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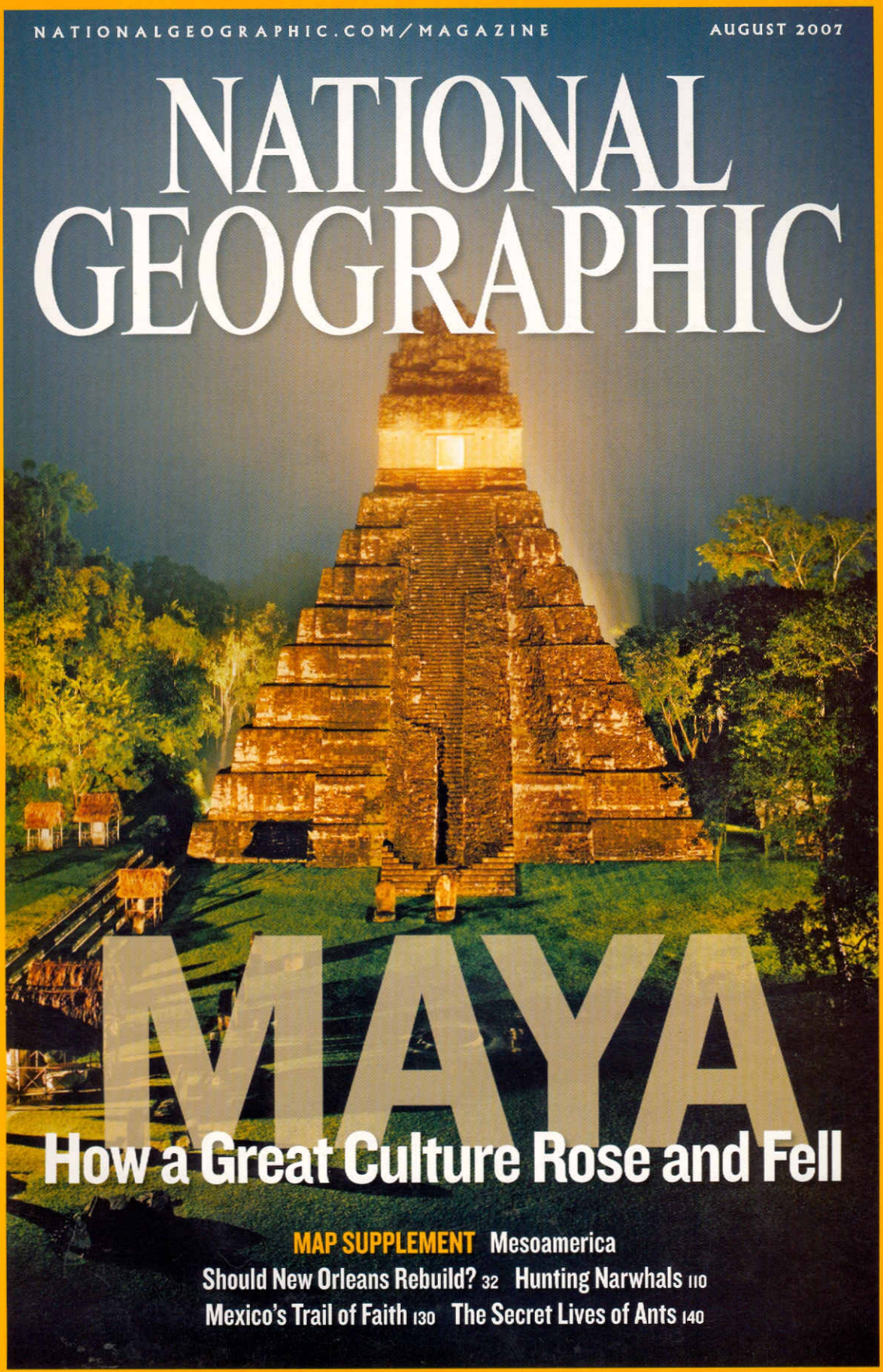
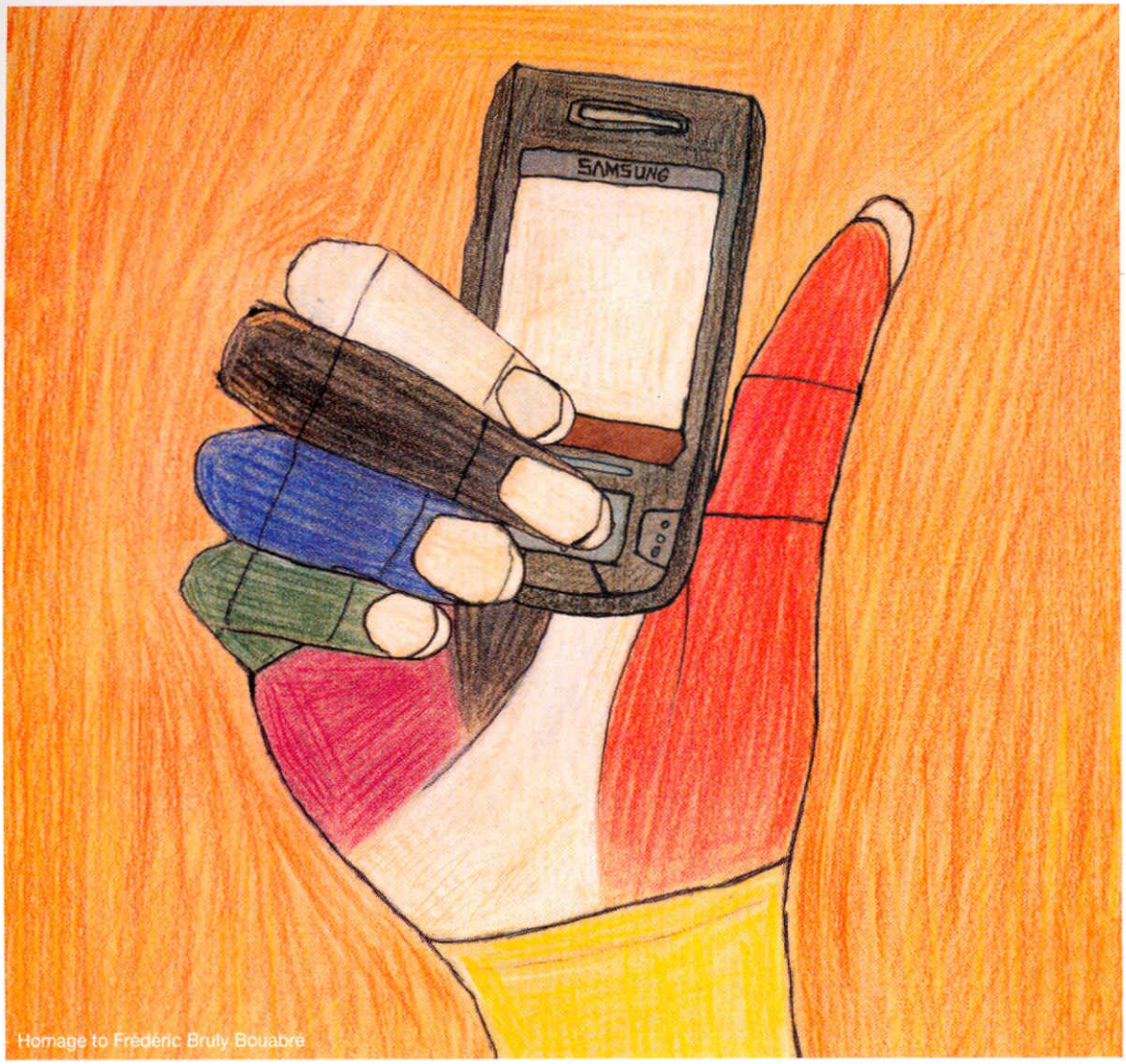
# NATIONAL GEOGRAPHIC



# MAYA

## How a Great Culture Rose and Fell

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U600

The Ultra Edition II

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U300

The Ultra Edition II

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U100

The Ultra Edition II

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# NATIONAL GEOGRAPHIC

AUGUST 2007 • VOL. 212 • NO. 2


Tusk to tusk: Two male narwhals come up for a breather. The white scar on the animal at right is from a rifle wound. Story on page 110.

PAUL NICKLEN



## Features



**COVER** The Temple of the Great Jaguar, built more than 1,000 years ago in Guatemala, exemplifies Maya majesty. **PHOTO BY SIMON NORFOLK**


Cover printed on recycled-content paper

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

Saving Odd Species

Harry Potter's Garden

Kon-Tiki: The Sequel

## Departments



## Miscellany



## On the Web

ngm.com/0708

**Marching in New Orleans**
Drop in on a second-line parade: the umbrella-carrying, kerchief-waving spectators who follow the "first line" of musicians. Photographer Tyrone Turner shares pictures and blasts of brass.

**Mapping the Maya**
Click on an interactive map to learn about the sophisticated civilization that once flourished in the Mesoamerican rain forest. Discoveries by National Geographic grantees are highlighted.

**Keeping Up With the Climate**
Check in with *Climate Connections*, a yearlong collaboration between National Geographic and National Public Radio at *ngm.com/climateconnections* and *npr.org/climateconnections*.



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PHOTOS (LEFT TO RIGHT): ZOOLOGICAL SOCIETY OF LONDON; REBECCA HALE, NGS STAFF; ANDERS BERG


**Hispaniolan Solenodon** *(Solenodon paradoxus)*
**Size:** Head and body length, 28 - 39 cm; tail, 17.5 - 25.5 cm **Weight:** 590 g - 1 kg
**Habitat:** Wooded and brushy areas on the island of Hispaniola; sometimes found near plantations and other agriculturally developed land **Surviving number:** Unknown; populations declining

*Photographed by Eladio Fernandez*

# WILDLIFE AS CANON SEES IT

A mammal in a million? One of only two surviving West Indian insectivores, the Hispaniolan solenodon is a definite oddity: not only is it separated from its nearest genus by some 76 million years, but it's also one of the very few poisonous mammals. However, the sociable burrow-dweller hunts only millipedes, ground beetles, snails and the like. Its venomous bite is not enough to deter introduced cats, dogs and mongooses, which make an easy meal of it. Defenseless against both predators and deforestation—and hampered by its slow rate of reproduction—this decidedly different creature is getting rarer all the time.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place—today and tomorrow. Visit **ngm.com/canonwildlife** to find out more.

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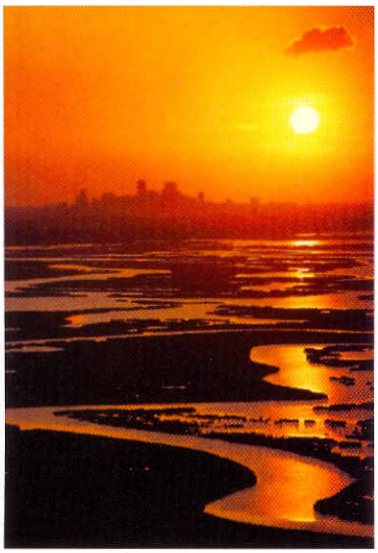
# EDITOR'S NOTE

**Katrina was no freak of nature.** You might even say that the terrible storm that landed on the Louisiana coast in the early hours of August 29, 2005, was a man-made disaster that began with the founding of New Orleans in 1718. Shortly afterward, the city was inundated because the Mississippi River did what it always does—it flooded. So people did what they always do—tried to stare down nature and rebuild. In a game of raise-you-one, hurricanes flattened the city in 1722 and again the following year. Each time, residents rallied and rebuilt.



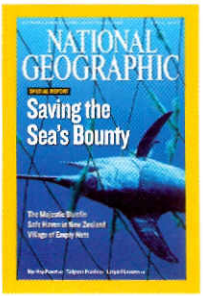
New Orleans wetlands are in trouble.

Do you see a pattern emerging? In the past three centuries, major hurricanes and river floods have pummeled and drowned New Orleans no fewer than 27 times. In the wake of disaster, levees were built and rebuilt. Inhabitants wisely stuck to high ground until the early 1900s, when A. Baldwin Wood, a city engineer, invented huge pumps used to drain the great cypress backswamp. As the city sighed with relief and considered the matter closed, the metropolitan area proceeded to expand. Human ingenuity had won. Or so it seemed until Hurricane Betsy clobbered New Orleans in 1965, reminding residents it wasn't that simple. The cycle of catastrophe and complacency, of lessons unlearned, continued. Another 40 years passed and all was quiet. Until Katrina arrived.

Given enough money for pumps, levees, and floodwalls, we can rebuild New Orleans. Or so we seem to think. But what will it *really* cost? The city, so dear to so many, is compromised by challenges that range from the loss of protective wetlands to the effects of global warming. Factor in human hubris, the risk of another disaster, and the ever present curse of geography, and the tab may turn out to be more expensive than we want to imagine.



PHOTO: TYRONE TURNER




**April 2007** *"The Global Fish Crisis" inspired many readers to write—and some to change their diets. Alvin T. Hudec of Victoria, British Columbia, has sworn off tuna: "I will know that from now on, I did not contribute to their extinction." From Ithaca, New York, Sara Hess writes, "Those of us who have the privilege of healthy options can slow down the demand."*

Comment on August stories at **ngm.com.**

## The Global Fish Crisis

I am a commercial fisherman in Alaska. It was an eye-opener to see the destruction and waste prevalent in the world's fisheries. The Alaska salmon fishery is very well managed, and we do not see the devastation occurring elsewhere. Many local people complain of the many restrictive laws in the fishery, but after reading these articles, I'm in favor of even stricter regulation. The sea is the basis for life on Earth, and we must take care of it.

**TOM HAGEN**
**Craig, Alaska**

Your report presents an overly pessimistic prognosis. Here in New England where I have fished commercially for 45 years, we are beginning a recovery from decades of overfishing. Under the newly authorized Magnuson-Stevens Act (the principal statute governing U.S. fisheries), fishermen are forming partnerships with scientists for the purpose of developing fishing-gear modifications to reduce bycatch and diminish impacts to fish habitat. Additionally, we are compiling information on fish stock abundance, population, and ecosystems. The New England Regional Fishery Management Council is sanctioning the formation of harvest sectors, which enable fishermen to accommodate changing market conditions. This type of local empowerment fosters a stewardship ethic where harvesters take a personal stake in sustainability.

