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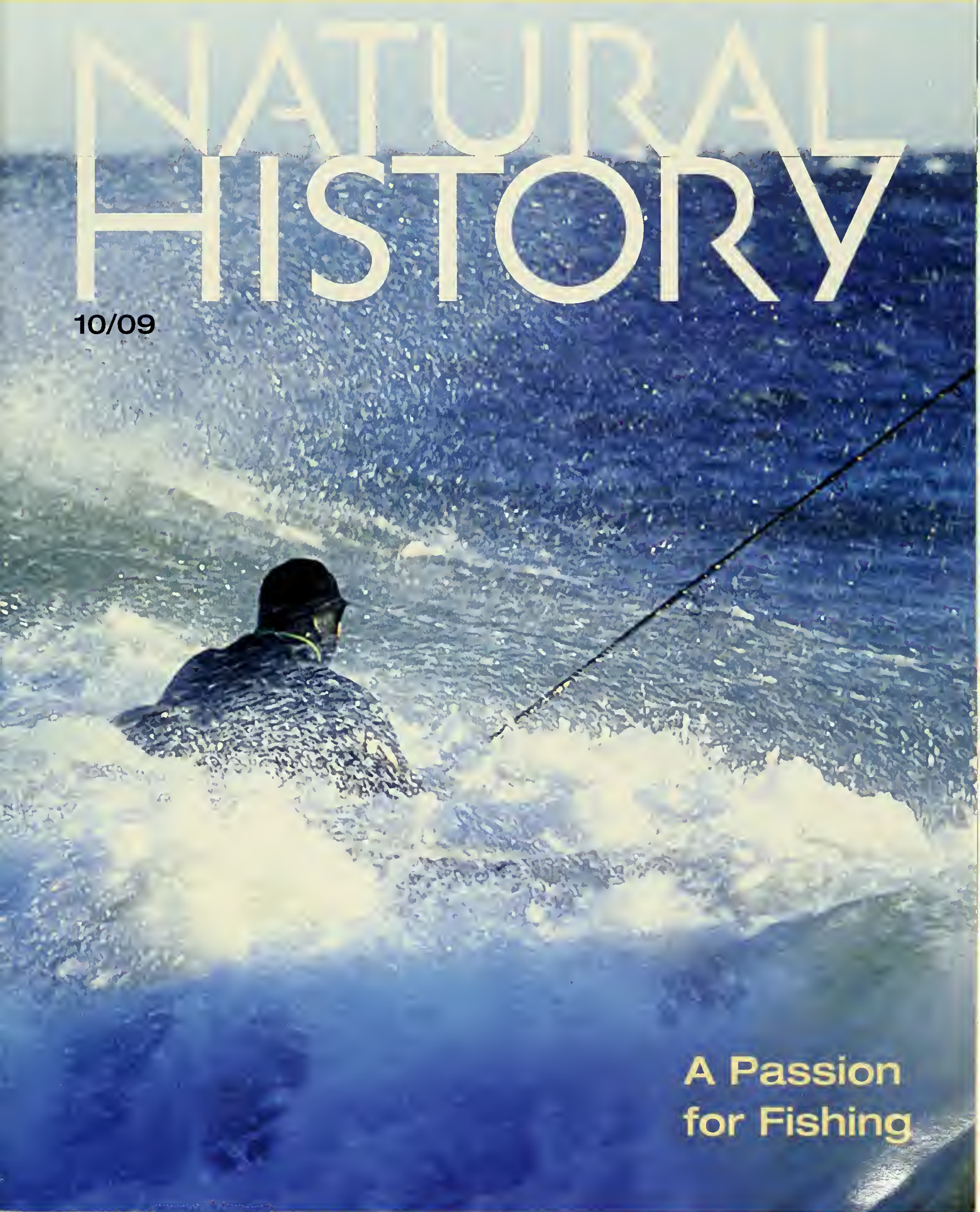
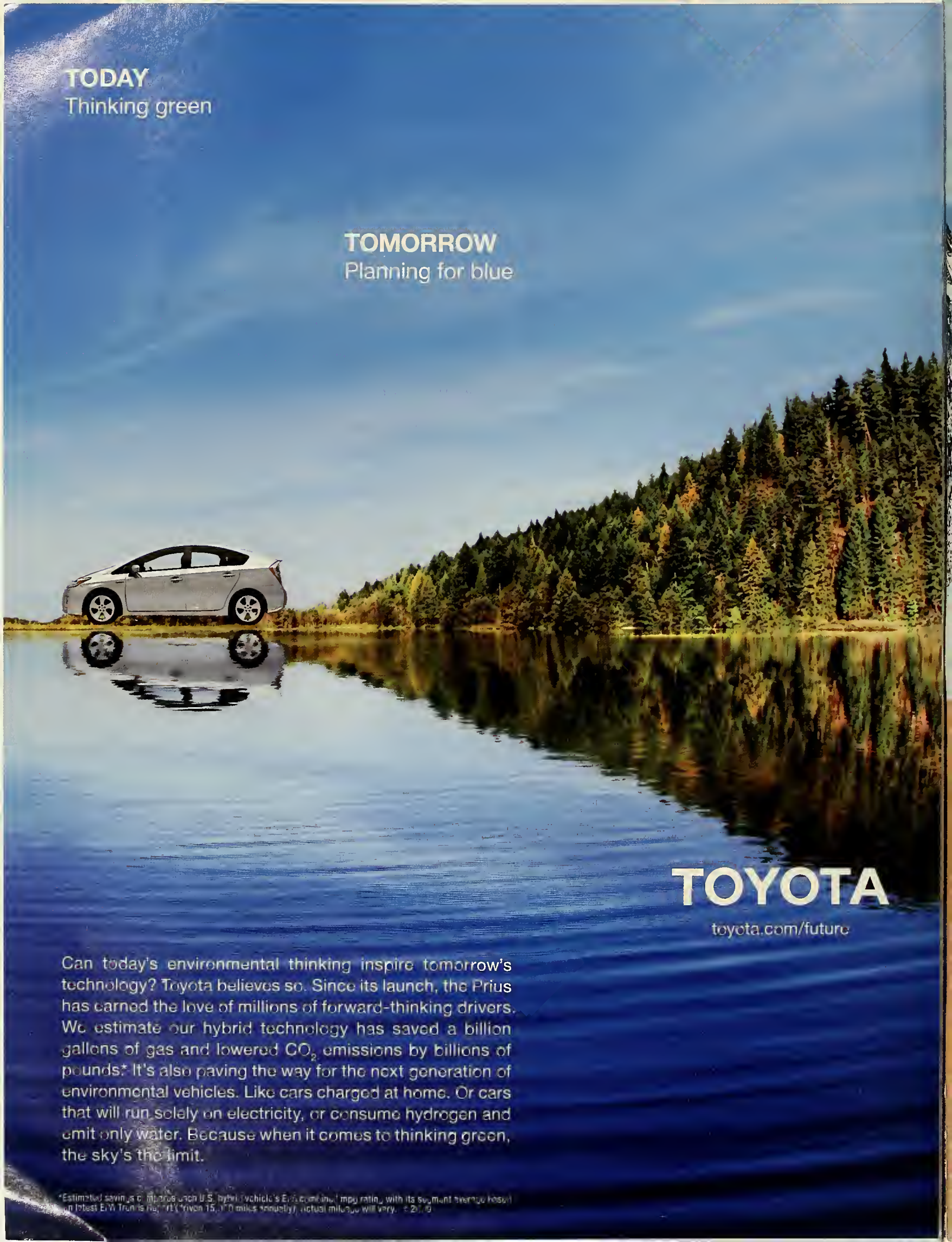


A Passion for Fishing



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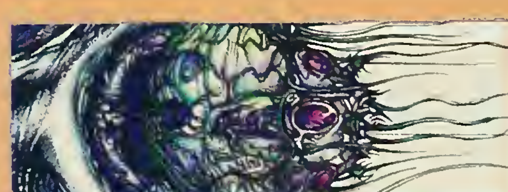
OCTOBER 2009 VOLUME 118 NUMBER 8

FEATURES

DEPARTMENTS



ON THE COVER: *Surfcaster at Montauk Point, Long Island, pursues the fall run of striped bass. Image by Richard Siberry, www.RichardSiberry.com*

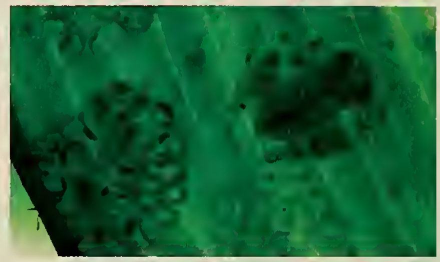
THE NATURAL MOMENT

UNARMORED GUARD

Photograph by Michael and Patricia Fogden

See preceding two pages

THE NATURAL EXPLANATION BY ERIN ESPELIE



Skin, even eyelid-thin skin, bulwarks most creatures against the elements. Frogs' skin, however, bucks the trend and eases the portage of water, oxygen, carbon dioxide, and more. In fact, one species discovered in 2007, the Bornean flat-headed frog, has the distinction of lacking lungs, and relies entirely on its permeable skin to breathe. Some of the thinnest skin of all spans the translucent underbelly of the reticulated glass frog (*Hyalinobatrachium valerioi*), pictured here in Costa Rica.

Direct connection to the bloodstream means that frog skin can be a useful marquee for internal compounds. For instance, many frogs appropriate toxins from the insects they consume, particularly ants, to secrete a poisonous coat for themselves. And the Australian green tree frog exudes its own version of mosquito repellent. Being vitreous, rather than venomous, is the reticulated glass frog's paradoxical defense. There are 150 or so known species in its family, the Centrolenidae. (That group, however, does not include the "see-through" frogs selectively bred in a Japanese laboratory to have skin clear enough that the humane and the squeamish can study their internal organs without dissection.) Why transparency evolved naturally remains somewhat mysterious, though camouflage is one good possibility.

It took perseverance for Michael and Patricia Fogden to find these two 0.8-inch-long reticulated glass frogs within La Selva Biological Station, a 3,900-acre research reserve. The photographers waded along the stream banks for weeks, looking under large leaves for egg clutches. One early morning they scored a twofer. The frog on the left [*see preceding pages*] is a female taking a brief breather alongside her newly laid clutch, and the one on the right is a male intently guarding a three- or four-day-old clutch deposited by his partner. Dots on both adults' backs are thought to mimic eggs, to confuse predators.

Beyond being a decoy, the male reticulated glass frog fends off predators and parasites for his two weeks of constant guard duty. Most important, he presses his stomach over the eggs for water transfer and urinates on them nightly for extra moisture. When a father is removed from the eggs, as shown in a study published earlier this year in the *Journal of Herpetology*, the defenseless embryos are far more likely to dry out or be eaten by arthropods.

Nine out of every ten amphibian species are frogs (a term which properly includes toads). And one in every three amphibians is threatened with extinction today, whether by habitat loss, changing temperatures, or the chytrid skin fungus, which may take advantage of stress-impaired immune systems. Frogs can't afford to have thicker skin, though the times seem to call for it.

Since 1978 **Michael and Patricia Fogden** have spent most of their time in the rainforests of Central America, working as freelance writer-photographers of natural history subjects. The couple enjoys collaborating in the field with scientists—having once been working zoologists themselves—and they are fascinated by the relationships that have evolved between plants and animals. See www.fogdenphotos.com for more information.

nature.net by robert anderson

NANO NANO

IN 1959, THE PHYSICIST Richard Feynman (known for safecracking at Los Alamos, bongo playing, and his insights into quantum electrodynamics) gave a talk at Caltech entitled, "There's Plenty of Room at the Bottom." That prophetic lecture is often cited as the beginning of nanoscience, the study of matter at the scale of one billionth of a meter. At Nanowerk (http://www.nanowerk.com), I found a video "Kavli Foundation: An Introduction to Nanoscience," in which narrator Alan Alda explains how Feynman's seminal thoughts were sparked by his interest in cellular biology (click on "nanoTube" in the main menu, then select "General," and scroll down). Feynman figured nature had been in the nanotechnology business for billions of years, and eventually we would be too. For my guide to Web sites exploring how nature is inspiring our nanotechnology future, please visit the magazine online (www.naturalhistorymag.com).

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

WORD EXCHANGE

Microbe Man

Congratulations and thanks for "A Head in the Clouds" [7-8/09]. Robert R. Dunn not only gave a moving tribute to one of the most underappreciated revolutionary thinkers in science, William D. Hamilton, but also provided a clear description of the master's last, potentially brilliant and far-reaching—yet typically edgy—hypothesis: that microbes have been selected to produce clouds! While Hamilton's molecules cycle in the biosphere, his ideas continue to cycle in the memosphere.

Craig Bowe
Needham Heights, Massachusetts

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Death Whiff

Bees, ants, and other social insects recognize and cart away their dead. That way, disease does not spread to the whole colony. Other insects, such as cockroaches, simply give their dead a wide berth, probably for a similar reason. Compounds emitted by the corpses—mostly oleic acid and linoleic acid—are the dead giveaways.

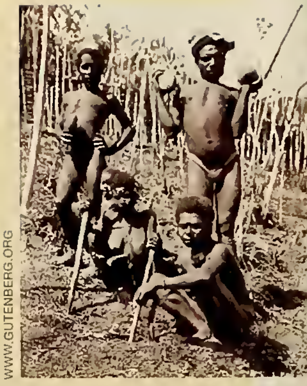
New research shows that those compounds' role as pheromones of death, or "necromones," may be ancient: wood lice (a.k.a. pill bugs or sow bugs), small terrestrial isopod crustaceans whose ancestors diverged from the insect lineage 420 million years ago, also respond to them.

A team composed of student Matthew Yao, his advisers C. David Rollo and Jack M. Rosenfeld, and three others at McMaster University in Hamilton, Ontario, offered the little crustaceans shelters tainted with the crushed bodies of other wood lice, or with solutions of oleic or linoleic acid. The woodlice steadfastly shunned those shelters. That's evidence of either an amazing convergence between isopods and insects or, more likely, a common response that goes back to the evolutionary ancestor of both groups.

In an interesting aside, the team also showed that tent caterpillars, those pesky defoliators of trees, steer clear of leafy branches swabbed with oleic or linoleic acid—perhaps providing a clue to a new control method. (*Evolutionary Biology*) —*Stéphan Reebs*

JOE SHARKEY

Hunter–Gardeners?



WWW.GUTENBERG.ORG

New Guineans pose while planting yams in a garden (early twentieth century).

Australian Aborigines were quintessential hunter–gatherers before their eighteenth-century encounter with Europeans—or so it has been thought. Now three scientists argue that Aborigines may once have had green thumbs, a long time ago.

The ancient horticultural practices of New Guinea spread to the south over a land bridge that once connected the island to northern Australia, claim archaeologist Tim Denham of Monash University in Clayton, Australia, and two colleagues, resurrecting a twenty-year-old hypothesis. New Guinea is one of the birthplaces of agriculture, where some kinds of taro, bananas, and yams were domesticated starting 10,000 years ago.

Denham and colleagues offer the greater yam, *Dioscorea alata*, as support. The vine, prized for its starchy tubers, has no wild type: all known populations worldwide are cultivars originally planted by hungry humans. The greater yam now grows wild in northern Australia, both along the coast and inland, and there's nothing in herbaria or history books to suggest it was introduced after European colonization.

The yams—as well as suspicious, albeit wild-type, populations of bananas and taro in the same region—may be the descendants of plants once cultivated by Aborigines, who would have learned the techniques from their neighbors to the north. It appears, however, that after sea levels rose around 8,000 years ago and the Torres Strait isolated New Guinea, native Australians lost their gardening habits. (*Antiquity*) —*S.R*

Who, Moa?

