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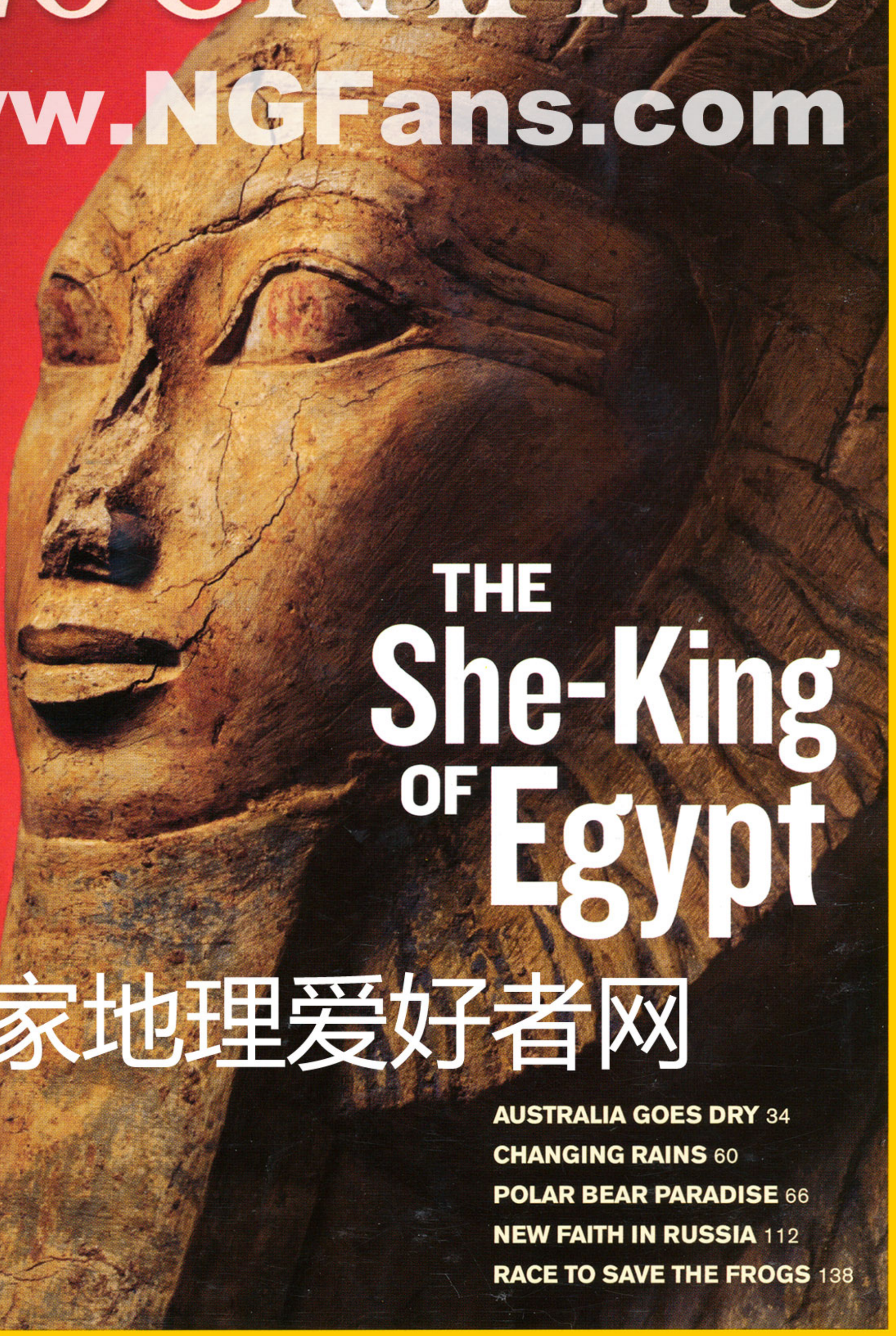

## THE She-King OF Egypt

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# NATIONAL GEOGRAPHIC

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A Gordon's mossy frog plays dead at a South Dakota reptile center.
The Asian species rolls over to fool predators.
Story on page 138.

PHOTO: JOEL SARTORE


OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

# NATIONAL GEOGRAPHIC

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ENVIRONMENT

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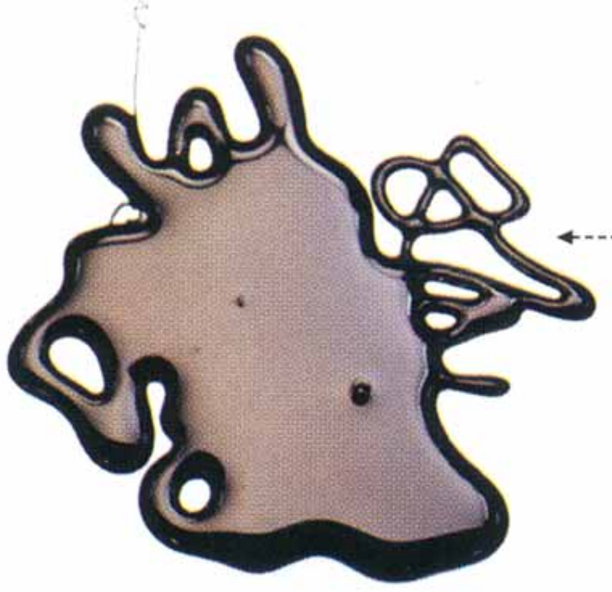

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How much oil has spilled since the *Valdez* disaster?

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**On the Cover**

Hatshepsut wore a false beard to emphasize her royal power.
*Photo by Kenneth Garrett*


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# EDITOR'S NOTE

Samantha (at left) and Natalie Turner sweep sludge from a trough on their family's drought-stricken farm in New South Wales, Australia.

**The diesel engine clatters** to life. My friend Mike is giving me a quick lesson in how to operate his father's bulldozer. Accompanied by a cacophony of metal on metal, I maneuver pedals and levers. I lower the blade and begin knocking down trees. I'm helping build a logging road near Prospect, Oregon. Despite a lack of finesse, I'm making progress and having fun. I'm on top of the world.

When I read Robert Draper's "Australia's Dry Run" and look at Amy Toensing's photographs in this month's issue, I'm reminded of that day three decades ago when I was young and didn't understand the potential consequences of bulldozers.

A decade ago the farmers of the Murray-Darling Basin were on top of the world. Their machinery had cut 15 billion trees; leveled fields; planted crops; built canals, weirs, and locks to divert water; and turned the basin into Australia's breadbasket.

Now the water is gone. A seven-year drought is taking its toll, and battles rage over the dwindling supply. "The last three years we've had essentially no water. That's what's killing us," says Malcolm Adlington, a dairy farmer who has had to sell all his heifers (six years ago he had nearly 500). There is no shortage of claimants for the water—from farmers to conservationists to the city of Adelaide.

The bulldozers that reshaped the basin are gone. But questions remain. What caused the drought? Climate change? Is deforestation breaking the natural cycles of rainfall? Slowly, the questions are being answered, with solutions to follow. In the meantime, the world watches and, hopefully, learns.

PHOTO: AMY TOENSING

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# LETTERS

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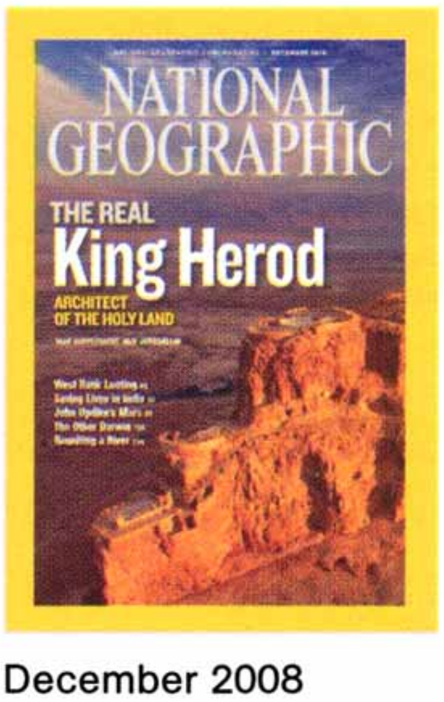


December 2008

## Herod: The Holy Land's Visionary Builder

The article on King Herod was most informative. But author Tom Mueller's statement that "Herod is almost certainly innocent of this crime" of slaughtering every male infant in Bethlehem in order to kill the newborn Jesus (offering no proof to back up this statement) makes me wonder whom I should believe: your author or Matthew in the Bible. I think I'll stick with Matthew.

**SIEGFRIED KLAMMER**
**Mahopac, New York**

You can't have it both ways. Herod's chroniclers, who were eyewitnesses of the generation immediately after the fact, say he ordered the deaths of males born when Christ was born because he perceived them as a threat to his reign. We weren't sure Herod existed until Israeli archaeologists found his name on an artifact at Masada. Tom Mueller says Matthew's account didn't happen, and yet Mueller reports Herod—cruel, brilliant, and probably insane—killed three of his own sons and his second wife for similar reasons. So, Herod was a great, visionary, murderous, infanticidal monarch kowtowing to Rome on behalf of what? His own fatal vision? The greater good of his people? What is so hard to believe in Matthew's Gospel?

**FRANK AND AUDREY CARROLL**
**Custer, South Dakota**

The fact that the accusation against Herod appears only in Matthew's Gospel does not make him "almost certainly innocent." The lack of other ancient documents corroborating the Gospel account is not evidence of innocence. The act of slaughtering infants was, and unfortunately still is, common. It would not have been an act so sensational that it would result in documentation. Look at the Holocaust or the more recent tribal genocides in Africa. People with Herod's disregard for the value of human life still are among us.

**GERALD M. PAULY**
**Sacramento, California**

While modern scholars and revisionists may argue that Herod did not order the execution of the innocents as described by Matthew, it is still completely in keeping with his character. What cannot be argued is that his kingdom and all its "cloud-capped towers" were built upon a foundation of bloodshed, murder, and fear. The world can well do without such "visionary builders."

**MARK NIELSEN**
**St. George, Utah**

*We received a great number of letters protesting the article's statement that Herod was "almost certainly innocent" of the infanticide described in the Gospel of Matthew. In the sense that the accused is "innocent until proven guilty," we stand by the phrase. Josephus, Herod's first-century biographer, makes no mention of such a crime, nor do any of the contributors to other Gospels of the Bible. The scholars consulted for our story indeed maintain that there is no archaeological or historical evidence that the killings ever occurred, beyond the account in Matthew, which was most likely written a century after the event was alleged to have taken place. That said, as the article points out, given the level of cruelty attributed to Herod, the killing of young boys in Bethlehem—or anyone else who posed a threat to him—would certainly have been consistent with his character.*

Not only was it a pleasant surprise to finally see the much vilified King Herod given long-overdue credit for his incredible feats of engineering and construction, as well as his skillful diplomacy, but your article also fulfilled my long-standing need to have him exonerated for the so-called Massacre of the Innocents, one of the cruelest and most unlikely fables in the Bible and one that was obviously concocted to fulfill prophecy. While Herod was no saint, few kings before or since have been.

**HARRY KATZ**
**Southold, New York**

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### The Stolen Past

There's just no way archaeologists are ever going to get the opportunity to completely examine every article at every site that exists. A sampling will be the best that they can get. West Bank inhabitants have been cut off from earning a living, so either lift the travel bans and develop the economic infrastructure, or train leading citizens in each village in the basics of archaeology. They can put the people to work digging, with the understanding that pictures must document the location of each find and each artifact. In return, they can get an authorization number and may sell what they find—with some exceptions, of course. In this way there is some control over the digging, the antiquities market is happy, and there is documentation for experts who arrive later. It's not perfect, but it's better than turning a precious site into a rabbit warren.

**J. McFARLAND**
**Stanfield, Oregon**

### The Man Who Wasn't Darwin

I'm weary of hearing about Alfred Russel Wallace, the man who was cheated out of his place in history alongside Charles Darwin. Mostly I weary of the myth that Darwin espoused one theory. He had two—natural selection and sexual selection. He knew full well that he had amassed enough evidence for his first theory well before Wallace happened on the scene. But it was the theory of sexual selection that really fascinated him. Despite ample opportunity to observe this force at work in the jungles of Borneo, Wallace disagreed with Darwin on this powerful theory, and for this he shall be forever relegated to the lower pedestal of history. Darwin's second theory was the one most unpalatable to Victorian society (which worried him sick) and to our conservative education system today. Darwin alone shouldered the abuse.

**JAMES K. FINLEY**
**Sidney, British Columbia**

**West Bank inhabitants have been cut off from earning a living, so either lift the travel bans and develop the economic infrastructure, or train leading citizens in each village in the basics of archaeology.**

Now that's a photo [page 107] that truly expresses the nature of an animal! A life of working with animals in two of the world's major zoos has given me the hands-on opportunity to work with many of the birds known as ratites. Of the larger forms of these, rheas are skittish and relatively harmless, emus are potentially dangerous during the breeding season, ostriches always present a threat, and cassowaries are large, heavy, and possess a mind-set that poses constant danger to handlers. The eyes and attitude in the cassowary head shot are the finest depiction of an animal's apparent intent that I can ever remember seeing. Malevolence incarnate.

**JOHN T. HULLEY**
**Brooklin, Ontario**

I would like to correct the statement that Alfred Russel Wallace was an Englishman. He was born and raised in Llanbadoc, Sir Fynwy, Mid-Wales. As such he would be a Welshman.

**JONATHAN MORGAN**
**Cardiff, Wales**

*Wallace was born of English parents in the county of Monmouthshire, which is now unquestionably part of Wales, although between 1542 and 1974 its status was ambiguous. Wallace might have been surprised to know that some consider him a Welshman. In his writings he referred to himself as an Englishman a number of times.*

### Reuniting a River

Your article on the Klamath was fascinating, but I challenge one aspect. To describe large reservoir hydroelectric facilities as having no carbon emissions is scientifically unfounded. The World Commission of Dams (a nonpartisan panel of scientists, engineers, and policy analysts), in a 2000 report, documented the environmental impact of large dams, including the climate impacts. They found that dams have a wide range of greenhouse gas impacts, from negligible in some locations to very significant impacts in others, in some cases nearly as great as fossil fuel power plants. The reasons for this are still under study.

**MICHAEL HOGAN**
**Programme Director, Power**
**European Climate Foundation**
**The Hague, Netherlands**

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**Eva Nahodilova** Amstelveen, Netherlands

"It was a very foggy morning when I took my camera out," says 24-year-old Eva Nahodilova, who shot this dock on a lake in Amsterdam. "All ways in this water kingdom are lost in the fog."

**Jim Pavletich** Elk Grove Village, Illinois

One misty morning just after a rain, Shadley the Labrador obeyed when Jim Pavletich, 44, gave her the command to sit—and he got his shot. "I take almost as many pictures of her as I do of my daughter, Ellie," he says. This photo was voted an *ngm.com* audience favorite.

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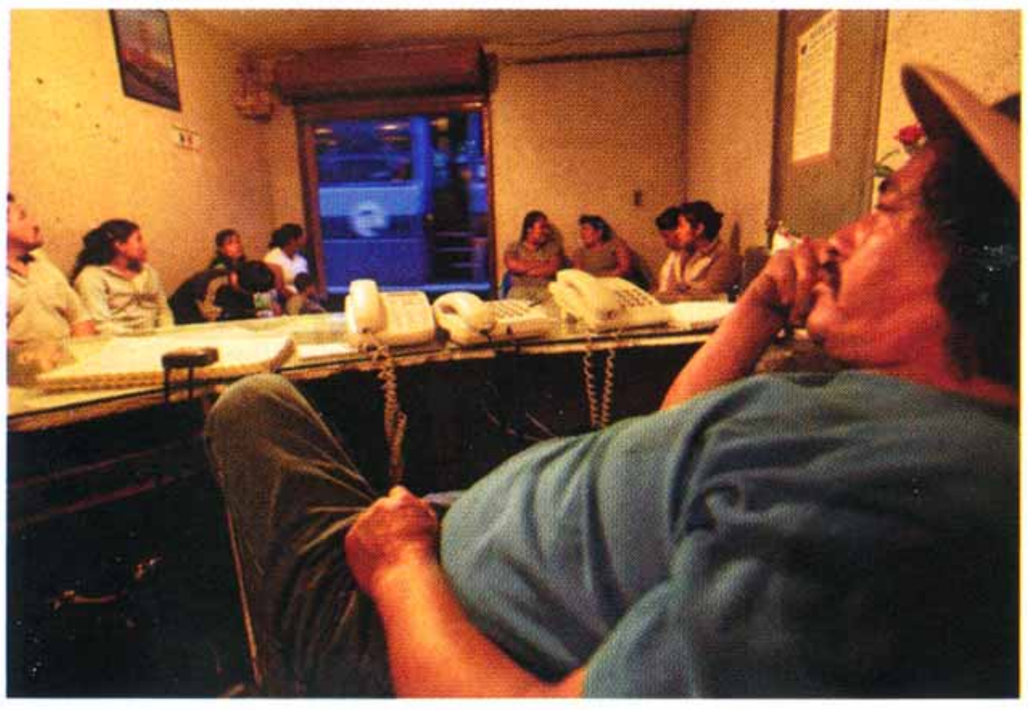
Juana Emilia Perez (at far left) and family watch a rodeo. Few men are left in their Oaxaca, Mexico, town.

*Freelance journalist Dana Romanoff began this project during her internship with* National Geographic. *She lives in Boulder, Colorado.*

**Only Women** The annual rodeo at San Pablo Huixtepec used to be a big event. Now organizers have to invite cowboys from other Mexican villages to get enough competitors—there aren't enough local men left. "When the boys turn 15, they go," says Juana Emilia Perez, whom I photographed watching the rodeo from a truck bed with other female family members (above). Her 22-year-old son will soon be gone too. He plans to leave to work in the United States, as his five siblings did before him. Due to riskier and more costly border crossings, Perez's sons, like many Mexicans living in the U.S. without papers, rarely chance coming home. I visited the small towns of Mexico's Oaxaca state photographing people and places left behind. Emigration is changing the societal structure here. Without men around, machismo is giving way to a more matriarchal arrangement known as *pura mujer*—only women.

Families do try to keep in touch at call centers like this one (left) in San Pablo Huixtepec. Vicente Benjamin Adenas Rodriguez (foreground) opened the business after working in the U.S. for 15 years. "Women come here to speak with loved ones in the U.S.," he says. "The recently married ones cry a lot."



# VISIONS OF EARTH

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**Indonesia** See dusk in the Dampier Strait through a half-submerged lens and glimpse two distinct worlds. Under a cloud-slung sky, fishermen work on wooden boats. Beneath a mirror-calm surface, waters flash with baitfish.

PHOTO: DAVID DOUBILET

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**China** A member of a ceremonial honor guard inspects his cohort's alignment, making sure it's suitable for the arrival of world leaders at the 2008 Asia-Europe Meeting, held at Beijing's Great Hall of the People.

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PHOTO: NG HAN GUAN, AP IMAGES

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**United Arab Emirates** Peninsulas of prosperity, the "fronds" of the $14-billion Palm Jumeirah—the first of three planned resort islands in Dubai—jut into the Persian Gulf. Building began in 2001; it may end in 2013.

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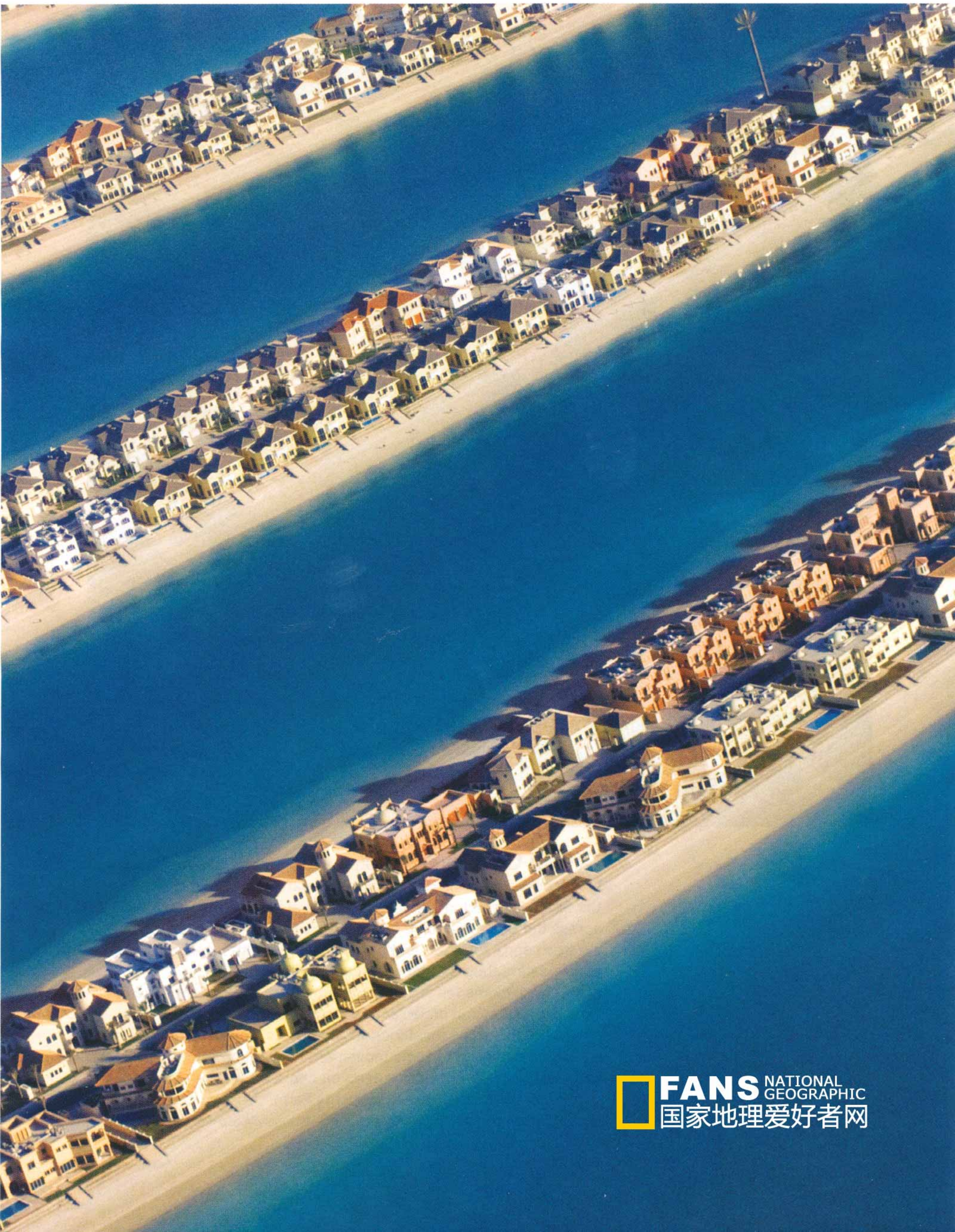
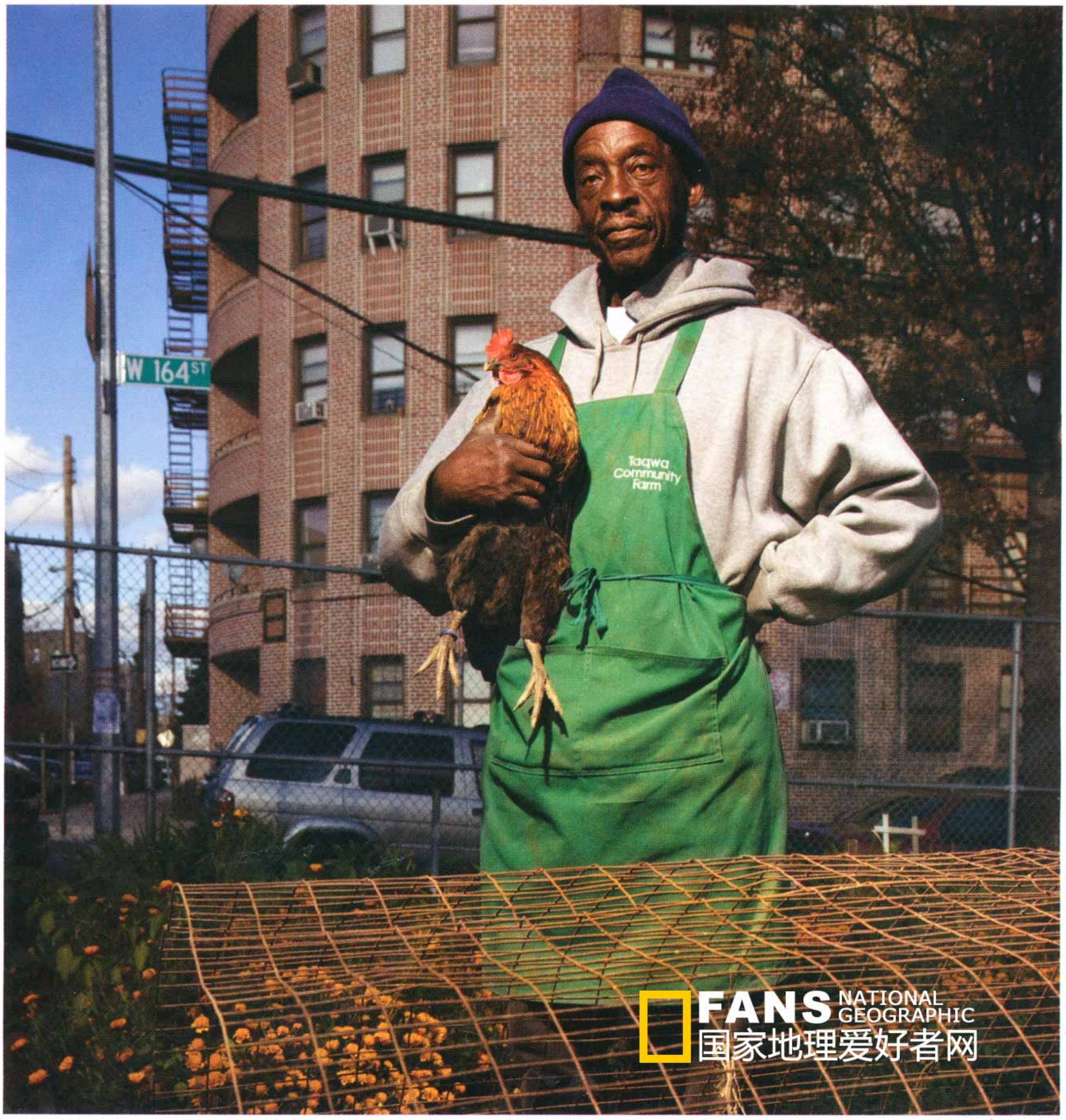
PHOTO: ALEXANDER HEILNER



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In New York City, senior gardener Abu Talib oversees the Taqwa Community Farm and its 13 chickens.

**Urban Chickens** In 19th-century Manhattan, hogs roamed the streets and cattle grazed in public parks. Today, chickens are the urban livestock of choice, and not just in New York. City dwellers across the U.S. are adding hens to their yards and gardens, garnering fresh eggs, fertilizer, and community ties, with localities debating and updating their ordinances accordingly.

Urban chickens fell out of favor in the last century because of industrialization and other factors. In the 1990s, though, they enjoyed a renaissance in the local-food-loving Pacific Northwest. The current recession and farm-to-table movement have taken the trend further still. "Just get a few chickens and you can feed yourself," says Abu Talib of the Bronx's Taqwa Community Farm. "He who controls your breadbasket controls your destiny." *—Winona Dimeo-Ediger*

PHOTO: IRA BLOCK

# ENVIRONMENT

**Budding Pursuit** "I love those first little green leaves," says octogenarian Jean Combes of England's oaks in spring. Since age 11 she's jotted down signs of winter's end. Too bad her girlish script shamed her and she tossed her first decade of notes. Such data are vital to phenology, the study of the timing of nature's cycles. The science is gaining visibility as climate change blurs seasonal lines.

Phenological data goes back to at least A.D. 705, when Kyoto royals kept cherry-blossom records. In 18th-century Europe "it began as a gentleman's pursuit, one of vicars and spinsters," says British environmental scientist Tim Sparks. Now anyone can sign up to contribute to one of numerous online databases worldwide. Combes takes daily walks to report first tree leafings to Nature's Calendar, a database out of the United Kingdom whose thousands of volunteers report on spring firsts (and fall lasts), from frog eggs to bird chirps to lawn mowings. Comparing old data with new shows the impact of rising temperatures, later frost dates, and more sunshine. As Sparks notes, "It's getting harder to answer the question: When does spring arrive?" *—Jennifer S. Holland*

**EARLY BLOOMERS**
Daffodil bloom dates near Cambridge, England; red line shows the trend over time.

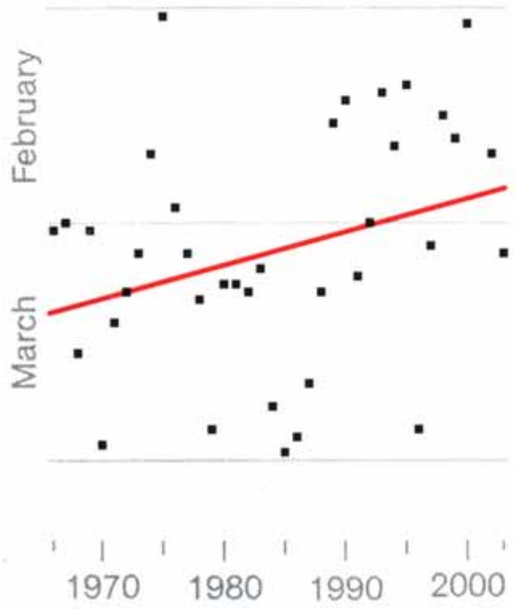

PHOTO: ALBERT G. RICHARDS, NATIONAL GEOGRAPHIC STOCK
GRAPH SOURCE: JOHN CLARKE, COURTESY NATURE'S CALENDAR, U.K.