**FRANK MIRARCHI**
**Scituate, Massachusetts**

You portrayed fishing around the world, but not here in the United States. There is no support for the American fisherman who is working under the harshest regulations on Earth, and the strictest gear restrictions. We are fishing in a fashion that is completely sustainable as required under the Magnuson-Stevens Act. The U.S. keeps importing more fish from countries that have no requirements on gear or on their catch. U.S. fishermen cannot compete with foreign prices, so the fishermen's numbers have been reduced. There are no young people who will take our place.

**JEREMIAH O'BRIEN**
**Morro Bay, California**

I was appalled at the utter lack of regard that the commercial fishing industry has for its very own resources. I'd like to ask these same fishermen who say that they cannot make a living on the quotas set for them, How are you going to make a living when all the fish are gone?

**TIFFANY MILLER**
**Fairfield, California**

You failed to note the glaringly obvious root cause of the global fish crisis, which is not new technologies but a ballooning world population. There simply are not enough fish in the ocean to feed us, and all the fisheries management and conservation in the world will do nothing to stop overfishing if nothing is done to stem the unsupportable demand for human consumption.

**NATHAN KENNEDY**
**Jamaica, New York**

As a veteran of some 35 years of membership in various conservation groups, and after writing thousands of emails, letters, and protest forms, I arrived at the sad conclusion that nothing I did mattered one bit. When the catch drops below the cost of operating expenses, the industry will die of its own accord, taking the health of the ocean with it. We will then all stand back and wonder why we let it happen.

**PETER PAUL**
**Surry, Virginia**

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## Hip-Hop Planet

As a member of the hip-hop generation, I was interested to hear the author's perspective as an older person, from the outside looking in, especially considering that I am white and he's black. Hip-hop is indeed the young world's culture. I have made friends digging through record shops from Berlin to Santo Domingo. If hip-hop brought blacks, Puerto Ricans, Italians, and Jews together in the 1970s streets of New York, think what it can do for the young of Somalia, Sri Lanka, or Palestine.

**LOKI DA TRIXTA**
**Brooklyn, New York**

The hip-hop I listen to has messages that concern much more than women and drugs. They communicate the hardships of poverty, warn about the future of society, and take stances on political issues. I felt insulted when I read that the only reason I like hip-hop is because black people are innately cooler than I am. Please take note that some white kids appreciate a vivid musical culture that captures the true creativity and passion of rappers.

**BRENDAN ROCHFORD**
**Santa Cruz, California**

James McBride quotes an African rapper as saying that hip-hop belongs to Africa because of the hardship there. Third World countries don't have the market cornered on pain and anguish. I love the fact that hip-hop has spread faster than the want for independence that it inspires. All I ask is that America get credit where credit is due.

**DAVID BUENO-HILL**
**Los Angeles, California**

McBride's analysis and history don't ring true to old-timers like me. We grew up in Chicago housing projects and were directly involved in the evolution of the music that morphed into hip-hop, and we didn't need the help of New Yorkers and Africans.

**HOSEA L. MARTIN**
**Chicago, Illinois**

Give the early hip-hop musicians their chops—they made something new, just like Hendrix did with an electric guitar. Hip-hop may well be similar in structure to older musical traditions of countries like Senegal. If so, it would make sense that it would be picked up in those countries, especially if the music appeals to people who feel oppressed or held in poverty. But then, what teenager doesn't feel oppressed? The music didn't come full circle. It just appealed to a whole lot of people worldwide.

**SCOTT TROUTMAN**
**Altoona, Pennsylvania**

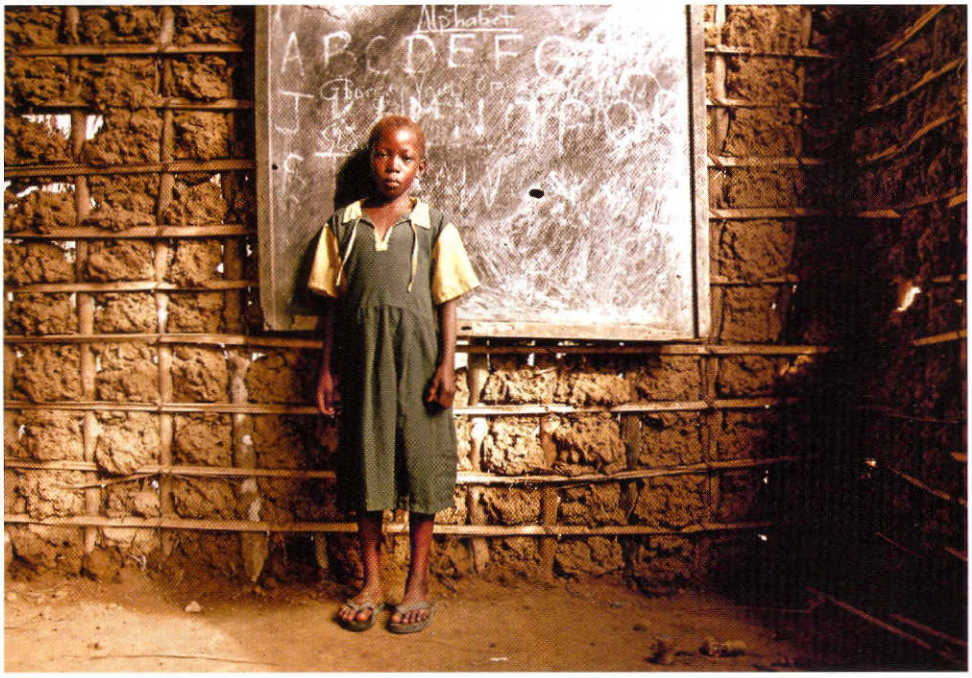
I know there will be readers who will not understand why this article was included in the magazine. I commend you for attempting to make people look beyond the offensive lyrics of gangsta rap and see that there is much more to hip-hop than that.

**KRISTI R. JOHNSON**
**San Antonio, Texas**

## Corrections, Clarifications

**April 2007:**
**The Global Fish Crisis** The name of the skipper pictured on page 55 is Barry Fitzpatrick.

**When the Light Is Right** This month, two particular reader submissions really lit up the Your Shot editors: a still life of bright lemons on an Indian drink vendor's cart, and a sunbeam-stroked portrait of a schoolgirl in Sierra Leone. Do your photographs shine, too? Send them to us for possible publication in NATIONAL GEOGRAPHIC. For more information, go to *ngm.com/yourshot.*




**Miguel W. Herrera** Sydney, Australia

While documenting a well-building project in Gbongay, Sierra Leone, Colombian-born filmmaker Miguel Herrera visited a village school. One young student (above) "jumped in front of the chalkboard spontaneously," remembers Herrera.

**Jen M. Chen** San Diego, California

A lemonade cart in Delhi, India, tempted Jen Chen, a communications engineer, but she did not succumb to its refreshment. "Taking precautions with street foods," she says, "I had to be quenched by this photo instead."

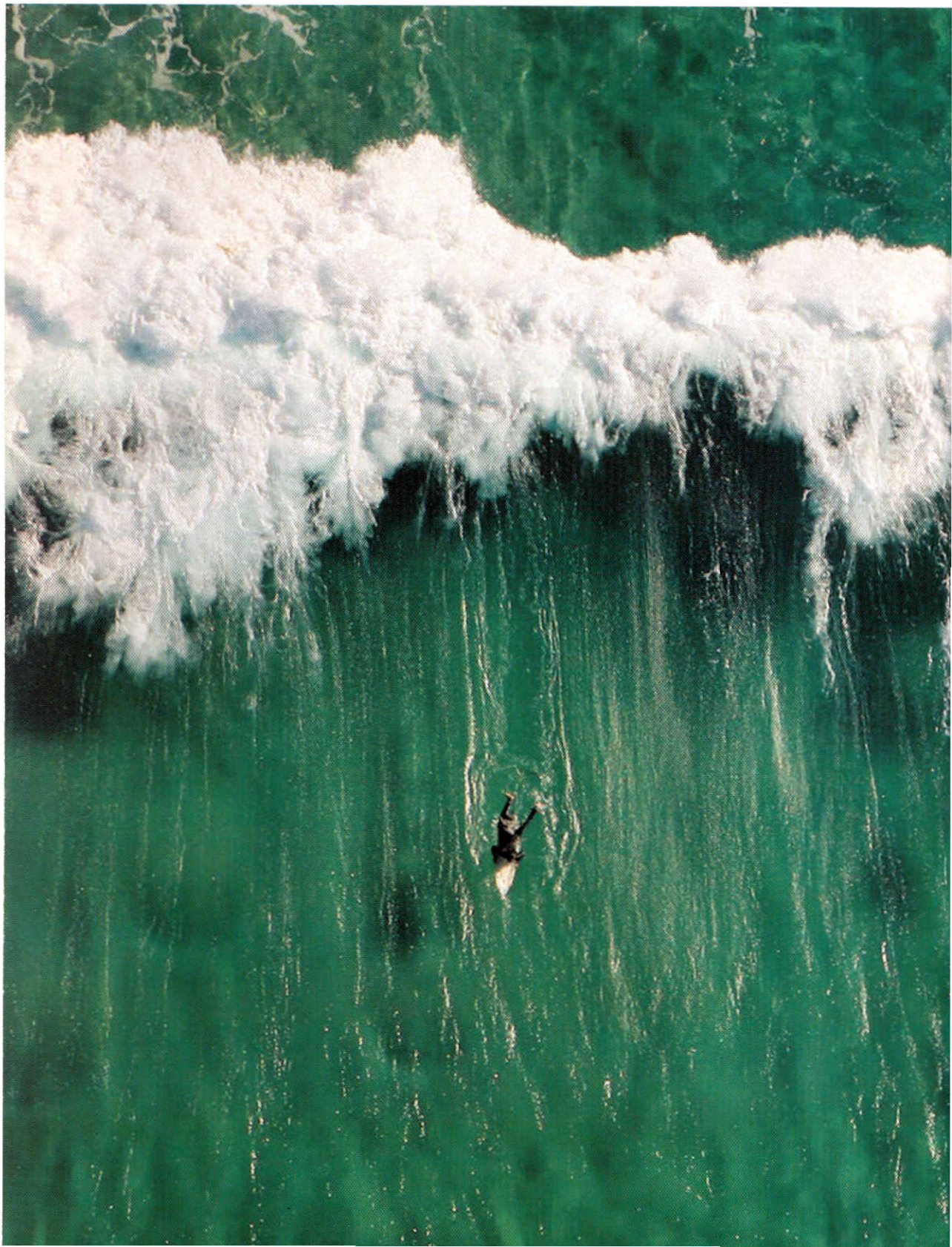
Secret Service agents watch and wait for President Bush to cross the tarmac in Golden, Colorado, in 2006.

*Christopher Morris is a founding member of the VII photo agency. He received the Infinity Award for his most recent book,* My America.

**Telling Secrets** Before I started covering President George W. Bush in 2001 for *Time* magazine, I was primarily a conflict photographer. The biggest difference between the two jobs is that in war, everything is spontaneous. At the White House, everything is staged and controlled, even down to where a photographer can stand and how long he can stand there. Concentrating on one man in a suit for five years—what did I get myself into?

So, early on in my White House coverage, I started looking at everything *but* the President. I photographed the things that visually stood out to me, things that seemed odd. You can sometimes see some strangeness traveling around the country in this very sterile presidential bubble. What stood out the most to me were the Secret Service agents assigned to protect the President. They seem to lurk everywhere: in parking garages, in fields, behind signs, on top of school buses. They are always standing in their perfect dark suits with perfect posture—and in perfect silence.

Once the agents on the presidential detail are on post, they don't talk with you. They barely even acknowledge that you exist. And you will never see them smile. Trust me, I have tried. But when they are off detail and the President has departed, they smile, joke, and tell stories. Then Secret Service agents are completely different people.



**Australia** Hard at play less than five miles from central Sydney, surfers off Bondi Beach relish a perfect day: five-foot waves and no wind. The sport was introduced to Australia in 1915 by Hawaiian legend Duke Kahanamoku.

PHOTO: STEVE CHRISTO, FAIRFAX PHOTOS

**China** A few dynamite seconds reduced Shenyang's 60,000-seat Wulihe Stadium to rubble and dust. Chinese soccer fans mourned: Their men's team qualified for a World Cup final for the first time here in 2001.

um to rubble and dust. Chinese
ne first time here in 2001.

PHOTO: XIE HUANCHI, XINHUA/WPN

**Brazil** A glittering, feather-swathed dancer rides a huge hummingbird in Rio de Janeiro's Carnival parade competition. She is one of thousands of Beija-Flor samba school members who captured the 2007 championship.

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PHOTO: JORGE SÁENZ, AP PHOTO

## Mummy Meltdown

The mummies of the Altay Mountains appear to be defrosting.

Nomadic herders first dug grave pits into the high valleys on the border of Russia and Mongolia nearly 3,000 years ago. They raised stone and dirt mounds, called kurgans, over wood-walled burial chambers. When water trickled into the mounds and froze, the blue-tattooed bodies were mummified in ice. German and Russian archaeologists began to excavate in the region in the 1860s.

Last summer, a team of archaeologists dug up a mummy partly preserved in an ice block that appeared to have once been much larger. They saw other signs of a thaw in the area. The water in nearby lakes has risen more than three feet in the past decade, says University of Aachen researcher Frank Lehmkuhl: "It can only come from melting glaciers and permafrost."

"This is a rescue archaeology situation," says Hermann Parzinger, president of the German Archaeological Institute. By mid-century, the permafrost could be gone. Scientists at the University of Ghent are mapping the hundreds of frozen tombs with satellite imagery as part of the effort to excavate and preserve the mummies. If attempts fall short, the remaining bodies will likely decompose, taking with them their tattoos and garb as well as clues to their diet and lifestyle. *—Andrew Curry*

**Climate Connections** For more coverage of Earth's changing climate from National Geographic and NPR, visit **ngm.com/climateconnections** and **npr.org/climateconnections**.


**HAT**

The blond-haired mummy wore a felt headdress decorated with gilded carvings of animals.

**FUR COAT**

Made of groundhog, mink, and sheep, it protected against the area's year-round snowstorms.

**BELT BUCKLE**

Four wooden buckles were found, with geometric designs on the rims.

**IRON KNIFE**

The warrior also carried a wooden comb and a bronze mirror.

**PANTS**

The knee-length trousers were made of wool.

**BOOTS**

They were made of white felt and ringed with red bands.