The lancewood, *Pseudopanax crassifolius*, is a New Zealand tree that goes through an unusual changing act as it grows. Seedlings' leaves are mottled; saplings' leaves have conspicuous pale green thorns; and adults' leaves are an unremarkable thornless green. Could the leaves' transformation be a vestigial defense against munching by now-extinct moas, as various researchers have proposed? Those giant, wingless birds were New Zealand's main herbivores until people extirpated them 700 years ago.

The mottling would have camouflaged vulnerable seedlings against a background of leaf litter, and the thorns would have discouraged swallowing, if their color hadn't already warned the birds away. Once the trees made it to ten feet tall—the maximum reach of an adult moa—they no longer needed extraordinary protection.

To test that idea, graduate student Nik Fadzly and his advisor Kevin C. Burns, of Victoria University of Wellington, New Zealand, along with two collaborators, measured the colors of the leaves and compared them with the visual capacity of ostriches, the moas' closest living relatives. They found that seedling leaves would indeed be concealed to an ostrich's (and presumably, a moa's) eye, whereas thorny sapling leaves would be conspicuous. Critically, the leaves of *P. chathamicus*, a cousin of the lancewood that evolved 500 miles away on the moa-free Chatham Islands, showed neither camouflage nor contrast coloration.

Many animals deploy color to hide from or deter their predators. The lancewood is the first documented case of a plant doing both. (*New Phytologist*) —*S.R.*

Lancewood tree grows from a speckled seedling, below left, into a thorny sapling, below right.

KEVIN BURNS

PAUL WEBER

Flipper Forms Follow Function

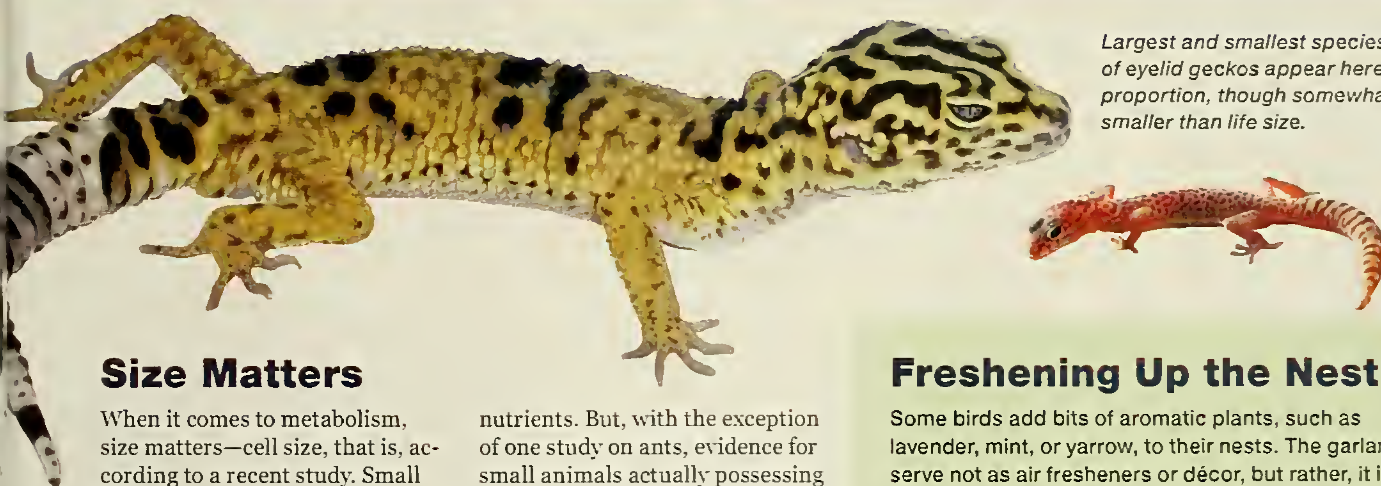
The flippers of cetaceans—dolphins, porpoises, and whales—come in different forms to fit the swimming needs of each species. But how, exactly, do the limbs perform in the water?

To find out, Paul W. Weber, his graduate advisor Laurens E. Howle of Duke University in Durham, North Carolina, and two colleagues conducted the first-ever comparative hydrodynamic analysis of cetacean flippers. The team made CT scans of the flippers of seven of the smaller species, taken from dead, stranded animals or museum collections, then made three-dimensional scale models based on the scans. They tested the models in a water tunnel to compare their hydrodynamic characteristics.

The flippers all exhibited lift (upward force) and drag (rearward force) comparable to engineered hydrofoils, the team found. That's somewhat expected, says Howle: surfboard rudders and other marine designs look a lot like flippers. More surprising was that flippers with sharply backward-swept edges, such as those of the Atlantic white-sided dolphin, exhibited the same unusually advanced lift properties as triangular-winged aircraft, such as the Concorde and some military planes.

Computer representation shows fluid flow around a model flipper of an Atlantic white-sided dolphin.

The researchers also noted that slow swimmers, such as the Amazon River dolphin, have relatively broad triangular flippers that aid maneuvering in complex river-floodplain systems. Open-ocean swimmers such as the bottlenose dolphin have comparatively small flippers for their body size, which, the water-tunnel tests confirm, improve stability while plowing through waves and currents at high speeds. (*Journal of Experimental Biology*) —*Harvey Leifert*



Largest and smallest species of eyelid geckos appear here in proportion, though somewhat smaller than life size.

ZUZANA STAROSTOVÁ & LUKÁŠ KRATOCHVÍL

Size Matters

When it comes to metabolism, size matters—cell size, that is, according to a recent study. Small animals have faster metabolisms relative to their body size than do large animals. According to the so-called metabolic theory of ecology, that scaling is responsible for many patterns in nature—from the average lifespan of a single species to the population dynamics of an entire ecosystem. Although scientists generally agree on the theory's fundamentals, they disagree on the reasons for the scaling. One camp thinks metabolic rate is driven by cell size; another thinks it corresponds to the size and geometry of physiological supply networks, such as the circulatory system.

The "cell-size" camp points out that small cells are more energetically demanding because they have a larger ratio of surface area to volume than big cells do, enabling them to exchange disproportionately more gas and nutrients. But, with the exception of one study on ants, evidence for small animals actually possessing small cells and correspondingly high metabolisms has been surprisingly lacking—until now.

With four colleagues, Zuzana Starostová, at the time a graduate student at Charles University in Prague, measured the size of red blood cells (a proxy for average cell size) and resting metabolic rate in fourteen species of eyelid geckos. The lizards are morphologically similar, but vary greatly in size: the largest, at a quarter pound, weighs thirty-three times as much as the smallest.

Sure enough, the team found that the larger geckos had bigger red blood cells and a lower metabolic rate relative to body size than small geckos did. Their work supports the idea that cell size helps determine metabolic rate—which, in turn, underlies much of life's patterning. (*American Naturalist*)

—*Lindsey Konkel*

Freshening Up the Nest

Some birds add bits of aromatic plants, such as lavender, mint, or yarrow, to their nests. The garlands serve not as air fresheners or décor, but rather, it is thought, as pesticides against such parasites as fleas and blowfly larvae, which commonly vex chicks. Yet various experiments have failed to confirm that quite reasonable idea. Now Adèle Mennerat, her former graduate adviser Marcel M. Lambrechts of the National Center for Scientific Research in Montpellier, France, and several colleagues say scientists may have been off track—bacteria could be the targeted affliction.

Every year in the Fango Valley of Corsica, a population of blue tits nest in boxes set up just for them. Each day during the 2005 nesting season, Mennerat removed the birds' freshly added greenery from forty boxes, and replaced it with either a standard mix of aromatic herbs or inert moss. When chicks were two weeks old, she pressed agar slides onto their flanks to sample the bacteria growing there. Fewer bacterial species were living on chicks from boxes with herbs than on chicks from boxes without.

In a separate study, the group found that aromatics improve chick growth and health, even though they don't affect the number of blowfly larvae infesting the nests. Heavy bacterial loads could lead to disease—hence the bactericidal herb bouquets. The heady scents and pretty swag are just bonuses. (*Oecologia*) —*S.R.*

LUCILLE CHAPUIS

Two cleaner shrimp attend to a peacock grouper

Fish or Shrimp?

When a coral-reef fish has an itch, it seeks out a skin cleaning to remove the parasites responsible. One servicing option would be small fish called cleaner wrasses, but the itchy fish could just as well visit a competing team of shrimp. New research suggests that, as in any long-established free market, there isn't much to distinguish those two alternatives.

Yet there are reasons to think the shrimp would provide better service. The wrasse, you see, is a cheater: sometimes it bites succulent bits of mucus off its client instead of picking parasites (you can tell because the client jolts and chases the cleaner away). And the wrasse is smart. It rarely sneaks mucus from dangerous predatory species, preferring to exploit the harmless. Shrimp, being lowly and fragile invertebrates, may neither dare to risk attacks by upset clients nor have the wits to recognize dangerous ones, predicted Lucille Chapuis of the University of Lausanne and Redouan Bshary of the University of Neuchâtel, both in Switzerland.

Their observations proved them wrong. Scuba diving in the Red Sea, the two biologists saw client fishes jolt equally often under the attentions of shrimp and wrasses. And the shrimp appeared sensibly circumspect around predators, which jolted less often than did non-predatory clients. Surprisingly, shrimp were four times less likely than wrasses to be abandoned or attacked by jolting clients, so they must possess some secret of the trade. (*Animal Behaviour*) —*S.R.*

THE WARMING EARTH

Fortune and Fertility

For decades, demographers have reported that the more developed a country is in terms of wealth, health, and living standards, the lower its citizens' fertility rate—so much so that most rich European and North American nations cannot sustain their populations without immigration. (The United States is a notable exception.) Eco-activists tend to welcome such news, foreseeing an end to overpopulation. But many economists and sociologists worry, because low fertility rates entail population aging, which often brings on socioeconomic problems. Both camps will be interested in a recent study by Mikko Myrskylä and Hans-Peter Kohler of the University of Pennsylvania, and Francesco C. Billari of Bocconi University in Milan, Italy.

Crunching the latest (2005) numbers for 140 countries, the study still finds a negative correlation between national fertility rates and the United Nations' development index, but only up to a point. At the highest development levels—attained only in recent years—countries' fertility rates rise again. Some are approaching the replacement value of 2.1 children per woman, whereas others still have a long way to go.

The team can't yet pinpoint the reasons for the upturn. Perhaps general affluence, or government programs, help women reconcile childrearing with professional pursuits.

Economists will be relieved, but the environmental implications are less clear. Development in the poorest nations, which are driving global population growth, will undoubtedly lower fertility rates there. Yet it's individuals living in highly developed countries who consume and emit the most. (*Nature*) —*S.R.*

Trees Down, Carbon Up

Deforestation of Brazil's Amazon Basin for cropland, grazing, and lumber has held relatively steady at its late-twentieth-century peak of around 7,000 square miles per year. Yet even if that rate remains constant, the resulting annual emission of carbon dioxide into the atmosphere will actually increase, say researchers at the Carnegie Institution for Science in Stanford, California.

Carbon release from deforestation is a function of the area cleared, the felled vegetation's biomass, and the fate of its carbon. To calculate the area and biomass, Scott R. Loarie and two colleagues studied satellite images that were collected between 2001 and 2007 and validated by on-site inspections. Then they estimated emission rates based on how much of the cleared vegetation is typically removed, burned, left to rot, used as lumber, or converted to charcoal.

The team found that the southeastern rim of the basin, cleared mainly in the 1980s and 1990s, was relatively low in biomass. During the 2001–2007 study period, deforestation moved northwest into denser forest with taller trees—and it's heading for acreage with higher biomass still. Consequently, carbon dioxide emissions rose steadily during the study period, and could rise yet another 25 percent above the study-period average—with increased risk for the climate. (*Geophysical Research Letters*) —*H.L.*

NASA

False-color satellite images—taken in 1992, above right, and 2006, right—show how deforestation changed one swath of central Brazil.

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THE VIRUS WITHIN

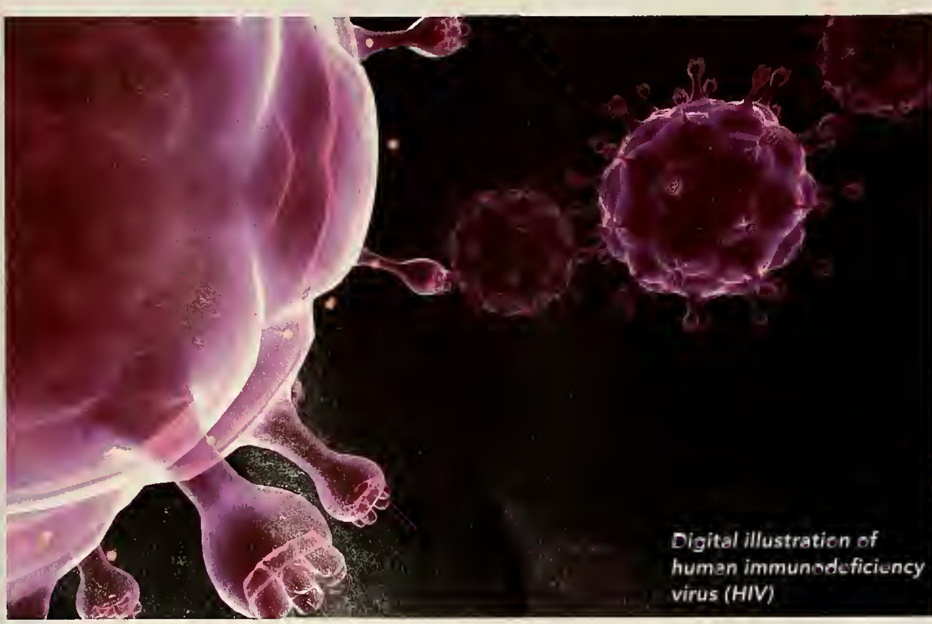
If HIV had spread 500 years ago, we might never have known it was an infectious agent.

IN THE EARLY 1980s, doctors believed stomach ulcers were caused by stress, diet, alcohol, and bad genes. Unable to persuade his colleagues that ulcers were actually infectious, the Australian physician Barry J. Marshall drank a cloudy brown liquid containing *Heliobacter pylori*. He promptly developed gastritis, proving bacteria could erode human stomachs. In 1911 a Rockefeller Institute pathologist, Peyton F. Rous, injected chickens to show a virus could cause cancer. Further back, the great nineteenth-century microbiologists such as Pasteur and Koch showed that many major human diseases were contagious in origin. Germ theory itself came on the back of thousands of years of people believing in the "spontaneous generation" of illnesses that were later proven to be infectious.

If we've mistaken infectious diseases for noninfectious ones throughout human history, it seems likely there might be similar muddles we haven't yet got straight. Many people think atherosclerosis could somehow be infectious. Others suspect that obesity, schizophrenia, and Alzheimer's are. Two particular proponents of infectious hypotheses argue that all conditions which significantly sap evolutionary fitness should be suspected of being infectious. Genetic causes, they argue, should have been selected out. The most extreme example they suggest is homosexuality. (It is worth noting that homosexuality combined with *in vitro* fertilization ceases to present a reproductive impasse. In schemes of thinking where diseases are defined by drops in evolutionary fitness, definitions of cure become as contorted as those of illness.)

If you think some of those examples sound ludicrous, I agree with you. Unfortunately for us, nature doesn't always work the way we guess. The idea that stomach ulcers or cancers could be infectious seemed equally bizarre not so long ago.