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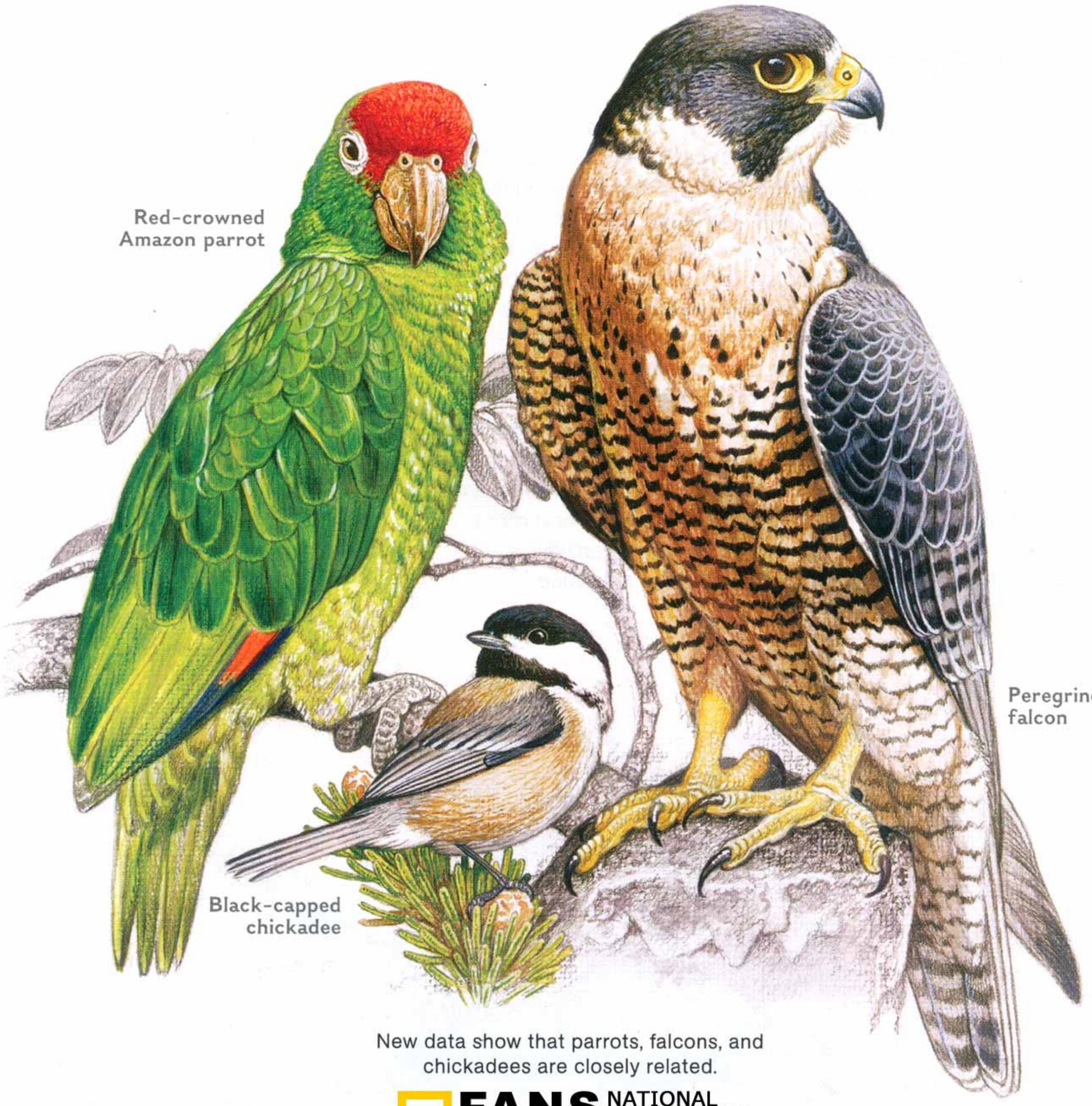


New data show that parrots, falcons, and chickadees are closely related.

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**Birds of a Father** Some birds that look very different—say, bright hummingbirds and drab nightjars—are long-lost kin. Some never considered together, like songbirds and parrots, are really close relatives. Others that act similarly, such as falcons and other birds of prey, may be genetically unrelated.

Those are just some of the sure-to-cause-a-flap findings of the Early Bird Project, a landmark study led by Chicago's Field Museum that compared the genes of 169 species and sequenced nuclear DNA from 15 chromosomes to fill in big evolutionary holes. The bird branch of zoology has always been a thorny one, with little fossil evidence to show stages of development, making anatomy, appearance, and behavior the main means of gauging kinship—until now. With five years' worth of new data, other long-held beliefs may also fly right out the window. *—Jeremy Berlin*

ART: ALDO CHIAPPE

## Crude Currents

Shortly after midnight on March 24, 1989, the *Exxon Valdez* impaled itself on Bligh Reef in Alaska's Prince William Sound. The tanker leaked 38,800 metric tons of crude oil, fouling 1,300 miles of coastline and wrecking the local fishing industry. During the next 20 years, Exxon spent more than two billion dollars on cleanup and lawsuits.

The accident served as a rallying cry for environmentalists and prompted the U.S. and other nations to implement stricter standards for cargo vessels in their waters. In 2010 a UN phaseout of single-hulled tankers, like the *Valdez,* in which a single steel plate separates cargo from sea, will take full effect. Improvements such as better radar and broad use of GPS navigation have also reduced mishaps.

Scientists struggle to learn how much oil enters the oceans each year. The National Research Council estimates 1.3 million metric tons, with tanker spills making up 8 percent. Perhaps the most surprising contributor is Mother Earth, with seepage from natural deposits accounting for as much as 46 percent. *—Peter Gwin*

This puddle consists of Venezuelan crude oil.

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**A WORLD OF SPILLS**
This map shows the 439 reported oil spills of ten metric tons or more from tankers and barges between 1989 and 2007. Since the 1980s, spills of 700 metric tons or more dropped from an average of nine a year to four.

PHOTO: REBECCA HALE, NG STAFF. NGM MAPS. SOURCES: INTERNATIONAL TANKER OWNERS POLLUTION FEDERATION; *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL

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**What will happen when the climate starts to change and the rivers dry up and a whole way of life comes to an end? The people of the Murray-Darling Basin are finding out right now.**

# Australia's DRY RUN

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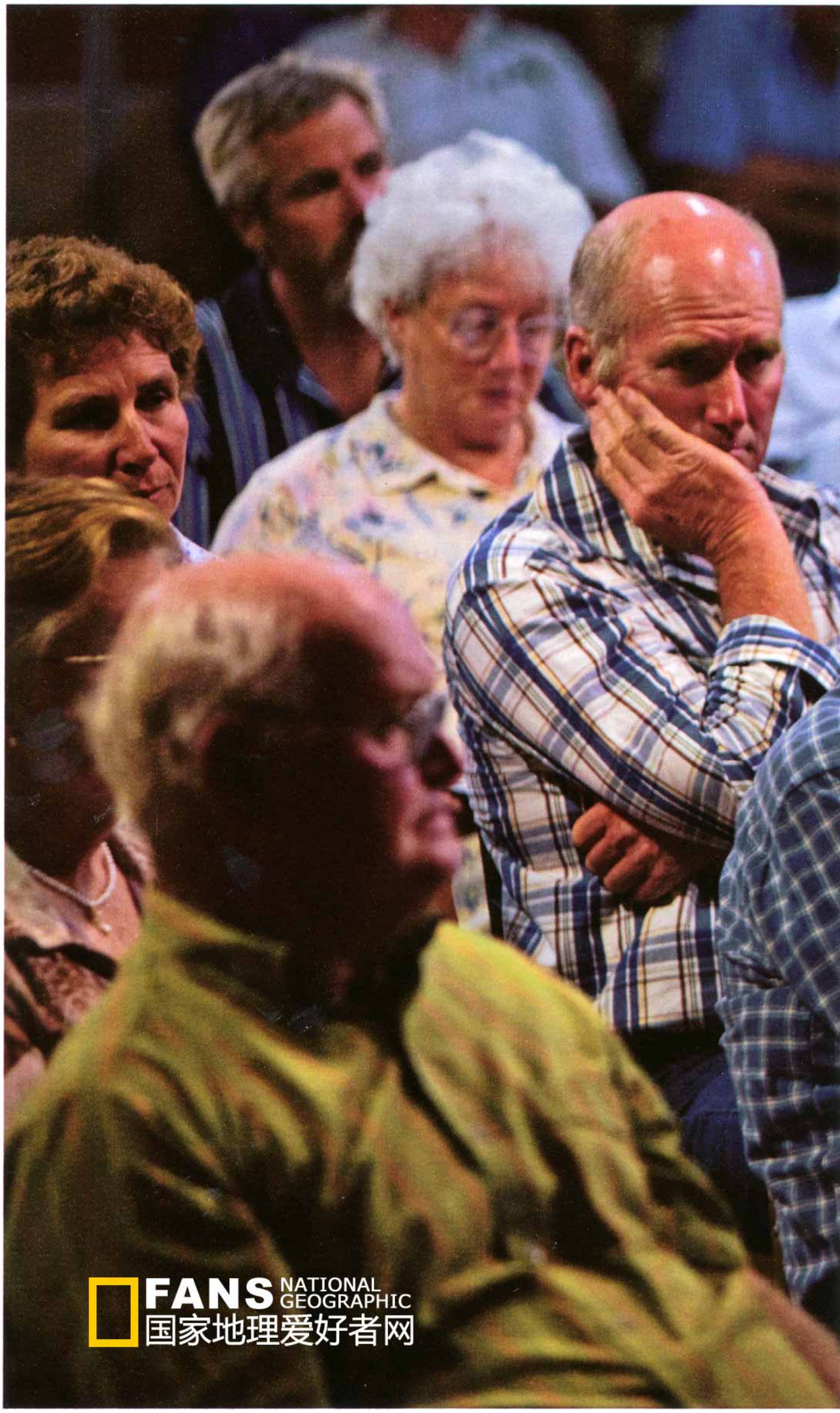
Simon Booth remembers when he grazed 250 head of cattle on his ranch in southeastern Australia—a sight his children Ryan and Claire may never see.

Stressed farmers in the rice-growing town of Coleambally meet to discuss slashed water allocations, which caused a 98 percent drop in rice production from 2006 to 2008. "The meeting was a bit scary," says 74-year-old Frank Whelan (at center), who didn't plant a crop for the first time in more than 50 years.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"Sheep graziers are as tough as teak," says Ed Lilburne (at center), who is auctioning off 40,000 animals at a stockyard near the town of Hay. They need to be. Years of drought have forced graziers in the Murray-Darling Basin to sell stock to conserve feed and precious water.

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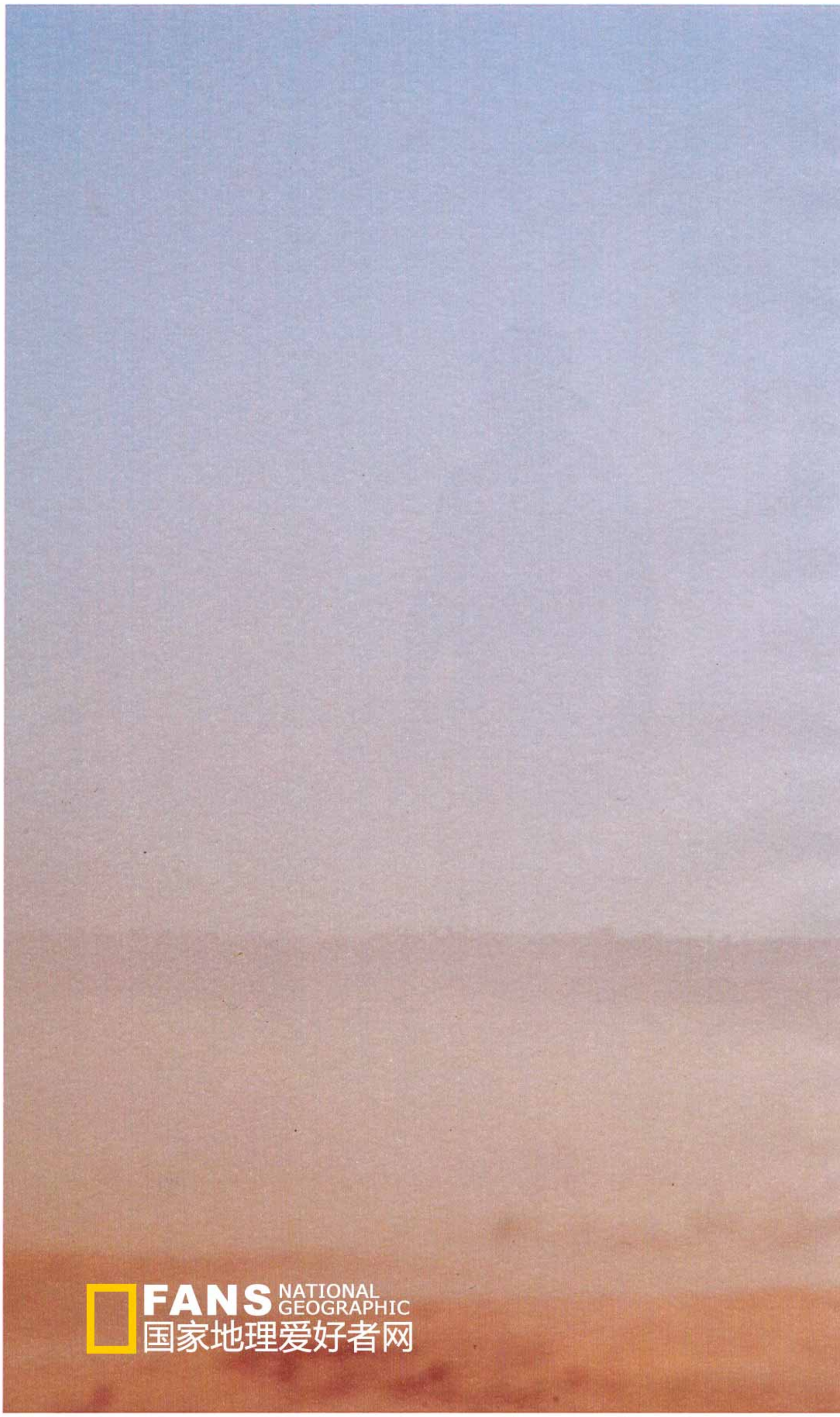
Blasted by dust and wind, the Booth family farm hasn't seen normal rainfall since 1991. But Simon Booth isn't giving up: "I know what this country's capable of with the right type of rain." Until it falls, he grazes his livestock 400 miles away, hoping that drought is not, as some say, the "new normal."



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BY ROBERT DRAPER
PHOTOGRAPHS BY AMY TOENSING

# The climate betrayed him.

On the side of a road somewhere in southeastern Australia sits a man in a motionless pickup truck, considering the many ways in which his world has dried up. The two most obvious ways are in plain view. Just beyond his truck, his dairy cattle graze on the roadside grass. The heifers are all healthy, thank God. But there are only 70 of them. Five years ago, he had nearly 500. The heifers are feeding along a public road—"not strictly legal," the man concedes, but what choice does he have? There is no more grass on the farm he owns. His land is now a desert scrubland where the slightest breeze lifts a hazy wall of dust. He can no longer afford to buy grain, which is evident from the other visible reminder of his plight: the bank balance displayed on the laptop perched on the dashboard of his truck. The man, who has never been rich but also never poor, has piled up hundreds of thousands of dollars in debt. The cows he gazes at through his windshield—that is all the income he has left.

His name is Malcolm Adlington, and for the past 36 of his 52 years he has been a dairy farmer, up at five every morning for the first milking of the day. Not so long ago Adlington used to look forward to a ritual called a dairy farm walk. State agriculture officials would round up local dairy farmers to visit a model farm—often Adlington's, a small but prosperous operation outside of Barham in New South Wales. The farmers would study Adlington's ample grain-fed heifers. They would inquire about his lush hay paddocks—which seeds and fertilizers he favored—and Adlington was only too happy to share information, knowing they would reciprocate when it came their turn. That was the spirit of farming, and of Australia. A man could freely experiment, freely reveal his farming strategies, with the quiet confidence that his toil and ingenuity would win out.

"That," Adlington observes today, "was before the drought came along." A decade ago, Adlington employed five farmhands. "It's just the wife and I now," he says. "The last three years we've had essentially no water. That's what is killing us."

Except there is water. You can see it rippling underneath the main road just a mile from where his truck is parked. It's the Southern Main Canal, an irrigation channel from Australia's legendary Murray River, which along with the Darling River and other waterways is the water source for the South Australia capital of Adelaide and provides 65 percent of all the water used for the country's agriculture. Adlington possesses a license to draw 273 million gallons of water

"We're always living in hope," says Malcolm Adlington of Barham, who's sold off his dairy cows to provide for his family. With his government water allocations reduced to near zero, "our farm is for sale," Adlington says, "but nobody's looking at it."

annually from the Murray-Darling River system. The problem is the water has been promised to too many players: the city of Adelaide, the massive corporate farms, the protected wetlands. And so, for the past three years, the New South Wales government has forbidden Adlington from taking little more than a drop. He still has to pay for his allocation of water. He just can't use it. Not until the drought ends. Adlington finds himself chafing at the unfairness of it all. "It's the lack of rain," he says, "but also the silly man-made rules." Those rules seem to favor everyone except farmers like him. Meanwhile, he's selling off his treasured livestock.

"It's easy to get depressed," he says in a calm, flat voice. "You ask yourself, Why have I done it?" Malcolm Adlington didn't use to doubt himself, but then he has not been himself lately. The drought has depleted more than just his soil. He finds himself bickering with his wife, Marianne, hollering at the kids. He can't afford the gas to take Marianne into town as he used to. With all of the other farmhouses closing up, the nearest boy for his son to play with now lives ten miles away.

Adlington has put his own family acreage up for sale. "Haven't had one person look at it," he says. Not his first choice, obviously. Not what an

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Adlington would ever wish to do. But when the hell did his dad or granddad ever have to deal with a bloody seven-year drought?

It has been three parched years since any dairy farm walk that Adlington can remember. Instead, there are morale-boosting events with upbeat monikers like Tackling Tough Times or Blokes' Day Out—or Pamper Day, which Adlington's wife happens to be attending today. At Pamper Day, a few dozen farming women receive free massages and pedicures and hair-styling advice. A drought-relief worker serves the women tea and urges them to discuss what's on their minds. They all share different chapters of the same story.

"It's been two years without a crop."

"The family farm is on its knees."

"We sold most of our sheep stock—beautiful animals we'd had for 20 years."

"I can't stand lying in bed every night and hearing the cattle bellow from hunger."

Still, the most poignant gatherings are out of public view. One takes place in a modest farmhouse near Swan Hill. A government rural financial counselor sits at the kitchen table, advising a middle-aged stone-fruit farmer and his wife to declare bankruptcy, since their debt exceeds the value of their farm and a hailstorm has just ravaged their crop.

Holding his wife's hand, tears leaking out of his eyes, the farmer manages to get out the words: "I have absolutely nothing to go on for."

The woman says she checks every couple of hours to make sure her husband is not lying in his orchard with a self-inflicted gunshot wound in his head. When the meeting is over, the counselor adds their names to a suicide watch list.

Back in Barham, Malcolm Adlington sits


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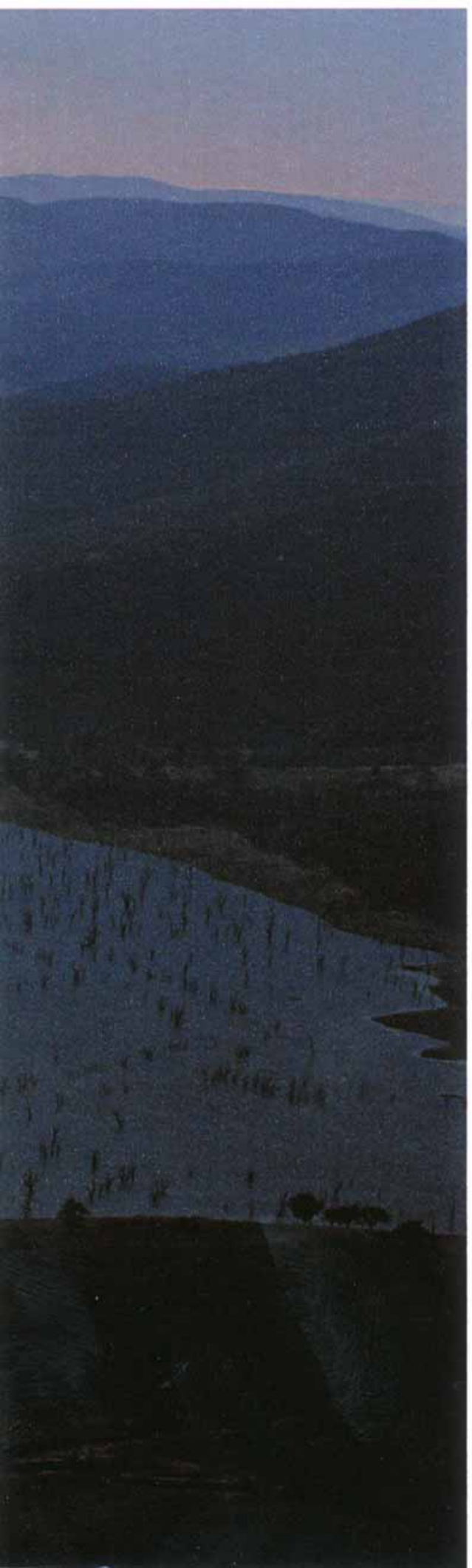
alone in his truck going nowhere—watching his herd dwindle, his meadows receding into desert scrubland. All he can do is watch.

The world's most arid inhabited continent is perilously low on water. Beyond that simple fact, nothing about Australia's water crisis is straightforward. Though Australians have routinely weathered dry spells, the current seven-year drought is the most devastating in the country's 117 years of recorded history. The rain, when it does fall, seems to have a spiteful mind of its own—snubbing the farmlands during winter crop-sowing season, flooding the towns of Queensland, and then spilling out to sea. To many, the erratic precipitation patterns bear the ominous imprint of a human-induced climate shift. Global warming is widely believed to have increased the frequency and severity of natural disasters like this drought (see "Outlook: Extreme," page 60). What seems indisputable is that, as Australian environmental scientist Tim Kelly puts it, "we've got a three-quarters of a degree [Celsius] increase in temperature over the past 15 years, and that's driving a lot more evaporation from our water. That's climate change."



Flooded by Hume Dam in the 1920s, the Murray's riverbanks were once thick with river red gum trees that captured moisture and helped drive cycles of rainfall. The skeletons of submerged trees are now visible in a ponded portion of the river's upper reaches, exposed by the lowest water levels in decades.

It has taken a while for Australia to wake up to that reality. After all, the country was transformed by rough-country optimists unfazed by living on one of the least fertile landscapes on Earth. Australian scientist Tim Flannery calls it a "low-nutrient ecosystem," one whose soil has become old and infertile because it hasn't been stirred up by glaciers within the past million years. The Europeans who descended on the slopes of the Murray-Darling Basin—a vast semiarid plain about the size of Spain and France combined—were lulled by a string of mid-19th-century wet years into thinking they had discovered a latter-day Garden of Eden. Following the habits of their homelands, the settlers felled some 15 billion trees. Unaware of what it would mean to disrupt an established water cycle by uprooting vegetation well adapted to arid conditions, the new Australians introduced sheep, cattle, and water-hungry crops altogether foreign to a desert ecosystem. The endless plowing to encourage Australia's new bounty further degraded its soil.

And so a river became the region's lifeline. Like America's Mississippi River, the 1,600-mile Murray carries mythological significance, symbolizing endless possibility. Its network of billabongs, river red gums, Murray cod, and black swans are as affixed to the Australian ethos as the outback. From its headwaters in the Australian Alps to its destination at the Indian Ocean, the slender river meanders along a northwestern course, fed by the currents of the Murrumbidgee and Darling Rivers as it cuts a long borderline between New South Wales and Victoria before entering the semiarid brush country of South Australia and plunging toward the ocean at Encounter Bay. That its journey appears unhurried, even whimsical, adds to the river's legend.

Progress, for Australians, has involved bending the Murray River to their will. Over the past

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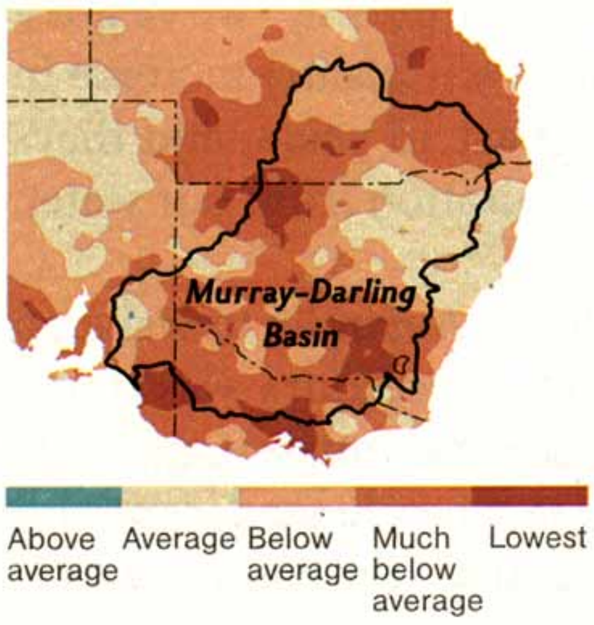
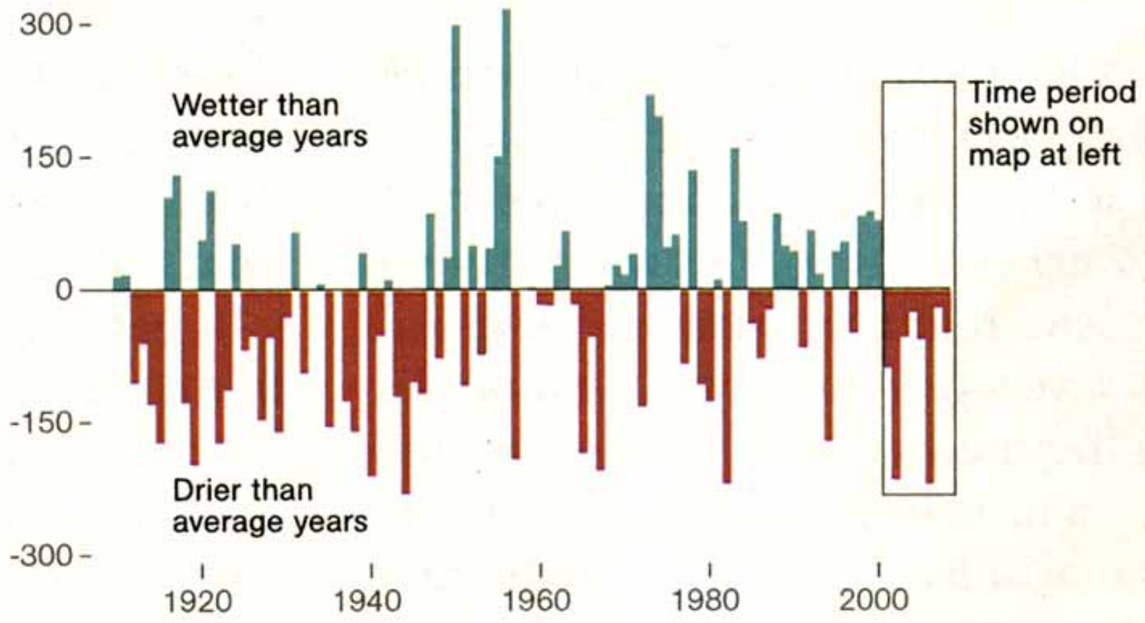
*Robert Draper is a contributing writer for* National Geographic. *Amy Toensing's photographs of Tonga appeared in the November 2007 issue.*

## RAINFALL

**Murray-Darling Patterns**
2001-2008

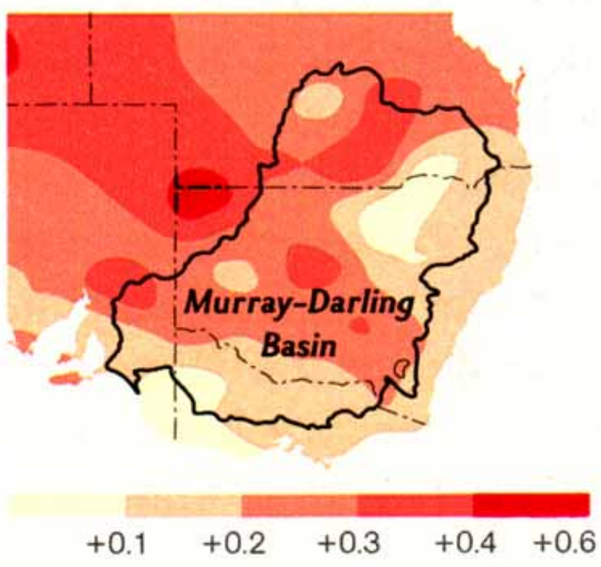



**Murray-Darling Anomalies**
1910-2007, in mm of rain (base average 1961-1990)

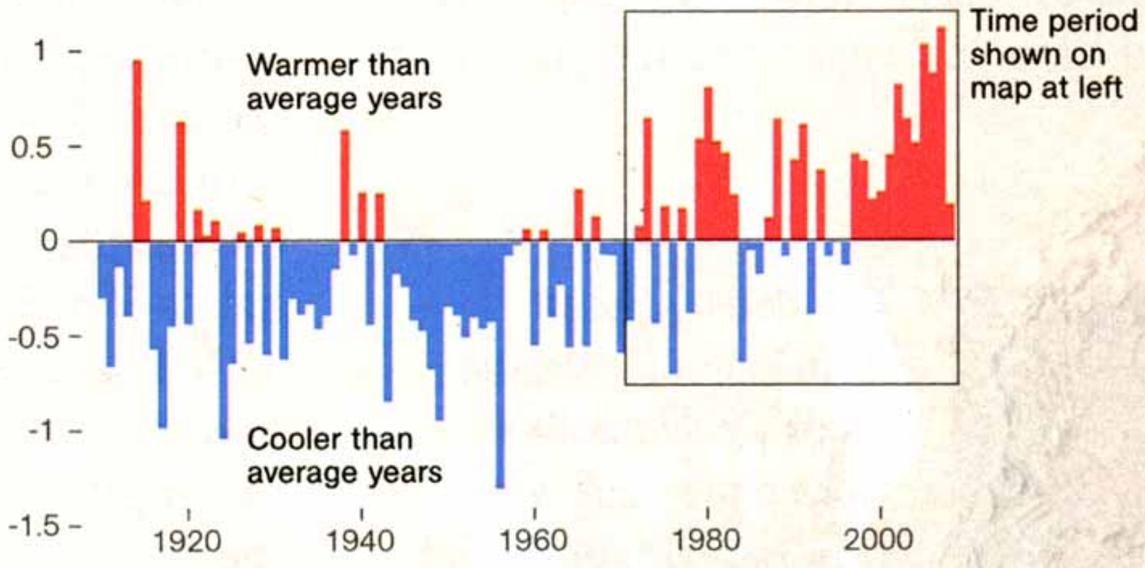


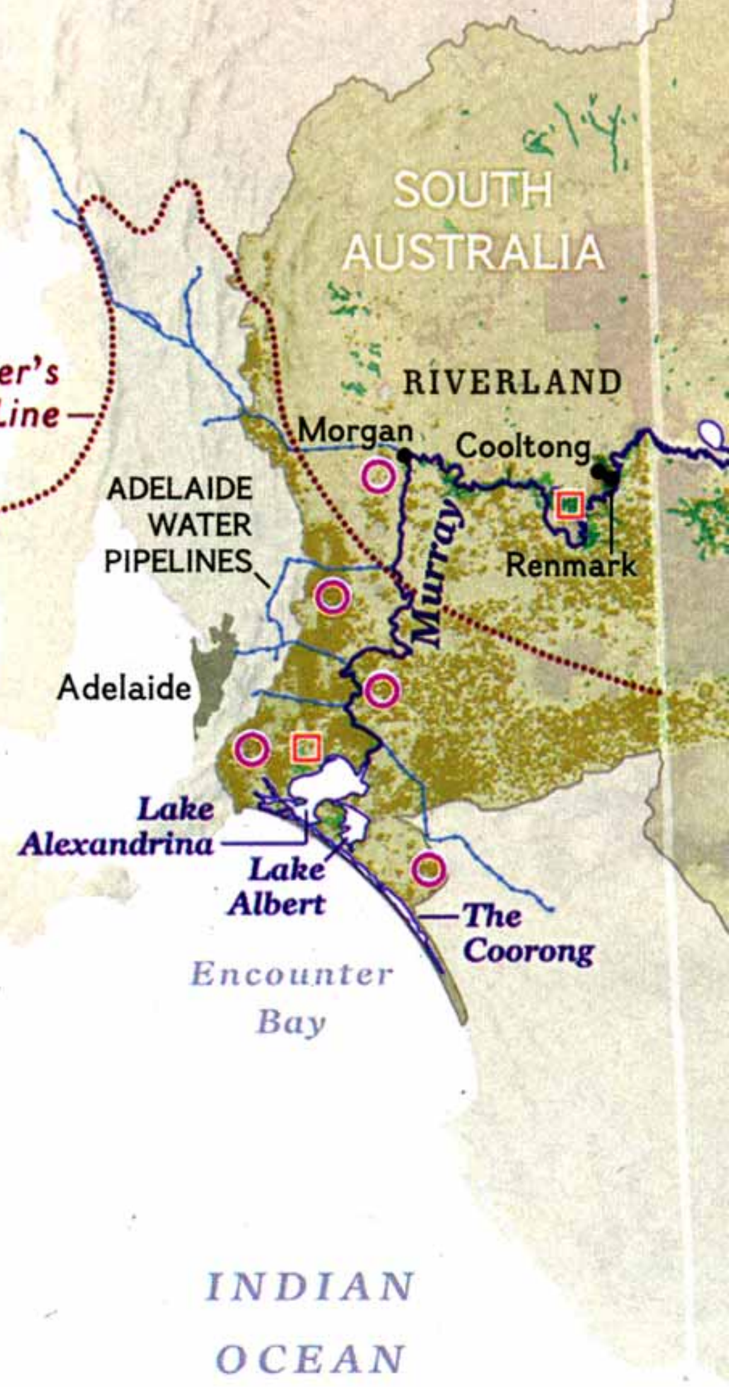

## WARMING

**Average Temperature Trends**
1970-2007, in degrees Celsius




**Anomalies**
1910-2007, in degrees Celsius (base average 1961-1990)



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# PARCHED LANDS

The dry and marginally fertile lands of the Murray-Darling Basin were transformed into the breadbasket of Australia through a massive water-management program that dammed rivers, filled reservoirs, and tapped water for irrigation and other human needs. It was a precarious balancing act, until seven years of drought—and decades of warmer temperatures—brought farmers to their knees. Stoked by drought, deadly bushfires dealt another blow early this year.

