NATIONALGEOGRAPHIC.COM/MAGAZINE | FEBRUARY 2009

NATIONAL GEOGRAPHIC

What Darwin Didn't Know

- HIS FIRST CLUES
- EVOLUTION NOW

NATIONAL GEOGRAPHIC

FEBRUARY 2009 · VOL. 215 · NO. 2

CHIEN-CHI CHANG

Smuggled into a safe house in China, North Koreans fear that if their faces are seen, they might be caught—or family at home might suffer.

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

NATIONAL GEOGRAPHIC

DEPARTMENTS

On the Cover

The *Scinax littoreus* lives in the rain forests of Brazil, which Darwin visited in 1832.

Photo by Mattias Klum

ngm.com

Darwin's Delay

Why did he wait 20 years to publish his revolutionary theory of evolution—and what finally pushed him to go public? Author David Quammen sheds light on the mystery.

DARWIN ONLINE

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EDITOR'S NOTE

Sometimes it takes the worst to see people at their best. For Bobby Model, a photographer who has worked for this magazine and a world-class climber, the worst happened two years ago while traveling in Cape Town, South Africa, with his sister, Faith. A concrete block crashed through the windshield and struck his head, causing massive brain injuries. Doctors doubted he would survive. Though never solved, the case was investigated as an act of random violence. That's the darkest side of humanity.

Photographer Bobby Model and his sister, Faith, spend as much time together as they can.

Now, here's the best. Witnesses fled except one man, who stopped, called an ambulance, and made sure Bobby got to the best hospital. "He saved his life," his mother, Anne Young, said. Bobby Model, veteran of many mountaineering expeditions, embarked on the longest expedition of his life. After a month, still in a coma, he was flown to New York City for surgery, then to Denver's Craig Hospital for rehabilitation. His family is his center of gravity, of course; his sister says it's a gift to be there for the person you love. But Bobby's big heart touched many, and many reached out in return. Schoolchildren in his hometown of Cody, Wyoming, sent cards. A blog for climbers posted a thousand messages. Friends flew in to visit, surrounding him with love.

"Sometimes I have to kick myself when I take my life for granted," Bobby once wrote. "I've been fortunate to witness so many amazing human moments." Now, Bobby's drive propels him from one amazing moment to the next. "You see it in his eyes," his mother said. "He is figuring it out." He gets around in a wheelchair, talks, and laughs. He snaps with a point-and-shoot in his right hand, and, because his left hand lacks strength, the staff at Craig will rig a bigger, heavier camera on his wheelchair. The expedition continues. There is far to go. "But he is so much with us now," Anne Young added. "He shows a sense of humor and sweetness that is pure Bobby."

Recently, he wrote his friends:

OK, everybody you can stop crying for me now. Thanks, though.

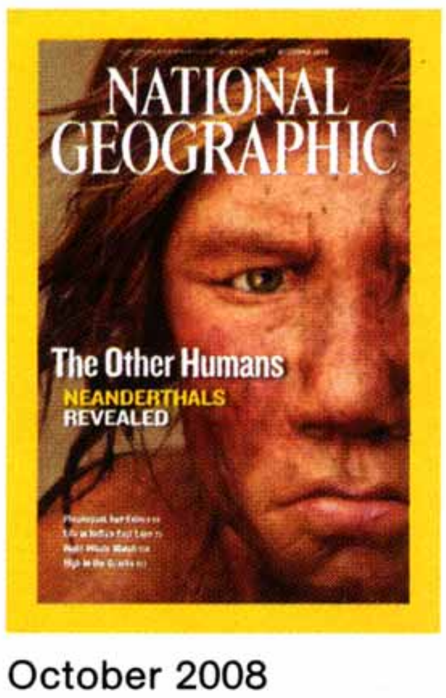
Love, Bobby

PHOTO: RICH CLARKSON

Inspiring people to care about the planet

The National Geographic Society is chartered in Washington, D.C., as a nonprofit scientific and educational organization "for the increase and diffusion of geographic knowledge." Since 1888 the Society has supported more than 9,000 explorations and research projects, adding to knowledge of earth, sea, and sky.

LETTERS



October 2008

FANS NATIONAL GEOGRAPHIC 国家地理爱好者网

Last of the Neanderthals

Thank you for not doing the expected—for not following a hundred years of tradition, for not making your Neanderthal reconstruction a male. This made the article and accompanying photos and illustrations enormously more interesting and thought provoking. And here's to hoping that there's a whole generation of girls out there who don't even know why I'm thanking you.

CHERYL ANN NOVICK
Kansas City, Missouri

The artists did a fine job of fleshing out a Neanderthal female and showing us what she possibly looked like. My problem is that she looks just like one of us. In my small hometown in northern California, I have seen females of northern European, Iberian, and Native American ancestry who look remarkably like her, including the receding chin, heavy build, and heavy browridges. One can find humans with heavy browridges, sloping foreheads, receding chins, and short, squat, barrel-chested, heavy-boned builds in almost every population one cares to examine. I know there are differences among the skeletal remains of Neanderthals and many modern humans, but I wonder just how significant those differences really are.

GAIL STUMPF NSENTIP
Fort Bragg, California

I find it laughable that we still try to compare "average human" features to Neanderthals. I am of European and Native American descent. I'm green-eyed, five feet one inch tall (shorter than your average Neanderthal), and stocky, with large cheekbones, a wide nose and facial features, and wide, deep-set eyes. From that description I probably sound hideous and not far from the look of the re-created Neanderthal myself. Barring the slightly rounder nose, she, in fact, looks like a much older, red-haired, grumpy, and worn-out version of me!

MELISSA WIDMAIER
Mesa, Arizona

I had to howl with laughter when I saw the photos of the naked Neanderthal woman. As a lifelong nudist, I've seen tens of thousands of naked people in many countries at many different naturist and clothing-optional venues, and I've seen modern humans who are shaped exactly like that nude Neanderthal woman in your issue. Apparently Neanderthals are not extinct after all. They congregate at nudist resorts.

JEFFREY VAN MIDDLEBROOK
Pacific Grove, California

It struck me that one of the reasons for Neanderthals' demise was lack of food, which was not helped by their enormous requirement for calories—around 5,000 a day compared with our 2,000 a day. They were a small population. We are an enormous population with a food supply that is heavily dependent on fossil fuel, which is running out. Maybe there is a lesson to be learned from our distant cousins.

DAVID S. CRAWFORD
Denbigh, Wales

Is it not possible that Neanderthals may have been infected by diseases carried by modern humans? After all, up to 90 percent of the Native American population in regions of first contact with Europeans died as a result of infectious diseases for which they had no immunities. If this were the case with the Neanderthals, it would have taken them below the critical mass needed to ensure their ability to reproduce, hunt for food, and defend themselves.

DONALD L. STOVALL
Fremont, California

Anyone who doubts that Neanderthals interbred with modern humans has obviously never seen a professional football or hockey player. When the Neanderthal genome is finally sequenced, comparing it with samples from these "modern humans" should remove all doubt.

JOHN YOUNG
Hermosa Beach, California

Contact Us

Email ngsforum@ngm.com
Write National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

That was Grandma looking out at us from the cover of the October issue. Just go to a flea market in Ohio in July and you will see her descendants.

FAITH CORRIGAN
Willoughby, Ohio

The Neanderthal researchers are smart people, so I'm sure they thought of this. Political correctness being what it is, I guess they could not mention it. But it's clear what probably happened. The Neanderthal women started going out hunting with the guys, researchers say, to put better cuts on the table. Maybe they liked hunting better than being stuck back at the cave with the kids. Lacking high-quality, subsidized child care back at camp, they decided to cut back on having babies. Fecundity dropped below the replacement level, which had to be pretty high in those days, and bingo—extinctionville. Women's lib did them in.

MIKK HINNOV
Bridgewater, New Jersey

India's Fast Lane to the Future

India's Golden Quadrilateral has proved to be a great leveler in a country with wide gaps in austerity and prosperity. It has brought far-flung areas into the mainstream. It is a living example for all the emerging economies to pave the way for development by reducing the urban-rural divide. After the completion of east-west and north-south corridors, India is expected to be on the fast track, both literally and metaphorically.

SEEMA MALIK
Ludhiana, India

I can look back over 70 years and comment on India's roads of bygone days. I was born in India in 1931. A simple trip of about 50 miles in our 1929 Model A touring car, from my southern India birthplace of Bobbili to my father's outstation in Palkonda, took from dawn to dusk. Potholes were hardly the problem. We faced such things as bridge washouts, culvert pipes removed to augment the efficiency of village wells, two-hour dust storms, chickens, geese, pigs, and once the Rajah's dying elephant. In the winter of 1943, at the ripe old age of twelve and a half, I learned to drive, in a three-ton truck "borrowed" from the nearby Royal Air Force base at Bardungi. My nighttime-driving training was not enhanced by the full blackout wartime regulations in effect, and the narrow slits of the truck lights were hardly an adequate forewarning of a sacred cow.

We faced such things as bridge washouts, culvert pipes removed to augment the efficiency of village wells, two-hour dust storms, chickens, geese, pigs, and once the Rajah's dying elephant.

GEORGE MATHESON
Vernon, British Columbia

Of all the wild beasts, exhilarating scenery, and compelling images rendered by your magazine over the many years, the photo of the three motorcyclists—each with a rider behind and one with a child in the front—traveling down an Indian highway with nary a safety helmet among them may be the single most frightening I have ever seen. No doubt India will enact helmet laws in the near future, but one has to pity every single day they delay.

RICHARD J. TAFILAW
Burbank, California

Ozark Highlands Trail

I spent much of my childhood in this beautiful country, and Peter Essick's photos, quite frankly, gave me goose bumps. While I may live in the Rockies, my heart will always long for the Ozarks.

JESSIKA LOUISE KYNETT
Livingston, Montana

Corrections, Clarifications

October 2008:
Conservation: Bird Guide
The video of the rehabilitated golden eagle Sampson is not available to view on *ngm.com*. It may be seen instead at *http://www.youtube.com/watch?v=-wvugqdPQRA*.

Science: Ratted Out
The rats' reward-based training method was incorrectly described as Pavlovian. The correct term for the method is operant conditioning.

Fast Lane to the Future
Page 88: The correct spelling of the name of the Finnish manager of the Nokia factory is Martti Salomaa.

Take a Shot Check out our website for reader-submitted photos of everything from softball players to waterfalls to whirling dervishes. Upload your own images, play jigsaw puzzles and memory games, and use our voting machine to vote for your favorite photo to be included in the magazine. Next month, it could be yours. For guidelines, a submission form, and more information, go to *ngm.com/yourshot.*

Nannette White Bountiful, Utah

She didn't want her husband to catch her using the camera during a dust storm, so Nannette White, 48, snapped five quick shots of her daughter's softball teammate through a chain-link fence. This one was a hit.

Bill Hinton Seattle, Washington

"I was leaving the falls when I looked back and noticed the mist with sunlight filtering through it," says Bill Hinton, 52, who works in television broadcasting. His photo was voted an *ngm.com* audience favorite.

Thigh deep in Lake Katwe's dark waters, a Ugandan man pulls mud from a salt pan.

More of photojournalist Andrew McConnell's work can be found at andrewmcconnell.com.

Salt of the Earth Eight months after arriving in Africa, I found myself in Uganda's capital, Kampala. It was there I first heard the surreal stories of Lake Katwe, a volcanic mere that is the country's chief source of salt. Its workers were said to wage a primeval battle with the black water, braving highly concentrated chemicals and toiling in stifling heat to produce the shining piles of salt that dot the shoreline. My imagination was inflamed. I had to go.

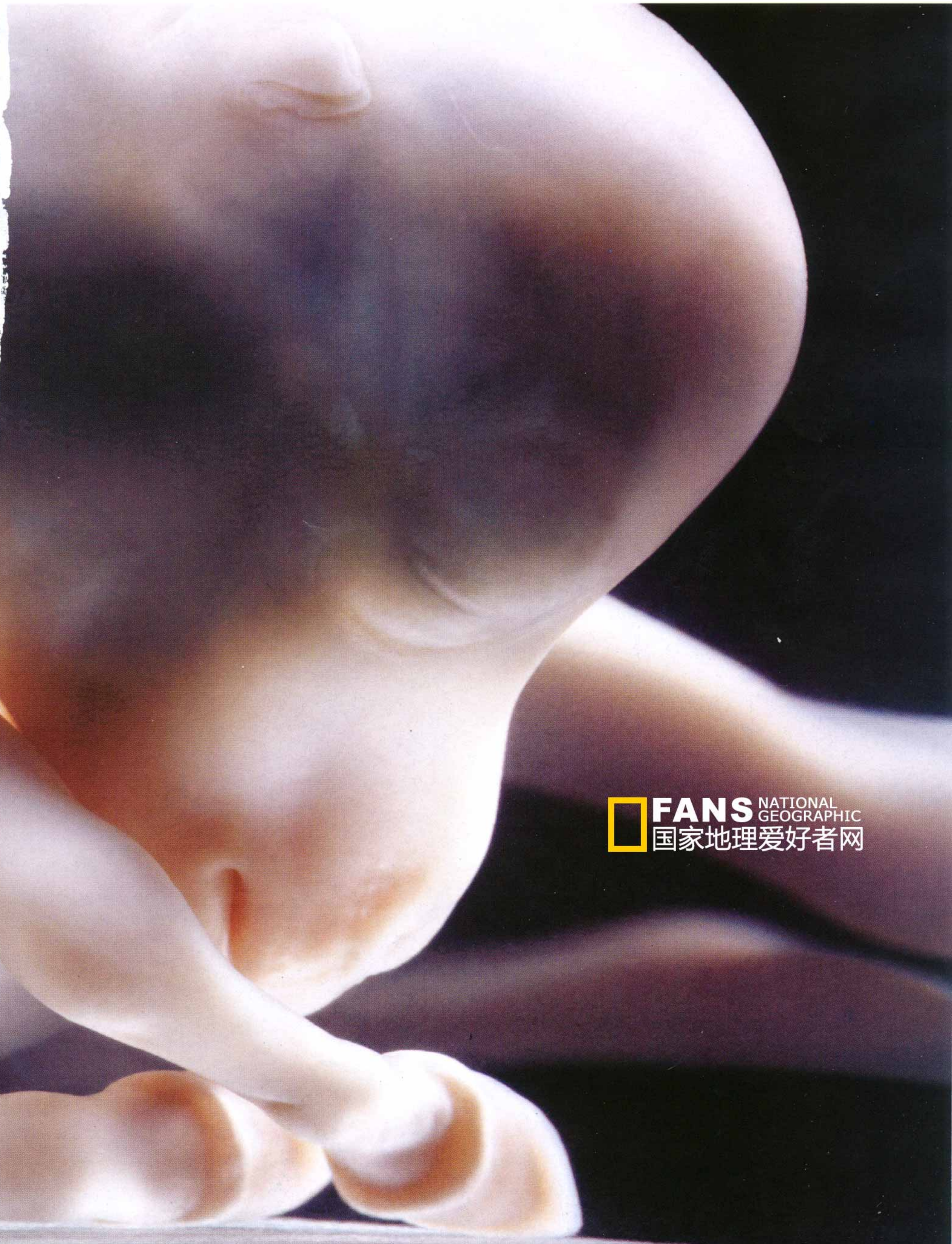
In a remote corner of the country, near the border with the Democratic Republic of the Congo, I found it. At first light, hundreds of people appeared on the steep ridges around the lake. Slowly they made their way down toward the salt pans, the scores of square harvesting pools cordoned off by mud walls and sticks. Even at dawn the lake—four to six feet deep, a mile and a half long, so corrosively salty it hardly feels like water—was ominous.

I had come to see this natural wonder, this crater lake the explorer Henry Morton Stanley had written about, but I found my lens drawn more to the men, women, and children who brave it. Most bore scars or open sores that the water won't let heal, yet all come back, day after day. For some, the seasonal rains offer the only respite. For many, as for their ancestors, this dangerous, painful, and exhausting work is the only way to survive.

VISIONS OF EARTH

England Like a porcelain figurine carved into repose, the fetus of a foal floats in a jar. The 85-day-old, 5.5-inch-long colt was removed postmortem and preserved in formaldehyde after its mother, a Thoroughbred, died.

PHOTO: TIM FLACH



United States Limned by Hurricane Ike, an abstract expressionist expanse of oil-sheened floodwater surrounds a pump jack—a mechanical device used to extract oil—near High Island, Texas.

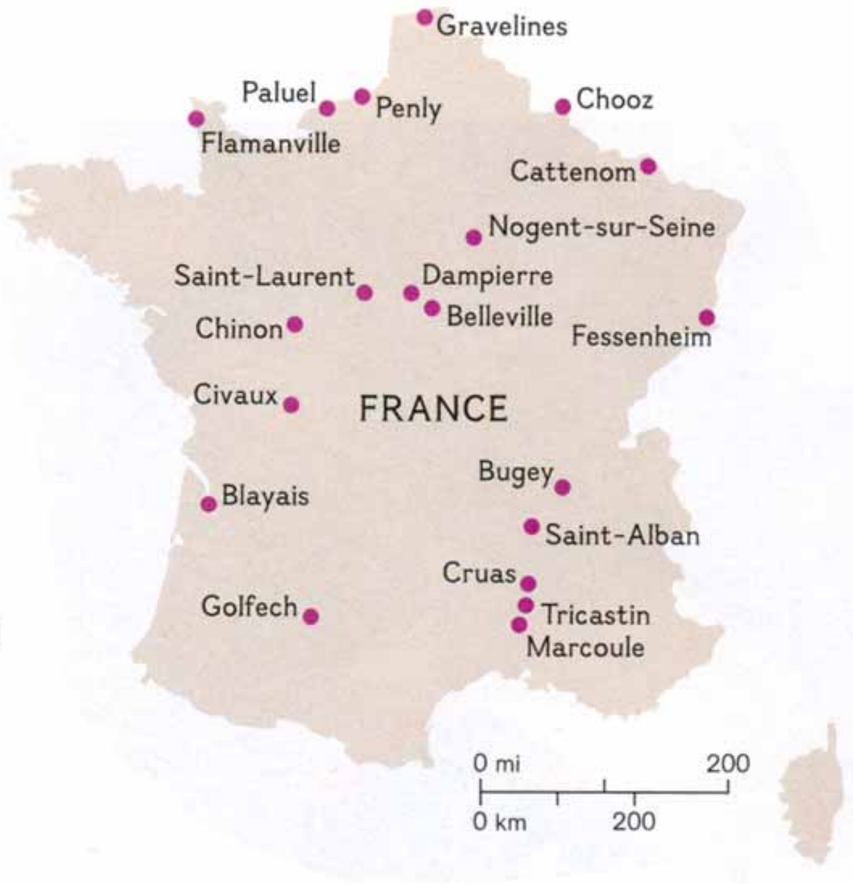
PHOTO: SMILEY N. POOL, GETTY IMAGES

Indonesia On the first day of Ramadan, in a mosque filled with white-robed women, one child stands up and stands out. During the month-long holiday, Muslims seeking spiritual purification fast from dawn till dusk.

PHOTO: SIGIT PAMUNGKAS, REUTERS

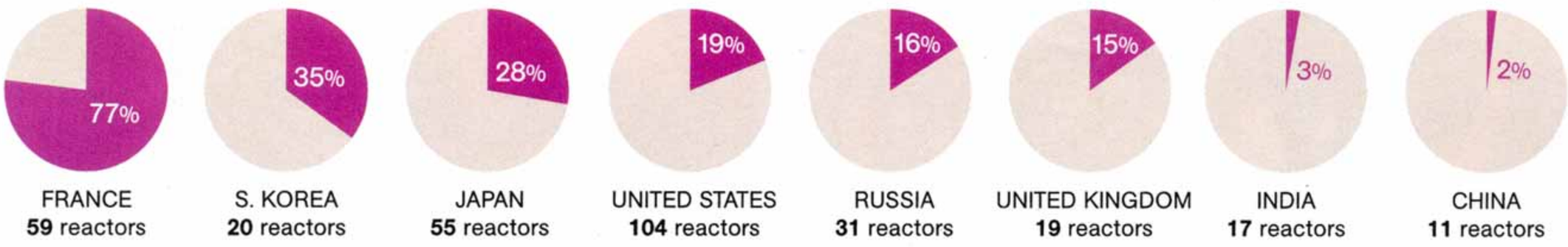
France's Nuclear Family Many nations have been spooked by the potential dangers of nuclear power. But those hazards, including the spread of radioactive waste and the specter of a catastrophic meltdown, haven't frightened France. Since the oil shocks of the 1970s, the nation has built a network of reactors that now produce nearly four-fifths of the country's electricity (though only two-fifths of its total energy needs).

Why this embrace of such a controversial technology? First, there's necessity. France has "no oil, no coal, no choice," according to a familiar refrain. Second, many of the nation's political leaders trained as scientists—expertise that elicits public confidence. And third, strategies about France's energy future have long been centralized, with government ministers making the big decisions. This system provides a measure of energy independence, but at too high a cost, say critics. "Our decision-making process is more Soviet than democratic," says Frederic Marillier, a nuclear specialist for Greenpeace France. "The government explains the benefits of nuclear, but they avoid debate about the risks." *—Alan Mairson*



France has 59 nuclear reactors in 20 locations. The first began operating in 1974; the most recent one in 2000.

Electricity Generated From Nuclear Power (as of October 2008)



Nuclear's upside: Clouds of water vapor, not CO_2, rise from cooling towers at France's Saint-Laurent facility.

PHOTO: HERVE HUGHES, GETTY IMAGES. MAP AND GRAPHICS: SEAN McNAUGHTON, NG STAFF. SOURCE: WORLD NUCLEAR ASSOCIATION

Jumpers in Command, a team from Brooklyn, do the double Dutch.

Dutch Treat Turners twirl two ropes fast as they can. Jumpers hop in, do dance steps and backflips, then deftly exit. There may be music. Or chanting: "Double Forces has got the beat, 'cause we do it with our feet, 'cause we are"—here they throw down their ropes and walk away—"bad." That's double Dutch jump rope, which this year becomes a varsity sport in New York City schools.

Blacks and, to a lesser extent, Jews pioneered the game in U.S. cities in the 1940s, says Kyra D. Gaunt, author of *The Games Black Girls Play.* "Kids are inventive," she explains. "Clotheslines were there, jumping rope was already common." So why not two ropes and fancy moves? "Double Dutch" is slang for something confusing or difficult, like turning cartwheels between two helicoptering ropes. It's also an insult dating to the 1800s, when the British used it to mock the Dutch language.

Other cultures are jumping in. Japanese teams often win world tourneys. But a trophy isn't the only payoff. "There's the cooperation thing," says Tenisha Nimmons, 18, of Brooklyn, a jumper since third grade. "And in society you gotta get along with everyone." *—Marc Silver*

PHOTO: ROBERT CLARK

Watching TV

February 18, 2009, could mark the biggest milestone in television history since 1956, when restless viewer fingers were introduced to the remote control. On that day all broadcasts in the United States will go digital. People who own analog TVs will see only snowy fuzz unless they've bought a digital converter box. Here's a look at past—and future—landmarks. *—Melody Kramer*

1928 1929 1948 1950s 1957 1958 1972 1979 1990s 2008

1900 Russian scientist Constantin Perskyi coins the word "television" at the Paris World's Fair to describe the transmission of still photos over electrical wires.

1925 The silhouette of a moving toy windmill is transmitted over wire circuits.

1936 First TV news broadcast in London, live from Alexandra Palace.

1939 RCA leads the launch of TV. By '41 the U.S. has some 7,000 sets.

1948 The U.S. goes from fewer than 200,000 sets to 975,000. The '47 Yankees-Dodgers World Series spurs sales in N.Y.C.

1954 NBC airs the first national color broadcast: the New Year's Day Tournament of Roses Parade.

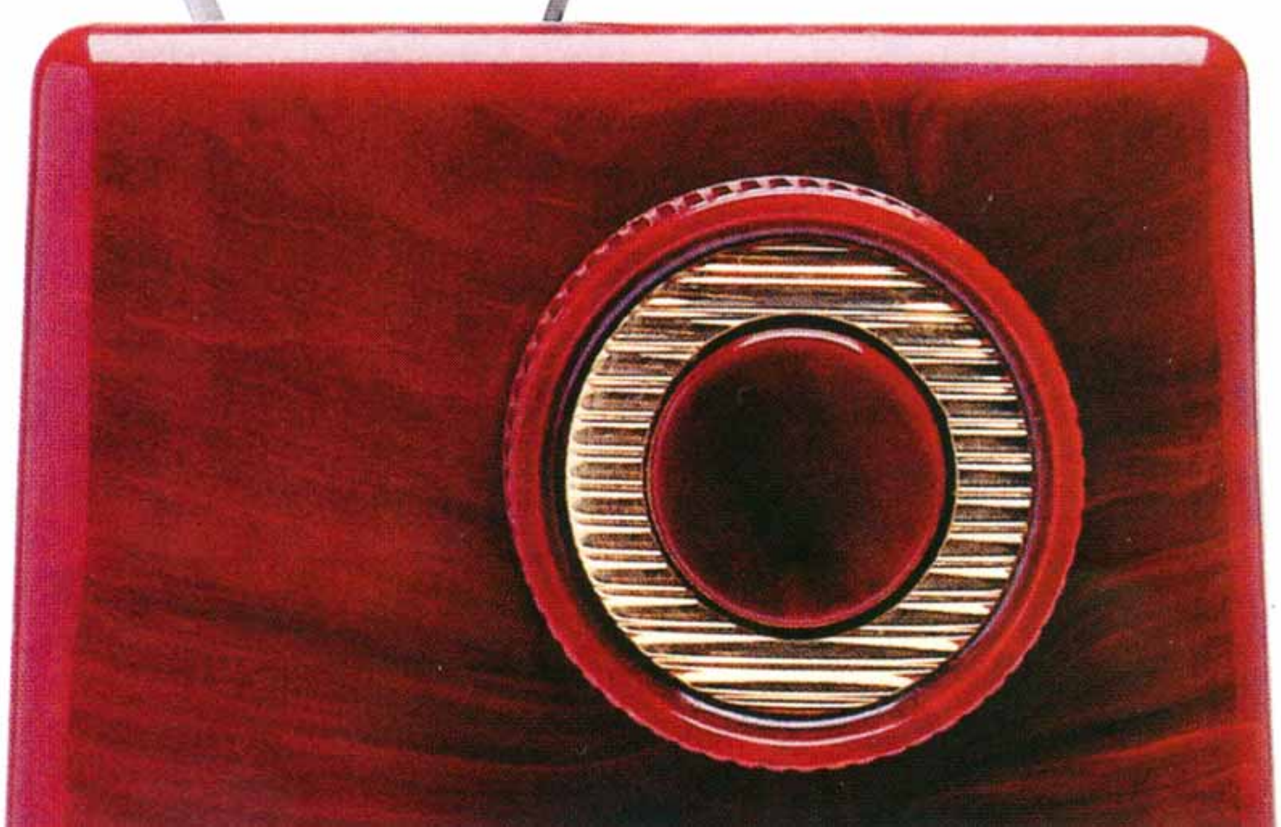
1974 Two-thirds of U.S. homes have color TVs.

1981 MTV debuts. The first broadcast: the Buggles' "Video Killed the Radio Star."

2007 Flat panels lead the U.S. market.

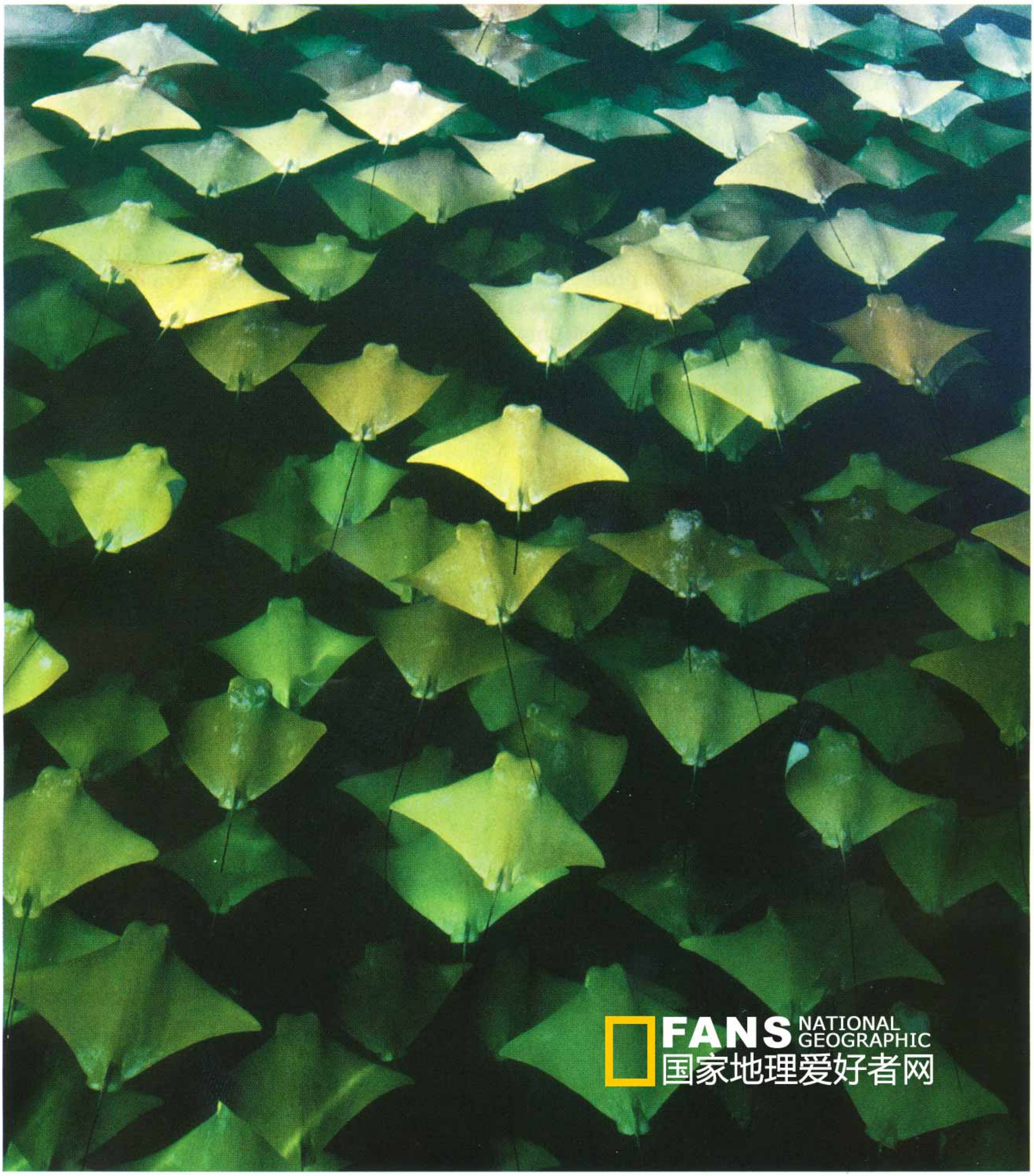
2013 Organic light-emitting diode (OLED) technology will create flexible screens as thin as paper.

2020 Using a keyboard, couch potatoes will rant on a scrolling screen bar, chat with producers of live shows.



TOP MODELS GE had the first U.S. set in '28. France's was in '29. The first color TV hit in '48, rabbit ears (right) in '56. In '58, a space-age look flopped. Screen sizes: 5 inches in '72, 3-mm-thick in '08.

PHOTOS: MZTV MUSEUM OF TELEVISION (1); MUSÉE DES ARTS ET MÉTIERS (2); COURTESY TOM GENOVA COLLECTION (3, 5, 7, AND 8); TAKESHI KANAZAKI, GETTY IMAGES (4); INDEX STOCK/ALAMY (6 AND RIGHT); STOCKB YTE/ALAMY (9); SONY ELECTRONICS, INC. (10)



Rhinoptera bonasus is one of the few mass-migrating rays.