PHOTOS: KIRILL SAMURSKIY

**Kon-Tiki: The Sequel** Sailing across the Pacific Ocean on a balsa wood raft may seem suicidal—but not to Thor Heyerdahl or his grandson Olav. In 1947, Thor, a Norwegian explorer, built the *Kon-Tiki,* and, with a five-man crew, set sail from Peru to prove his controversial theory: Native Americans could have settled the South Pacific. *Kon-Tiki* made it to French Polynesia, where it crashed on Raroia atoll, mostly because the craft was difficult to steer. Thor later learned that the flat bottoms of these ancient rafts were equipped with perpendicular boards that improved maneuverability. With a crew led by Torgeir Higraff, who proposed the reenactment, Olav built the *Tangaroa* (above), with ten centerboards and a bigger sail, and set out for French Polynesia in April 2006. They arrived safely 70 days later, 31 days faster than *Kon-Tiki.* While most experts dismiss Thor's migration theory as wrong, they don't argue with his 30-year-old grandson: "It was fun—and a great adventure." *—Alan Mairson*



Olav Heyerdahl (top) sailed a raft across the Pacific last year. His late grandfather Thor sailed a similar route in 1947 and wrote a best seller.

PHOTO: ANDERS BERG, NGM MAPS

The eyes of the slender loris open wide for night-time hunting.

**Saving Odd Species** If the slender loris, a big-eyed, insect-eating primate in Sri Lanka, were to disappear, an entire branch on the evolutionary tree of life would snap off. To prevent the loss of the slender loris and scores of other species with few close relatives, the Zoological Society of London has launched a program to identify and assist the most vulnerable of Earth's one-of-a-kind creatures. Called EDGE, for Evolutionarily Distinct and Globally Endangered, the fund-raising project has put out a list of the top 100 mammals with unusual traits that are at risk of extinction. Over the next five years, EDGE hopes to initiate conservation plans for all 100, with similar programs to follow for amphibians and birds. *—Tom O'Neill*

## And the Losers Are...

In 2007, the Zoological Society of London is publicizing the plight of these threatened unusual mammals.

**1 Yangtze River dolphin**
*Lipotes vexillifer*
Fishing and collisions with boats on this busy river may have already wiped out the freshwater dolphin.

**2 Attenborough's long-beaked echidna**
*Zaglossus attenboroughi*
This species of the egg-laying mammal hasn't been reported on New Guinea since 1961.

**3 Hispaniolan solenodon**
*Solenodon paradoxus*
Attacks by cats and dogs introduced to Hispaniola have put the shrewlike insectivore at risk.

**4 Bactrian camel**
*Camelus bactrianus*
Hunting, mining, and habitat loss jeopardize the two-humped Bactrian in China and Mongolia.

**5 Pygmy hippopotamus**
*Hexaprotodon liberiensis*
Hunted for meat, the pygmy hippo survives mostly in war-torn Liberia.

**6 Slender loris**
*Loris tardigradus*
Hunters seek the primate's tears for use in traditional medicine.

**7 Hirola**
*Beatragus hunteri*
The rare antelope's enemies are East African drought, poaching.

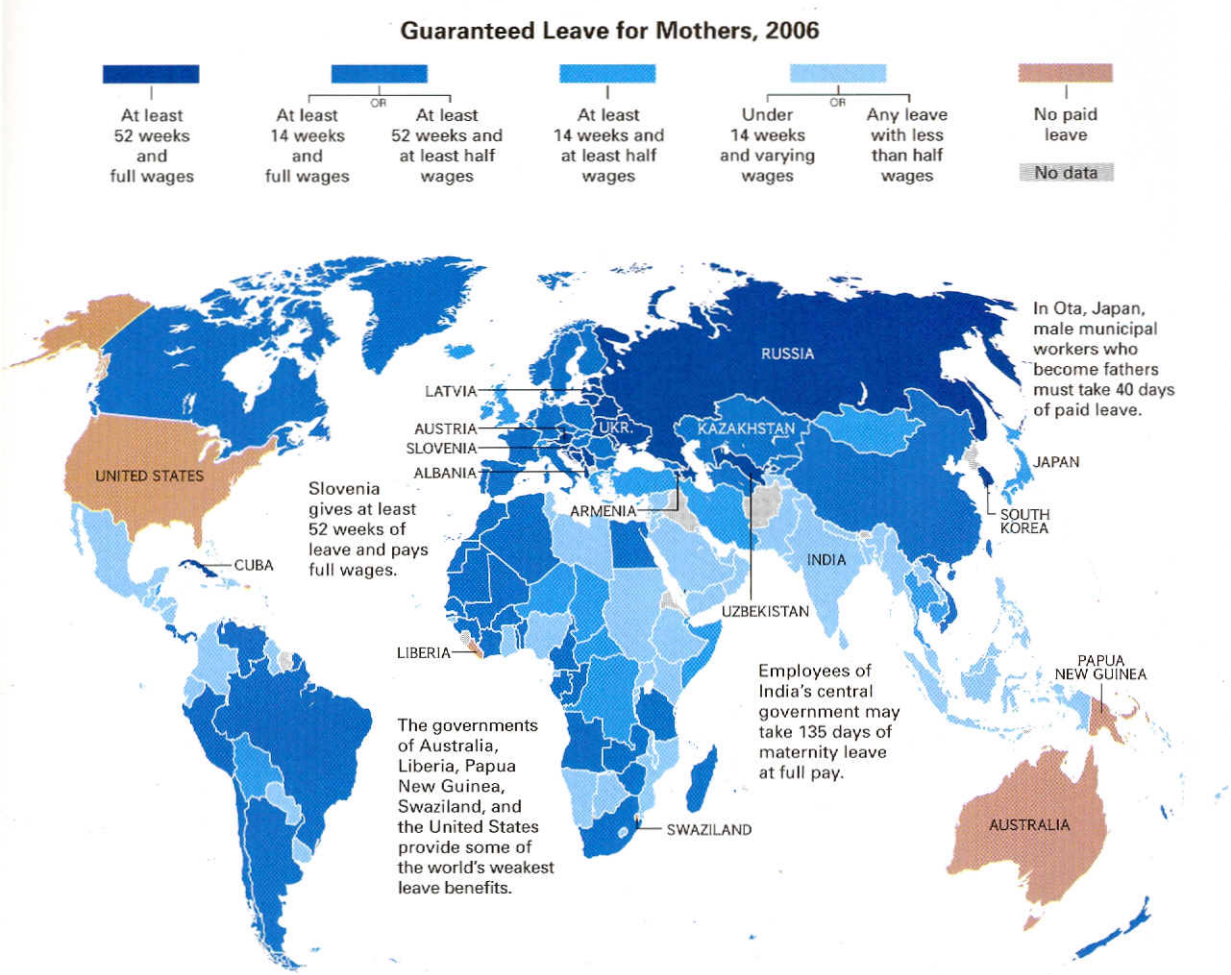
**8 Golden-rumped elephant shrew**
*Rhynchocyon chrysopygus*
Distantly related to elephants, the shrew with a flexible snout is losing forest habitat in Kenya.

**9 Bumblebee bat**
*Craseonycteris thonglongyai*
The world's smallest (bee-size) mammal is threatened by the burning of forests near caves where it roosts in Thailand.

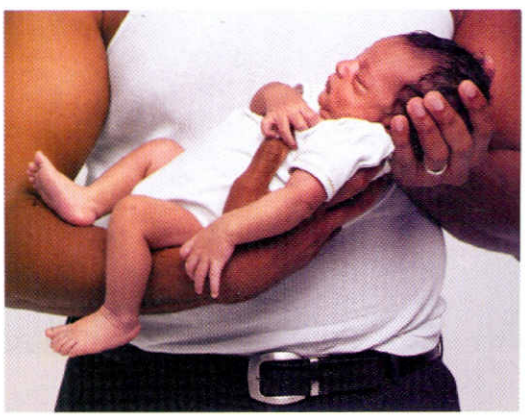
**10 Long-eared jerboa**
*Euchoreutes naso*
No one knows how many of the obscure jumping rodents remain in the Gobi desert.

PHOTO: ZOOLOGICAL SOCIETY OF LONDON

# Who Gives Parents a Break?




American moms-to-be might consider a move to Slovenia. While U.S. law guarantees a mere 12 weeks of unpaid leave under certain conditions, the least of any industrialized nation, the relatively poor central European country offers far more substantial benefits. Many nations give new mothers at least 14 weeks of leave from work around the time their child is born. Some 66 countries let dads take time off, too. The consensus is that bonding time with parents is good for a newborn's health and development. By that measure, places like Cuba, Uzbekistan, and South Korea earn high marks. And the U.S., says Jody Heymann, a social policy expert at McGill University, could definitely do better. *—Neil Shea*



In the U.S., Mark Vann III's lucky dad got a paid week off.

SOURCE: McGILL INSTITUTE FOR HEALTH AND SOCIAL POLICY AND THE PROJECT ON GLOBAL WORKING FAMILIES. NGM MAPS. PHOTO: REBECCA HALE, NGS STAFF

Raising taxes lowers

a) incomes

b) the sea level

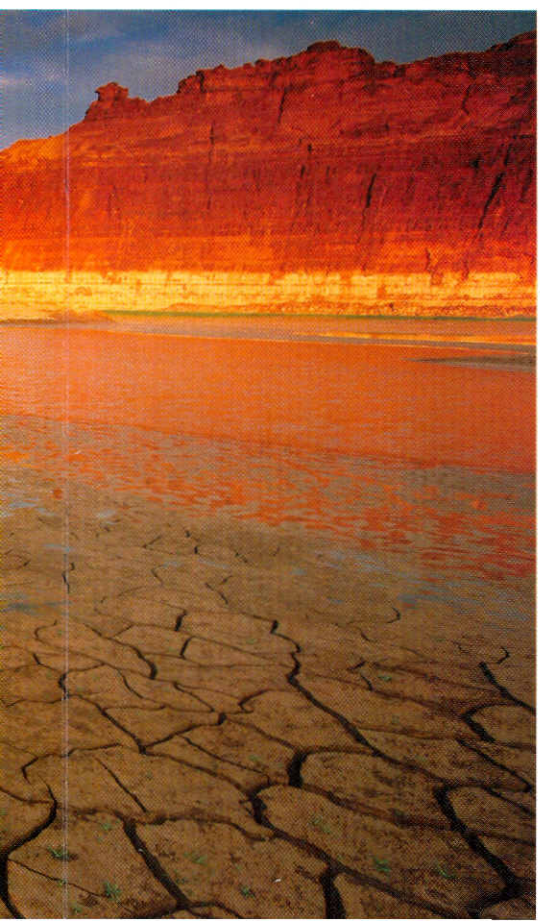
NATIONAL GEOGRAPHIC .COM

**The face of the world is changing.** The past 12 years have experienced 11 of the globally hottest on record, and by 2100 the world is expected to be significantly warmer.

By mid-century we could see the tropical forests of eastern Amazonia replaced by savanna, while in Europe many mountain species may be lost. Rising ocean temperatures would further damage Australia's Great Barrier Reef and could trigger mega-droughts in the western U.S. The melting of the Himalaya glaciers is predicted to increase flooding, followed by water shortages

## Changing Knowledge:

## ıe: CLIMATE CHANGE



affecting over a billion people in Asia. At the same time, shrinking agricultural land and shortened growing seasons could halve the yield of rain-fed crops in parts of Africa.

In the Northern Hemisphere the spring freshwater ice breakup now arrives earlier with a palpable impact on feeding grounds and natural habitats. Ice melt and thermal expansion have already raised sea levels. The rapid shrinking of the Greenland ice sheets could directly affect over 100 million people from low-lying Bangladesh to coastal cities like New York and Tokyo.

These are the challenges to which individuals, along with businesses and governments, are responding with bold new initiatives to lower greenhouse emissions and conserve energy. Climate change is a reality, but we can limit its toll. To expand your understanding of global warming and other urgent issues facing the world today, visit **nationalgeographic.com/changingknowledge.** The face of the world is indeed changing, but through knowledge we can change our ways.

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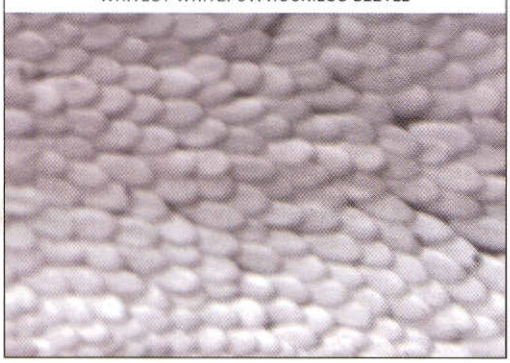
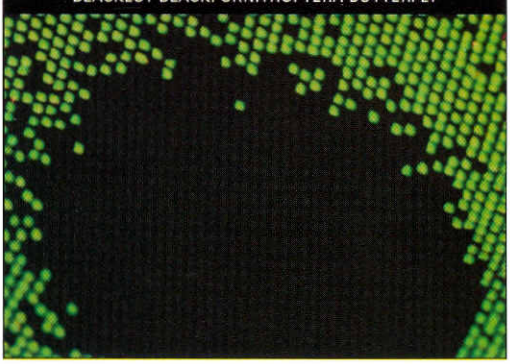
WHITEST WHITE: CYPHOCHILUS BEETLE



BLACKEST BLACK: ORNITHOPTERA BUTTERFLY



You'd need an electron microscope to see the pattern of structures that scatter light on the *Cyphochilus* beetle (for a peerless white) and trap it on the *Ornithoptera priamus* butterfly (for pure black). Synthetics use similar textures to embolden shades.

**Beyond the Pale** Zebras? They're slackers! Insects do far more with black and white. Consider the *Cyphochilus* beetle. Scientists now say it may possess the whitest white of any animal. Pigment alone doesn't make the bug gleam like fallen snow; it's the way its body structure manipulates light. What we see as white is the color spectrum dispersed haphazardly, explains physicist Peter Vukusic of the United Kingdom's University of Exeter. Random pits and columns on the beetle's ultra-thin scales scatter light efficiently. The payoff: first-rate camouflage on a white fungus it frequents.