MARTIN GAMACHE, NG STAFF

SOURCES: AUSTRALIAN BUREAU OF METEOROLOGY; AUSTRALIAN BUREAU OF STATISTICS; BRETT BRYAN, CSIRO; GEOSCIENCE AUSTRALIA; MURRAY-DARLING BASIN AUTHORITY

Canals and irrigated cropland

Nonirrigated cropland

Cattle and sheep grazing

Nonagricultural land use

Dairy*

Cotton*

Rice*

Vineyards, fruits, and vegetables*

*2001 CLUSTERS

Charleville
Warrego
Paroo
Balonne
Condamine
St. George
DARLING DOWNS
Weir
Macintyre
Dumaresq
Great Dividing Range
Source of the Darling
QUEENSLAND
NEW SOUTH WALES
Gwydir
Moree
Barwon
Bourke
Darling
Bogan
Macquarie Marshes
Namoi
NEW ENGLAND
Tamworth
Lake Menindee
MURRAY - DARLING BASIN
Dubbo
Willandra Cr.
Lachlan
Darling
Mildura
Murray
Hay
Murrumbidgee
Barellan
Coleambally
RIVERINA
MALLEE
Edward
Deniliquin
Swan Hill
Lake Boga
Barham
MULWALA CANAL
Lake Mulwala
Wagga Wagga
Albury
Murray
VICTORIA
Wodonga
HUME DAM
Shepparton
WIMMERA
Bendigo
DARTMOUTH DAM
Snowy Mts.
Alps
Source of the Murray
Australian Alps
Great Div
Brisbane
Gold Coast
Sydney
Canberra
Australian Capital Terr.
Melbourne
30°S
145°E
0 mi 50
0 km 50

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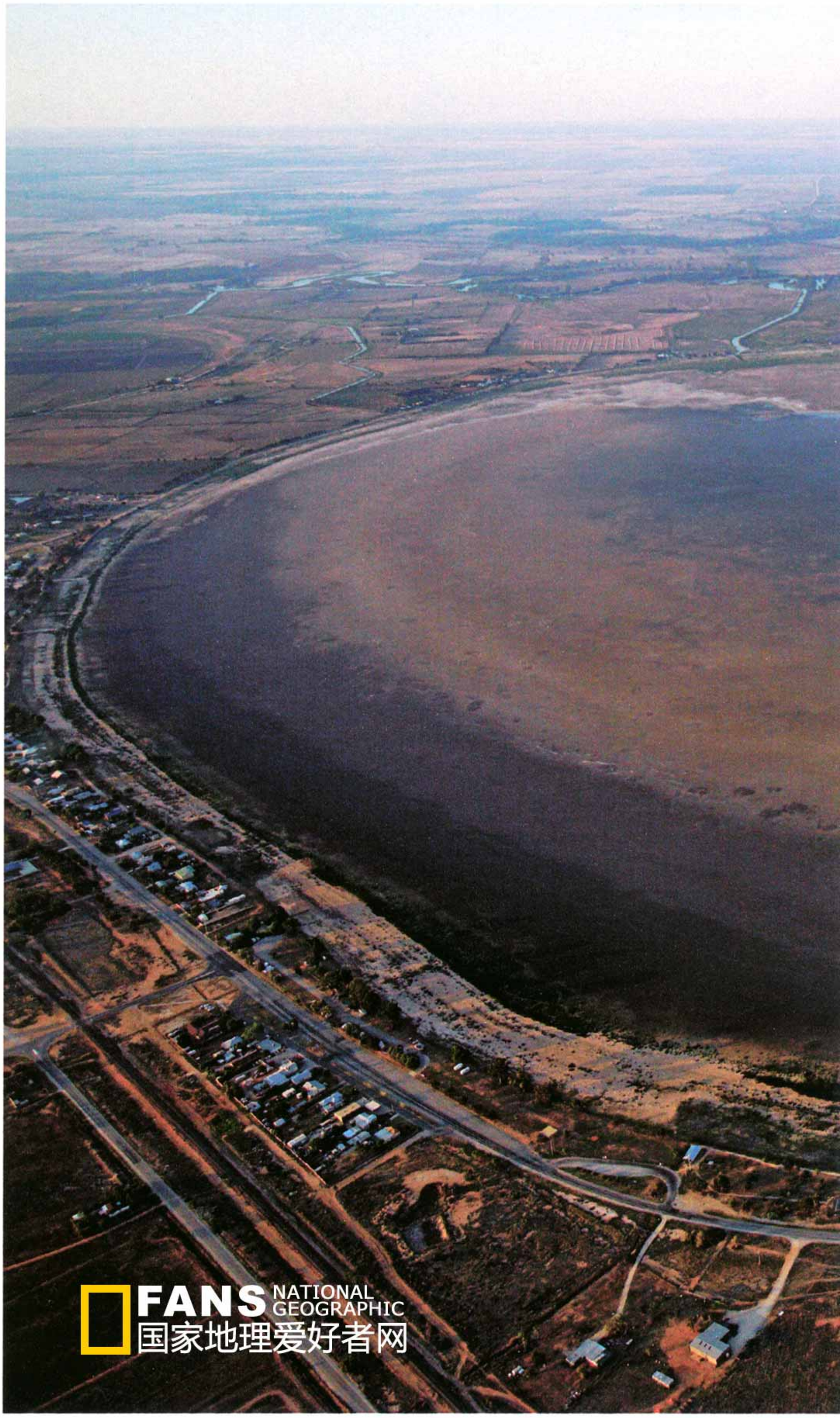
## THIRSTIEST CROPS

Agriculture uses up most of the water in the Murray-Darling Basin, though only a small portion of its cropland is irrigated. Its thirstiest crop is cotton, which in 2005-2006 used 20 percent of the basin's water, followed by dairy farming, livestock, and rice. Grapes, other fruits, and vegetables use far less water and generate more income for the region than cotton.

A wet spot is all that's left of Lake Boga, once a water-sports playground, since its tributary was tapped for irrigation in 2007. Fish died by the thousands, and Lake Boga's resort-based economy was left high and dry. "We're a very proud little town," says resident Pauline Coke. "We're devastated."



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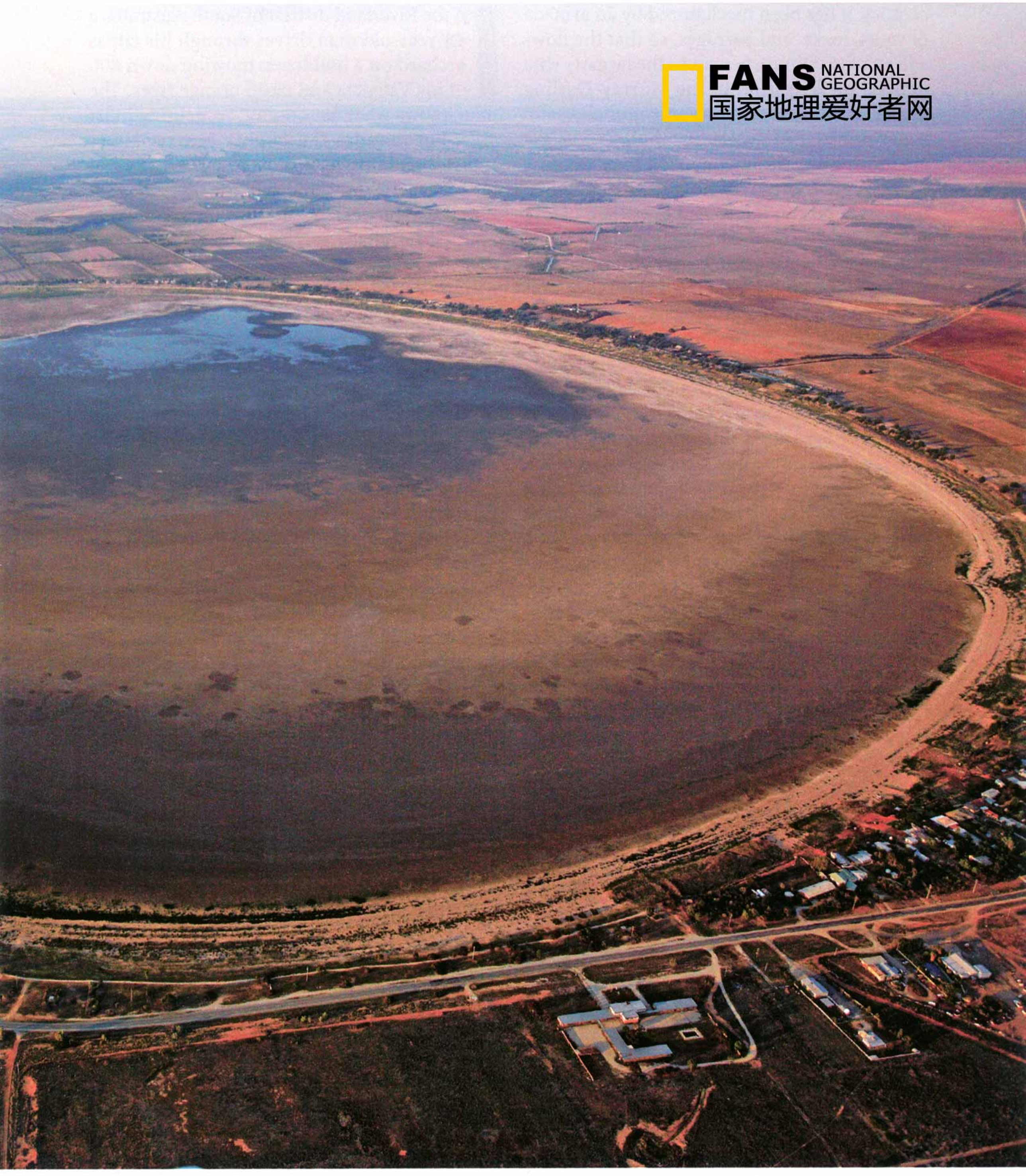

**THE DROUGHT FELL ON AUSTRALIA LIKE A MALLET, DELIVERING A PSYCHIC BLOW FOR WHICH THE PLUCKY LAND DOWN UNDER WAS NOT PREPARED.**

century, it has been mechanized by an armada of weirs, locks, and barrages, so that the flows will be of maximum benefit to the farmers who depend on irrigation in the Murray-Darling Basin. As a result, says former commonwealth water minister Malcolm Turnbull, "we've got an unnatural environment in the river. Because it's regulated, the river now runs high when nature would run it low, and low when nature would run it high." That manipulation had unintended consequences. Irrigation caused salinity levels to skyrocket, which in turn poisoned wetlands and rendered large stretches of acreage unfit for cultivation.

Such was the rickety state of Australia's water supply even before the drought fell on it like a mallet, delivering a psychic blow for which the plucky land down under was not prepared. The crisis has pitted one state against another, big cities against rural areas, environmental managers against irrigators, and small farms against government-backed superfarms in a high-stakes competition for a shrinking commodity. Well beyond the national breadbasket of the Murray-Darling Basin, every major urban area has faced the clampdown of water restrictions and the subsequent browning of its revered English gardens and cricket ovals. The trauma is particularly acute in rural bastions of self-reliance, like the New South Wales dairy community inhabited by Malcolm Adlington, which are fast becoming ghost towns. Whole crops have been wiped out by heat stress and low moisture, while entire growing sectors—rice, cotton, citrus—face collapse.

The once quintessential Australian swagger has now come to resemble, in the wake of the water crisis, what Swiss psychiatrist Elisabeth Kübler-Ross famously termed the "stages of grief": denial, anger, bargaining, depression, acceptance. In what is shaping up to be a cautionary tale for other developed nations, the world's 15th biggest economy is learning hard lessons about the limits of natural resources in an era of climate change. The upside is that Australians may be the ones to teach those lessons to the rest of the industrialized world.

In the Riverland district of South Australia, a 48-year-old man drives through his citrus orchard on a bulldozer, mowing down 800 of his Valencia and navel orange trees. The man knows what he is doing. Something must give. For decades the mighty Murray River transformed this land into a lush patchwork of olive, citrus, apricot, and avocado orchards. But now the water bureaucrats have announced that South Australians may use only 16 percent of their annual allocation. And so Mick Punturiero, a third-generation farmer of Italian descent, has made a hard choice: He elects to sacrifice his orange trees and reserve what water he has for his prized lime orchard. Underneath the roaring of the engine, Punturiero hears the cracking of muscular trunks he has nurtured for 20 years. And what roils inside him is something darker than sorrow.

A few weeks later two state officials come to Punturiero's village of Cooltong, just outside Renmark, a few hours' drive from Adelaide. They have an announcement to make. The catchment levels at Hume Dam have been revised, and it's good news: The water allocation has been doubled, to 32 percent! The farmers in attendance are not overjoyed. Truthfully, with the drought bearing down on them, 32 percent of what they need is not enough to save their orchards. All Punturiero can think is, I could have kept my orange trees.

Two months later, Punturiero is still possessed of operatic rage as he pours a guest some homemade lime juice and drops his meaty frame into a chair. Why has it taken them so long to recognize this water crisis? he demands. "Let's go to THEIR house! Tell them which child THEY have to sacrifice to save their whole family! Let's put THEIR family in a pile!"

He takes a deep breath. "I get very upset talking about this issue," he says. "I get very, very, VERY agitated over it. End of the day, what's been done is criminal." As to the actual crime and its perpetrators, Mick Punturiero flails with theories. Mostly he blames government officials who encouraged agricultural development beyond sustainable levels. Even in his more

Lettuce grower Donato Gargaro irrigates seedlings with water from the Murrumbidgee River near Hay. About 95 percent water, lettuce is best grown in winter, when rain can augment irrigation and temperatures drop, reducing the water lost to evaporation.

reflective moments, he does not entertain the notion that the problem arises from the folly of growing citrus on the wrong side of "the line."

The line is Goyder's Line, a boundary that marks the limit of sufficient rainfall for crops to grow in South Australia. In 1865 a surveyor named George Goyder set out on a remarkable journey by horseback to trace the point where grassland gave way to sparse bush country. Australia's settlers relied on Goyder's Line to demarcate arable land from land unsuitable for agriculture. Except when they didn't: Renmark, for instance, lay on the wrong side of Goyder's Line, but that did not stop two Canadian brothers named Chaffey from developing an irrigation system in Renmark two decades after the surveyor's warning.

As it turns out, the Chaffeys were three decades ahead of their time. The Australian government inaugurated its first "soldier settlement" scheme after World War I, offering land, water, and farm machinery to veterans. In the decades that followed, orchards and vineyards and wheat fields miraculously sprang up from former scrub desert north of Goyder's Line. Canal after canal was dug to deliver the Murray's water to the new farmland—and later, to sprawling irrigation districts dedicated to the nascent (and highly water-thirsty) rice industry. By the early 1970s, Australia was a major exporter of such crops, its farming lobby had emerged as a formidable political force, and the government was selling off water licenses to any bloke who fancied being his own boss and who wouldn't whinge when the odd drought came along.

Mick Punturiero's grandfather was a Calabrian émigré who bought his first acreage from a retiring World War II veteran, one of thousands more soldiers enticed by the government to develop the basin. The audacity of farming in such an arid area was not readily apparent to Punturiero's grandfather, who had no education other than in how to grow an exquisite grape.

Soon the Murray began to run low, and fields started to salt up. Unfortunately, the prescriptions only helped spread the disease. Leakproof irrigation technology meant that less water returned to the system. Salt interceptors kept crops from being poisoned, but only by pumping out limitless quantities of water. In 1995 the Murray-Darling Basin Commission finally introduced a cap on how much water each state could draw from the river. But the binge didn't end. Farmers who owned water rights but had never used them proceeded to sell their now coveted "sleeper licenses" to others who would. Industrialists were offered tax incentives to create superfarms and introduced vast olive and almond groves to the basin.

Meanwhile, the governments of New South

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Spin masters, overheated farm boys near Deniliquin put the Mulwala Canal to good use on a cloudless summer day. The largest irrigation canal in the Murray-Darling Basin, the channel transports water from Lake Mulwala more than a hundred miles to the heart of New South Wales farm country.

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To water their garden, the Charter family of Hallett Cove—including parents Carl and Leita—shower together and catch the runoff in buckets. It's one of many measures promoted by the state of South Australia that the family has used to cut its water consumption in half.

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Wales and Queensland routinely flouted the extraction cap and continued to hand out licenses. "The increase in diversions from the Murray River in the late nineties was rather like drinkers in a bar," says Malcolm Turnbull. "The barkeeper says, 'Last orders, gentlemen.' And everyone rushes in to drink as much as they can before they get thrown out. That's what we were doing. Just as it became apparent that resources were overtaxed, there were more claims on it."

A decade ago, Mick Punturiero had grown to be South Australia's biggest lime producer and was doing all the right things. He employed the latest water conservation technology. What water he did not need he donated back to the state for environmental usage. Even so, he could see where the increasing demands on the Murray would lead. He recalls warning a state official in the late 1990s, "You need to stop this development. We're poorly managing our water resources."

He remembers the official's words as if uttered yesterday: "Mick, you can't control progress."

Then came the drought, which began like any other, in 2002. But it has not ended, and now the binge is over. Though dryland farmers who depend on rain have watched their corn and wheat fields dwindle into dust plains, they at least have been accustomed to braving parched seasons. By contrast, "irrigated farmers have always had water, and never in their wildest dreams did they think somebody would turn the tap off," says rural financial counselor Don Seward. But as the drought advanced, the allocations have plummeted: 95 percent. Then 50. Then 32. And now, in Mick Punturiero's case, back to 16 percent.

"The river's no different from the highways every Australian pays for through his taxes," he argues. "Every Australian has paid for the locks. We've paid for the Dartmouth Dam, which was supposed to drought-proof South Australia. So why don't you give me my full allocation? Give it to me! It's rightfully mine!"

Punturiero sees himself as the faithful caretaker of land that the Australian government gave to reward the service of young men who died on the sands of Gallipoli. He sees that land as a gold ingot that the government has turned into a lump of lead. He sees powerful interests profiting at his expense. He sees new irrigators downriver sucking the system dry. He also sees fellow farmers much like his grandfather, who never bothered to put a dime into savings, tumbling into insolvency. Or committing suicide. And he understands their bottomless despair. He feels it himself at times—"boxed into a corner," he says in a suddenly depleted voice, "and I can't defend my family no more."

But fury returns. Anger is all Mick Punturiero has at the moment. He will not go down without a fight—that he pledges: "You won't see me

**ADELAIDE MAY HAVE THE DUBIOUS DISTINCTION OF BEING THE FIRST INDUSTRIALIZED CITY TO LIVE IN A CONSTANT STATE OF WATER SHORTAGE.**

crawling off the farm on me hands and knees—not unless I see some bloody heads roll first!"

It is hard for many Australians to reconcile the sputtering, surgically disfigured version of the Murray River with the shimmering idyll of their younger days. At the river's mouth, a flourishing ecosystem had long been nourished by the natural ebb and flow of seawater and fresh water. The ocean would rush in when the river ran low and then be pushed out by fresh water as the first hard rains drained down the Murray to the sea. Today the overallocation of irrigation water, coupled with the drought, has brought the river to a virtual standstill. So that the beleaguered Murray can meet the sea, its mouth must be dredged around the clock. Without dredging, the mouth would silt up, cutting off fresh water to the lagoon ecosystem called The Coorong and to nearby Lake Alexandrina.

It is here, every morning, that a 65-year-old silver-haired fisherman in waders and a Windbreaker navigates his aluminum boat out into the waters of Lake Alexandrina, or what is left of it. Long humps of silt-covered land rise up out of the water. Since most everyone else in his line of work has moved away, Henry Jones has the lake to himself—not counting the pelicans, though he, in fact, does count them, thinking: *Maybe a tenth of what there was. And no white ibis. No blue-billed duck.* Edging up to the northern Coorong lagoon, Jones reaches into the water to collect his gill nets. Among his catch there is not a single silver perch or Murray cod or bony bream. The salty water has done them in. Only carp survive. Dozens of carp, which did not even exist in the lower lakes a quarter century ago, and whose presence signals the demise of the freshwater environment.

Jones has adapted to the changes in a way the vanishing species cannot. He has found retailers who will buy all the carp he can catch. And truthfully, he could adapt further. If, as is expected, the government constructs a weir near the bottom of the river to give urban dwellers in Adelaide more water, Lake Alexandrina and its sibling Lake Albert would become saltwater lakes. "Personally, I'd probably be better off catching mullet, flounder, black bream, and a couple of other marine species," he says as he sits at the dining room table of the house he built 40 years ago. "But it's just not right. These lakes have always been freshwater. It's just a massive change. It's nonsense."

The drought has left his community reeling. Local winemakers have recently been informed that the Murray River would no longer be available for their vineyards. And Jones is a close friend to the elders of the Ngarrindjeri Aboriginal people, whose 30,000-year domain over the river abruptly ended when the expedition led by Capt. Charles Sturt arrived at the Murray's mouth in 1830. For the Ngarrindjeri, the drought has led to the disappearance of black swan eggs, freshwater mussels, and other sacred totems that are vital to their spiritual and physical nourishment.

Still, in the scramble to claim a share of Australia's diminishing water supply, these people at least have a voice. The creatures of the lakes and wetlands do not. "In a crisis, the entitlement the environment supposedly has is totally subjective to political whims," says Murray River environmental manager Judy Goode, who refers to herself as "the manager of dead and dying things." Even protected ecosystems—such as The Coorong and, in the northern basin, the Macquarie Marshes of bird-nesting legend—receive no special dispensation, so long as there is a "critical human need" to be met.

So Henry Jones has become the de facto voice for the dead and dying, delivering a well-honed, if mournful, monologue to whoever will listen: *All the systems are on the point of collapse. Two-thirds of The Coorong is already dead—its salinity is almost that of the Dead Sea.* What Jones finds, as he travels around the basin to argue that water must be allocated for his Coorong and his lakes, is a sentiment that the whole water crisis is the environmentalists' fault anyway. The greenies are derided for their shrill sanctimony. Farmers express indignation that any of their precious "working river" is lost to the sea. They tell Jones that it makes more

**IT'S UP TO AUSTRALIA TO SHOW THE REST OF THE WORLD WHAT THE NEW LANDSCAPE WILL BE—ONE THAT'S COME TO TERMS WITH LIMITATIONS.**

sense to divert the Murray all the way inland, officially consigning the river to eternal servitude as an irrigation channel, while fishermen buck up and learn to live off the sea. In cotton-growing areas wholly dependent on irrigation, Jones says, "I'm lucky to get out with my life."

The Coorong represents only one glaring example of the Murray-Darling Basin's imperiled ecosystem. For example, Australian scientists and government officials were caught unaware when farther upriver some invisible drought-tolerance threshold was crossed and hundreds of thousands of river red gum trees—in the world's biggest such forest—suddenly died. And of late, a fresh concern has emerged: that the wetlands may be brewing toxins. Robbed of their seasonal flushing, and instead unnaturally submerged for decades, the swamps have become so dry that the crusted silt has reacted with air to form large surfaces of sulfuric acid. Scientists haven't fully gauged the threat to animals and people. For now, as University of Adelaide water economist Mike Young observes, "you wouldn't want to put your hand in it."

Adelaide may have the dubious distinction of being the world's first industrialized city to live in a constant state of water shortage. Its unhealthy reliance on the Murray—up to 90 percent of its water supply in low-rainfall periods—is symbolized by two unsightly pipelines that stretch more than 30 miles from the river to the city's water tanks. Since shortly after the drought's onset in 2002, the South Australia capital has been on water restrictions. Its residents dutifully cart buckets of used shower and washing machine water outside to their gardens. Native plants and artificial lawns are de rigueur. The racks of hardware stores are crammed with soil wetters, gray water diverter hoses, water-restricting shower nozzles, four-minute shower timers, and other tributes to water austerity. The radio "talk-back" shows have become reliable outlets for ranting about this or that water abuser.

Still, civic virtue is no substitute for lasting reform. The nation's water crisis won't be solved by "drought-proofing" Adelaide, which, despite its dependence on the Murray, claims only 6 percent of the total drain on the river. "South Australia's very aware that they're living precariously," says Wilderness Society environmental activist Peter Owen. "We're not going to save our river system by standing in buckets."

Meanwhile, outside of the Murray-Darling Basin, the drought has exposed serious flaws in the water resources of Sydney, Melbourne, and Brisbane, among other urban areas. The hard lesson of Australia's dry run is that the country's jaunty boosterism no longer suffices as the way forward. "I work on the assumption that we're going to see more episodes of this type of drought in the future because of climate change," says Malcolm Turnbull, whose Liberal Party leader John Howard, a longtime climate change skeptic, was turned out of office in November 2007. "A prudent minister assumes it's going to get hotter and drier, and plans accordingly."

But what does this mean, really? Will it mean the construction of expensive desalination plants in Adelaide, Sydney, and elsewhere, with escalating energy bills? Will it be possible to develop drought-resistant crop varieties to keep food production up? Or to drastically reduce the water needs of dairy farmers who use a thousand gallons of water for each gallon of milk they produce? Will the Murray River's hard labor continue, or will it see mercy? A robust new landscape is required, and it's up to Australia to show the rest of the industrialized world what that new landscape will be. For starters, it may be a landscape that's come to terms with limitations. Goyder's Line is even more relevant today, as drought and climate change give new urgency to the question of how intensively marginal agricultural land should be worked—or whether it should be left fallow.

After all, the final stage of coping with loss is acceptance. Back in 1962 Frank Whelan was the third farmer in his New South Wales district to receive a water allocation to grow rice, six years before the town of Coleambally was incorporated. Until this season he always had a crop. Although he's 74, his memory is as clear as his eyes.

"It hurts," says Frank Eddy, to destroy his own healthy peach trees, but the drought and reduced allocations have forced him to cull thousands of older trees on his orchards near Shepparton, Victoria.

Droughts, market fluctuations, wrangles with the government, and, yes, incessant sniping by environmentalists that rice requires enormous quantities of water and therefore has no right-ful place on this semiarid continent—Whelan remembers Coleambally prospering through all the adversity. He remembers town gatherings when the news was almost always good, because the irrigation water was always there.

Today the mood is different as Whelan sits in the local bowling hall with 200 fellow farmers. For four hours they listen as a panel of experts say there will be no irrigation water for Coleambally for the foreseeable future. They are suggesting new economic avenues for the town—things that have nothing to do with rice. A number of farmers voice their outrage. They blame the bureaucrats. They blame the environmentalists. They blame New South Wales. But Whelan says nothing. He just sits there, his pale eyes blinking, occasionally rubbing his wrinkled forehead with a hand that includes two fingers mangled by a farm equipment accident.

He has seen this coming. With the onset of the drought, he compacted his soil with a padfoot roller to minimize leakage. He began to cut off some of his acreage from water. Then still more acreage. All the while, the lifelong farmer watched as national production of rice dropped from more than a million tons a year to 21,000, contributing to the food shortage being felt across the globe. Australia, which has served as a food bowl to the world, is searching for a future. Whatever that future may be, Whelan knows the rice-growing town of Coleambally will never play the same role.

And so after the meeting breaks up, a fellow farmer sidles up to him and asks, "Well, what do ya think, mate?"

The question is one that will continue to preoccupy Coleambally for some time to come. At one point, residents actually tossed in the towel and offered to sell the entire town and its water supply to the commonwealth for $2.4 billion. A few days later, they rescinded the offer, digging in their heels and insisting the town will remain a vital food provider.

The wrangle will continue, in Coleambally and throughout Australia. But some have arrived, however reluctantly, at a point of acceptance. A year after the reporting for this story began, dairy farmer Malcolm Adlington sold off the rest of his cattle and now drives a minibus for a living. The citrus grower Mick Punturiero uprooted half of his orchard and acknowledges that he will probably be unable to continue farming. And on this night in Coleambally, Frank Whelan makes a decision as well.

"Oh," he replies to his fellow rice farmer with a sad smile, "I think I'll go home and retire." □

Scanning the horizon for rain is a way of life for the Kenny girls, Hannah (at left) and Alice. Their family have been dryland farmers of wheat near Barellan for three generations. "We will have a harvest this year," says the girls' mother, Julie. But just barely—months have passed without a single drop of rain.

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# Outlook: EXTREME

**As the planet warms, look for more floods where it's already wet and deeper drought where water is scarce.**

**BY ELIZABETH KOLBERT**

The world's first empire, known as Akkad, was founded some 4,300 years ago, between the Tigris and the Euphrates Rivers. The empire was ruled from a city—also known as Akkad—that is believed to have lain just south of modern-day Baghdad, and its influence extended north into what is now Syria, west into Anatolia, and east into Iran. The Akkadians were well organized and well armed and, as a result, also wealthy: Texts from the time testify to the riches, from rare woods to precious metals, that poured into the capital from faraway lands.

Then, about a century after it was founded, the Akkad empire suddenly collapsed. During one three-year period four men in succession briefly claimed to be emperor. "Who was king? Who was not king?" a register known as the Sumerian King List asks.

For many years, scholars blamed the empire's fall on politics. But about a decade ago, climate scientists examining records from lake bottoms and the ocean floor discovered that right around the time that the empire disintegrated, rainfall in the region dropped dramatically. It is now believed that Akkad's collapse was caused by a devastating drought. Other civilizations whose demise has recently been linked to shifts in rainfall include the Old Kingdom of

CHINA

In July 2007 nine inches of rain in 24 hours turned a Chongqing stairway into a waterfall. At the same time in the north, more than a million people faced severe water shortages.

Egypt, which fell right around the same time as Akkad; the Tiwanacu civilization, which thrived near Lake Titicaca, in the Andes, for more than a millennium before its fields were abandoned around A.D. 1100; and the Classic Maya civilization, which collapsed at the height of its development, around A.D. 800.