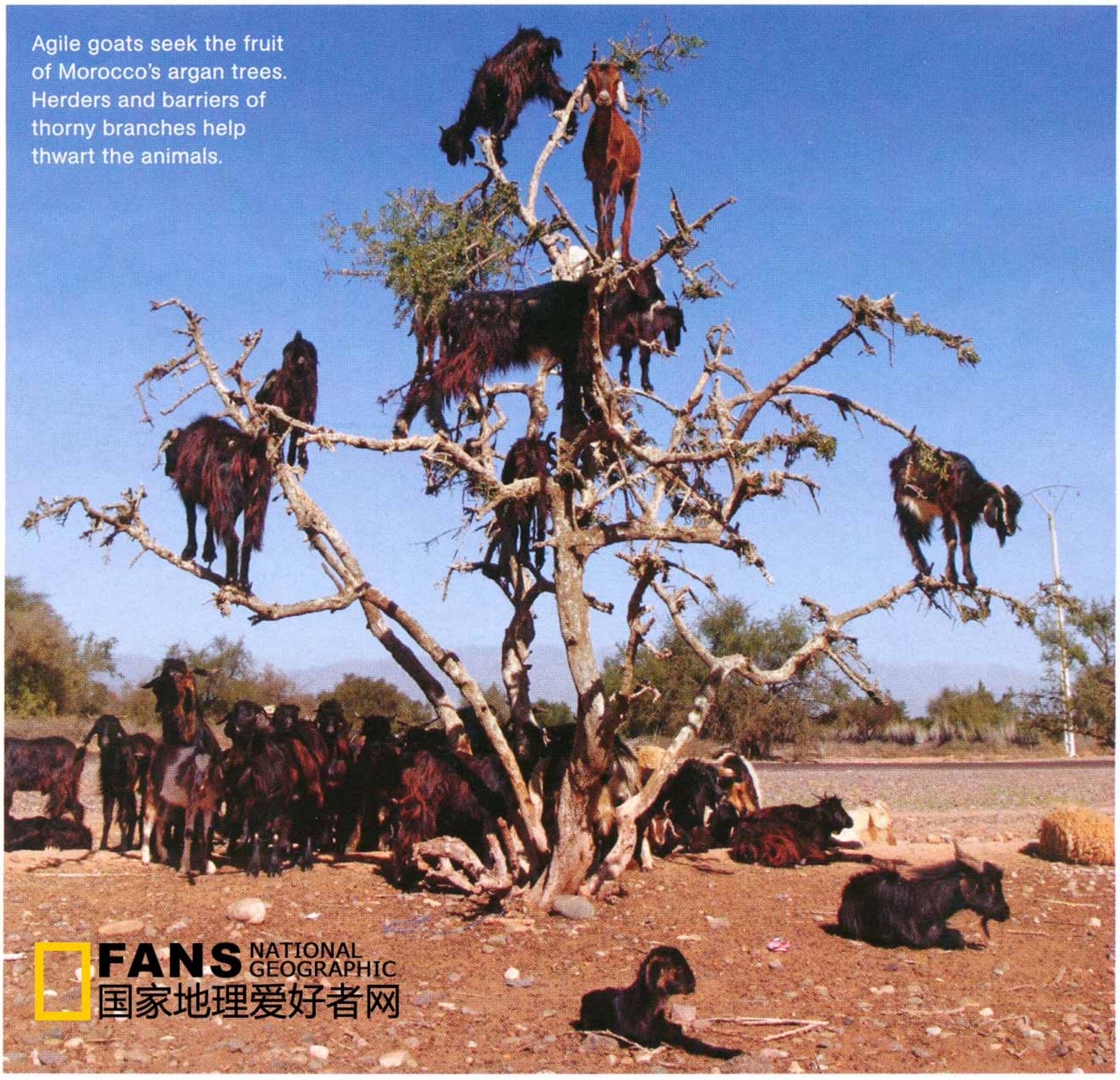
Rays of Light Artist M. C. Escher might have composed this scene, a massive school of cownose rays migrating, layer upon layer to the horizon, in the Gulf of Mexico. On wings sometimes three feet across, these blunt-faced gliders are seen moving clockwise from the Yucatán Peninsula through the Gulf's coastal bays, chasing warm water, daylight, and prey, which includes burrowing shellfish sucked from the sand and crushed between tooth plates. According to marine ecologist Julie Neer, "These guys have only one pup per litter and one litter per year"—making a school of thousands a remarkable thing indeed. *—Jennifer S. Holland*

PHOTO: SANDRA CRITELLI

Oil Boon The goats of southwestern Morocco go out on a limb to find the nuts of the native argan tree. So do the region's Berbers. For many centuries, they've extracted oil from the nuts. They use it as a seasoning—it has an earthy, nutty flavor—as well as a skin moisturizer, a hair softener, and a treatment for ills like acne. Now the oil also generates income. As scientists have revealed its rich antioxidants and healthy fatty acids and consumers abroad have discovered its benefits, sales have risen. Priced at about $45 for a mere 8.5 ounces, the oil has become a costly elixir.

A decade ago only two cooperatives produced argan oil. Today about a hundred employ 4,000 women to hand-crack pits and remove the nuts, which machines crush for oil. But production can't expand much in the near future. The trees are late bloomers, waiting 25 years or so after planting to bear much fruit. *—A. R. Williams*

Each thumb-size pit (above) holds one to three argan nuts.



Agile goats seek the fruit of Morocco's argan trees. Herders and barriers of thorny branches help thwart the animals.

PHOTOS: FOODFOLIO/ALAMY (TOP); REMO SAVISAAR

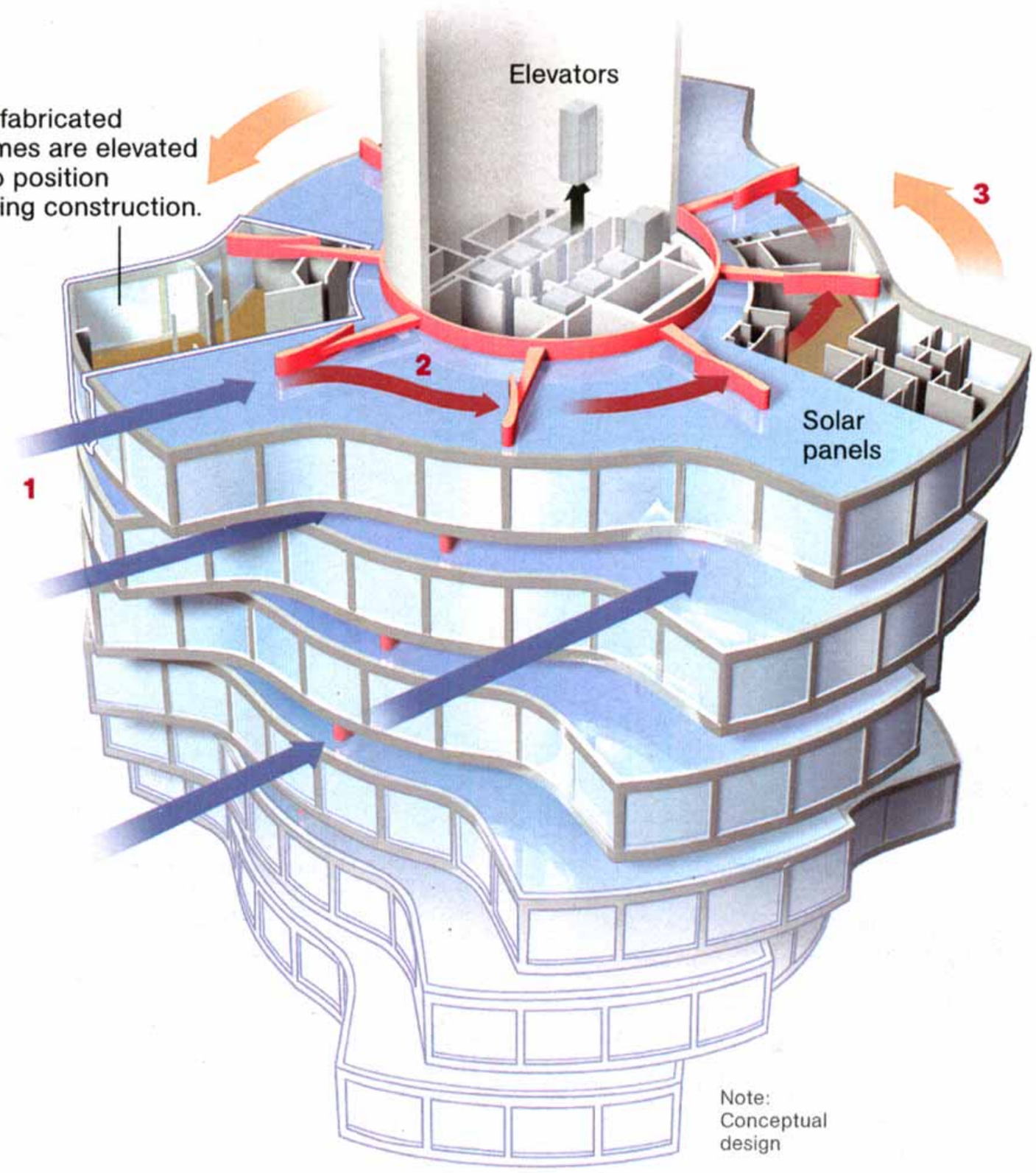
Dubai's Rotating Skyscraper

Four years ago, architect David Fisher was admiring the view from a friend's New York City apartment. "My friend said, 'Look at this view! Nobody else has this view!' And I thought, Why can't we rotate the entire building so everybody can see?"

Construction begins soon on Fisher's Dynamic Tower, where none of the 200 apartment owners will be able to claim the best view—each of the 80 floors rotates individually and can complete a 360-degree survey of the Dubai skyline in as little as one hour.

Wind turbines and solar cells positioned between each floor should provide enough electricity to power the entire building, and possibly others nearby. "This is not just a tower," says Fisher, "it is a green power plant."

Apartments in the Dynamic Tower range from $3 million to $30 million. Already more than 1,100 people are on the waiting list for the luxurious building, and no wonder: A drive-in elevator lets residents park right outside their front doors, so after taking a spin in their sports cars, they can let their cars take a spin in their building. *—Winona Dimeo-Ediger*



HOW IT WILL WORK

1 Wind flows between each floor, making contact with turbine blades.

2 Blades catch wind, generating electricity that can be used to turn the building.

3 Voice-activated controls allow some owners to "tell" their floors when to rotate.

The tower's constantly changing shape adds a fourth dimension: time.

ART: HIRAM HENRIQUEZ, NG STAFF (TOP).
BUILDING IMAGES: COURTESY DAVID FISHER, ARCHITECT, DYNAMIC ARCHITECTURE GROUP. NGM MAPS

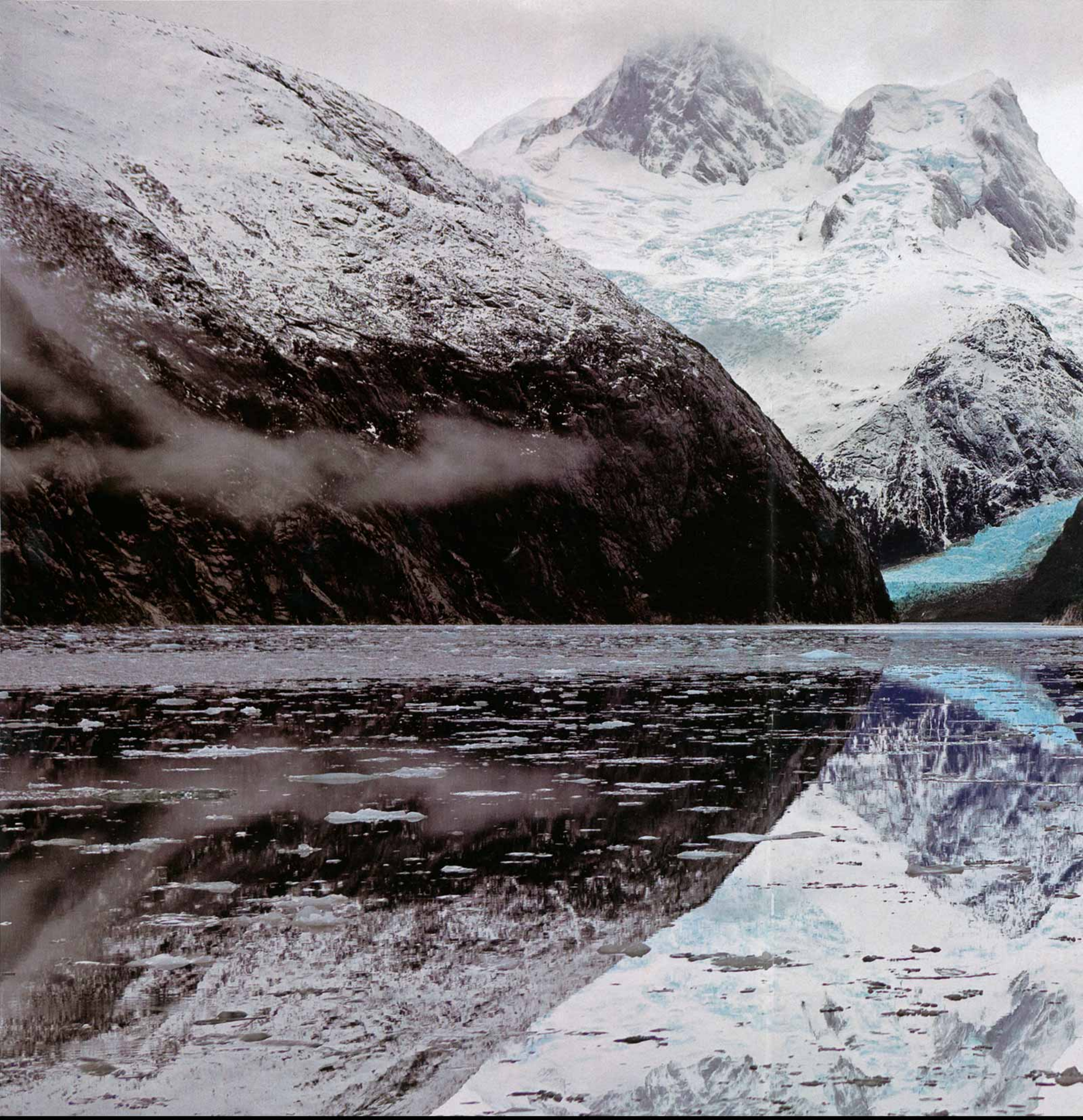
THE ATLANTIC FOREST, CARLOS BOTELHO STATE PARK, BRAZIL

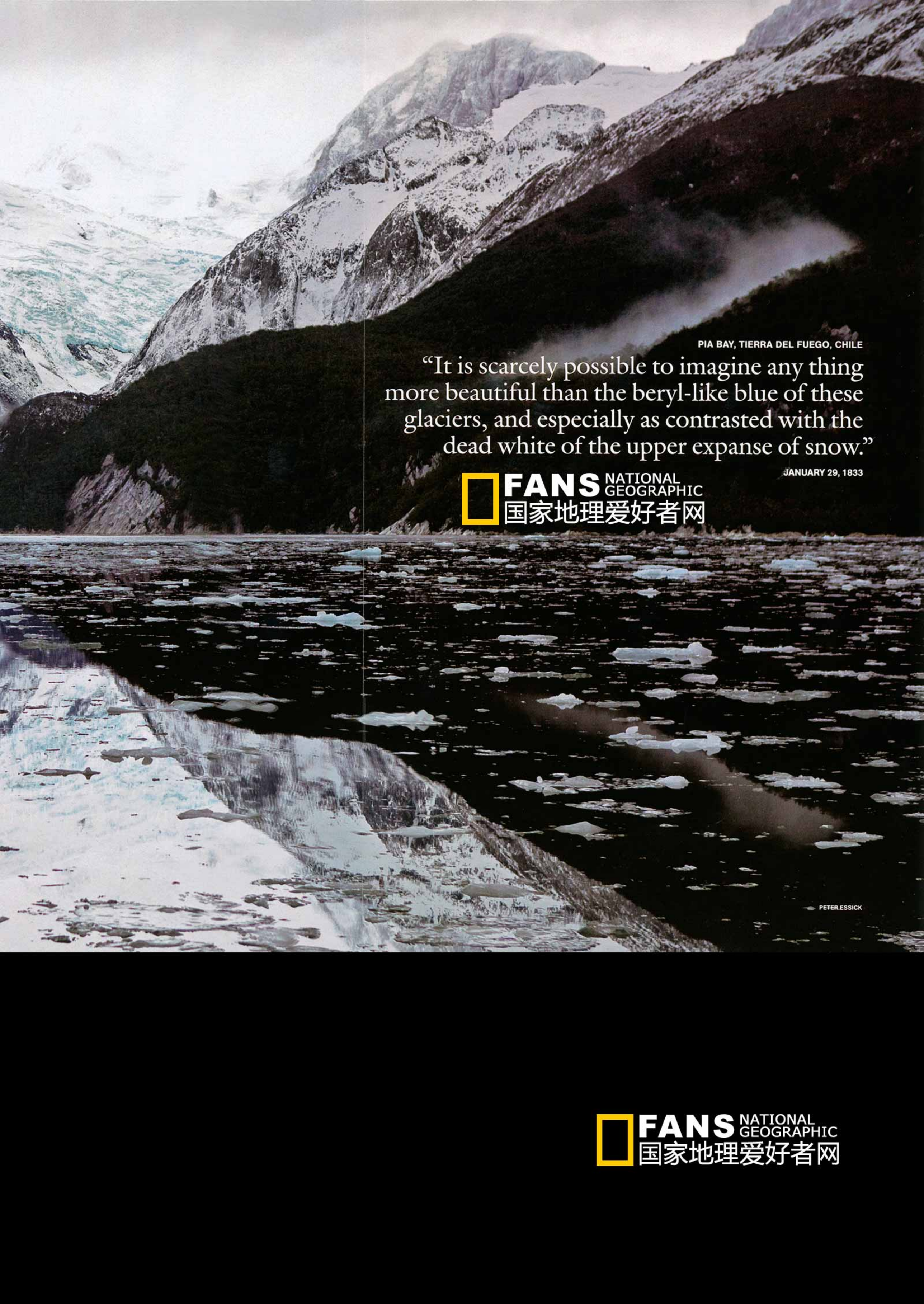
"The day has past delightfully. Delight itself, however, is a weak term to express the feelings of a naturalist who, for the first time, has wandered by himself in a Brazilian forest."

—*THE VOYAGE OF THE BEAGLE*, FEBRUARY 29, 1832

DARWIN'S FIRST CLUES

LUCIANO CANDISANI, MINDEN PICTURES





PIA BAY, TIERRA DEL FUEGO, CHILE

"It is scarcely possible to imagine any thing more beautiful than the beryl-like blue of these glaciers, and especially as contrasted with the dead white of the upper expanse of snow."

JANUARY 29, 1833

PETER ESSICK

Charles Darwin, circa 1831

THIS YEAR MARKS THE 150TH ANNIVERSARY OF THE MOST incendiary book in the history of science, and, coincidentally, the 200th birthday of the mild-mannered Englishman who wrote it. Charles Darwin did not invent the idea of evolution, any more than Abraham Lincoln, who happens to share his birthday on February 12, invented the idea of freedom. What Darwin provided in *The Origin of Species* was a powerful theory for *how* evolution could occur through purely natural forces, liberating scientists to explore the glorious complexity of life, rather than merely accept it as an impenetrable mystery. "Nothing in biology makes sense, except in the light of evolution," the geneticist Theodosius Dobzhansky wrote 36 years ago. That light, which began as a glimmer in the mind of a young naturalist aboard H.M.S. *Beagle,* today casts a beam so bright we can read the very text of life by it. Darwin would be overjoyed to see how much he did not know, and how much we have yet to learn.

ENGLISH HERITAGE PHOTO LIBRARY/DARWIN HEIRLOOMS TRUST

KICKER ROCK, OFF SAN CRISTÓBAL, GALÁPAGOS ISLANDS

"The archipelago is a little worl
itself…both in space and time
to be brought somewhat near
fact—that mystery of mysterie
appearance of new beings on t

OCTOBER 8, 1835

within
we seem
o that great
—the first
is earth."

MATTIAS KLUM

FANS NATIONAL GEOGRAPHIC
国家地理爱好者网

GALÁPAGOS TORTOISES IN ALCEDO CALDERA, ISABELA ISLAND

"Near the springs it was a curious spectacle to behold many of these huge creatures, one set eagerly travelling onwards with outstretched necks, and another set returning, after having drunk their fill."

OCTOBER 8, 1835

FRANS LANTING

THE DARWIN BICENTENNIAL PART ONE

BY DAVID QUAMMEN

THE JOURNEY OF YOUNG CHARLES DARWIN aboard His Majesty's Ship *Beagle,* during the years 1831-36, is one of the best known and most neatly mythologized episodes in the history of science. As the legend goes, Darwin sailed as ship's naturalist on the *Beagle,* visited the Galápagos archipelago in the eastern Pacific Ocean, and there beheld giant tortoises and finches. The finches, many species of them, were distinguishable by differently shaped beaks, suggesting adaptations to particular diets. The tortoises, island by island, carried differently shaped shells.

These clues from the Galápagos led Darwin (immediately? long afterward? here the mythic story is vague) to conclude that Earth's living diversity has arisen by an organic process of descent with modification—evolution, as it's now known—and that natural selection is the mechanism. He wrote a book called *The Origin of Species* and persuaded everyone, except the Anglican Church establishment, that it was so.

Well, yes and no. This cartoonish account of the *Beagle* voyage and its consequences contains a fair bit of truth, but it also confuses, distorts, and omits much. For instance, the finches weren't as illuminating as the diversity of the islands' mockingbirds, at least not initially, and Darwin couldn't make sense of them until a bird expert back in England helped. The Galápagos stopover was a brief anomaly near the end of an expedition devoted mostly to surveying the South American coastline. Darwin hadn't signed on to the *Beagle* as its official naturalist; he was a 22-year-old Cambridge graduate pointed rather indifferently toward a career as a country clergyman, invited on the voyage as a dining companion for the captain, a mercurial young aristocrat named Robert Fitzroy. Darwin did assume the role of naturalist, and think of himself that way, as time went on. But his theory developed slowly, secretively, and *The Origin of Species* (full title: *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*) didn't appear until 1859. Many scientists, along with some Victorian clergymen, resisted its evidence and arguments for decades afterward. The reality of evolution became widely accepted during Darwin's lifetime, but his particular theory—with natural selection as prime cause—didn't triumph until about 1940, after it had been successfully integrated with genetics.

Apart from those clarifications, the most interesting point missed by the simplified tale is this: Darwin's first real clue toward evolution came not in the Galápagos but three years before, on a blustery beach along the north coast of Argentina. And it didn't take the form of a bird's beak. It wasn't even a living creature. It was a trove of fossils. Never mind the notion of Darwin's finches. For a fresh view of the *Beagle* voyage, start with Darwin's armadillos and giant sloths.

IN SEPTEMBER 1832, during the first year of its mission, the *Beagle* anchored near Bahía Blanca, a settlement at the head of a bay about 400 miles southwest of Buenos Aires. A certain General Rosas was waging a genocidal war against the Indians, and Bahía Blanca stood as a fortified outpost, occupied mostly by soldiers. For more

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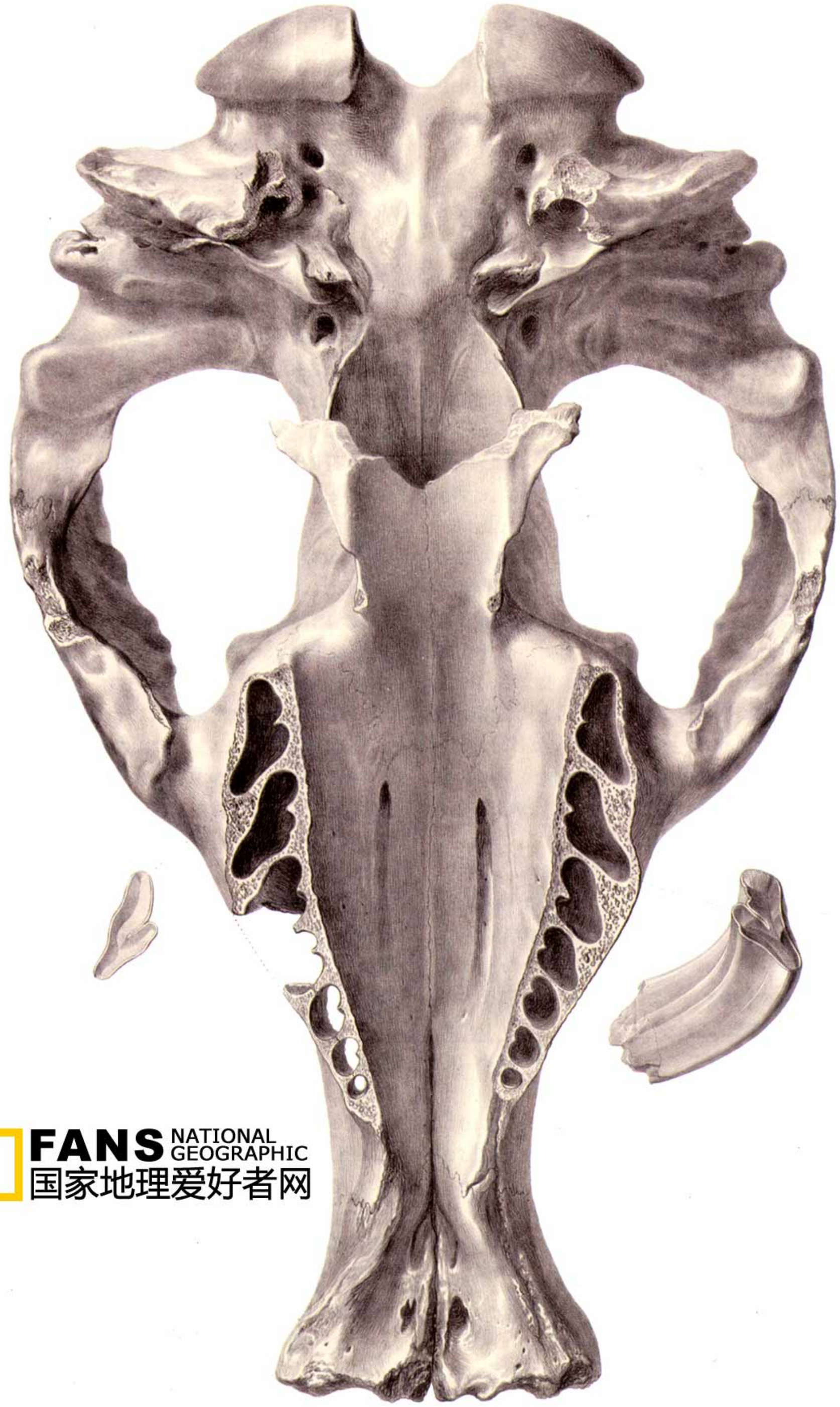
David Quammen is a National Geographic *contributing writer. He wrote the December 2008 story on naturalist Alfred Russel Wallace.*



In Uruguay, Darwin paid a farmer 18 pence for “the head of an animal the size of a hippopotamus.” Scientists named the extinct herbivore *Toxodon platensis*.

ILLUSTRATIONS FROM *THE ZOOLOGY OF THE VOYAGE OF H.M.S. BEAGLE*; REPRODUCED BY PERMISSION OF JOHN VAN WYHE, ED., THE COMPLETE WORK OF CHARLES DARWIN ONLINE

than a month the *Beagle* remained in that area, some of its crew occupied with surveying, others assigned to shore duties—digging a well, gathering firewood, hunting for meat. The landscape round about was classic Argentine Pampas, fertile grassland, giving way to grass-anchored sand dunes along the coast. The hunters brought back deer, agoutis, and other game, including several armadillos and a large flightless bird Darwin loosely called an "ostrich." Of course it wasn't an ostrich (which is native to Africa, and formerly the Middle East); it was a rhea, specifically *Rhea americana,* ostrichlike in appearance but endemic to South America and the heaviest bird on the continent.

"What we had for dinner to day would sound very odd in England," Darwin wrote in his diary on September 18, reveling in the exoticism of his new regimen: "Ostrich dumpling & Armadilloes." He was out for a romping adventure, not just a natural history field trip, and his shipboard diary (later transformed into a travel book that came to be known as *The Voyage of the Beagle*) reflects his attention to cultures, peoples, politics, as well as to science. The red meat of the big bird resembled beef, he recorded. The armadillos, peeled out of their shells, tasted and looked like ducks. His culinary experiences here on the Pampas, and later in Patagonia, besides being part of his voracious tour of discovery, would eventually play a role in his evolutionary thinking.

A few days afterward, on September 22, 1832, Darwin and Fitzroy took a small boat to visit a site called Punta Alta, ten miles from their anchorage, where they found some rocky outcrops overlooking the water. "These are the first I have seen," Darwin wrote, "& are very interesting from containing numerous shells & the bones of large animals."

Despite the name, Punta Alta ("high point") was not very high, its reddish mudstone cliff rising only about 20 feet. But if the headland wasn't dramatic, the exposed fossils were: big shapes, unusual shapes, and abundant. Darwin and a helper went to work on the soft rock with pickaxes. Between that session and later efforts, he harvested from Punta Alta the remains of nine great mammals, all unknown or barely known to science. They were extinct Pleistocene giants, unique to the Americas in an age sometime before 12,000 years ago.

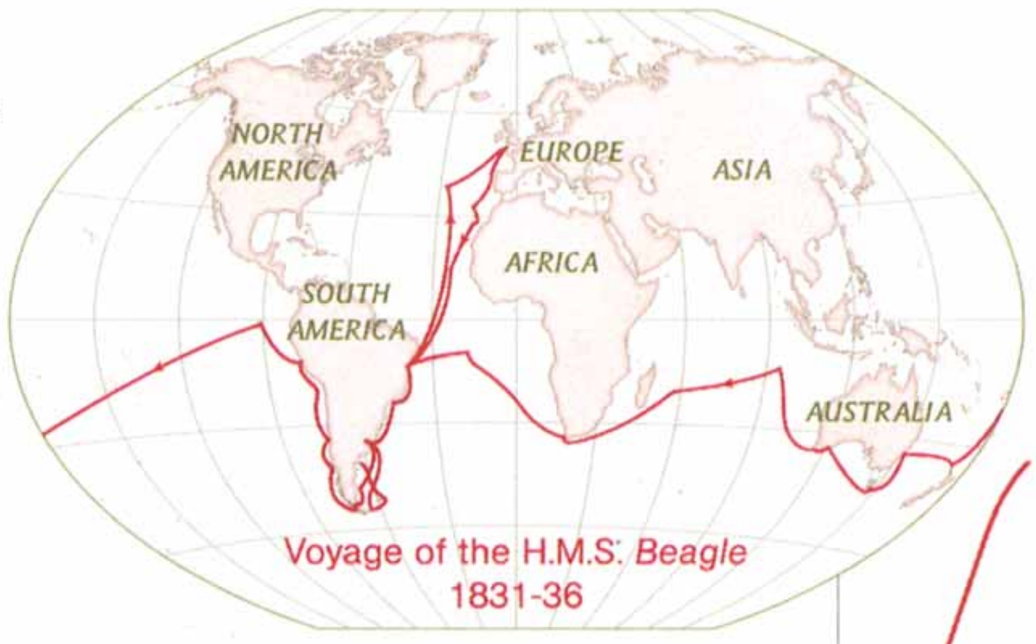
The most famous of them was *Megatherium,* an elephant-size ground sloth that had already been named and described by the French anatomist Georges Cuvier on the basis of one set of fossils found in Paraguay. Living sloths are native to Central and South America, and only there; *Megatherium* shared many of their anatomical traits but was far too large for climbing trees. Darwin's finds also included at least three other giant ground sloths, an extinct form of horse, and a protective carapace of small bony scutes fitted closely together, remnant from some big beast that must have strongly resembled an armadillo. He was already familiar with flesh-and-blood armadillos, having eaten those shucked, ducky ones with his ostrich dumplings. He had also watched local gauchos kill armadillos and roast them in the shells. Of the 20 species of living armadillo, all are confined to the Americas and several are common on the Pampas; the roasted animals may have been six-banded armadillos *(Euphractus sexcinctus),* plentiful thereabouts and reputed to taste terrible, which might not have dissuaded those unfussy gauchos, who sometimes lived off the land for weeks. "Like to snails, all their property is on their backs & their food around them," Darwin wrote, referring to the cowboys, not the armadillos.