Sometimes, though, the borderline between what is and is not infectious can move in a different direction. Let's take HIV as an example. Today, despite knowledge of how the virus spreads and public education on how to avoid it, the disease is still ravaging sub-Saharan Africa. Imagine what would have happened if HIV had struck 500 years ago, with no coordinated campaigns of public education, no condoms, little understanding of how to stanch the spread. Hard to imagine how our species would have survived. Yet humans must have faced similar challenges over the millennia. And there are genetic clues to those ancient events in the form of viral footprints in our genome.



Digital illustration of human immunodeficiency virus (HIV)

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TO GAIN ENTRY INTO OUR cells, HIV binds to receptor molecules on their surfaces. One of them, called CCR5, shows a curious pattern in our genome. Some human populations possess an unexpectedly high number of copies of a mutated version. That version, CCR5 delta 32, is missing thirty-two base pairs—a deletion that makes those immune cells expressing it *less* effective. Odd, right? Why should 15 percent of northern

Europeans carry a genetic abnormality that appears to do nothing other than subdue their immune systems? (Not that those individuals seem to pay a huge price; so far, the only infectious illness identified as more likely to afflict people with CCR5 delta 32 is the rare West Nile virus.)

Yet a person with a single copy of CCR5 delta 32 receives some protection against the effects of HIV; the body succumbs to the virus and develops AIDS more slowly. Having two copies (being homozygous), makes the news even better: coming down with AIDS seems to be almost an impossibility. Making use of that effect, a group of antiretroviral drugs known as "entry inhibitors" have been designed to copy the mutation's effects, with some success. In a remarkable case of "natural" gene therapy, CCR5 delta 32 even seems to have cured someone of AIDS in 2008. An American AIDS patient living in Germany was suffering from leukemia, for which he needed a bone marrow transplant. His doctors deliberately chose a donor who was homozygous for CCR5 delta 32. The transplant not only worked against the patient's leukemia but also against his AIDS; he no longer tests positive for HIV.

Illustration of a retrovirus shows a cutaway of the exterior, or "envelope" (red), to reveal RNA at its core.

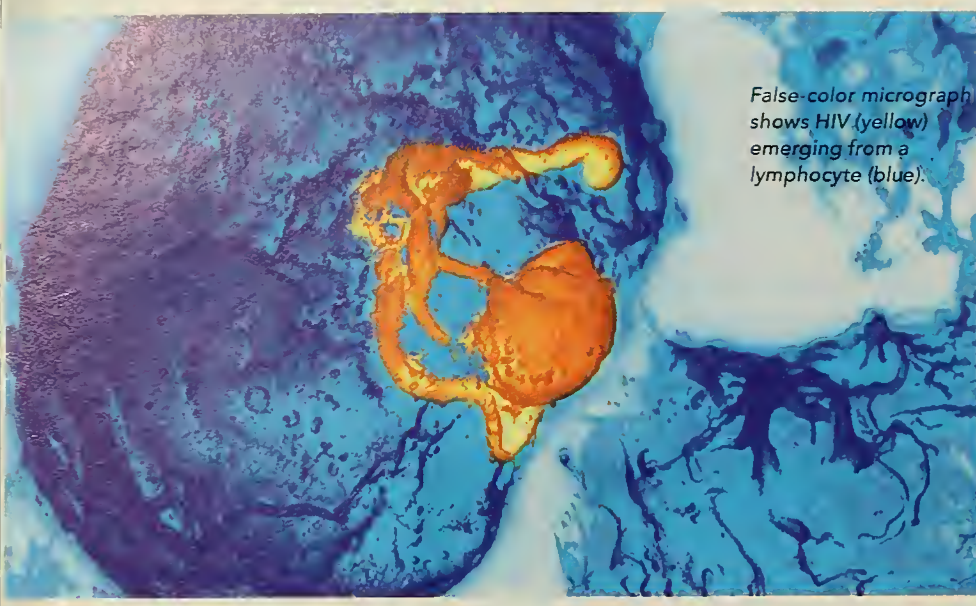
If HIV had come along half a millennium ago, it might have spread to everyone. You can imagine the population crashing—and then, with the spread of a mutation like CCR5 delta 32, recovering. Yet there is an even more intriguing way of imagining how life might have played out. CCR5 delta 32 protects you from infection with HIV. Other mutations seem to leave a tiny minority of people HIV positive but free from any progression to developing AIDS. The virus simply sits in the cells of these "non-progressors": detectable but causing no apparent harm. Why anyone should have such a genetic resistance isn't clear—despite being the focus of intense investigation—but the evolutionary advantage is plain.

Now imagine if HIV, after driving natural selection into making the non-progressor genotype universal, found a way of becoming part of the DNA of *all* our cells—not only the somatic ones (*soma* meaning body) but those of our germ line also, our eggs and sperm. For the most part, people would now be free of AIDS. Since new genetic mutations are always cropping up, however, every so often a child would be born who *would* progress. The HIV that was lingering in his or her genome would burst into full-blown AIDS. But now it would no longer seem that AIDS was the result of a contagion. It would seem to be a purely genetic hiccup, the result of a congenital predisposition.

All of a sudden there would be a curious categorical shift. The virus's effects would be the same as ever, but our perception of them would become very different. Have you developed the signs and symptoms of advanced AIDS? Ah, that's not an infection, not anymore, that's just you. Tragic, but no different from any of the other genetic diseases that occasionally end our lives early. AIDS would have shifted from being an infectious to a noninfectious disease.

For this mental experiment to seem realistic, of course, we have to believe it possible for a virus to hop into germ-line DNA. HIV and other retroviruses use their reverse transcriptase enzyme to zip themselves into our somatic genomes. The techniques required for getting into our sperm and eggs are not vastly different. And in the last few years we've even been seeing it happen—in koalas. A virus (the aptly named "Koala retrovirus") has been spreading southwards across Australia, turning up in the DNA of koala sperm. It isn't yet clear what the effect is on the koalas, but the genetic implication is clear. We've got past theorizing that retroviruses could jump into a species' genome: we've shown they actually do.

Surprisingly, scientists now speculate that viral material—genetic information that ultimately stems from viruses—may make up *more than half* of our DNA. The great bulk of this appears to be noncoding, that is, it doesn't direct the assembly of proteins. Some of the mystery of so-called "junk" DNA seems explained by the fact that it consists of the archaeological remains of millennia of viral invasion. Not all of it, though, is junk. Some coding genes also appear to have viral ori-



False-color micrograph shows HIV (yellow) emerging from a lymphocyte (blue).

©A. T. WILLETT/ALAMY

gins. Retroviral material peppers our genome.

CCR5 delta 32 exists in some populations at frequencies strongly suggesting it has been selected for. Since it modifies immune cells, the obvious thought is that it conferred protection from infectious disease. The only one it has been shown to provide a big advantage against, however, is HIV—which has not been around long enough to be responsible. Most researchers think that CCR5 delta 32 protected us against something that has now died out, and both smallpox and plague have been touted as possibilities (without general acceptance). Unfortunately, populations in the parts of Africa most affected by HIV actually have very little CCR5 delta 32—a trend that might change over the coming generations.

At the moment scientists simply don't know for sure why CCR5 delta 32 exists, or why it is found in some populations far more than in others. Our mental experiment, though, raises interesting questions. Could similar evolutionary events account for the origins of diseases whose causes are currently mysterious? Might what appear to be non-infectious illnesses—such as multiple sclerosis, say, or Lou Gehrig's disease—actually be the results of old viral invasions of our DNA?

If so, there could be consequences. Not because we'd necessarily want to reclassify these diseases as infectious; they may have been so originally, without remaining that way today. But understanding how diseases first arose could help us fight them. Just as a new class of drugs has been derived from exploring the way CCR5 delta 32 protects people from HIV and AIDS, so we might uncover vital clues to future treatments.

THERE IS ALSO AN EVEN bigger question—not an immediately practical one, but mesmerizing all the same. If viruses can infect our genomes in lasting, harmless, and stable ways, might they be doing other things than causing disease? Might they, in fact, be a crucial part of our evolution, a key part of ourselves?

Viruses are often thought of as agents of horizontal gene transfer. They swap genes into and out of bacteria, conferring traits like antibiotic resistance. But the small size and relative simplicity of viruses means their great evolutionary advantage is the rapidity with which they change. The sheer quantity of them, combined with their short lifespans, mean they generate far more genetic variation than larger and longer-lived organisms. Viruses are frequently spoken of as though all they do is shuttle genetic change. It may be more accurate to see them as creating it.

As has been pointed out many times over the years, and often in the pages of this magazine, evolution does not seem to follow a steady course. Periods of stasis sometimes last for geological stretches, and then are interrupted by short periods of great change. Recent advances in the field of evolutionary development ("evo-devo") show that small genetic mutations in regulator genes can have major dramatic effects, like doubling the number of wings on an insect. But the notion that such "hopeful monsters" could prove adaptive is questionable, given the complexity of biochemical systems. And even if one of those new monsters successfully emerged, it might require others of a similar nature to mate with, in order for its new constellation of changes to be passed down meaningfully.

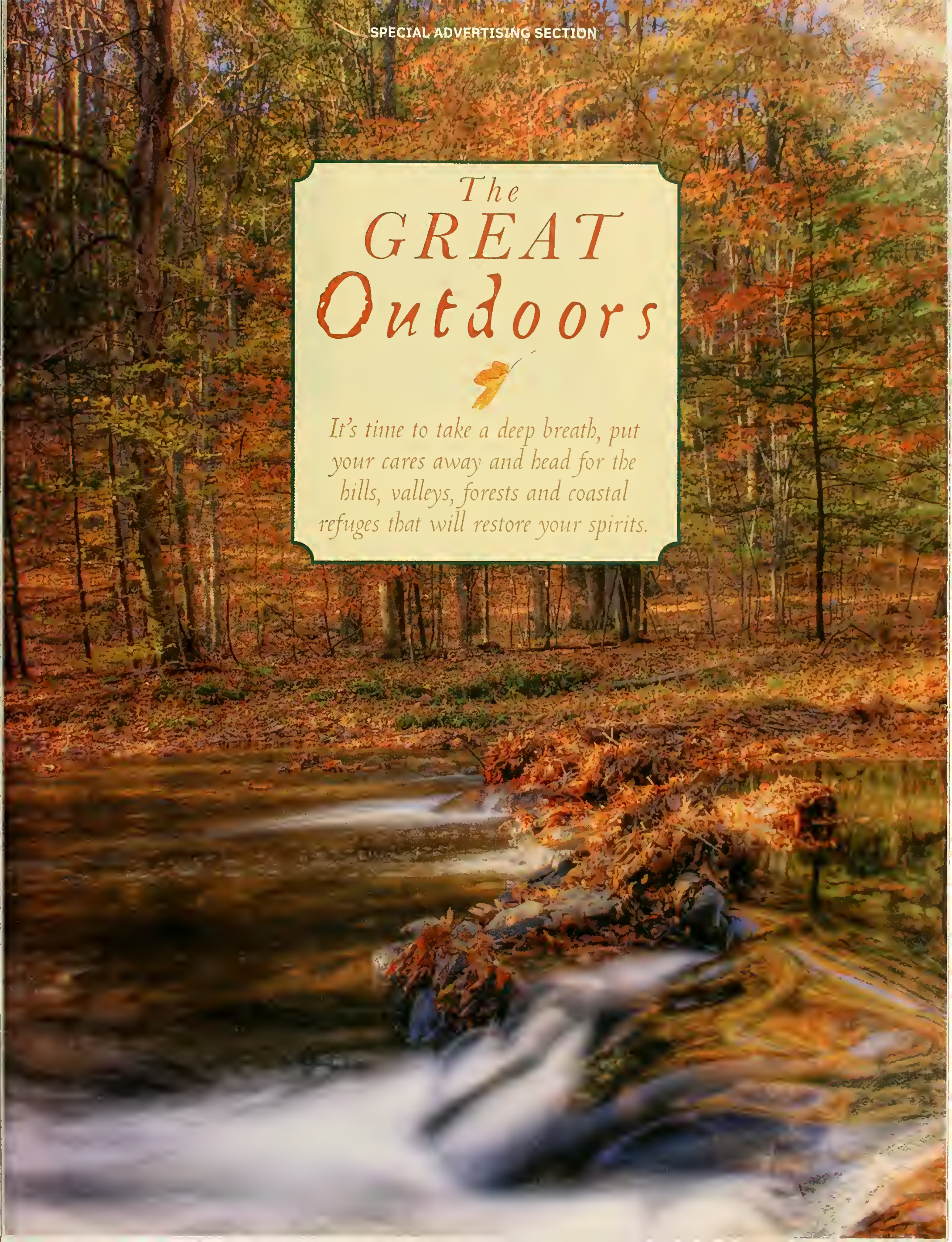
IN 1959, A DECADE AFTER the work on viruses that later won him a Nobel Prize, microbiologist Salvador E. Luria suggested that those entities might be more than just destructive. "May we not feel," he wrote, "that in the viruses, in their merging with the cellular genomes and their reemerging from them, we observe the units and processes which, in the course of evolution, have created the successful genetic patterns that underlie all living cells?"

Luis P. Villarreal, director of the Center for Virus Research at the University of California in Irvine, agrees. He cited Luria when writing a 2004 paper for the *Proceedings of the American Philosophical Society* entitled "Can Viruses Make Us Human?" Villarreal suggested ways in which the answer might be yes. For one, our adaptive immune system—which is capable of using a small number of genes to generate an astronomical multiplicity of antigen receptors—may be based on viral code that jumped into the genomes of the original jawed vertebrates. The mechanism by which placental cells fuse together appears to be viral in origin, therefore supporting the

Continued on page 42

The GREAT Outdoors

It's time to take a deep breath, put your cares away and head for the hills, valleys, forests and coastal refuges that will restore your spirits.



From Dinosaurs and Birds to Chateau Country in *Delaware*

DON'T BE FOOLED BY Delaware's small size. This remarkably diverse little state packs in an outsized number of natural, cultural and historical attractions. Enjoy a drive through its bright fall foliage; stop at roadside farm stands; birdwatch at its wildlife refuges; tour the estates and follow the nature trails in the Brandywine Valley.

You'll want to explore Delaware's Coastal Heritage Scenic Byway (Route 9), from historic New Castle nearly to Dover, taking in 50 miles of the state's carefully preserved shore, unparalled on the East Coast. You'll find some great birding along the way, and you'll pass pastoral villages and working farms. A magnet for birds and birders alike are the route's generous stretches of unspoiled marshland, including the Thousand Acre Marsh, the largest freshwater tidal wetland in northern Delaware. The route will also take you south to the Bombay Hook National Wildlife Refuge and the adjacent Little Creek Wildlife Area, with their boardwalks and towers for viewing the profusion of waterfowl.

Don't miss the Delaware Museum of Natural History near Wilmington, where you'll encounter life-sized dinosaurs, take a look under the oceans, come face to face with a jaguar, linger at an African watering hole, and marvel at the diversity of birds and shells from around the world.

A drive through the rolling hills of Delaware's Brandywine Valley will take you from historic estates to nature havens. This area, known as Chateau Country, is replete with historic sites and magnificent mansions with glorious gardens. Take the Red Clay Valley Scenic Byway to reach the Mt. Cuba Center, dedicated to the conservation of Appalachian Piemont plants, and the Ashland Nature Center, with its Butterfly House and nature trails winding through meadows and marshes.