The rainfall changes that devastated these early civilizations long predate industrialization; they were triggered by naturally occurring climate shifts whose causes remain uncertain. By contrast, climate change brought about by increasing greenhouse gas concentrations is our own doing. It, too, will influence precipitation patterns, in ways that, though not always easy to predict, could prove equally damaging.

Warm air holds more water vapor—itself a greenhouse gas—so a hotter world is a world where the atmosphere contains more moisture. (For every degree Celsius that air temperatures increase, a given amount of air near the surface holds roughly 7 percent more water vapor.) This will not necessarily translate into more rain—in fact, most scientists believe that total precipitation

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*Elizabeth Kolbert is a staff writer for the* New Yorker *and author of* Field Notes from a Catastrophe: Man, Nature, and Climate Change.

CHINA DAILY/REUTERS/CORBIS

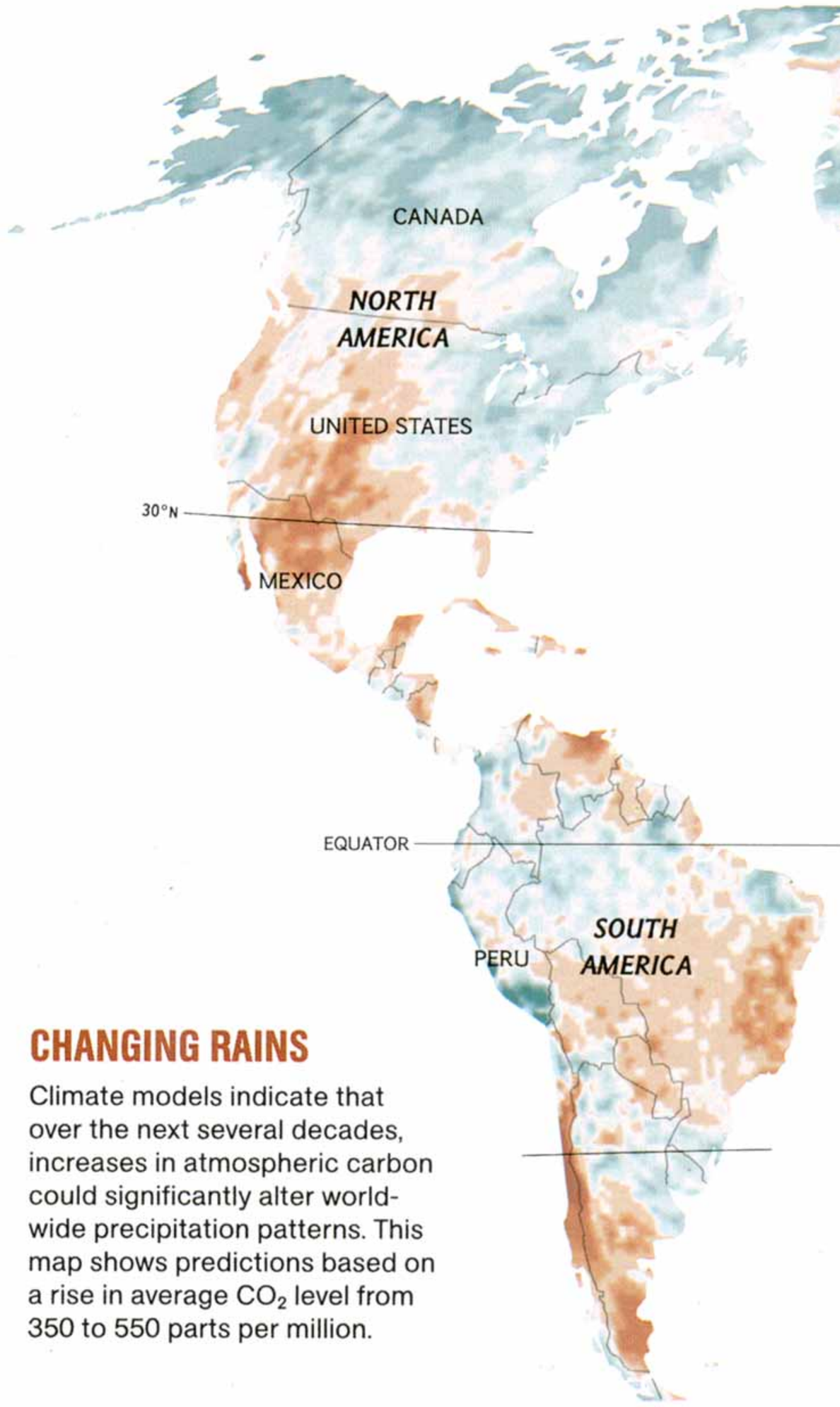
will increase only modestly—but it is likely to translate into changes in where the rain falls. It will amplify the basic dynamics that govern rainfall: In certain parts of the world, moist air tends to rise, and in others, the moisture tends to drop out as rain and snow.

"The basic argument would be that the transfers of water are going to get bigger," explains Isaac Held, a scientist at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory at Princeton University. Climate models generally agree that over the coming century, the polar and subpolar regions will receive more precipitation, and the subtropics—the area between the tropical and temperate zones—will receive less. On a regional scale, the models disagree about some trends. But there is a consensus that the Mediterranean Basin will become more arid. So, too, will Mexico, the southwestern United States, South Africa, and southern Australia. Canada and northern Europe, for their part, will grow damper.

A good general rule of thumb, Held says, is that "wet areas are going to get wetter, and dry areas drier." Since higher temperatures lead to increased evaporation, even areas that continue to receive the same amount of overall precipitation will become more prone to drought. This poses a particular risk for regions that already subsist on minimal rainfall or that depend on rain-fed agriculture.

"If you look at Africa, only about 6 percent of its cropland is irrigated," notes Sandra Postel, an expert on freshwater resources and director of the Global Water Policy Project. "So it's a very vulnerable region."

Meanwhile, when rain does come, it will likely arrive in more intense bursts, increasing the risk of flooding—even in areas that are drying out. A recent report by the United Nations' Intergovernmental Panel on Climate Change (IPCC) notes that "heavy precipitation events are projected to become more frequent" and that an increase in such events is probably already contributing to disaster. In the single decade between 1996 and 2005 there were twice as many inland flood catastrophes




## CHANGING RAINS

Climate models indicate that over the next several decades, increases in atmospheric carbon could significantly alter worldwide precipitation patterns. This map shows predictions based on a rise in average $CO_2$ level from 350 to 550 parts per million.

## DROUGHT AND DELUGE

Warm air holds more moisture, carrying it away from dry areas (1) and toward wetter ones (2). Thus as global temperatures rise, dry areas will likely get drier and wet areas wetter. Seasonal extremes will likewise intensify, as moisture accumulated in the dry season is shed in downpours in cooler times, leading to seasonal floods in regions otherwise prone to drought.

## SPREADING DESERTS

Atmospheric warming is also predicted to affect rainfall by altering global air circulation. At present, warm air carried from the tropics by circulation loops called Hadley cells meets cool polar air carried by Ferrel cells in zones around 30° north and south, creating arid zones. As the planet warms, these zones are expected to expand and shift toward the Poles.

EUROPE
ASIA
CYPRUS
SPAIN
GREECE
SYRIA
IRAN
CHINA
TAIWAN
EGYPT
SUDAN
AFRICA
30°S
SOUTH AFRICA
AUSTRALIA
Murray-Darling Basin

**Projected change in precipitation**
Percentage change from 1971-2000 average to 2041-2070 average

+50
30
20
10
5
0
-5
-10
-20
-30
-50

0 mi 1,000
0 km 1,000

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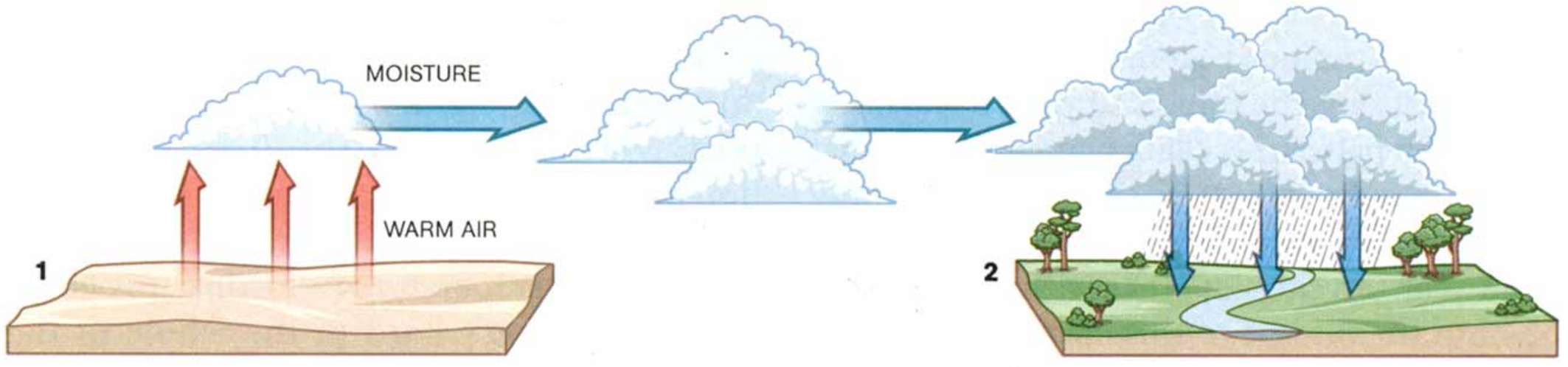
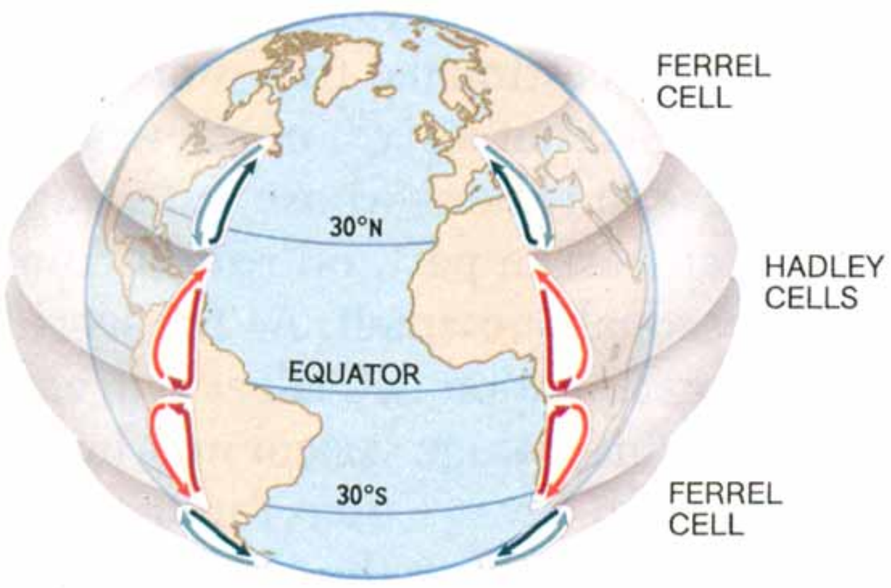
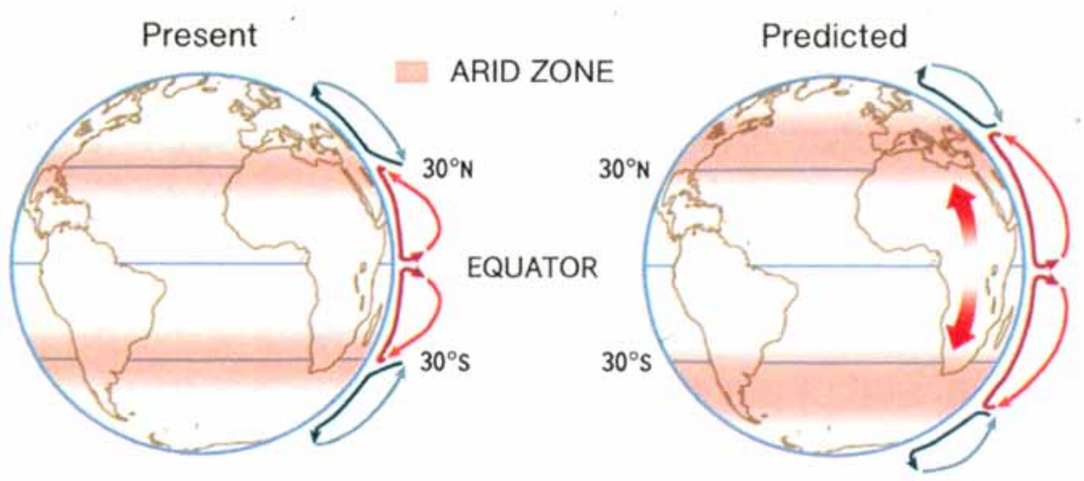
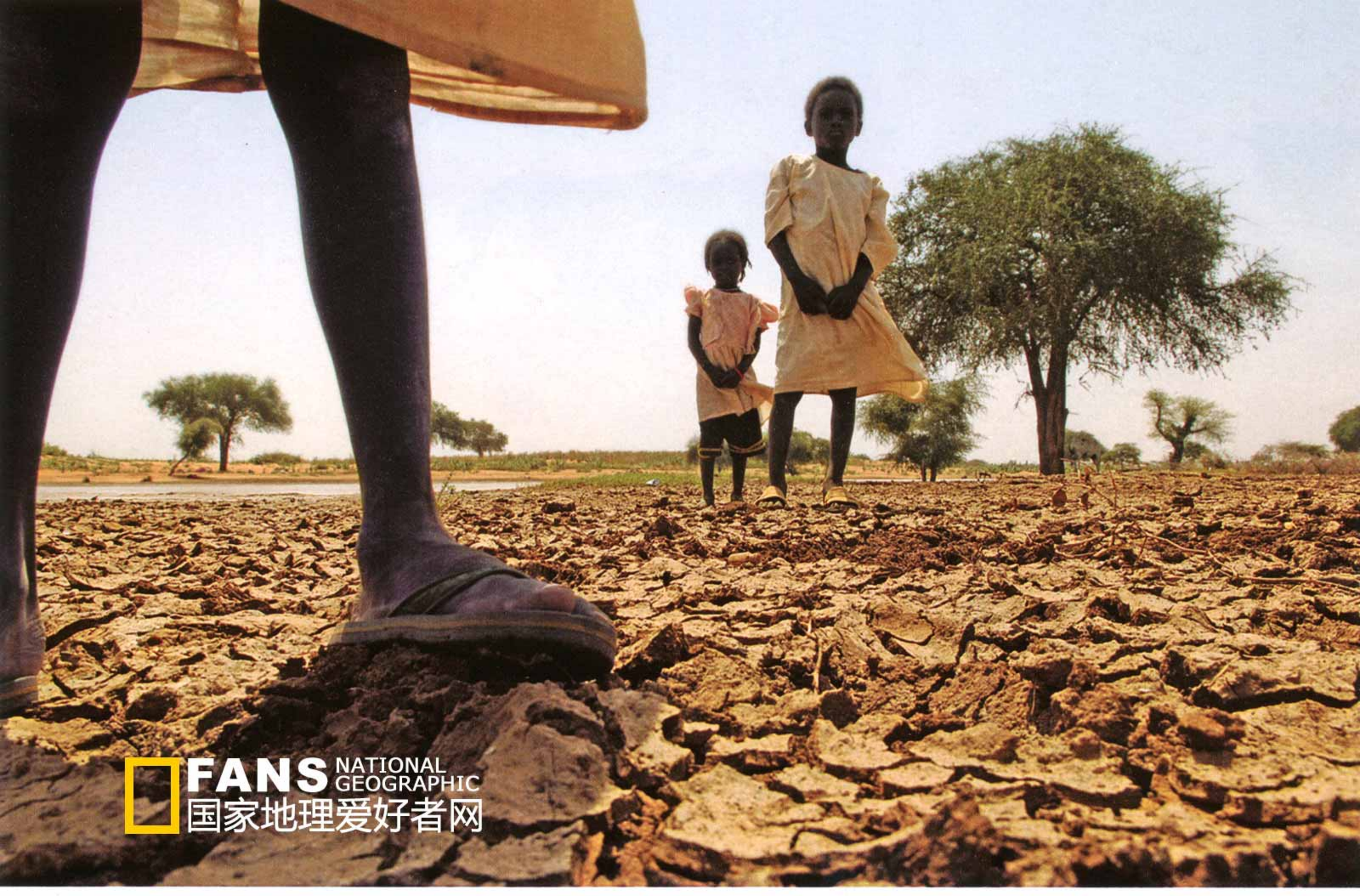



SEAN MCNAUGHTON AND LISA R. RITTER (MAP), HIRAM HENRIQUEZ (GRAPHICS), ALL NG STAFF
SOURCE: GEOPHYSICAL FLUID DYNAMICS LABORATORY, NOAA




**SUDAN** Drought scars the earth in Northern Darfur in October 2005. The UN calls this region "a tragic example of the social breakdown that can result from ecological collapse."

as in the three decades between 1950 and 1980.

"It happens not just spatially, but also in time," says Brian Soden, a professor of marine and atmospheric science at the University of Miami. "And so the dry periods become drier, and the wet periods become wetter."

Quantifying the effects of global warming on rainfall patterns is challenging. Rain is what scientists call a "noisy" phenomenon, meaning that there is a great deal of natural variability from year to year. Experts say that it may not be until the middle of this century that some long-term changes in precipitation emerge from the background clatter of year-to-year fluctuations. But others are already discernible. Between 1925 and 1999, the area between 40 and 70 degrees north latitude grew rainier, while the area between zero and 30 degrees north grew drier. In keeping with this broad trend, northern Europe seems to be growing wetter, while the southern part of the continent grows more arid. The Spanish Environment Ministry has estimated that, owing to the combined effects of climate change and poor land-use practices, fully a third of the country is at risk of desertification. Meanwhile, the island of Cyprus has become so parched that in the summer of 2008, with its reservoir levels at just 7 percent, it was forced to start shipping in water from Greece.

"I worry," says Cyprus's environment commissioner, Charalambos Theopemptou. "The IPCC is talking about a 20 or 30 percent reduction of rainfall in this area, which means that the problem is here to stay. And this combined with higher temperatures—I think it is going to make life very hard in the whole of the Mediterranean."

Other problems could follow from changes not so much in the amount of precipitation as in the type. It is estimated that more than a billion people—about a sixth of the world's population—live in regions whose water supply depends, at least in part, on runoff from glaciers or seasonal snowmelt. As the world warms, more precipitation will fall as rain and less as snow, so this storage system may break down. The Peruvian city of Cusco, for instance, relies in part on runoff from the glaciers of the

U.S.A.

Neighbors in Fredonia, Kansas, helped each other salvage treasured possessions after flash floods, driven by days of record-breaking rainfall, saturated homes in June 2007.

Quelccaya ice cap to provide water in summer. In recent years, as the glaciers have receded owing to rising temperatures, Cusco has periodically had to resort to water rationing.

Several recent reports, including a National Intelligence Assessment prepared for American policymakers in 2008, predict that over the next few decades, climate change will emerge as a significant source of political instability. (It was no coincidence, perhaps, that the drought-parched Akkad empire was governed in the end by a flurry of teetering monarchies.) Water shortages in particular are likely to create or exacerbate international tensions. "In some areas of the Middle East, tensions over water already exist," notes a study prepared by a panel of retired U.S. military officials. Rising temperatures may already be swelling the ranks of international refugees—"Climate change is today one of the main drivers of forced displacement," the United Nations High Commissioner for Refugees, António Guterres, has said—and contributing to armed clashes. Some experts see a connection between the fighting in Darfur, which has claimed an estimated 300,000 lives, and changes in rainfall in the region, bringing nomadic herders into conflict with farmers.

Will the rainfall changes of the future affect societies as severely as some of the changes of the past? The American Southwest, to look at one example, has historically been prone to droughts severe enough to wipe out—or at least disperse—local populations. (It is believed that one such megadrought at the end of the 13th century contributed to the demise of the Anasazi civilization, centered in what currently is the Four Corners.) Nowadays, of course, water-management techniques are a good deal more sophisticated than they once were, and the Southwest is supported by what Richard Seager, an expert on the climatic history of the region, calls "plumbing on a continental scale." Just how vulnerable is it to the aridity likely to result from global warming?

"We do not know, because we have not been at this point before," Seager observes. "But as man changes the climate, we may be about to find out." □

LYNSEY ADDARIO (LEFT); LARRY W. SMITH, EPA/CORBIS (RIGHT)

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**The rich life of Svalbard, Norway's Arctic archipelago, faces a creeping thaw.**

# ICE PARADISE

Drifts of Barents Sea ice can still bear the weight of a bear, but this young male is leaping into a changing world.

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Brünnich's guillemots plunge into the ocean near Bjørnøya Island to snatch schooling fish, sometimes reaching depths of 500 feet. These stout seabirds breed here by the hundreds of thousands, most dispersing to Iceland or Greenland in winter.

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An Atlantic walrus plods toward shore after gorging on clams in the shallows. Such a big bull may stir up, shell, and suck down thousands of clams a day in summer, relying on his muzzle full of sensitive whiskers, called vibrissae, to help locate prey.

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**Even a polar bear seems small against the walls of Magdalene-fjorden on Spitsbergen, largest of Svalbard's islands. Glacial ice covers more than half the terrain of this archipelago, which lies 400 miles north of the Norwegian mainland.**

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**By Bruce Barcott ▪ Photographs by Paul Nicklen**

FIVE MINUTES PAST MIDNIGHT in Svalbard: The wild world is awake and clattering. At the edge of a sheltered estuary in the Adventdalen, a valley on a cluster of islands halfway between Norway and the North Pole, a flock of arctic terns soar and wheel in the perpetual daylight. They're agitated. A pair of glaucous gulls—chick snatchers, egg stealers, the Arctic's formidable winged predators—are approaching from the east. The terns put up a fierce defense. They flash their red beaks at the gulls and turn themselves into a cloud of sharpness.

The gambit works. The gulls bypass the terns and circle inland, passing over a pair of ground-nesting eiders, a kennel of sled dogs, and a solitary reindeer feeding on the tundra.

It's a typical summer night in Svalbard, an entirely atypical refuge in the high Arctic that abounds with an extraordinary array of wildlife. Few places in the circumpolar region can match its biodensity. Polar bears thrive here. Roughly half the estimated 3,000 bears in the Barents Sea population raise their young on the archipelago's isolated islands, and humans are warned not to venture beyond town without a rifle as protection against *Ursus maritimus*. Seabirds migrate to Svalbard in the millions. Five species of seals and 12 kinds of whales feed in the waters off its coast. Atlantic walruses prosper on the rich clam beds along the shallow shelf of the Barents Sea. On the open tundra of Svalbard's plateaus and valleys, reindeer forage and arctic fox hunt free from predators.

To the human eye, the terrain is stark, austere, unforgiving. More than half the landmass is encased in glacial ice. Less than 10 percent offers enough light and soil to support vegetation. On a summer climb up the rocky slopes of Nordenskiöldfjellet (Mount Nordenskiöld), I counted only seven different plant species in five hours—and those clung to a tenuous existence, hunkering between sheltering plates of broken rock like hermits in a desert.

Years ago when Norwegian archaeologist Povl Simonsen considered the limits of human survival in the far north, he spoke of the "edge of the possible." For most of its history, Svalbard has existed beyond that edge. Ancient civilization never got a toehold here. The Vikings didn't colonize it. The Inuit stayed away. Even today, as tourists enjoy daily air service from Oslo, just 2,500 people live here year-round, many working in Svalbard's coal mines. Winter brings perpetual darkness.

But for a select number of species, Svalbard acts as an extraordinary cradle of life. And the secret to the place isn't bound up in the land. Svalbard is ruled by water, light, and temperature.

Up here the biotic machine is fueled by the Gulf Stream, which sweeps up the East Coast of the United States. If you rode the Gulf Stream's main branch, the North Atlantic Current, all the way north, you'd end up in the West Spitsbergen Current off the coast of Svalbard. There the warm, salty current (though at 42°F, "warm" is a relative term) keeps the water mostly ice free and nurtures massive plankton blooms every spring. The plankton lure whales and great schools of capelin and polar cod, which provide food for seabirds and seals. The abundance of seals, in turn, keeps Svalbard's polar bears fed. Adult bears consume a huge amount of seal blubber, primarily from ringed seals and bearded seals. That food produces the energy necessary to keep the bears' massive bodies (males commonly weigh up to 1,300 pounds, females about half that) moving over a home range that can vary from 60 square miles up to 144,000.

The energy-rich waters off the coast also draw an annual infusion of seabirds. Every May and June, when the ice retreats and the tundra clears of snow, upwards of three million birds flock to Svalbard. They're vast in number but not variety. Only about 28 species are considered common or abundant, and only one—the Svalbard rock ptarmigan—has what it takes to survive on land year-round. The birds migrate up here for the safe breeding and the nonstop feasting. A quirk of geology makes the whole thing work. In places, Svalbard's coastline rises

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**Inspecting a human interloper, this female polar bear noses into photographer Paul Nicklen's cabin after munching on his snowmobile seat, his camera bag, and his hat. The icy strip of land just outside was a "bear superhighway," Nicklen recalls. "They'd come hungry, looking for food."**

from the sea in near-vertical cliffs. They're not sheer walls like Yosemite's El Capitan, though. The cliffs contain millions of rock outcroppings wide enough to support a nest but often too precarious for predators like the arctic fox.

It's a perfect breeding setup. Pairs of fulmars, Brünnich's guillemots, and black-legged kittiwakes, sometimes intermingled on the same cliff, will claim a ledge for the season and raise their chicks on seafood caught just off the balcony, available 24 hours a day in the nightless summer. When the birds take over a cliff, the transformation can be profound. Once, while riding a former fishing trawler around an inner Spitsbergen fjord, I looked up to see a light dusting of snow on a tombstone-gray sea cliff. Glassing the scene with my binoculars, I realized I wasn't seeing snow at all. It was the blending of tens of thousands of kittiwakes nesting on cliff ledges, their white heads creating a pointillist effect from miles away.

As impressive as Svalbard's summer birds are, they're sort of nature's carpetbaggers: here for the good times, gone for the bad. Come September, most will be winging south. It's hard not to reserve your highest respect for Svalbard's year-round residents, each of which seems to employ one of two common strategies to survive the brutal Arctic winter: Keep hunting or cache extra energy.

The master practitioner of the first tactic is the polar bear, of course, which spends much of the winter hanging out around seal breathing holes, waiting for dinner to surface. The arctic

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*Bruce Barcott's story about the European bee-eater appeared in the October 2008 issue. Canadian-born Paul Nicklen is a frequent contributor to the magazine.*

15°E

25°

ARCTIC OCEAN

80°N

SJUØYANE

KVITØYA

Smeerenburg-fjorden

Wijdefjorden

Liefdefjorden

NORDAUSTLANDET

Magdalene-fjorden

Monacobreen

Kapp Fanshawe

Krossfjorden

Kongsfjorden

SPITSBERGEN

Fuglehuken

Ny-Ålesund

Newtontoppen
1,713 m
5,620 ft

Kongsøya

SVALBARD
(NORWAY)

KONG KARLS LAND

Svenskøya

Pyramiden

PRINS KARLS FORLAND

BARENTSØYA

Longyearbyen

Adventdalen

Isfjorden

Barentsburg

Norden-skiöldfjellet
1,050 m
3,445 ft

Sveagruva

Storfjorden

EDGEØYA

Barents Sea

West Spitsbergen Current

Bellsund

Hornsund

Sea-ice extent
March 2008

## EBBING ICE

From March 1979 to March 2008 the average ice area in the Barents Sea declined by nearly 30 percent, though annual ice cover has varied widely. In 2007 and 2008 the sea-ice extent dipped to the lowest on record.

HOPEN

**Average extent of March sea ice**

1979-1988

1989-1998

1999-2008

Sea-ice extent encompasses areas with ice cover of 15 percent or more.

75°

0 mi 20
0 km 20

VIRGINIA W. MASON, NG STAFF
SOURCE: NORWEGIAN POLAR INSTITUTE

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BJØRNØYA

fox employs a hybrid strategy. It keeps hunting in white fur camouflage but when times get tough, digs into caches of food lardered months earlier. In more temperate regions the fox's reputation for surplus killing—going postal in the chicken coop, killing far more birds than it can eat—has earned it the enmity of farmers, but up here storing those surplus kills often means the difference between life and death.

For both reindeer and rock ptarmigan, caching extra energy means one thing: fattening up. To watch a reindeer feed at midnight in Svalbard is to witness an extraordinary event. The reindeer here, like the ptarmigan, let go of the nocturnal rhythms that govern the lives of most animals. They eat and eat and eat, then rest a little, then eat some more, regardless of the time of day. The reindeer build up a layer of blubberish fat as thick as four inches. When food grows scarce in winter, the fat acts as the reindeer's energy reserve.

Svalbard's wild survivors have figured out how to adapt to the high Arctic's darkness, its bitter cold, and its meager vegetation. But there's one force that has come at them too fast for evolutionary change: humans.

From the 17th to 19th centuries, whalers sailed to Svalbard to hunt the region's mighty cetaceans, whose thick blubber could be turned into whale oil and, ultimately, handsome profits. On a voyage to Svalbard in 1612, the captain of a Dutch ship reported that the Barents Sea was so full of whales that the ship's prow parted the beasts as though it were cutting through pack ice. By the end of the 18th century, the world's insatiable appetite for whale oil had almost wiped them out. Some 50,000 bowhead whales, the longest lived mammal on the planet, were taken by Dutch vessels alone. The commercial carnage drove the species to near extinction. (Today more than 10,000 bowheads survive, mostly in the Bering, Chukchi, and Beaufort Seas.) After mowing through the whales, the hunters turned their attention to the walrus—for its ivory—and nearly snuffed out that species too.

At the end of World War I the Svalbard Treaty gave Norway sovereignty over the archipelago, whose resources Sweden and Russia also eyed. The treaty proved to be a turning point. Over the course of the 20th century Norwegian officials put a halt to the free-for-all and turned one of the world's greatest wildlife killing grounds into one of its most protected sanctuaries. Today 65 percent of Svalbard's islands and 75 percent of its marine areas lie within national parks or nature reserves. A remarkable thing happens when you give animals habitat and peace. They thrive. Svalbard's walrus population, winnowed to a few hundred animals by the 1950s, rebounded to more than 2,600 in 2006. Only a thousand reindeer grazed in the valleys in the 1920s. Today some experts believe there may be as many as 10,000.

The days of outright slaughter are gone, but humans continue to pressure wildlife here in indirect ways. Toxins like PCBs and perfluorinated compounds swirl up to Svalbard on air and ocean currents and become trapped in the fatty tissue of glaucous gulls, great skuas, arctic foxes, and ringed seals, compromising their immune systems. Polar bears carry much higher levels of the pollutants than their Alaskan and Canadian counterparts. Climate change, meanwhile, forces a retreat of the summer ice pack, imperiling the region's polar bears. The wildlife that thrives up here has adapted to one of the toughest habitats on Earth. As temperatures rise, those birds, fish, and mammals will be forced to adapt even further.