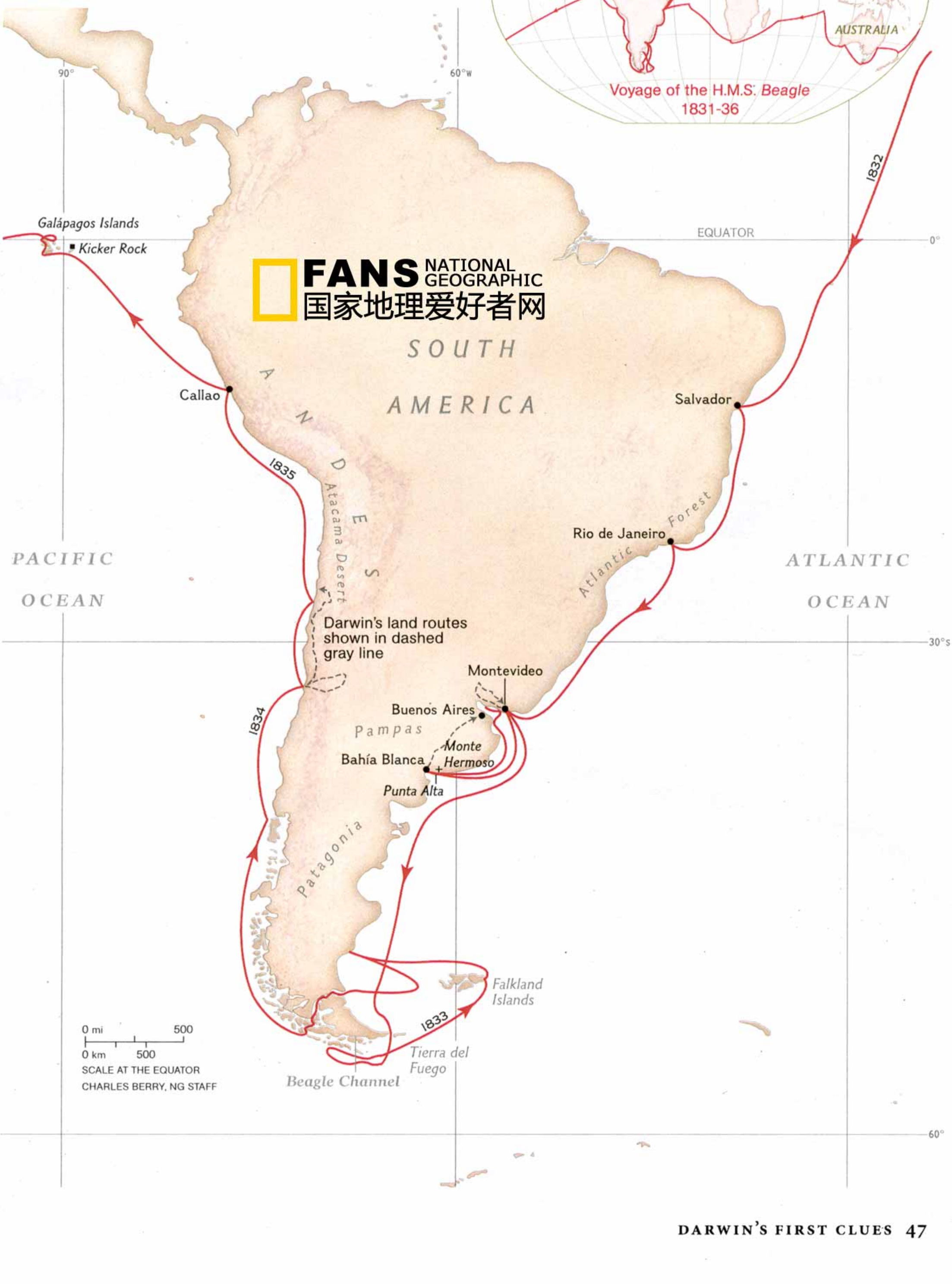
A month later, 30 miles up the coast from Punta Alta, Darwin discovered another fossil-rich sea cliff, this one rising 120 feet and marking a place called Monte Hermoso. There he unearthed the stony remains of several gnawing creatures, which variously put him in mind of an agouti, a capybara, and a smaller South American rodent, the tuco-tuco, except that again, in each case, the match between fossil and living species was close but not identical. Still later and farther south on the Argentine coast, he excavated a third set of mammal bones, which, to an anatomist who eventually examined them, suggested an extinct form of camel. That creature became known as *Macrauchenia.* The camel family includes two wild South American species, the guanaco and the vicuña, as well as their domesticated forms, the llama and the alpaca. Darwin was well aware that living guanacos inhabited that area, having shot one himself just days earlier.

These discoveries, analogies, and juxtapositions went into his memory and imagination, to ferment there as the voyage continued and for years afterward. Meanwhile the fossils

The *Beagle* in South America

The *Beagle* expedition's primary mission was to map the harbors and coastlines of South America. Darwin spent much of his time on land, exploring parts of the Argentine Pampas, the Atacama Desert, and the Andes mountains.





Mus Darwinii.

"These little animals swarm amongst the thickets in the valleys, where they cannot for months together taste a drop of water excepting the dew."

APRIL 22, 1834

Darwin collected 27 species of mice in South America, including *Mus darwinii.* The vast assemblage of specimens he shipped back to London for study included 5,436 skins, bones, and carcasses.

"We passed the night in Punta Alta, and I employed myself in searching for fossil bones; this point being a perfect catacomb for monsters of extinct races."

AUGUST 1833

themselves were crated up for shipping back to England, mostly to the care of John Stevens Henslow, the gentle botanist who had been Darwin's mentor at Cambridge.

"I have been lucky with fossil bones," he told Henslow in a letter. He mentioned the giant rodent, the ground sloths, and the section of bony polygonal scutes, commenting on the last: "Immediately I saw them I thought they must belong to an enormous Armadillo, living species of which genus are so abundant here." And he added: "If it interests you sufficiently to unpack them, I shall be very curious to hear something about them."

It's important not to overstate how clearly Darwin could even identify, let alone interpret, what he had found. Most of his fossils, apart from the *Megatherium,* represented species not yet familiar to experts, and he was no expert. He wasn't a comparative anatomist, like the great Cuvier; he wasn't especially knowledgeable about mammals; and the very word "paleontologist" hadn't yet come into use. Darwin entrusted the description and identification of his fossils to a brilliant young anatomist back in London named Richard Owen, an up-and-coming authority on extinct mammals. It was Owen who gave names to the unknown sloths, and Owen who suggested (mistakenly, later correcting himself) the affinity between *Macrauchenia* and a camel.

Darwin himself was no Owen. He was just a highly attentive fieldman, greedy for specimens, learning as he went. The *Beagle* invitation had rescued him from an unsuitable future as a country pastor, and since his first days aboard ship he had applied himself diligently, maturing fast to assume (and then transcend) the role of ship's naturalist. His best qualifications for interpreting the fossils were his intense curiosity, his talent for close observation, and his instinctive sense that everything in the natural world is somehow connected with everything else. Also, he wasn't afraid to speculate boldly—so long as he could do it in private.

ANOTHER SMALL but suggestive datum reached him months later, while the *Beagle* lingered off northern Patagonia and Darwin spent time ashore among another congenial group of gauchos. First it was hearsay: The gauchos mentioned a rare form of ostrich, smaller than the common one, with shorter legs, and more easily killed using their bolas, but otherwise similar. The possibility of finding that bird slipped Darwin's mind until one of his shipmates shot such a smaller "ostrich" (another rhea) for its meat. Darwin paid little attention, assuming it was a juvenile. "The bird was skinned and cooked before my memory returned," he wrote, in a passage so candid you can almost see him smacking his forehead with a palm. "But the head, neck, legs, wings, many of the larger feathers, and a large part of the skin, had been preserved." He rescued those scraps and sent them to England, where they were stitched into a presentable specimen for the museum of the Zoological Society. The ornithologist John Gould, to whom Darwin would consign his Galápagos finches and mockingbirds for identification, also got a first look at this creature. Gould confirmed that it was a distinct species and called it *Rhea darwinii* (a name later changed because of taxonomic technicalities) for the man who had rescued it from the midden.

What intrigued Darwin most about the two rhea species was that, similar as they were, they overlapped very little in geographic distribution. The greater rhea inhabited the Pampas and northern Patagonia, as far south as Argentina's Río Negro, which drained to the coast at about 41° south latitude; the lesser rhea replaced it beyond the Río Negro and occupied southern Patagonia. Together with the evidence of extinct South American mammals, the implications of rhea diversity and distribution would prove almost as suggestive to Darwin as the patterns he would later find among the finches and mockingbirds of the Galápagos.

Its skull exhibiting traits similar to both mice and elephants, *Toxodon* perplexed Darwin, who called it "perhaps one of the strangest animals ever discovered."

HOW DO SPECIES ORIGINATE, and how do they come to be where they are? The orthodox story, still firmly embraced by European science at the time of the *Beagle* voyage, was that God had created species independently, in sequential batches (to compensate for extinctions), and had chosen to place them, almost arbitrarily, in their particular locales—kangaroos in Australia, giraffes and zebras in Africa, rheas and sloths and armadillos in South America, extinct and living forms clustered closely in space and time. But to Darwin, both the extinct mammals (along with their living counterparts among sloths and armadillos) and the two rheas (occupying adjacent regions of habitat) suggested something more rational: the ideas of relatedness and succession among closely allied species. The living tree sloths and armadillos seemed to have succeeded earlier such forms in time, inhabiting roughly the same terrain during different epochs of Earth's history. (Those earlier forms of sloth were true sloths; the earlier armored creatures are now known as glyptodonts, a family distinct from but closely related to living armadillos.) The two rheas, similar but not identical, likewise seemed to succeed each other—but in space, across the horizontal dimension of landscape. The clustering in time and in space thus hinted that each group had descended, with modification, from common ancestors: rheas from rheas, sloths from earlier sloths, armadillos from an armadilloish or glyptodontish precursor, possibly far larger than armadillos living today. That's the explanation to which Darwin felt drawn, because it seemed more economical, more inductive, and more persuasive than the creationist scenario.

How important were the South American data in shaking his faith in the orthodox view—persuading him that evolution was a reality for which he should seek a material explanation? Darwin himself would give several answers to that question over the length of his lifetime. His answers ranged, in essence, from very important, but less so than the Galápagos birds, to crucially important, period.

He hinted at the subject in 1845, in the second edition of his *Beagle* narrative, revised by him to include coy hints about the theory he was still unprepared to publish. The relationships between fossil and living forms among the rodents, the sloths, the camels, and the armadillos were "most interesting facts," he noted. Further work by other investigators had meantime revealed the same kind of pattern in Brazil—fossil and living forms of anteater, of tapir, of monkey and peccary and possum. "This wonderful relationship in the same continent

"The teeth indicate, by their simple structure, that these Megatheroid animals lived on vegetable food, and probably on the leaves and small twigs of trees."

AUGUST 24, 1833

between the dead and the living," Darwin wrote, would "throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts." But what sort of light? What would that light reveal? Throwing light was one of his favorite metaphors, and it would return, but not for a decade and a half—not until he was ready to shine the blinding beam of his theory in public.

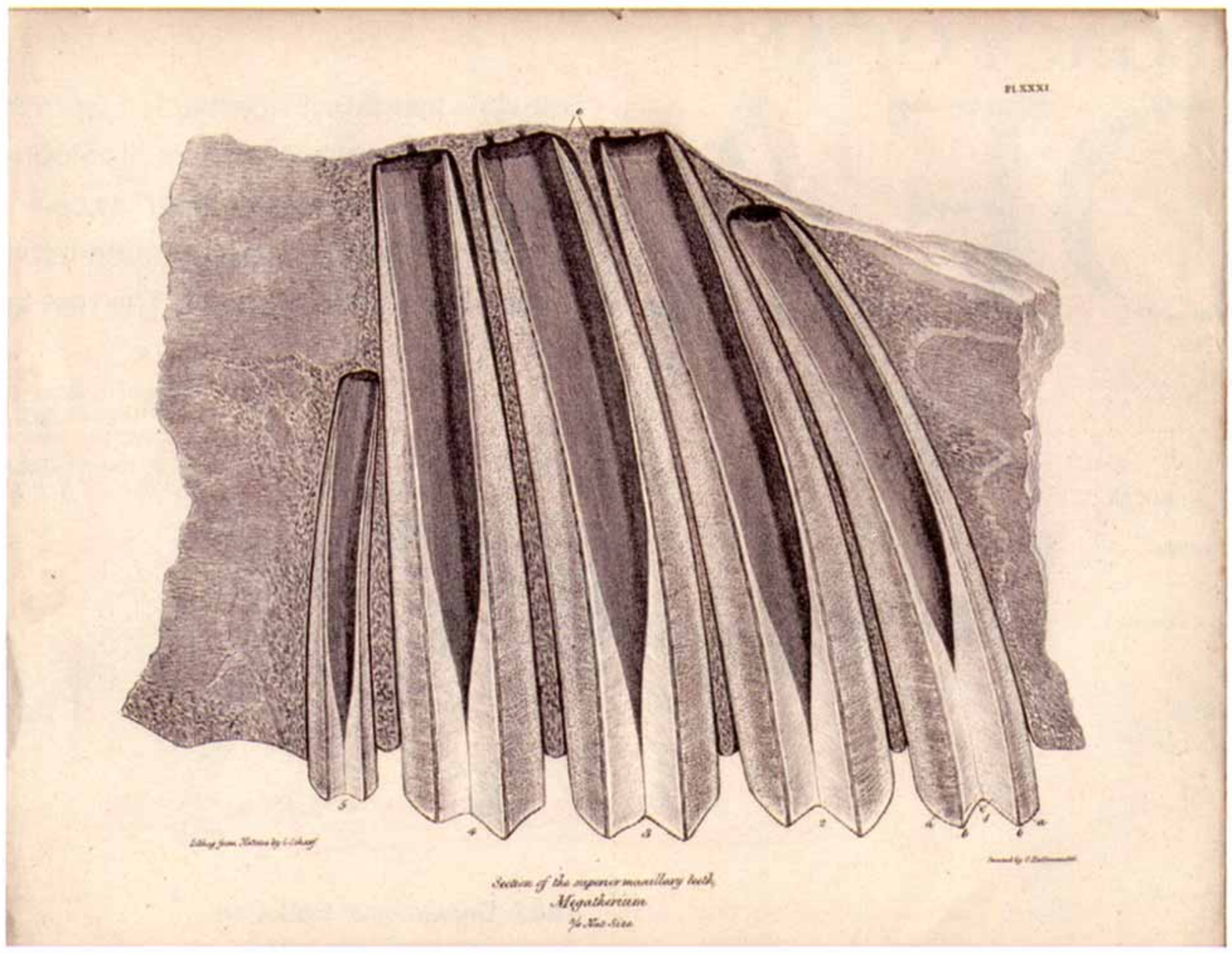
There's another intriguing question about the South American fossils and rheas: When did this evidence register on Darwin, tipping him toward the idea of evolution? The widely accepted view is that he returned from the *Beagle* voyage not yet an evolutionist, merely puzzled by what he had seen, and that he made the big leap to evolutionary thinking after his consultations in London, with John Gould and Richard Owen, about the bird and fossil specimens he had consigned to them. (Soon after that he began using a new term for the process: "transmutation.") But not everyone agrees.

"I think he was personally converted much earlier," a historian of paleontology named Paul D. Brinkman told me. We were sitting in his office at the North Carolina Museum of Natural Sciences in Raleigh, amid a portrait of young Darwin, a *Jurassic Park* poster, and photos of old ground sloth and glyptodont specimens. "Why would there be this resemblance between the fossil fauna and the extant fauna of this area? Why would they be so similar?" he asked, repostulating questions that Darwin must have framed. The ancient rodents and the living agoutis, the glyptodonts and the armadillos—why? "I think one of the possible explanations he was mulling over, even as early as 1832, was that one begat the other. Transmutation." But even Brinkman admits that there is only tenuous evidence, "no smoking gun," for his hypothesis about Darwin having converted to evolutionism long before ever striding ashore in the Galápagos.

One cryptic piece of testimony came from Darwin himself, near the end of his life, in the private autobiography he wrote for his family. "During the voyage of the *Beagle*," he reminisced, "I had been deeply impressed by discovering in the Pampean formation great fossil animals covered with armour like that on the existing armadillos." He alluded also to the rheas and to the Galápagos species, differing island by island. "It was evident," Darwin wrote, "that such facts as these, as well as many others, could be explained on the supposition that species gradually become modified; and the subject haunted me." In years since, it has also haunted scholars.

THE *BEAGLE*, having completed its South American survey work and then spent a year circumnavigating the world, reached England in October 1836. Darwin, then 27 and a seasoned naturalist, weary of travel, eager for home, was a changed man in other ways too. He no longer saw himself serving time in a country parsonage; he was committed to a life of science. And he had at least started to lose his belief in the immutability of species. It's not possible to know with certainty, but he seems by then to have identified the great question, though not yet the great answer, that would dominate the rest of his working life.

With his specimens outsourced for expert identification—the birds to Gould, the fossil mammals to Owen, the reptiles to a zoologist named Thomas Bell—he set about putting his thoughts in order and following out his suspicions. He brainstormed in his most private notebook about ostriches, guanacos, and whether "one species does change into another." If so, how might such transmutation occur? About a year and a half later, after adding one crucial piece to his thinking (the idea of excess reproduction and struggle for existence, adopted from an essay on human population by Thomas Malthus), Darwin hit upon his theory: natural selection, whereby the best



Fossils collected by Darwin of the giant ground sloth *Megatherium* had sharp teeth (above), vastly different from those of its living tree-dwelling cousins.

adapted individuals of each population survive to leave offspring and others don't. Then he nurtured, refined, developed, and concealed that theory for 20 years, until a younger man named Alfred Russel Wallace (see "The Man Who Wasn't Darwin" in *National Geographic,* December 2008) struck upon the same idea, forcing Darwin to rush to get his own ready for print.

That was 1858. By then Darwin had begun writing a long, detailed, heavily footnoted treatise on natural selection, but it was only half finished. Panicked, feeling proprietary, yet also reawakened to the wondrous immediacy of the story he had to tell, he shoved the big book aside and quickly composed a more streamlined account. This shorter, slapdash version would be merely an "abstract" of the theory and its supporting data, he claimed. He called it "my abominable volume" because, after decades of cogitation and delay, the writing process was so hurried and painful. He wanted to title it *An Abstract of an Essay on the Origin of Species and Varieties Through Natural Selection,* but his publisher persuaded him to accept something at least marginally more snappy. It appeared in November 1859, titled *On the Origin of Species by Means of Natural Selection* et cetera, and was a sellout success immediately.

Five more editions went to print during Darwin's lifetime. Almost inarguably, it's the most significant single scientific book ever published. After 150 years, people still venerate it, people still deplore it, and *The Origin of Species* continues to exert an extraordinary influence—though, unfortunately, not many people actually read it.

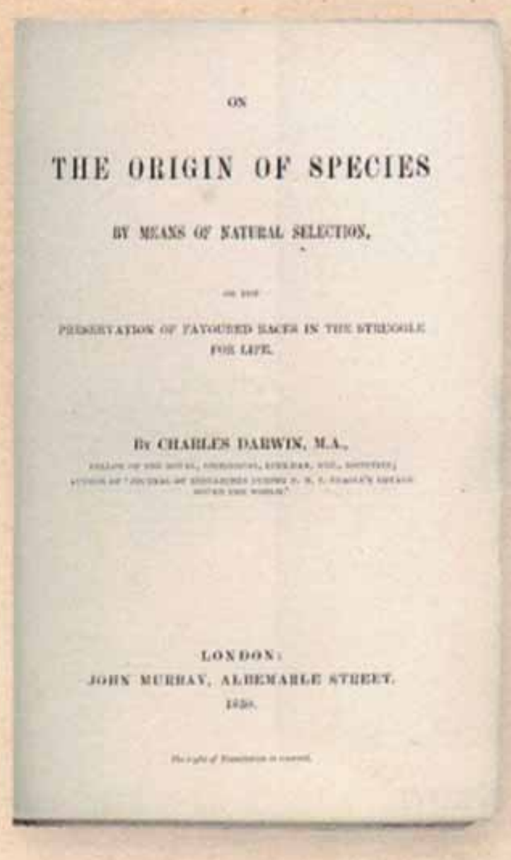
And the forgotten clues that led him to his theory are still largely forgotten. Anyway, they're omitted from the mythic account. Scholars still dispute the significance of those extinct and living Argentine creatures, especially the ground sloths and glyptodonts, the tree sloths and armadillos and rheas. Evidence is mixed, even among the various comments on the matter left behind by Darwin himself. The most telling of those comments, in my view, is one so conspicuously placed that it tends to get overlooked. It comprises the first two sentences of *The Origin of Species,* beginning the book on a nostalgic note. It says:

"When on board H.M.S. 'Beagle,' as naturalist, I was much struck with certain facts in the distribution of the inhabitants of South America, and in the geological relations of the present to the past inhabitants of that continent. These facts seemed to me to throw some light on the origin of species...."

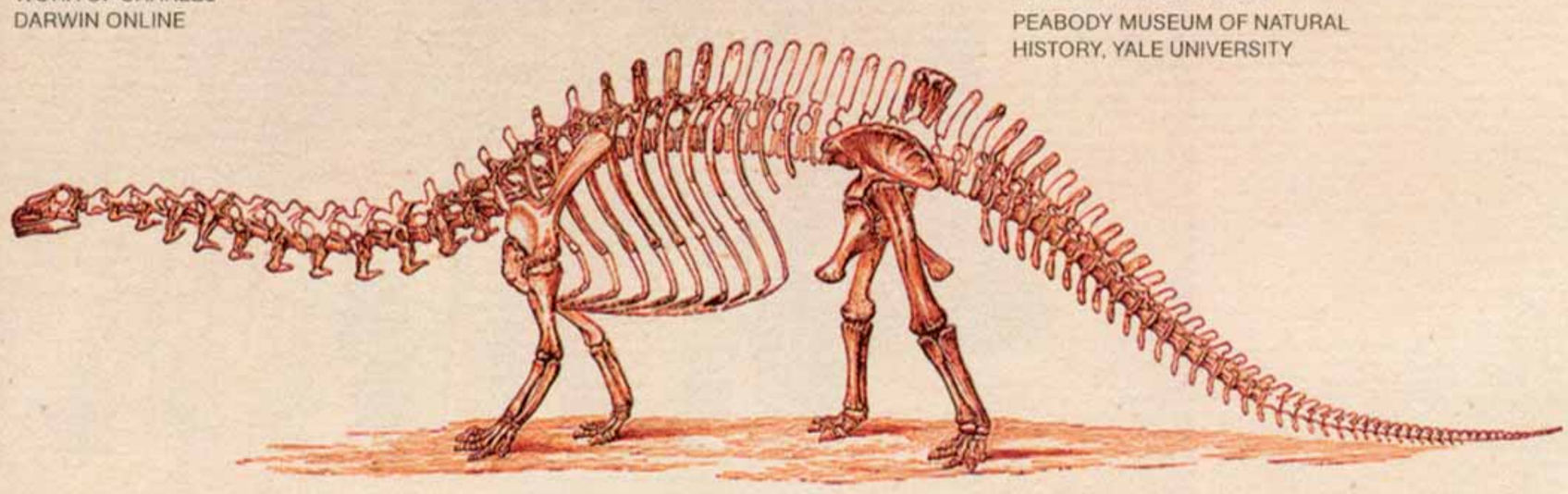
The finches of the Galápagos make their appearance about 400 pages later. □

THE LEGACY OF AN IDEA

Darwin's insights into evolution were astonishing given how little was known in his lifetime about genes and the means of inheritance. It took almost a century to find common ground between evolutionary theory and genetics. The rest is history.



JOHN VAN WYHE, ED., THE COMPLETE WORK OF CHARLES DARWIN ONLINE



NEW FOSSIL DISCOVERIES HELPED FOSTER A PUBLIC INTEREST IN EVOLUTION.
PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY

1859 Darwin publishes *The Origin of Species,* igniting intense controversy over the role of natural selection in evolution and the challenge his theory poses to religion, morality, and social tradition.

1871 Darwin publishes *The Descent of Man,* showing how higher human faculties such as intelligence and morality could have evolved by natural selection in ape-like ancestors.

1882 Darwin dies. Evolution is now generally accepted, but not the notion that mankind descended from apes. Darwin's belief in natural selection as the mechanism for change is also increasingly challenged. Other scientists argue that evolution is directed by internal forces, or by the inheritance of traits acquired by the adult.

ca 1906 Measurements of radioactive decay reveal the Earth is billions of years old, countering claims that there has not been enough time for species to evolve through natural selection.

△ DARWINISM

△ GENETICS

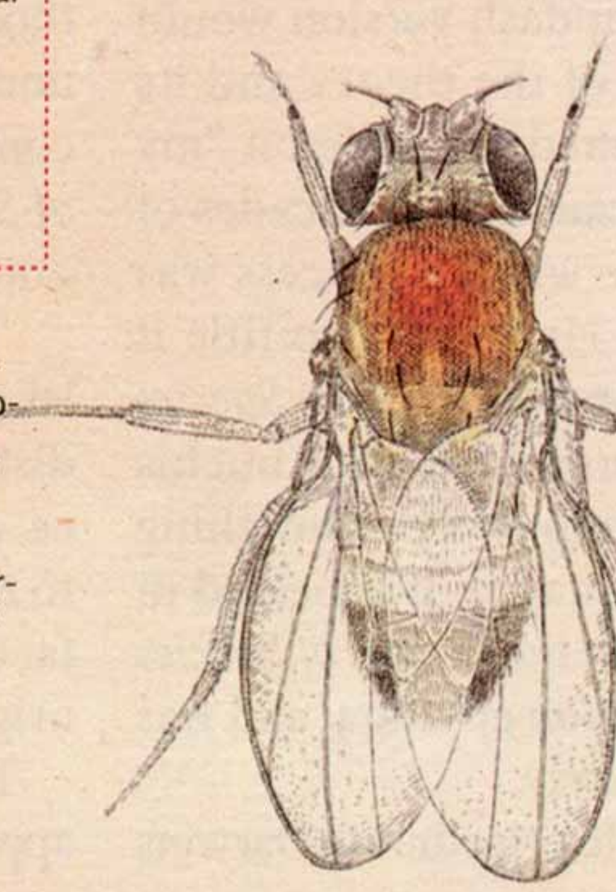
ca 1865 Gregor Mendel, a Moravian monk, demonstrates that "factors" in pea plants—what will later be called genes—do not blend together in successive generations, but instead are inherited independently from one another. His experiments go largely unnoticed.

WELLCOME LIBRARY, LONDON

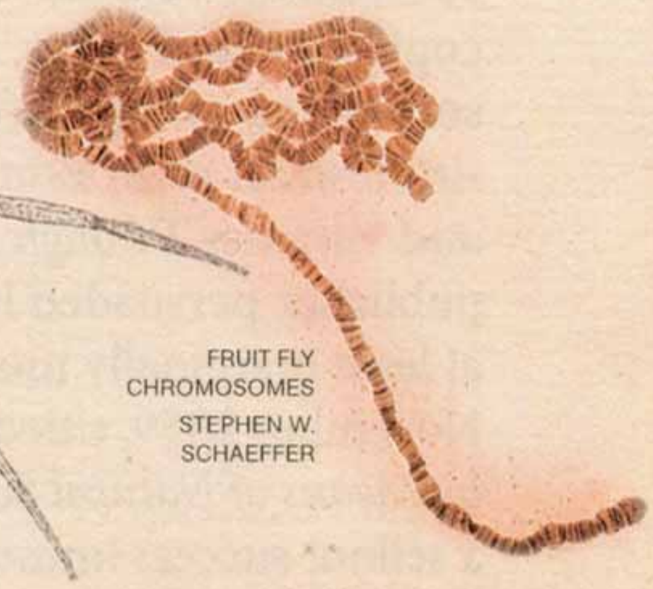
1892 August Weismann postulates that a substance in chromosomes within the cell's nucleus, which he calls the germ plasm, is responsible for the inheritance of traits. The germ plasm is later identified as the material basis of the gene.

ca 1900 Mendel's experiments on pea plants are rediscovered. Rather than offering support for Darwin's theory, they initially bolster the view that species arise through sudden transformations, or "mutations," from one generation to the next, rendering natural selection and adaptation irrelevant.

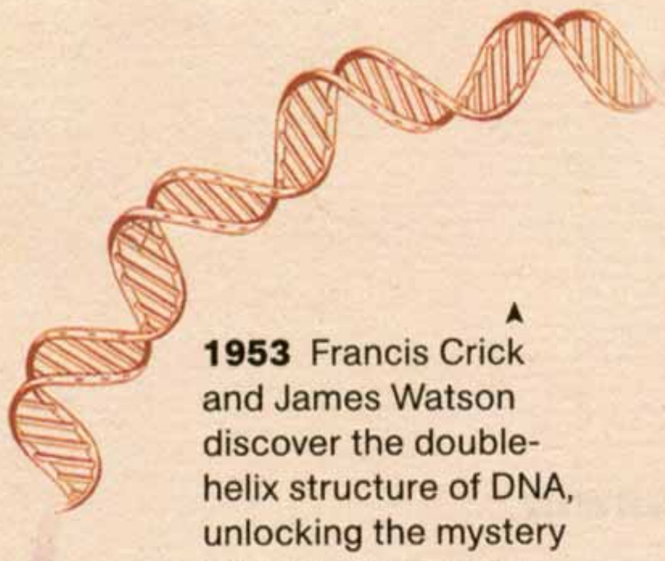
1910–1915 By studying multiple generations of fruit flies, Thomas Hunt Morgan and his colleagues are able to infer the existence of genes, link them to inheritance, and map their locations on chromosomes.



1920s Advances in genetics prove that mutations cannot transform species, but instead provide the raw material of variation for natural selection to work upon. Population geneticists Ronald Fisher, J. B. S. Haldane, and Sewall Wright develop models showing how small, favorable mutations can spread throughout a population.



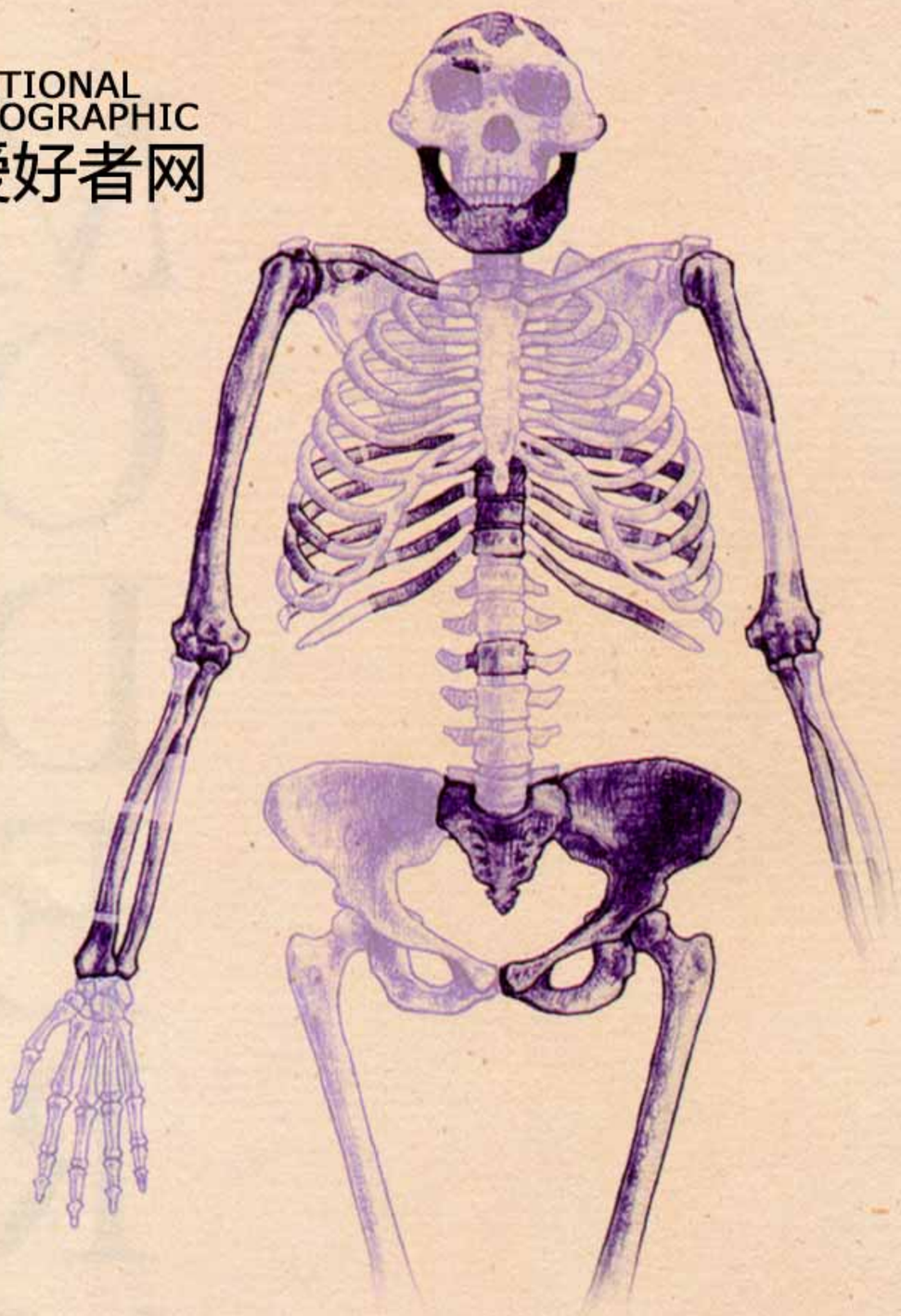
FRUIT FLY CHROMOSOMES
STEPHEN W. SCHAEFFER



1953 Francis Crick and James Watson discover the double-helix structure of DNA, unlocking the mystery of how genetic information is passed from one generation to the next.