The Birkenhead Mills, one of the most beautiful views along the Brandywine at Hagley Museum and Library

Change your perspective.
Feel the uniqueness of *Sierra Vista, Arizona.*

Huachuca Mountains

FIRST, BRING YOUR SPYGLASS. You'll need it. Direct it at the 9,500-foot peaks of the Huachuca Mountains and imagine Geronimo and his Chiricahua Apache standing atop.

See the blazing colors in the brilliant iridescence of hummingbirds that migrate through our canyons from April through September. Envision hunters during the Ice Age—tracking Mammoths—as you walk through the 13,000-year-old Murray Springs Clovis Site.

Or, be pulled by the history found in the hundreds-year-old petroglyphs and pictographs along the San Pedro River or on Fort Huachuca, carved and drawn by skilled artists.

Take a picturesque bike ride on the mountain trails of the Coronado National Forest, along the rural back roads or on the miles of the City's multi-use paths.

Amaze at the smoke-and-mirrors exhibits in the U.S. Army Military Intelligence Museum on Fort Huachuca. With displays of a camera-in-a-fake-tree-branch and an original German Enigma encryption machine, the museum is a spy-lover's dream.

For those whose childhood excitement was playing cowboys and Indians, the Fort Huachuca Museum chronicles the history of the U.S. Army in the Southwest.

Visit www.VisitSierraVista.com or call the Sierra Vista Visitor Center at 1-800-288-3861.

MARYLAND

Visit **CALVERT COUNTY, MARYLAND**, to explore the Chesapeake Bay's ecosystems and hunt for fossils in two of the largest fossil-bearing deposits on the East Coast—Calvert Cliffs State Park and Flag Ponds Nature Park. Within a few miles of each other, they offer abundant natural resources and ample opportunity to search for shells, shark teeth and other fossils from the Miocene Epoch when the Bay was home to a warm reef environment and numerous now-extinct animal species. This ancient ecosystem is now well preserved in the exposed rocks along the shoreline. Visitors to Flag Ponds Nature Center, named one of the "Top 10 Beaches for Shells" by CNN.com, frequently discover ancient fossils washed up on the beach and deposited from the Calvert Cliffs. Several miles of trails lead through a variety of habitats from upland forests to wooded swamps and into open marshes and beach dunes typical of the coasts of Maryland's Eastern Shore or the Carolinas.

The Bucktown Village Store is a stop on the *Finding a Way to Freedom* Driving Tour

Reaching out into the Chesapeake from Delmarva Peninsula, heart-shaped **DORCHESTER COUNTY, MARYLAND**, is known, appropriately, as the Heart of the Chesapeake. This unique part of Maryland has retained much of the traditional way of life along the Chesapeake and has preserved much of the unspoiled Eastern Shore landscape associated with the history of this region. Dorchester County also evokes a remarkable aspect of this region's history: the Underground Railroad, the secret network that offered refuge to escaping slaves. The *Finding a Way to Freedom* Driving Tour is a self-guided tour that takes you to exhibits, home sites, meeting houses and courthouses and through natural landscapes

MARYLAND

that illustrate the story of the Underground Railroad. You can begin your journey by picking up a map in historic Cambridge. Stops include the Harriet Tubman Museum, where you'll learn about this extraordinary woman's strength of character and determination, and the Bucktown Village Store that played a part in her story. Much of the tour takes you in and around Blackwater National Wildlife Refuge, south of Cambridge. The 27,000-acre preserve offers excellent bird watching, hiking, cycling and kayaking.

FREDERICK COUNTY, the gateway to western Maryland, is home to historic battlegrounds, untamed rivers, scenic mountains, and fabled trails. The county spans the fringes of suburban Washington D.C. to the rugged shoulders of the Piedmont. At the heart of the county are the "clustered spires" of historic Frederick. To the west are the Blue Ridge Mountains and the Appalachian Trail; to the north lie the Catoctin Mountains; and to the southwest is the Potomac at its wildest. Nestled in the county's swath of Catoctin Mountains are Catoctin Mountain National Park and the adjacent Cunningham Falls State Park, with its dazzling fall foliage. Cunningham Falls Park is named for the 78-foot cascade that is considered by many to be Maryland's most distinctive waterfall. A popular place to begin exploring the Appalachian Trail, as it winds over South Mountain, is at South Mountain State Park or at nearby Gathland State Park, where you can also absorb Civil War history at the South Mountain State Battlefield. Follow the trail southward, and you'll come to the Potomac and the C&O Canal, whose historic towpath, now a national park, has become a popular birding and biking trail.

Frederick's 44-acre Baker Park provides a great vantage point to enjoy the "clustered spires."

KENT COUNTY, MARYLAND, where fresh and salt water meet, claims a coastline sprinkled with historic waterfront towns and stretches of rolling farmlands beribboned by the tidewater tributaries of the Chesapeake. The county's roadways and waterways beckon bicyclists and kayakers as well as drivers and boaters to explore its pastoral countryside and important wildlife refuges. Many of the two-lane roads that wind through this tidewater county have been included in Maryland's first National Scenic Byway. Kent County's portion of the byway includes the routes from the Chester River Bridge to Georgetown and the Sassafras River, from Chestertown to Rock Hall, and from Rock Hall to the Eastern Neck National Wildlife Refuge. Stop in Chestertown to stroll and shop on its classic Main Street, and tarry a while in Rock Hall to enjoy the sunsets from a bench along the town's popular boardwalk. And be sure to explore the boardwalks and trails of Eastern Neck National Wildlife Refuge, with its year-round population of bald eagles and its profusion of waterfowl.

MARYLAND

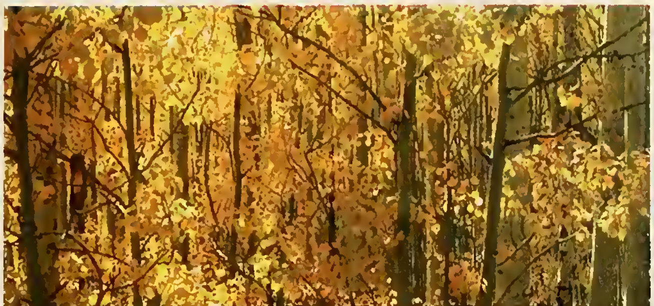
Assateague Island State Park's wild horses

Wetlands near Ocean City

Situated on Maryland's Eastern Shore, **WORCESTER COUNTY** is the state's only seaside county, with a bounty of beaches, bays and barrier islands along the Atlantic for exploring and birding. The county's varied habitats play host to more than 350 species of birds, the most in the state. Bicyclists enjoy its marked trails, and history lovers flock to the Victorian-era town of Berlin and to Snow Hill, with its century-old homes. South of Ocean City, known for its long swath of soft beige sand and its delectable steamed crabs, is Assateague Island State Park and National Seashore, home to the state's famous wild pony herd as well as piping plovers and elusive sika deer.

In contrast are the forests and cypress swamps plied by the beautiful black-water Pokomoke River. For exploring the river, the Nature Conservancy maintains a mile-long trail through the Pocomoke Forest and over the Nassawango Cypress Swamp, along Nassawango Creek, shaded by ancient bald cypress and black gum trees. The Delmarva Discovery Center on the Pocomoke River in downtown Pocomoke City is a great introduction to the history of the river, including exhibits on shipbuilding, fishing and local Native American culture.

Recharge your spirit in *Ruidoso*



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Witness the breathtaking sight of an illuminated Midtown Ruidoso—a must see!
More info: www.ruidosofol.org

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Three Rivers Petroglyphs

Nature's Avant-Garde

An interview with the directors of *Microcosmos,* Claude Nuridsany and Marie Pérennou

BY SCOTT MACDONALD

DDM

Few could have predicted the theatrical success of the recent spate of feature-length nature films, especially *Winged Migration* (2001), directed by Jacques Perrin and Jacques Cluzaud, and Luc Jacquet's *March of the Penguins* (2005), which has spawned no end of penguin-philia. What led the way was a 1996 documentary on insect life, Claude Nuridsany and Marie Pérennou's *Microcosmos,* subtitled *Le peuple de l'herbe* (The people of the grass).

PHOTOS 12/ALAMY

I first saw *Microcosmos* at Film Forum in New York City, a nonprofit cinema house; I remember entering the theater and realizing with dismay that I was surrounded by children. I had read that the film had almost no narration, and I couldn't imagine young children having the patience for it. To my amazement, they maintained a rapt silence throughout the film—as did I.

In the United States, nature films have become a staple of television and of the Imax presentations in museums and science centers, but historically, few have made it into commercial theaters. Of course, there have been exceptions. Beginning with *Seal Island* (1946), Disney's True-Life Adventure films were hits on the big screen before becoming ubiquitous on television and in schoolrooms. And the alarmist slant of *The Hellstrom Chronicle,* which warned that insects would overtake humanity, helped that film succeed as a commercial release even as it won its directors, Walon Green and Ed Spiegel, the 1971 Academy Award for best documentary feature.

Seeing the tiny worlds revealed by Nuridsany and Pérennou projected large was a revelation that transformed the world normally beneath our feet into mythic proportions. Not only did I find the imagery of insects in *Microcosmos* astonishing, but I was deeply moved by the filmmakers' attitude toward their subjects, and especially by their willingness to allow viewers to *see* what insects do, rather than

At left and on pages 26, 27, 29: scenes from Microcosmos; *opposite page: film posters*

NOSTALGIA FACTORY

COUSTEAU SOCIETY

WALT DISNEY COMPANY

simply listen to an explanatory lecture.

Nuridsany and Pérennou began as biology students, then reconfigured themselves into accomplished nature photographers, publishing several books. In the mid-1980s they decided to try their hand at 16-millimeter filmmaking, producing three films for French television: *Les habitants du miroir* (The inhabitants of the mirror, 1986), *Le jeu de l'insecte et de la fleur* (The play of insect and flower, 1987), and *Voyage au pays de l'invisible* (Journey to the land of the invisible, 1987). The success of those films, and the filmmakers' increasing discomfort with the restrictions of television, led to their decision to make a feature. *Microcosmos* took four years to make; it was followed by *Genesis* in 2004. A third feature, *La clé des champs* (The key to the fields) is in progress.

After seeing *Microcosmos* and other recent nature films in theaters, and discussing them with the students who participate in my classes on the history of cinema, I have come to see nature filmmaking as a new kind of avant-garde. I am increasingly impressed by the creators' courage, persistence, and implicit environmentalist commitment. And as is typical of avant-garde film, this body of work has been largely ignored by those who chronicle film history. Despite their cinematic accomplishments and their recent successes, nature filmmakers are rarely accorded the respect they deserve.

To develop a more complete understanding of theatrical nature features and the backgrounds of those who make them, in March of 2007 I initiated an interview with Nuridsany and Pérennou. With the assistance of my French-speaking Hamilton College colleague, Martine Guyot-Bender, I exchanged questions and answers with them over a period of several months. Our edited exchange follows.

Q: What moved the two of you into filmmaking, and into this particular kind of filmmaking?

A: When we met, both of us were students in biology in Paris at the Pierre and Marie Curie University. We had decided to study biology because, ever since our childhoods, both of us had been very interested in animals and in nature, but we were also interested in philosophical issues: for example, what does it mean to be "alive"? This is the main theme of our most recent movie, *Genesis*. As students we were asking ourselves many questions about life, and not only about the lives of animals, but also about our own lives. We were full of questions about our correct place in this world.

We earned master's degrees, then worked on our PhDs. Our original plan was to become researchers in biology, but we were very disappointed with our first contacts with research laboratories—maybe we had too romantic an idea about research work. We decided to leave the university and become freelance researchers.

For several years, we took photographs of nature and enjoyed writing about nature, trying always not to do "pure science" articles or books, but to mix science and more personal expression. Very soon, we wanted to make films about nature and animals, thinking it would be the best way to combine what had become our two primary passions: cinema and nature.

Q: Were nature films an important part of your growing up?

A: When we were little children, of course, we were enthusiastic about films like Disney's True-Life Adventure *The Living Desert* (1953) and Jacques-Yves Cousteau and Louis Malle's *Le Monde du silence* (*The Silent World*, 1956), but later, we were much more impressed by the fiction films of the great directors. The cinémathèque was like a second university for both of us.

Our favorite filmmakers also have in common a seeming effortlessness, a simplicity. As is sometimes the case in theater, major filmmakers manage to give birth, before our very eyes, to extraordinary images, using the sparest of means. They do not overload us with images. An economy of visual means is used to invite spectators to engage with the experience that is presented to them. This participation is so intense that, at the end of a screening, we spectators may feel a sort of exhaustion.

Of course, one of the great aporias of cinema, its founding contradiction, is that it uses a quasi-scientifically objective recording tool—the movie camera—to create a universe that reveals a unique, personal vision of the world.

Q: Were there nature films that were important to you, other than the Disney True-Life Adventures and Cousteau's work?

A: The French feature called *Le territoire des autres* (The territory of the others, 1970), directed by François Bel, Gérard Vienne, and Michel Fano, was, for us, a revolution in wildlife filmmaking. It had no commentary, no music, a very original soundtrack, and the editing was very free. They shot for seven years! That was the *only* nature film that made a great impression on us. We hoped it was the beginning of a new era for wildlife films, but it remains a unique case (we were not enthusiastic about their second film, *La griffe et le dent* [The claw and the tooth, 1976]). We do not know if *Le territoire des autres* was distributed in the United States; nobody speaks about that film in France—it has been forgotten. Orson Welles was enthusiastic about the film.

Q: How did your collaboration evolve? And does each of you take charge of particular dimensions of your films, or do you work together on all aspects of the process?
A: We became filmmakers together, and our collaboration has always been the same: we work together on all aspects of the process. When we started to make nature and animal films, we discussed what exactly we wanted to do and not do. We were not convinced by the animal films that were shown on television. Some showed surprising and interesting things about animals, but in a very academic way. There was always the voice-over commentary, almost interchangeable from film to film, that dictated what spectators should understand from the images that were presented to them. The music was often overbearing, and the editing imposed an artificial storyline, to create events that never happened in real life. And we didn't like that the animal world was always presented through a natural-science bias—as if, for example, human love stories in films should be based entirely on reproductive biological discourse.

The systematic scientific tone so characteristic of these films sounded fake to us. In those movies we did not find the emotion that *we* felt when we watched animals in real life. Everything was explained by Mister Know-It-All. There were no dark areas, no mystery, no ambiguity. During our childhoods, before we were shaped by the bible of science, we saw animals as accomplices, peers, monsters, fairies, divinities, and it is this very vision that we maintain as adults—though our relationship to the universe has never been as intense as it was then.
Q: Being interested in making films about wildlife is one thing, but being able to actually make the films is another. How were you able to get financial support?
A: Regarding our first three shorts, we owned a Beaulieu 16mm camera, complete with all its accessories, but we were waiting for the opportunity to use it. Marlyse de la Grange, the person in charge of the then well-known television program, *Les animaux du monde* (Animals of the world), had contacted us because she wanted to shoot a program on our work as photographers (we had already published several books). We offered to complete her program with some micro-cinematographic shots of our own. She asked to see what we had already shot, but we had absolutely nothing to show her! We asked her to trust us, which she did after much hesitation, which we fully understood. Finally, we showed her some work, and she liked what we shot and integrated our images into her program. Soon after that, we offered to shoot several twenty-six-minute shorts for her program, and she agreed. She gave us total freedom. So that is how the public television channel Antenne 2 produced our first three films in the 1980s.