At the other extreme are butterflies like *Ornithoptera priamus*—"ultrablack," Vukusic calls it. Again, structure is key. Its honeycombed wing scales absorb more light than would a smooth surface, so the black pigment looks blacker still. The hue helps regulate body heat and makes other wing colors stand out in mating displays. Engineers already use microtextures to boost hues in paint and plastic. By aping bug patterns, they hope to develop deep black solar cells (to absorb more rays), paper that gets its whiteness from surface architecture rather than an infusion of minerals, and an uneven coating that'll make teeth sparkle. *—Jennifer S. Holland*

PHOTOS: PETER VUKUSIC, UNIVERSITY OF EXETER

**Harry Potter's Garden** When the young wizard battles vile Voldemort for the last time in *Harry Potter and the Deathly Hallows,* he'll wield a wand made of ordinary holly. Only it turns out holly isn't so ordinary, even in the Muggle (or nonmagical) world. Long ago, healers made a tea of its leaves to induce sweating and relieve fevers. They also believed that juice from its berries could cure jaundice. Many real plants studied at Harry's wizardry school have ancient or modern medicinal uses. But Potterites shouldn't brew any home potions: Though holly berries are said to ward off evil, their juice is toxic. —*Melody Joy Kramer*

## OF MAGIC AND MEDICINE

- **Yew** Voldemort's wand is crafted from this evergreen, a symbol of death in Renaissance literature and a cancer fighter in the medical world. The drug Taxol, prescribed to treat breast, lung, and ovarian cancer, was first synthesized from a compound in the tree's bark and needles.

- **Sage** In fiction, stargazing centaurs burn the herb to bolster senses. In fact, sage has properties that disinfect; some herbal mouthwashes use it as an ingredient.

- **Nettles** Wizards use the stinging plant to cure boils. Scientists add it to anti-nosebleed medicine, and German doctors prescribe nettle products to treat enlarged prostate.

- **Willow** Harry's late mum, Lily, had a wand made from this tree, a traditional symbol of grief. Actually, folks once drank willow leaf tea for pain relief. In the 1800s, a forerunner of aspirin consisted of an extract from the leaves. But the modern pill is all synthetic.

- **Mandrake** The toxic, tangled root (right) helps Harry's teacher reverse a turn-to-stone spell. The Bible alludes to its use as an aid in conception. Ancient Greeks added it to wine as an anesthetic. Today, eyedrops contain a mandrake derivative that temporarily paralyzes eye muscles so the pupil can stay open.

- **Wormwood** An ingredient in sleeping potions in the Potter series, this bitter plant contains santonin, a substance that expels parasitic worms from the body. The old-fashioned remedy fell out of favor as pharmaceutical treatments were developed.

- **Aconite** Potter's potion-makers use the plant, aka wolfsbane, to keep werewolves from going loco. Real doctors once pounded it to a pulp, diluted it with alcohol, and applied tiny doses to unbroken skin to relieve pain. Ingesting just one gram can be fatal; a Pakistani cricket-team coach, found dead in March, reportedly had traces of aconite in his system.

Mandrake lore: Its root seems to have a head and limbs, and it issues a maddening yell if yanked.

PHOTOS: REBECCA HALE, NGS STAFF

LOWER NINTH WARD, AUGUST 30, 2005

VINCENT LAFORET, *NEW YORK TIMES*

BY **Joel K. Bourne, Jr.** NATIONAL GEOGRAPHIC STAFF

PHOTOGRAPHS BY **Tyrone Turner**

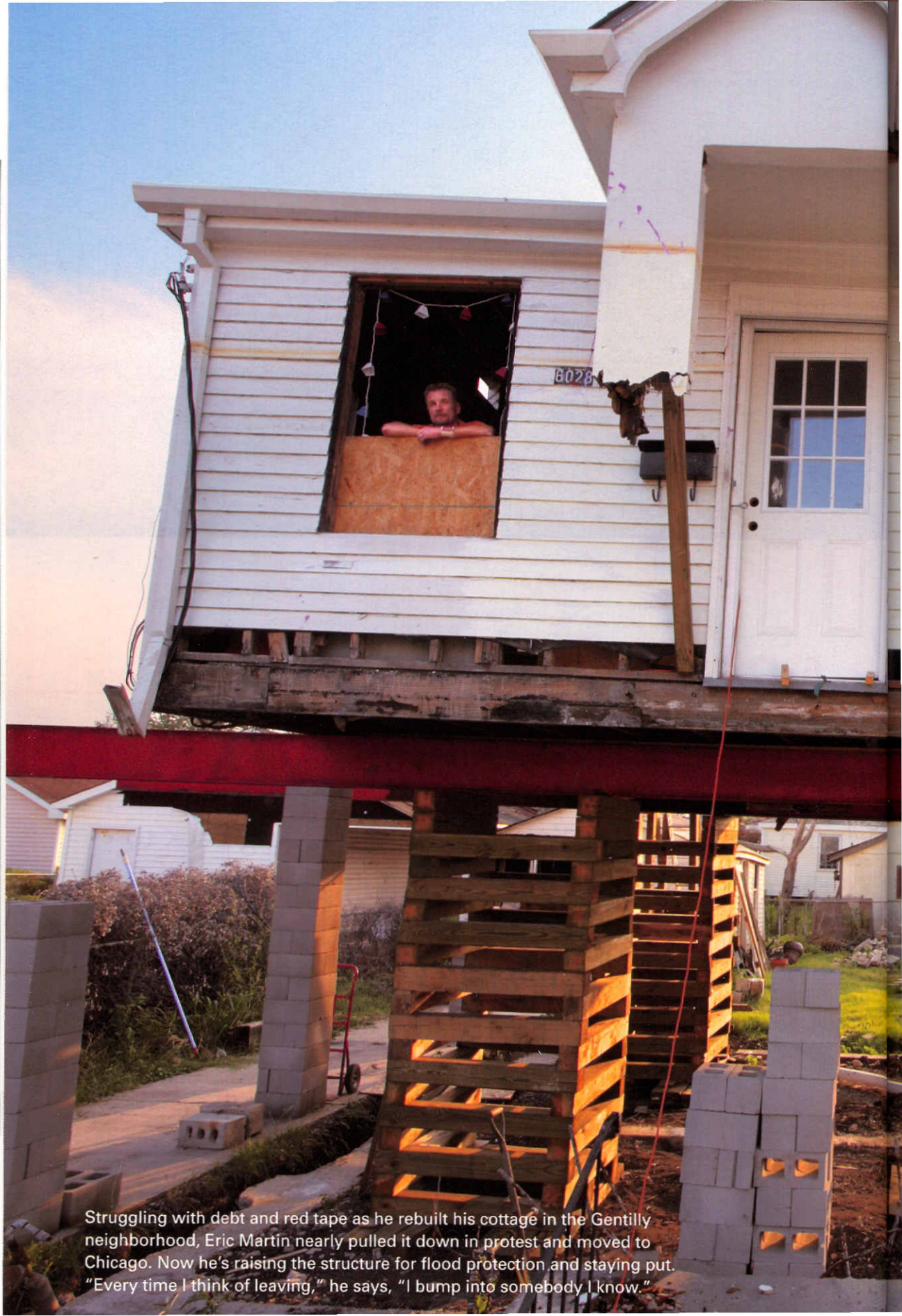
# New




## A PERILOUS FUTURE

The **SINKING CITY** faces **RISING SEAS** and **STRONGER HURRICANES,** protected only by **DWINDLING WETLANDS** and **FLAWED LEVEES.** Yet people are trickling back to the place they call home, rebuilding **IN HARM'S WAY.**

# Orleans



Struggling with debt and red tape as he rebuilt his cottage in the Gentilly neighborhood, Eric Martin nearly pulled it down in protest and moved to Chicago. Now he's raising the structure for flood protection and staying put. "Every time I think of leaving," he says, "I bump into somebody I know."


DAVIE
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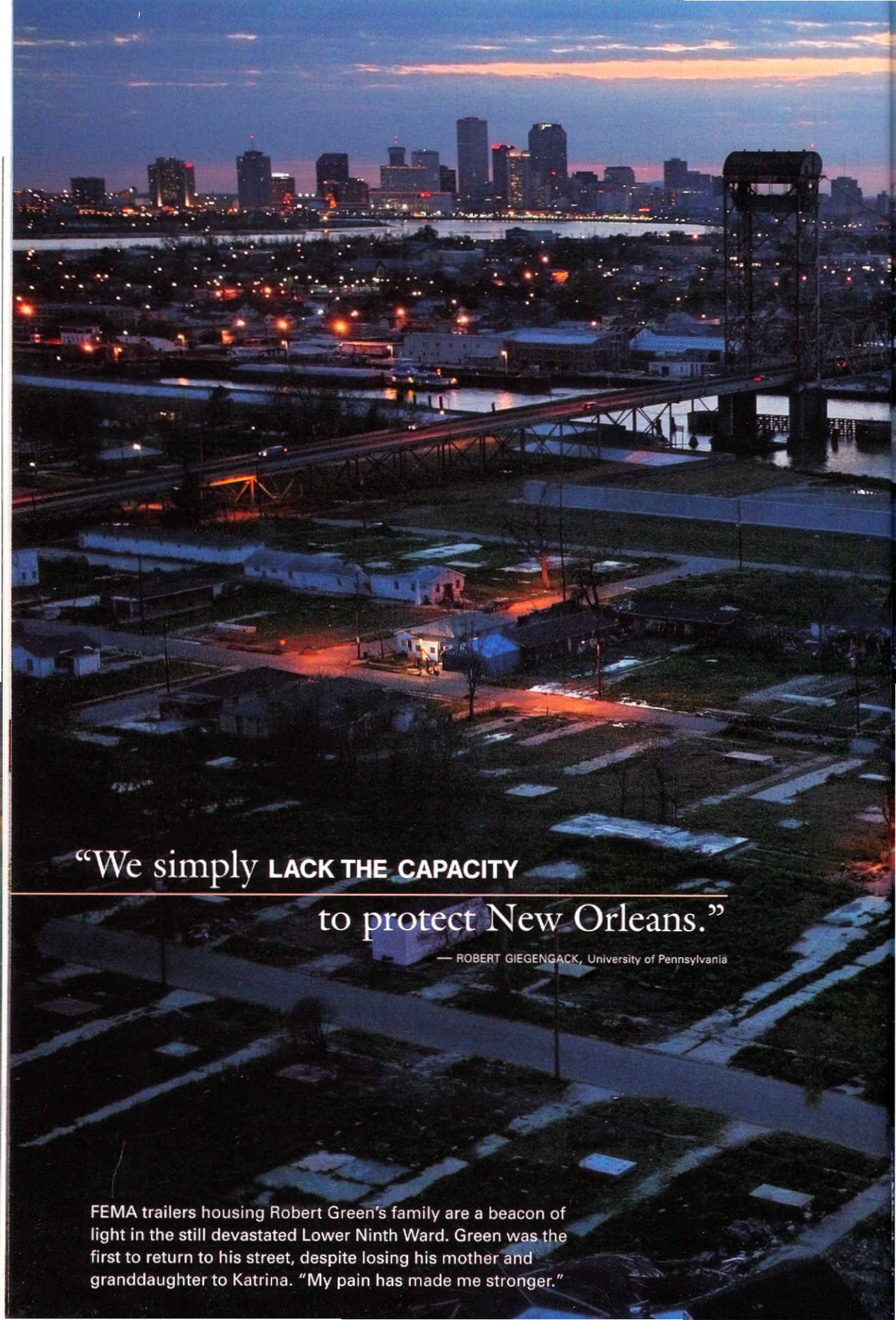
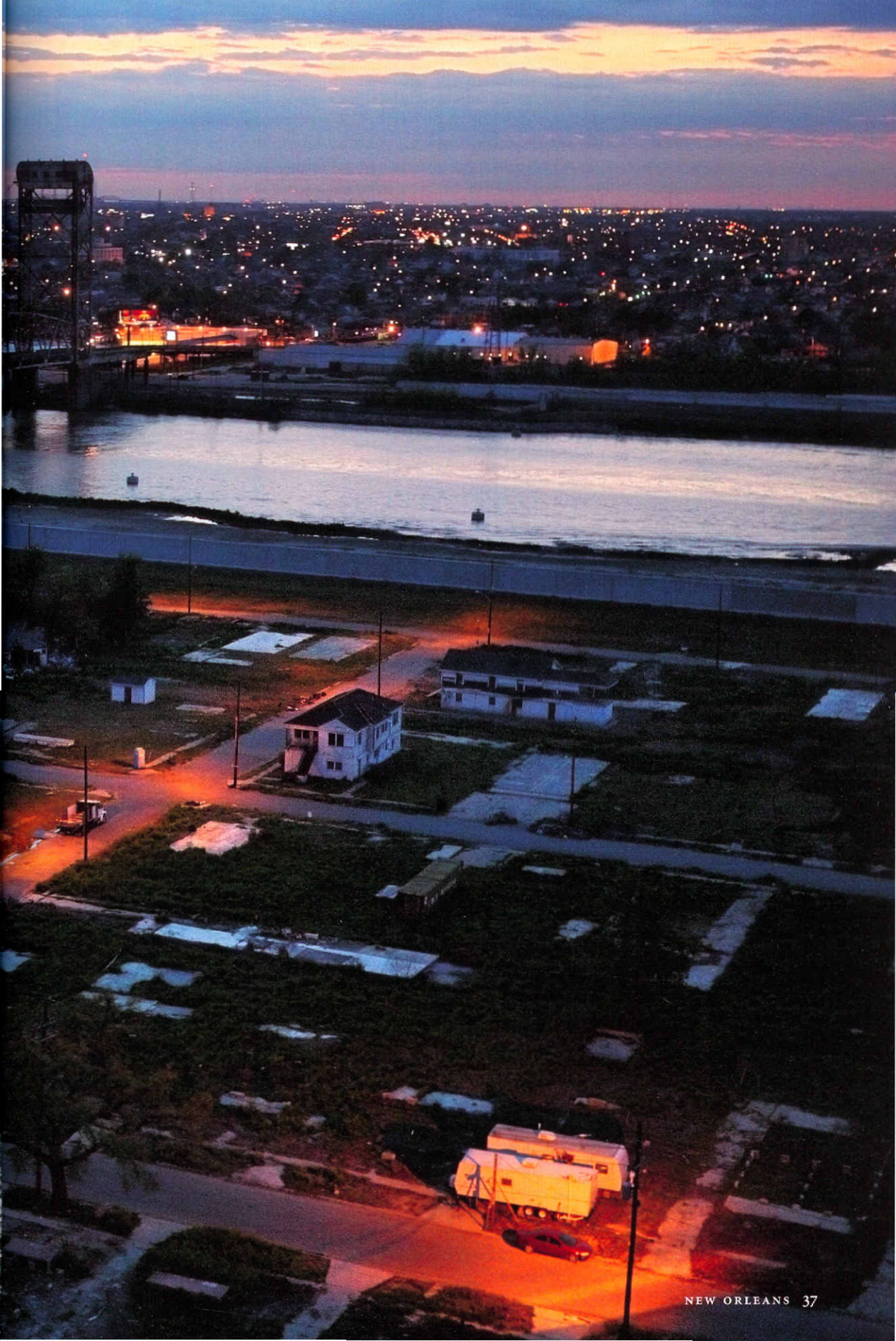


"We simply **LACK THE CAPACITY** to protect New Orleans."