1960s–1970s A series of fossil discoveries by the Leakeys, Donald Johanson, and others working in the Great Rift Valley of East Africa climaxes in 1974 with the discovery of the partial skeleton of a 3.2-million-year-old hominid in Ethiopia. Nicknamed "Lucy," the skeleton helps define the new species *Australopithecus afarensis*, which Johanson and colleagues place at the base of the human lineage.

1970s Niles Eldredge and Stephen Jay Gould challenge the modern synthesis view that evolution proceeds gradually, arguing that species remain static over long periods of time, to be rapidly replaced by related species that have evolved in isolation. The publication of Richard Dawkins's *The Selfish Gene* and E. O. Wilson's *Sociobiology* triggers intense debate over the mechanisms of evolutionary change and the degree to which genes determine behavior.

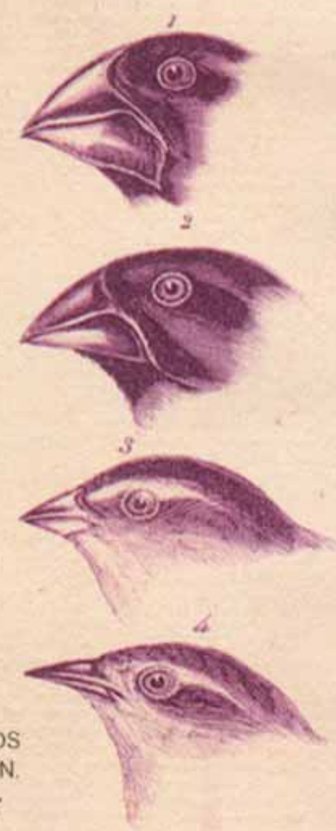


"LUCY" FOSSIL 40% COMPLETE (DARK COLOR).
ART BY GREG HARLIN

MODERN SYNTHESIS

1930s–1940s After decades of pursuing often conflicting paths of research, biologists, population geneticists, paleontologists, and field naturalists reach accord in a "modern synthesis" of reinvigorated Darwinism. Evolution is seen to proceed through natural selection and other random mechanisms, with new species originating through the gradual accumulation of mutations in isolated populations.

Mid-1970s to present Peter and Rosemary Grant's studies of finch populations in the Galápagos Islands demonstrate that natural selection can cause evolutionary change "in real time," rather than only over the course of thousands of years, as Darwin believed. The same phenomenon is later observed in other organisms. ➤



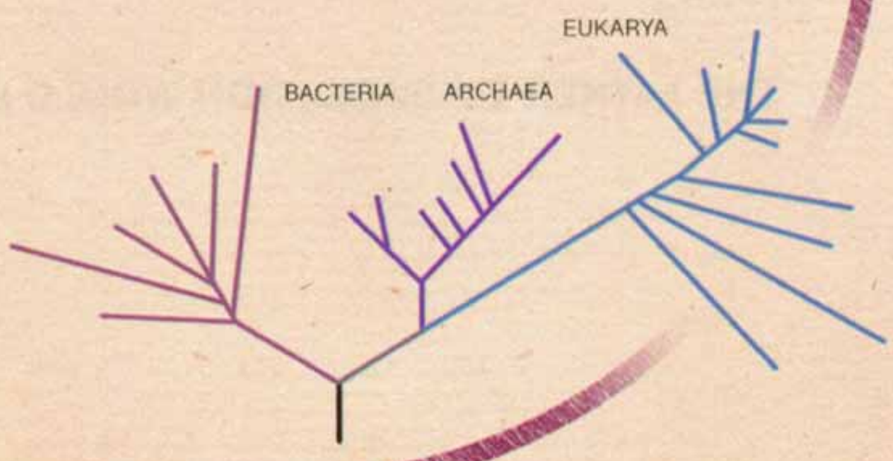
FINCHES FROM THE GALÁPAGOS ISLANDS OBSERVED BY DARWIN.
MARY EVANS PICTURE LIBRARY

Present day Biologists continue to expand on Darwin's initial insights, incorporating new genetic, paleontological, and behavioral evidence. Variation among species is seen to be in part the result of mechanisms controlling how genes are switched on and off during an organism's development.

2003 Sequencing of the human genome is completed. Close similarity between the human and chimpanzee genomes underscores their descent from a common ancestor.

1977 Carl Woese redefines the tree of life. By classifying organisms by their genetic rather than their physical similarities, he shows that life is composed of three domains, splitting microbes into bacteria and archaea.

FRUIT FLY, DNA, AND EMBRYO ART BY JOHN BURGOYNE



JUAN VELASCO AND AMANDA HOBBS, NG STAFF. SOURCES: PETER J. BOWLER, QUEEN'S UNIVERSITY BELFAST; JANE MAIENSCHEIN AND MANFRED D. LAUBICHLER, ARIZONA STATE UNIVERSITY

THE DARWIN BICENTENNIAL

PART TWO

MODERN DARWINS

THE FATHER OF EVOLUTION WOULD BE THRILLED TO SEE THE SCIENCE HIS THEORY HAS INSPIRED.

ONE LIGHT, ONE DARK, THESE TWO MICE ARE THE SAME SPECIES, AND PARTICIPANTS IN GROUNDBREAKING SCIENCE EXPLORING HOW NATURAL SELECTION ACTS ON GENES, CREATING A WORLD OF DIVERSITY.

BY MATT RIDLEY · PHOTOGRAPHS BY LYNN JOHNSON

JUST TWO WEEKS BEFORE HE DIED, Charles Darwin wrote a short paper about a tiny clam found clamped to the leg of a water beetle in a pond in the English Midlands. It was his last publication. The man who sent him the beetle was a young shoemaker and amateur naturalist named Walter Drawbridge Crick. The shoemaker eventually married and had a son named Harry, who himself had a son named Francis. In 1953, Francis Crick, together with a young American named James Watson, would make a discovery that has led inexorably to the triumphant vindication of almost everything Darwin deduced about evolution.

The vindication came not from fossils, or from specimens of living creatures, or from dissection of their organs. It came from a book. What Watson and Crick found was that every organism carries a chemical code for its own creation inside its cells, a text written in a language common to all life: the simple, four-letter code of DNA. "All the organic beings which have ever lived on this earth have descended from some one primordial form," wrote Darwin. He was, frankly, guessing. To understand the story of evolution—both its narrative and its mechanism—modern Darwins don't have to guess. They consult genetic scripture.

Consider, for instance, the famous finches of the Galápagos. Darwin could see that their beaks were variously shaped—some broad and deep, others elongated, still others small and short. He surmised (somewhat belatedly) that in spite of these differences, all the Galápagos finches were close cousins. "Seeing this gradation and diversity of structure in one small, intimately related group of birds," he wrote in *The Voyage of the Beagle,* "one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends."

This, too, was inspired guesswork. But by analyzing the close similarity of their genetic codes, scientists today can confirm that the Galápagos finches did indeed descend from a single ancestral species (a bird whose closest living relative is the dull-colored grassquit).

DNA not only confirms the reality of evolution, it also shows, at the most basic level, how it reshapes living things. Recently, Arhat Abzhanov of Harvard University and Cliff Tabin of Harvard Medical School pinned down the very genes responsible for some of those beak shapes. Genes are sequences of DNA letters that when activated by the cell make a particular protein. Abzhanov and Tabin found that when the gene for a protein called BMP4 is activated (scientists use the word "expressed") in the growing jaw of a finch embryo, it makes the beak deeper and wider. This gene is most strongly expressed in the large ground finch *(Geospiza magnirostris),* which uses its robust beak to crack open large seeds and nuts. In other finches, a gene expresses a protein called calmodulin, which makes a beak long and thin. This gene is most active in the large cactus finch *G. conirostris,* which uses its elongated beak to probe for seeds in cactus fruit.

In another set of islands, off the Gulf Coast of Florida, beach mice have paler coats than mice living on the mainland. This camouflages them better on pale sand: owls, hawks, and herons eat more of the poorly disguised mice, leaving the others to breed. Hopi Hoekstra, also at Harvard, and her colleagues traced the color difference to the change of a single letter in a single gene, which cuts down the production of pigment in the fur. The mutation has occurred since the

beach islands formed less than 6,000 years ago.

Darwin's greatest idea was that natural selection is largely responsible for the variety of traits one sees among related species. Now, in the beak of the finch and the fur of the mouse, we can actually see the hand of natural selection at work, molding and modifying the DNA of genes and their expression to adapt the organism to its particular circumstances.

Darwin, who assumed that evolution plodded along at a glacially slow rate, observable only in the fossil record, would be equally delighted by another discovery. In those same Galápagos finches, modern Darwins can watch evolution occur in real time. In 1973, Peter and Rosemary Grant, now of Princeton University, began annual observations of the finch populations on the tiny Galápagos island of Daphne Major. They soon discovered that the finches in fact evolved from one year to the next, as conditions on the island swung from wet to dry and back again. For instance, Daphne Major initially had only two regularly breeding ground finches, one of which was the medium ground finch *(G. fortis)* that fed on small seeds. When severe drought struck the island in 1977 and small seeds became scarce, the medium finches were forced to switch to eating bigger, harder seeds. Those with larger beaks fared better and survived to pass on the trait to their offspring.

Another shift took place after a competitor arrived in 1982: the large ground finch *(G. magnirostris),* which also eats large, tough seeds. For many years the two species coexisted, and in 2002 both became unusually abundant. But then drought struck, and by 2005, only 13 large and 83 medium ground finches remained

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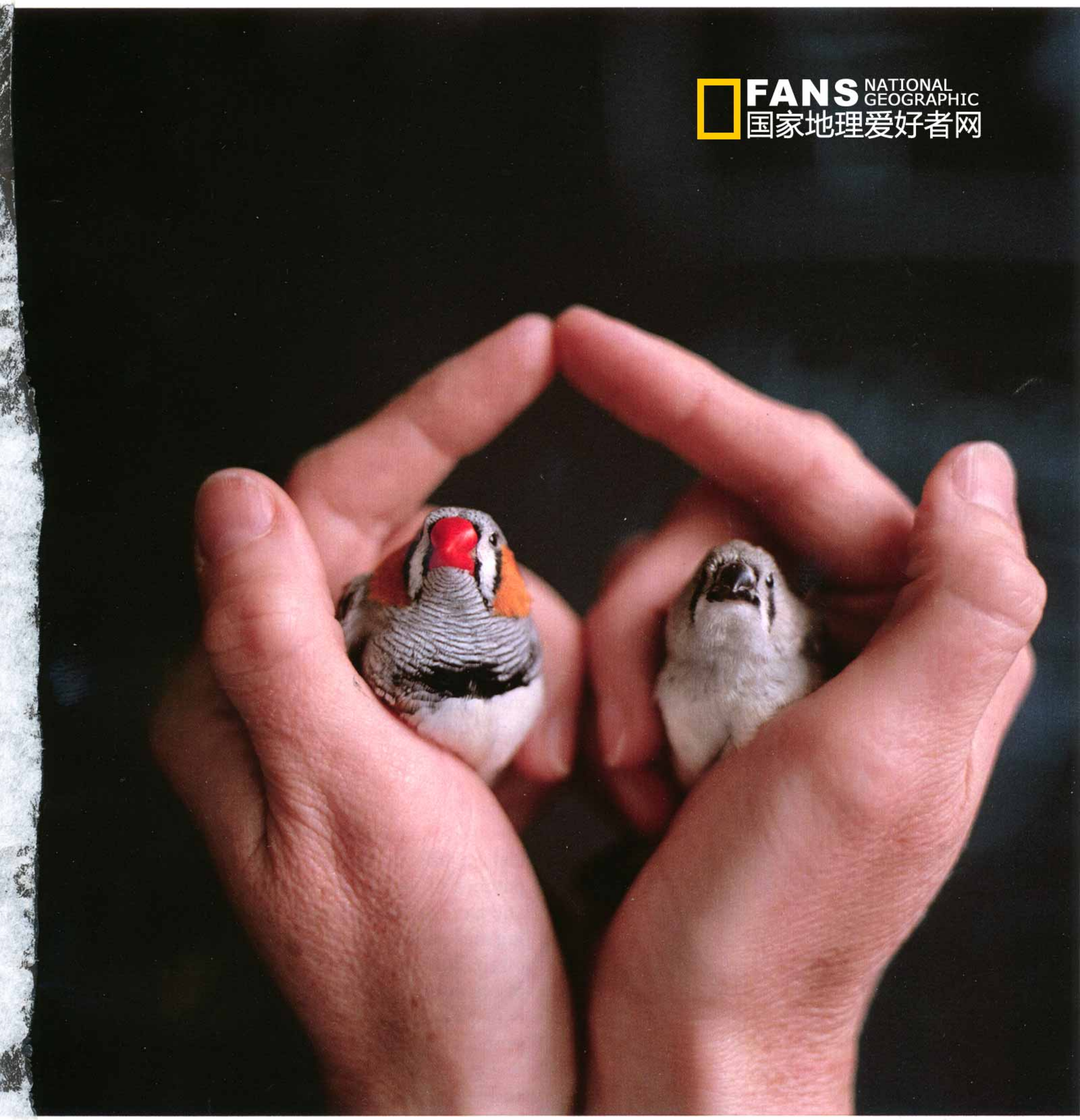
Matt Ridley's latest book is Francis Crick: Discoverer of the Genetic Code. *Lynn Johnson photographed "Village Health Workers" in December 2008.*

To understand the story of evolution—both its narrative and its mechanism—modern Darwins don't have to guess. They consult genetic scripture.

FANS NATIONAL GEOGRAPHIC
国家地理爱好者网

GUPPY TEST SUBJECTS BUMP AGAINST THE CONFINES OF A HOLDING TANK (LEFT). LATER THEY'LL SWIM FREE IN POOLS THAT DOT ISOLATED STREAMS IN TRINIDAD, WHERE BIOLOGIST DAVID REZNICK (ABOVE) CONTROLS THE GUPPIES' EXPOSURE TO PREDATORS, THEN TRACKS CHANGES IN POPULATIONS. BODY SIZE, AGE AT MATURITY, AND NUMBER OF YOUNG HAVE EVOLVED IN HIS EXPERIMENTS. "DARWIN THOUGHT EVOLUTION BY NATURAL SELECTION WAS TOO SLOW TO OBSERVE," REZNICK SAYS. "BUT WE'RE WATCHING EVOLUTION OCCUR OVER JUST A FEW YEARS."

AN ADULT FINCH (RIGHT, WITH RED BEAK) TEACHES ITS SONGS TO A CHICK. THE *FOXP2* GENE IS KEY FOR THE PROTÉGÉ TO LEARN VOCALIZATIONS. DISABLE THE GENE, AND THE YOUNGSTER WILL CHIRP NONSENSE, SAYS NEUROBIOLOGIST CONSTANCE SCHARFF (ABOVE), WHO FINDS INSPIRATION SWIMMING NEAR HER BERLIN HOME. HER DISCOVERIES TRACE A THREAD WOVEN THROUGH ALL CREATURES: "THE GENETIC HARDWARE A BIRD USES TO LEARN TO SING PROBABLY ISN'T FAR FROM WHAT A MOUSE USES TO LEARN TO RUN A MAZE, AND WHAT YOU USE TO LEARN TO SPEAK."



In the beak of the finch and the fur of the mouse, we can see the hand of natural selection at work, molding and modifying individual genes to adapt the organism to its particular circumstances.

alive. Remarkably, instead of adjusting to the drought by eating bigger seeds as they had 28 years before, the surviving medium finches experienced a marked reduction in the size of their beaks, as in competition with their larger cousins they struggled to carve out a niche by surviving on very small seeds. A finch with a smaller beak is not a new species of finch, but Peter Grant reckons it might take only a few such episodes before a new species is established that would not choose to reproduce with its parent species.

The variation seen among the Galápagos finches is a classic example of "adaptive radiation," each species evolving from a common ancestor to exploit a special kind of food. Another famous radiation took place on a different set of islands—islands of water rather than land. The lakes and rivers of Africa's Great Rift Valley contain some 2,000 species of cichlid fish that have evolved from a few ancestors, some in an instant of geologic time. For example, Lake Victoria, the largest of those lakes, was completely dry just 15,000 years ago. Its 500 diverse species of cichlid have all evolved since then from a handful of species of uncertain origin. Like the finches, cichlid fish species have adapted to diets in different habitats, such as rocky or sandy patches of lake beds. Some species eat algae and have densely packed teeth suited to scraping and pulling plant matter, while others feed on snails and have thick, powerful jaws capable of crushing open their shells. And what gene is responsible for thickening those jaws? The gene for the protein BMP4—the same gene that makes the Galápagos ground finch's beak deep and wide. What better evidence for Darwin's belief in the commonality of all species than to find the same gene doing the same job in birds and fish, continents apart?

In *The Origin of Species,* Darwin tactfully left unspoken how his theory would extend that commonality to include humankind. A decade later he confronted the matter head-on in *The Descent of Man.* He would be delighted to know that a certain gene, called *FOXP2,* is critical for the normal development of both speech in

people and song in birds. In 2001 Simon Fisher and his colleagues at the University of Oxford discovered that a mutation in this gene causes language defects in people. He later demonstrated that in mice, the gene is necessary for learning sequences of rapid movement; without it, the brain does not form the connections that would normally record the learning. In human beings, presumably, *FOXP2* is crucial to learning the sophisticated flicker of lips and tongue with which we express our thoughts.

Constance Scharff of the Free University of Berlin then discovered that this very same gene is more active in a part of the brain of a young zebra finch, just when the bird learns to sing. With fiendish ingenuity, her group infected finches' brains with a special virus, carrying a mirror-image copy of part of the *FOXP2* gene, which stifled the gene's natural expression. The result was that birds not only sang more variably than usual but also inaccurately imitated the songs of adults—in much the same way as children with mutant *FOXP2* genes produce variable and inaccurately copied speech.

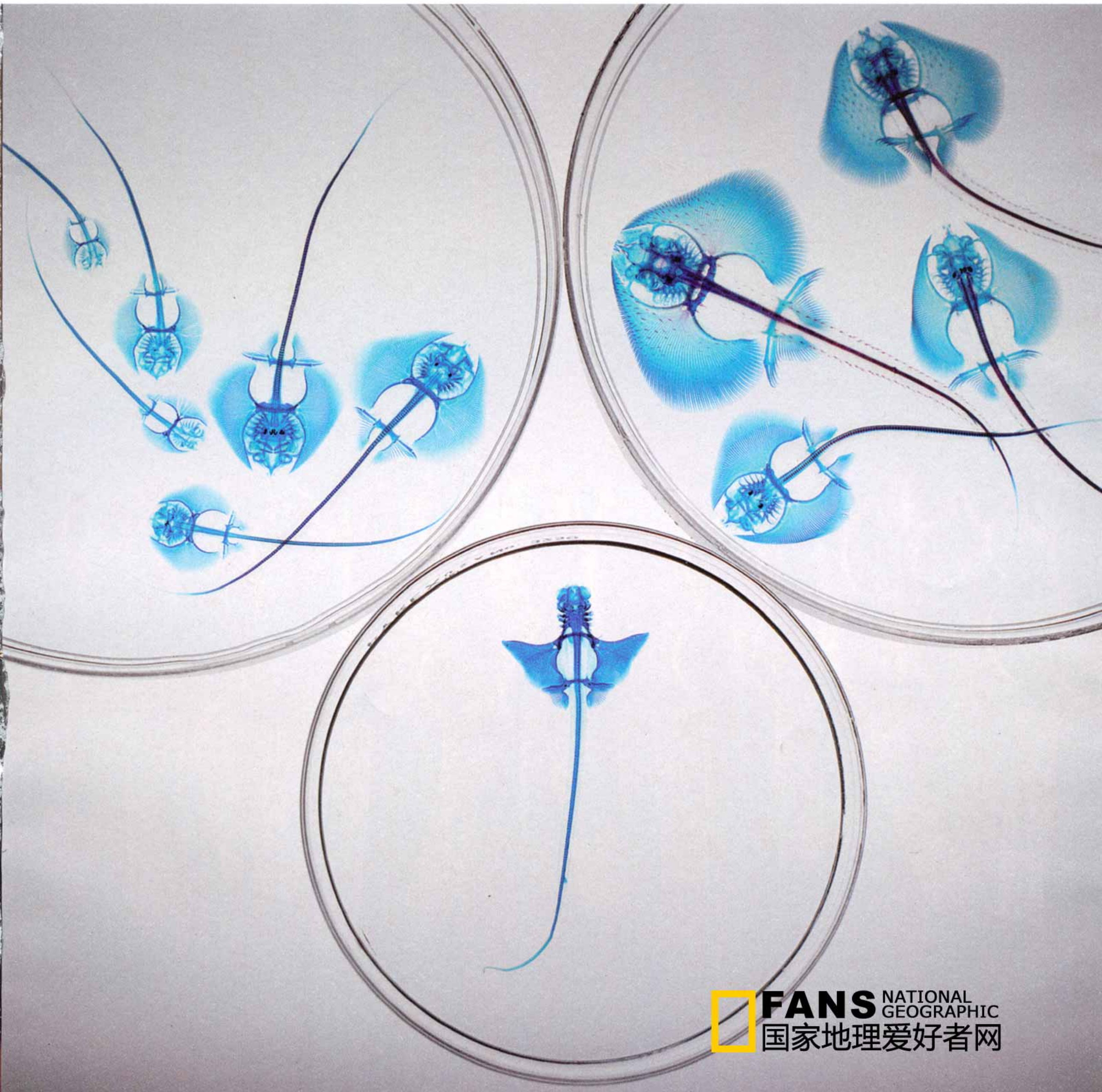
TODAY'S DARWINS see in detail how pressures such as competition and a changing environment can forge new species. But Darwin also proposed another evolutionary driver: sexual selection. In Lake Victoria, cichlid fish have vision adapted to the light in their surrounding environment—at greater depths, where available light is shifted toward the red end of the spectrum, their visual receptors are biased toward red light, while closer to the surface they see better in blue. Ole Seehausen of the University of Bern and the Swiss Federal Institute for Aquatic Science and Technology has found that male cichlids have evolved conspicuous colors to catch the female eye: typically red nearer the lake bottom, and blue at shallower depth. The blue and red populations appear to be genetically diverging—suggesting they represent two separate species in the making.

If natural selection is survival of the fittest (a phrase coined by the philosopher Herbert Spencer, not by Darwin), then sexual selection is reproduction of the sexiest. It has the delightful effect of generating weapons, ornaments, songs, and colors, especially on male animals. Darwin believed that some such ornaments, such as stags' antlers, helped males fight each other for females; others, such as peacocks' tails, helped males "charm" (his word) females into mating. It was, in truth, an idea born of desperation, because useless beauty worried him as an apparent exception to the ruthlessly practical workings of natural selection. He wrote to the American botanist Asa Gray in April 1860 that "The sight of a feather in a peacock's tail, whenever I gaze at it, makes me sick!"

His notion of sexual selection was politely ignored by most Victorian opinion, which was mildly scandalized by the thought of females actively choosing a mate, rather than submitting coyly to the advances of males. Even biologists dropped the idea for roughly a century, because they became obsessed with arguing that traits evolve to suit the species, rather than to suit the individual. But we now know Darwin was right all along. In all sorts of species, from fish and birds to insects and frogs, females approach the males with the most elaborate displays, and invite them to mate.

Darwin did not speculate much on why a female would choose an ornamented male. It is a question that still excites biologists, because they have two equally good answers to it. One is simply fashion: When females are choosing gorgeous males, other females must follow suit or risk having sons that do not attract females. The other is more subtle. The tail of a peacock is an exhausting and dangerous thing for the bird to grow. It can only be done well by the healthiest males: parasites, starvation, and careless preening will result in duller plumage. So bright plumage constitutes what evolutionary biologists call an "honest indicator of fitness." Substandard peacocks cannot fake it. And peahens, by instinctively picking the best males, thereby unknowingly pass on the best genes to their offspring.

In one of his flights of fancy, Darwin argued that sexual selection might account for human



FILLING A BLANK ON THE EVOLUTIONARY MAP, PALEONTOLOGIST NEIL SHUBIN (LEFT) SKETCHES THE SKULL OF 375-MILLION-YEAR-OLD *TIKTAALIK ROSEAE*, DUG FROM CANADIAN ARCTIC ROCKS IN 2004. A FISH WITH LAND-ANIMAL FEATURES, *TIKTAALIK* HELPS TRACK LIFE'S JOURNEY FROM SEA TO LAND. IN THE LAB, SHUBIN, A NATIONAL GEOGRAPHIC GRANTEE, STUDIES HOW BODY PLANS EVOLVE. IN LARVAL SKATES (ABOVE), HE TINKERED WITH A GENE THAT, IN HUMANS, INFLUENCES HAND SHAPE. THE RESULT WAS A PREDICTABLE CHANGE IN FIN SHAPE (AT BOTTOM).

THE PELT OF A MOUSE THAT BURROWED IN PALE SAND (ABOVE, AT FAR LEFT) HAS SUBTLE PIGMENTATION. AT THE OTHER END OF THE SPECTRUM, LOAMY INLAND SOIL FAVORED DARKER FUR. THEY'RE THE SAME SPECIES—OLDFIELD MICE—AND EVOLUTIONARY BIOLOGIST HOPI HOEKSTRA (RIGHT) IS DELVING INTO GENE MECHANICS TO SHOW HOW ANIMALS ADAPT TO THEIR ENVIRONMENTS. TRAPPING MICE ON FLORIDA BEACHES IS ROUTINE, BUT STILL THRILLING, SHE SAYS: "OPENING A TRAP WITH A MOUSE IS A LITTLE LIKE CHRISTMAS MORNING."

MOUSE PELTS PHOTOGRAPHED AT THE MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY

racial differences: "We have seen that each race has its own style of beauty.... The selection of the more attractive women by the more powerful men of each tribe, who would rear on an average a greater number of children, [would] after the lapse of many generations modify to a certain extent the character of the tribe." The jury is still out on that particular idea, but there are hints that Darwin might be at least partly right.

Take blue eyes. Darwin, like many Europeans, had blue eyes. In early 2008, Hans Eiberg and his colleagues at the University of Copenhagen announced that they had found the genetic mutation common to all pure blue-eyed people. The mutation is a single letter change, from A to G, on the long arm of chromosome 15, which dampens the expression of a gene called *OCA2,* involved in the manufacture of the pigment that darkens the eyes. By comparing the DNA of Danes with that of people from Turkey and Jordan, Eiberg calculated that this mutation happened only about 6,000-10,000 years ago, well after the invention of agriculture, in a particular individual somewhere around the Black Sea. So Darwin may have gotten his blue eyes because of a single misspelled letter in the DNA in the baby of a Neolithic farmer.

Why did this genetic change spread so successfully? There is no evidence that blue eyes help people survive. Perhaps the trait was associated with paler skin, which admits more of the sunlight needed for the synthesis of vitamin D. That would be especially important as people in less sunny northern climates became more dependent on grain as a food source, which is deficient in vitamin D. On the other hand, blue-eyed people may have had more descendants chiefly because they happened to be more attractive to the opposite sex in that geographic region. Either way, the explanation leads straight back to Darwin's two theories—natural and sexual selection.

Intriguingly, the spelling change that causes blue eyes is not in the pigment gene itself, but in a nearby snippet of DNA scripture that controls the gene's expression. This lends support to an idea that is rushing through genetics and evolutionary biology: Evolution works not just by changing genes, but by modifying the way those genes are switched on and off. According to Sean Carroll of the University of Wisconsin at Madison, "The primary fuel for the evolution of anatomy turns out not to be gene changes, but changes in the regulation of genes that control development."

THE NOTION OF genetic switches explains the humiliating surprise that human beings appear to have no special human genes. Over the past decade, as scientists compared the human genome with that of other creatures, it has emerged that we inherit not just the same number of genes as a mouse—fewer than 21,000—but in most cases the very same genes. Just as you don't need different words to write different books, so you don't need new genes to make new species: You just change the order and pattern of their use.

Perhaps more scientists should have realized this sooner than they did. After all, bodies are not assembled, like machines in factories; they grow and develop, so evolution was always going to be about changing the process of growth rather than specifying the end product of that growth. In other words, a giraffe doesn't have special genes for a long neck. Its neck-growing genes are the same as a mouse's; they may just be switched on for a longer time, so the giraffe ends up with a longer neck.

Just as Darwin drew lessons from both fossil armadillos and living rheas and finches (see "Darwin's First Clues," page 34), his scientific descendants combine insights from genes with insights from fossils to understand the history of life. In 2004, Neil Shubin of the University of Chicago and his colleagues found a 375-million-year-old fossil high in the Canadian Arctic—a creature that fit neatly in the gap between fish and land-living animals. They named it *Tiktaalik,* which means "large freshwater fish" in the local Inuktitut language. Although it was plainly a fish with scales and fins, *Tiktaalik* had a flat, amphibian-style head with a distinct neck, and bones inside its fins corresponding to the upper

and lower arm bones and even the wrists of land animals: a missing link, if ever there was one. It may even have been able to live in the shallows or crawl in the mud when escaping predators.

Equally intriguing, however, is what *Tiktaalik* has taught Shubin and his colleagues in the laboratory. The fossil's genes are lost in the mists of time. But, inspired by the discovery, the researchers studied a living proxy—a primitive bony fish called a paddlefish—and found that the pattern of gene expression that builds the bones in its fins is much the same as the one that assembles the limb in the embryo of a bird, a mammal, or any other land-living animal. The difference is only that it is switched on for a shorter time in fish. The discovery overturned a long-held notion that the acquisition of limbs required a radical evolutionary event.

"It turns out that the genetic machinery needed to make limbs was already present in fins," says Shubin. "It did not involve the origin of new genes and developmental processes. It involved the redeployment of old genetic recipes in new ways."

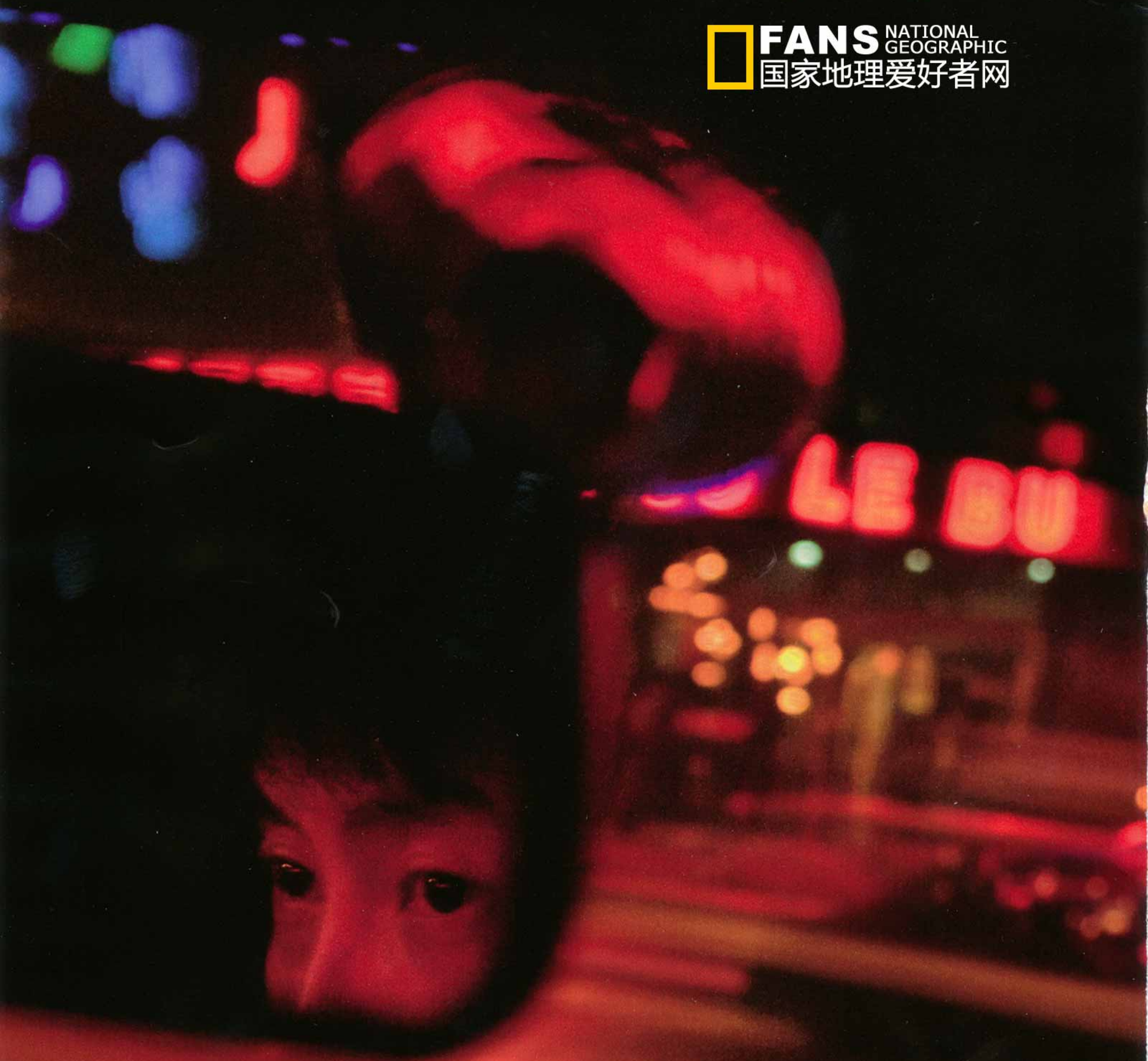
Though modern genetics vindicates Darwin in all sorts of ways, it also turns the spotlight on his biggest mistake. Darwin's own ideas on the mechanism of inheritance were a mess—and wrong. He thought that an organism blended together a mixture of its parents' traits, and later in his life he began to believe it also passed on traits acquired during its lifetime. He never understood, as the humble Moravian monk Gregor Mendel did, that an organism isn't a blend of its two parents at all, but the composite result of lots and lots of individual traits passed down by its father and mother from their own parents, and their grandparents before them.