We were shooting images, writing and recording commentaries, composing and interpreting music, creating sound effects. It was a lot of fun, and it taught us a lot. Unfortunately, Antenne 2 did not have much of a budget for this type of film: we were paid for three weeks of work, while we actually spent between four and five months behind our camera. More important, the twenty-six-minute frame, along with our own self-censorship, prevented us from expressing what we really had in mind and from trying to work in an innovative style.

Q: In what ways did shooting your first feature differ from that early television experience?
A: Moving from short films to features was a major step for us. It allowed us to liberate ourselves from television's limiting time frame and from its old-fashioned documentary style. The project we had in mind, as we started what became *Microcosmos*, was to make a film based on nature

and animals, but also to trade the usual pedagogical tone for an evocation of a distinct world. We often say that what we create are "natural fictions," or "natural tales." We find it strange that speaking about animals can only be done within the frame of natural science. Whatever our respect for and interest in the scientific register, it does not seem to us adapted to "spectacle," and a film is, before anything else, a spectacle. And as we've said, the presence of a commentary tends to overwhelm films about the natural world. To us it's as unbearable as commentaries by tour guides during organized tours of exhibitions: they limit your imagination and your sensibility, alienate your liberty, and as far as we're concerned, spoil your pleasure.

Q: What did you hope to accomplish with *Microcosmos*?
A: With *Microcosmos*, we wanted to project the spectator onto an unknown planet, Earth rediscovered at the centimeter scale (humans actually only know it at the meter scale). On the other hand, in order to film the inhabitants of that planet, we wanted to use the same tools used to film actors and actresses in fiction films—traveling shots, cranes, et cetera—so as to give the insects the stature of real characters. For that, we had to conceive new tools, since the ones that already existed could not function satisfactorily at such a small scale. The elaboration of a sophisticated "motion control," able to function satisfactorily at this scale with no noticeable vibration, was extremely laborious.

Q: It took you the better part of four years to shoot the film. How fully did you know what you might shoot before you began?
A: We had observed insects for decades, keeping journals of behaviors that appeared interesting. (Our descriptions were more like theatrical notes than like the notes of entomologists.) For example, one day we caught sight of a group of ants around a minuscule pool of water. We saw that scene only once, and decided we really wanted to integrate it into our movie. Waiting for the scene to reproduce itself was unrealistic, so we arranged things in the hope of making it happen again.

We chose a large, flat rock and carved a hole in the middle of it, which we waterproofed with a special varnish. We placed the rock in a basin full of water, leaving only the top of the rock dry. We filled up the small cavity with sweetened water (which ants love), and we moved a couple dozen ants onto the rock. After a few minutes of excitement, during which they ran all over (without being able to escape the rock because of the surrounding water), they formed a perfect circle around the sweetened water. [*See photograph on page 29.*]

What we are looking for in such arranged sequences (obviously, we always prefer when things happen naturally) is to find the memory we have of a particular scene, to present a sort of mental image—and, on the other hand, to confront the spectator's imagination by showing him scenes of nature, so that he too can mentally create a particular comparison, or metaphor, or mythological episode—in other words, so that he actively uses his mental powers, rather than passively swallowing flatly realistic images.

Q: At what point is the sound recorded for your films? And how much of it is the actual sound of the creatures we are seeing?
A: We mixed real sounds with sounds we created or enhanced in the studio with a sound designer (Laurent Quaglio). The sound in our films seems to us as important as the visuals, and we spend a lot of time (eight months!) on sound editing. We feel more freedom with sound; we can more easily forgo concerns about realism than with images. Sounds represent the secret life of images. They allow images to penetrate more deeply into the labyrinth of the viewers' mental space. Sounds reach us as bootlegged merchandise: always hidden behind the almighty images, filtering through the border of our perception. That is why their power over the viewer's imagination is so strong. They travel straight into the heart of the unconscious.

Q: All in all, how much material did you shoot for the film? Four years of shooting for a seventy-five-minute film suggests a very high shooting ratio.

PAGES 26 & 27: PHOTOS 12/ALAMY

A: For *Microcosmos*, we shot about forty times the length of the movie (about fifty hours of rushes), which is not that enormous if you take into consideration the length of time we spent shooting. In fact, in some cases, we did not shoot at all, in spite of all our efforts, for weeks. Since we know exactly the effect we want to get and what is useful for the film, we avoid filming so long as the scene we are expecting is not happening in front of the camera. And, when it finally happens, we shoot the scene as much as possible, sometimes thirty times in a row, trying to improve the framing, the light, the camera movements.

Q: In *Microcosmos* the structure of the composite day is a useful device for arranging a very wide range of material, allowing you to do away with a narrator except for two brief passages. But in *Genesis* you chose a twofold organization—the chronological history of the development of life on Earth, and the chronological development of particular creatures in the womb/egg and in the

SHOW AND TELL: Early nature films find a home in the classroom.

BY JENNIFER PETERSON

Films that depict mammals, birds, insects, plants, and other natural history subjects have always been a staple of cinema. Many film historians date the birth of the industry to the well-known experiments in animal locomotion by Eadweard Muybridge and Étienne-Jules Marey, who pioneered series photography as both art and science in the 1870s and 1880s. In a more popular vein, beginning in 1891, Thomas Edison's employees W.K.L. Dickson and William Heise made numerous films of animals for Edison's peephole Kinetoscope viewer—often of animals fighting, such as *The Boxing Cats* (a trained vaudeville act) and *The Cock Fight*, both produced in 1894.

It wasn't until around 1907, when British wildlife photographer Oliver Pike made *In Birdland*, that nature films began to depict animals, plants, and their habitats with more care. In 1908, Great Britain–based producer and distributor Charles Urban, who specialized in educational films on travel and science, began releasing films made by F. Percy Smith, later to become famous for his Secrets of Nature series, popular in the 1920s. Smith's films, such as *The Acrobatic Fly* (1910), in which a fly "juggles" a variety of objects, were hugely successful.

The depiction of natural settings, whether real or simulated, became perhaps the most important characteristic of the nature-film genre by the 1910s. At the beginning of that decade, it was still unclear what business practices or film subjects would be the most profitable, and there was a brief moment when some in the industry hailed educational film subjects as the commercial future of cinema. Wildlife was the selling point for dramatic feature films such as *Chang: A Drama of the Wilderness* (1927) and *Simba: The King of the Beasts* (1928). Some films, such as *A Murderous Midget Fish* (no date) and *Wing, Claw, and Fang!* (1946) presented nature as a strange and ferocious domain: a space to be tamed. Efforts to establish educational films as profitable theatrical ventures were largely unsuccessful, however. Instead, films with more plainly descriptive titles—such as *Bees and Spiders* (1927), *Trees* (1928), and *Beavers* (1930)—were configured to suit classroom use.

By the early 1930s, classroom films were becoming less of a novelty and more of a "standard piece of instructional technology." One study estimated that in 1931 there were 350,000 "nontheatrical" projectors in the United States. A 1934 U.S. government report stated that "thirty-two of our forty-eight States have film libraries of varying qualities under the supervision of educational directors." The new nontheatrical field may not have been as profitable as the theatrical side of the movie business, but it was more stable.

Some early nature films were made to illustrate individual scientific concepts, such as *The Struggle for Existence* (1925), which very loosely deals with one part of Charles Darwin's theory of evolution. Others focused on a group of organisms populating a given region: for example, *Wildlife on the Deserts of America's Great Southwest* (no date) documents both plant and animal life in the Colorado Desert of southern California. But the largest number of nature films from this era focus on just one organism, or several closely related organisms. These films, such as *Frogs, Toads, and Salamanders* (1932), present the life cycle, physiology, and environment of their subjects in the style of early biology textbooks.

Natural history topics made for ideal classroom films, uniting the competing needs of education and entertainment.


F. Percy Smith

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Animals in particular, as both enduring science fare and a favorite of children, were perhaps an inevitable cornerstone of the medium. Filmmakers such as the producers of Eastman Classroom Films strove to represent animals as they were, not to judge them in human terms.

The early nature films may not have entirely succeeded in modeling scientific objectivity for their young audiences. But then, the goal of pure objectivity was by definition unattainable even in the realm of advanced scientific practice. The fact that, as early as the 1920s, children and young adults were exposed to a cinematic version of natural history in the classroom was itself a remarkable development. Encounters with film at school may have been as significant for viewers of the time as going to the movie theater.

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PHOTOS ©: ALAMY

world—held together by using Sotigui Kouyaté as narrator. What led to that decision?

A: We wanted to experiment with something different from the near-absence of narration in *Microcosmos*, while at the same time trying to stay away from the ordinary, scientific commentary in animal movies, for which we have no taste. We started our project with this question: "What does it mean to be alive?" That is an existential question—at once very simple and vertiginous, unsettling. Everyone asks it. We needed a person on screen to personify the question and some of its answers in the form of daydreaming. We decided to use a *griot*.

For us, the griot is not a conventional narrator. Griots are African storytellers/musicians/genealogists who work for royal families and transmit their status from father to son. They were quite numerous during the ancient Mandingo (Mali) empire, which corresponds to parts of today's Mali, Guinea, Mauritania, and Senegal. In *Genesis* Sotigui Kouyaté represents humankind and the questioning by all human beings. We chose an African man because Africa is the cradle of humankind and also a land of storytelling, a place where oral tradition is still very much alive. However, our storyteller does not tell an *African* story, he shows us the way in which a person today can answer questions on the origin of our being, the origin of life in general, of the Earth, of the universe, all those themes which, since humans have been on Earth, have belonged to mythology.

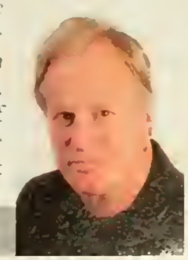
Today, science professes to answer most of the questions we wanted to confront: Darwin tells us the origins of humankind, and the big bang theory tells us the origin of our universe. The sciences fulfill the role of mythology. Our intention was to allow today's knowledge to be heard in the form of traditional tales. The African griot is there to give these tales the flavor of ancient myths of origin. He is a human being who questions life; his questions are as much about his own origin as they are about the universe or animals.

Q: At one point the narrator in *Genesis* says, "We are all born of love." When *March of the Penguins* was being reviewed in the United States, many critics objected to the use of "love" in connection with the penguins, and I'm sure these same critics would also object to the idea that insects and crabs and frogs can "love." How do you mean the word?

A: One of the most basic questions in making nature films is the question of anthropomorphism. From our point of view, to reject any type of anthropomorphism is to assume that humans and animals have no commonality, and that human beings are absolutely unique (if not divine). That is of course questionable. On the other hand, using an excessive anthropomorphism plays on the viewer's feelings by betraying the true nature of animals, turning them into zoomorphic puppets; that is artistically indefensible.

Can we speak of "love" between animals? "Love" is a very ambiguous term that designates both a feeling and an act. *Genesis* attempts to convey to the viewer that we do have some kind of familial link with the animal kingdom (and not only to animals, but also to mountains, clouds, stars). If you spend time observing the very subtle preliminaries that precede lovemaking (and sometimes *devouring*) between daddy long legs spiders (*Pholcus phalangioides*), it is difficult to think that these are merely little robots whose behavior is entirely genetically programmed. Do they have feelings? We may have to find another term. In any case, placing all the animals on one side of a line and humankind on the other is artificial: reality is much more complex and mysterious.

Scott MacDonald is author of the five volumes of the Critical Cinema series (University of California Press); *The Garden in the Machine: A Field Guide to Independent Films about Place* (University of California Press, 2001); and the just-published *Adventures of Perception: Cinema As Exploration* (University of California Press, 2009), which includes a more detailed version of his interview with Nuridsany and Pérennou. He is currently Visiting Professor of Film History at Hamilton College, in Clinton, New York.



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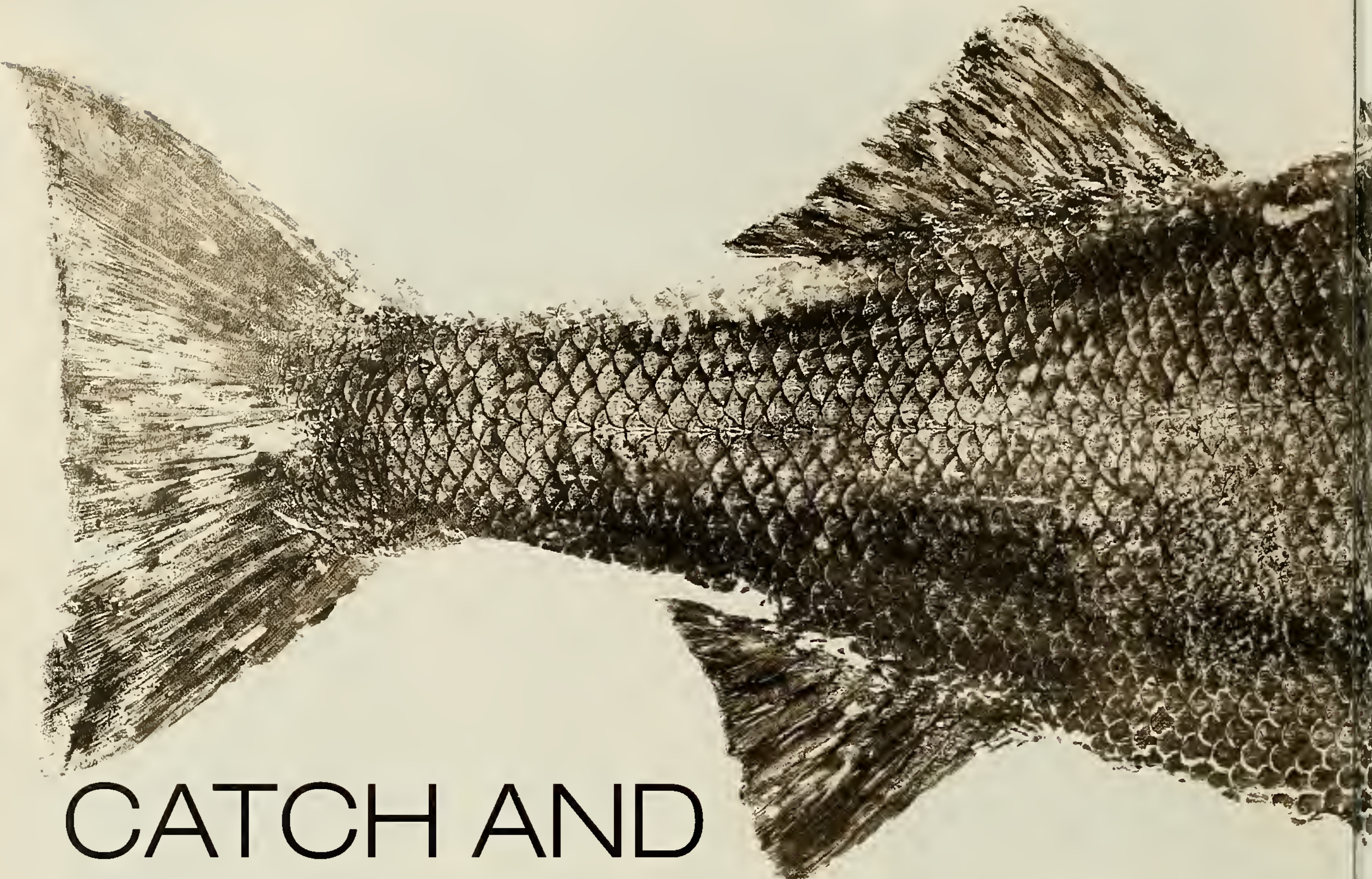


CATCH AND RELEASE

Long Island's striped bass are an ageless lure.

