME have served residencies at the AMNH conserving objects and helping AMNH curators interpret and describe the artifacts to be exhibited. Three more have traveled to the AMNH to help prepare for the exhibition's March 15 opening.

Just as the exhibition focuses on the notion of journeys, the collaboration itself can be seen as a journey—of two countries with a complex and difficult past moving toward a future of understanding and friendship. According to Dr. Kendall, "An encounter with Vietnam in the 21st century is an important step toward healing."

## Center for Biodiversity and Conservation's Spring Symposium Addresses Sustainable Tourism



Much of the world's biodiversity is located in developing tropical countries, areas that have become increasingly popular as tourist destinations. While the traveling public's growing interest in visiting these unique places can bring with it much-needed revenue and jobs, as well as increased incentive to conserve natural areas, many scientists are concerned that tourism-related activities will result in serious consequences for already threatened ecosystems.

Increased pollution; overuse of natural resources; the introduction of invasive species; disruption of migration, feeding, and breeding patterns; habitat transformation; and even harassment of animals are among the possible—and potentially irreversible—ramifications of nature-based tourism. There is also urgent concern about maintaining and protecting a region's cultural integrity, which can be enormously affected by the influx of visitors and increased industry.

Tourism is now the world's largest industry, and nature-based and cultural travel is widely considered its fastest growing segment. While such travel now accounts for an estimated \$100–200 billion per year worldwide, there is still no universally agreed-upon definition of the word “ecotourism,” nor are there standard industry or policy guidelines to minimize its impact on the environment or cultures.

On March 20 and 21, 2003, the Museum's Center for Biodiversity and Conservation (CBC) will address this complex topic during its eighth annual symposium, *Tiger in the Forest: Sustainable Nature-Based Tourism in Southeast Asia*. A key aim of the conference is to develop recommended guidelines for decision makers, tour operators, conservation practitioners, and consumers.

The decision to focus the 2003 symposium on nature-based tourism and its impact on biodiversity conservation grew out of the CBC's long-standing work in Southeast Asia and discussions with colleagues there, specifically those in Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam. In discussing the various factors that affect biodiversity in this region, which harbors a significant proportion of the world's rare and endemic plants and animals, tourism emerged as an important issue.

*Tiger in the Forest* will provide an important forum for information exchange and partnership-building among biologists, tourism-industry professionals, conservation practitioners, governmental decision makers, and community stakeholders. The conference sessions will focus on the needs of unique and fragile ecosystems; the economic and conservation potential of nature-based tourism; case studies of well designed, properly monitored, and sustainable tourism sites; and sharing of cautionary tales of lessons learned. In addition, the symposium will examine what responsible travelers can do—no matter what the destination—to minimize their impact on natural areas and biodiversity.

The symposium is organized by the CBC in collaboration with the Wildlife Conservation Society and World Wildlife Fund.

In 1993, in response to increased threats to biodiversity, the Museum created the CBC to focus its scientific and educational resources on conservation policy and action.

### TIGER IN THE FOREST: SUSTAINABLE NATURE-BASED TOURISM IN SOUTHEAST ASIA

Thursday and Friday,  
March 20 and 21  
9:00 a.m.–6:00 p.m.

Advance registration is recommended. Please visit [research.amnh.org/biodiversity](http://research.amnh.org/biodiversity) or call 212-769-5200.

### Vietnam: Journeys of Body, Mind & Spirit

March 15, 2003–January 4, 2004  
Gallery 77, first floor

Explore daily life in the early 21st century among Vietnam's more than 50 ethnic groups. The objects on display range from the traditional to the contemporary, and often merge the two, reflecting the dynamic process that has created modern Vietnamese culture.

Organized by the American Museum of Natural History, New York, and the Vietnam Museum of Ethnology, Hanoi. This exhibition and related programs are made possible by the philanthropic leadership of the Freeman Foundation. Additional generous funding provided by the Ford Foundation for the collaboration between the AMNH and the VME. Also supported by the Asian Cultural Council. Planning grant provided by the National Endowment for the Humanities.



These paintings are worn as masks during Yao initiation rituals in Vietnam.



# MUSEUM EVENTS

## EXHIBITIONS

### **Biodiversity of Vietnam**

Opens March 20

Akeley Gallery, second floor

This exhibition of photographs highlights Vietnam's remarkable diversity of plants and animals and the Museum's Center for Biodiversity and Conservation's ongoing research there.

*This exhibition is made possible by the generosity of the Arthur Ross Foundation.*

### **The First Europeans: Treasures from the Hills of Atapuerca**

Through April 13

Gallery 3, third floor

*The First Europeans* reveals the mysteries of ancient humans in western Europe through exquisitely preserved hominid and animal fossils found in northern Spain.