Perhaps there is cause for hope in the curious ways Svalbard's wildlife has already adjusted to humans, the predator turned protector. In the coal-mining outpost of Barentsburg, dozens of black-legged kittiwakes have turned abandoned buildings into makeshift bird cliffs, nesting on the window ledges. At midnight or noon—it makes no difference to the birds—the parents leap off the ledges to dive after fish schooling in the harbor below. In their own small way the kittiwakes are expanding the edge of the possible, windowsill by windowsill. It's ingenious but, for Svalbard, not atypical. Up here opportunity and abundance often appear in unlikely places. □

Tusks of all lengths suggest a mix of ages among these walruses, part of Svalbard's peak summer count of some 2,600. By the early 1900s ivory hunters had nearly wiped out Norway's herds. Protected since 1952, the population is still recovering.

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**Svalbard's ecosystem links sky, sea, and shore. Dovekies (above) dive for copepods and nest on rocky slopes. The guano and carcasses that the flocks deposit on land fertilize a mossy garden, ideal lurking ground for the arctic fox. This hunter preys on puffins (top right) and other birds and eggs to feed her pups. In winter she scours snowy terrain for scraps. Nutrients also wash off the shore and drop from the sky into the ocean, nourishing vibrant anemones and soft corals (bottom right).**

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Overturned by waves, a chunk of glacial ice yields to the sea. Vikings may have found these far-flung islands as early as the 12th century. Whalers, scientists, and Arctic explorers have used them as a base. But only 2,500 people call Svalbard home.

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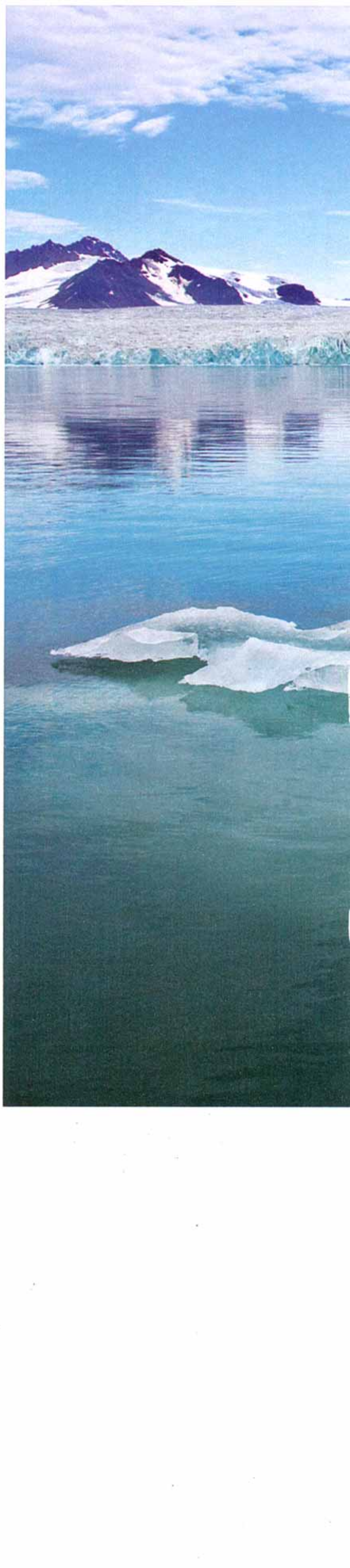

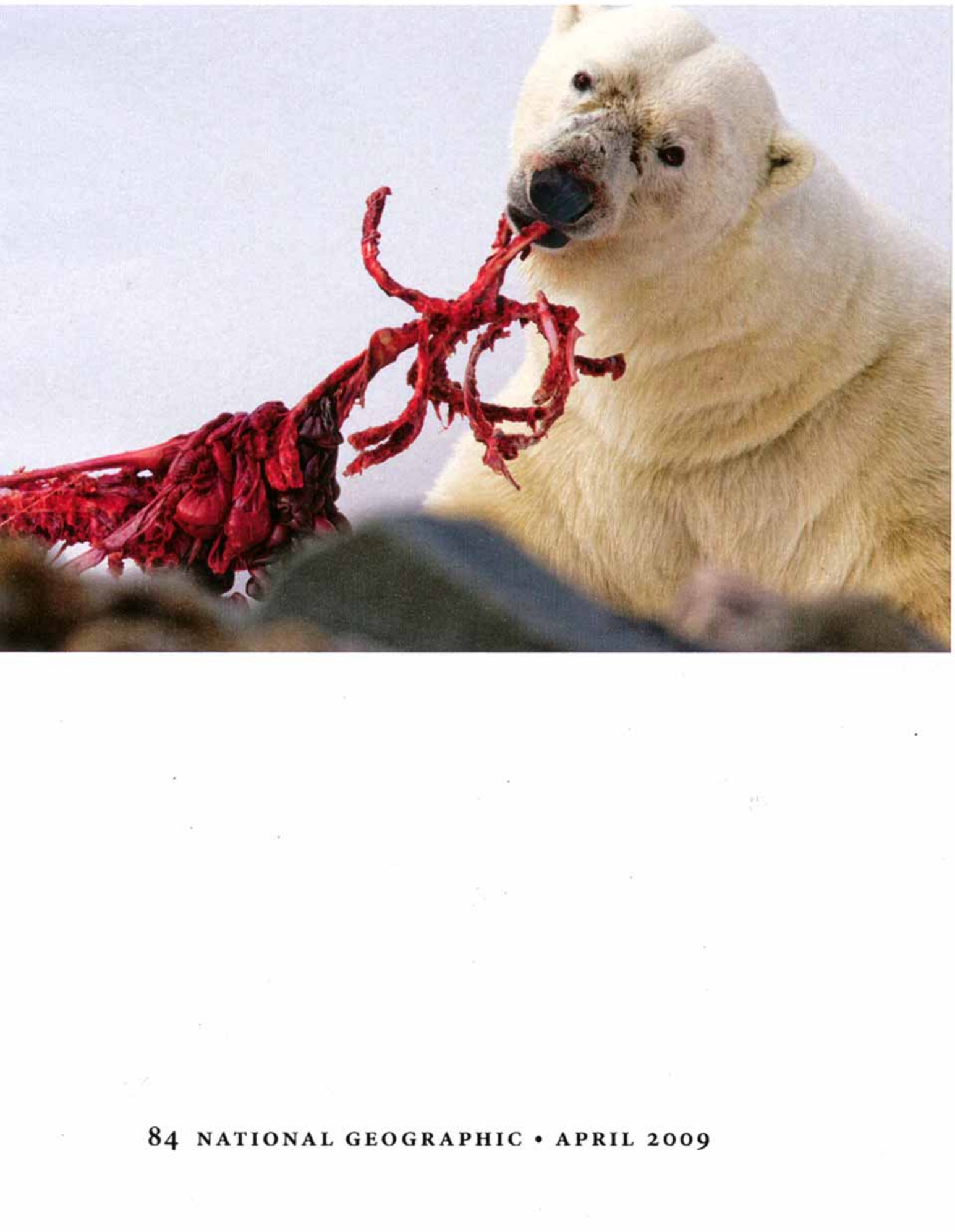

**Svalbard supports about half the 3,000 polar bears in the Barents Sea region. But the Arctic's iconic mammal isn't the only one married to the ice. Another is the bearded seal, often a meal for a hungry bear (bottom left). The seal depends on ice platforms (above) for birthing, but sea ice is shrinking as temperatures rise. Warming waters also alter food stocks and distribution, and may wipe out some of the seal's own prey.**

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In a far north without ice, a mother bear could be stranded a long way from good hunting, struggling to feed herself and her cubs. This snow-free scene near Kapp Fanshawe (Cape Fanshawe) offers a glimpse of what may be the Arctic's rockier future.

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# THE KING HER-SELF

*What motivated Hatshepsut to rule ancient Egypt as a man while her stepson stood in the shadows? Her mummy, and her true story, have come to light.*

BY CHIP BROWN | PHOTOGRAPHS BY KENNETH GARRETT

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*A grand expression of royal power, Hatshepsut's mortuary temple rises against a desert bluff at Deir el Bahri. Reliefs in the porticoes record the greatest triumphs of her 21-year reign.*

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*In a scene at Deir el Bahri, men carry a myrrh tree to Egyptian ships in Punt, a land still not clearly identified. Hatshepsut sent a trading mission down the Red Sea to procure luxuries there in about 1470 B.C.*

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There was something strangely touching about her fingertips. Everywhere else about her person all human grace had vanished. The raveled linen around her neck looked like a fashion statement gone horribly awry. Her mouth, with the upper lip shelved over the lower, was a gruesome crimp. (She came from a famous lineage of overbites.) Her eye sockets were packed with blind black resin, her nostrils unbecomingly plugged with tight rolls of cloth. Her left ear had sunk into the flesh on the side of her skull, and her head was almost completely without hair.

I leaned toward the open display case in Cairo's Egyptian Museum and gazed at what in all likelihood is the body of the female pharaoh Hatshepsut, the extraordinary woman who ruled Egypt from 1479 to 1458 B.C. and is famous today less for her reign during the golden age of Egypt's 18th dynasty than for having the audacity to portray herself as a man. There was no beguiling myrrh perfume in the air, only some sharp and sour smell that seemed minted during the many centuries she had spent in a limestone cave. It was hard to square this prostrate thing with the great ruler who lived so long ago and of whom it was written, "To look upon her was more beautiful than anything." The only human touch was in the bone shine of her nailless fingertips where the mummified flesh had shrunk back, creating the illusion of a manicure and evoking not just our primordial vanity but our tenuous intimacies, our brief and passing feel for the world.

The discovery of Hatshepsut's lost mummy made headlines two summers ago, but the full story unfolded slowly, in increments, a forensic drama more along the lines of *CSI* than *Raiders of the Lost Ark*. Indeed the search for Hatshepsut showed the extent to which the trowels and brushes of archaeology's traditional toolbox have been supplemented by CT scanners and DNA gradient thermocyclers.

In 1903 the renowned archaeologist Howard Carter had found Hatshepsut's sarcophagus in the 20th tomb discovered in the Valley of the Kings—KV20. The sarcophagus, one of three Hatshepsut had prepared, was empty. Scholars

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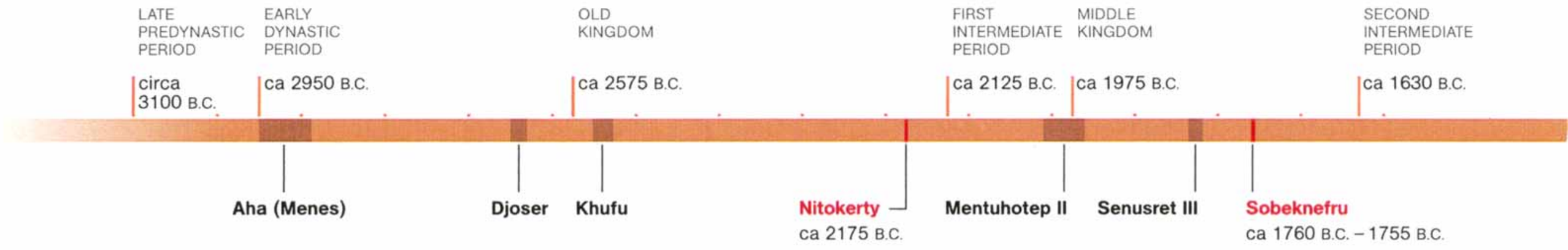
*Abandoning the queenly attire of a regent, Hatshepsut came to adopt the classic regalia of a king. At left, she wears the royal headcloth of the pharaoh, yet softly rounded breasts and a delicate chin subtly suggest her female gender. As a sphinx (above), she displays the unmistakably male symbols of a lion's mane and a pharaoh's false beard.*




## WOMEN WHO RULED AS KINGS

A pharaoh was meant to be both man and god, but a few women broke with that tradition. Only Hatshepsut enjoyed a long, prosperous reign, taking her place among notable male pharaohs.

**Female pharaohs in red**

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did not know where her mummy was or whether it had even survived the campaign to eradicate the record of her rule during the reign of her co-regent and ultimate successor, Thutmose III, when almost all the images of her as king were systematically chiseled off temples, monuments, and obelisks. The search that seems to have finally solved the mystery was launched in 2005 by Zahi Hawass, head of the Egyptian Mummy Project and secretary general of the Supreme Council of Antiquities. Hawass and a team of scientists zeroed in on a mummy they called KV60a, which had been discovered more than a century earlier but wasn't thought significant enough to remove from the floor of a minor tomb in the Valley of the Kings. KV60a had been cruising eternity without even the hospitality of a coffin, much less a retinue of figurines to perform royal chores. She had nothing to wear, either—no headdress, no jewelry, no gold sandals or gold toe and finger coverings, none of the treasures that had been provided the pharaoh Tutankhamun, who was a pip-squeak of a king compared with Hatshepsut.

And even with all the high-tech methods used to crack one of Egypt's most notable missing person cases, if it had not been for the serendipitous discovery of a tooth, KV60a might still be lying alone in the dark, her royal name and status unacknowledged. Today she is enshrined in one of the two Royal Mummy Rooms at the Egyptian Museum, with plaques in Arabic and English proclaiming her to be Hatshepsut, the King Herself, reunited at long last with her extended family of fellow New Kingdom pharaohs.

Given the oblivion that befell Hatshepsut, it's hard to think of a pharaoh whose hopes of being remembered are more poignant. She seems to have been more afraid of anonymity than of death. She was one of the greatest builders in one of the greatest Egyptian dynasties. She raised and renovated temples and shrines from the Sinai to Nubia. The four granite obelisks she erected at the vast temple of the great god Amun at Karnak were among the most magnificent ever constructed. She commissioned hundreds of statues of herself and left accounts in stone of her lineage, her titles, her history, both real and concocted, even her thoughts and hopes, which at times she confided with uncommon candor. Expressions of worry Hatshepsut inscribed on one of her obelisks at Karnak still resonate with an almost charming insecurity: "Now my heart turns this way and that, as I think what the people will say. Those who see my monuments in years to come, and who shall speak of what I have done."

Many uncertainties plague the early history of the New Kingdom, but it's clear that when

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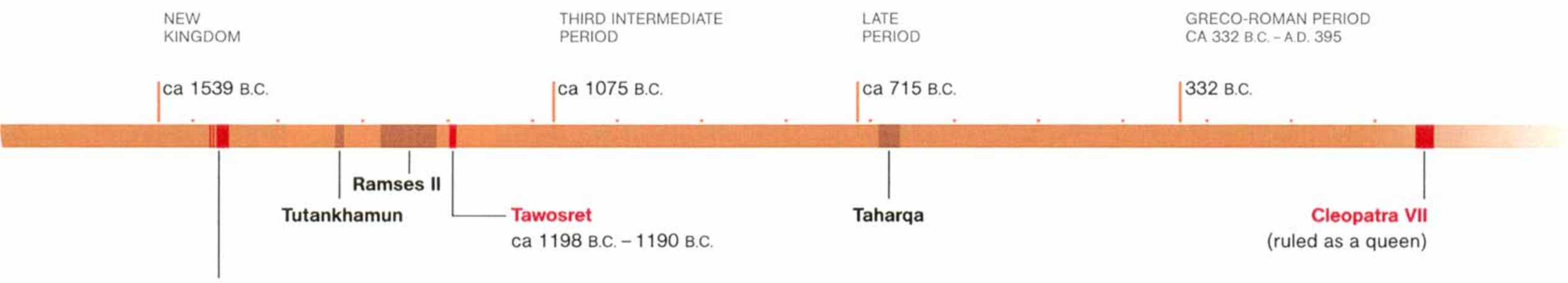
*Chip Brown has written two books as well as articles for more than 30 national magazines. Kenneth Garrett's photographs of Nubian pharaohs appeared in the February 2008 issue.*




**HATSHEPSUT**
ca 1479 B.C. – 1473 B.C.
Regent for Thutmose III

ca 1473 B.C. – 1458 B.C.
Pharaoh and co-ruler
with Thutmose III

Royal cartouche of the pharaoh Hatshepsut

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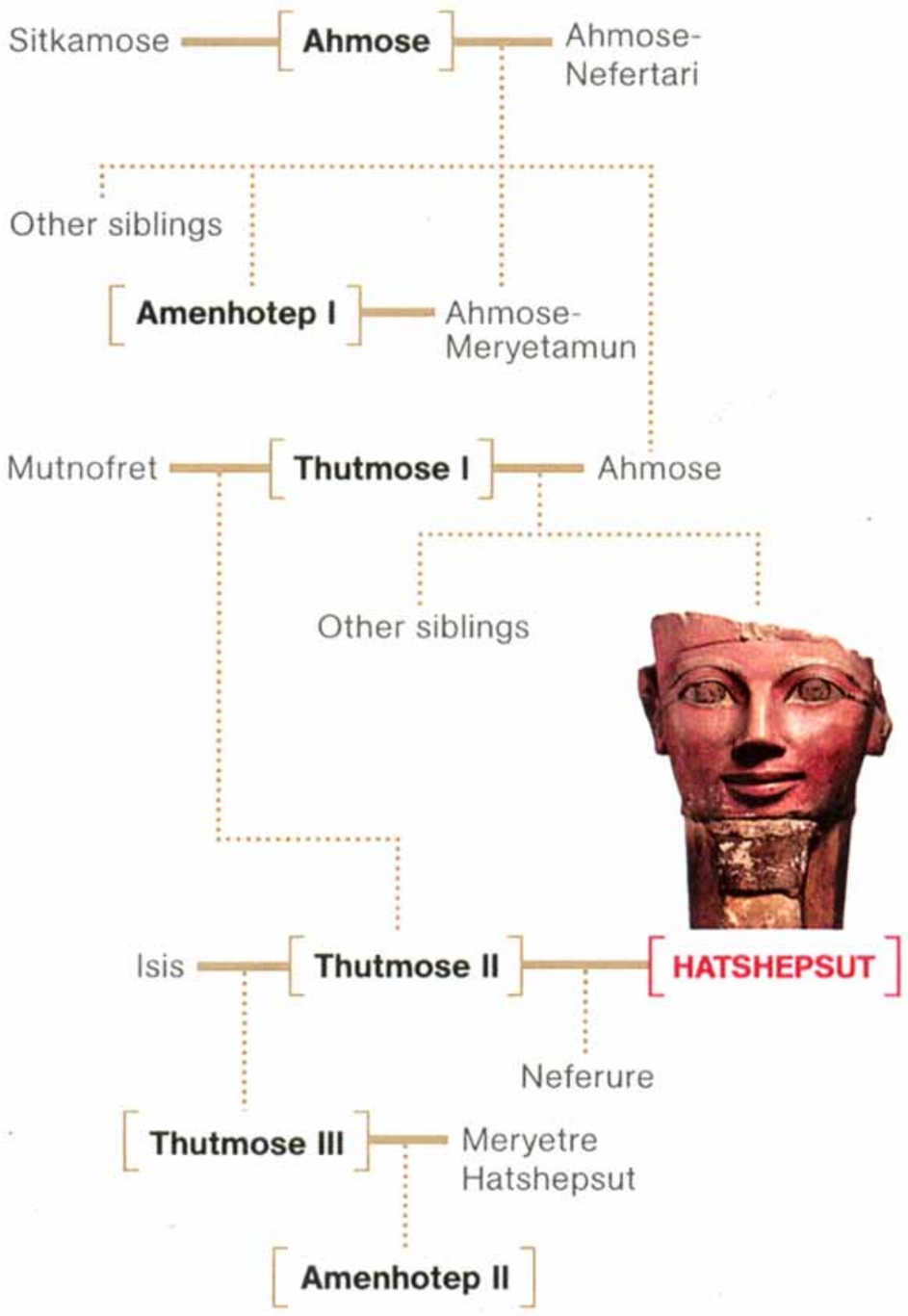
## HATSHEPSUT'S FAMILY TREE

The female pharaoh's mother, Ahmose, is believed to have been a king's daughter, which gave Hatshepsut a unique advantage. Her father, Thutmose I, had no royal blood. Hatshepsut may have used her status to seize power after her stepson inherited the throne.




Scholarly interpretations of royal lineages differ.

Pharaoh — Spouse
Child

NG ART
SOURCES: ZAHI HAWASS, SUPREME COUNCIL OF ANTIQUITIES (TIME LINE); *HATSHEPSUT: FROM QUEEN TO PHARAOH*, METROPOLITAN MUSEUM OF ART (FAMILY TREE)

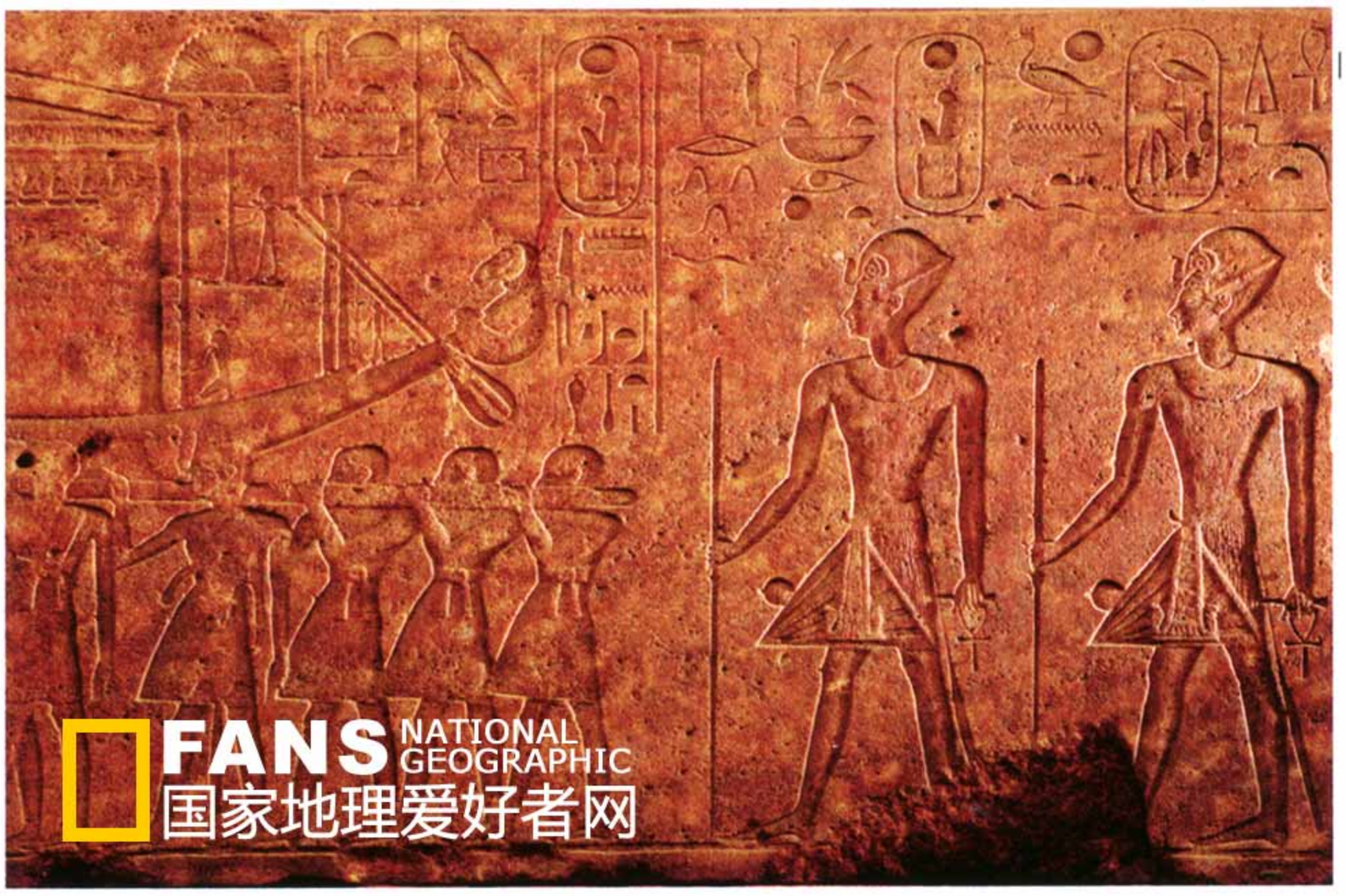
Hatshepsut was born, Egyptian power was waxing. Her possible grandfather Ahmose, founder of the 18th dynasty, had driven out the formidable Hyksos invaders who had occupied the northern part of the Nile Valley for two centuries. When Ahmose's son Amenhotep I did not produce a son who lived to succeed him, a redoubtable general known as Thutmose is believed to have been brought into the royal line since he had married a princess.

Hatshepsut was the oldest daughter of Thutmose and his Great Royal Wife, Queen Ahmose, likely a close relative of King Ahmose. But Thutmose also had a son by another queen, and this son, Thutmose II, inherited the crown when his father "rested from life." Adhering to a common method of fortifying the royal lineage—and with none of our modern-day qualms about sleeping with your sister—Thutmose II and Hatshepsut married. They produced one daughter; a minor wife, Isis, would give Thutmose the male heir that Hatshepsut was unable to provide.

Thutmose II did not rule for long, and when he was ushered into the afterlife by what CT scans 3,500 years later would suggest was heart disease, his heir, Thutmose III, was still a young boy. In time-honored fashion, Hatshepsut assumed effective control as the young pharaoh's queen regent.

So began one of the most intriguing periods of ancient Egyptian history.

At first, Hatshepsut acted on her stepson's behalf, careful to respect the conventions under



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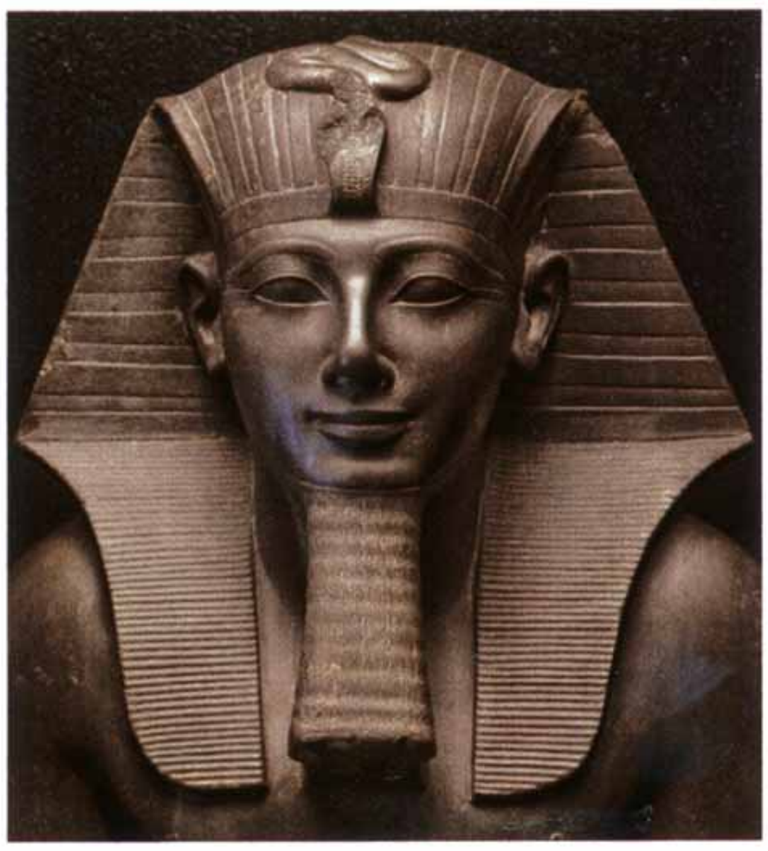


*Firmly gripping the reins of power, Hatshepsut relegated her stepson, Thutmose III (left), to a supporting role. Reliefs on the walls of the Red Chapel at Karnak (right) hint at the unusual nature of this arrangement. In a festival scene (above) she stands in front of him, but both are dressed as pharaohs, and the titles above them read as if they were one person.*

which previous queens had handled political affairs while juvenile offspring learned the ropes. But before long, signs emerged that Hatshepsut's regency would be different. Early reliefs show her performing kingly functions such as making offerings to the gods and ordering up obelisks from red granite quarries at Aswan. After just a few years she had assumed the role of "king" of Egypt, supreme power in the land. Her stepson—who by then may have been fully capable of assuming the throne—was relegated to second-in-command. Hatshepsut proceeded to rule for a total of 21 years.

What induced Hatshepsut to break so radically with the traditional role of queen regent? A social or military crisis? Dynastic politics? Divine injunctions from Amun? A thirst for power? "There was something impelling Hatshepsut to change the way she portrayed herself on public monuments, but we don't know what it is," says Peter Dorman, a noted Egyptologist and president of the American University of Beirut. "One of the hardest things to guess is her motive."

Bloodlines may have had something to do with it. On a cenotaph at the sandstone quarries of Gebel el Silsila, her chief steward and architect Senenmut refers to her as "the king's firstborn daughter," a distinction that accents her lineage as the senior heir of Thutmose I rather than as the chief royal wife of Thutmose II. Remember, Hatshepsut was a true blue blood, related to the pharaoh Ahmose, while her husband-brother

was the offspring of an adopted king. The Egyptians believed in the divinity of the pharaoh; only Hatshepsut, not her stepson, had a biological link to divine royalty.

Still, there was the small matter of gender. The kingship was meant to be passed down from father to son, not daughter; religious belief dictated that the king's role could not be adequately carried out by a woman. Getting over this hurdle must have taken great shrewdness from the female king. When her husband died, Hatshepsut's preferred title was not King's Wife, but God's Wife of Amun, a designation some believe paved her way to the throne.

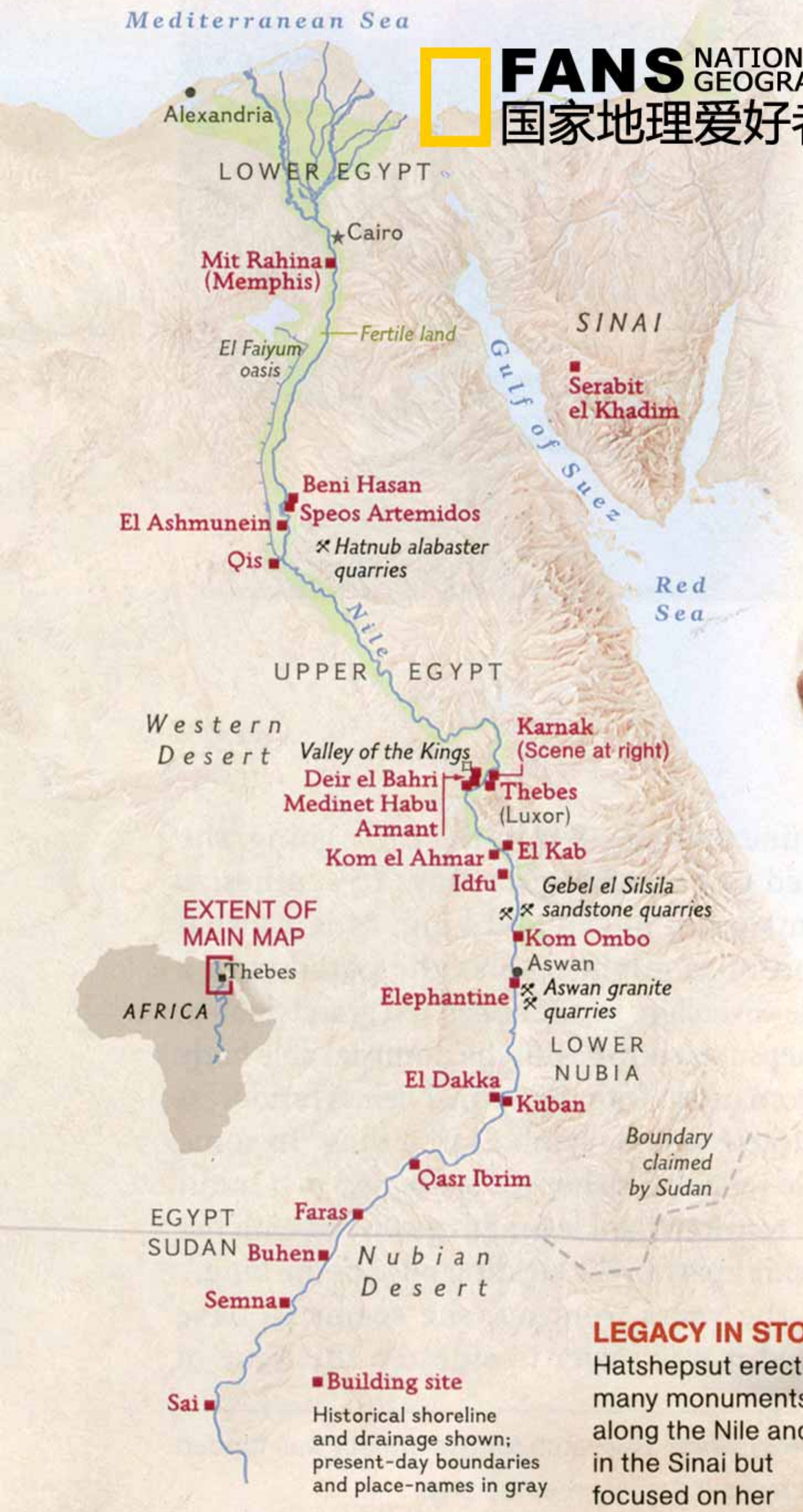
Hatshepsut never made a secret of her sex in texts; her inscriptions frequently employed feminine endings. But in the early going, she seemed to be looking for ways to synthesize the images of queen and king, as if a visual compromise might resolve the paradox of a female sovereign. In one seated red granite statue, Hatshepsut is shown with the unmistakable body of a woman but with the striped *nemes* headdress and uraeus cobra, symbols of a king. In some temple reliefs, Hatshepsut is dressed in a traditional restrictive ankle-length gown but with her feet wide apart in the striding pose of the king.