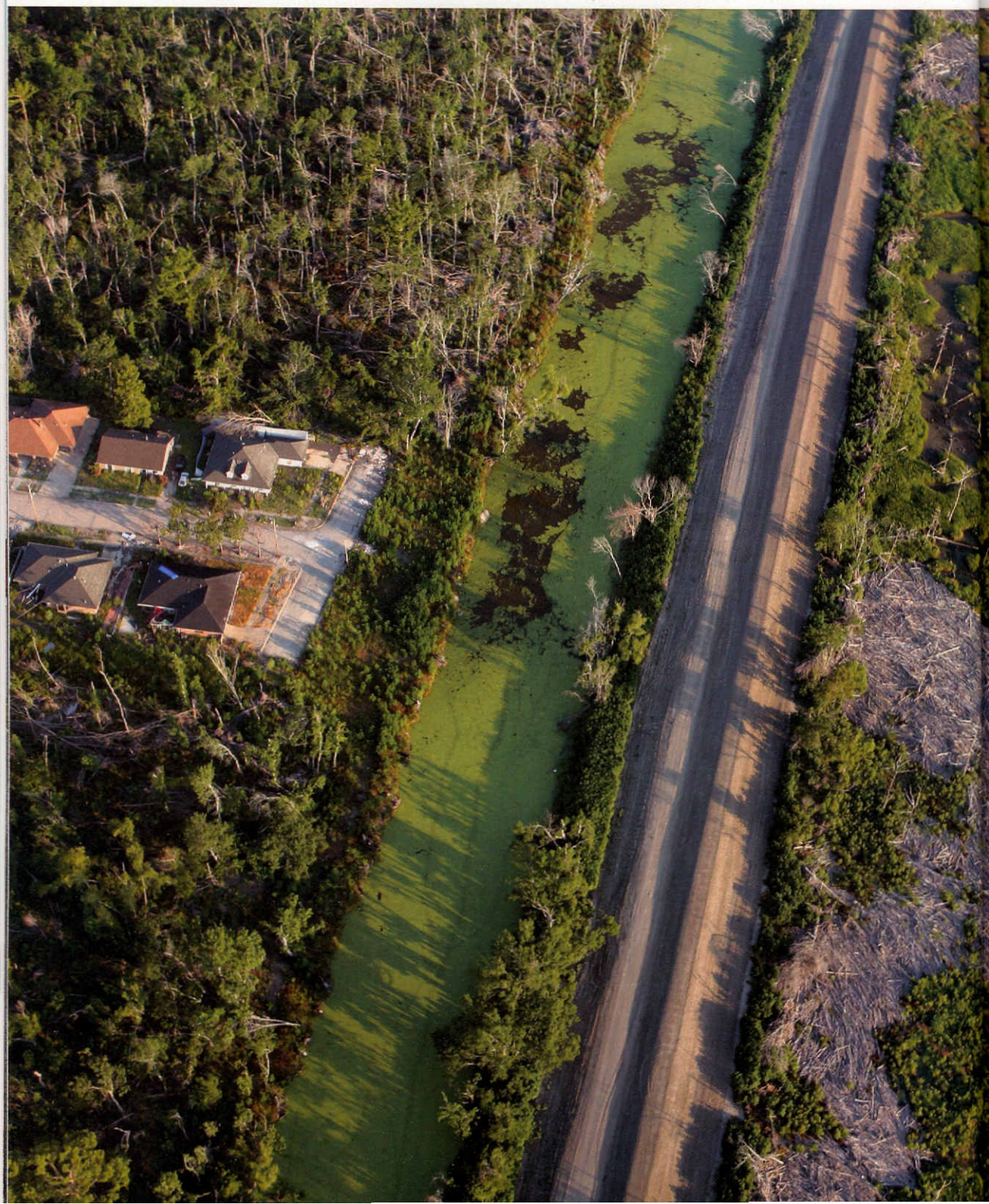
— ROBERT GIEGENGACK, University of Pennsylvania

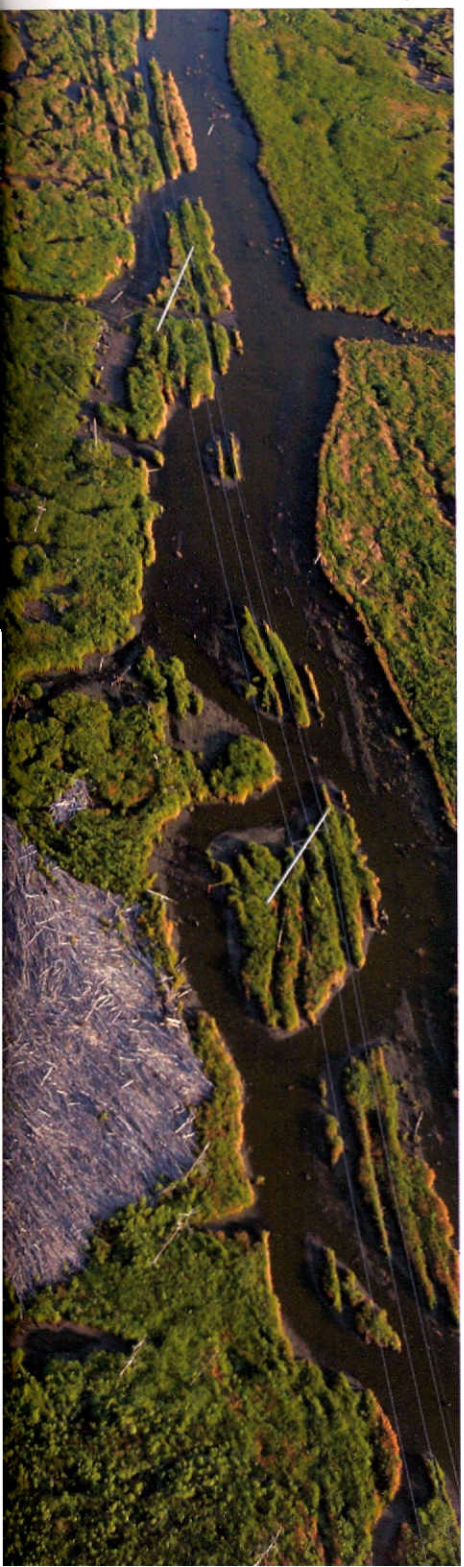
FEMA trailers housing Robert Green's family are a beacon of light in the still devastated Lower Ninth Ward. Green was the first to return to his street, despite losing his mother and granddaughter to Katrina. "My pain has made me stronger."



With a slide and a shuffle, the Big Nine Social Aid and Pleasure Club parades past empty houses on Forstall Street in the Lower Ninth Ward. The city's deep-rooted culture draws many back home despite the risks. "I've been in two major floods in 40 years," says club president Ronald Lewis (not shown). "That's pretty good odds. I hope we have another 40 years to live our life to the fullest."

Cut into a cypress swamp in the early 1980s, Maureen Lane, in St. Bernard Parish, was hit by at least 12 feet of water when Katrina's surge blasted over the canal and floodwall. "If I'd gotten all my insurance money, I wouldn't be here now," says Shirley Calhoun, who owns several properties in the development. "If they don't do nothing, in 30 years this is all going to be water."

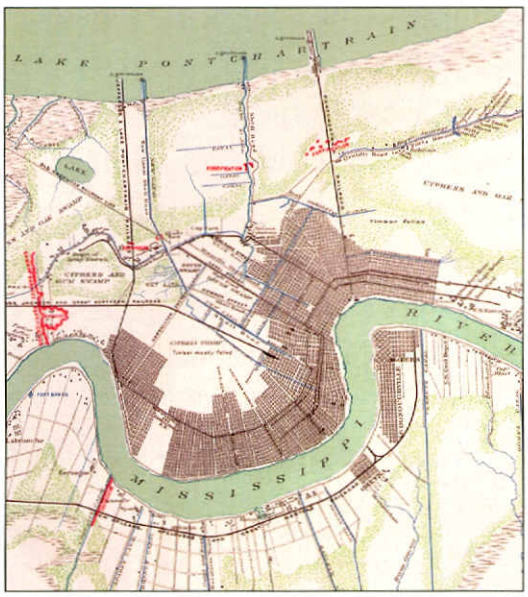




Hurricane Katrina, the costliest natural disaster in United States history, was also a warning shot. Right after the tragedy, many people expressed a defiant resolve to rebuild the city. But among engineers and experts, that resolve is giving way to a growing awareness that another such disaster is inevitable, and nothing short of a massive and endless national commitment can prevent it.

Located in one of the lowest spots in the United States, the Big Easy is already as much as 17 feet below sea level in places, and it continues to sink, by up to an inch a year. Upstream dams and levees built to tame Mississippi River floods and ease shipping have starved the delta downstream of sediments and nutrients, causing wetlands that once buffered the city against storm-driven seas to sink beneath the waves. Louisiana has lost 1,900 square miles of coastal lands since the 1930s; Katrina and Hurricane Rita together took out 217 square miles, putting the city that much closer to the open Gulf. Most ominous of all, global warming is raising the Gulf faster than at any time since the last ice age thawed. Sea level could rise several feet over the next century. Even before then, hurricanes may draw ever more energy from warming seas and grow stronger and more frequent.

And the city's defenses are down. Despite having spent a billion dollars already, the U.S. Army




DAVID RUMSEY MAP COLLECTION

An 1863 Civil War map shows New Orleans clinging to the high ground by the river. In the 20th century the city expanded into nearby swamps—areas that flooded during Katrina.

Corps of Engineers now estimates it will take until after 2010 to strengthen the levee system enough to withstand a 1-in-100-year storm, roughly the size of Category 3 Katrina. It would take decades more to protect the Big Easy from the truly Big One, a Category 4 or 5—if engineers can agree on how to do that and if Congress agrees to foot the almost unimaginable bill. For now, even a modest, Category 2 storm could reflood the city.

The long odds led Robert Giegengack, a geologist at the University of Pennsylvania, to tell policymakers a few months after the storm that the wealthiest, most technologically advanced nation on the globe was helpless to prevent another Katrina: "We simply lack the capacity to protect New Orleans." He recommended selling the French Quarter to Disney, moving the port 150 miles upstream, and abandoning one of the most historic and culturally significant cities in the nation. Others have suggested rebuilding it as a smaller, safer enclave on higher ground.

But history, politics, and love of home are powerful forces in the old river town. Instead of rebuilding smarter or surrendering, New Orleans is doing what it has always done after such disasters: bumping up the levees just a little higher, rebuilding the same flood-prone houses back in the same low spots, and praying that hurricanes hit elsewhere. Some former New Orleanians may have had enough. More than a third of the city's pre-Katrina population has yet to return. Those who have face deserted neighborhoods, surging crime, skyrocketing insurance, and a tangle of red tape—simply to rebuild in harm's way.

**IF PARIS, AS HEMINGWAY SAID,** is a movable feast, then New Orleans has always been a floating one. Born amid willow and cypress swamps atop squishy delta soils, the city originally perched on the high ground formed by over-wash deposits from annual river floods. Jean-Baptiste Le Moyne, Sieur de Bienville, actually had to wait for the water to recede before he could plant the French flag in 1718. A flood destroyed the village the year after he founded it, and hurricanes wiped it off the map in 1722 and again a year later. In its 289-year history, major hurricanes or river floods have put the city under 27 times, about once every 11 years. Each time, the fractious French, Spanish, blacks, Creoles, and Cajuns raised the levees and rebuilt.

Until the 20th century, they kept to the high ground along the Mississippi River and on three nearby rises—the Metairie, Gentilly, and Esplanade Ridges. But in the early 1900s a brilliant city engineer, A. Baldwin Wood, invented massive pumps, up to 14 feet in diameter, that were used to drain the great cypress "backswamp." The booming metropolis began spilling north toward Lake Pontchartrain. As the swamp soils dried, they shrank and compacted, slumping below sea level. In every flood since, the newer, lower neighborhoods suffered the most as the waters found their former haunts in the old swamp.

# But flood losses are largely **ACTS OF MAN.**"

— GILBERT F. WHITE, Geographer, 1942

The great tragedy of Katrina is that the hard lessons learned in those earlier storms were blithely forgotten by all. After the great Mississippi River flood of 1927 wreaked havoc all along its course and came within a few feet of spilling over the river levees and inundating New Orleans, the growing city clamored for additional protection. Over the coming decades, the federal government erected a vast network of levees and spillways along the river and around the city, while giant new dams along the Missouri—the Mississippi's longest tributary—ponded water all the way to South Dakota. The system was billed as a triumph of engineering over nature.

Yet Gilbert F. White, considered the "father of floodplain management," came to a far different conclusion, one that Katrina drove home with a vengeance. As a young University of Chicago geographer, White had studied the delta after the 1927 disaster and realized that much of the suffering could have been avoided. "Floods are 'acts of God,'" he wrote in 1942, "but flood losses are largely acts of man." White and his colleagues argued that dams, levees, and other flood protections may actually increase flood losses because they spur new development in the floodplain, which incurs catastrophic losses when man-made flood protections fail. The phenomenon came to be known as the "levee effect."