*Co-organized by the American Museum of Natural History and Junta de Castilla y León.*

### **Einstein**

Through August 10, 2003

Gallery 4, fourth floor



LOTTE JACOBI COLLECTION/UNIVERSITY OF NEW HAMPSHIRE

This exhibition profiles this extraordinary scientific genius, whose achievements were so substantial that his name is virtually synonymous with science in the public mind.

*Organized by the American Museum of Natural History, New York; The Hebrew University of Jerusalem; and the Skirball Cultural Center, Los Angeles. Einstein is made possible through the generous support of Jack and Susan Rudin and the Skirball Foundation, and of the Corporate Tour Sponsor, TIAA-CREF.*

### **The Butterfly Conservatory: Tropical Butterflies Alive in Winter** Through May 26, 2003

The butterflies are back! This popular exhibition includes more than 500 live, free-flying tropical butterflies in an enclosed tropical habitat where visitors can mingle with them.

*The Butterfly Conservatory is made possible through the generous support of Bernard and Anne Spitzer and Con Edison.*

## CONFERENCE

### **Vietnam in the 21st Century: Journeys on the Ground and in the Imagination**

Saturday and Sunday, 3/22 and 3/23  
10:00 a.m.–5:00 p.m.

This conference on recent fieldwork in Vietnam highlights contemporary marriage, tourism and local identity, environmental issues, religious traditions, and more. Please call 212-769-5891.

## FILM SCREENING

### **Tay Puppet Story: Tham Roc Village**

Vietnam Museum of Ethnology and Richard Connors. 2000. 30 min.

Sunday, 3/23, 12:30 p.m.

In this story of cultural revival, the last surviving members of a venerable puppet troupe lead young apprentices in mounting the first public performance in nearly 50 years. Post-screening discussion.

## LECTURES

### **Women as Society Builders**

Saturday, 3/8, 10:30 a.m.–1:00 p.m.

Celebrate International Women's Day

with an address by Mae Jemison, the first African American female astronaut, followed by film screenings and tours of Museum exhibits.

### **Beneath the Myth of the Kalahari Bushman**

Thursday, 3/13, 7:00 p.m.

Travel writer Rupert Isaacson discusses his book *The Healing Land: The Bushmen and the Kalahari*, followed by a book signing.



RUPERT ISAACSON

Dawid Kruiper, traditional leader of the Xhmani bushmen

### **The Empty Ocean**

Tuesday, 3/18, 7:00 p.m.

Richard Ellis addresses the fate of the ocean's wildlife in his latest book, *The Empty Ocean*.

### **Journeys: A Dialogue**

Tuesday, 3/25, 7:00 p.m.

The co-curators of *Vietnam* will discuss how staff of two museums with distinct traditions of museum practice worked together on the exhibition's implementation.

## WORKSHOP

### **Animal Drawing**

Eight Thursdays, 3/6–5/1

An intensive drawing course among the Museum's famed dioramas.

## FAMILY PROGRAMS

### **Andrew Lost**

Saturday, 3/15, 2:00 p.m.

Meet author J. C. Greenberg.



**Identification Day**

Saturday, 3/29, 1:00–4:30 p.m.  
Bring your basement curios and garage-sale finds of natural and cultural objects to this perennial favorite event, and Museum scientists will try to identify them. Please call 212-769-5176.

**Puppets on Parade**

Saturday, 3/29, 1:00–4:30 p.m.  
Explore the diverse art of puppetry as it illustrates traditional and contemporary stories. Please call 212-769-5315.

**CHILDREN'S ASTRONOMY PROGRAMS**

**I Want to Be an Astronaut**

Saturday, 3/8, 12:00 noon–1:30 p.m., or 2:30–4:00 p.m.  
(Ages 4–6, each child with one adult)

**Star Myths: An Introduction to Mythology**

Sunday, 3/16, 1:00–2:30 p.m.  
(Ages 7–9)

**Fly Me to the Moon**

Saturday, 3/29, 12:00 noon–1:30 p.m., or 2:30–4:00 p.m.  
(Ages 4–6, each child with one adult)

*Space Explorers*  
**Myths and Constellations of the Spring Sky**

Tuesday, 3/11, 4:30–5:45 p.m.  
(Ages 12 and up)

**HAYDEN PLANETARIUM PROGRAMS**

**The Life and Death of Planet Earth**

Monday, 3/3, 7:30 p.m.  
Peter Ward discusses his latest book, coauthored with Don Brownlee.