Mendel's paper describing the particulate nature of inheritance was published in an obscure Moravian journal in 1866, just seven years after *The Origin of Species*. He sent it hopefully to some leading scientists of the day, but it was largely ignored. The monk's fate was to die years before the significance of his discovery was appreciated. But his legacy, like Darwin's, has never been more alive. □

What better evidence for Darwin's belief in the commonality of all species than to find the same gene doing the same job in birds and fish, continents apart?

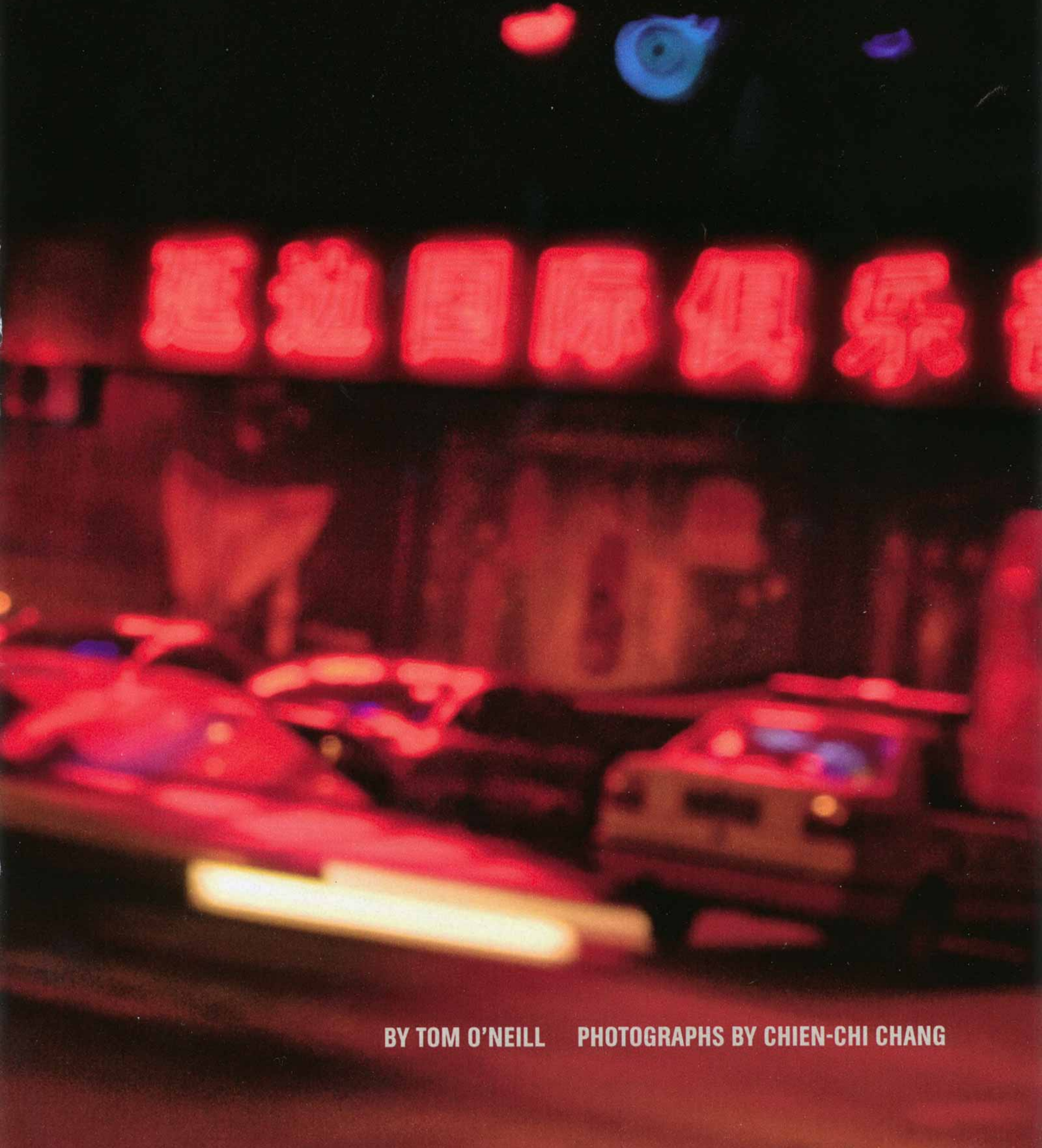
"HOW DID A GIRAFFE GET ITS LONG NECK AND SPECTACULAR FUR PATTERNS?" WONDERS GENETICIST SEAN CARROLL (ABOVE, AT A ZOO IN MADISON, WISCONSIN). HIS WORK FOCUSES ON FINDING THE GENES CRITICAL TO GENERATING SPECIFIC ELEMENTS OF ANATOMY AND TRACKING HOW THOSE GENES ORCHESTRATE HIGHLY VARIABLE AND OFTEN EYE-CATCHING PATTERNS AND FORMS, FROM INTRICATELY DECORATED BUTTERFLY WINGS (LEFT) TO A TIGER'S STRIPES. "THESE EXTREMES IN THE ANIMAL KINGDOM," CARROLL SAYS, "HAVE INSPIRED BIOLOGISTS FOR CENTURIES."

For those fleeing their brutal homeland, the 2,000 perilous miles across China are just the beginning. Then comes the challenge of making a new life.



CHINA | In the border city of Yanji a missionary cautiously looks for North Koreans needing help on their long journey to freedom.

ESCAPE FROM NORTH KOREA



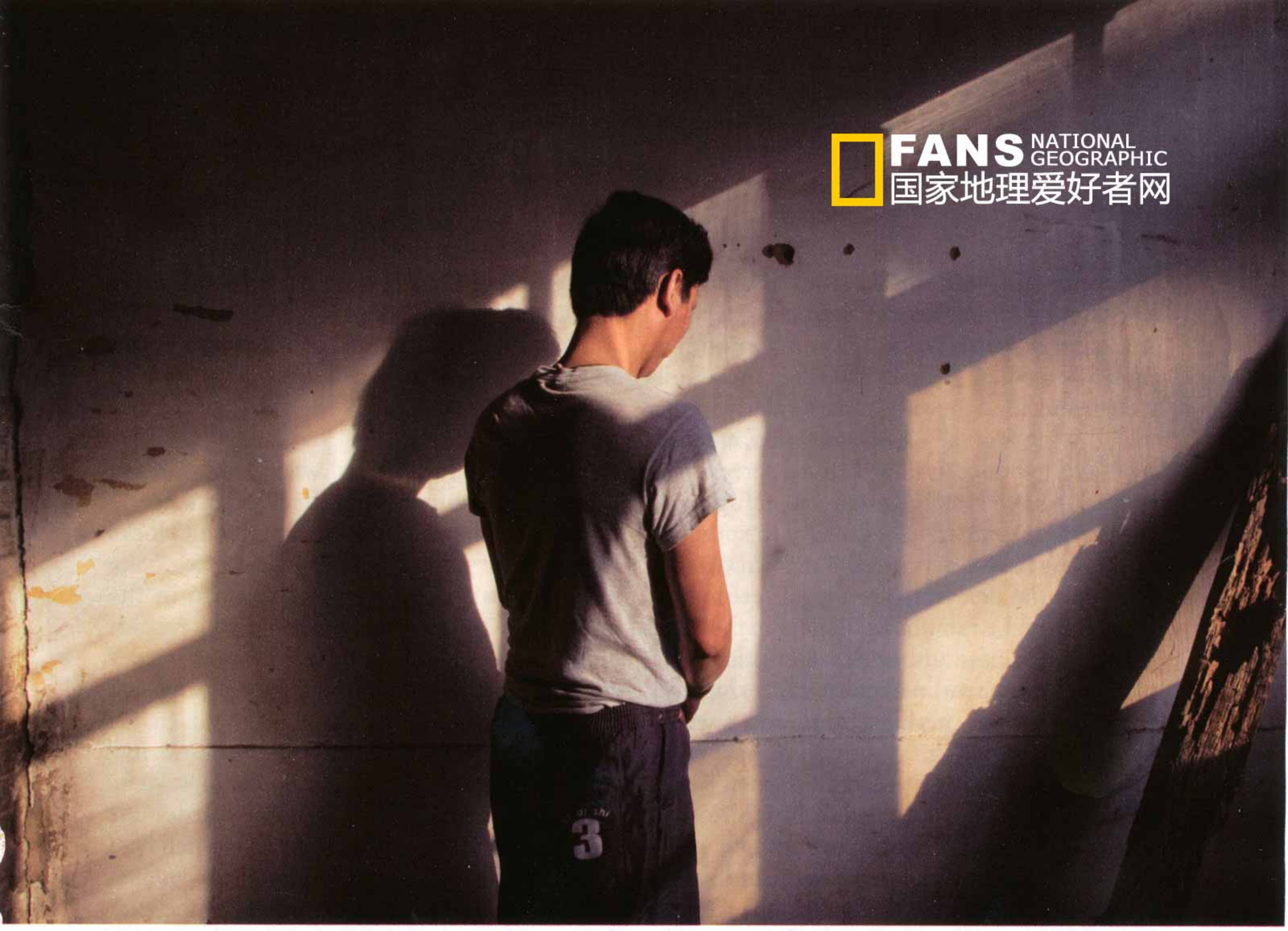
BY TOM O'NEILL PHOTOGRAPHS BY CHIEN-CHI CHANG

NORTH KOREA | Peering from a bunker on the Tumen River, soldiers have orders to shoot anyone trying to sneak into or out of North Korea. Cross-shaped posts possibly support electrical wires. Many guards take bribes to let defectors cross to China.

A frigid November day pressed against the windows of a shabby apartment building in the Chinese city of Yanji, ten miles from the North Korean border. Three stories up, footsteps stopped outside a door. At the sound, two young women hurried to a back room and shrank against a wall. Then came a knock. The women, defectors from North Korea, bowed their heads, expecting the worst. If the Chinese police found them without identity cards, they would be deported in handcuffs and chains. Back in North Korea, they would be sentenced to years of hard labor in a prison camp.

Their former boss, the Korean-Chinese owner of an Internet sex operation, was hunting them as well. For the past year Red and White (aliases I gave them in my notebook in case police stopped me) had been held in a room as virtual prisoners, forced to "talk dirty" and take off their clothes in front of a camera for online clients in South Korea. The night before, Christian missionaries had helped them escape and brought them to this safe house.

The knocking continued. A man called out, "Are you there? Open up." White recognized the voice: It came from one of their rescuers. She rushed to the door and fumbled it open. Standing there was a thin man with an awkward smile, holding up a cooker and a bag of rice. "You must be hungry." Bowing in greeting, the women led him into the kitchen. Soon the room filled with their chatter. The missionary also brought a message: "Be ready to leave soon. The call just came."



BORDERLANDS | Barbed wire marks the high-security zone where the frontiers of Russia, China, and North Korea meet (left) at the Tumen River. Elsewhere the border is more porous. The defector called Black in the story stole across the frozen Tumen at night. In China he hid in a church shelter (above), fearing arrest and deportation.

Some 50,000 North Koreans, and possibly many more, are hiding in China, most in cities and villages along the remote 900-mile-long border between the two countries. Uncounted others have come for a few months and then slipped back to North Korea with food and money. Yet many stay on, unable or unwilling to return to their cruel homeland. They are left with two desperate choices: Keep hiding—often as prisoners of exploitative employers—or embark on the Asian underground railroad, a perilous journey by foot, vehicle, and train across China and Southeast Asia. Confronted with an obstacle course of checkpoints, informants, and treacherous terrain, numerous defectors have been caught. But aided by a small band of humanitarians and by smugglers charging $3,000 and up, some 15,000 have reached safe haven, most often in South Korea. There, traumatized and barely skilled, they face the most formidable challenge of all: starting over.

The exodus from North Korea began in the mid-1990s as a devastating famine broke out across the country. In the worst hit areas, people were reduced to eating roots, grasses, and tree bark. More than 2.5 million people would perish. At first the Chinese openly aided the desperate border crossers. But following protests from the North Korean government, China cracked down. Police regularly raid neighborhoods and villages to ferret out North Korean runaways, who live in terror of being caught and deported. In North Korea, crossing the border without permission is punishable by three to five years in a prison labor camp,

and conspiring with missionaries or others to reach South Korea is considered treason, with offenders starved, tortured, and sometimes publicly executed. Human rights organizations and various foreign leaders, particularly in the United States and the European Union, are urging China to honor its international agreements by treating the North Koreans as refugees, a status they're entitled to because of the punishments they face if deported. But China maintains that the defectors are illegal "economic migrants." In the months leading up to the 2008 Olympics, Chinese authorities intensified their efforts to apprehend defectors, capturing and deporting dozens, perhaps hundreds, a week. Yet they keep coming.

Most sneak across the narrow Tumen River, which forms roughly a third of North Korea's border with China, crossing in summer, when the river is shallow enough to wade, or in winter, when it's possible to walk across the ice. The Chinese side of the Tumen looks strangely benign—it isn't crawling with soldiers or bristling with electrified fences. On the opposite bank, in North Korea, bunkers every few hundred yards look more like abandoned hunting blinds than guard posts. Visiting the Chinese side, I asked my driver why the border isn't better protected. He smiled faintly. "The North Koreans figure they'll catch troublemakers before they ever reach the river, and the Chinese are sure they can find North Koreans anytime they want."

Apart from the guard posts, the view across the river betrays nothing of the North Korean reality beyond: the dozens of prison camps for citizens deemed insufficiently loyal, the malnutrition and hunger that stalk as many as a fourth of the country's 23 million people, the number of people in uniform—at least a million—who bully and spy on the citizenry. Collective farms, most appearing to lack electricity, dot the river plain. A single-lane bridge leads to Namyang, a town of unpainted apartment blocks, its streets empty except for a few military vehicles and bicycles. The only color is a giant mural of a smiling Kim Il Sung, founder of North Korea and father of its present leader, Kim Jong Il, both held up as deities.

For Red, whose family lived within sight of the border, China appeared a seductive paradise. "I could see so many lights from apartment blocks and a power plant. China looked so rich." She had been raised on a collective farm in the province of North Hamgyong, the poorest part of North Korea and the source of most border crossers. "I grew up seeing people getting sick and dying from eating grass," she said. Lately she also noticed that entire housing blocks in a nearby city had been nearly emptied of women. They had all escaped across the border. As recently as 2003 the ratio of men to women fleeing North Korea was roughly equal; now women make up more than three-quarters of the traffic, a gender imbalance unusual in the world's refugee movements. With most men either in the military or working on farms or in factories, women can slip away from homes and jobs more easily, and once in China they more readily find work, though increasingly, like Red and White, they're caught up in the sex industry or are trafficked as brides to Chinese farmers.

Red escaped on a rainy July night. The teenager had been worried that she was a burden to her family and was embarrassed to start a job that required her to read news of the "Dear Leader"—Kim Jong Il—over a town loudspeaker. Her aunt left with her, and after paying guards about $15 to look the other way, they reached the Tumen. With panicked arms, Red paddled across on a raft of roped-together inner tubes. Her aunt didn't make it, forced back by a leaky float. Terrified and alone, Red, then only 15, set out walking. She was soon taken in by a North Korean woman who had been sold as a bride to a Chinese farmer. For the next three years Red worked out of sight as a farmhand and dishwasher. Eventually, after stealing money from an employer and traveling to Yanji, she ended up in the computer sex operation, facing a camera next to White.

Tom O'Neill is a senior writer for the Geographic.
Taiwan native Chien-Chi Chang is with the Magnum photo agency and lives in Taipei and New York City.

PASSAGE TO FREEDOM

Each year hundreds of North Koreans in hiding embark on long, dangerous journeys across China. Aided by missionaries, human rights activists, and profit-seeking brokers, defectors travel secretly by foot, train, and car. The goal for nearly all is to reach safe haven in South Korea. Others find asylum in the U.S., Europe, and Japan.

OUT OF NORTH KOREA

- Escape
- Resettlement

THAILAND
Reaching Thailand, defectors request asylum. They are put in detention for several months or more until a country accepts them.

CHINA
With tightened security on the Mongolian and Vietnamese borders, the path to Thailand has become the most used escape route.

NORTH KOREA
Since a famine in the 1990s, large numbers of North Koreans have fled to China across the Tumen River. Many hide in the border region.

SOUTH KOREA
South Korea has admitted some 15,000 North Korean defectors since the mid-1990s, giving the refugees money and citizenship.

RUSSIA
MONGOLIA
Ulaanbaatar
CHINA
Beijing
Shenyang
Tumen
Yanji
Namyang
Tumen
Yalu
NORTH KOREA
JAPAN
Pyongyang
Seoul
Han
Hanawon resettlement facility
Tokyo
SOUTH KOREA
To South Korea
To Japan
Kunming
MYANMAR (BURMA)
Nay Pyi Taw
Yangon (Rangoon)
Hanoi
LAOS
Vientiane
Mekong
THAILAND
Bangkok
CAMBODIA
Phnom Penh
VIETNAM
TAIWAN
Manila
PHILIPPINES
To South Korea
To Japan
To Europe
To U.S.
0 mi 400
0 km 400

M. BRODY DITTEMORE AND MARGUERITE B. HUNSIKER, NG STAFF

INSTRUCTIONS TO THE DEFECTORS WERE SUCCINCT: STAY QUIET, PRETEND TO SLEEP OR HIDE IN A RESTROOM IF POLICE COME TO CHECK ID'S, AND PRAY TO GOD.

CHINA | Under all-seeing eyes on an advertisement in a Beijing rail station (right), Chinese police often hunt for North Koreans attempting to escape cross-country by train. Police crackdowns can net hundreds of victims. Lacking legal documents, Black (left) eluded official questioning during his harrowing 40-hour rail journey by pretending to be asleep or intoxicated.

White had waded across the river one October night. She had been living in an industrial city in the northern part of North Korea with a sick mother and two younger siblings. She was often hungry, unable to earn enough at her jobs, first in a chopstick factory and then selling fruit on the street. When a man approached her, offering work in China in the computer industry, the 26-year-old White naively agreed, thinking she'd stay in China long enough to buy medicine for her mother. The North Korean broker drove her to a remote spot on the Tumen and told her to look for a car waiting on the other side. Shivering after the crossing, she saw a car and jumped in, no questions asked. She had been tricked. White would spend the next year locked in a room selling sex.

From his office two stories above a food market in Seoul, South Korea, Pastor Chun Ki-won had made the call—the signal for defectors to leave on the underground railroad—many times before. Founder of Durihana (Two Become One) Mission, one of numerous Christian organizations that have sprung up in South Korea to help defectors, Chun has masterminded the escapes of hundreds of North Koreans trapped in China, providing them sanctuary in South Korea, the U.S., and other countries. He belongs to a diverse group of activists, humanitarians, traffickers, and fellow missionaries who operate the Asian underground railroad. Some hope to precipitate the collapse of North Korea; others want to convert North Koreans to Christianity. What binds most of them is the instinct to aid people under severe duress. "Their sufferings in North Korea and China are indescribable," Chun says. "I have no choice but to help them."

Pastor Chun is no stranger to the risks. In 2002 Chinese police, alerted by informants, arrested him near the Mongolian border, on the escape route he pioneered. Nine North Koreans he was guiding were also caught, sent back to North Korea, and never heard of again. The pastor spent eight months in a Chinese prison, after which he was sent home to South Korea and

banned from returning to China. Chun's arrest and imprisonment caused a stir in South Korea, exposing the plight of North Korean defectors to a wide audience.

Red and White came to Chun's attention when a love-struck online client of White's figured out that she was a North Korean working against her will and instructed her on how to contact Durihana over the Internet. White's covert emails pleading for help moved Chun to activate his network in China, setting in motion their rescue from the sex business. Fearing that Red and White's enraged boss would soon recapture them, he moved them to the top of his list for the underground railroad.

As the two women waited anxiously for the signal to leave, a few miles away another North Korean I'll call Black was praying that his turn would come soon. A Korean-Chinese missionary arranged for me to meet Black in a private room at a restaurant in Yanji. He entered wearing a dark nylon jacket, too thin for the piercing winds outside. His face looked careworn. Over a bowl of steaming beef marrow soup, he smiled warily, reluctant to talk until I assured him that, to protect his family in North Korea, I wouldn't disclose his name or any details of his life there.

Black said he'd escaped across the frozen Tumen River two years earlier. He was a college graduate, a rarity among defectors, and during his days as a security guard in the North Korean capital, Pyongyang, he'd grown disillusioned with the corruption and bribery that he said pervaded the "workers' paradise." For years he'd planned his escape, saving the several hundred dollars needed to hire a broker in North Korea to arrange passage for him and his girlfriend to China. First they'd be driven to the Tumen River. But when it came time to leave, Black was afraid they'd be too conspicuous in a car and insisted that they instead walk through the mountains to the crossing point, a seven-hour ordeal that permanently damaged the nerves in his toes.

"Crossing the Tumen was easy compared to what happened next," Black said. Like White,

CHINA | Defectors braced themselves against car sickness as their guide drove them along back roads, dodging police check-points near the Laos border. Women currently account for 80 percent of North Korean refugees fleeing through China.

LAOS | Too exhausted to celebrate their exit from China, escapees rested briefly after 16 hours of hiking over mountains and through jungle. Still vulnerable to arrest in Laos, the defectors changed into clean clothes, camouflaging themselves as tourists.

"I WAS SUDDENLY SCARED OF BEING CAUGHT; AFTER ALL WE'D BEEN THROUGH, THERE WAS NO GUARANTEE WE'D MAKE IT."

MEKONG RIVER | Darkness settles over the river (right), providing cover for North Koreans who slip over in boats from Laos to Thailand. After an anxious crossing, the defectors known in the story as White (left, at left) and Red (at right) huddled in the back of a vehicle that met them on the Thai shore. Later that day both women reached Bangkok, where they requested asylum.

Black had been tricked by his broker, sold to a Korean-Chinese gangster to carry drugs and money back and forth across the Tumen. "I refused to help," said Black, who was otherwise vague about how he survived those early days in China. His darkest time followed the sale of his girlfriend to an aging addict, after which Black lost contact with her. Eventually Black heeded the advice whispered among defectors: "Head for a cross." Thirty or more churches around Yanji offer temporary refuge to North Koreans, along with food and clothing. Their pastors stay out of trouble as long as they don't openly proselytize or draw attention to their support for the defectors.

As soon as Black found shelter at a church, he took Bible lessons and became a star convert, attracting Pastor Chun's notice. Chun prefers that the North Koreans he helps adopt Christianity, but he accepts that a defector's professed belief may be skin-deep, a means of survival. "Many are not real Christians," he told me. "For them it isn't that different from believing in Kim Il Sung to believing in God. They change in head, not heart."

Black's faith seemed intense, and as he talked, the missionary beamed. He said that the turning point in Black's education had come when they were in an Internet café. "I asked him to type in 'Kim Jong Il personal life' on the browser, and when stories came up of affairs and illegitimate children, I watched the light come on in his face as he realized he had been fed lies all his life."

At one point during the meal Black pulled a small wooden cross from under his shirt and held it as if it were a warm, breathing thing. "My dream," he said, "is to attend a seminary in South Korea and then to return to my home village to preach the Gospel." When I mentioned that if he were caught in North Korea carrying a Bible, he could be shot, Black said, "I am following God's plan."

The moment came. Pastor Chun received the go-ahead from his operatives for the escape to begin—a 2,000-mile train trip from Beijing

to Yunnan Province, followed by an arduous trek on foot over mountains into Laos, cutting through jungle to the Mekong River. Crossing it puts the refugees in Thailand, where North Koreans can apply for asylum. Red and White would leave first, and Black a few days later with another group.

Accompanied by a Chinese guide, Red and White were driven overnight to Beijing and dropped off near a railway station in front of a Kentucky Fried Chicken. The plan called for them to board a train to Kunming, Yunnan's capital, their rendezvous point with three other North Koreans. I would catch the same train. Chun's relayed instructions to the defectors were succinct: Stay quiet, pretend to sleep or hide in a restroom if police come to check IDs, and pray to God. If arrested, don't reveal the names of those who helped you.

Once on the train Red and White climbed to the top bunks in a sleeper car and huddled under blankets. Occasionally they sneaked looks out the windows, watching vistas of frozen fields and cities veiled in coal smoke give way to green fields and thick fruit orchards. At one stop, White dashed outside to buy a bag of mandarin oranges. Several times during the 40-hour journey, police and railroad agents came down the corridors to check tickets and identifications, but Red and White lay inert in their beds, and the officials ignored them.

Reaching Kunming, they joined the crowd milling about in the station's cavernous waiting room. Soon they spotted the other defectors. The leader was a 30-year-old former taxi driver, who carried a cell phone and fake documents and spoke passable Chinese. An 18-year-old woman wearing a stylish beret had, like Red and White, been a sex industry worker. The third defector was a 57-year-old mother, determined to join a daughter who had already made it to South Korea.

Amid the crush of people on the sidewalk, they waited for a guide Chun had hired to lead them to Thailand. Martial anthems blared from loudspeakers, and soldiers regularly marched

past. The minutes crawled. The exhausted group huddled near a pillar, wide-eyed at the commotion around them. Sensing that if the five North Koreans stood outside much longer, an official would come up to question them, I invited them to wait in my hotel room.

For the next few hours the North Koreans sat on a long sofa, avidly watching movies on the TV. "He's so handsome," one cooed about Tom Cruise, whom she'd never heard of. They savored Cokes from the minibar and shared the fruit. "I can't even imagine what will happen next," White said, switching the channel. "I just want to get to South Korea; it seems so civilized and wealthy." She would fit in, at least on the surface. She had changed into tight jeans (illegal in North Korea), high black boots, and a frilly blouse, topped off with a heart-shaped pendant around her neck. Red switched into flashier clothes too, but she appeared lost, wrapping her arms around herself as if to squeeze out fearful thoughts. She startled when asked about her plans. "Maybe learn English, take computer classes," she said hastily. No one was thinking that far ahead.

Finally the guide called. The five grabbed their packs and hurried out. Seconds later there was a knock on the door. It was White. Laughing, she handed back the TV remote.

In his loose plaid shirt and khaki pants, Pastor Chun could have been any tourist watching the morning light glaze the brown surface of the Mekong River. Behind him a Thai town woke with a buzz of motorcycle traffic and the call of vendors selling coconuts and fish. Across the river, in Laos, a few figures stirred near stilt houses poking up out of the dense weave of forest. Chun had flown into Bangkok from Seoul the night before and had come to the Mekong shore to meet White, Red, and the other defectors. But his charges were marooned in China, and all he could do now was look across the broad river and pray.

After picking them up at the Kunming hotel, Chun's guide had driven the group over mountain roads to a safe house near the Laos frontier.

BANGKOK | Giving thanks, North Korean refugees waiting for papers that will allow them to immigrate to the U.S. gather for a holiday meal at a shelter run by the Durihana Mission. Durihana, a Seoul-based Christian organization, has arranged safe passage for more than 700 defectors in the past ten years, including individuals whose stories are told in this article.

And there they sat, days later, fidgeting. The guide had learned that Laos had tightened border patrols in advance of a national holiday, and he decided it was too dicey to proceed. Like their Chinese counterparts, Laotian police and military are ordered to seize escaping North Koreans and deport them. While the group waited, Black caught up with them, jittery from his clandestine train trip across China. "I almost got caught," he told them. "When police came to check documents, I pretended I was drunk, ready to pass out, and they left me alone."

News of the delay worried Chun. "They've reached the riskiest part of the journey, having to cross the Chinese border on foot and then traveling through Laos," he said as we stood by the Mekong. "They probably have a 50 percent chance of making it to here."

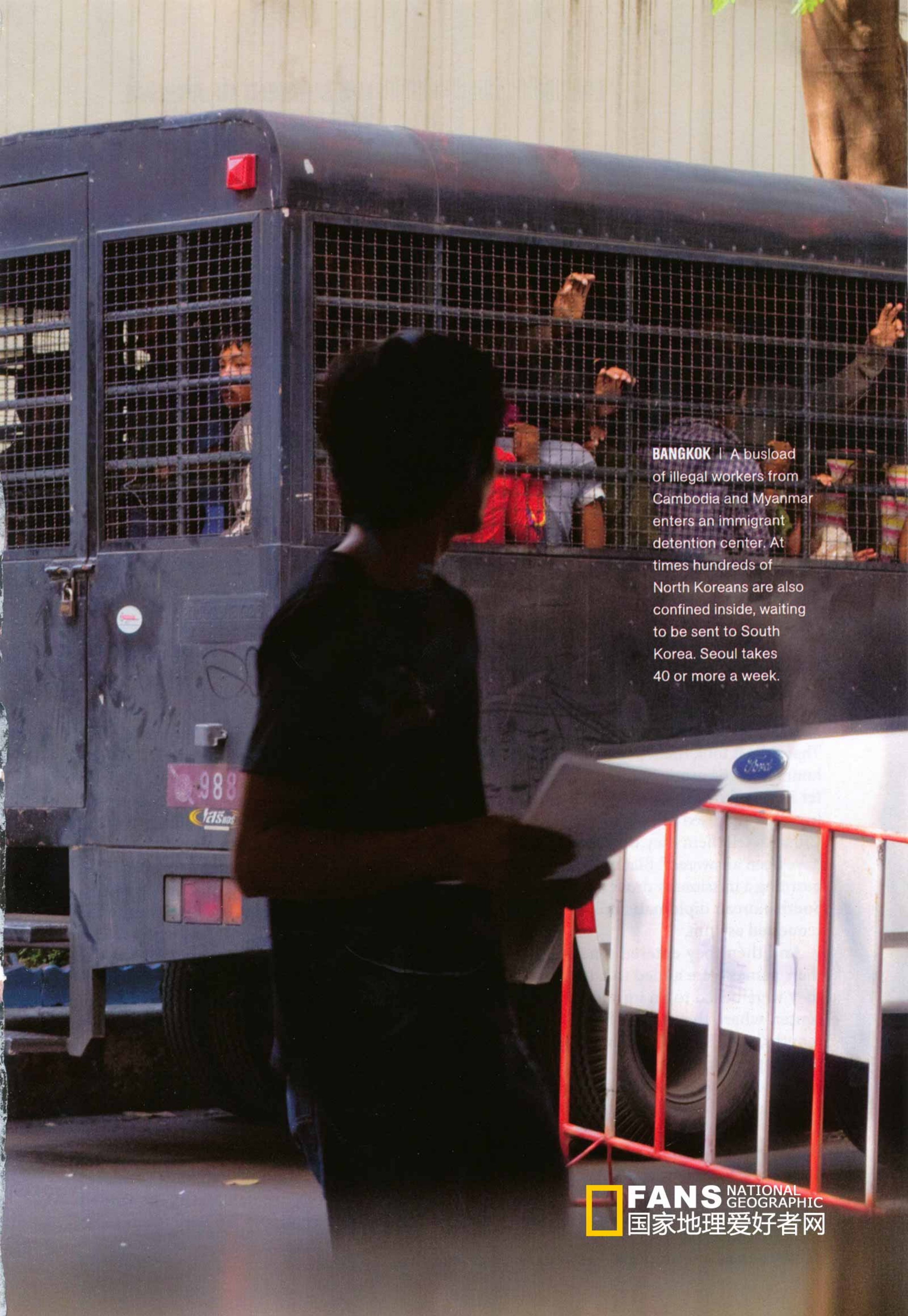
Chun's calling as a Good Samaritan came at age 40, when the former hotel manager surprised friends and family by joining a seminary. His activism was kindled in 1995 when, as a missionary in the Yanji region, he met his first

North Koreans in hiding. "These people had lost all their rights," he said. "The most important thing I could do was revive their humanity." Given the risks, Chun has an impressive record: He has orchestrated the escapes of more than 700 North Koreans, with only a handful of failures. "The North Korean government wants me dead," he said.