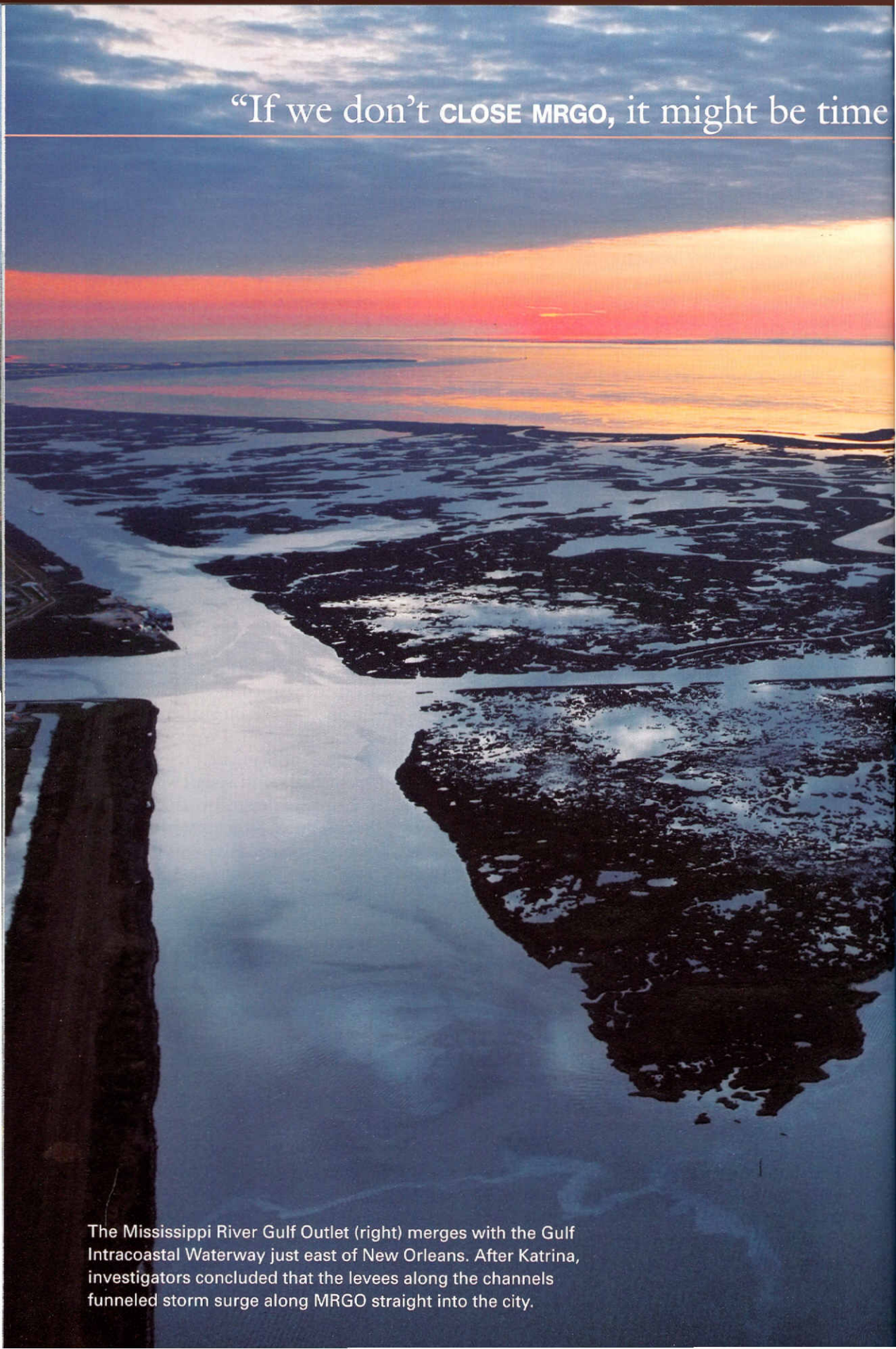
Nowhere was White's advice more gleefully flouted than in the Lake Pontchartrain and Vicinity Hurricane Protection Project—the 125-mile-long system of levees and gates built by the U.S. Army Corps of Engineers to protect the city after Hurricane Betsy ravaged it in 1965. City planners and developers applauded as the corps not only strengthened existing levees around the city but also threw new levees far and wide, enclosing thousands of acres of undeveloped wetlands lining the new I-10 corridor. In fact, 79 percent of the estimated benefits that the corps initially used to justify the cost of the project came from the future development of those wetlands. Within a decade, Jefferson Parish had built 47,000 new housing units—modern-day Metairie and Kenner—while Orleans Parish added another 29,000 units, mostly in New Orleans East.

"It was basically a development scheme," says Oliver Houck, a Tulane professor of environmental law who has fought other corps projects. "They put it around New Orleans East, and the developers laughed all the way to the bank."

**FROM ITS INCEPTION,** the project was beset with technical problems, litigation, and political tinkering. What was supposed to be built in 13 years for 85 million dollars became a never ending 740-million-dollar project that was still ten years from completion when Katrina hit. The Government Accountability Office—the watchdog of Congress—had a field day, regularly criticizing the corps for cost overruns and delays.

Early on, experts warned about serious flaws in the system. In 1984 Wilson Shaffer, a storm-surge modeler at the National Weather Service, told the corps that the Standard Project Hurricane, the hypothetical storm against which engineers tested their levee designs, was too small to represent the true threat. Stronger storms—such as the Category 5 Hurricane Camille, which slammed into Mississippi four years after Betsy—could easily overtop the system and flood the city, Shaffer said. "There are no high areas near the city that wouldn't flood in extreme cases," he wrote. "High ground is several tens of miles away. Evacuation routes are limited. . . . Imagine, if you can, the massive destruction and loss of life."

The corps rejected these warnings. Protection against these "rare" events, the corps deemed, would be "prohibitively expensive," a conclusion seconded by the Orleans Levee District, the local flood-protection authority. The corps also dismissed another, longer range threat, summed up in a graph made by John S. Hoffman of the Environmental Protection Agency: rising sea level because of global warming. By 2100, Hoffman projected, the sea *(Continued on page 54)*



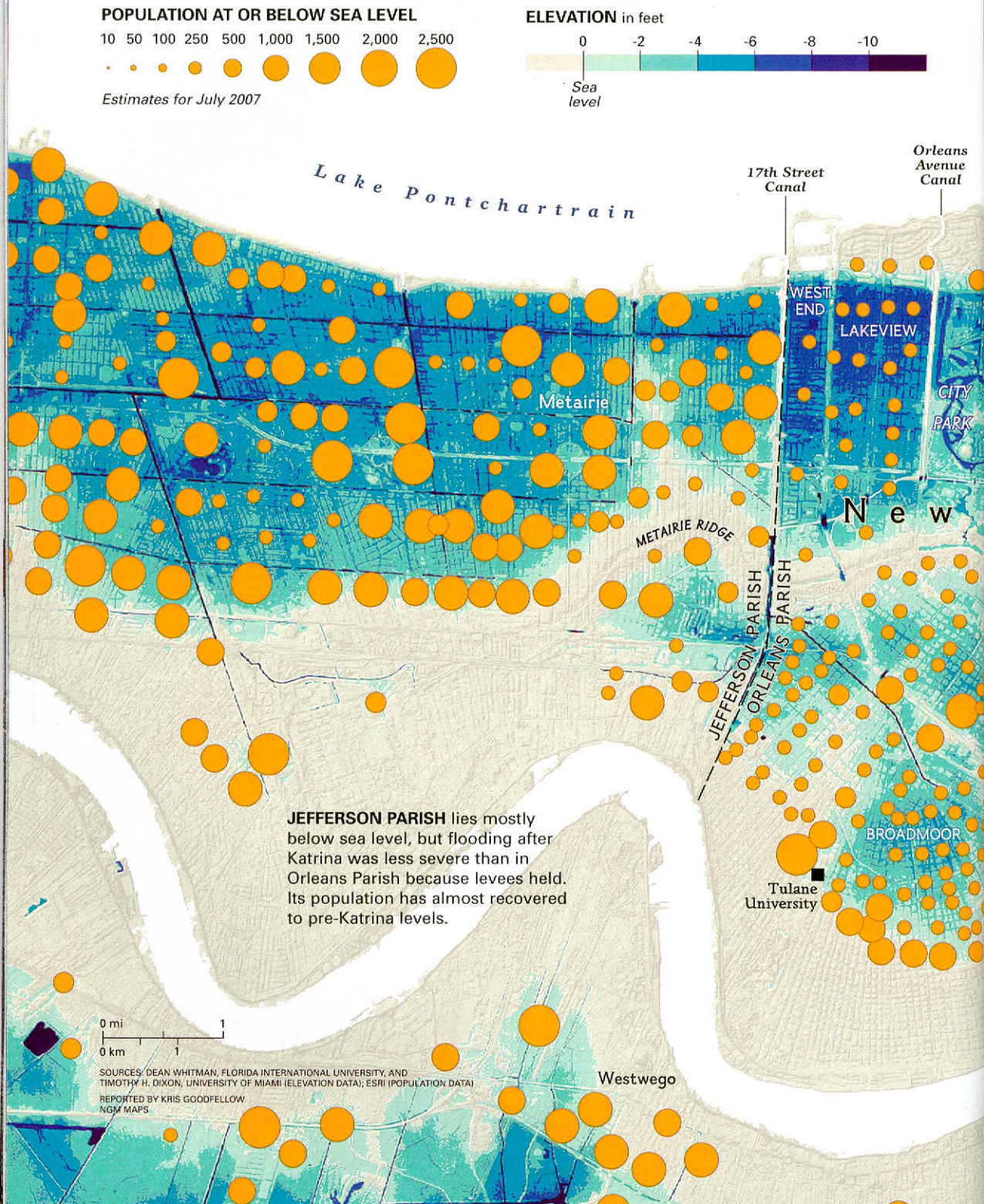

The Mississippi River Gulf Outlet (right) merges with the Gulf Intracoastal Waterway just east of New Orleans. After Katrina, investigators concluded that the levees along the channels funneled storm surge along MRGO straight into the city.

to do what my wife says and move to Kansas."

— JOHN LOPEZ, Lake Pontchartrain Basin Foundation

# LIVES STILL AT RISK

In New Orleans and adjoining parishes, 500,000 people now live at or below sea level, as shown in a map giving population for low-lying neighborhoods. Some of these areas lay underwater for weeks after Katrina; all face serious risk of flooding in future storms. Jefferson and Orleans Parishes have the nation's highest number of properties with repeated flood losses.



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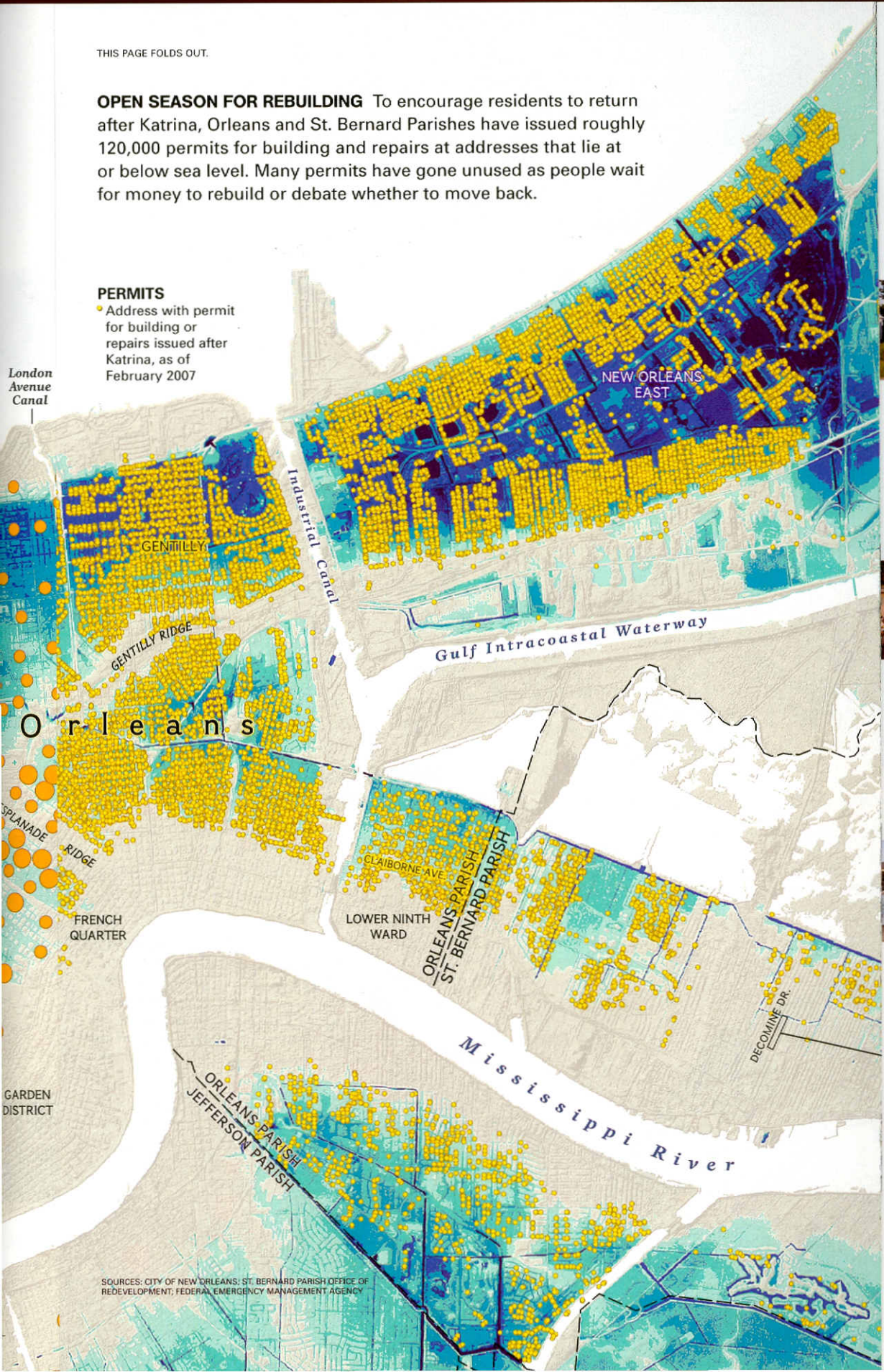
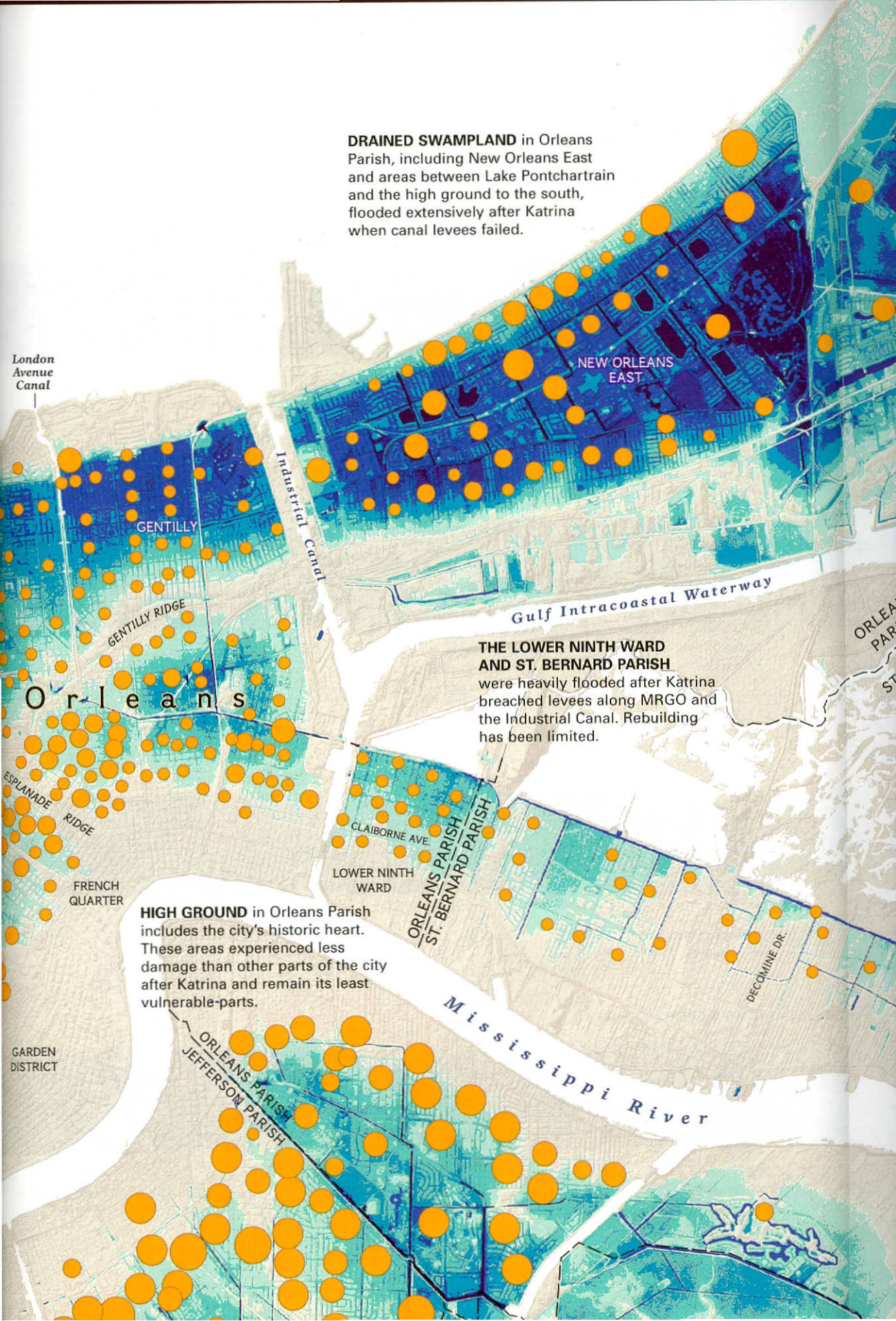
**OPEN SEASON FOR REBUILDING** To encourage residents to return after Katrina, Orleans and St. Bernard Parishes have issued roughly 120,000 permits for building and repairs at addresses that lie at or below sea level. Many permits have gone unused as people wait for money to rebuild or debate whether to move back.