**Cosmos 1: Reaching for the Stars**  
Monday, 3/24, 7:30 p.m.  
Learn how “light pressure” has the power to send a solar sail out among the stars. With Louis Friedman.

**Celestial Highlights**

Tuesday, 3/25, 6:30–7:30 p.m.  
This monthly tour of the heavens offers a view of the constantly changing night sky.

**SPACE SHOWS**

***The Search for Life: Are We Alone?***  
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All programs are subject to change.

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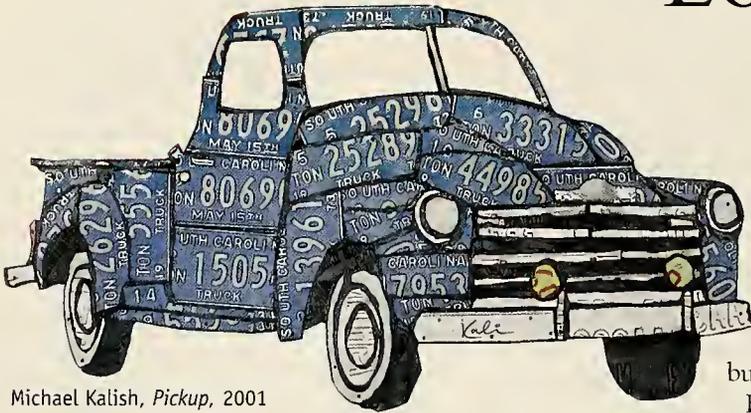
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# Lost and Found

By Beth A. Middleton



Michael Kalish, *Pickup*, 2001

My father always knew just which direction he wanted to go and how he wanted to get there. Of course he did have a secret: he and his truck never left the secure confines of the dairy country south of Lodi, Wisconsin. He drove the back roads of Dane County in a big Ford F-150 pickup on his rounds, delivering tractor oil to the farmers and carrying pesticides back to our own place—the same pesticides that probably caused his kidney cancer. I marveled at how he never got lost.

I have fond memories of wandering our farm, bringing my father his lunch during the spring field work. On his infrequent breaks he taught me—as his mother had taught him—the names of the plants and animals that tenaciously clung to the wild nooks and crevices of our land. My farm background turned out to be excellent training for my adult occupation as a wetlands ecologist and environmentalist.

After my father died, I rescued his truck from our dirt-floor garage. Its back bumper, which had taken the brunt of many an unloaded oil barrel, drooped as forlornly as the tail of a dog that's lost its master. The cab still smelled vaguely of farm animals and cigar smoke. I fixed it up and made it my own.

The pickup had been the perfect vehicle for my father, but it raised eyebrows and drew surprised comments from my colleagues in Carbondale when I self-consciously parked it next to their Toyotas and Hondas in the faculty parking lot of Southern Illinois University. "It was my dad's," I told them, as though that would explain everything.

One day I drove the truck out of comfortable, rural southern Illinois and into the city of Saint Louis. I was driving alone, with no one sitting beside me to read the map, and memorized the route before entering the city. But on my way back, I

missed a turnoff on the interstate and suddenly found myself in heavy traffic on a highway unknown to my mental map. I tried to find a place to pull off and study my Rand McNally, but all the exits led to abandoned buildings and blighted industrial complexes.

Few urbanites understand the panic the city brings on in country bumpkins. If we get lost, we risk being blinded by fright. We have no survival skills for the city. John Muir, America's most famous country bumpkin, grew up on a farm not far from my parents' place. So Muir and I were both products of the same rural landscape. When the obstacle of Louisville stood in Muir's way during his famous thousand-mile walk, he navigated the city with his compass and talked to no one.

Now here I was on an unknown highway, surely headed into the city's most treacherous section, and all I had to guide me out of danger were my farmer's instincts—the legacy of generations of people living close to nature. My father had taught me to love the land, hate the politics. Surely there was something in that philosophy to guide me out of this heart of darkness called Saint Louis.

Cars and trucks hurtled by at amazing speeds. "Go east, drive to the river," my ancestors shouted—just when my brain was millimeters away from stone-cold shutdown and my heart was pounding like a half-killed rabbit going into shock. And so I steered my dad's truck along a course that followed no map except the faint natural marks of the land. I drove east, away from the sun. The road began to slope toward the river. My heart pounded less; my head cleared. The blighted city gave way to cranes and riverside loading equipment and then, there were the Mississippi and the Gateway Arch to Illinois. I drove across some bridge and soon found myself in the farm country east of Saint Louis. The wheels of my dad's truck hummed beneath me. I was safely on my way back home.

*Beth A. Middleton is now a research ecologist at the U.S. Geological Survey's National Wetlands Research Center in Lafayette, Louisiana.*

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