But the pastor, now in his 50s and beginning to gray, is no storybook saint. His missionary contacts in China sometimes chafe at what they consider his bossy, reckless decisions; his top guide is a former drug smuggler; and Chun is not above resenting what he sees as ingratitude. "Do you know that of all the people I've helped rescue, only 30 or so have ever called to thank me," he said. But, he added, "they're not bad people. They just can't understand that someone would help them without a reward."

After nearly three weeks at the safe house, the defectors received orders to move. Shouldering packs, they entered the backcountry led by the erstwhile drug runner. The overnight hike took them into the Golden Triangle, the lawless opium-growing territory where the borders of China, Myanmar, Laos, and Thailand meet. For 16 hours they slogged in the dark through tangled forest and leech-infested streams, terrain their guide knew by heart. Climbing to nearly 4,000 feet, they stumbled out of China into Laos. "We were wet and dirty," Red said. "The ground was steep, and I kept falling. I cried most of the time."

The next afternoon the group reached a house owned by a friend of the guide. Late the next night they were driven to a spot near the Mekong, and from there they hiked to the river, lined with lookout towers. For Red, the combination of darkness, the river's strong current, and the nearby presence of Laotian soldiers made the five-minute crossing to Thailand in a small motor launch more unnerving than even the train trip across China. "I was suddenly scared of being caught; after all we'd been through, there was no guarantee we'd make it."



BANGKOK | A busload of illegal workers from Cambodia and Myanmar enters an immigrant detention center. At times hundreds of North Koreans are also confined inside, waiting to be sent to South Korea. Seoul takes 40 or more a week.

THE MOMENT OF ARRIVAL WAS OVERWHELMING. "I KEPT TOUCHING MY FACE, THINKING, IS THIS REAL, IS THIS A DREAM?"

SOUTH KOREA | Before moving to an apartment, Black spent eight weeks at the Hanawon resettlement facility (left), where aid workers and loved ones wait to greet refugees on release days. Now he works a construction job during the day, saving money to rescue his family from North Korea. At night he savors the bright lights and high spirits of Seoul (right).

A Durihana pickup truck found them on the Thai side. It took them to a bus station, and ten hours later the group reached a Durihana shelter in Bangkok. There they ate their best meal in weeks and used cell phones to call friends in China to tell them they were safe. "Our prayers have been answered," Black cried out. The next morning a missionary drove the defectors to the South Korean diplomatic mission, where they requested asylum.

And then they entered a new limbo. After their names were added to a long waiting list, they were bused to an immigration detention center, where they would be warehoused for months, until South Korean officials processed their paperwork.

Defectors entered the packed detention center as fast as they were released to South Korea—30 to 40 a week while the trio was there. In the women's section of the detention center, 450 people were crammed inside a space built for half that many. "There was no room to sit or sleep. Only two toilets worked, and the air was horrible," White said. When people left, they sold their precious space, getting $400 for roughly two square feet. People who couldn't afford to pay ended up standing against a wall during the day and sleeping at night inside the toilet stalls. With help from Durihana, White and Red each bought three square feet. The men's side was also squalid, but less crowded. (Since then conditions have improved, as the South Korean government has sped up its admissions process, thinning out the crowd.)

After nearly 80 days of confinement in Thailand, Red, White, and Black were told to gather their meager belongings for the last leg of their journey. A plane was waiting.

Nothing prepares North Koreans for the impact of Seoul. For Red, the moment of arrival was overwhelming. "I kept touching my face, thinking, Is this real, is this a dream?" she said, recalling the sensation of watching buildings and streets bloom beneath her as she landed at Incheon International Airport. Then came

the bus ride along the Han River past downtown Seoul, the embodiment of the South's hypercompetitive, prosperous, fast-paced life, a world more complex and foreign than any the refugees had encountered. What little the defectors know of the South is distorted by North Korean propaganda—the South is enemy territory, the land of murdering capitalists—or by images from soap operas and movies smuggled into the North, or by fantasies that success will come fast and easy in the southern paradise. A North Korean who had been living in Seoul for two years summed up the culture shock: "The difference between North and South is like jumping ahead a century."

After being debriefed to make sure they're not spies, defectors are sent to Hanawon, a high-security facility south of Seoul, where for two months they receive mandatory instruction in South Korean culture and practical matters such as taking the subway and opening a bank account. They're granted South Korean citizenship, paid a settlement bonus of roughly $5,000, with small monthly installments to follow, and provided a housing allowance and employment incentives.

In the mid-1990s the few dozen defectors arriving each year were greeted with adulation and hefty rewards; most were elite members of the military or Communist Party from Pyongyang who brought valuable intelligence. With rare exceptions, today's defectors, averaging more than 2,000 a year since 2006, are farm laborers, factory workers, and low-level soldiers and clerks from impoverished regions. What they bring mostly are problems. Compared with the average South Korean, they are markedly less educated and skilled. Having experienced years of malnutrition and the pain of seeing family members die of starvation, many suffer from serious physical and mental illnesses. Because of these handicaps, says Andrei Lankov, a North Korean expert at Kookmin University in Seoul, the defector population is in danger of "becoming a permanent underclass." Their life in the South is immeasurably richer and freer,

SOUTH KOREA | Days after reaching South Korea, White (center) had surgery for thyroid cancer. Outside her hospital room, overcome with gratitude, she prays with refugee Hana Kim and Chun Ki-won (right), the Seoul pastor who arranged her escape.

but they crave a sense of belonging. "Most South Koreans are indifferent to their plight," Lankov said. "And to not have your suffering recognized is an almost unbearable form of violence."

Red answered at the first knock, throwing open the door of her 12th-floor apartment in Incheon, near the airport. Eight months had passed since I'd seen her hurry from a hotel room in China, a scared, dark-eyed teenager on the run. Her face was rounder now, her arms fleshier, thanks to regular meals. She'd streaked her hair red and was dressed in black jeans and a T-shirt. Proudly, she showed me her home of seven weeks, a spotless two-room apartment, bare except for a mattress on the bedroom floor and a desk crowned with a personal computer. A sheet of paper taped to a wall showed pink Chinese characters for happiness.

"Kimchi!" she squealed, using the Korean equivalent of "Say cheese!" as she shot pictures and video with her new camera. Deft as any South Korean youth, she downloaded the images and zapped them to my wife in the U.S.

Red showered bars of chocolate on my lap and ordered me to eat. I suspected that I was a rare guest. "Do you have many friends?" I asked. She shook her head vehemently. "How can I make friends if I can't make sense of the society outside?" She confessed that she rarely left the apartment, self-conscious about her accent and not understanding the language South Koreans use, with its liberal sprinkling of English words. Red also didn't feel confident about her job prospects. Language courses and classes in hairstyling cost too much for her monthly $400 government check, and with only a high school education, she was probably limited to low-wage jobs. She had already quit a job at a gas station and now was thinking about working in a cafeteria. "At job interviews," she said, "I'm afraid to say I'm North Korean, because of all the disadvantages that come with it."

We ate fish and rice at a nearby restaurant, where Red snapped more pictures, giggled, sent messages to fellow defectors on her cell phone, and practiced saying "computer" in English.

SEOUL | Still fearful of revealing his name or face, a defector takes a break from studying for a medical exam in a home as unsettled as his prospects. A doctor in North Korea, the new South Korean citizen is finding that much of his training doesn't translate. But every day reminds him of why he came so far: "Here I'm free to talk, to look, and to never worry about food again."

"Life is tough here, but I'm glad I came," she said, before returning to her sanctuary. "I still dream of being a success. I want to make my parents in North Korea proud of me."

White was sharing a hospital room with five other women in the provincial city of Cheonan, near the Hanawon resettlement facility. At Hanawon doctors had diagnosed her with thyroid cancer, and they immediately operated. If she had remained in North Korea, or even in China, she almost certainly would have died. Now she had a chance of healing.

She rose unsteadily from her hospital bed to greet me, a shy smile on her face. A scar from the surgery extended around to the base of her throat. The intense young woman I remembered, with the deep laugh and showy clothes, now teetered in baggy pajamas, her voice a hoarse whisper. "I called Pastor Chun to thank him," she said. "Durihana is helping pay for my treatment. Sometimes Pastor Chun comes here, and we pray together." White, Chun had

told me, is a committed Christian—"the real thing, a good, pure spirit."

White had already visited the apartment she hoped to move into. "First I will buy a computer and a refrigerator," she said, "and I will cook North Korean dishes." She caught me staring. I couldn't help it. She had spent a year locked in a room in China, followed by three months in a crowded detention center in Thailand, and now three months in a hospital room, during which time she had learned of her mother's death and her brother's imprisonment. How could she look so beatific? She walked outside with me to the taxi stand to say goodbye, and when I looked back from the car, White was still standing there, smiling at the spacious sky.

Black moved into an apartment in downtown Seoul, not far from the Han River. Traffic noises and the hum of cicadas drifted through his windows. On a wall hung the wooden cross he'd held so tightly in China, and a Bible lay open on the floor amid other books. He hadn't bought any furniture yet. "Everything is more difficult and complicated than I was prepared for," the 40-year-old said. His dream of attending seminary was dashed when he learned that scholarships were restricted to those under 35. For now he was a day laborer at a construction site. "I need to make money fast to bring my brother and sister out of North Korea," he said.

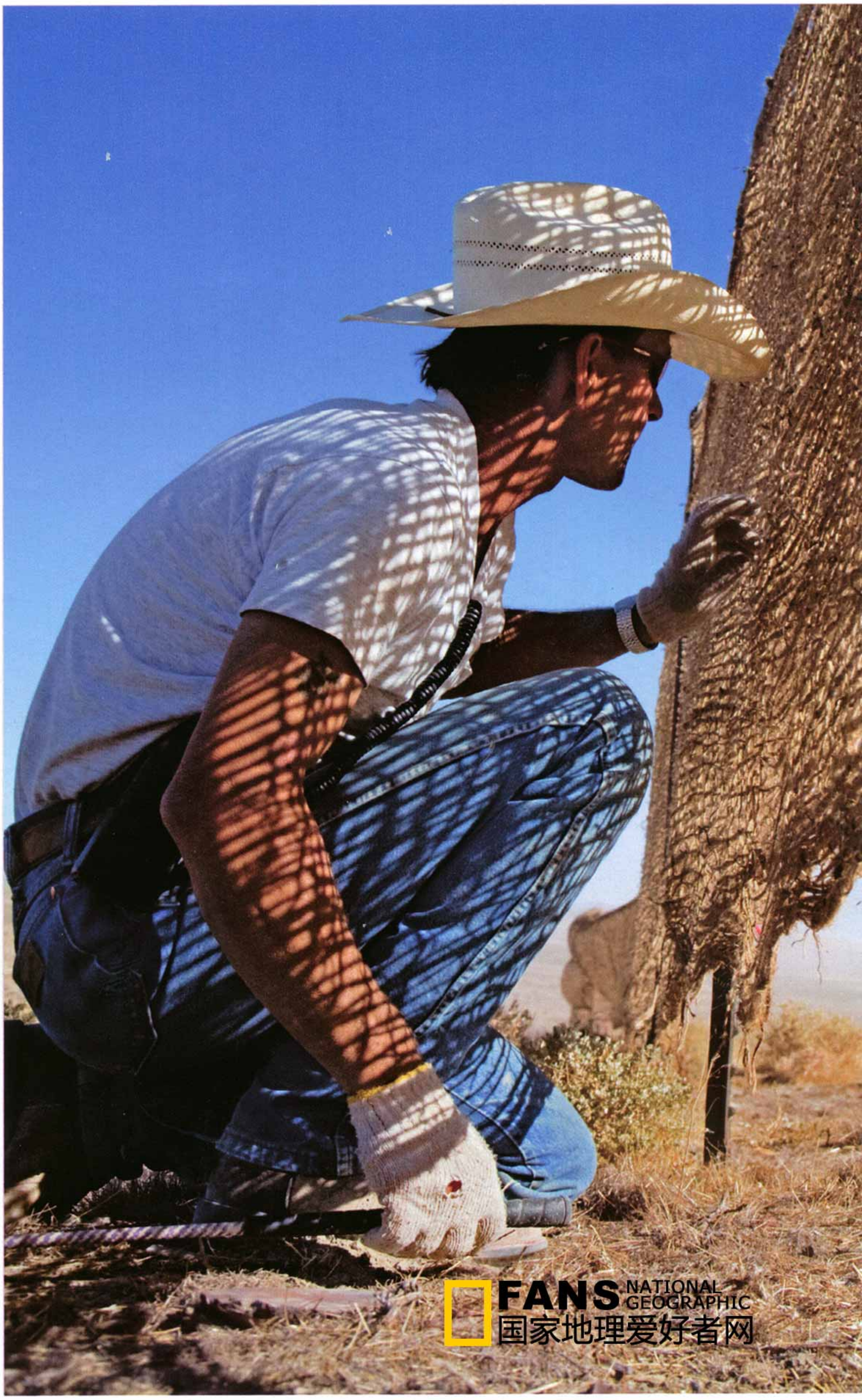
Whenever he heard himself complaining to me, Black apologized. "I am so relieved to be here. When I read about street demonstrations in Seoul, I get so happy. If I did that in North Korea, I would be sent to prison."

We hailed a taxi to take us across town to a student neighborhood filled with cheap, noisy restaurants. Horns shouted, and signs and pedestrians swept past in a blur. Eight months earlier, in a missionary's van in China, Black's shoulders had been hunched, his eyes alert to danger, his hand clutching his cross. Now amid the glorious tumult of his new home, Black closed his eyes and dozed off. He was safe, and he was free. □

Spirit of the Shrinking West

MUSTANGS

Two stallions fight at a wild horse conservation center in South Dakota. It's an equine echo of an ongoing struggle across the western United States, where mustangs compete for space with ranching and energy development.



Wranglers in the air and on the ground drive mustangs into a corral during a Nevada roundup. The BLM orders such gathers with the aim of limiting the number of free-running horses to 27,000, in ten states. The number of wild horses now in BLM holding facilities: 30,000.

Born to the wild, Dot now works the Wyoming range with sheepherder Edgar Oscanoa. "He's very strong and intelligent," Oscanoa says. Respected too. The story of how the mustang once saved a man's life is part of local legend.

By ALEXANDRA FULLER

Photographs by MELISSA FARLOW

In the winter of 2005 Nelson Quispe, new from Peru to North America, was hired to herd sheep in Wyoming's Red Desert. His sheep-rancher boss, Pat O'Toole, gave him a six-year-old mustang to help him cover the long miles over snow whales and sagebrush to open range. The mustang was white all over, with dark spots on his rear, betraying some Appaloosa in his ancestry, but with hooves like dinner plates, suggesting the additional introduction of something more along the lines of a draft horse. He'd been named Dot by the inmates at the Honor Farm near Riverton, where he'd been trained as a wild-born five-year-old. As a result the mustang had both native sense and correctional-facility manners, and you can do a lot worse than that in a horse.

O'Toole told the Peruvian, "If the wind picks up, and the sheep get blown out, just head back to your sheep camp. Whatever you do, don't try to follow them." He said this in both English and Spanish and, just to be sure, in gestures, because the way weather can turn on you in Wyoming, a man needs all the languages at his disposal to explain it. After that, a veteran herder of these ranges, also a Peruvian, gave the young man one short, critical piece of advice in Spanish. Then Quispe rode off with Dot and the sheep into the wide-open world.

He wasn't there very long before the wind turned to speeding metal sheets, and the temperature hit 35° below zero Fahrenheit. Quispe, full of youth's eagerness to prove itself, tried to stay with the flock. Then the sheep blustered off the range, and night fell, and the wind sped all the harder. The young shepherd was lost, frozen solid to his horse and sure he would die. Just then, however, he remembered the key piece of advice the veteran shepherd had given him. So Quispe leaned forward, took off Dot's bridle, and wrapped his arms around the mustang's neck. He closed his eyes and committed his soul to the Holy Mother.

Dot—whose ancestors roamed these plains roughly one and a half million years ago, and who was born wild onto this very land just six years earlier, and therefore knew this world to the millionth power—lowered his head to smell for prairie dog and badger holes to keep from falling and, compensating with brains and courage for what he lacked in beauty, took the terrified youngster right back to camp.

WHEN THE WEATHER in Wyoming seems hell-bent on murder, and a shepherd can't see past his nose, the difference between life and death is—just as it used to be a century ago—a good, native-bred horse with more than a usual dose of backcountry smarts. But when the wind dies down, and cell phone service is restored, this modern age arrives with noisy, impatient abruptness, and wild horses look out of place in a West that is shrinking around them. So a straggle of mares and a few foals led by a single stud running parallel to a barbed-wire fence, power pylons, and an oil-field truck behind them is the way I first saw mustangs near Rock Springs late in the fall of 2007.

"Wild horses are right in the middle of a culture that wants nothing to do with them," said Jay Kirkpatrick, director of science and conservation biology at ZooMontana, in Billings, a center for the development of contraceptives for wildlife. Kirkpatrick, who has spent more than 30 years studying the animals, said the wild horse has been despised ever since white men came west—blamed for everything that can and

Millions of pounds of wild horsemeat were processed into food for dogs, cats, and chickens during the 1930s.

does go wrong on these grasslands. So in the mid-1800s, when stockmen released up to 40 million cattle on the plains, where horses had lived for centuries without destroying the grazing, at most two million mustangs were held responsible for the suddenly depleted range.

At the same time, the range-tough wild horses, a fast-breeding renewable resource, were indispensable to early settlers. Occasionally hunted to keep their numbers in check, they were also rounded up periodically for ranch work and transport or were used to conquer and define the growing nation. Lt. Ulysses S. Grant, invading Mexico with Gen. Zachary Taylor's army in March 1846 on a freshly caught mustang (from *mestengo,* meaning "stray"), tells in a contemporary account: "As far as the eye could reach to our right, the herd extended. To the left, it extended equally. There was no estimating the number of animals in it."

But then came railroads and roads, cars and tractors, tanks and combine harvesters, and you can't fix a dead horse with a monkey wrench, so the mustang lost its value as transport and instead became, literally, dogmeat. Millions of pounds of wild horsemeat were processed into food for dogs, cats, and chickens during the 1930s alone. "Man," as Pat O'Toole said, "was the wild horses' natural predator."

Traditionally ranchers haven't had much time for anything that competes with them for resources. It's not uncommon to find coyote carcasses draped over barbed-wire fences, as if Westerners had gone trolling for whatever offended their souls and, unable to shoot the wind, turned their ire on something more tangible. In February 2006 the Sportsman's Warehouse in Reno, Nevada, sponsored a competition in which the varmint hunter who brought in the most proof—such as the jaws of coyotes, foxes, bobcats, and mountain lions—would win a boat. Around the same time several wild horses were also shot, even though mustangs have been federally protected since 1971—under the Wild Free-Roaming Horses and Burros Act—from capture, branding, harassment, or killing. (It was largely the efforts of a Nevadan, Velma Bronn Johnston, better known as Wild Horse Annie, to bring the plight of mustangs to public attention that led to passage of the act.)

You can outlaw cruelty, but you can't outlaw the culture that spawned that cruelty. Wild horses around the Rock Springs area (where Dot is from) have been killed in greater numbers than anywhere else in the country. It's impossible to know if the deaths are the deliberate work of ranchers fed up with the pressures on their grazing or of careless young men with too much time on their hands. In the spring of 2005 two Wyoming men and two men from Utah roped a wild stallion and castrated the animal with a knife. The mustang bled to death, and its body was dragged to a remote draw and left to rot. All four men were apprehended, convicted of misdemeanors, given six-month suspended jail sentences, and ordered to pay fines of a little more than a thousand dollars each.

It's hard to conceive that anyone would kill a federally protected mustang in this way, until you take into account the anatomy of the West: little towns strung like beads along highways, and between the towns an impression of endless public lands where it's still possible to imagine getting away with anything, in part because these expanses feel as if they belong to no one and everyone all at once.

IN THE TEN WESTERN STATES where wild horses are found, the federal agency in the unenviable position of overseeing the interests competing for public lands—livestock and minerals, trees and the people who hug them, hikers and wildlife, wild horses and watersheds—is the Bureau of Land Management. The BLM is required to manage its 258 million acres (more than any other federal agency) for an ever changing West

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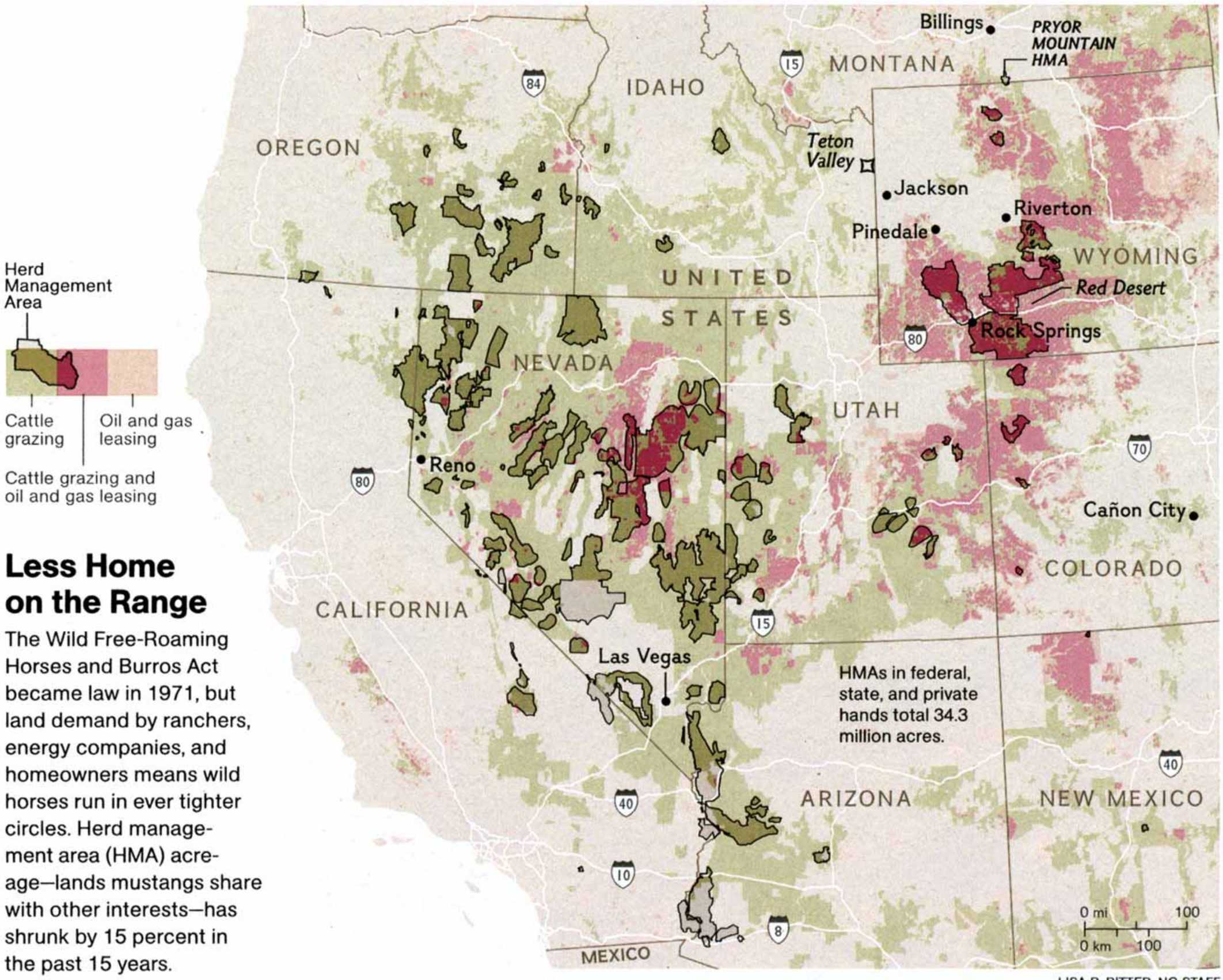
Alexandra Fuller's latest book, The Legend of Colton Bryant, *is set in Wyoming. Melissa Farlow photographed the July 2007 Tongass Forest story.*



LISA R. RITTER, NG STAFF
SOURCE: U.S. BUREAU OF LAND MANAGEMENT

Less Home on the Range

The Wild Free-Roaming Horses and Burros Act became law in 1971, but land demand by ranchers, energy companies, and homeowners means wild horses run in ever tighter circles. Herd management area (HMA) acreage—lands mustangs share with other interests—has shrunk by 15 percent in the past 15 years.

and for "multiple use." In theory there should be enough room for everything, but in reality, from the moment pioneers settled here, resources have been extracted with little patience for anything that got in the way of a silver dollar. These are not—and never were—lands managed for all things equally, but for the priorities of the age.

Historically the priority has been livestock, and in 2006 cattle and sheep consumed 20 times as much forage on BLM land as wild horses and burros. But in the past 30 years the tone of the culture has been changing. Ranchers in many parts of the West have been losing their dominant place, and the loudest voice is now coming from oil companies. With intensifying pressure to make the United States more energy independent, the BLM has leased 44 million acres of land for oil and gas, nearly five million of that in areas set aside for wild horses. It's an indelible use of the land: Even when capped, the wells don't go away.

"The energy is where you find it," said Tom Gorey, PR officer for the BLM's wild horse program. He sounded profoundly reconciled to that fact.

Gorey's agency oversees some 30,000 wild horses, which are confined to 29 million acres of disconnected BLM herd management areas (HMAs). Under the 1971 act the BLM must keep the herds at what it decides are appropriate management levels (AMLs). Some horse advocates believe the AMLs are arbitrarily low, threatening the genetic viability of the herds; ranchers say they're unrealistically high, threatening vital grazing.

Pat O'Toole's grazing allotments (an allotment is an area of BLM land leased to stockmen) overlap with HMAs in south-central Wyoming and northwestern Colorado, and he has the measured calm and authority of a man who has learned his priorities the hard way. "When the wild horses were regularly harvested by ranchers," he said, "they couldn't take the range down. Then the wild horse was

Fleeing a Nevada roundup, these horses were among 900 eventually gathered. The BLM took nearly 74,000 mustangs off ranges between 2001 and 2007. Some 44,000 have been adopted by private citizens, for about $125 each. To own a horse, an adopter must first provide humane care for a year.

protected, and the ability to control their numbers was taken out of the ranchers' hands—and now there's just too many of them." He thought for a moment. "We've had a ten-year drought. Then add to that, oil and gas development is putting inconceivable pressure on the public land, and then consider that the wild horses have already taken the grassland to nothing. It's hard on everyone—the wild horses, the ranchers, the wildlife, everyone." But even as O'Toole spoke about his frustration at wild horses' appetites, he defended their right to exist as a symbol. "Wild horses have their place on the range," he said, "but when they've eaten themselves onto bare dirt, it's hard to feel that they're being appropriately managed."

Jay Kirkpatrick of ZooMontana agreed that wild horses "can exceed carrying capacity in places and cause problems not only for livestock and wildlife but for themselves. But," he said, "the key to understanding why wild horses are the scapegoat for poor land management and worse politics is that, unlike huntable wildlife and livestock, they have no economic value."

So the argument about wild horses and the resources they use comes down to this question: Do we have the landscape—physical and emotional—for them? While horse advocates and stockmen often argue the relative merits and demerits of the mustang on more emotional grounds, scientists are arguing on the basis of a fundamental fact: If the horses can be classified as native to North America, they have a right to the use of the land. If they're not native, they don't.

"**FREE-ROAMING HORSES** are a feral, exotic species," said Joel Berger, a wildlife biologist based in Teton Valley, Idaho. "They're in direct competition for habitat with native wildlife." Berger suggested that the BLM's budget for wild horses might be better spent on the study and protection of native species. But Kirkpatrick and his sometime collaborator Patricia Fazio, an environmental writer, have long asserted that the wild horse is a native species and should be regarded

Gathered mares, foals, and stallions are all held in separate corrals before they're trucked to a holding facility. Federal law grants the BLM authority to destroy captured horses, and although culling hasn't occurred since 1982, the option troubles mustang partisans.

Horses will likely be around as long as there are humans. What is less sure is whether there will always be enough wild for mustangs to run free.

as such by state and federal agencies. "Modern horses evolved on this continent 1.6 million years ago, only to later disappear," Kirkpatrick told me. "The two key elements for classifying an animal as a native species are where it originated and whether it coevolved with its habitat. The horse can lay claim to doing both in North America."

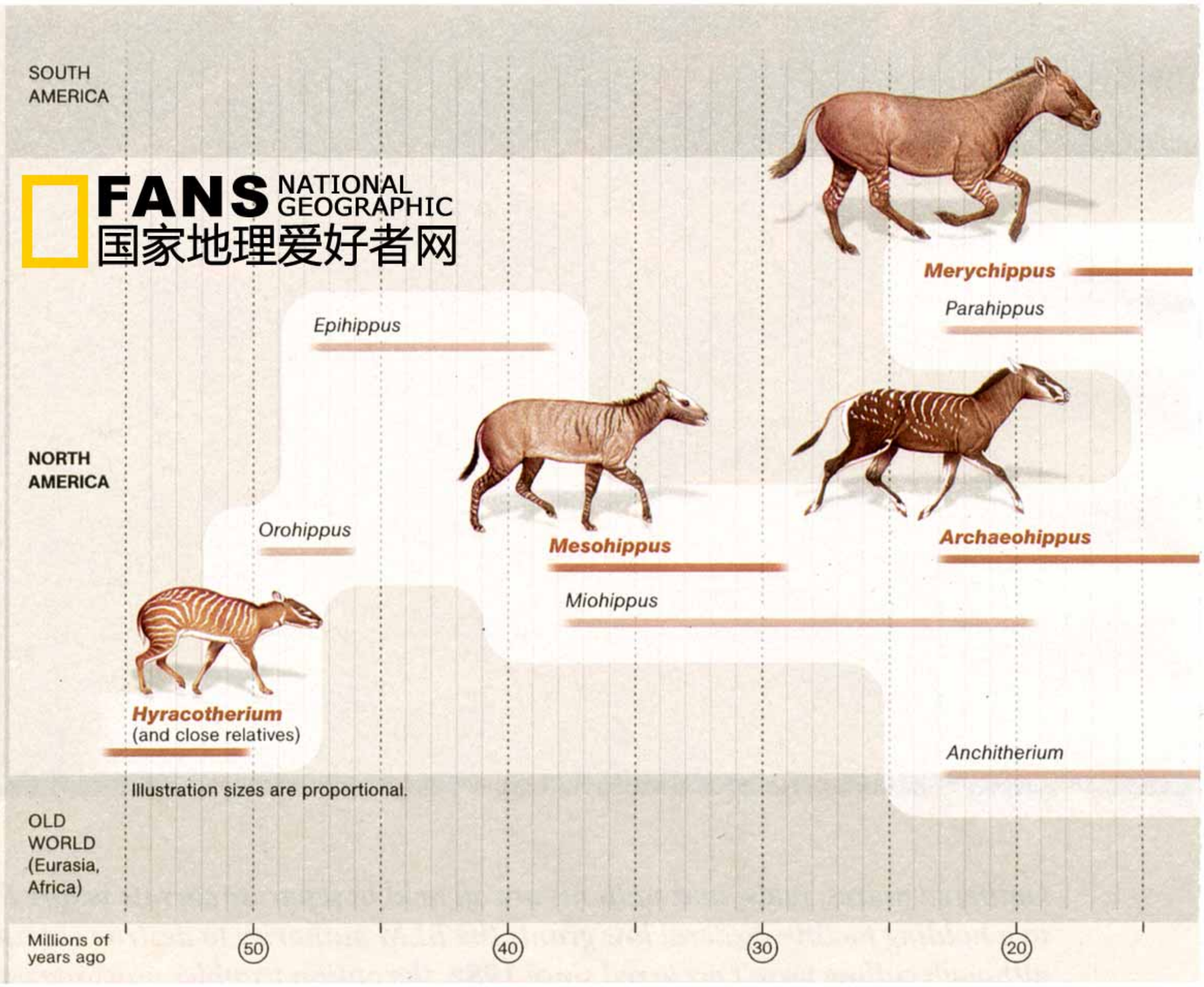
Although scientists differ on where today's horse, *Equus caballus,* arose, it is agreed that early members of the genus *Equus* appeared in North America some five million years ago. Some of them wandered across the Bering land bridge and spread into Asia (where they were eventually domesticated), Africa, and Europe. But these horses disappeared from their North American cradle about 12,000 years ago. One theory is that Pleistocene man, entering the continent around that time, hunted the horse to extinction. Other scientists theorize that a virulent disease, or perhaps a combination of climate change, disease, and hunting, wiped out the horse. In 1519 horses were brought to the North American mainland when Hernán Cortés arrived in Mexico. Some scientists argue that the Spanish conquistadores' horses encountered and bred with a remnant native population, but there's no proof of this.