As the years went on, she seems to have decided it was easier to sidestep the issue of

**Society Grant** Research for this project was funded in part by your Society membership.

# GLORIES OF HER REIGN

In the wake of the campaigns fought by her predecessors at the dawn of the New Kingdom, Hatshepsut ushered in a time of peace and recovery. By her command, temples damaged during the earlier conflicts were restored, new ones were built, and obelisks were quarried in Aswan. With lucrative trade contacts reestablished, Egypt once again received timber from Lebanon, turquoise from mines in the Sinai, and a wealth of luxuries (right) from the land of Punt.




## LEGACY IN STONE

Hatshepsut erected many monuments along the Nile and in the Sinai but focused on her capital at Thebes, today the ruins of Karnak and Luxor.

A high priest of the god Amun wears a distinctive leopard skin.

A royal scribe records each offering as it is presented.

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## THE RICHES OF PUNT

Early in her rule as king, Hatshepsut sent trading ships to Punt, a land somewhere along Africa's Red Sea coast. When the ships returned, priests at Karnak presented a dazzling array of goods to the pharaoh, who dedicated it all to Amun, her patron god.

**Hatshepsut** wears the *nemes* headcloth with its sacred cobra.

**Thutmose III** stands next to Hatshepsut, the proper place of a co-ruler on official occasions.

The pharaoh waves a *sekhem* scepter over the offerings.

Pharaonic regalia includes a false beard.

Imports from Punt include circular gold ingots (right), spices, tusks, ebony, myrrh trees for incense, panther skins, and live baboons.

FERNANDO G. BAPTISTA AND AMANDA HOBBS, NG STAFF

SOURCE: W. RAYMOND JOHNSON, ORIENTAL INSTITUTE OF THE UNIVERSITY OF CHICAGO

MAP: CHARLES BERRY

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gender altogether. She had herself depicted solely as a male king, in the pharaoh's headdress, the pharaoh's *shendyt* kilt, and the pharaoh's false beard—without any female traits. Many of her statues, images, and texts seem part of a carefully calibrated media campaign to bolster the legitimacy of her reign as king—and rationalize her transgression. In reliefs at Hatshepsut's mortuary temple, she spun a fable of her accession as the fulfillment of a divine plan and declared that her father, Thutmose I, not only intended her to be king but also was able to attend her coronation. In the panels the great god Amun is shown appearing before Hatshepsut's mother disguised as Thutmose I. He commands Khnum, the ram-headed god of creation who models the clay of mankind on his potter's wheel: "Go, to fashion her better than all gods; shape for me, this my daughter, whom I have begotten."

Unlike most contractors, Khnum gets right to work, replying: "Her form shall be more exalted than the gods, in her great dignity of King...."

On Khnum's potter's wheel, little Hatshepsut is depicted unmistakably as a boy.

Exactly who was the intended audience for such propaganda is still disputed. It's hard to imagine Hatshepsut needed to shore up her legitimacy with powerful allies like the high priests of Amun or members of the elite such as Senenmut. Who, then, was she pitching her story to? The gods? The future? *National Geographic?*

One answer may be found in Hatshepsut's references to the lapwing, a common Nile marsh bird known to ancient Egyptians as *rekhyt*. In hieroglyphic texts the word "rekhyt" is usually translated as "the common people." It occurs frequently in New Kingdom inscriptions, but a few years ago Kenneth Griffin, now at Swansea University in Wales, noticed that Hatshepsut made greater use of the phrase than other 18th-dynasty pharaohs. "Her inscriptions seemed to show a personal association with the rekhyt which at this stage is unrivaled," he says. Hatshepsut often spoke possessively of "my rekhyt" and asked for the approval of the rekhyt—as if

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HER STATUES WERE SMASHED AND THROWN INTO A PIT IN FRONT OF HER TEMPLE.

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*A craggy bay in the Western Desert embraces Hatshepsut's mortuary temple. Behind its crowning ridge lies the great rift now known as the Valley of the Kings, the royal cemetery that holds the entrance to her tomb. Her father was likely the first pharaoh to prepare his final resting place in the valley, launching a tradition that would last for more than four centuries.*

*Hatshepsut's wet nurse*

*Hatshepsut*

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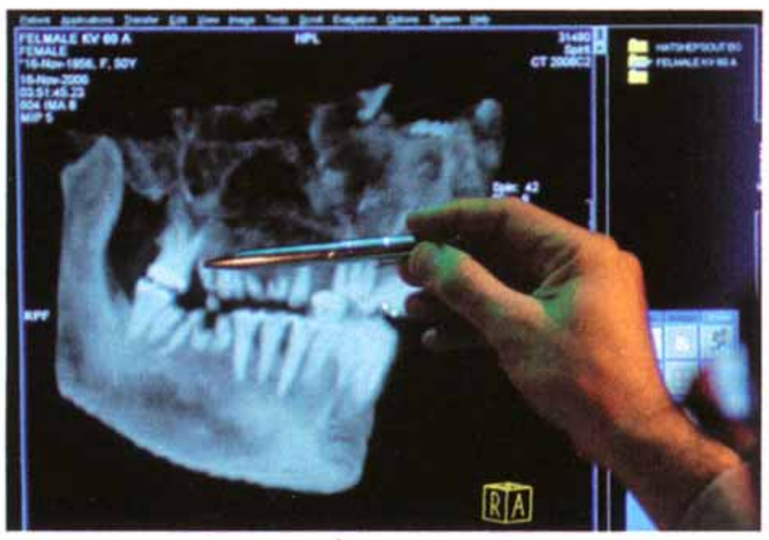
the unusual ruler were a closet populist. When Hatshepsut's heart flutters this way and that as she wonders what "the people" will say, the people she may have had in mind were the ones as common as lapwings on the Nile, the rekhyt.

After her death, around 1458 B.C., her stepson went on to secure his destiny as one of the great pharaohs in Egyptian history. Thutmose III was a monument maker like his stepmother but also a warrior without peer, the so-called Napoleon of ancient Egypt. In a 19-year span he led 17 military campaigns in the Levant, including a victory against the Canaanites at Megiddo in present-day Israel that is still taught in military academies. He had a flock of wives, one of whom bore his successor, Amenhotep II. Thutmose III also found time to introduce the chicken to the Egyptian dinner table.

In the latter part of his life, when other men might be content to reminisce about bygone adventures, Thutmose III appears to have taken up another pastime. He decided to methodically wipe his stepmother, the king, out of history.

When Zahi Hawass set out to find Her Majesty King Hatshepsut, he was fairly certain of one thing: The naked mummy found resting on the floor of a minor tomb was not her. "When I started searching for Hatshepsut, I never thought I would discover that she was this mummy," Hawass says. For starters, she had no apparent regal bearing; she was fat, and as Hawass wrote in an article published in the journal *KMT,* she had "huge pendulous breasts" of the sort more likely to be found on Hatshepsut's wet nurse.

Months earlier Hawass had visited Hatshepsut's tomb, KV20, to search for clues to her whereabouts. Wearing his trademark fedora, Hawass lowered himself 700 feet into one of the most dangerous tombs in the Valley of the Kings. The tunnel through friable shale and limestone



***Where was Hatshepsut's mummy? A century ago, two unidentified females (left) were discovered in a minor tomb, likely moved there by priests intent on hiding them from thieves. When recent tests revealed that a tooth found inside a box with Hatshepsut's name (right) exactly matched a gap in the fatter mummy's jaw (above), the mystery of the lost pharaoh appeared to be solved.***

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reeked of bat droppings. When Howard Carter cleared it in 1903, he called it "one of the most irksome pieces of work I ever supervised." In the tomb Carter found two sarcophagi bearing Hatshepsut's name, some limestone wall panels, and a canopic chest, but no mummy.

Carter made another discovery in a tomb close by—tomb KV60, a minor structure whose entrance was cut into the corridor entrance of KV19. In KV60 Carter found "two much denuded mummies of women and some mummified geese." One mummy was in a coffin, the other on the floor. Carter took the geese and closed the tomb. Three years later another archaeologist removed the mummy in the coffin to the Egyptian Museum. The inscription on the coffin was later linked to Hatshepsut's nurse. The mummy on the floor was left as she was, as she had been since being stashed there, probably by priests during the reburials of the 21st dynasty, around 1000 B.C.

Over the years Egyptologists lost track of the entrance to KV60, and the mummy on the tomb floor effectively disappeared. That changed in June 1989, when Donald Ryan, an Egyptologist and lecturer at Pacific Lutheran University in Tacoma, Washington, came to explore several small, undecorated tombs in the valley. Prompted by the influential Egyptologist Elizabeth Thomas, who suspected that KV60 might house Hatshepsut's mummy, Ryan had included it on his application for a research permit. Arriving too late his first day to start work, Ryan decided to stroll around the site to drop off some tools. He wandered over to the entrance of KV19 and for the heck of it, thinking KV60 might be nearby, started sweeping the entranceway with his broom. He worked backward from the door of KV19. Within half an hour he'd found a crack in the rock corridor. A stone hatch revealed a set of stairs. A week later, with Beethoven's *Pathétique* Sonata playing on a tape deck, he

BRANDO QUILICI, AGENTUR FOCUS (X-RAY, ABOVE)

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and a local antiquities inspector entered the "lost" tomb.

"It was spooky," he recalls. "I had never found a mummy before. The inspector and I walked in very carefully. There was a woman lying on the floor. Oh my gosh!"

The mummy was lying in a tomb that had been trashed in ancient times by robbers. Her left arm was crooked across her chest in a burial pose some believe to be common to 18th-dynasty Egyptian queens. Ryan set about cataloging what he found. "We found the smashed-up face piece of a coffin and flecks of gold that had been scraped off," he recalls. "We didn't know how much had been moved around by Howard Carter, so we documented it as an intact site." In a side chamber Ryan found a huge pile of wrappings, a mummified cow's leg, and a stacked pile of "victual mummies," wrapped bundles of food laid up for the deceased's long journey through eternity.

The more Ryan studied the mummy, the more he thought she might be someone important. "She was extraordinarily well mummified," he says. "And she was striking a royal pose. I thought, Why, she's a queen! Could it be Hatshepsut? Possibly. But there was nothing to link the mummy to any specific individual."

Still, it didn't seem right to leave whoever she was lying naked on the floor in a mess of rags. Before he closed the tomb, Ryan and a colleague tidied the burial chamber up a bit. At a local carpenter's shop they had a simple coffin built. They lowered the unknown lady into her new bed and closed the lid. Hatshepsut's prolonged period of anonymity was nearing its end.

Historians long cast Hatshepsut in the role of evil stepmother to the young Thutmose III. The evidence of her supposed cruelty was the payback she posthumously received when her stepson had her monuments attacked and her kingly name erased from public memorials. Indeed, Thutmose III did as thorough a job smiting the iconography of King Hatshepsut as he had whacking the Canaanites at Megiddo. At Karnak her image and cartouche, or name symbol, were chiseled off shrine walls; the texts on her obelisks were covered with stone (which had the unintended effect of keeping them in pristine condition).

At Deir el Bahri, the site of her most spectacular architectural achievement, her statues were smashed and thrown into a pit in front of her mortuary temple. Known as Djeser Djeseru, holy of holies, on the west bank of the Nile across from modern Luxor, the temple is set against a bay of lion-colored cliffs that frame the tawny temple stones the way the nemes frames a pharaoh's face. With its three tiers, its porticoes, its spacious ramp-linked terraces, its now vanished sphinx-lined causeway and T-shaped papyrus pools and shade-casting myrrh trees, Djeser Djeseru is among the most glorious temples ever built. It was designed (perhaps by Senenmut) to be the center of Hatshepsut's cult.

Images of her as queen were left undisturbed, but wherever she had proclaimed herself king, the workers of her stepson followed with their chisels, the vandalism careful and precise. "The destruction was not an emotional decision; it was a political decision," says Zbigniew Szafrański, the director of the Polish archaeological mission to Egypt that has been working at Hatshepsut's mortuary temple since 1961.

By the time excavators cleared the debris from the mostly buried temple in the late 1890s, the mystery of Hatshepsut had been refined: What kind of ruler was she? The answer seemed self-evident to a number of Egyptologists quick to embrace the idea that Thutmose III had attacked Hatshepsut's memory as revenge for her shameless usurpation of his royal power. William C. Hayes, the curator of Egyptian art at the Metropolitan Museum of Art and a principal at the Deir el Bahri excavations in the 1920s and '30s, wrote in 1953: "It was not long…before this vain, ambitious, and unscrupulous woman showed herself in her true colors."

When archaeologists discovered evidence in the 1960s indicating that the banishment of King Hatshepsut had begun at least 20 years after her death, the soap opera of a hotheaded

## THE SOAP OPERA OF A HOTHEADED SON WREAKING VENGEANCE FELL APART.

stepson wreaking vengeance on his unscrupulous stepmother fell apart. A more logical scenario was devised around the possibility that Thutmose III needed to reinforce the legitimacy of his son Amenhotep II's succession in the face of rival claims from other family members. And Hatshepsut, once disparaged for ruthless ambition, is now admired for her political skill.

"Nobody can know what she was like," says Catharine Roehrig, now a curator in the same department once headed by Hayes. "She ruled for 20 years because she was capable of making things work. I believe she was very canny and that she knew how to play one person off against the next—without murdering them or getting murdered herself."

Close to two decades after Donald Ryan rediscovered the location of KV60, Zahi Hawass asked the curators at the Egyptian Museum to round up all the unidentified and possibly royal female mummies from the 18th dynasty, including the two bodies—one thin, one fat—that had been found in KV60. The thin mummy was retrieved from storage in the museum's attic; the fat one, KV60a, which had remained in the tomb where it had been found, was transported from the Valley of the Kings. Over a four-month period in late 2006 and early 2007, the mummies passed through a CT scanner that enabled the archaeologists to examine them in detail and to gauge their age and cause of death.

The CT results from the four candidate mummies were inconclusive. Then Hawass had another idea. A wooden box engraved with Hatshepsut's cartouche had been found in a great cache of royal mummies at Deir el Bahri in 1881; it was believed to contain her liver. When the box was run through the scanner, the researchers were astonished to detect a tooth. The team dentist identified it as a secondary molar with part of its root missing. When Ashraf Selim, professor of radiology at Cairo University, reexamined the jaw images of the four mummies, there in the right upper jaw of the fat mummy from KV60 was a root with no tooth. "I measured the root in the mummy and the tooth, and we found that they both matched," Selim says.

To be sure, the scientists have proved only that a tooth in a box belongs to a mummy. The identification is based on the assumption that the contents of the box are properly labeled and were once vital parts of the famous female pharaoh. And the box inscribed with Hatshepsut's cartouche is not the typical canopic vessel in which mummified organs are found. It's made of wood, not stone, and might have been used to hold jewelry or oils or small valuables.

"Some would say we have not found absolute proof," Selim says. "And I would agree."

Still, Hawass asks, what are the odds that a box identified with Hatshepsut and found in a cache of royal mummies contains a tooth that exactly matches a hole in the smile of a mummy found next to the beloved nurse of Egypt's great female pharaoh? And how marvelous that the tooth was there to connect Hatshepsut's cartouche with a mummy. "If the embalmer hadn't picked it up and put it in with the liver, there is no way we would have known what happened to Hatshepsut," Hawass says.

Already the CT scans have changed history, dispelling theories that Hatshepsut might have been killed by her stepson. She probably died of an infection caused by an abscessed tooth, with complications from advanced bone cancer and possibly diabetes. Hawass speculates that the high priests of Amun may have moved her body to the tomb of her nurse to protect it from looters; many royalty of the New Kingdom were hidden in secret tombs for security. As for the DNA tests, the first round began in April 2007 and has shown nothing definitive.

"With ancient specimens you never have a 100 percent match, because the genetic sequences aren't complete," says Angélique Corthals, a professor of biomedicine and forensic studies at Stony Brook University in New York and one of three consultants working with the Egyptians. "We looked at mitochondrial DNA for the suspected Hatshepsut mummy and her grandmother Ahmose Nefertari. There is about a 30 to 35 percent chance that the two

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*Visitors to the Temple of Amun at Karnak can see firsthand how images of Hatshepsut as a virile pharaoh were chiseled away years after her death. The likely culprit was her stepson, who may have hoped to keep her blood relatives from using the images to support their own claims to the throne.*

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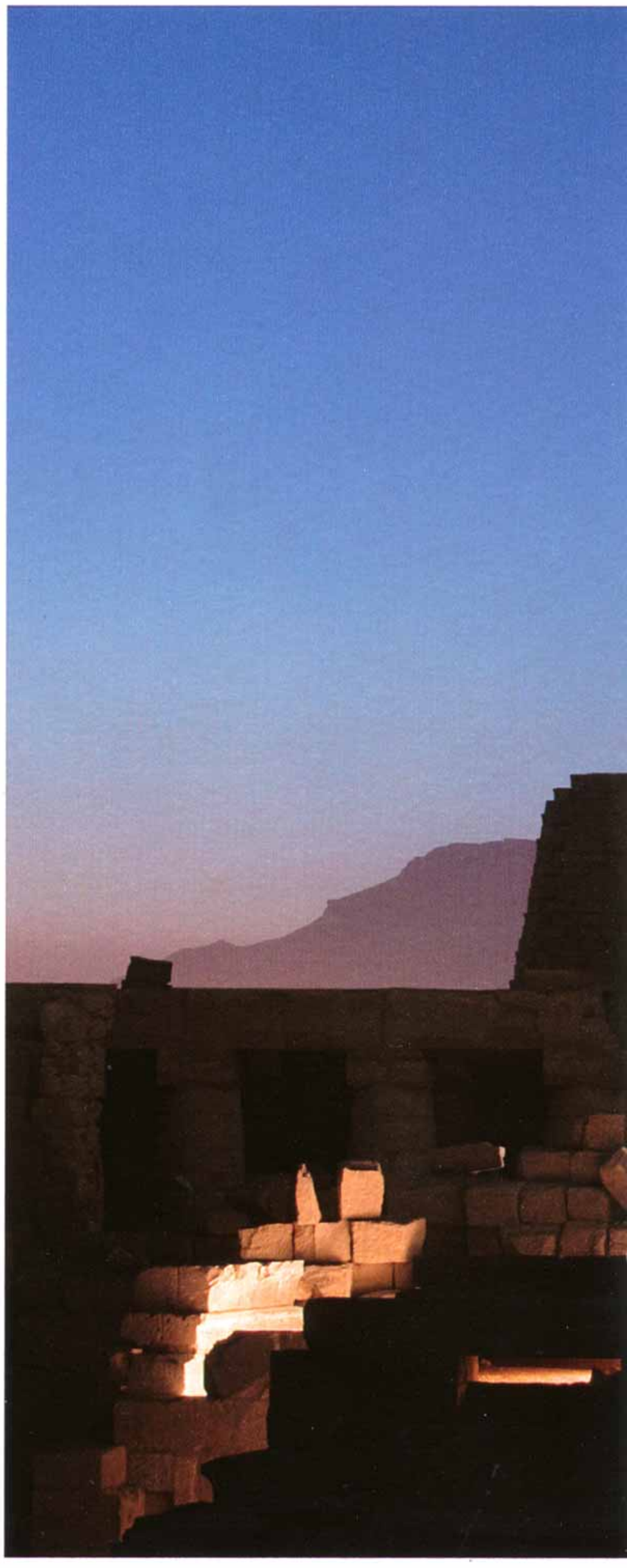
samples are not related, but I cannot emphasize enough that these are just preliminary results." Another round of tests may soon deliver a clearer verdict.

Last spring photographer Kenneth Garrett asked Wafaa El Saddik, director of the Egyptian Museum in Cairo, to review a list of Hatshepsut treasures he hoped to photograph for this article: a limestone sphinx of Hatshepsut from the ruins of her temple, the wooden box containing the tooth, a limestone bust of Hatshepsut in the guise of the underworld god Osiris. El Saddik came to the final item on the list: the mummified body of Hatshepsut herself. "You want us to remove the glass?" she asked incredulously, as if the mummy, long neglected, now possessed something unspeakably precious. The photographer nodded. The director shuddered. "This is the history of the world we're talking about!" she exclaimed.

In the end, it was decreed that one of the panels of glass could be removed from the case in the Royal Mummy Room without jeopardizing the history of the world. Staring at what was left of the great female pharaoh as the lights were being set up, I found myself wondering why it was so important to authenticate her corpse. On the one hand, what could better animate the astonishing history of ancient Egypt than the actual woman preserved in defiance of nature and the forces of decay? Here she was now, among us, like an ambassador of antiquity.

On the other hand, what did we want from her? Wasn't there something oppressively morbid about the curiosity that brought millions of rubberneckers to the Royal Mummy Rooms and made a fetish of the royal dead in the first place? The longer I stared at Hatshepsut, the more I recoiled from those unfathomable eyes and the suffocating fixity of that lifeless flesh. Most of us live by the lapwing creed that is the antithesis of the pharaohs' faith: ashes to ashes, dust to dust. It struck me how much more of Hatshepsut was alive in her texts, where even after so many thousands of years, you can still feel the flutter of her heart. □



# WASN'T THERE SOMETHING MORBID ABOUT MAKING A FETISH OF THE ROYAL DEAD?

*Hatshepsut's obelisk, sculpted from a single block of granite, soars a hundred feet above the ruins of Karnak. Defying the attempts to erase her from history, it now stands magnificently as the tallest such monument in Egypt.*

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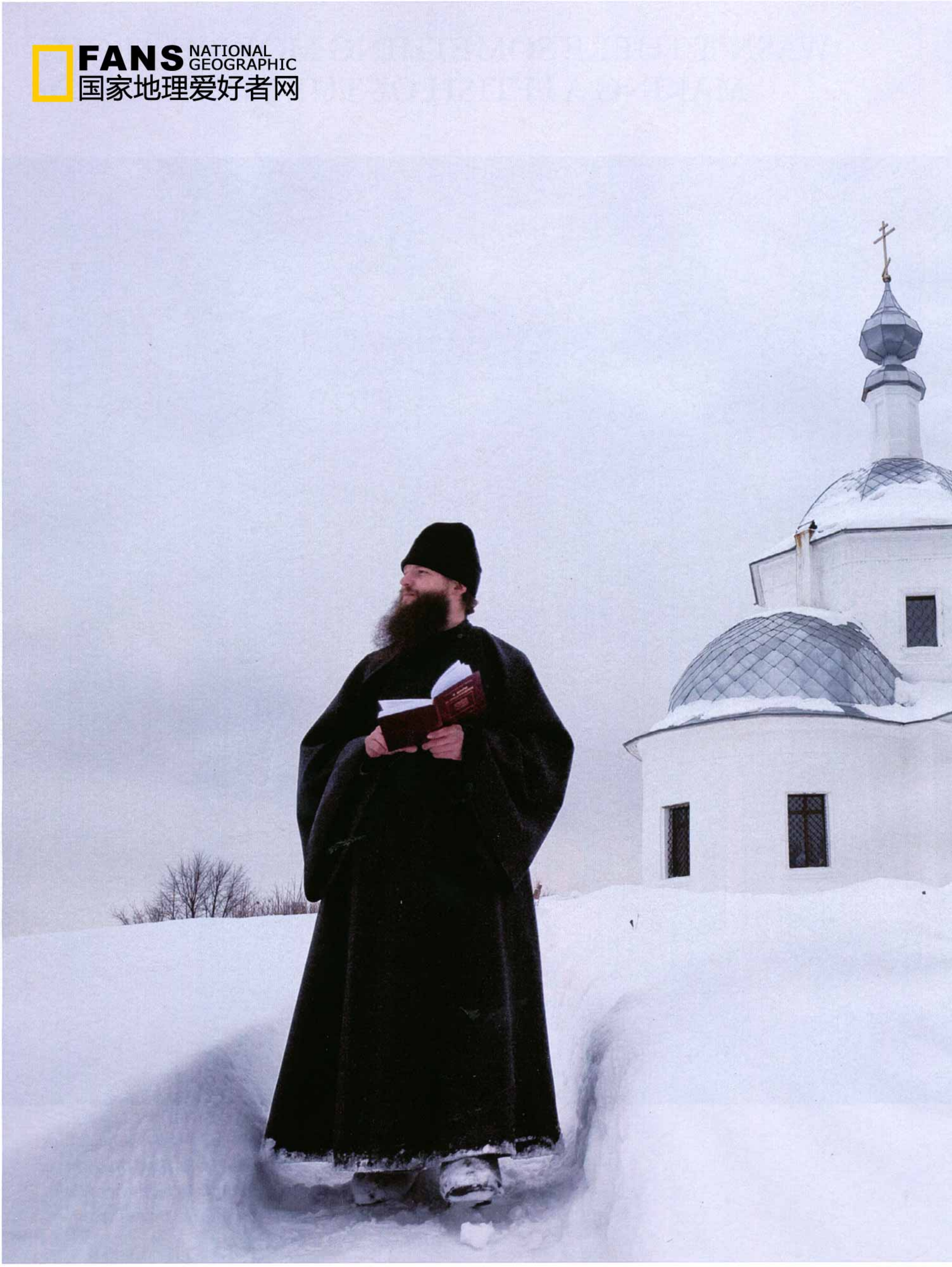

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# Soul of RUSSIA

**DRIVEN UNDERGROUND FOR 75 YEARS, THE FAITH OF THE RUSSIAN TSARS NOW ENJOYS FAVORED STATUS.**

*Father Sevastyan meditates on the Gospels at Svyato-Kazansky hermitage, one of many Russian Orthodox communities resurrecting across the land.*

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*Vladlena Fofonova's husband filmed it all: submersion three times in water, solemn praying, and finally the symbolic snipping of hair by Archbishop Vikenty as he baptizes Fofonova at*

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*Church on the Blood in Yekaterinburg. Millions of Russians have been baptized since the end of Soviet rule. Nearly two-thirds of the population now identify themselves as Orthodox.*

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*Resplendent icons of saints oversee Mass at the restored 15th-century Assumption Cathedral in Moscow's Kremlin. Historic seat of the Russian Orthodox Church, where emperors once*

*worshipped, the cathedral became a museum during the communist era. The revitalized faith remains conservative, with the liturgy still recited in Old Church Slavonic.*

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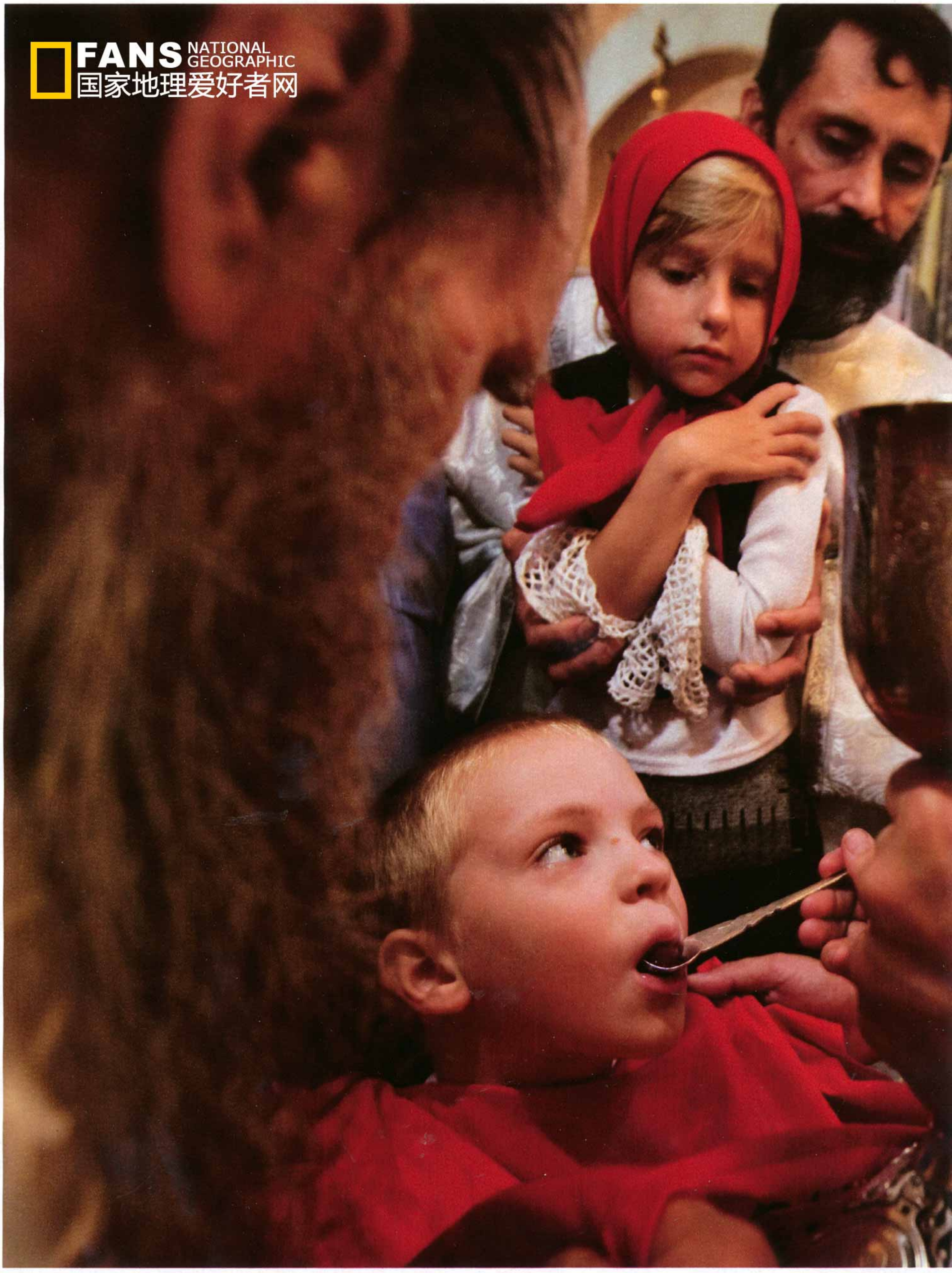

*Tending his flock, Father Sergiy gives Communion to a child at Znamensky Cathedral in Tyumen. As many as 50,000 clergy were executed and countless others jailed and defrocked*

*during more than seven decades of persecution. Today so many Russians have thronged to the priesthood that some clergy worry that many lack spiritual seasoning.*

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BY SERGE SCHMEMANN
PHOTOGRAPHS BY GERD LUDWIG

*Prime Minister Vladimir Putin kisses the body of Patriarch Alexy II, a favored ally, at his funeral last December at the Cathedral of Christ the Savior in Moscow. Alexy's successor, Metropolitan Kirill (in white crown), stands close. Putin has called the church as vital to Russia's security as its nuclear shield.*

The new Russia steadily ebbs away on the drive out of Moscow. The gridlock and pollution, the sprawling malls and billboards of the recent boom years give way to the gray suburbs and rusting factories of the Soviet era. These in turn fade into tall forests of pine and birch, punctuated by meadows and timeless villages of log houses. Now and again a whimsically painted steeple breaks the horizon, its gilded cupola glittering in the bright spring sun. We're back in the *glubinka,* the "deep" Russia beloved of Slavophiles, exiles, and painters. And we're headed for its very heart.