**DRAINED SWAMPLAND** in Orleans Parish, including New Orleans East and areas between Lake Pontchartrain and the high ground to the south, flooded extensively after Katrina when canal levees failed.
London Avenue Canal
NEW ORLEANS EAST
Industrial Canal
GENTILLY
GENTILLY RIDGE
Gulf Intracoastal Waterway
Orleans
**THE LOWER NINTH WARD AND ST. BERNARD PARISH** were heavily flooded after Katrina breached levees along MRGO and the Industrial Canal. Rebuilding has been limited.
ESPLANADE RIDGE
FRENCH QUARTER
CLAIBORNE AVE.
LOWER NINTH WARD
ORLEANS PARISH
ST. BERNARD PARISH
DECOMINE DR.
**HIGH GROUND** in Orleans Parish includes the city's historic heart. These areas experienced less damage than other parts of the city after Katrina and remain its least vulnerable parts.
Mississippi River
GARDEN DISTRICT
ORLEANS PARISH
JEFFERSON PARISH

**AND** in Orleans
ew Orleans East
Lake Pontchartrain
d to the south,
after Katrina
ailed.

NEW ORLEANS EAST

Gulf Intracoastal Waterway

Bayou Bienvenue

Mississippi River Gulf Outlet (MRGO)

ORLEANS PARISH

ST. BERNARD PARISH

Lake Borgne

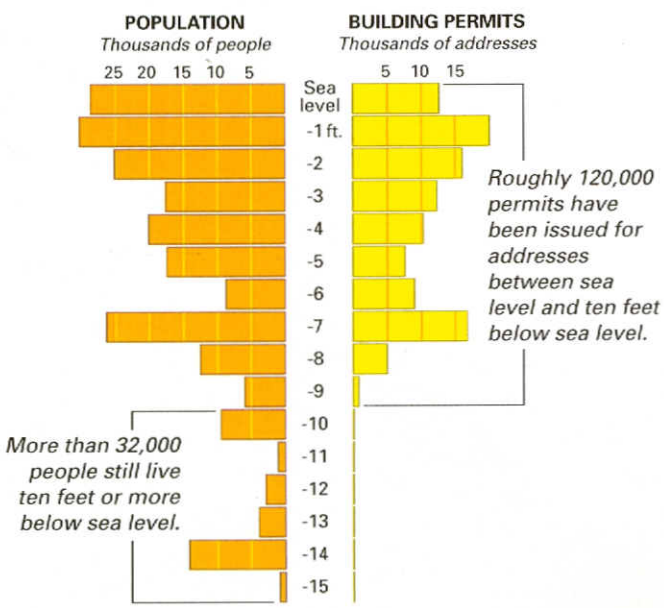
**HE LOWER NINTH WARD**
**ND ST. BERNARD PARISH**
ere heavily flooded after Katrina
reached levees along MRGO and
ne Industrial Canal. Rebuilding
as been limited.

DECOMINE DR.

sissippi River

## Below Sea Level

### ORLEANS PARISH AND ST. BERNARD PARISH



**2608**
UNDER RENOVATION, VACANT

**2612**
GUTTED
For Sale

**2616**
RENOVATED
PERMITS: Multiple

**2712**
GUTTED

**2800**
GUTTED, DEBRIS CLEARED
For Sale
PERMITS: Electrical

**2804**
TRAILER ON PROPERTY
For Sale
PERMITS: Electrical

**2904**
GUTTED, DEBRIS CLEARED
Structure Condemned

**2908**
OCCUPIED, TRAILER REMOVED
PERMITS: Multiple

## DECOMINE DRIVE, ST. BERNARD PARISH

**3008**
RENOVATED, VACANT
For Sale
PERMITS: Multiple

**3012**
GUTTED
For Sale

**3016**
DEMOLISHED

**MEMORY LANE** Images from June 2006 were stitched together to show the desolation along one side of Decomine Drive, a once comfortable street in St. Bernard Parish. Only three families had moved back, living in trailers. Below each address is the state of the house a year later. "People wait for their insurance money to rebuild," says Mario Bertrand, at 2908 Decomine. For some it may be too late; owners had to start rehabbing by June 4 or raise their houses for flood protection.

**2700**
GUTTED

**2704**
GUTTED

**2708**
GUTTED

**2808**
TRAILER ON PROPERTY
PERMITS: Electrical

**2812**
DEMOLISHED

**2900**
GUTTED

**2912**
VACANT

**3000**
GUTTED

**3004**
TRAILER ON PROPERTY
PERMITS: Multiple

**3020**
UNDER RENOVATION, VACANT
PERMITS: Electrical

**3024**
GUTTED

**3028**
TRAILER ON PROPERTY


SOURCE: ROBERT G. BEA, UNIVERSITY OF CALIFORNIA, BERKELEY

## Weakened Levees

Last year the U.S. Army Corps of Engineers said it had restored New Orleans' levees and floodwalls to pre-Katrina strength. But this spring engineer Bob Bea of the University of California, Berkeley, identified potential weak spots. They include levees along the Mississippi River Gulf Outlet, which Katrina's storm surge breached. Rebuilt of soft soil, the levees are already eroding. Bea also pointed to Katrina-damaged floodwalls, still not repaired, and gaps in the barriers that could admit flooding.

Bea is an expert witness in a lawsuit against the corps. But others share his concerns. One expert notes that the new floodgates guarding the city's three main drainage canals have no mechanism to clear debris that might keep them from closing. He also doubts the reliability of pumps installed to expel rainwater from the city when the gates close.

The corps says the city's defenses are a work in progress. "After Katrina we achieved a massive accomplishment, repairing the damage," says John Meador, deputy director of the Army Corps group rebuilding the levees. "We believe we are putting the system back better than it was before, but we're not at an end point yet."

### POINTS OF CONCERN

**1 DUNCAN CANAL FLOODWALL**
Built on soft soil, it is sinking and buckling; repairs with steel pilings may be inadequate.

**2 17TH STREET CANAL**
Levee work constricts water flow and could lead to flooding.

**3 ORLEANS AVENUE CANAL**
During Katrina, water spilled through a floodwall gap that still has not been closed.

**4 LONDON AVENUE CANAL**
New pumps and floodgates are designed to keep out storm surge, but some experts are skeptical.

**5 LONDON AVENUE CANAL**
The floodwall still includes sections damaged and weakened by Katrina.

**6 LONDON AVENUE CANAL**
A gap in the wall makes way for a bridge across the canal—but could admit floodwater.

**7 BAYOU BIENVENUE**
Concrete and rock armor could channel water onto the adjacent earthen levee, eroding it.

**8 MRGO LEVEES**
Rainwater has carved furrows into the newly reconstructed levees along the channel.

**More on Levees**
For additional details on this story and more photographs of the levee problems, go to **ngm.com/0708.**

A buckling floodwall along the Duncan Canal (1)

Erosion on the MRGO levees (8)

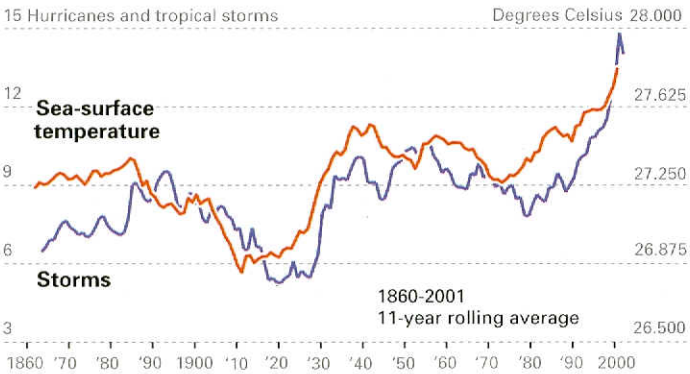
Old floodwall (right) on the London Ave. Canal (5)

Pump discharge pipes at London Avenue gates (4)

A floodwall gap on the Orleans Avenue Canal (3)

## Storm Warnings

Two years after Katrina, a hurricane could easily reflood New Orleans by pushing storm surge over the levees. The computer simulations below show the effect of a hurricane moving due north at 15 mph, hitting at high tide. Even a Category 3 storm would put much of the city underwater.


**Hotter oceans, more storms**

Warm seas are fuel for hurricanes. Storm frequency in the North Atlantic rises and falls with a decades-long, natural cycle of sea-surface temperatures, still years away from the next peak. Yet one study shows that storms in the past decade were 50 percent more common than at the previous peak, in the 1950s (left), a sign that global warming may be boosting storm frequency.

SOURCES: NOAA NATIONAL HURRICANE CENTER (MAPS); NOAA HURRICANE DATA ANALYZED BY GEORGIA INSTITUTE OF TECHNOLOGY (CHART)

*(Continued from page 43)* could rise "at least two feet, with a more likely amount as 3.7 feet. A rise as high as 12.6 feet cannot be ruled out." The corps responded: "Given the uncertainty of projections of sea level changes, an attempt to accommodate such changes in the design of the project . . . would represent a very poor use of funds."

"Locals wanted the cheapest possible protection system," says Oliver Houck. "But it wasn't cheap, it was just badly built."

The floodwalls along the city's major drainage canals were a classic example of the shortcomings. The corps didn't want to build most of them. Initially it planned to block storm surge with giant barriers across the eastern inlets of Lake Pontchartrain, beef up the levees along the southern lakeshore, and erect massive floodgates to keep high water out of the canals. Environmental groups, concerned about impacts on the lake and its wetlands, blocked the plan in court. The corps dropped the barriers and switched to a system that would rely on higher lake levees and floodgates. State and local officials—who were required to pick up nearly a third of the ballooning tab—balked at the cost of the gates. They also feared that closing the gates could actually cause flooding, as rainwater piled up in the canals. City leaders pushed instead for floodwalls along the canals. The groups remained at loggerheads until 1992, when Congress passed a water resources act that forced the corps to do it the city's way.

Foundation problems plagued the levees and floodwalls from day one. A contractor building the 17th Street Canal floodwalls in the mid-1990s actually tried to sue the corps for more money as the mucky soils drove up costs. The underlying sheet piles—steel panels driven into the ground to form a barrier—were shifting and

pushing the concrete walls on top out of line.

Katrina, alas, exposed these weak underpinnings. When the storm drove floodwaters to within four feet of the top, the walls deflected backward, opening a crack at their base. Water poured in, found a thin layer of clay as slick as jelly, and forced nearly 450 feet of levee into Orleans Parish. On the London Avenue Canal, sandy soils led to similar blowouts. Floodwall failure let in nearly 80 percent of the water that flooded the central part of the city. "Just ten million dollars more spent on sampling and foundation investigation, and the system wouldn't have failed," says engineer J. David Rogers, who investigated the breaches with a team from the University of California, Berkeley. "It didn't come within a country mile of the design load."

And that was just a start. In the year after Katrina, two independent investigations and the corps's own 25-million-dollar study painted a detailed picture of flaws in the planning, design, and construction of the levee system. The corps, in its defense, says it was hamstrung by a political process that tied the project to what the local sponsor wanted and, more important, could afford. "Basically, you had political influence on significant engineering decisions," says the corps's project manager for the hurricane protection system, Al Naomi. "We went from fighting surge at the Rigolets and Chef Menteur passes, to fighting surge at the lakefront, to fighting surge in the heart of a major American city. Failure at the Rigolets would have had far less consequences than failure on 17th Street."