Some herds are direct descendants of those brought by the conquistadores, notably the Pryor Mountain herd in Montana and northern Wyoming, whose centuries-old Spanish heritage was established through blood tests in 1992. These horses tend toward more primitive, exotically wild markings—they have zebra stripes on their legs and lines down their spines, and they come in camouflaging shades of dun and charcoal.

But nearly all wild horses in the West are like Dot, the mustang that saved the Peruvian

Journey of the Horse

The horse family took root in North America some 55 million years ago. The sole survivors of this lineage, which counts hundreds of extinct species, belong to the genus *Equus:* modern horses, zebras, asses, and donkeys. Some ancient horses migrated out of North America and evolved in the Old World and South America, followed later by far-ranging *Equus.* By about 10,000 B.C. the horse had vanished from the Americas. Sixteenth-century Spanish explorers brought the native home.



ALEJANDRO TUMAS AND AMANDA HOBBS, NG STAFF

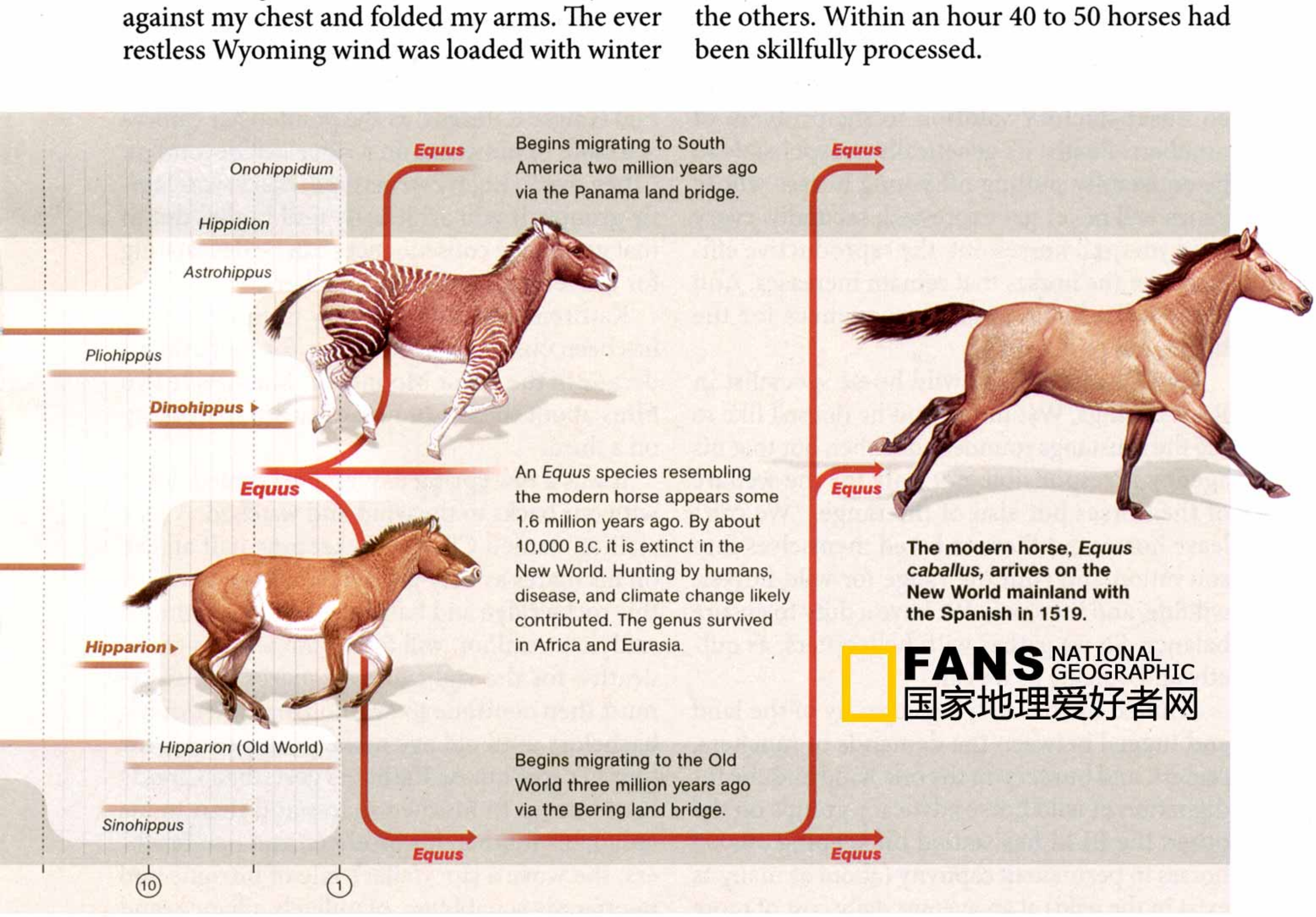
ART BY ALDO CHIAPPE

SOURCE: BRUCE MACFADDEN, UNIVERSITY OF FLORIDA

shepherd. They're a mixture of breeds that made it out onto the range over the centuries (many during the Great Depression), their stock enhanced by deliberately released draft, Thoroughbred, Morgan, and Arabian stallions, with the weaknesses of each pureblood salted out of it and the instinct for survival whetted with each successive generation.

MIDMORNING IN EARLY NOVEMBER I was hunkered down on a butte near Rock Springs, northwest of where the BLM had caught Dot, to watch horses being rounded up. "Don't move, don't talk," I'd been warned, "or the horses might startle away from the corrals." Wild horses are acutely attuned to dangers in their environment, chief among them humans. I tucked my chin against my chest and folded my arms. The ever restless Wyoming wind was loaded with winter intentions, and the water in the troughs in the corrals below had frozen inches thick.

A helicopter pilot contracted by the BLM swept out across the plains, herding groups of horses into a canyon below us. The canyon shrank into a camouflaged burlap chase, at the mouth of which a "Judas" horse was released, leading its wild cousins into a metal corral, where yesterday's wild horse catch was already waiting. At the gate, the pilot tipped his blades at a few balking horses, which shocked forward into the cloud of dust. The gate was slammed shut, and a handful of young cowboys, quick as cats, spilled over the fences into the midst of the herd. The helicopter went back out for more horses. Inside the corral the cowboys separated the stallions from the mares, the foals from all the others. Within an hour 40 to 50 horses had been skillfully processed.



"The health of the herd is far stronger when nature decides who stays in the herd and who doesn't, rather than humans." —GINGER KATHRENS, DOCUMENTARY FILMMAKER

The horses' panic subsided to what looked to be anxious resignation. A vet hovered near the corrals, inspecting each horse. A few had sustained superficial injuries, but none appeared seriously hurt, although wild horses are sometimes injured or killed during gathers.

Every year 40 to 60 gathers remove between 5,000 and 10,000 wild horses from the western range. Over nine days at Rock Springs, more than 600 horses were brought in, then trucked to Cañon City, Colorado, to a prison where they were branded, gelded, doctored, and sorted by gender and age. Some would be trained by inmates for auction later in the season; others would await adoption or removal to long-term sanctuaries.

"I'm not a bunny hugger," Jay Kirkpatrick told me, "but I'll never attend another gather as long as I live. They're flat-out inhumane." He paused: "There are three reasons why these gathers are an unsatisfactory solution to the problem of numbers. Firstly, it's genetically irresponsible to be constantly pulling off young horses whose genes will never get expressed; secondly, every time you pull horses out, the reproductive efficiency of the horses that remain increases. And thirdly, the behavioral consequences for the horses are profound."

Jay D'Ewart, a BLM wild horse specialist in Rock Springs, Wyoming, said he doesn't like to see the mustangs rounded up either, but that his agency is responsible not only for the welfare of the horses but also of the range. "We can't leave horses out there to breed themselves into starvation and ruin the range for wild horses, wildlife, and livestock. We have a duty to ensure balance. So we gather with helicopters, as quietly and quickly as we can."

Limited by the carrying capacity of the land and tugged between the demands of ranchers, miners, and hunters on the one hand and the indignation of wild horse advocacy groups on the other, the BLM has settled on keeping 30,000 horses in permanent captivity (about as many as exist in the wild) at an average daily cost of more than two dollars each. This arrangement soaks up funds and provides, at best, a stopgap solution to the animals' tendencies toward prolific breeding. Every year thousands more horses are rounded up, and every year thousands more end up in long-term holding.

Last year the agency said it might have to euthanize horses to reduce costs (which prompted Madeleine Pickens, T. Boone Pickens's wife, to offer to adopt many, if not all, of the BLM's captive mustangs). "Everyone could see this coming," said Chris Heyde of the Animal Welfare Institute in Washington, D.C. "Every year they pull more and more horses off the range to keep the ranchers happy. Meantime the scenario for the horses is just awful."

"THE MORE WE KNOW about the emotional and social lives of horses, the more we realize that they draw on a powerful collective wisdom," said Ginger Kathrens, as she pointed her camera at a band of mustangs on a ridge just beyond us. "They live in highly structured, hard-won family groups. If you arbitrarily pull horses out of that group, the consequences can be devastating for the remaining family members."

Kathrens is a documentary filmmaker who has been observing wild horses for more than a decade in the Pryor Mountains. She's made two films about these 170 horses and was working on a third.

It was a raw spring day, and we settled down with our backs to the wind and watched. A pale stallion named Cloud was keeping half an eye on his mares as they grazed the range on top of this rocky ridge and half an eye on us. Kathrens said that a stallion will fight—sometimes to the death—for the right to own mares, which he must then continue to defend from interloping bachelors until old age makes it impossible for him to carry on. As Kathrens described Cloud's relationship to his own mares and then to his father, his mother, his brothers, and half brothers, she wove a storyteller's tale of intrigue and interfamily squabbling, of unlikely alliances and

terrible, sudden wars. There was even a case of what might be called love—a solitary and now elderly couple that broke the rules of wild horse society to be together. When the stallion that had won the mare let her out of his sight the night she was foaling, she escaped and sneaked back to her stallion of choice. "In some cases," Kathrens said, "I've seen a stallion lose his mares in a BLM gather, and for that stallion, who has fought life-threatening battles for those mares, his life is over. He'll end up on his own, and I don't think it's too strong to say that some stallions succumb to a form of depression."

Kirkpatrick said contraception offers a humane alternative to rounding up the animals, but that the BLM is resistant. He said the agency is spending too little studying fertility control and too much on helicopter roundups. When he suggested to a BLM official that the agency inject the mares with the wildlife contraceptive vaccine porcine zona pellucida (PZP), he recalled being told, "That's not how we do it out here. We do it with horses and ropes." According to Tom Gorey, the BLM spokesman, PZP has been administered on an experimental basis to about 1,800 mares since 2004. "The effects on population growth are being monitored," he said.

Kathrens is wary of any kind of human intervention to manage herd numbers. As we were speaking, a thin, charcoal-colored mare lay down next to her foal. Kathrens explained that the mare had been vaccinated nearly seven years earlier with PZP. When it wore off six years later, she conceived out of season. The foal had been born in September, too close to the onset of winter to allow either animal to meet a cold, snowy spring in anything close to decent condition. Kathrens told me that out of season births have been a sad side effect of PZP on the Pryor mares, an observation adamantly rejected by Kirkpatrick, who says that there are always some out of season births, with or without PZP. Kathrens turned the camera on the mare, whose head was now flat on the ground. The foal nudged its mother. "Oh, look at that," Kathrens exclaimed. "If this weather keeps up, I don't know if this pair will make it into summer alive."

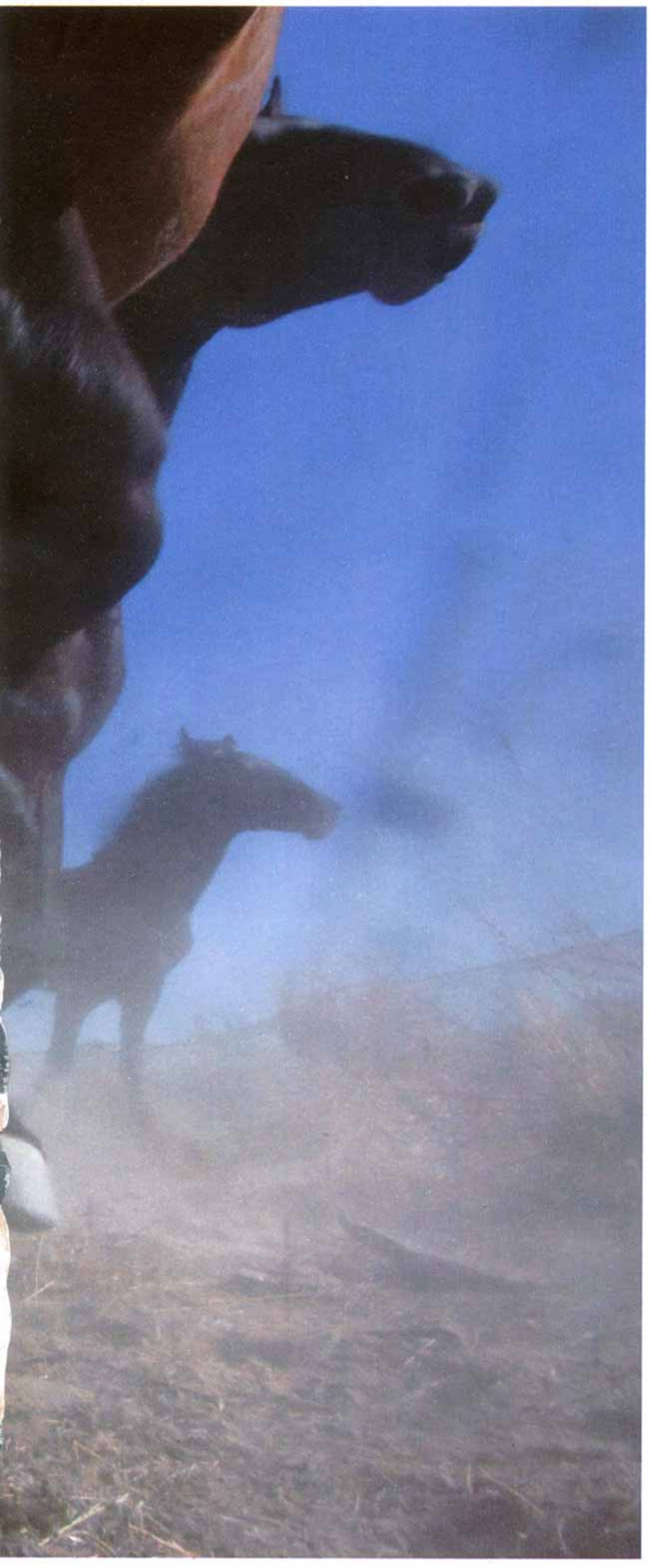
When I asked Kathrens what she considered the best alternative to either gathers or PZP, she was adamant: "Nature. Natural selection by mountain lions, exposure, starvation. It may sound harsh to say, Let nature take its course, but it works. The health of the overall herd is far stronger when nature decides who stays in the herd and who doesn't, rather than humans making those kind of decisions."

Kathrens owns one Pryor-bred wild horse and anticipates making room for more. Roughly 5,000 wild horses go to private homes every year through the BLM adoption process. (Pat O'Toole has adopted eight, including Dot.) Of those, at least 500 end up in equine rescue centers or at auctions. There they risk being sold to "kill buyers," who sell the animals to slaughterhouses. Although the adoption agreement discourages owners from unloading their mustangs for slaughter, the BLM has no legal way to prevent it. Inexperienced owners overwhelmed by the wild horses' powerful survival instinct or by the very real cost of owning a mythical part of the Old West sometimes end up sending their mustangs to auction, desperate to be rid of such trouble.

Few people adopt horses and then sell them to slaughter purely for profit. But it does happen. In 2005 an Oklahoma man who said he wanted wild horses for a church youth program adopted half a dozen for $50 each and sold them to an Illinois slaughterhouse for a small profit.

Two years later the U.S. Court of Appeals for the Seventh Circuit upheld the decision by Illinois to ban the slaughter of horses for human consumption, and the last slaughterhouse in the country closed down. An unintended consequence of the new law is that more horses than ever before are being sent to slaughter in Canada and Mexico, and there is no way of telling how many of those animals, exported in crowded trailers, are former wild horses. "I can't see brands," a U.S. Department of Agriculture employee told me under condition of

Like these mustangs, about half of all the wild horses that still run free in the U.S. live in Nevada. "Horses were brought here by the Spaniards, served in the cavalry, worked in our fields," says Patti Colbert of the Mustang Heritage Foundation. "Wild or mild, they deserve our respect."



anonymity. "I'm just counting bodies. It's hard enough to figure out what gender the horses are, let alone what breed."

THE WAY PAT O'TOOLE TELLS IT, Nelson Quispe herded sheep again for him in the winter of 2006. Naturally the young shepherd insisted on riding Dot. For one person at least, the unholy terror of a Wyoming winter storm had transformed the wild horse from a symbol of nobility and survival to the actual beating heart of all that those words imply. But O'Toole didn't have time to ponder the romance of the story. "I don't know if we can carry on running sheep," he told me. "We've been through tough times before, but this is as tough as I've ever seen it." There was a long pause in which both of us contemplated what he faced—the squeeze on land from oil and gas development, competition for range with wild horses, drought, and the skyrocketing price of feed. And then we talked about what would be lost if O'Toole were to close down his operation: sheep, the rancher's stewardship of the open range, a use for the wild horse.

Horses will likely be around as long as there are humans to attach themselves to a saddle. What is less sure is whether there will always be enough wild to allow mustangs to run in secure, functional, genetically viable herds. Driving home from the Rock Springs gather, through Pinedale to Jackson, I'd seen acres of the High Plains turned over to oil and gas development, rigs towering out of the frozen sage, the outskirts of towns bristling with man camps and trailer parks for the roughnecks. Oil field traffic hurried out on a web of roads, seeming to skim along on a silver-rimmed mirage. Roadkill, mostly pronghorn and mule deer, lay bleaching on the verges in unprecedented numbers.

Until maybe 20 years ago there used to be a herd of wild horses out here too, kicking around the edges of town in the spring and getting rounded up periodically by local ranchers. No one I spoke to could remember the exact moment they disappeared. ▯

WHERE THE DEAD DON'T SLEEP

BY A. A. GILL

PHOTOGRAPHS BY
VINCENT J. MUSI

A desiccated face looks out from an Italian catacomb. Sicilian mummies are revealing details of life and death centuries ago.

In Palermo the bodies of men from the 1800s hang in ghoulish rows. In 1599 naturally dried bodies inspired friars to mummify clergy. Soon laypeople asked to be preserved too. "Mummification was seen as a miracle," says anthropologist Dario Piombino-Mascali. "A direct intervention from God."

PALERMO'S AIRPORT is named Falcone-Borsellino. It sounds like a '70s American cop show, and you'd be forgiven for not knowing who either of the names belong to. They were a pair of mortally brave magistrates who tried to finally break the ancient grip of organized crime in Sicily. Both were assassinated. They don't like to talk about the Mafia to strangers here; it's an embarrassing family concern, none of our business, a private tragedy. Sicily is a secretive place. You can sense it in the blackened, baroque streets of Palermo, the capital, where the bomb damage from the 1943 Allied landings still hasn't been quite cleaned up and where the tenement palaces are inhabited by North African refugees. It's a watchful and masculine place, beautiful and thwarted.

Sicily's history is as mordant and miserable a romance as any in Europe—well into the 1950s these were among the poorest peasants in the Western world. For centuries they eked out a meager life, suffering constant vendettas and feuds, injustice, exploitation, honor killings, and murderous codes, all surrounded by the smell of mandarin blossom and incense. In Sicily, blood called to blood for blood down the ages.

The Capuchin monastery in Palermo is a discreetly blank building. It sits in a quiet square beside a graveyard, across town from where, in 1992, the Mafia settled its account with Magistrate Borsellino. Outside the door, tucked into a corner, are a couple of hawkers peddling postcards and guidebooks; inside, a friar sits behind a table selling tickets and more postcards and votive trinkets. It's a slow day; he reads the paper.

Down a flight of stairs, past a wooden statue of Our Lady of Sorrows, is the door to the catacomb, the waiting room of the dead. Surprisingly large, with high, vaulted ceilings and long corridors stretching away at right angles. It's cool and dank and smells of sour, spiced dust and rotting cloth. The windows are high and diffuse the sunlight into a pale glow. Fluorescent bulbs vibrate, adding a medically forensic, anemic brightness. Hanging from the walls, propped on benches, resting in their decrepit boxes, are nearly 2,000 dead. They're dressed in their living best, the uniforms of their earthly calling. There's no one else down here.

In Europe the desiccation and preservation of corpses is a particularly Sicilian affair. There are other examples in Italy, but the great majority are in Sicily, where the relationship between the living and the dead is especially strong. Nobody knows how many there really are, or how many have since been removed from catacombs and buried in cemeteries by priests uneasy with the theology of keeping votive corpses. The phenomenon provokes an instant question: Why would anyone do this? Why would you exhibit decaying bodies?

I walk down their ranks with that awkward confusion of trying to make sense of what it is I'm actually feeling. In the West we don't often see dead bodies—the absence of life is shrouded and hidden. These dead have a mystique; they come with an attitude and previous convictions. Examining the corpses with a morbid interest—so this is what death looks like—I

NGM MAPS. SOURCE: DARIO PIOMBINO-MASCALI

Under the 15th-century cathedral of Novara di Sicilia lie six mummified priests. At least 50 mummies are known in Piraino and Savoca; nearly 2,000 are found in Palermo.

realize that the big difference between the living and the dead is that you can stare at the dead with an intense, close-up curiosity that the living would never tolerate. And then I think they really ought to be playing Michael Jackson's "Thriller" as background music, given how like prosthetic, schlock-horror-effect zombies these bodies look, how comically and pathetically the great denouement of nature mimics not just art but cheap art. Their jaws hang open in silent yowls, rotting teeth grin with menace, eye sockets stare bleakly, shreds of hard skin cling to shrunken cheeks and arthritic knuckles. These people are mostly small, their arms crossed as they sag against the wire and nails that hold them upright, their heads lolling on shoulders, bodies slowly collapsing with the effort of imitating a past life.

The corridors are segregated into religious folk and professional, meaning doctors and lawyers and a couple of vaudeville grand soldiers in their carabinieri uniforms. There's a women's corridor where the guide points out that we can admire the fashions of the past. The skeletons stand in shredded rags, grimed and bleached a murky gray. There is little to admire. A side chapel is devoted to those who died virgins, especially poignant and by contemporary mores a pathetically cruel appellation to carry into eternity. When they were interred here, they must have appeared as symbols of purity amongst the decay.

And then there is a small chapel for infants. The children are dressed in their party frocks, propped up like living-dead dolls. One sits on a nursery chair with a little skeleton on her lap, perhaps a younger sibling, unbearably pitiful and simultaneously laughably grotesque.

THIS ISN'T LIKE THE CATACOMBS of Rome, an archaeological excavation of tombs. Here the bodies were always meant to be seen, and they charge you a small fee for the pleasure. There

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A. A. Gill writes for the Sunday Times *and is a contributing editor to* Vanity Fair *and* GQ. *Vincent Musi shot the March 2008 cover story on animal minds.*

are signs to remind you to be respectful and not take photographs, but they sell them. It's not clear if this is a religious experience or a cultural one, but it is a tourist attraction.

The first and oldest mummy is a friar: Silvestro da Gubbio, standing in his niche since 1599. (The word "mummy" is from an Arabic word for bitumen, which resembled the blackened resin the ancient Egyptians used as a preservative.) Most of the bodies are from the 19th century. To begin with, they were exclusively friars and priests attached to the monastery. As time went on, the religious men were joined by benefactors and dignitaries and notables.

No one knows exactly what started the mummification; probably by chance it was discovered that a body left in a crypt with a particular atmosphere of coolness and porous limestone would actually dry out rather than rot. Then a system was devised. The newly dead were laid in chambers, called strainers, on terra-cotta slats over drains, where their body fluids could seep away and the corpses slowly desiccate, like prosciutto. After eight months to a year, they'd be washed with vinegar, put back in their best clothes, and either placed in coffins or hung on the walls.

Preserving ancestral bodies is done in any number of places, but they're rarely displayed like this. Sicily has so many cultures, so many people came here with their practices and beliefs and were assimilated, that little bits now and again rise to the surface, their origins long forgotten. It has been suggested that perhaps the practice is the residual echo of a much older, pre-Christian rite—belief in the shamanistic power of corpses. Not every corpse would have dried out; some must have rotted, and so the preservation of others might have been an intimation of God's will, a divine hand keeping certain individuals as they were as a mark of a particular worldly goodness. As saints' relics are used to aid prayer and belief, maybe these bodies were thought to have been preserved by God to reinforce faith. Or perhaps the catacombs were made as a great *vanitas*, a memento mori, an illustration of the passing of all worldly ambition and the inevitability of death and the vanity and foolishness of storing up wealth on Earth.

In later years some of the bodies were more elaborately preserved by means of chemical injections, taking the responsibility out of the hands of God and leaving it to undertakers and science. In one of the chapels a little girl, Rosalia Lombardo, lies in her coffin. She appears to be sleeping under a filthy brown sheet. Unlike many of the other strained and dried mummies, she has her own hair, which hangs in doll-like curls over her yellow forehead, tied up with a big yellow silk bow. Her eyes are closed, the eyelashes perfectly preserved. If she weren't surrounded by the grinning skulls and rot of this place, she could be just a child dozing on the way home from a party. The naturalism and the beauty are arresting; the implication that life is a mere breath away, disturbing and spooky. Rosalia was two when she got pneumonia and died. Crazy with grief, her father asked Alfredo Salafia, a noted embalmer, to preserve her. The effect is dreadfully, tragically vital, and the grief still seems to hang over this little blond head. (Salafia sold his mummification fluid—keeping the formula secret—to funeral homes in the United States, as the fashion for embalming spread after the slaughter of the Civil War.) In Palermo, Rosalia is mentioned as a sort of semideity, a magical little angel. The taxi drivers say, "Did you see Rosalia? *Bella.*"

SAVOCA IS A SILENT VILLAGE that crawls up the side of a hill until it reaches a view across the eastern end of the island to the sea. A tightly

Trapdoors before the cathedral's altar lead to the crypt in Novara di Sicilia. Traditionally saints were interred under altars to secure divine protection for the church. Ordinary people were thought to receive benefit: The closer to the altar, the more sought after the burial place.

The paper-brittle skin of a clergyman in Piraino survives because Capuchin monks dried his body immediately after death. The corpse was placed on a wooden rack so fluids could drain away. Ventilation likely removed the remaining moisture, and branches of herbs were tucked inside the body to mask odors.

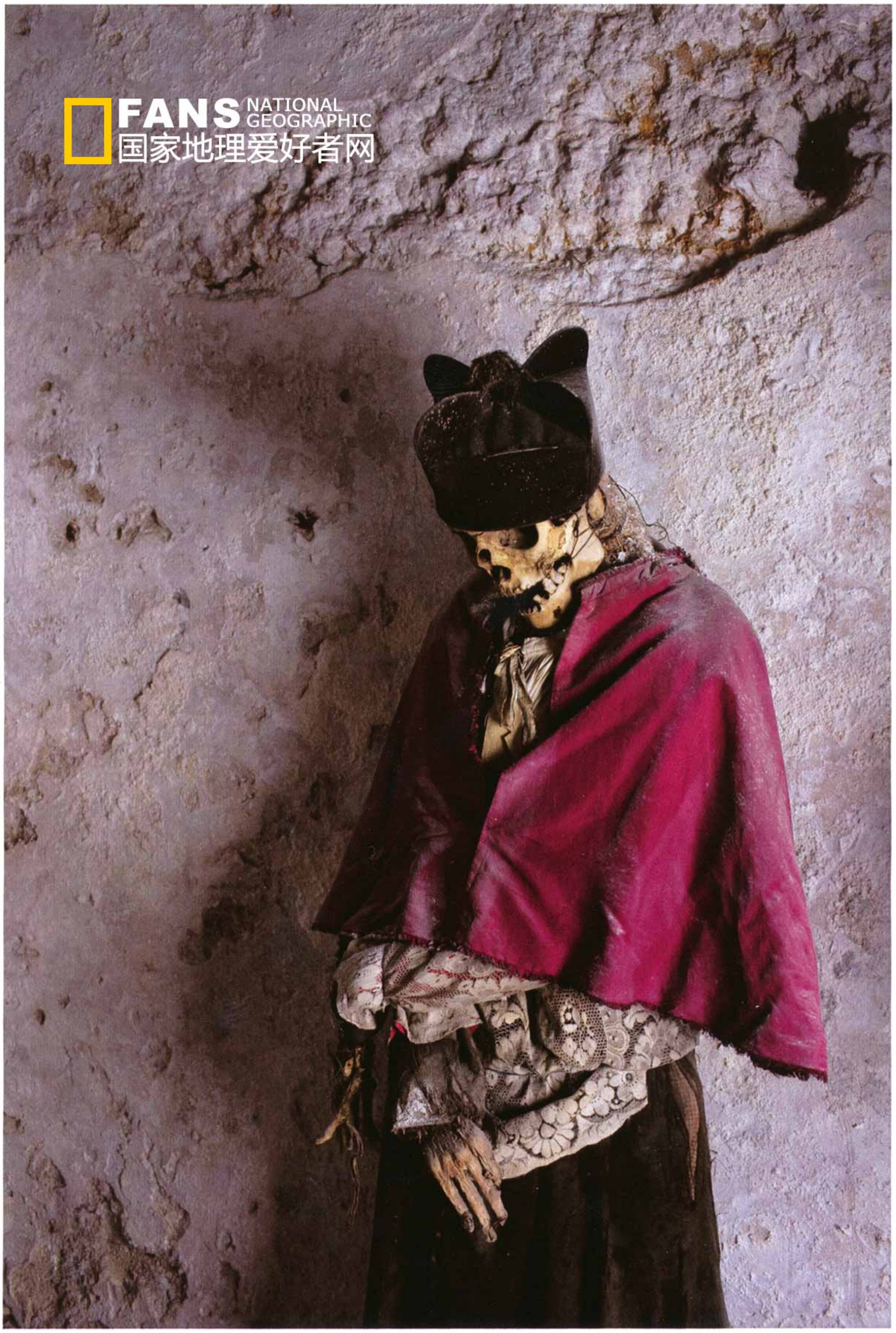
Bathed in a halo of light, a mummified clergyman presides over a niche in Piraino. People visited the crypts to pray for the souls of dead relatives and ask their intercession with God.

wound place that corkscrews back on itself. This is where Francis Ford Coppola filmed *The Godfather.* The bar where Michael and his tragic wife had their wedding reception sits on the tiny square looking exactly as it did 37 years ago on-screen. There's no obvious sign mentioning the movie. They don't like the association; most Sicilians I ask profess never to have seen it.

At the top of the hill is a convent, a place that looks more like a youth hostel than a Gothic medieval institution. There are only two nuns here, both Indians from Jharkhand. They wear woollies and jackets over their saris. In a side room, laid out in temporary plywood packing cases, are a couple of dozen cadavers that are being studied by a trio of scientists.

They're an unlikely team: Arthur Aufderheide, an octogenarian American from Minnesota who started as a pathologist and moved on to become one of the world's top mummy experts; Albert Zink, a big German who is the director of the Institute for Mummies and the Iceman in northern Italy; and a young Sicilian, Dario Piombino-Mascali—excitable and nervous, constantly worried, enthused and driven and possibly brilliant—who has a bolt through his eyebrow and a jacket that has "Boxfresh" written on the back, apparently without irony.

I find him leaning over a very unfresh box and delicately lifting the surplice of a 19th-century priest. He is looking for an unobtrusive piece of organic material for Professor Zink to do tests on. "Ooh, is this what I think it is?" We all poke our heads up the vicar's frock and concur that it probably is. A thin pouch



The scarlet cape and black hat on these remains in Palermo mark them as a priest's. Most Sicilian mummies were clergy or high-ranking, wealthy supporters of the Capuchins—nobles, professionals, and merchants. Tests reveal that many suffered from ailments linked to rich diets.

This 19th-century friar in Palermo kept his beard because low humidity in the crypt allowed the skin holding his whiskers to dry out quickly. Modern work on sewer lines now threatens mummies here. Water that used to drain away is infiltrating the catacomb, causing the plaster ceiling to crumble to dust.

of powdery dry skin comes away in his hand. A half-centimeter sample is meticulously labeled and packaged. He's not going to miss his scrotum now.

An enormous amount can be gleaned from dead bodies about the day-to-day lives of the past—diet, illnesses, and life expectancy. Knowing more about diseases like syphilis, malaria, cholera, and tuberculosis centuries ago can help us get the better of them today. The scientists move methodically, checking the corpses' heights and ages, examining skulls and teeth, looking for the ridges interrupting enamel that signify years of malnutrition. Two mummies are gouty. Five show signs of degenerative arthritis. Almost all these people suffered horribly from dental conditions—tartar buildup, receding gums, caries, and abscesses.