Our destination is Murom, among the most ancient of Russian cities. Arrayed on seven hills along the left bank of the Oka River, Murom was a proud sentinel on the eastern periphery of ancient Rus in medieval times, before the empire stretched on, leaving behind a poor provincial town rich in monasteries, memories, and myths. Soviet rulers tried to suppress many of these, and part of the story of Russia today is the effort to reconnect with the past. Out here, part of that past is also mine.

Four centuries ago, a pious young woman arrived here as the wife of a "husband of good birth and prosperous." Despite a life of extraordinary trials—a husband ever away at war, the birth of 13 children and the death of 8, the famines, plagues, invasions, and banditry of what history calls the Time of Troubles—Juliana Osorin remained steadfast in her charity and faith. After her death in 1604 she was canonized by the Russian Orthodox Church as St. Juliana of Lazarevo, after the village outside Murom where she lived. Her canonization was intended to persuade a people in panic and despair that holiness could be achieved in the home and family, not only through escape to a monastery. My mother, born Juliana Ossorguine, is her direct descendant and namesake.

I had been to Murom before, when Russia was emerging from another time of troubles. It was March 1992. The ice on the Oka was melting, and everywhere there was a sense of new beginnings. I had been the *New York Times*

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bureau chief in Moscow during the last years of the Soviet state, in the 1980s, and I was back to report on the collapse of communist rule and the rise of a new Russia.

It was a giddy and chaotic period, a time of confusion and great hopes—for democracy, economic freedom, and perhaps most of all, for spiritual revival. The Russian Orthodox Church was rising everywhere from the ashes of the Soviet era, and millions of Russians were rushing to be baptized. Most were only dimly aware of the religious significance of the sacrament but eager to reclaim a past and an identity that the communists had for 75 years worked to erase.

Thousands of ruined churches—including those the Soviets had used as warehouses, factories, or barns—were being restored to their original function, and eventually to their former splendor. The monumental Cathedral of Christ the Savior, destroyed on Stalin's orders in 1931, rose anew on the banks of the Moscow River. Believers who had gone underground during Soviet times emerged and began energetically establishing parishes, orphanages, halfway houses, and schools. Thousands of men were ordained to the priesthood, and thousands more—men and women—took monastic vows, all yearning to recover a guiding faith.

For almost a thousand years the Orthodox Church, with its magnificent liturgy and iconography, had been an integral part of Russian identity and history. I was Russian enough

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*Serge Schmemann is the author of* Echoes of a Native Land: Two Centuries of a Russian Village. *Gerd Ludwig frequently covers Russia for the* Geographic.

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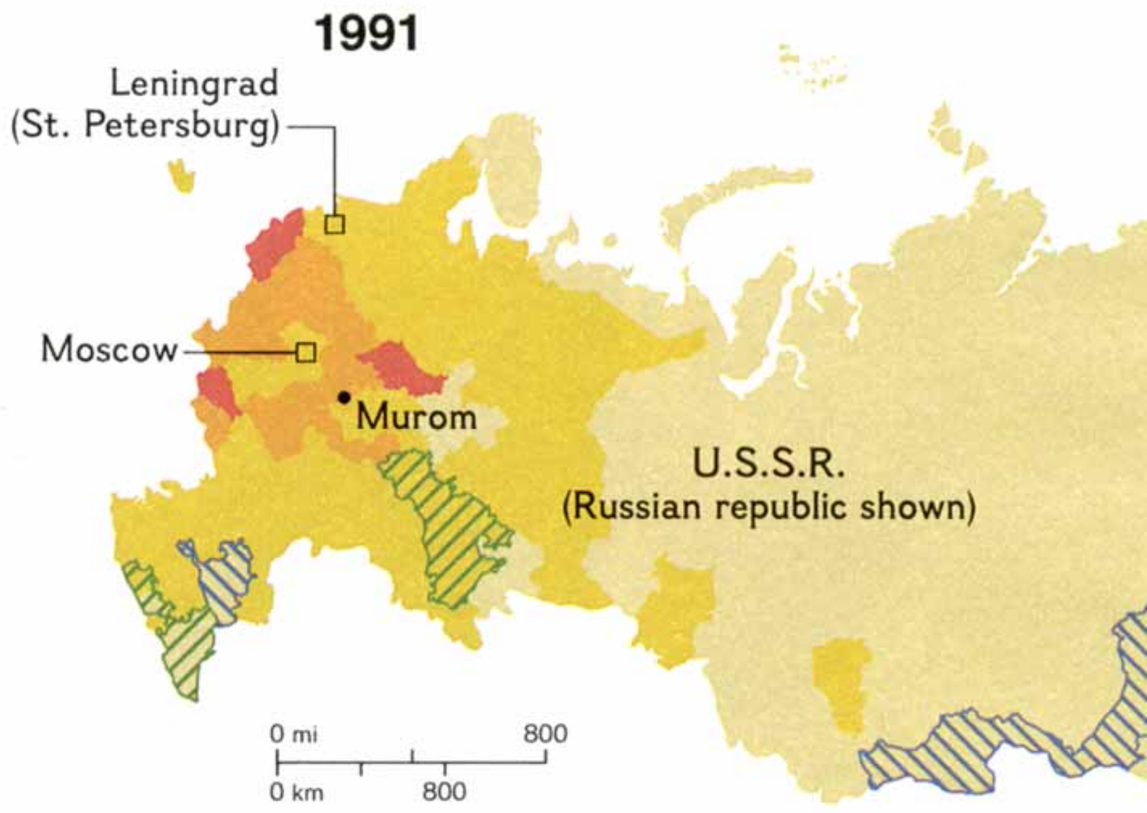
to feel profoundly moved that the faith of my ancestors was coming alive again. At the same time, as a Western reporter, I wondered where this plunge into the past, often idealized and dimly perceived, could lead. Would the Orthodox Church become a potent force for reform, speaking truth to the Kremlin's power? Or would it resume the role it had played over centuries of tsarist rule and again become an ornament and tool of an authoritarian state?

These questions concerned not only the church; the future shape of Russia was at stake. As Russia scholar James H. Billington, now librarian of Congress, wrote a few years after the collapse of the Soviet Union: "Whether the Orthodox Church can wrest itself from the state and become the conscience of the nation will be important in determining whether Russia can discover a new, democratic and civil culture or will return to a dark and threatening authoritarianism." Since then, the darker scenario has seemed to play out, with church leaders allying themselves with an aggressive, antidemocratic Kremlin. But as I returned to Murom last year, I wondered if something of St. Juliana's charity and piety lives on in the revived church.

I also had reason to think that an open and questioning spirit may have taken root among some believers. My father, the Reverend Alexander Schmemann, an Orthodox priest and theologian who, like my mother, was born of Russian émigrés, had been well-known among dissidents and intellectuals in the Soviet Union for his books and his broadcasts over Radio Liberty, which the U.S. government beamed behind the Iron Curtain. Both thoroughly Russian and proudly Western, he lived most of his life in the United States and dedicated much of it to stripping his faith of its ethnic crust and focusing on its universal message. In 2005 the diaries he kept from 1973 until his death in 1983 were published in Russia. To my astonishment, they became an instant sensation among many Russian believers and thinkers. Why, I wanted to learn, were the thoughts of a Western priest resonating so powerfully?




## Reviving a Church

The number of people claiming a religious affiliation, which had begun to creep upward in western Russia, surged after the communist collapse in 1991. By 2004 (map at right) communities of the dominant Russian Orthodox Church had more than tripled in number. Other faiths, including Islam and several branches of Protestantism, also expanded their reach.

THE MUROM I RETURN TO is little changed. Some nightclubs, ATMs, service stations, and billboards, to be sure, but whatever wealth seeps out of Moscow seems to stop somewhere short of here. There's still no permanent bridge over the Oka, only a pontoon bridge in summer. The potholes are still treacherous, and the old wooden houses are weathered and listing. There is one dramatic change, however: The monasteries and churches on the high bluff above the river now gleam in restored grandeur.

Dating to the late 11th century, Spassky Monastery is one of the oldest in all of Russia. The army used it as a barracks until 1995, leaving behind a sad and stinking ruin. The Russian Orthodox Church assigned a dynamic priest, Father Kirill Epifanov, to resurrect the historic religious center. He began by building a bakery

to sustain his handful of monks. Then, finding funds and labor where he could, he rebuilt the churches and restored the grounds. The results are stunning: Busloads of pilgrims arrive to marvel at the medieval splendor. The immaculate grounds include an aviary with peacocks, and the thriving bakery fills the air with the aroma of freshly baked bread.

Spassky is but one of hundreds of monasteries revived in the thaw that began with Mikhail Gorbachev's perestroika in the late 1980s. In 1987 there were only three monasteries in Russia; today there are 478. Then there were just two seminaries; now there are 25. Most striking is the explosion of churches, from about 2,000 in Gorbachev's time to nearly 13,000 today. The Russian Orthodox Church has grown into a sprawling institution, with dozens of publishing houses and hundreds of thriving journals, newspapers, and websites.

When I meet him, Father Kirill has just returned from a pilgrimage to the Eastern Orthodox monasteries of Mount Athos in Greece. A large man with a room-filling voice and a broad black beard, he distributes gifts to his monks like a loving but stern parent. Always on the move, with his cassock swirling around him, he seems the model leader the reviving church needs—a pastor and manager bristling with energy, enthusiasm, and faith. Yet over tea in his vaulted study, Father Kirill is subdued.

Raising money and restoring buildings is the easy part, he says. The pilgrims? Most are "religious tourists" who come to accumulate totems. Even the monks are here today, off to another monastery tomorrow. The church still has

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*Pious in the extreme, a parishioner gasps after plunging into a cross-shaped hole cut into Lake Shartash for the Feast of the Epiphany. In Russian Orthodox tradition, the January feast*

*day celebrates the baptism of Jesus in the Jordan River. A popular folk belief holds that swimming in the icy, priest-blessed water protects the faithful from evil.*

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no real communal life, no true spiritual revival.

"The Soviet regime was the product of faithlessness, but at least it allowed real believers to live the flame of faith," he says. "Today we are more concerned with fighting sects and 'enemies' than with repentance. These forces are tearing the church from within."

Many of the people who rushed to be baptized in the first flush of freedom ended their religious involvement right there, he says. Other priests and believers voice similar laments about the decline of interest in the faith among the Russian rank and file, as well as the slide of the official church toward xenophobia and nationalism.

Figures on church attendance are sketchy, since the Russian Orthodox Church keeps no membership rolls or parish registers. According to Nikolai Mitrokhin, a historian and critic of the church, about 60 percent of Russians today identify themselves as Orthodox—they may be baptized, married, and buried in the church—but less than one percent actually enter a church at least once a month. Other sources put the figure closer to 10 percent. One reason for the sparse attendance may be that the Orthodox Church is not entirely friendly to people who are casual or clueless about its hallowed traditions—as I discover in Murom.

The relics of St. Juliana now repose in the bright yellow Church of St. Nicholas on the Embankment, perched precariously on a steep bluff. As I enter to pay my respects, two babies are being christened. The portly priest, sweaty and impatient with the young parents and godparents, shows less interest in making the rite

# Obedience and ritual have ruled THE RUSSIAN CHURCH

**SINCE 988, WHEN PRINCE VLADIMIR ORDERED HIS PEOPLE TO BE BAPTIZED IN THE DNIEPER RIVER.**

***Covering a penitent's head with his stole, Father Rafail hears confession in the open at his makeshift church in Vorkuta. Children readily confess to disobeying their parents, a legacy, the father claimed, of the Soviet past, "when ideology was put higher than a parent's will."***

understandable than in getting it over with.

"Come on, come on, undress them," he barks. "How can I put them in the water like this? Let him hold the candle. No! In the right hand! What are you doing?" The babies scream, the cameras flash, the parents fuss, and soon the baptisms draw to a close.

On the other side of the church, a middle-aged woman with a white kerchief tied fiercely around her head berates me for photographing the relics of St. Juliana. "Did the priest bless you to take photographs?" she demands. "Photographing without a blessing will only bring evil!"

I recognize her kind from my years in the Soviet Union. There were always women like her in the few churches that were open in those days, women who scrubbed the floors, tended the candlestands, and stood through all the services when Soviet disapproval had frightened off everyone else. In a sense, they nursed the church through its long incarceration. They were the custodians of propriety and custom: Stand like this! Face the altar! Cover your head! Cross yourself! They were insufferable, but the church owes them a great debt. So I do what other Russians do when confronted by these vigilantes: I meekly bow and put away my camera.

Obedience and ritual have ruled the Russian Church ever since the pivotal day in 988 when Prince Vladimir, ruler of Kievan Rus, ordered his people to be baptized in the Dnieper River. According to the legend familiar to every Russian, Vladimir had sent envoys abroad in search of a faith for his pagan nation. Those dispatched to Constantinople returned home awestruck by the Eastern Greek ritual they had witnessed in the Hagia Sophia, then the largest cathedral in the world. "We knew not whether we were in heaven or on earth," they reported.

The religion imported by Prince Vladimir shaped the Russian nation and was, in turn, shaped by it. Orthodox monasteries became the spiritual, economic, cultural, and at times, defensive core of the nation. The churches that spread through Russia were awe-inspiring in their magnificence and immutable in their ritual. To this day the language of the church is an archaic but mellifluous Old Church Slavonic. Priests in their glittering vestments are separated from the congregation by an elaborate icon screen, and choirs sing most of the liturgy, often with hymns by Russia's greatest composers. For worshippers, the experience is as otherworldly as a Baptist service is direct and unadorned.

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On my first visit to Murom, in 1992, I stood in wonder before the reliquary of St. Juliana, who was then ensconced in a just reopened cathedral. Alongside were the reliquaries of two 12th-century princes, St. Constantine of Murom and his son St. Michael. Constantine had come to what was then a hinterland to plant his religion and his rule. This was the ancient narrative of Russia: righteous warrior-princes who spread the Orthodox Kingdom, and tireless workers of the church who sustained it through times of crisis. Over the centuries Russians came to perceive themselves as a people with a unique spirituality and mission, as "Holy Russia."

THE INTIMIDATING GRANDEUR of Holy Russia was much in evidence at the Moscow residence of Patriarch Alexy II, the late leader of the Russian Orthodox Church. Hushed clerics in black cassocks referred only to "His Holiness." Huge oil canvases on the dark paneled walls depicted epic events in Russia's religious history. Acolytes instructed visitors where to stand when His Holiness entered the room.

But the patriarch entered with a smile and a hearty greeting (we had met several times in the early 1990s). He rang for tea and solicitously recommended the chocolates. Although he suffered from heart and respiratory problems that would prove fatal in less than a year, Alexy was still robust and active for a man of 79. "After my illness I officiate at services a bit less, but I still serve 150 times a year," he told me. Then, with a twinkle in his eye: "Doctors who measure my blood pressure say it's a bit high before a service, but always normal afterward."

Alexy presided over the Russian Orthodox Church from its rebirth in 1990 until his death

***Praying that the cross will replace the swastika in a young criminal's heart, Father Oleg (in gold) gathers inmates for baptism at a juvenile prison in Bogandinskoye —part of the church's renewed social outreach effort. "Many had not heard of the Bible," Father Oleg said.***

in December 2008. His story is the story of the church and its struggle with the state. Born in Estonia in 1929 to a family of Russian émigré nobility, Alexy served as a priest and bishop for 40 years under a Soviet regime that reduced the church to a barely tolerated "cult" and compelled "servers of cult" to play a constant, humiliating game of collusion and deception. Alexy never denied that he cooperated with the state "organs," but he insisted that everything he did was to safeguard the essential functions of the church. "In the most difficult days of repression the church did not flee into the catacombs," he said. "It sustained the sacraments, the prayers."

Alexy made it his personal mission to identify the "new martyrs and confessors"—the victims of communist persecution who, in the eyes of the church, died for their Christian faith. He set aside the fourth Saturday after Easter for a special service to commemorate at least 20,000 "enemies of the Soviet state" who, at the height of the Great Purge of 1937-38, were shot and buried in mass graves just south of Moscow.

There I joined thousands of Muscovites as the patriarch, along with scores of bishops and hundreds of priests, celebrated the Divine Liturgy. Some people pushed lit candles into the grassy mounds that now cover the trenches where the victims were felled and buried. A modest billboard displayed photographs of some who died here: a bearded monk, a tousled peasant, a Jewish woman, a student—their eyes either wide in horror or half-closed in surrender. A chart chronicled the numbers killed day-by-day, month-by-month. December 10, 1937: 243 executed. Total for the month: 2,376. May 28, 1938: 230. Total for the month: 1,346.

There has been some grumbling that the church has singled out its own for honor when so many others were killed. Indeed, the thousand bishops, priests, deacons, and nuns who died here lie alongside Bolsheviks, monarchists, Trotskyites, accused counterrevolutionaries, Jews, German communist refugees, kulaks, "social misfits," and even Moscow's Chinese launderers, all caught up in Stalin's orgy of death.

But Patriarch Alexy was resolved: "We are now returning to our history. We have to remember it." He talked as if those long dead were his brothers and sisters: "Can you imagine? Archimandrite Kronid, the last deputy abbot of the Trinity–St. Sergius Lavra, was 83! They brought him out on a stretcher and shot him!"

The hatred for clerics that burned among communist revolutionaries was fueled by a fact of history. For centuries the Russian Orthodox Church had served as a handmaiden of the tsars. The emperor was head of the church, and all awards, promotions, and appointments passed through the imperial court.

In 1990 Alexy became the first patriarch since the Russian Revolution to be elected without the direct interference of the government. "We have managed to establish an entirely new relationship with the state," he said, "one which never existed before." He insisted the church had no

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*Judgment day arrives at Novo-Tikhvinsky cloister when Father Abraham sits down to critique icons painted by resident nuns. If the icon of St. Peter, keys to heaven in hand, is to pass his*

*test, the father said, "anyone looking at it must want to pray." Reviving a tradition that almost died during Soviet times, sisters train for as long as a decade to excel at the art.*

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intention of becoming a state church, noting that he banned his clergy from elected office.

But critics argue that Alexy and other senior prelates have been all too happy to accept the trappings of a state church and have done little to resist the Kremlin's drift into authoritarianism. Although the Russian Constitution calls for the separation of church and state, Russia's three post-Soviet presidents—Boris Yeltsin, Vladimir Putin, and Dmitry Medvedev—have made regular, well-publicized appearances in church, and Orthodox bishops and priests are fixtures at state functions.

This closeness has fed an impression abroad that the Orthodox Church has teamed up with the Kremlin to create a new Russian autocracy. Church officials deny this. They cite a host of differences and unresolved disputes between the church and the government, from control over religious antiquities to religious education. If the church and state are intertwined, they say, it is in a profound and complex search for a new, post-Soviet identity. In that search Russia's imperial history offers only a partial template, and the final result is far from certain.

Still, the Orthodox Church's favored status often works to the detriment of other denominations and faiths—especially those perceived, rightly or wrongly, as Western.

ON THE FRINGES of the southern city of Rostov-on-Don, Alexander Kirillov unlocks the gate to a large Baptist church that his community recently finished building. The authorities, the elder says, seized on a bureaucratic glitch—failure to submit an annual form—and shut down the association to which the church belongs.

*Above the Arctic Circle, a church rises for the first time in the former gulag city of Vorkuta. Father Rafail (left) hopes believers will fill its spaces, though church attendance remains low in Russia, with less than 10 percent of the population considered regular worshippers.*

# If the church and state are intertwined, IT IS IN A PROFOUND SEARCH FOR A NEW, POST-SOVIET IDENTITY, AND THE FINAL RESULT IS FAR FROM CERTAIN.

"We're at fault, of course. But they could just as easily have sent us a notice reminding us to file it." The real reason for the ban, he says, is that his church doesn't belong to the mainstream Baptist group sanctioned by the government.

"They're not used to the fact that there are denominations other than the 'official' ones, so they don't think we have the right to exist," Kirillov says. "The Orthodox Church is the dominant denomination, so of course they are represented in every sphere of authority. I watch the news: They open a new artillery institute, new entrants are arriving, and there's an Orthodox priest. Why?"

One reason traces back to the early post-Soviet years, when the euphoria of freedom gave way to disillusionment with the consumerism, corruption, and chaos that followed. Reactionaries in the government and the church accused the West of deliberately humiliating Russia, fueling suspicion of denominations and groups with ties to liberal democracies. In right-wing circles, the call went out for Holy Russia to return to her roots.

Some astoundingly dark and retrograde notions openly circulate in reactionary churches and on nationalist websites. One is a drive to canonize Rasputin and Ivan the Terrible, two of the more noxious characters of Russian history who have been reinvented by extremists as "defenders of Holy Russia."

Outside St. Petersburg, the decaying summer palaces of old Russia's tsars and grand dukes overlook the Gulf of Finland. Behind the ruins of one such palace stands a tiny, half-restored chapel. Inside I come face-to-face with a spectacle that makes me gasp—a large icon of Joseph Stalin. He's not wearing the halo of a saint, but a saint is blessing him.

The icon depicts a legend in which Stalin, at the outbreak of World War II, secretly visits St. Matryona of Moscow, a blind and paralyzed woman to whom many people came for spiritual guidance until her death in 1952. According to the legend she counseled the Soviet dictator not to flee Moscow before the invading German Army, but to stand firm against the onslaught.

The chapel's pastor, Evstafy Zhakov, is a fiery nationalist highly regarded by his flock for his charismatic sermons. In an interview with the right-wing newspaper *Zavtra,* he defended the icon by explaining that Russia has a long tradition of saints blessing warriors before battle.

"But Stalin was an atheist," the interviewer interjected.

*The weight of ritual intensifies on Easter Sunday, holiest day on the Orthodox calendar, as parishioners in Vorkuta collect banners and icons for a procession through town before*

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*midnight Mass. Celebrants plan to walk three miles to their new church's construction site, circle it once, and join in a service that requires them to stand for hours—until dawn.*

"How do you know?" Father Evstafy retorted. Two wartime patriarchs proclaimed Stalin a believer, "and I will believe them before I believe all these liberals and democrats."

WHILE IN SOME DARK CORNERS of the church priests such as Father Evstafy recast mass murderers as champions of Holy Russia, many mainstream pastors pursue a more enlightened agenda: rehabilitating drug abusers, rescuing neglected children, and extending Christ's forgiveness to criminals.

In a brightly lit foster home in St. Petersburg, four-year-old Nikita shows me his toys and proudly tells me that his mama will soon give him a gift. He doesn't yet understand that he has just been placed in this home because his mother is a drug addict—a fast-growing blight in Russia—and she can no longer care for him.

Father Alexander Stepanov has been caring for castoffs ever since he left a job in physics to join the priesthood some 20 years ago. "I was ordained right into prison," he quips, recalling how he started his ministry by discussing the Bible with inmates. "I had no idea about that world of gold teeth and tattoos."

All private humanitarian work had been strictly banned in the Soviet Union—social problems don't exist in a workers' paradise—but after the collapse of communism, Father Alexander found no shortage of people willing to plunge in, and Western churches were quick to offer help. Today, working out of two restored buildings on St. Petersburg's waterfront, Father Alexander oversees a parish church, a foster home, an orphanage, a halfway house for teenagers in trouble, and a corps of volunteers who visit hospitals and prisons. He also has a radio station in the attic, and the offices of a summer camp in the basement. No space is wasted, and no time—his cell phone rings (to the tone of church bells) repeatedly.

Many churches now have some form of outreach, and there are plenty of volunteers, Father Alexander says. But the government is jealously seeking to reclaim its monopoly on social work. "The government doesn't want to support the social initiatives of the church," he says sadly. "It forces us to beg for scraps."

In offering little or no resistance to the "dark and threatening authoritarianism" James H. Billington warned of 15 years ago, the church has failed a crucial test. Yet no one who has witnessed the enormous love and labor that has gone into restoring churches and reviving charitable work can doubt that something good and promising has also awakened in Russia.

As I walk through an orphanage in St. Petersburg or a restored monastery in Murom, I am amazed at the mere fact that a religion so ruthlessly repressed for so long has been born anew. And I begin to understand why my father's diaries have had such resonance among many Russians. The journal he kept for the last ten years of his life was a voyage through the ideas, books,

***Painted eggs and iced sweet breads await a priest's blessing at Easter daybreak in Vorkuta. For many Russians awakening to their country's traditional faith, the attraction is nationalistic. But among the deep believers, said a clergyman, "their souls long for spiritual food."***

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discoveries, struggles, and joys of an Orthodox believer and priest. He endured many of the same frustrations and sorrows Russians have known in this latest time of troubles, yet however tough the battle—even his final battle with cancer—he, like St. Juliana, accepted them as the norm of a Christian life. That was the heart of it: In this Western priest's daily life and thought, the Russians found an affirmation that their own doubts and frustrations and confusion were not wrong, that they were, in fact, normal, as long as they remained steadfast in faith and charity.

IT'S SUNDAY MORNING in Murom, and I wake early to the tolling of church bells. Pilgrims are gathering in the monastery, but Father Kirill's kindly housekeeper offers to drive me to Lazarevo, St. Juliana's village. The old church where she worshipped has finally been reopened.

We drive past abandoned Soviet military factories to a muddy cluster of wooden houses around the large, battered church, still undergoing restoration. Piles of bricks and bags of cement are stacked by the walls, and the door is reached over a bridge of wobbly boards. Inside, a modest icon screen has been set up at one side altar; on the other side rests an icon of Juliana.

Two dozen local people, most of them women, gather for the Sunday liturgy. There is no fuss, no politics, no soul-searching, just a quiet appeal to a modest woman who lived, prayed, and suffered here, much as they have: "O blessed one, intercede also for the Russian land, and for all who are in dispersion, that they may receive peace and prosperity, and all the more return to thine ancient piety...." □

# THE VANISHING

We are witnessing a mass extinction. An exotic fungus is delivering the fatal blow to many amphibians already hit by habitat loss, pollution, and climate change. But unprecedented research and rescue efforts may offer a lifeline to species on the edge.

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BY JENNIFER S. HOLLAND
PHOTOGRAPHS BY JOEL SARTORE

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SURO STREAM FROG · *Hyloscirtus pantostictus*
At Pontificia Universidad Católica del Ecuador
UP TO 2.5 INCHES · SOUTH AMERICA · ENDANGERED

Far from civilization, mountain yellow-legged frogs high in California's Sierra Nevada are dying in droves. The culprit: amphibian chytrid fungus, which first appeared here in 2004 and has since wiped out tens of thousands of animals.

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HE GRIPS HIS MATE, front legs clasped tight around her torso. Splayed beneath him like an open hand, she lies with her egg-heavy belly soaking in the shallow stream. They are harlequin frogs of a rare *Atelopus* species, still unnamed and known only in a thin wedge of the Andean foothills and adjacent Amazonian lowlands. The female appears freshly painted—a black motif on yellow, her underside shocking red. She is also dead.

Above this tableau, at the lip of the ravine, a bulldozer idles. Road construction here, near the town of Limón in southeastern Ecuador, has sent an avalanche of rocks, broken branches, and dirt down the hillside, choking part of the forest-lined stream. Luis Coloma steps gingerly over the loose rocks, inspecting the damage to the waterway. The 47-year-old herpetologist is bespectacled and compact in a yellow shirt dotted with tiny embroidered frogs. He hasn't bothered to roll up his khaki pants, which are soaked to the knees. Poking a stick into the debris, he says, "They have destroyed the house of the frog."

Frogs and toads, salamanders and newts, wormlike (and little-known) caecilians—these are the class Amphibia: cold-blooded, creeping, hopping, burrowing creatures of fairy tale, biblical plague, proverb, and witchcraft. Medieval Europe saw frogs as the devil; for ancient Egyptians they symbolized life and fertility; and for children through the ages they have been a slippery introduction to the natural world. To scientists they represent an order that has weathered over 300 million years to evolve into more than 6,000 singular species, as beautiful, diverse—and imperiled—as anything that walks, or hops, the Earth.

Amphibians are among the groups hardest hit by today's many strikes against wildlife. As many as half of all species are under threat. Hundreds are sliding toward extinction, and dozens are already lost. The declines are rapid and widespread, and their causes complex—even at the ravine near Limón the bulldozer is just one hazard of many. But there are glimmers of hope. Rescue efforts now under way will shelter some animals until the storm of extinction passes. And, at least in the lab, scientists have treated frogs for a fungal disease that is devastating populations around the world.

In Quito, Coloma and his colleague Santiago Ron have established a captive-breeding facility for amphibians at the zoological museum at Pontificia Universidad Católica del Ecuador. They admit it's a drop in the pond, offering safe harbor to a select few in hopes of stemming national losses. The facility houses just 16 species, although Ecuador is home to more than 470. And that's just what's on the books. Despite heavy deforestation across this country, every year new species are discovered. Coloma's lab has about 60 recently discovered species still

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*Jennifer S. Holland is a senior writer for* National Geographic. *Joel Sartore is a frequent contributor to the magazine, often photographing threatened species.*

BOREAL TOAD
*Anaxyrus (Bufo) boreas*
At the Cheyenne Mountain Zoo, Colorado
UP TO 5 INCHES · WESTERN UNITED STATES · DECLINING

COMMON FIRE SALAMANDER
*Salamandra salamandra*
At the St. Louis Zoo, Missouri
UP TO 10 INCHES · EUROPE · DECLINING

Scientists in Ecuador's Andes test an *Atelopus* frog for chytrid fungus (result: positive). The frog's breeding stream was clogged with construction debris. Forest clearing, aridity, and infectious disease are proving a lethal mix for a host of species in the amphibian-rich Southern Hemisphere.