STORY BY MARGARET HART
GYOTAKU PRINTS AND WOODCUTS
BY STEVE THURSTON

WE REACH OUT from the edge of our element to the fish in theirs; that, in a nutshell, is surfcasting. The object of our pursuit is the striped bass, *Morone saxatilis,* native to the eastern seaboard of North America. The species' intelligence, beauty, and power stir our admiration and challenge our skill and determination. Just when we think we have a handle on its movement, some nuance of nature—the heave of a powerful storm, a bitterly cold winter, an offshore shift of bait, the new curve and set of a sandbar—alters the balance. This is as it should be.

A tradition began at the end of the nineteenth century when the Long Island Rail Road added a line to Montauk, and urban anglers in New York City could ride all the way east to catch the early morning run of charter and party fishing boats. Upon arrival on a "fisherman's special," men in three-piece suits and bowler hats could be seen racing on foot down East Lake Drive, rods in hand, to the docks on Fort Pond Bay. In the early 1900s, striped bass tipping the scales at more than a hundred pounds were weighed in at the Fulton Fish Market in New York City. Sadly, fish of that size are no longer recorded. The current official world record is held by Al McReynolds for a 78-pound 8-ounce fish he caught on September 21, 1982, from a jetty off Atlantic City, New Jersey. These days, a surf-caught bass weighing thirty to forty pounds will usually win a local tournament.

The original range of the Atlantic striped bass extended from the Saint Lawrence River in Nova Scotia as far south as Florida (a separate population colonized the estuaries and rivers of the northern Gulf Coast). Then in 1879, a pioneering fish culturist and conservationist employed by the U.S. Fish Commission transported 132 striped bass fingerlings from the Navesink River in New Jersey by train across the United States in ice-cooled wooden barrels and milk cans, and released the fish in

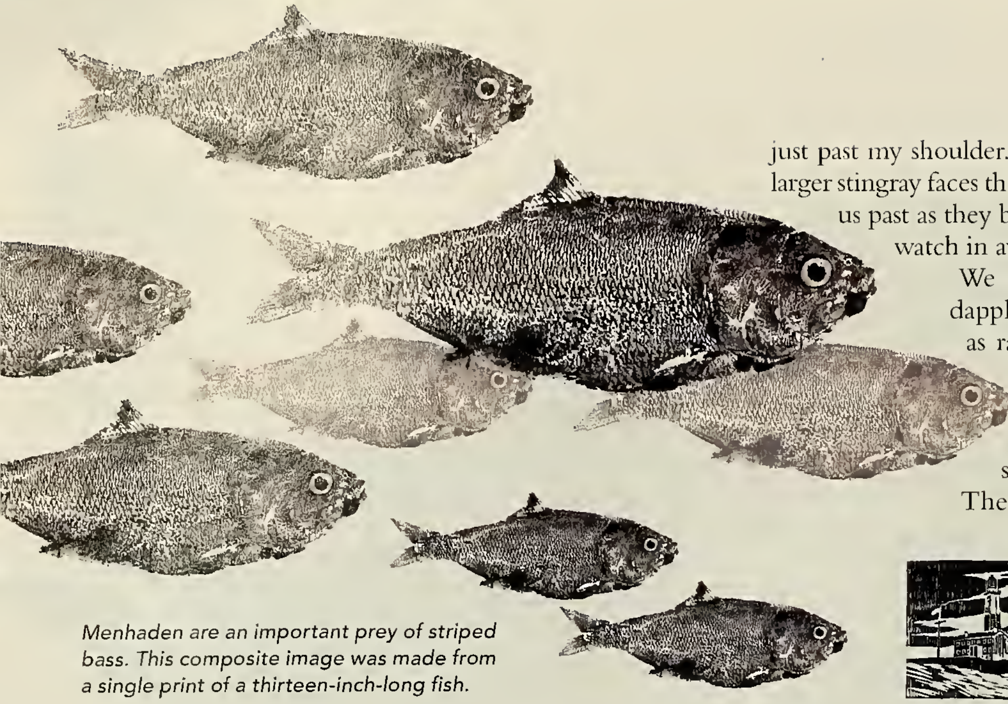
Striped bass is rendered as a gyotaku (fish rubbing) print. The craft, of Japanese origin, involves painting a fish with India ink and pressing a sheet of rice paper against it (the eyes, left blank, are then inked in by hand). This fish, caught at Montauk on June 24, 2008, was thirty-two inches long in life. Opposite page, below, and pages 34 and 35: wooden lures handcrafted by Steve Thurston.

San Francisco Bay, California. Within ten years, a new population was thriving in the Pacific.

Striped bass are anadromous, migrating inland each spring to spawn in freshwater rivers, such as the Hudson and the Delaware, before swimming back out to the sea and north to feed in coastal waters. In the Atlantic, the first fish arrive on the South Shore of Long Island at the end of April. Some continue north, but others take up residence in local waters. By early December, the bass have returned south to winter in more temperate zones, such as Chesapeake Bay.

Menhaden are their primary source of food, but striped bass are generalists, also feeding on crustaceans, mollusks, eel, fluke, herring, mullet, squid, and sand eel. They favor rough water and rocky structure, where they can outmaneuver a rich variety of prey. Those features define Montauk Point, Long Island, as one of the premier striper surfcasting locations in the country. The tremendous volume of water flowing out of Long Island Sound creates a whip-like current along that jagged terminus, making it among the most challenging waters to fish in the world.

MAY THE OCEAN TEMPERATURE IS just flirting with 60 degrees Fahrenheit this early in the season, but as the evening's last light fades, my friends and I can't wait to find the fish. Even augmented with a hooded, waterproof top, the chest waders worn by most anglers can be inadequate in the surf, so we don our full body, seven-millimeter-thick wetsuits along with spiked sandals over neoprene boots. We tuck a ten- or eleven-foot rod into a sturdy utility belt and clip on a small bag stuffed with the rest of our gear. Entering the water we scramble over slippery rocks, battle our way past the breakers, and swim out hundreds of feet to fish on gnarly subsurface rocks. It is here, under the cloak of darkness, tenuously suspended between sea



Menhaden are an important prey of striped bass. This composite image was made from a single print of a thirteen-inch-long fish.

and shore, that we have the best chance of connecting with quality fish.

Wetsuiting is growing in popularity among adventurous anglers, but it takes a strong swimmer to leave the refuge of the beach. When you are surrounded by rocks, the crashing surf can be treacherous. You must stay alert and use all your senses to remain upright. Only a few engage in the ultimate fringe of surfcasting: they slip on small fins, release their last foothold on the rocks, and swim out even farther, where they careen freestyle, to cast and fight fish midcurrent. The technique is called "skishing," a term derived from swimming, fishing, and skiing. It is a long way, as long as it gets, from the safety of the piers and party boats most anglers rely on.

About eight years ago, a wetsuiter who was skishing landed at an infamous perch at Montauk Point but then was swept off into the current. Thinking fast, he grabbed the heaviest bucktail jig from among his lures, tied it on, and dropped it down to the bottom, where it eventually snagged and held. He gripped his line tightly, signaled with his flashlight, and was finally picked up by a trawler, nearly two miles offshore.

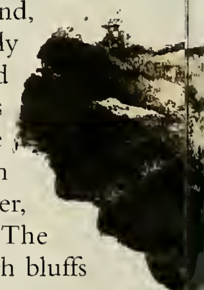
AUGUST STRIPED BASS ARE LESS active close to shore during the summer, so they are more challenging to find. One afternoon, when a friend and I are snorkeling in search of bass, he spots something and motions wildly for me to swim over. A long object, serrated near its base, rises up from the bottom. There, less than eight feet beneath us, is an eye the size of a grapefruit, looking out across the speckled sea floor. I have to shift my focus to see the other eye, it is so far away.

The creature is a rough-tailed stingray, well over five feet across, and its long tail bows up gently in the water column just past my shoulder. We quickly realize that another, even larger stingray faces the first, nose to nose. The current pushes us past as they begin to hover like large spacecraft. We watch in awe as they wing off silently.

We swim toward shore through water dappled by schools of bay anchovy known as rain bait. In the shallows, we feel the water temperature rise. I lift my head above the surface and pull up my mask. Montauk Point Lighthouse stands high above, on a cliff's edge. The Sun is setting; it's time to go fishing.

OCTOBER MIGRATION IS A stressful feat that requires tremendous stores of energy. Yet inclement weather that defeats the heartiest of mammals and birds seems to invigorate the striped bass. When most people take shelter, the leading edge of a storm draws anglers to the surf like a powerful magnet. Setting out in the dark, my surfcasting friends and I rush to Montauk to meet the onslaught of a powerful nor'easter.

The ground reverberates with pounding surf, and gale force winds bellow. Still, through the din, we hear the high-pitched chirps of migrating songbirds. As the Sun begins to rise, we can see them swinging westward across Block Island Sound by the hundreds. They land, exhausted, at our feet. I see one warbler quickly leap inside a small bush and tuck his head behind his wing to sleep. An eerie golden light emanates from a thin break in the steely clouds that line the horizon, and for the first time we see the battalion of waves rounding Montauk Point. Walls of water, ten feet high, culminate in white fiery crests. The beach is engulfed by a moon-tide flood, the high bluffs are lashed by chop and swells.



The barometric pressure drops like a stone as the storm makes landfall. Fishermen, like song- and seabird alike, are staging in flocks. When the waters draw back, surfcasters inch forward. In this wild surge and vaulting sea, the fish are biting. A friend, up to his shoulders in white water, heaves in a bass on the end of his line.

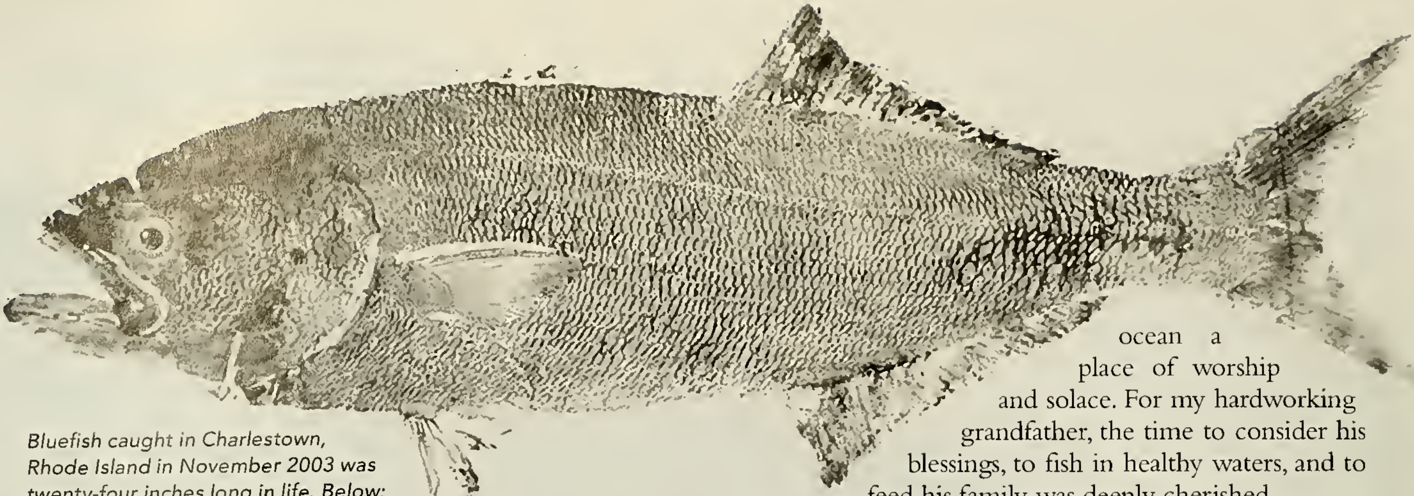
Steve Thurston, whose prints you see here, is also fishing on this day, outside of town. He packs a handful of favorite lures into a small bag that clips around his waist, which makes his surfside journey efficient and easy going.

In contrast with his streamlined approach, many of us pack our surf bags with every size, shape, and color of lure conceivable until the weight of it becomes prohibitive. Lures are often handcrafted by the most serious anglers. Like a waterfowl decoy, to be effective, a lure must be carefully designed. The angler turned artisan carves it from select wood, soaks it in linseed oil, through-wires it with sturdy steel, and coats it with a bombproof yet luxurious epoxy finish. The lure must be balanced and waterproof; it must survive the merciless battering of rocks. Above all, it must catch fish.

If you have a good set of hands you can lure in, hook, and land many fish on a simple bucktail jig. You make one by attaching a hook to a molded piece of lead for weight, and tying hairs from the tail of a deer (or a synthetic substitute) along the shank. For the final flourish, you attach a strip of pork rind, which waves enticingly behind the lure as you reel it in. According to Henry Cowen, writing in the online fly-fishing magazine Midcurrent, the bucktail is so effective that during World War II, each U.S. military pilot carried one, along with some fishing line, in his survival kit in case he was shot down over water.

For bait we carry rigged eels—dead eels sewn with steel hooks cinched in with dental floss—and as an alternative, live eels, carried in a mesh bag tied to our belt. We also carry pliers, a waterproof flashlight, and a length of thin rope called a stringer that we can slip through the mouth

Head of twenty-two-pound striped bass caught at Montauk on September 21, 2007, appears here approximately life size.

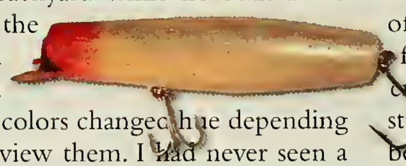


Bluefish caught in Charlestown, Rhode Island in November 2003 was twenty-four inches long in life. Below: a metal-lipped swimmer; opposite page: a pencil-popper.

and a gill in the event we want to carry a fish back from the beach. (Most often, we release them.)

Steve started fishing as a small child, on the freshwater ponds and rocky beaches of coastal Rhode Island. In recent years, he began to follow fish along eastern Long Island, many miles from his home and work as a scientific illustrator at the American Museum of Natural History, in New York City. Steve's grandfather Ben Thurston spent decades surfcasting on Cape Cod, Massachusetts. An enigmatic man, he camped along the outer beaches with a self-styled beach buggy converted from a U.S. Army pickup truck. He was not alone: by the late 1950s an entire subculture of traveling surfcasters had evolved. Today, from Gloucester, Massachusetts, down along every rip line and inlet to the Outer Banks of the Carolinas, that pilgrimage continues.

I grew up on the Great South Bay of Long Island. The first time I saw a striped bass, I was nine years old. Uncle Pete had caught a twenty-pounder, and it was laid out whole for dinner in the backyard while he built a fire under the grill. I studied the deep shades of maroon and chestnut along each gilded



stripe and noticed that the colors changed hue depending on the angle you took to view them. I had never seen a fish so large or so striking. Then, one early July morning, my father took me to Moriches Inlet in our Cape Dory. When I looked over the gunwale, I could see clear to the sandy bottom, nearly twenty-five feet below. A large striped bass was pointing into a fierce outgoing current. The torch was lit.

My grandfather John Hart also loved being on the water. He purchased a parcel of land on Brown's River in Sayville, Long Island, with a stretch of brackish shoreline that provided a perfect launch site for his eighteen-foot Jersey skiff. During the long striped bass fishing season, he was often moved to distraction by his desire to fish. My grandfather would sometimes disappear at sundown and not return to his bed until dawn the next morning. His wife, Marjorie, was a devout Catholic. It took her many years to understand that for her husband, fishing was also a religion, the bays and ocean a place of worship and solace. For my hardworking grandfather, the time to consider his blessings, to fish in healthy waters, and to feed his family was deeply cherished.