Abdomens are checked for missing organs. One of the bodies has had its soft tissue removed, and others have been stuffed with rags and leaves, including bay leaves, perhaps to mitigate the smell, or because they were supposed to have some preservative value. Filling out the shrunken forms would have made them more lifelike. The skin has the waxy quality of parchment, the clothes feel sticky and damp, the faces bloat and yawn, mouths give up wizened larynxes and shriveled tongues for examination.

The scientists are respectful of the bodies, never losing touch with the fact that they were human—they were like us—but still they refer to each one as "it," to keep a distance, a dispassion, when they're pulling a molar out.

A few years back these bodies were vandalized in their crypt. People broke in and poured green paint over them. Lurid and humiliating, it spatters and dribbles across their faces and coats and shoes, making them look even more like characters from a funfair ghost train. The nuns who are keepers of this strange congregation look on with pity and distaste. They tell me the bodies should be decently buried, allowed to return to dust. One says there's nothing spiritual or uplifting to be learned from all this.

The paint-spattered, rag-filled bodies will soon be returned to their empty niches. At the moment the arched alcoves along the wall hold nothing but hundreds of dried, dead centipedes. A number of bodies are still kept in their elaborate coffins. Gingerly I lift a heavy lid that may not have been moved for over a century and peer inside. The air seems to escape with a thick sigh, and the smell grabs the back of my throat—not a rotten smell but the odor of beef tea and the clogging aroma of dry mold and fine, powdery layers of human dust. It's a smell that is dramatically unforgettable, the tincture of silence and sadness, the scent of repeated prayer heard in the distance, or of remorse and regret, a smell that's both repellent and intimately familiar. Something sensed for the first time, but also with a strange and compelling sense of déjà vu.

WE WILL NEVER KNOW for sure what these corpses meant to the congregations who laid them out and dressed them. They remain one of Sicily's many mysteries. We are left with our own concerns, thoughts, and doubts when confronted by these comic and tragic visions of death. It is difficult to untangle the feelings aroused by the bodies, frozen on the journey between nothing and nothing—the mysteries, fears, and hopes, the contradictions of life and loss, that are eternal and universal.

The beautiful town of Novara di Sicilia has a large and piously decorated church. In front of the altar is a secret door to the crypt, and at the press of a hidden button, the floor opens electronically, just as in a James Bond film. Down a flight of steps is a room with carved stone niches containing the variously and now familiarly sagging bodies of six more prelates. On a high shelf stacked with skulls is a box containing two cats, naturally mummified, like a faint shadow of ancient Egypt. They got trapped in the crypt, a reminder that even with nine lives, there's only one end. □

■ **Society Grant** Research on these mummies was funded in part by your Society membership.

Among the last laid to rest in Palermo's catacombs, two-year-old Rosalia Lombardo died of pneumonia in 1920. But it seems only yesterday, thanks to the artful work of embalmer Alfredo Salafia, whose formula was recently rediscovered. In Sicily's crypts the dead live on.

Ryan Buckley, an intern at the weather station on the summit, bends to the will of a hundred-mile-an-hour gust.

BACKYARD ARCTIC

NIGHTMARISH WINTER WEATHER TURNS NEW ENGLAND'S MOUNT WASHINGTON INTO THE KILLER NEXT DOOR.

BY NEIL SHEA
PHOTOGRAPHS BY JOSÉ AZEL

Sunset-burnished clouds roll up the flanks of Mount Monroe and toward the Lakes of the Clouds hut on Mount Washington's southern shoulder. In summer the 90-bunk hut run by the Appalachian Mountain Club offers rest and meals to hikers.

MOUNT WASHINGTON RISES RUMPLED AND SOFT ABOVE the New Hampshire forests, beyond the brick towns, the old mills, and the cold cities, but not really too far away from anything. Just within reach. In summer you can even drive up it. On a clear day you might almost see home from the summit, and the Atlantic Ocean gleams calmly on the horizon, a thin sliver of mercury. It's practically in the backyard, people say. *How dangerous can it be?*

It can be very dangerous. The mountain is a foothill compared with western peaks, but it sits at the convergence of three storm tracks, along which weather systems and wind hurtle seaward. Barely 6,000 feet, Mount Washington is the largest obstacle blocking this crush of weather, an atmospheric pinch point, a boulder in a fast moving stream that churns wind into white water.

During summer, millions of people swarm into the White Mountains when the weather is fine—solid New England fare with cool nights and warm days. Perhaps some rain. Occasionally, hail. The mountains resemble anthills then, with crowds streaming up their steep trails. Others ride a small cog railway to the summit or take the winding eight-mile road. At the top of Washington there is a parking lot, often humming with motorcycles. There is also a snack bar, a museum, a weather observatory, and a large observation deck.

Winter strips away the crowds. Another Mount Washington appears, blasted by weather as fierce as almost anywhere on the planet. "Stop," the signboards warn. They are hammered into the earth by the trails leading up into the alpine zone that crowns the mountain. "The area ahead has the worst weather in America. Many have died there from exposure, even in summer. Turn back now if the weather is bad." Temperatures may drop to minus 30°F or lower, and wind screams over the rock. In April 1934 the world's wind-speed record was set here at 231 miles an hour. During winter, only a handful of meteorologists and others remain on the summit, bunkered inside the concrete observatory.

The combination of notorious storms and easy accessibility makes it one of the continent's deadliest peaks, and this has fixed it in regional folklore, shaping thought and action around the mountain the way the mountain shapes weather. It is a regular star in television forecasts, a coffee shop conversation starter, a murderer.

Of course, for some, all this is just a lure.

My brother Jon is a professional mountaineer out West, a guide on glaciered peaks where the air is thin enough to kill. But on this late January morning we are two and a half hours north of Boston, headed for the mountain that taught us to climb. The gray farms blur past, wrapped in whispers of snow. Volunteer firehouses, ice-clotted rivers. Ahead, the White Mountains stretch beneath clouds the color of bathwater. Everything still in the long pause of winter.

Jon and I hadn't seen much of each other for a long time. At our last meeting, more than a year before, an argument over old grievances had spun out of control, and we had nearly come to punches. Now we planned to spend a few days hiking across the range and climbing Mount Washington.

"Where you guys from?" asks the driver we've hired to drop us at the trailhead.

I tell him I live in Virginia now. He laughs.

"Sure you know what you're gettin' into?"

A reasonable question. For Jon and me, Washington was always the Everest of the East Coast, its ferocious potential irresistible. My three brothers and I grew up south of Boston,

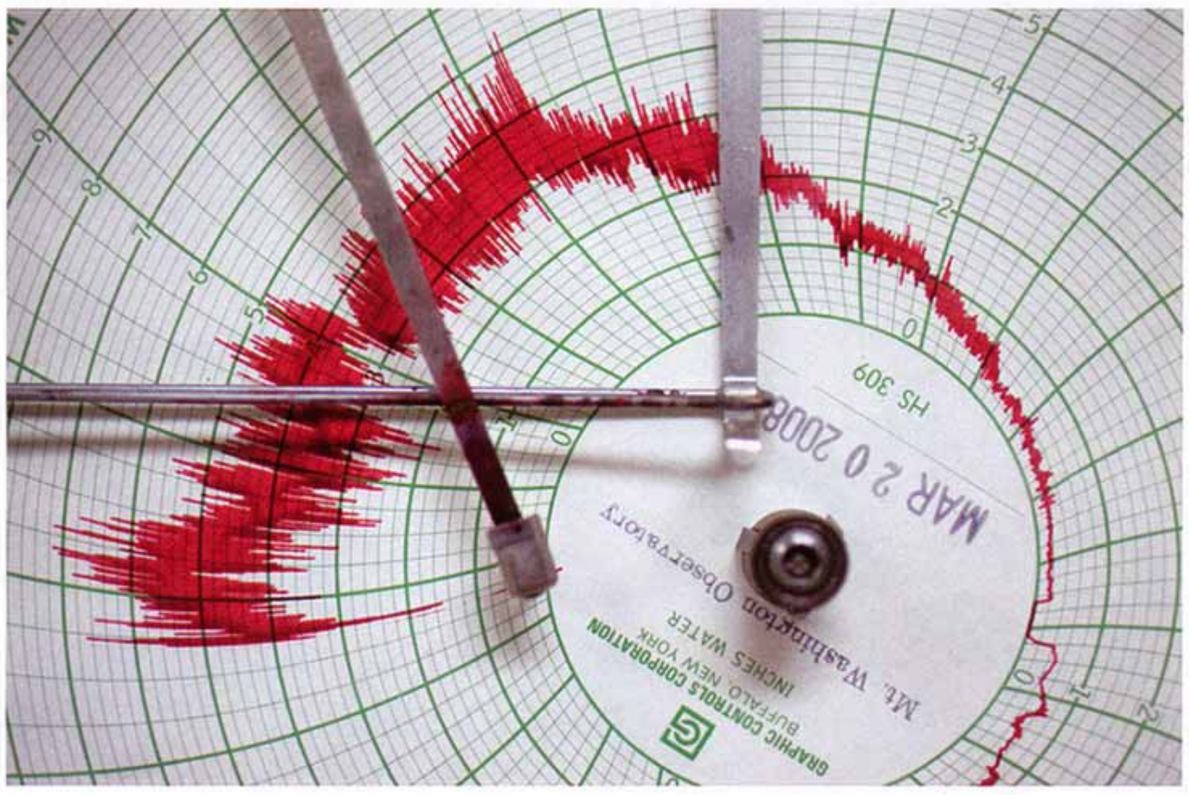
Steadied by poles and crampons, a hiker scrapes through Arctic-like conditions on the lip of Huntington Ravine, one of Mount Washington's most dangerous areas. Every few years someone dies on the mountain or in nearby ravines; many freeze or fall to their deaths.

and we learned the basics of mountaineering on Washington. We competed there, against each other and our peers, stacking up ascents in ridiculous conditions, trying to distinguish ourselves in the way of brothers everywhere. I was a teenager, the oldest of us, when I began climbing it alone in winter; Jon, the youngest, pestered to tag along. I was annoyed, even angry. Few relationships match the intense closeness of brotherhood, and I didn't want to cede territory. Back then it had already begun: We were more rivals than friends, our tempers driving us apart. The mountain was one more wedge in the crack.

Jon was 12 when we climbed the mountain together for the first time, 15 years ago. It was a perfect January day. At the summit we stood in the cold and took a couple of photos. I didn't notice that Jon hadn't eaten enough and was having trouble staying alert. He was too stubborn, or too cold, to say anything. On the way down, clouds and fog flooded in, a whiteout, and we got lost for nearly an hour on an ice-covered ridge. We stumbled up to the lip of a ravine, lucky not to slide in, and eventually followed it back to the trail. At the bottom, Jon nearly lost consciousness. I remember thinking of it as a charmed escape, something lucky that would gild tall tales. Jon remembers it as a beginning, an adventure that helped him choose a path. Both of us look back now and shake our heads at the errors—we should have talked more, turned around earlier. I had more experience; the mistakes were mostly mine.

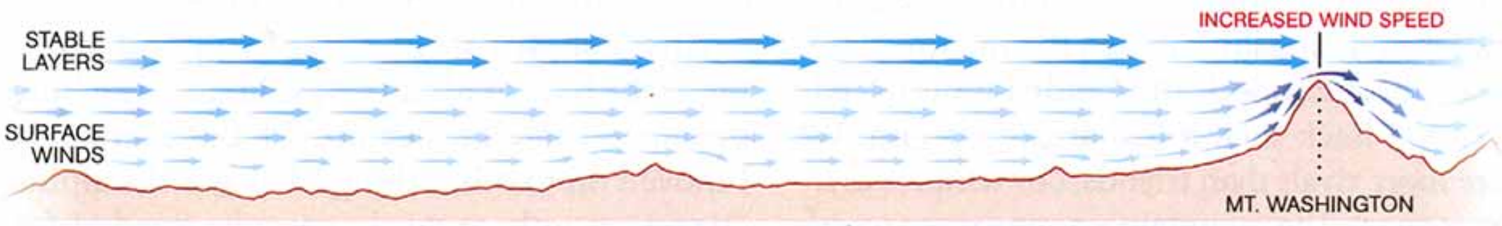
After college I spent a year living and working at the base of Mount Washington, teaching people to snowshoe, camp, ski. But eventually I moved on to other things. For Jon the alpine attraction only grew sharper; he headed for larger peaks and more technical challenges. He now leads—sometimes drags—clients up mountains in Washington State, Alaska, and Nepal. So when I was asked to write about Mount Washington, I wanted him to join me. We could revisit old battlegrounds, try once more for the summit. "I guess it's fitting," he wrote back. "Kind of like returning to the scene of the crime." *(Continued on page 148)*

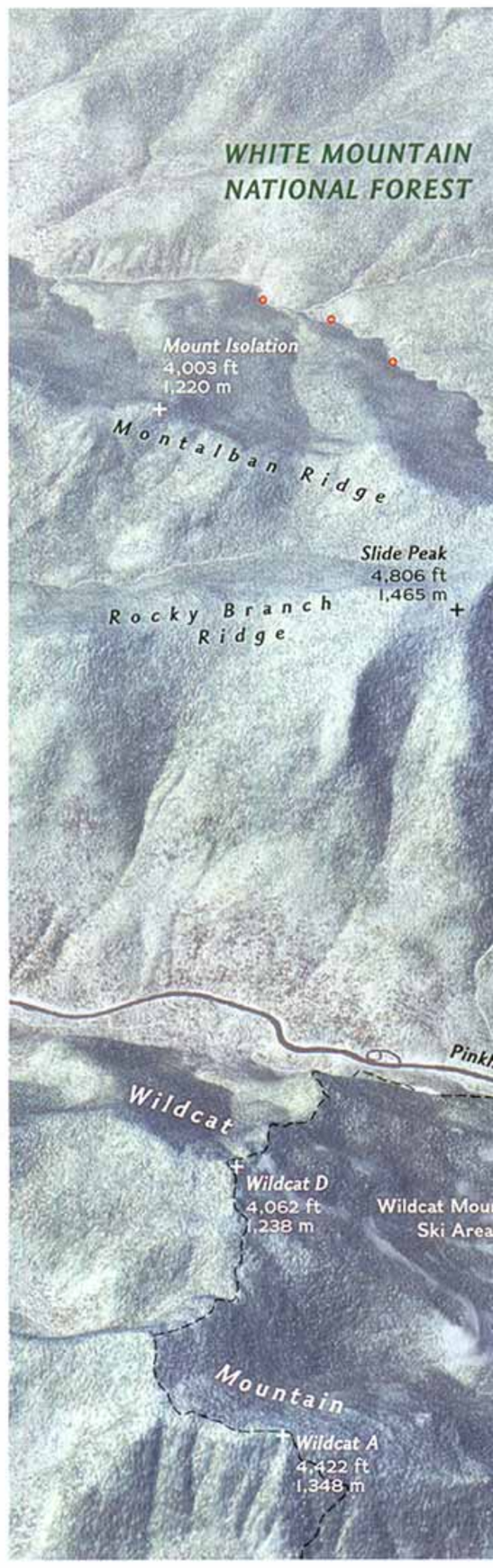
Neil Shea is a staff writer for the magazine. José Azel is the founder of Aurora Photos. He can frequently see Mount Washington from his hometown in Maine.

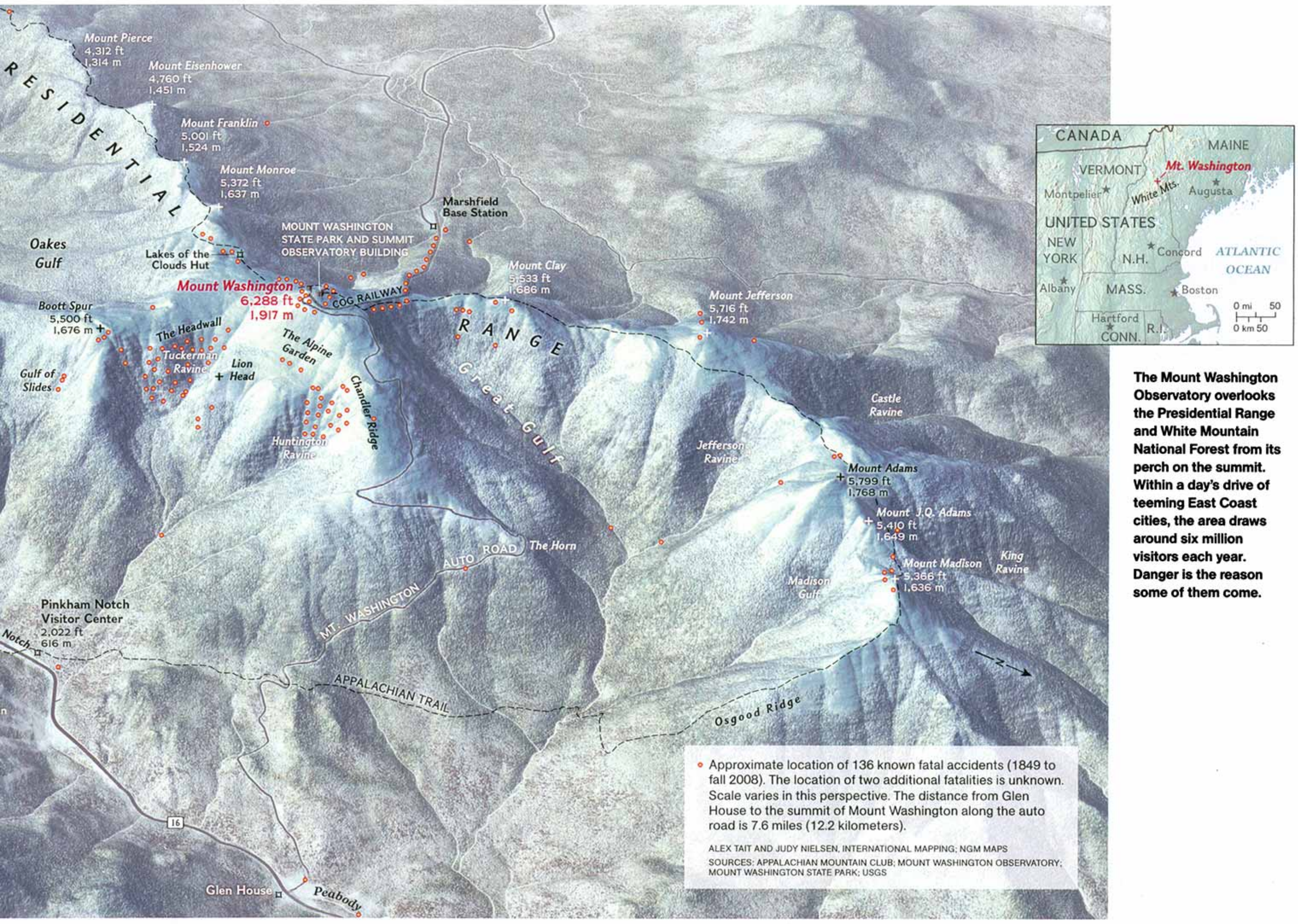


WIND MACHINE

At the Mount Washington Observatory, a wind-speed recorder sketches a portrait of the first day of spring (above), documenting gusts as high as 123 miles per hour. Squeezed between the ground and more stable layers of air aloft, wind accelerates as it crests over Mount Washington (below). Everyday breezes average 35 mph, and winds exceeding the hurricane-force threshold of 74 mph blow on an average of more than 120 days each year. The world record for wind speed clocked at a surface station was set here on April 12, 1934: 231 mph.







The Mount Washington Observatory overlooks the Presidential Range and White Mountain National Forest from its perch on the summit. Within a day's drive of teeming East Coast cities, the area draws around six million visitors each year. Danger is the reason some of them come.

Approximate location of 136 known fatal accidents (1849 to fall 2008). The location of two additional fatalities is unknown. Scale varies in this perspective. The distance from Glen House to the summit of Mount Washington along the auto road is 7.6 miles (12.2 kilometers).

ALEX TAIT AND JUDY NIELSEN, INTERNATIONAL MAPPING; NGM MAPS

SOURCES: APPALACHIAN MOUNTAIN CLUB; MOUNT WASHINGTON OBSERVATORY; MOUNT WASHINGTON STATE PARK; USGS

The warm glow of observatory lights and distant towns softens a January night. Under the crust of ice lie trails and a parking lot. Summer draws hordes of hikers to the summit, while less energetic visitors can drive to the top.

Fighting ice with iron, weather observer Mike Finnegan smashes rime—frozen fog—from an instrument mounting. Rime builds up rapidly during some storms, forcing crews outside in brutal conditions for de-icing duty around the clock.


FANS NATIONAL GEOGRAPHIC
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On the second day of our traverse we wake to bad weather above tree line, howling wind and snow. Temperatures far below zero. Washington is several miles away across exposed ridges, and we'd chosen to approach it along a route we've never taken together, looking for something fresh in a familiar landscape. In the colorless dawn we stamp like horses and weigh our options. I'd forgotten the fearsome power of cold. Each breath stings as it slides down. Silently we consider the option of retreat but decide aloud to go on.

The balaclavas covering our faces freeze stiff as wood. Visibility drops and the sky darkens, iron clouds shuttling overhead. The cold forces us to shelter in the lees of stones, behind mounds of snow, and add layers of clothing. By noon the snow stops and the sky brightens, and we reach a place where the wind falls away.

But soon the trail fades. In alpine zones all through the Whites, trails are marked by stacks of stones called cairns. Winter sheathes them in windblown ice; sometimes it buries them completely beneath snowdrifts. Beside a cloud-choked ravine, the cairns disappear and we are once again lost on a white blank, just as we were many years ago. We strip off our packs and fish out the map. Tendrils of cloud make it difficult to read the terrain, but we find we're near Mount Jefferson, a spot that is infamous for us, for many New Englanders.

Each year in the Whites at least a dozen climbers get lost, caught in storms, carrying inadequate equipment. Some don't know how to use their expensive new gear. An increasing number arrive equipped with cell phones instead of experience or even maps, thinking rescue is only a few buttons away. "They persist," says one expert, "in bad courses of action." One of the worst examples in recent memory unfolded not far from where Jon and I have stopped.

In January 1994 a young climber froze to death there, alone and delirious. His name was Derek Tinkham, and he died doing the same traverse, headed for the same summit. In terrible weather, night falling upon them, Tinkham and his hiking partner, Jeremy Haas, kept going. The temperature plummeted, and the wind picked up, Tinkham growing weaker with each step. Eventually he could walk no farther. Haas tried to bundle Tinkham into his sleeping bag, then he left him to seek help. Winds reached hurricane speeds, forcing Haas to crawl; cold near 30° below zero began killing his exposed skin. After miserable hours he reached the observatory atop Washington, where the crew found him and brought him inside. He suffered severe frostbite, his hands eventually swelling into black stumps. But he lived.

Haas was the more experienced climber, and he was roundly blamed, first for continuing in weather that called for retreat, then for abandoning his friend, who was exhausted but did not protest out of stubbornness or simply because he was hypothermic and his brain was shutting down. A rescue team found Tinkham the next day, half inside his sleeping bag, his face a mask the men would remember for years.

Seated atop my pack, scanning the map, I remember the days after Tinkham died, when the newspapers and everyone I knew talked about weather and arrogance and death. The tragedy didn't keep Jon or me out of the mountains. We barely paused. We each thought, as all young climbers do, It will never happen to me.

Before us, several possible routes open across a snowfield sheathed with an ice crust. We choose one, Jon leading. He takes a few steps and then sinks to his hips in deep snow. He wrestles with his trekking poles and tries to push himself out of the hole, the heavy backpack fighting him. He takes another step, sinks again. Soon I'm postholing too, fir branches below the snow clawing at my legs. The process—step, sink, repeat—is exhausting, the price of an audience with Washington.

"I forgot about this," Jon says, thrashing in a hole. "This is one thing you don't worry about out West. I hate this."

We try three different paths, postholing for an hour, losing time and heat before we finally reach a nose of rock where the snow thins but

The mountain's moods aren't all bad. Spring warmth draws crowds to Tuckerman Ravine, including thrill seekers who attempt to ski a steep headwall. Others simply relax in the sun-washed glacial cirque and bask in the presence of the peak.

the wind returns with violence. Jon is a dozen yards ahead when he suddenly falls hard, taken out by ice and wind. He stays down, a broken line of color in the whiteness. An injury would be very bad here, miles from help. Slowly he leans into his poles and stands.

As we move on in silence, I'm thinking of Tinkham, the wind shutting out conversation. More postholing, a fall or two. My mind settles into our rhythm, assessing and reassessing the numbness in my hands. Where the snow is loose and powdery, it squeaks beneath our crampons—Styrofoam snapping, or the complaint of fine sand. Ice is more musical. It splinters and tinkles, shards of it spinning away into the ravines, sharp as broken Christmas ornaments. Only once do we hear human noise—the rip of snow machines miles away.

Jon later admits that all day he is sizing me up, the guide in him recording my mistakes. It's been years since I hiked in winter, and it shows. He says nothing at the time. "How do you tell your brother he's doing it wrong?" he eventually says. "It wasn't a competition. It was about two brothers doing it." The kid who would've delighted in his brother's missteps is gone. Before we set out, a friend worried we would get too mired in competition, that old striving, to turn back if things went bad. Once, perhaps. But I sense that is mostly gone now too.

The trail arcs toward Washington, and the summit cone is washed in brilliant light. We wind around to a spot just below the summit, drop our packs, and climb over rocks and ice to the top. Cocooned in the observatory, a crew tracks the passage of the storm that hours ago nearly turned us back. But the sky is clear now, the horizon open to infinity. Far below us firs stand green and rigid like ranks of frozen soldiers. Ten minutes at the top is enough.

Later we lie in our sleeping bags, shivering while the night cold consolidates its dominion and relentlessly steals our heat. Frost forms on the walls of the tent and rains upon us each time we move. We chew slabs of cookie dough from a tube for the calories, to keep warm. Between mouthfuls Jon tells stories of his life I've never heard, and we laugh at memories we haven't shared in years. Outside, winter constellations swing slowly over the spine of the mountains and Washington gleams like marble in the moonlight, rising in the dreams of the East. □

X-Ray Insights At age two Rosalia Lombardo died of pneumonia and was embalmed. That was in 1920. Today her mummified body rests in a glass-fronted coffin in the Capuchin Catacombs of Palermo (page 133), looking so lifelike that, until recently, some locals believed she must be a doll.

To check the extent of Rosalia's preservation, researchers wanted to peek beneath the sheet covering most of her body. But they did not want to open the coffin and risk damaging her. X-rays (one, at left) revealed that the body is undeniably real and phenomenally intact, its organs in excellent shape. Experts credit the dryness of the catacombs, formaldehyde in the embalming fluid, and another ingredient, now rarely used. Petrified by zinc, Rosalia's body shows only minor signs of age, such as darkened skin from exposure to air or light. With details from the x-rays, researchers hope to keep her in good condition. *—Karen E. Lange*

CAUSE OF DEATH

Tests on tissue samples from mummies in Savoca, Sicily, show that people whose bodies were placed in that crypt during the 1800s suffered from illnesses that once plagued only the rich.

Forestier disease This rare degenerative arthritis is more apt to strike people over 50 and is linked to obesity and diabetes.

Gout A metabolic arthritis tied to protein-rich diets, it mainly affects older men.

Researcher Dario Piombino-Mascali x-rays Rosalia's sealed coffin in the Palermo catacombs.

X-RAY: ALBERT ZINK; SEDECAL/CANON MEDICAL DIVISION
PHOTO: GIANLUCA COLLA

Mustangs investigated Melissa Farlow's camera—then Melissa Farlow herself—at a conservation center in South Dakota.

ON ASSIGNMENT **On the Hoof Beat** "There are very few places where you can actually watch wild horses relate to each other," says photographer Melissa Farlow. While working on this month's story about mustangs, Farlow had an opportunity to see how wild horses related to her.

On assignment in Lantry, South Dakota, "I was taking pictures at the International Society for the Protection of Mustangs and Burros," says Farlow. "I walked away from my tripod and lens for a minute, and this group of horses went up to check it out. When I ran back to the camera to steady it, they moved in closer and started smelling me. The expression on my face (above) is that I'm just thrilled to be able to experience this, to be able to feel their breath."

Farlow wasn't as thrilled when mustangs broke two of her camera traps. "Contractors with the Bureau of Land Management let me put camera traps out where these horses were, with metal boxes around the cameras that are supposed to protect them. Horses ran over the camera probably a dozen times and it was fine, but then one hoof hit just right and cracked its protective case. This happened once, but I still had two cameras left with boxes, so I decided to put another one in the path. Sure enough, they broke another."

PHOTO: LORI FAITH MERRITT, PHOTOGRAPHY BY FAITH

INSIDE GEOGRAPHIC

ON ASSIGNMENT **High Point** Staff writer Neil Shea (above, at left) and his brother Jon (at right) hadn't spoken for over a year when they set out to climb New Hampshire's Mount Washington. "It was a little awkward," Neil says, "but when we started talking, telling each other new things, that was a breakthrough. We filled in the gaps." While Jon makes his living as an outdoor guide and mountaineer, Neil hadn't done any serious climbing for years. Despite dangerously cold temperatures and a fierce storm, Neil enjoyed his return to the mountain. "It was great to be challenged physically, it was great to be thrown into an extreme environment, it was great to be with Jon," he says. But he adds, "Like a lot of climbers, I love coming down, sleeping in a warm bed, and eating pizza."

Saltire Prize The Scottish government is offering a £10-million prize (more than $16 million) for innovation in marine renewable energy—and the National Geographic Society is playing a part. National Geographic Society President John Fahey was named one of four inaugural Friends of the Saltire Prize to help build awareness of the competition, officially launched in December. First Minister of Scotland Alex Salmond explains, "The Saltire Prize is the Scottish Government's way of playing its part in inspiring a revolution in clean, green energy as the world enters a new golden age in innovation prizes." Says Fahey, "The Saltire Prize holds great promise for all of us."

PEOPLE BEHIND THE STORIES

■ **Alexandra Fuller** The writer of this issue's "Mustangs: Spirit of the Shrinking West" says it can be "a hard thing to have a powerful experience that won't fit into the confines of a story." Watching the workings of an innovative rehabilitation program—in which prison inmates train captive wild horses—was one such thing for author Fuller. "The connection between the men and the horses was incredibly moving," she says, "as was the realization that they were both incarcerated. At sunset the men were back in their cells, the horses were back in their corrals, and the Arkansas River was weaving through cottonwood trees under a vivid red sky. I felt as if that moment was a story in and of itself."

■ **Tom O'Neill** While reporting "Escape From North Korea," *Geographic* staff writer O'Neill spent weeks interviewing defectors and learning how bad life was in their homeland. So he was unnerved when, in a Chinese town, he sat down with true believers in a restaurant set up by the North Korean government. "The waitresses were wearing pins of Kim Il Sung. The television was showing heroic workers from propaganda films. And our server, when she learned that I was an American, kept staring at my South Korean wife as if she wanted to blurt out: How can you stand being with that capitalist dog?"

PHOTOS (CLOCKWISE FROM TOP LEFT): JOSÉ AZEL; REBECCA HALE, NG STAFF (BOTH)

Vicious velociraptors are relatives of today's turkeys.

NATIONAL GEOGRAPHIC CHANNEL

Original Species

Did you eat a dinosaur sandwich at lunch today? Turns out turkey may have surprising origins. A new National Geographic Channel series, *Morphed,* makes the connection between dino and bird with state-of-the-art, computer-generated images (left). Additional shows explore the origins of whales and bears. The first episode of *Morphed* airs February 8 at 8 p.m.

NG BOOKS **Traveler's Guide** For the tenth anniversary of this series of guidebooks (above), the editors added new features, including tips from Society photographers, writers, and explorers. "Today's travelers want to have meaningful experiences, rather than just going to sights and checking them off," says series editor Barbara Noe. The first 12 guidebooks—nine revised books and three new titles—are in bookstores this spring ($19.95 to $27.95).

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PHOTO: KABOOM (TOP)

FLASHBACK

Cryptic Monk Since the 1700s, awed tourists have filed past the mummified corpses—there are thousands—at the Convento dei Cappuccini, a monastery in Palermo, Sicily. This meditative friar led visitors through the catacombs. The picture did not appear in *National Geographic,* but a similar image by the same photographer was published in September 1924. The caption noted that each skeleton bears "a label of identification." The tradition of catacomb tourism continues today, with many thousands of visitors coming each year. By charging the equivalent of two dollars or so for a tour, and by selling books and postcards, the modern-day Capuchin friars earn money for their own expenses and to donate to the poor. *—Marc Silver*

Flashback Archive Find all the photos at **ngm.com.**

PHOTO: A. W. CUTLER, NATIONAL GEOGRAPHIC STOCK

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