*OOPHAGA SYLVATICA*
At Pontificia Universidad Católica del Ecuador
UP TO 1.5 INCHES · SOUTH AMERICA · DECLINING

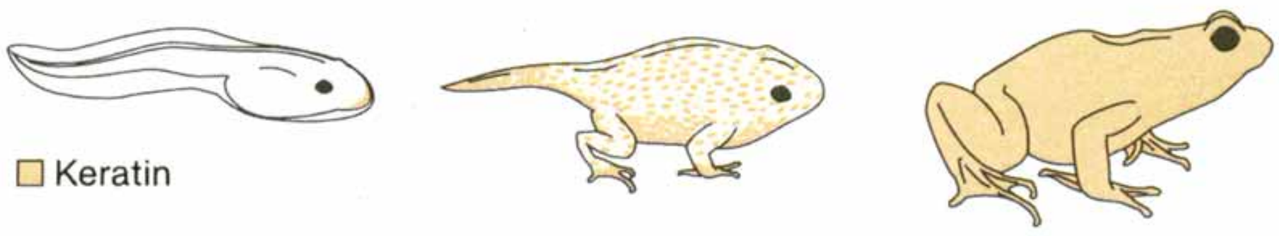
*PRISTIMANTIS* SP.
At Reserva Las Gralarias, Ecuador
UP TO 2 INCHES · ECUADOR · STATUS UNKNOWN

GOLDEN POISON FROG
*Phyllobates terribilis*
At Rolling Hills Zoo, Salina, Kansas
UP TO 2 INCHES · COLOMBIA · ENDANGERED

**By 2000, teams were grabbing up animals to stash them away—at zoos, at hotels, anywhere space could be carved out.**

awaiting scientific names—enough to keep ten taxonomists hard at work for a decade.

Coloma and Ron, who have also initiated land purchases for habitat protection, hope to add room at the captive facility for more than a hundred species. But the pool of wild animals is shrinking fast. Where field scientists once had to watch their step to avoid crushing frogs moving in mass migrations, now counting a dozen feels like a victory. "We're becoming paleontologists, describing things that are already extinct," Ron says. At the Quito lab the evidence is stacked high. Coloma holds up one jar from a cabinetful. Two pale specimens bob in alcohol. "This species," he says, his face distorted through the glass, "went extinct in my hands."




**The protein keratin** is the target of chytrid fungus. Frogs have more of it than tadpoles, making them more vulnerable to infection.

IT'S NO WONDER some view our time on Earth as a mass extinction. Biodiversity losses today have reached levels not seen since the end of the Cretaceous period 65 million years ago. Yet amphibians were able to hold on through past extinction spasms, surviving even when 95 percent of other animals died out, and later when the dinosaurs disappeared. If not then, why now?

"Today's amphibians have taken not just a one-two punch, but a one-two-three-four punch. It's death by a thousand cuts," says University of California, Berkeley, biologist David Wake. Habitat destruction, the introduction of exotic species, commercial exploitation, and water pollution are working in concert to decimate the world's amphibians. The role of climate change is still under debate, but in parts of the Andes, scientists have recorded a sharp increase in temperatures over the past 25 years along with unusual bouts of dryness.

But a form of fungal infection, chytridiomycosis (chytrid for short), often administers the coup de grâce. It did for the mating pair in the Limón stream. Both animals tested positive for chytrid fungus, and the male died soon after the female.

Chytrid was wiping out amphibians in Costa Rica back in the 1980s, although no one knew it at the time. When frogs started dying in big numbers in Australia and Central America in the mid-1990s, scientists discovered the fungus was to blame. It attacks keratin, a key structural protein in an animal's skin and mouthparts, perhaps hampering oxygen exchange and control of water and salts in the body. African clawed frogs, exported widely for pregnancy tests beginning in the 1930s, may have been the initial carriers of the fungus. "It's amazing we haven't seen even more population crashes, the way we shuffle things all over the world, complete with pathogens," notes Ross Alford of Queensland's James Cook University.

Chytrid is now reported on all continents where frogs live—in 43 countries and 36 U.S. states. It survives at elevations from sea level to 20,000 feet and kills animals that are aquatic, land-loving, and those that jump the line. Locally it may be spread by anything from a frog's legs to a bird's feathers to a hiker's muddy boots, and it has afflicted at least 200 species. Gone from the wild are the Costa Rican golden toad, the Panamanian golden frog, the Wyoming toad, and the Australian gastric-brooding frog, to name a few. Some scientists play down the importance of any single factor in overall declines. But in a 2007 paper, Australian researcher Lee Berger and colleagues, who first laid blame on the fungus, put it this way: "The impact of chytridiomycosis on frogs is the most spectacular loss of vertebrate biodiversity due to disease in recorded history."

It's been a time of desperate measures. For example, after Southern Illinois University researcher Karen Lips and colleagues reported

MARIEL FURLONG, NG STAFF. SOURCES: LEE BERGER AND RICK SPEARE, JAMES COOK UNIVERSITY

fungus-related declines in Costa Rica and Panama in the late 1990s, they began mapping chytrid's path and predicting its victims. By 2000, teams were grabbing up animals from the most vulnerable species to stash them away—at zoos, at hotels, anywhere temporary space could be carved out for stacks of aquariums. Sick frogs were treated and quarantined. Many were exported (with much political wrangling) to U.S. zoos, while a Panamanian facility was built to house nearly a thousand animals. So began the Amphibian Ark, a growing international venture aimed at keeping at least 500 species in captivity for reintroduction when—if—the crisis is resolved. But the task is immense and expensive, and there's no guarantee how many healthy wild places will be left for amphibians to recolonize.

THE TROPICS, where conditions foster high amphibian biodiversity, have seen the most dramatic declines. But more temperate climates haven't been spared. Consider the cold, upper reaches of the Sierra Nevada of California. Here,

## Chytrid on the March

Global data reveal the alarming reach of amphibian chytridiomycosis, first reported in the wild in Australia, but likely originating in Africa.

**In Central America** (above) the fungus has moved like a wave—spreading up to 27 miles a year. In 2008 it jumped the Panama Canal, putting that country's eastern amphibian populations in the line of fire.

NGM MAPS

CENTRAL AMERICA DATA: KAREN R. LIPS, SOUTHERN ILLINOIS UNIVERSITY.
CHYTRID SAMPLING DATA: DEANNA H. OLSON AND KATHRYN L. RONNENBERG, U.S. FOREST SERVICE; MATTHEW C. FISHER, IMPERIAL COLLEGE, U.K.

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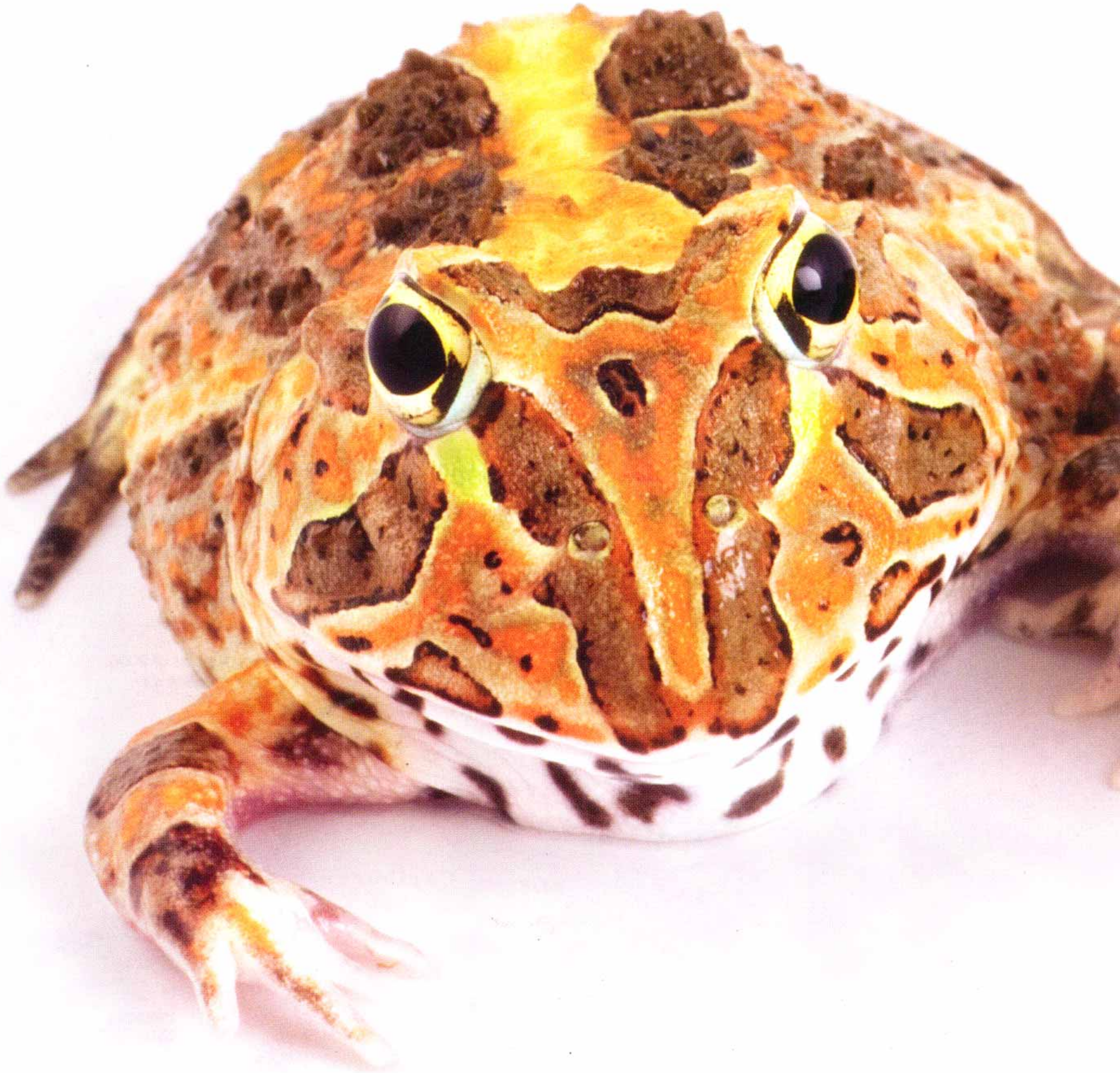

In the wild, Pacific horned frogs breed explosively during good rains and burrow underground most other times. Conversion of scrub and sandy habitat for agriculture is reducing frog numbers, but now the species is reproducing in captivity for the first time.

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PACIFIC HORNED FROG · *Ceratophrys stolzmanni*
At Pontificia Universidad Católica del Ecuador
UP TO 3 INCHES · ECUADOR AND PERU · VULNERABLE

A display of species deemed “likely extinct” illustrates Ecuador’s profound loss of biodiversity in recent years. “It is a disaster,” says herpetologist Luis Coloma. One step forward: The country’s new constitution protects natural resources, which could lead to fewer specimens under glass.

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Captivity is the last resort for *Gastrotheca pseustes* (above) and 15 other endangered species, more than 900 individuals total, at Pontificia Universidad Católica in Quito. A staff of seven, a few volunteers, and about $100,000 a year now support the breeding facility. Expansion plans will beg more funds.

ORNATE HORNED FROG
*Ceratophrys ornata*
At the Tennessee Aquarium, Chattanooga
UP TO 4 INCHES · SOUTHERN SOUTH AMERICA · DECLINING

REINWARDT'S TREE FROG
*Rhacophorus reinwardtii*
At the Knoxville Zoo, Tennessee
UP TO 2.5 INCHES · ASIA · DECLINING

MARSUPIAL FROG
*Gastrotheca pseustes*
At Pontificia Universidad Católica del Ecuador
UP TO 2.5 INCHES · ECUADOR · ENDANGERED

at 11,000-foot-high Sixty Lake Basin, stands a stark paradise of granite towers made famous through the lens of Ansel Adams, where alpine lakes once roiled in summer with hearty frog populations. The most common species is the mountain yellow-legged frog—subtly pretty, tinged yellow on torso and limbs, spotted brown and black. But recently this palm-size frog has been hard to find.

A slender man with a camper's stubble and a soft demeanor squats at the side of pond number 100, bordered by stoic rock walls and edged with pink mountain heather and tangled grasses. Vance Vredenburg is a biologist at San Francisco State University, and he's been studying the mountain yellow-legged frog for 13 years, slumming in a tent on the mountainside for weeks at a time as he monitors 80 different study lakes. Today, mosquito net balled up around his neck, he contemplates ten dead frogs, stiff-legged, white bellies going soft in the sun.

"It wasn't long ago when you walked along the bank of this pond," he recalls, "a frog leapt at every other step. You'd see hundreds of them alive and well, soaking in the sun in a writhing mass." But in 2005, when the biologist hiked up to his camp anticipating another season of long-term studies, "there were dead frogs everywhere. Frogs I'd been working with for years, that I'd tagged and followed through their lives, all dead. I sat down on the ground and cried."

Vredenburg's biggest remaining study population, in pond number 8, has about 35 adults. Most of the rest of the animals he's known in this place are gone. What happened here is the perfect example of those multiple punches—a case study of how a thriving species can get knocked to its knees.

It started with the trout.

Until the late 19th century, the Sierra Nevada was mostly fishless above the waterfalls. But state policy of fish stocking eventually climbed to the high Sierra to transform those "barren" lakes into a fisherman's paradise. The California Department of Fish and Game began sending trout up the cliffs, first in barrels on muleback, and by the 1950s in the bellies of airplanes. (The planes would fly over the water and let drop their living cargo, much of which missed its mark and was left flopping on dry land.) All told, more than 17,000 mountain lakes were stocked.

As it turns out, trout eat tadpoles and young frogs. As trout multiplied, frogs disappeared.

Vredenburg's work in Sixty Lake Basin became an attempt to restore the lakes to their pre-1900s fishless status in order to bring back the frogs. He unfurled wide nets bank to bank, reeled them in, and disposed of the catch (often on the grill with a little salt and pepper). Eventually the National Park Service took over the project, and now 14 lakes are fish-free or virtually so. As more fish were netted out, Vredenburg says, the "frogs started to recolonize; the lakes were coming back to life."

But then came another blow. Chytrid, which had already invaded Yosemite National Park,

LEMUR LEAF FROGS
*Hylomantis lemur*
At Zoo Atlanta, Georgia
UP TO 2 INCHES · CENTRAL AMERICA · CRITICALLY ENDANGERED

EASTERN HELLBENDER
*Cryptobranchus alleganiensis*
At San Francisco State University, California
UP TO 16 INCHES · UNITED STATES · DECLINING

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BUDGETT'S FROG · *Lepidobatrachus laevis*
At the National Aquarium, Baltimore, Maryland
UP TO 4 INCHES · SOUTH AMERICA · DECLINING

**Amphibians have evolved into 6,000 singular species as beautiful, diverse—and imperiled—as any on Earth.**

arrived in Sixty Lake Basin and swept from lake to lake, around a hundred of them, in a predictable and deadly line. After removing fish and restoring habitat, "to have this disease wipe the frogs out again—it breaks my heart," he says.

Oddly, the fungus infects but doesn't kill tadpoles, which is why wriggling schools remain in otherwise lifeless ponds. Mountain yellow-legged frogs take some six years to mature. "Those tadpoles are from years ago—there's been no breeding in this pond since chytrid arrived," Vredenburg explains. "As soon as they transform into frogs, they'll die."

Yet Vredenburg remains doggedly optimistic. He calls pond number 8 his victory pond. When he saw the frogs start to die, he removed some of the adults and treated them with an antifungal medication, then put them back. The population—though tiny—has now been stable for three years running. Vredenburg plans to apply his painstaking capture-treat-release method to animals in other ponds in Sixty Lake Basin. (Recently announced, a similar treatment project by a U.K. team aims to mitigate disease in the Mallorcan midwife toad of Spain.) If enough fungal spores can be cleared from frogs' bodies, he says, the disease may lose its hold.

Other sites are also yielding good news. Some amphibians aren't affected by the fungus or can carry it without being hobbled. Certain Costa Rican tree frogs have skin pigments that allow them to bask in the sun without drying out, killing the fungus with heat. Most encouraging, Reid Harris of James Madison University and colleagues have found an innate defense in salamanders and some frogs: symbiotic skin bacteria that inhibit chytrid infection. (Some naturally occurring skin proteins show similar fungus-fighting properties.) "If we can augment the good bacteria to help lower transmission, there may be time for the animals to ramp up their own immunity," Harris says. "And we wouldn't be putting anything into the environment that isn't already there. Perhaps we can stop the epidemic outbreaks of chytrid."

Upcoming Amphibian Ark projects may help researchers test these measures. In Panama, chytrid has only recently jumped the canal and begun a march eastward toward the still pristine Darién Province, where at least 121 amphibian species are known. One rescue facility is already up and running there; U.S. and Panamanian partners are now planning another—in part for research into how to boost enough healthful skin microbes in wild populations to stop the fungus cold. If the strategy works, the golden frog, for one, may be returned in healthy numbers to Panama's forests. Meanwhile, in frog-rich Ecuador, Coloma and Ron have petitioned the government for an environmental audit of the Limón road project. Construction has ceased for now, and some habitat restoration may be done. Though perhaps too late to save the choked stream's animals, media attention there could help future land preservation efforts.

**WHY CARE ABOUT FROGS?** "I could give you a thousand reasons," says Coloma. Because their skin acts not only as a protective barrier but also as a lung and a kidney, they can provide an early warning of pollutants. Their insect prey carries human pathogens, so frogs are an ally against disease. They serve as food for snakes, birds, even humans, playing a key role in both freshwater and terrestrial ecosystems. "There are places where the biomass of amphibians was once higher than all other vertebrates combined," says David Wake. "How can you take that out of the ecosystem without changing it in a major way? There will be ecological consequences that we haven't yet grasped."

"The story is much bigger than frogs," says Vredenburg. "It's about emerging disease and about predicting, coping with, and fighting things we don't fully understand. It's about all of us. Everyone should care." □

Gaping defensively, a single Budgett's frog stands among many in the fight for amphibian survival. Researchers have ramped up the search for solutions, and each small victory breeds new hope.

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Covered head to toe in white to match a snowy Svalbard ridge, Paul Nicklen patiently waits for polar bears.

**ON ASSIGNMENT** **Iceman** Parked deep in the snow as a blizzard raged, photographer Paul Nicklen hoped a polar bear would saunter by and provide a shot for this month's Svalbard story. "Svalbard bears are not hunted, so they're relaxed and approach quite closely," he says. For three hours Nicklen sat with freezing hands and ice-crystal-covered lashes, yet the perfect moment was elusive. One female did come by, but just to munch the seat of his snowmobile. She visited his cabin later (see page 75). Tragically, a few days after taking this picture, Nicklen's guide and friend Karl Erik Wilhelmsen suffered a fatal fall through the sea ice.

PHOTO: KARL ERIK WILHELMSEN

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Zahi Hawass examines the mummy of Hatshepsut in Cairo's Egyptian Museum.

**Unveiled** Probably no man in the world knows more Egyptian mummies—or more about them—than Zahi Hawass, secretary general of that country's Supreme Council of Antiquities and director of the Egyptian Mummy Project. The National Geographic explorer-in-residence checked in with his (very old) friend Hatshepsut, subject of this month's "The King Herself," when a panel was removed from her display case to give photographer Ken Garrett a better view. Hawass was leader of the effort to identify the remains as those of the fabled female ruler from ancient Egypt's 18th dynasty.

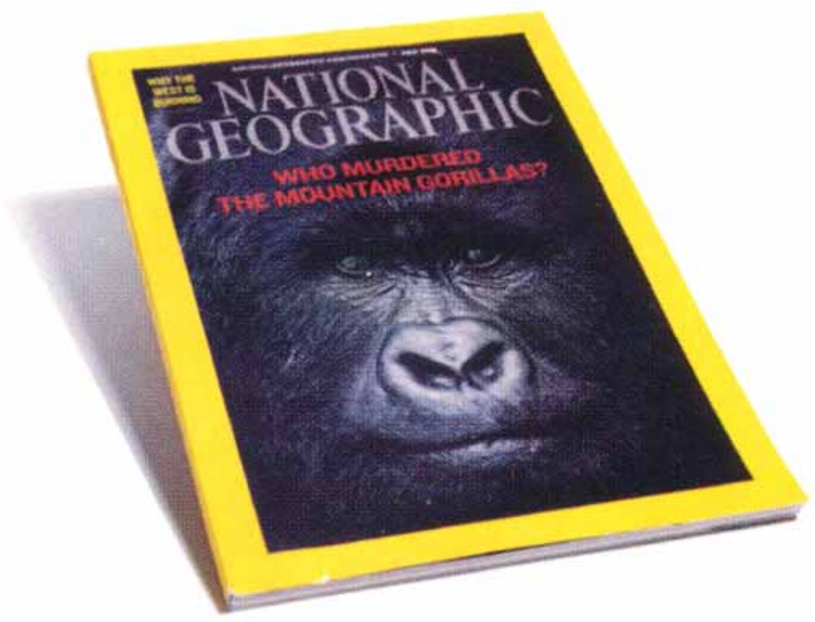
IN THE STUDIO

**Oil Painting** That's not just any ebony puddle oozing across this issue's "Crude Currents" piece on oil spills: It's actual Venezuelan crude. Researcher Mary McPeak spent hours tracking down the stuff, then—since it qualifies as a hazardous substance—had to find out about its proper handling and disposal to get it shipped to *Geographic* headquarters. There design editor Oliver Uberti (at right) artfully drizzled the goo and tried to survive its fumes.

Photographer Rebecca Hale (at left) and Oliver Uberti do some dirty work.

PHOTOS: KENNETH GARRETT (TOP); CHRISTY STEELE, NG STAFF

# INSIDE GEOGRAPHIC

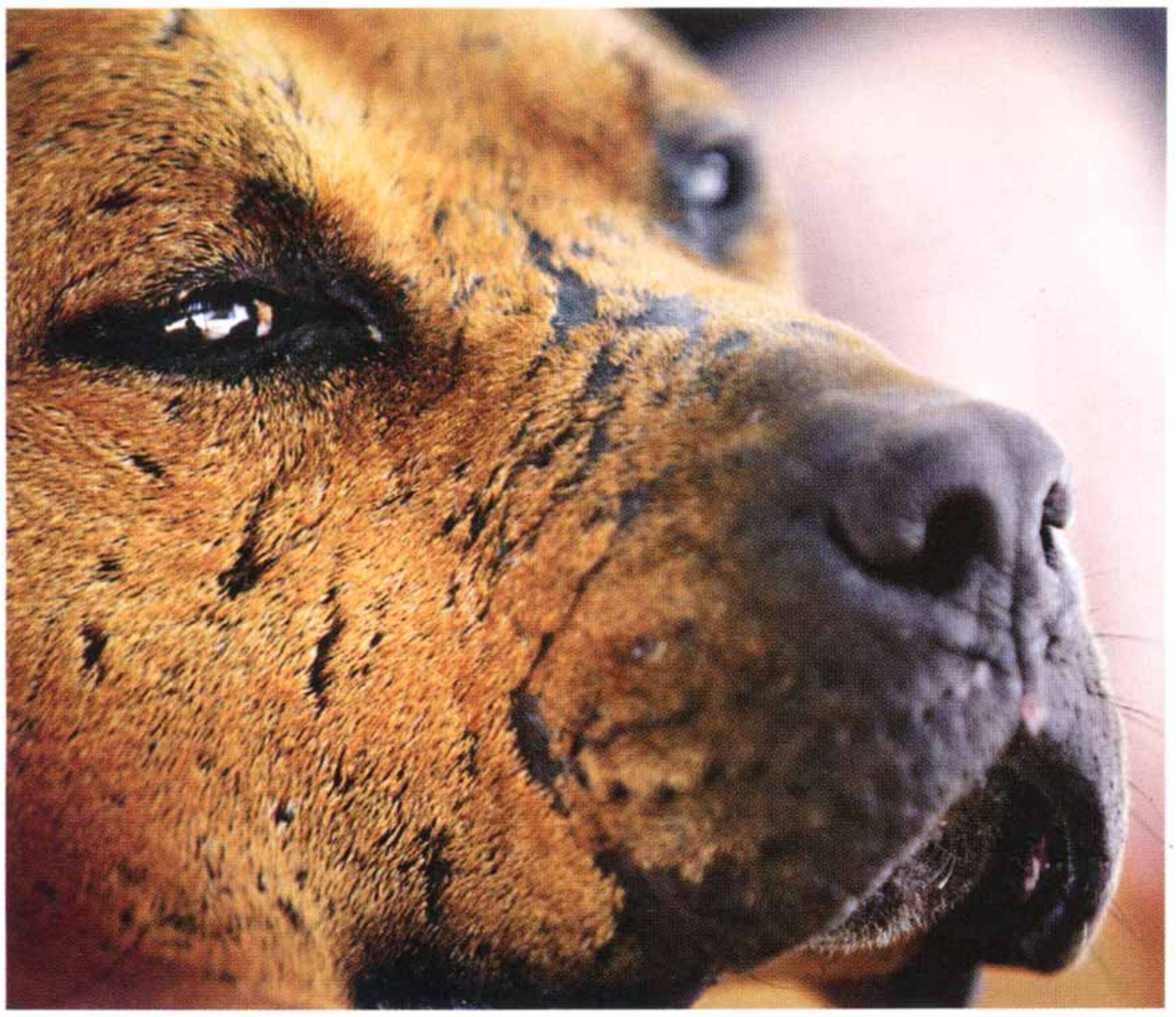



**UPDATE** **Good News for Gorillas** Last July *National Geographic* (left) reported on a dire situation in the Democratic Republic of the Congo's Virunga National Park. In 2007, as a warning to the warden who'd thwarted a thriving illegal charcoal trade, local men killed seven of the park's mountain gorillas. Only 720 of the animals are left in the world. Soon additional violence in the park between rebels and government troops drove out Virunga's rangers entirely, and the mountain gorillas were left unprotected.

Now the rangers are back. Virunga park director Emmanuel de Merode negotiated their return with rebel leader Laurent Nkunda. "It's a case of conservation ahead of politics," says photographer Brent Stirton, who has long covered the conflict. And the conservation news is good: Rangers discovered that five gorilla babies had been born in the 15 months since they'd last seen their charges.

Documenting recent gorilla births in Virunga National Park, ranger Innocent Mburanumwe meets a new arrival.

PHOTO: BRENT STIRTON, REPORTAGE BY GETTY IMAGES



Lucas, a pit bull that was forced to fight, found a peaceful life at Dogtown.

NATIONAL GEOGRAPHIC CHANNEL

## Canine Rehab

Barney lived in a puppy mill in West Virginia, confined to a cage, his skin mangy and flecked with feces. Today the shih tzu is "living the good life" in Manhattan, says Chris Valentini, producer of *Dogtown,* the second season of which airs on Fridays at 10 p.m. Ten episodes will track rescue and rehabilitation efforts at Dogtown, part of Best Friends Animal Sanctuary in Utah. Besides Barney, the new season's stars include two street dogs from Ethiopia and a biting bloodhound.

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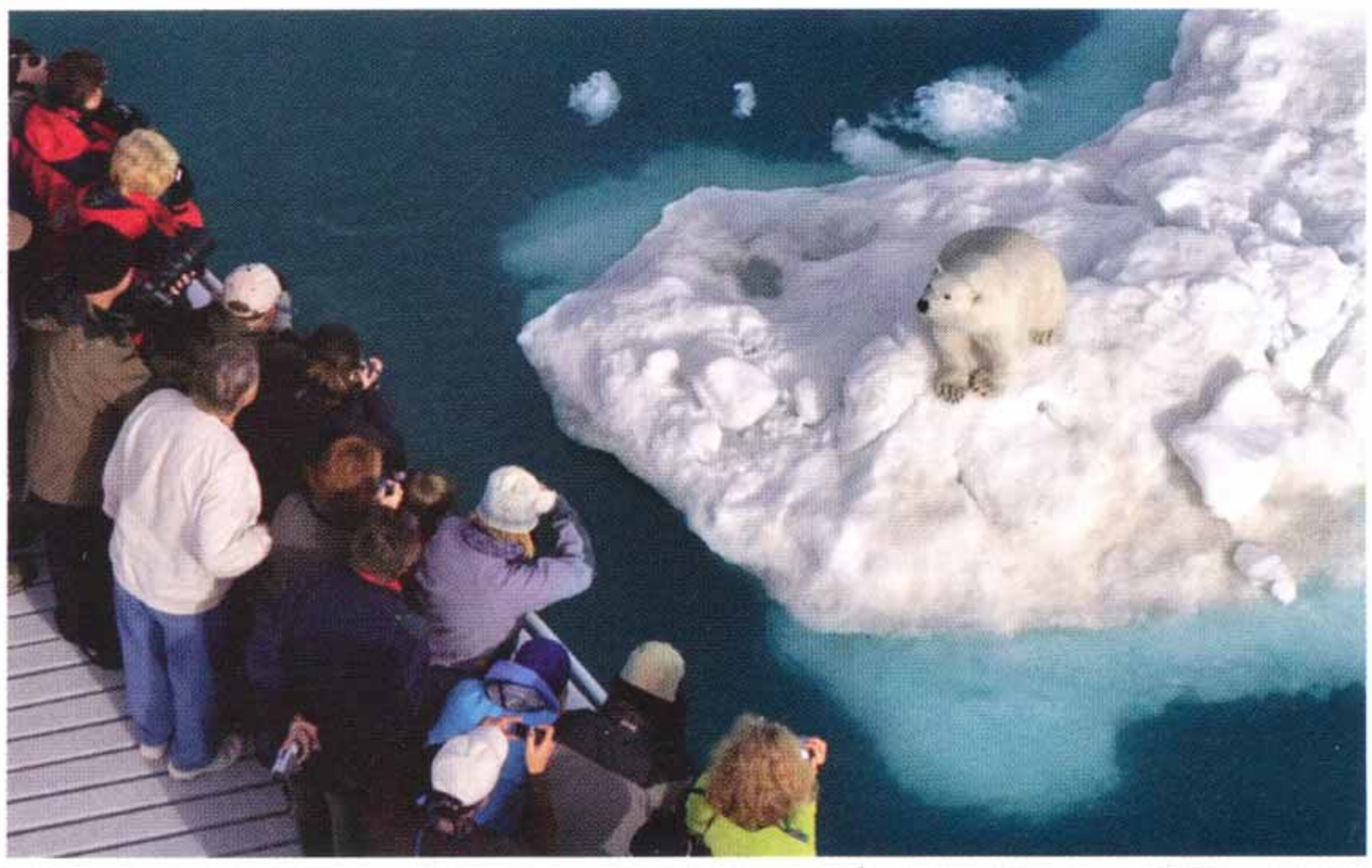
## Polar Circling

Naturalists are always on duty as the Lindblad Expeditions ship *National Geographic Explorer* cruises around the Arctic Svalbard islands. Taking advantage of 24-hour daylight, they look for rare birds, crashing ice cliffs, floating polar bears (right)—and they'll wake sleeping passengers who don't want to miss a thing. Photographers are on hand as well to serve as mentors. Lindblad's Svalbard trip is now available with five July departures.



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PHOTOS: GARRETT DAVIS, NEW YORK TIMES/REDUX (TOP); PAUL NICKLEN

# FLASHBACK

**The Coming Plague** A cloud of plague locusts descends on a field outside Melbourne, Australia, in 1955. Such swarms usually occur in years of plentiful rain, when conditions are most favorable for successive generations to reproduce quickly. But locusts can and do travel great distances, so even drought-stricken regions can be stormed by the hungry bugs. Last year was a particularly good year for Australian plague locusts—and a bad year for those who had to live with them. In Victoria state, motorists were urged to be wary of swarms. "As their fat-laden bodies can measure up to 42mm [1.6 inches]," warned Michael Case of the Royal Automobile Club of Victoria, "when they impact on a windscreen they literally explode. This leaves a sticky residue that may render windscreen wipers useless and can very quickly obscure a driver's vision." *—Margaret G. Zackowitz*

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

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PHOTO: UNITED PRESS PHOTO, NATIONAL GEOGRAPHIC STOCK

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