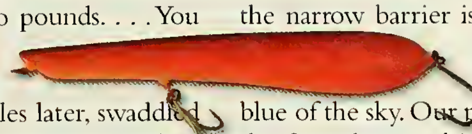
Steve and I must have that same passion for the water forged into our bloodstreams. Steve can hear the condition of the surf even before he steps out the door of his rented bungalow in Montauk. He sets off down the beach well before dawn, rod and reel in hand. If he is lucky, and he often is, he catches a bluefish, fluke, scup, sea robin, skate, weakfish—or striped bass. He rinses it in the wash and carries it home. There he places the fish on its side, paints it with India ink, lays down a piece of rice paper, and gently presses so that each of its scales will be imprinted. After a moment, he carefully peels off the paper and leaves it to dry. That technique, known as *gyotaku* (fish rubbing), originated in Japan as a means of recording a prized catch—a much less cumbersome method than taxidermy. Steve takes it further as an art form, later carving a woodcut to add an element of the local land- or seascape.

Once the fish print is made, dinner can be prepared. Steve relishes a freshly filleted striped bass or bluefish, splashed with lemon juice and olive oil and baked over a driftwood fire on the beach. That's one of the finest meals that can be enjoyed on any seaboard. My friends and I often bring an array of ingredients to the beach, including fresh lime, lemon, garlic, cilantro, chilies, and tomatoes to create a tasty seviche. My other grandmother would make stuffing out of duck sausage, homemade cornbread, and beach plums, collected fresh from the dunes of Fire Island. If her husband was lucky that week, that wonderful recipe would make its way into a striped bass for Thanksgiving. They used to call it a Long Island sea turkey.

Back in the 1960s, when I was growing up, Long Island's local bays and inlets still teemed with winter flounders, American eels, and horseshoe crabs. Pollutants such as the pesticide DDT, however, were devastating the local populations of osprey, great blue heron, and many other bird species. Less than a decade later, further environmental contamination had combined with the overharvesting of commercial fish, and striped bass were in steep decline. It took an abrupt turnaround in policy and practice—strict changes in state and federal regulation and an emergency fishing moratorium in some states—to bring the striped bass fishery back into balance, tenuous though it remains. It was a close call for the striped bass, and it could happen again.

The pressure from commercial and large-scale recreational fishing is an ever-present concern. Now, winter flounder is in jeopardy. Many surfcasters practice catch and release, so the fish can return to the sea. That simple act of stewardship is one of many that can yield sustainable rewards for all.

NOVEMBER A FRIEND AND I FISH HARD through a chilly sunset, 24 degrees Fahrenheit and dropping. We drive home, shake the sand and snowflakes out of our gear, and hang it up to dry. A full lunar eclipse is underway, and we stand in the yard looking up at the Earth's shadow until the cold drives us indoors. We are sound asleep when the phone rings after midnight. We both leap up, instantly alert. Anytime between May and December, a call at odd hours usually means just one thing: someone, somewhere has found the fish. This night is no exception. Our friend Ray is calling from the surf in East Hampton, excitement and wind fragmenting his every word. "Bass . . . peanuts, everywhere! Birds! . . . Weird light! Twenty-four fish up to twenty-two pounds. . . . You have to get out here!"



He hangs up without waiting for an answer. Forty-five minutes and forty miles later, swaddled in layers of winter woolens and fleece beneath our waders, we hit the beach running.

In the time we've taken to pack and drive east, the lunar eclipse is ending and the Moon gives off a potent silvery light. In a highly unusual display of nocturnal activity, a cyclone of gulls emerges to feast on thick schools of young menhaden ("peanuts") driven into the shallows by large schools of migrating bass and bluefish. A confluence of factors drives this behavior: a light north wind laying down the waves, the shorter days, the combined lunar and solar pull of a "spring" tide, and instinct. In a series of whitewater explosions, striped bass break the surface and chase a bright spray of menhaden up onto the sand at our feet. Ray tosses a new lure onto the beach amid the peanuts and grins. "Use this," he says enthusiastically. It's a perfect match for the baitfish.

Amid the inferno of white wings, the shrill cries of gulls pierce the icy air as I cast out. The rod jumps forward in my hand and line screams off my reel. Off to my left, three friends lean back, their rods bent over with fish. Our pulses race. Westward down the beach, receding waves sift back through the sand. In their oscillating wake, a constellation of menhaden glitter in the sand as far as the eye can see. It's like fishing on the edge of the Milky Way.

DECEMBER IT IS THE END OF THE BASS season and the migrant birds from farther north are settling in. A friend and I are up early to search for a winter resident we eagerly await each year. Snow buntings dip through the air and land to forage in the wind-sculpted dunes of Fire Island. Surf clam, oyster, and scallop shells lie strewn on the outer beach. Two herrings gasp, red-eyed, on the wet sand. Both are freshly and deeply notched, where the jaws of large bluefish narrowly missed their hold. A single starfish glistening in the rinse is spotted by a great black-backed gull; startled by a crashing wave, the bird leaps aside, wings held high. A delicate ripple of departing menhaden flashes up from behind the wash and then disappears. Spring will come soon enough, and with it, I hope, healthy new and old generations of finfish.

Heavy fox tracks lead a deep drag mark up from the water's edge and behind the gray arc of an old oak, worn smooth and nearly buried in the sand. The vixen's reddish tail flicks as she pivots intently around something at her feet. We sneak up to investigate, but she vanishes. Behind the bough, the drag mark fades into the dune grass. The sand shimmers with fish scales.

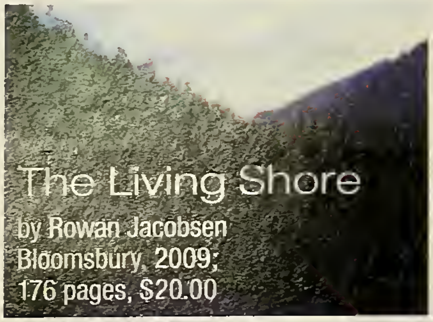
From this high vantage point, we look eastward down the narrow barrier island. A flock of black ducks rises up from the bay to the north, their dark wings contrasting with the rose-tinted blue of the sky. Our path along the dune descends to where the frosted ground is matted with shadbush, bayberry, and goldenrod. Here, on the edge of the Atlantic, we wait. Only the quick turn of a long brown ear, the mirror of dark eyes, transforms some of the winter foliage surrounding us into the six-point antlers of a regal white-tailed buck.

At this hour of the morning, the Great South Bay before us is merely an illumination, mirroring light in all directions. The Sun climbs higher in the sky, but the wind chill is close to zero. Beneath an osprey nest that fledged two chicks this year, a great blue heron is poised to spear. The broad crown of intertwined branches supporting the nest has held strong through a season of fierce northeasterly winds. In March, if all goes well, the pair will return from their South American wintering grounds to this same nest.

Then, on the far northern horizon, a speck appears. We take a sudden deep breath of the December air. Even at this great distance, the eagle reveals itself with its long, slow wingbeats.

Margaret Hart is an ornithologist who lives on Long Island. **Steve Thurston,** who earned a Master of Fine Arts from the San Francisco Art Institute, is a scientific illustrator in the Division of Invertebrate Paleontology at the American Museum of Natural History in New York City. See more of his work at www.fishprintsite.com.

BOOKSHELF BY LAURENCE A. MARSCHALL



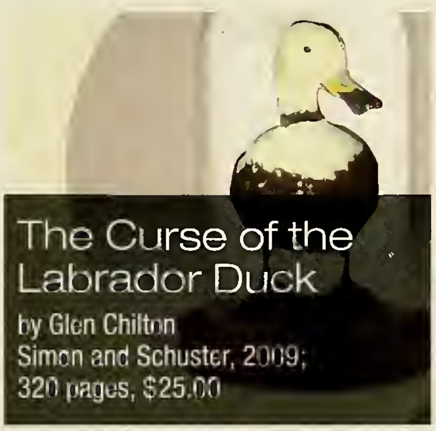
From where I sit reading *The Living Shore*, it looks as if Rowan Jacobsen has the ideal job. He's already won one of the James Beard Foundation Awards—the so-called Oscars of the food world—for his 2007 book *A Geography of Oysters*, which no doubt involved considerable gustatory research on the mouthwatering mollusks. Then in 2008 he signed on as the literary chronicler of a nine-member expedition to the pristine coast of British Columbia. Their mission: find a thriving bed of Olympia oysters (*Ostrea conchaphila*), known locally as Olys, as part of an effort to restore the native ecosystem of Puget Sound, including a sustainable shellfish industry. What a job for a nature/food writer! Fresh air, beautiful scenery, and all the seafood you can eat.

Olys, smaller cousins of the oysters I enjoy each year on Cape Cod, were once abundant all along the Pacific coast from Panama to Sitka, Alaska. They were a staple food for natives, who left behind shell middens occasionally as big as high school football fields. (Appropriately, Jacobsen calls oysters "the ham sandwich of 1000 B.C.") The hordes of prospectors who flocked to California in the mid-1800s feasted on Olys, too, and enterprising oystermen found the shellfish beds a surer way to riches than the goldfields. But overharvesting wiped out one rich shellfishery after another. The coup de grâce for the Oly came in the late 1920s, when industrial pollution and cold weather decimated the last remaining native oyster communities of Puget Sound and British Columbia. Larger and hardier breeds of oyster have been introduced successfully to North America's Pacific coast, but only a few scattered colonies of the Olympia oyster remain. A shame, writes Jacobsen, because their "coppery, smoked-mushroom sweetness is unlike anything else in the world."

It's not giving away any punch lines to reveal that Jacobsen's expedition found a remote estuary off the coast of Vancouver Island that is literally paved with Olympia oysters, and that the resulting ecological data may provide the key to a resurgence of the species in bays and raw bars along the Northwest coast.

But Jacobsen's experience also provided him with food for thought. Just as agriculture led to the spread of civilization in the Old World, he believes, aquaculture may have spread civilization in the New World. Recent archaeological work in British Columbia suggests that the first humans to cross the Bering land bridge during the last ice age thrived on shellfish. Their high nutritional content may also have aided in developing the prodigious brains of *Homo sapiens* during a far earlier ice age, along the coasts of southern Africa.

Jacobsen is doubtless right that shellfish played an important role in the diet and culture of the past. And he's equally persuasive in urging the preservation and protection of native shellfish habitats. (As a spur to action, he provides a substantial appendix listing organizations devoted to this task.) So if he sometimes seems to be taking things to extremes, regarding humans as creatures created for the shore and by the shore, you may be inclined to indulge him. After all, the oyster is his world—and the world, it seems to me, is his oyster.



The Curse of the Labrador Duck
by Glen Chilton
Simon and Schuster, 2009; 320 pages, $25.00

Don't blame the Labrador duck for Glen Chilton's mild insanity. All the creature wanted to do was to fill its ecological niche as an ordinary working seabird, spending summers in northeastern Canada and winters along the mid-Atlantic coast. And that was life for the Labrador duck, century after century. Beyond that, nobody knows much about the Labrador duck because not a single live specimen has been seen since 1875, when one was shot near the shore of Long Island, making it the first endemic North American bird species to be hunted to extinction.

No, the source of this morbid fixation is all Chilton's. An ornithologist, recently retired from St. Mary's University College in Calgary, Alberta, he normally studies bird behavior. Some time ago, on a lark perhaps, he got it into his head to become the Boswell of the Labrador duck. That entailed examining, in person, all the extant evidence of its existence on our planet, to wit: nine alleged Labrador duck eggs and fifty-some stuffed ducks and skins, scattered around the museums of North America and Europe. And thereupon hangs a tale, or rather many tales. (Perhaps this is the place for a warning: any wordplay you may note in Chilton's book, or in this review for that matter, is definitely intended.)

Chasing dead birds can be an expensive and time-consuming occupation, but not one likely to be supported by research grants. So Chilton, with the help of his wife, Lisa, who is also an academic, managed to make professional conferences and family vacations serve double duty as Labrador duck-hunting expeditions. Over the years, he visited collections in enough cities to qualify him for frequent-flyer tickets to the Andromeda galaxy and back. There's a certain dramatic satisfaction in seeing him tick off one bird on his list after another, and discovering that at least one is a fake—a white domestic duck painted to look like its Labrador relative. But after a while one bird blends into another, and you begin to lose track . . . was it the duck in Prague, St. Petersburg, or Dresden that lost its tailfeathers when it was looted by the Russian Army at the end of World War II?

The stuffed ducks, it turns out, serve mainly as foils for Chilton's wisecracking travelogue, an amusing blog of his opinions, his encounters with odd characters, his travails with foreign languages, and a potpourri of factlets about the places he's been. For instance, when Chilton visits the Horseshoe Bar at the Shelbourne Hotel in Dublin, he is told that James Joyce hung out in the joint, "although I suspect he didn't do a lot of his best imbibing there, having died several years before it opened." And of his visit to a museum on Grand Manan Island, New Brunswick, he writes: "In glass jars, we saw some preserved invertebrates, the eyeballs and kidneys of a seal, and the dung of a right whale. It might easily have been the vomit of a right whale, and I had to wonder who had collected it, why, and how."

The upshot of all this is a book that will tell you almost everything science now knows about Labrador ducks, which is not very much, and a little bit about a lot of destinations from Halberstadt, Germany, to Falkirk, Scotland, to La Châtre, France. In sum, Chilton's quest makes entertaining reading, even if it ultimately turned out to be, shall we say, a bit quacksotic.

Mr. Jefferson and the Giant Moose

by Lee Alan Dugatkin
University of Chicago Press, 2009; 192 pages, $26.00

According to Wikipedia, an adult male moose measures six to seven feet tall at the shoulder and weighs as much as fifteen hundred pounds, making it second only to the bison as the largest land animal in North America. But when the curator of France's Royal Botanical Gardens, Georges-Louis Leclerc Buffon, was compiling his influential *Histoire Naturelle,* published in thirty-six volumes between 1749 and 1788, information about moose was not a mouse click away.

Naturalists such as Buffon relied on two primary sources of information: specimens that survived the rigors of a transatlantic voyage, and accounts of traveling naturalists, most of whom were amateurs. Unaware of how fragmentary and misleading that evidence was, Buffon proclaimed that the New World was naturally "degenerate." It had no beasts as large as an elephant nor as noble as a lion, and where similar creatures existed on both sides of the Atlantic, the American species were smaller, weaker, and less energetic—largely as a result of the debilitating atmosphere they lived in. Even the Indians were a degenerate form of humans: slow-witted, unemotional, and sexually stunted. To French readers, that was a congenial notion. They'd known in their hearts that Europeans were superior; Buffon assured them that this was a law of nature.

Citizens of the newly liberated United States, however, read Buffon with astonishment. They might laugh at his inaccuracies, but they were also politically outraged. The notion that theirs was anything but a land of wealth and opportunity was not only false, but was also harmful to the nation's social and commercial development. Alexander Hamilton, in *The Federalist Papers,* mocked the Europeans for suggesting "that even dogs ceased to bark after having breathed awhile in our atmosphere." James Madison, John Adams, and Benjamin Franklin attacked Buffon and his followers in numerous letters and articles, and Thomas Jefferson devoted a major part of his *Notes on the State of Virginia* to establishing the falsity of the degeneracy theory. The founding fathers may have seen it as a matter of getting the science right, but from a twenty-first-century viewpoint, it seems like the first round of a European–American culture war that still surfaces from time to time in battles over Big Macs in Paris and "Freedom Fries" in the Congressional cafeteria.

Where does the moose come in? According to Lee Alan Dugatkin, a professor of biology at the University of Louisville, Jefferson conceived the notion of sending a specimen of a moose to Buffon, hoping that it would provide clear proof that America's creatures were every bit as large and vigorous as Europe's. And he succeeded, with the help of correspondents in New England, who arranged to kill a moose in Vermont, cart it to the coast, and ship its skeleton and skin to Paris, where it arrived around October 1, 1787. Unfortunately, Buffon died within little more than a year of the moose, writing nothing more on the subject, so we will never know if he was convinced of the error of his ways.

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

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SKYLOG BY JOE RAO

In the Northern Hemisphere, the autumnal equinox is a September event: this year it came on the 22nd in the eastern time zone, though other years it may fall on the 23rd or, rarely, on the 21st. The full Moon closest to that equinox is traditionally called the Harvest Moon. Most often the honor goes to a September Moon, but every three or four years the closest full Moon occurs in early October—as it does this month.

Another autumn highlight in the more northerly latitudes is the departure of vast numbers of birds on their flights south to warmer climes. Most songbirds migrate at night. How do they find their way? A Cornell University study conducted in the late 1960s under the artificial skies of a planetarium strongly suggested that the indigo bunting, for one, uses the stars as a guide. The experiments indicated that indigo bunting nestlings learn to recognize star patterns that revolve closely around the celestial pole—such as the Big Dipper—and subsequently use them for orientation.

Birds that migrate at night use other cues as well. Even under heavy cloud cover, large flocks follow a direct course, as radar operators have often detected. The birds

JOE SHARKEY AFTER NASA

may be guided by Earth's magnetic field, olfactory cues, and learned landmarks, all on top of genetically programmed predispositions.

Absent radar, ornithologists have developed a way to study nocturnally migrating birds called "Moon watching." They train small telescopes on the full or gibbous Moon and tally their quarry as it passes in fleeting silhouette. Their most celebrated discovery using that method answered a long-standing question: do birds migrate nonstop for hundreds of miles across the Gulf of Mexico? Many land species do.

Although the Harvest Moon will be an obstacle to stargazers, birdwatchers will be scanning it to glimpse otherwise secretive wayfarers on their marathon journeys.

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

OCTOBER NIGHTS OUT

4 The Moon waxes to full at 2:10 A.M. eastern daylight time (EDT) (see story above).

5 Mercury is at its greatest western elongation, 18 degrees from the Sun, making it easily visible for viewers near 40 degrees north latitude. It rises due east an hour and a half before sunrise, 6 degrees below and slightly to the left of far more brilliant Venus. Dimmer than Mercury, Saturn rises 3 degrees below and slightly to the speedy planet's left.

8 This morning Mercury and Saturn are separated by only three-tenths of a degree, with Mercury below and to the ringed planet's right. Venus shines brightly above and to their right.

11 The Moon wanes to last quarter at 4:56 A.M. EDT.

13 Venus and Saturn rise before the first glimmering of dawn, separated by only one-half degree. Nearly 100 times brighter, Venus sits below and to the right of its ringed companion.

18 The Moon is new at 1:33 A.M. EDT.

21 With the Moon absent from the morning sky, viewing conditions are favorable for the annual Orionid meteor shower, so named because its radiant, or apparent source, lies in Orion. The time to observe is after midnight, preferably for the hour or two before dawn, when the radiant is highest above the horizon.

25 The Moon waxes to first quarter at 8:42 P.M. EDT.

26 Sitting in the south as darkness falls is the Moon, to the right of and somewhat above brilliant Jupiter.

MEDICAL EXAMINER

Continued from page 20

idea that so was the development of uterine gestation in mammals. Villarreal argues that the origin of the cell nucleus, which differentiates eukaryotes from prokaryotes, could have been the result of viral invasion. And almost at the other end of our evolutionary history, he wonders about the role of viruses in creating traits that make humans different from chimpanzees. Could the development of our capacity for language have been a virally mediated event?

It's not news that viruses have the ability to alter surprising aspects of their host's lifestyles; Villarreal cites the way in which DNA viruses alter the reproductive habits of some wasps. He suggests that schizophrenia—a uniquely human disease that, like language, involves brain lateralization—may be viral in origin, noting the extent to which retrovirus-like material appears to be expressed in affected parts of the brain. Cause and effect are opaque here; this is an association rather than an established causal link. But there are grounds to wonder.

A viral origin for schizophrenia and language—the insertion of a complex package of genetic changes, difficult or impossible to separate out from one another, prompting both our capacity for thought and our susceptibility to the disease—could fit. Just as the border between infectious and noninfectious disease is sometimes blurred, so, too, is that between imagination and delusion. A built-in propensity for mental illness seems paradoxical. Then again, so does suggesting that destructive viruses may be the creative engines of our evolution.

Druin Burch is a medical resident and a tutor at the University of Oxford. His first book, Digging Up the Dead *(2007), profiles the pioneering surgeon Astley Cooper; his second,* Taking the Medicine *(2009), is the story of how doctors have historically killed more than cured, but have finally learned to improve.*

EXPLORER GUIDE

Prepared parts of the mammoth mandible (lower jaw) from the Thomas Jefferson School of Law site, positioned in the Museum's PaleoServices Department's laboratory sand box.

Fossil Discoveries in Downtown San Diego

Part II

By N. Scott Rugh, Collections Manager, Fossil Invertebrates

Within the past few years, field staff from the PaleoServices Department of the San Diego Natural History Museum collected the first fossils of mammoths in downtown San Diego. In the summer of 2007, an eight-foot-long tusk was removed from the future site of the Saint Vincent de Paul Village high-rise at the corner of 16th and Market Streets.

In December 2007, while monitoring the excavation of a bore hole at the SDG&E Silvergate Substation near the San Diego Bay Harbor, Field Paleontologist Pat Sena recovered a short section of another tusk.

At the 16th and Market project site, mammoth fossils were found in sediments where no shell beds were found. At the Silvergate Substation, the auger bit that retrieved the tusk fragments mixed sediments from different layers together as it bored through them. It was not possible to go into the hole to obsetve the sediments, but from street level, shell layers including pectens were observed above and below the tusk.

Of the seven discoveries which included the remains of tusks, three were found in downtown San Diego and the harbor area to the immediate southeast.

Other fossils were found downtown before the mammoth fossils were discovered. During the first few years of collecting fossils from the many project sites within the East Village area, thousands of fossil shell specimens were collected, most commonly from the Pecten Bed. However, very little was found in the way of vertebrate fossils, aside from occasional small shark teeth and small fossil elements from other fish species. Also, the fossil plates of a barnacle species that only lives on sea turtles provided evidence that sea turtles were present in the prehistoric Pleistocene bay as well.

On March 29, 2004, during excavation for the Metrome housing project, a partial camel jaw was found by Excavation Operator Jose Morales. In addition, other small vertebrate fossils, including shark, bird, rodent bones and teeth, and an Antilocaprid (pronghorn family) partial tooth were found by PaleoServices field collectors within the Broadway Faunal Horizon beds.

The site of the Thomas Jefferson School of Law is located on the same block at 12th and Island Avenue where the Metrome was built. In January of 2009, excavation began on the project, and a paleontologist from the Museum began to monitor the location for fossils. In early February came the first of several incredible discoveries: 20 feet above sea level (about 23 feet below street level), Pat Sena discovered two tusks and a skull of a mammoth in the southeast corner of the project site. The elements of this spectacular fossil find were lying directly on top of the pecten shell bed of the Broadway Faunal Horizon. The sediments containing the mammoth fossil contained no shells and had eroded into the Pecten Bed. This was the first skull of a mammoth ever found in San Diego County. Thus, not only did we have one of the most important vertebrate fossil discoveries ever made by the PaleoServices Department, we also were able to document the relationship of the deposit containing the mammoth fossils with the Pleistocene shell deposit, well-known in downtown San Diego. Within a little over a year the total number of sites where fossil remains of mammoths have been found in San Diego County increased from 10 to 13. Of the seven discoveries which included the remains of tusks, three were found in downtown San Diego and the harbor area to the immediate southeast.

Three weeks later, when Pat Sena informed the Paleontology Department that grading had uncovered the bones of a large whale, it was almost impossible to believe. In the same southeast corner of the project site, about 10 feet below the spot where the mammoth bones had been excavated and collected, another extremely important vertebrate discovery was made. According to Dr. Tom Deméré, the bones of a Gray Whale (*Eschrichtius robustus*) or a very closely related ancestor were uncovered—including a lower jaw bone, skull fragments, shoulder blade, and other diagnostic bones. The Paleontology Department has collected fossil bones of a number of other whales from Pliocene-age deposits (about 3.5 million years old) in San Diego County. However, the fossil whale found at the Thomas Jefferson School of Law is the first Pleistocene-age whale found in San Diego County (about 0.6 million years old), and only one of a few whale fossils from the Pleistocene in southern California. Whereas the mammoth was carried into the environment where the shell bed existed (probably with river sediments), the whale was deposited on the bottom of a deep bay and was directly incorporated into the sediments of that environment, tens of thousands years older than the bay environment that the mammoth remains were carried into.

With each of these fossil discoveries, almost every staff member of the Paleontology Department worked in the field to unearth the bones, and prepare them for transport to the Museum warehouse where they were temporarily stored before being relocated to the Museum. With each new fossil discovery, several days were required to plaster jacket and transport the very large fossils from the project site, yet this was relatively quick and efficient in relation to the total work schedule for the project. Even though the fossil bones of the mammoth and whale have been removed from the Thomas Jefferson School of Law job site, a great deal of work still needs to be done in the laboratory to complete the preparation of the fossils, and this work could last the better part of a year. When completed, the fossil discoveries made at the Thomas Jefferson School of Law will be a fantastic addition to the San Diego Natural History Museum's Paleontology collections.

Photos by Kesler Randall and Sarah Siren of the Museum's PaleoServices Department.

San Diego Natural History Museum field paleontologists mapping bones at the Thomas Jefferson School of Law construction site. Underneath the grid is a tusk (upper) and atlas vertebra of a mammoth (lower right).

LA Times Takes on the San Jacinto Centennial Resurvey

(l-r) Mule Packer Tom Firth, Student Assistant Nick Smith-Herman, Photographer Myung Chun

In June, a reporter and photographer with the *LA Times* accompanied Museum scientists as part of the Museum's ongoing San Jacinto Centennial Resurvey project. A month later, a story appeared in the front section of the *LA Times*, with corresponding online coverage including a video of the journey, photos, and more. Curator of Herpetology Bradford Hollingsworth, who was on the expedition, had the following to say about the news coverage and his experience with Louis Sahagun, the main writer of the story:

> The San Jacinto Centennial Resurvey has been such a great project and I'm thrilled to see it get the needed attention (*LA Times* is the fourth largest paper in the U.S., behind *USA Today*, *Wall Street Journal*, and *New York Times*). The project really suits our core research mission.
>
> Louis Sahagun is a true-to-life spokesperson for the environment who has worked at the *LA Times* since the 1970s, starting as a copy boy and working his way up to a newsman. In the field, the reporters had the motivation to climb Devil's Slide Trail, up 2500 feet from the base, plus another traverse once on top. Both carried their own backpacks—the video reporter, Myung Chun, even carried a backpack filled with heavy camera equipment. Both had to keep up with the multiple research groups—mist-netting birds at 5 AM, checking small rodent live traps at midnight, and hiking all day to keep up with Lori Hargrove, as Lori completed elevational transects to the summit of every major and minor peak in the area. At the end of day, Louis was describing Phil Unitt, Curator of Birds and Mammals, as the modern-day "Indiana Jones" and that he is the "real deal" of modern environmental science.

To read the *LA Times* article and watch the video, visit http://bit.ly/rxQC7.

Help Fulfill Our Mission!

The San Diego Natural History Museum's mission is to interpret the natural world through research, education and exhibits; to promote understanding of the diversity of southern California and the peninsula of Baja California; and to inspire in all a respect for the environment. A gift to the Annual Fund is a gift toward fulfilling that mission—from start to finish. Annual Fund contributions are used to support important needs such as critical research projects—like the San Jacinto Resurvey—or helping thousands of students visit the Museum each year. Your Annual Fund donation is 100% tax-deductible, which means you are supporting the Museum in the most generous, philanthropic way. Make a gift today online at www.sdnhm.org or by calling 619.255.0172.

October Program Picks

Growing a Social Movement to Change the Food System

Lecture with Erika Lesser, Executive Director of Slow Food USA
When Slow Food was founded in 1989, it quickly got a reputation for long lunches, abundant wine and a utopian view of gastronomy. Over the past 20 years, the organization has grown dramatically in both size and scope, linking the pleasure of food with a commitment to community and the environment. Learn what Slow Food is doing in the U.S. and around the world to move us toward a food system that is good, clean and fair—and to a society in which food is both a universal right and a pleasure. Part of the Museum's Sustainable Planet: Food Lecture Series. $5 per lecture.
Tuesday, October 6; 6:30–8 PM

Close-up Flower Photography

Capture the essence of flowers with 35mm macro photography and learn to create high-quality close-up nature images. A tripod and a camera with interchangeable lenses (digital or film SLR) are required. A macro lens and/or supplemental close-up lenses or zoom lens with macro capability are also necessary to get the full benefit from class. Member $89; Nonmember $99.
Classes: Tuesdays, October 15 and 22; 6:30–8:30 PM
Field trip: Saturday, October 17; 8 AM–4 PM

Close Encounters with the Wondrous

Amazing! Stupendous! Electrifying! A cast of thousands… of legs! Curator of Entomology Michael Wall, Ph.D., and Research Library Director Margi Dykens join forces to bring you the *Theater of the Insects*, a rare look behind the scenes at the Museum's incredible insect collection, as well as rare books about this most diverse and bizarre group of animals. Member $25 per adult; Nonmember $33.
Tuesday, October 20; 6:30–8 PM

For more information or to register for programs, visit www.sdnhm.org or call 619.255.0203 (M–F).

We're Number One!

The San Diego Natural History Museum was voted "Best Museum in San Diego" in a recent *Union-Tribune* contest. And with this year's fabulous line up of films, exhibitions and programs, we think we'll stay in first place in the minds and hearts of San Diegans.

May we suggest membership to the "Best Museum in San Diego" as a perfect gift for the person or family that has everything? A membership to the San Diego Natural History Museum not only supports the Museum's innovative education programs, wonderful exhibitions, and our great scientific research, but is also a gift that keeps giving, 365 days a year! All gift memberships include a special gift package and letter with your personal message. Give the gift of nature today; call 619.255.0275 for more information.

P.S. Don't forget to gift yourself by renewing your membership.

b

Spinose projections above the rudimental valves; at the bottom of the figure are represented, as seen through the whole thickness of the animal, the prehensile larval antennae.

a

Orifice of the sack of the male.

PLATE *Ibla Scalpellum*

FIGURE 9

Complemental Male of *Scalpellum vulgare*, attached over the fold in the occludent margin of the scutum of the hermaphrodite.

d

The depression for the attachment of the adductor scutorum muscle of the hermaphrodite; see fig. 15a′.

e, e

A transparent layer of chitine, which forms a border to the occludent margin of the scutum of the hermaphrodite. This border supports long spines which are connected with the underlying corium by sinuous tubuli.

This page, part of a series of twenty-four original drawings for the planned book *Barnacle Codex*, was designed to inspire appreciation of Charles Darwin's eight years of intensive research on barnacles.

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FIGURE 15a′

Scutum of the hermaphrodite *Scalpellum vulgare*, internal view of.

a

Fold on the occludent margin.

Pit for the adductor muscle.

By Julie Rauer 1.20.09


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MILGAUSS
SUPERLATIVE CHRONOMETER
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