**TALLER, STRONGER FLOODWALLS** now glisten in the breaches, their clean white concrete contrasting starkly with the still ruined neighborhoods behind them, while massive new black floodgates are poised to close the canals at the lakefront. The rebuilt hurricane protection system gives returning New Orleanians some sense of security. But the corps has yet to fix what many see as the weakest link in the system, the 76-mile ship channel called the Mississippi River Gulf Outlet—Mr. Go to the locals—which the corps dug east of town in the late 1950s and early 1960s.

On a steamy summer afternoon with squalls in the offing, coastal scientists Paul Kemp of Louisiana State University and John Lopez of the Lake Pontchartrain Basin Foundation set out by boat to inspect the "funnel," formed east of town by the levees lining the MRGO and another channel that converges with it, the Gulf Intracoastal Waterway. Computer models run by Kemp's colleagues at LSU show the funnel raised Katrina's massive surge by more than three feet in the Industrial Canal, overtopping and destroying floodwalls protecting the Lower Ninth Ward. Farther east, the storm surge hammered through more than eight miles of the MRGO levees, which in turn wiped out much of St. Bernard Parish.

St. Bernard residents had been clamoring for years for the corps to close the little-used channel they call the "hurricane highway." Touted as a shortcut to the port for ocean freighters, the channel instead destroyed tens of thousands of acres of wetlands. It brought in salt water that killed marsh plants, while the wakes of the few ships eroded the banks of the channel, widening it from 500 feet to almost a half mile in places. One lesson of Katrina is simple, says Lopez: Close MRGO.

The corps says it now intends to do so. But when or how the channel might be shut down is anyone's guess. Congress has yet to give a green light. "If we don't close MRGO," says Lopez, "it might be time to do what my wife says and move to Kansas."

Though the corps denies that the channel amplified Katrina's surge, everyone agrees that its levees—St. Bernard's primary hurricane defense—failed miserably. The corps insists the structures simply weren't high enough to withstand Katrina's 17 feet of surge and six-foot waves. But at many of the breaches, the levees were built of weak sand and shell dredged from the canal itself. Kemp believes the shell-sand

sections began to collapse as soon as the waves started breaking on them, long before the main surge hit. He also notes that where these levees were fronted by intact wetlands or trees, they survived. Where they ended directly in the water, they failed.

Old ways die hard in the bayou. Even after the dramatic failure of the shell sand in the levees, independent investigators found corps contractors using the same material to rebuild them. Only after the discovery was made public did the corps barge in yellowish clay from Mississippi to cap the levees. And parts of the new structures still have no buffer against erosion.

Kemp points to a new section of bare levee right next to the channel and shakes his head. "This is a recipe for disaster," he mutters. "The waves are going to break right on that thing. If a big storm comes in here this year, it's gone." Even sections of the levees newly capped with clay are already eroding from rainfall, Kemp says. In fact, during a recent inspection, engineering professor Bob Bea, who helped lead the UC Berkeley team that investigated the levee failures, found multiple chinks in the city's hurricane armor, from newly eroded levees along MRGO to Katrina-battered floodwalls that had not been repaired (see pages 52-3).

"When you start thinking about long-term protection, it doesn't give me any confidence," says Bea, a former resident of New Orleans who actually lost his home during Hurricane Betsy. "The system is ratty, shot full of defects. My advice for the people in low-lying areas: I wouldn't start rebuilding my life there."

**YET MANY ARE DOING JUST THAT,** regardless of what the experts say, with a typical New Orleans cocktail of denial, faith in the levees, and 100-proof love of home. Three months after the storm, when much of the city still lay in ruins, the mere suggestion by a blue-ribbon panel of planners from the Urban Land Institute to hold off rebuilding the lowest areas set off a howl of protests. Mayor C. Ray Nagin, who was in a tight election race at the time, dropped the notion of "shrinking the footprint" like a hot beignet, as did his opponent, Lieutenant Governor Mitch Landrieu. The mayor, however, fell short of promising every neighborhood city services.

To make matters even more confusing, the federal government declared it would offer flood insurance for most new or substantially rebuilt houses only if they were raised by several feet. Yet the city government granted exemptions to many returning homeowners, grandfathering their houses at their prior elevations. The result has been an unplanned patchwork recovery, with some people raising their homes to protect against floods and others building right back where they were in the lowest sections of the city.

Even after the massive engineering breakdown during Katrina, Matt McBride believes people can live safely at the bottom of the New Orleans bowl in a neighborhood called Broadmoor, which dips as much as ten feet below sea level. Streets of colorful "shotguns" and raised basement houses, many built in the 1920s and 1930s, have put Broadmoor on the National Register of Historic Places. Its less glorious claim to fame is that for much of its history the place was prone to flooding in any heavy downpour, resulting in one of the highest rates of repetitive flood losses in the nation. In one section of Broadmoor, homeowners with multiple losses have filed an average of six flood claims each.

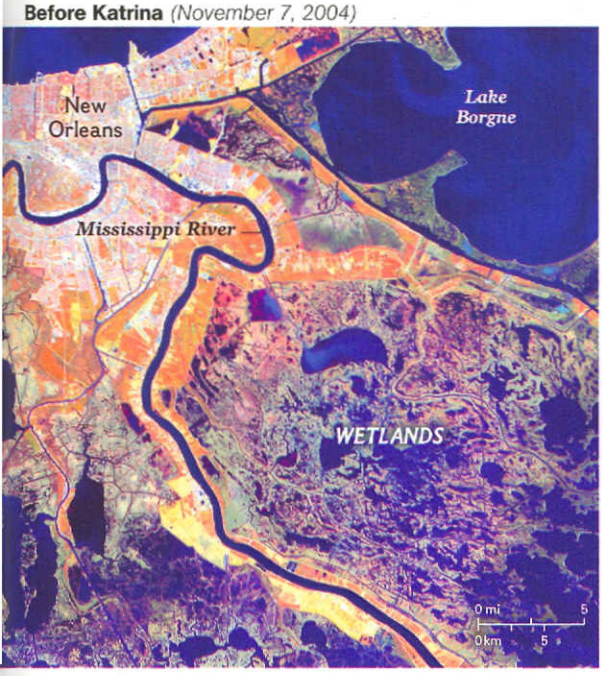
A 1995 flood following a rainstorm that dumped 14 inches on the neighborhood led to a multimillion-dollar drainage improvement project, completed in 2002, that drastically decreased flooding. Even during Katrina, with its 12 inches of rainfall, Broadmoor only flooded to the lawns and was pumped dry before the levees breached and the real flooding began. It was proof of what good engineering can do, says McBride, himself an engineer. "You can't design a perfectly flood-proof home," he says. "But if you get adequate levee protection and adequate drainage, I think people will return."

Keysha Finley didn't wait for the levees to be

people shouldn't be living, **YET WE'RE HERE.**"

— ROY DOKKA, Louisiana State University

**Before Katrina** *(November 7, 2004)*




**After Katrina** *(October 25, 2005)*

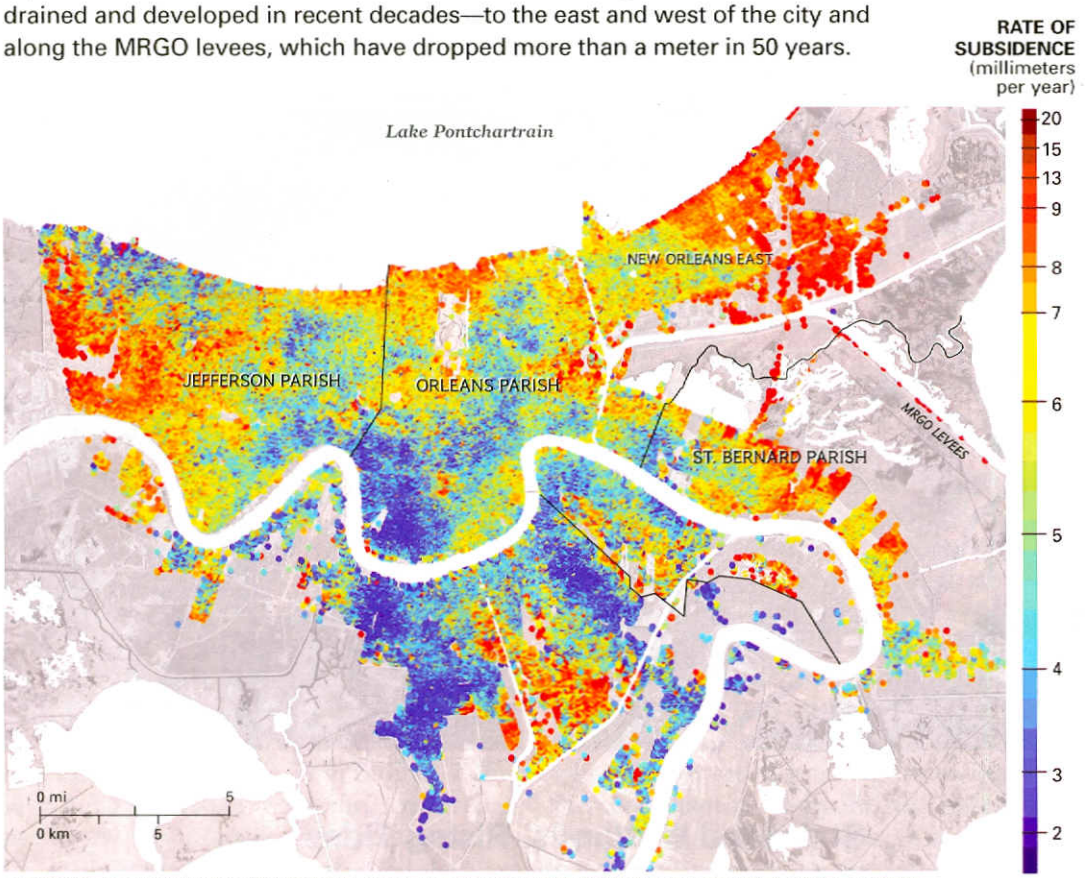
SOURCE: JOHN BARRAS, USGS NATIONAL WETLANDS RESEARCH CENTER

## Shredded Wetlands, Rising Tides

Louisiana is losing roughly 12 square miles of storm-buffering wetlands each year as levees block sediment, canals are dredged, and ground subsides. In 2005 Hurricanes Katrina and Rita took out 217 square miles, much of it east and south of New Orleans (above, seen from space before and after the storms). Some areas scoured by Katrina (below) may never recover.

## New Orleans Is Sinking

Largely below sea level already, the city subsides an average of six millimeters a year, satellite data from 2002 to 2005 show. The sinking is fastest in areas drained and developed in recent decades—to the east and west of the city and along the MRGO levees, which have dropped more than a meter in 50 years.




SOURCES: TIMOTHY H. DIXON, UNIVERSITY OF MIAMI CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING; TRE; *NATURE*, JUNE 1, 2006; RADARSAT

fixed. Just nine months before the storm, Finley had moved into a new four-bedroom brick house off Bullard Avenue, in one of the tonier neighborhoods of New Orleans East. Singer Aaron Neville lived in the posh Eastover subdivision nearby. Though most media attention has focused on the working-class Lower Ninth Ward, the damage was just as bad in New Orleans East, a bastion of middle- and upper-class black flight from crime and failing schools in the inner city. It's also one of the lowest sections of the city, with some areas more than ten feet below sea level.

Less than a year after the flood, Finley was back. Her kitchen, where four feet of muddy water sloshed for weeks, is now filled with warm Mediterranean colors and has a new tile floor. Is she concerned about the low elevation? "It was never a consideration," she says. "Before we bought, we asked the neighbors if it ever flooded. They said never."

Nearby houses remained boarded up and empty for months, but now the neighbors are rebuilding, reassuring Finley that she and her husband were right to return. "I know things happen wherever you go. You can't run from them," she says. But the months of stress have taken their toll. "If it happens again, I won't come back. I don't think I could go through this again."

The die-hard refusal to give up on home persists in the Lower Ninth Ward, where many houses had been in families for decades. Caught by a pincer of tidal waves coming from the blown-out levees to the east and the blown-out floodwalls of the Industrial Canal to the west, the black working-class neighborhood stewed in floodwaters for four weeks. Residents were not allowed to move back for another two months, to the utter dismay of Tanya Harris, an organizer for the community-rights group ACORN. Harris's family had lived for 60 years in the

hardest hit section, north of Claiborne Avenue, what she calls "way back-a-town."

"My neighborhood was an extension of the inside of my house," she says, driving over the rusty drawbridge over the Industrial Canal. "When I turned off Claiborne Avenue after work, it would take me 20 minutes to drive the last ten blocks home because I've got to wave to Aunt May and 20 other people. I'd complain about it, but I loved it."

Aunt May left after the storm, as did the kids who once played in the streets. The last ten blocks to Harris's home remain the same blur of destruction that blazed over television screens across the nation, with most houses abandoned or destroyed. Her house survived, a one-story yellow brick affair with red shutters. Twenty months after the storm, her renovations were nearly complete, and she hoped to move in soon.

The tortoise pace of repairing fractured sewer and water lines in the Lower Ninth originally fed suspicions that the city would take the Urban Land Institute's advice and redevelop the neighborhood with higher income homes and condos near the river and green space way back-a-town, replacing the derelict houses. But thanks largely to the efforts of Harris and ACORN, the city in March included the Lower Ninth in its rebuilding plan, which provides seed money for redevelopment. In fact, one of the first two new houses built in the neighborhood belongs to Harris's grandmother, Josephine Butler, the five-foot-tall, 85-year-old matriarch of her clan. "Nobody," says Harris, "not Ray Nagin, not George Bush, is going to tell her what to do."

**THE REALITY REMAINS DAUNTING** for those trying to rebuild, or trying to decide whether to come back at all. The risk of catastrophic flooding is rising year by year, with no end in sight—in no small part because the city is sinking.

Even before it was covered by millions of tons of floodwater, New Orleans had sunk well below sea level, because of the draining and compacting of the backswamp and the pumping of groundwater. According to the latest satellite measurements, the city continues to sink at around two-tenths of an inch each year. The rate is faster in Lakeview and fastest of all in neighborhoods to the east and west. In St. Bernard Parish, subsidence tops out at nearly an inch a year. Some sections of the MRGO levees have sunk up to four feet since they were built, according to Roy Dokka, an LSU geologist who co-authored the satellite study, and Katrina breached many of the low spots.

"This is a place where people shouldn't be living, yet we're here," says Dokka. "But subsidence isn't going to kill people. It's the ever increasing vulnerability to storm surges and our inability to prepare for them."

Sinking is only part of the city's elevation challenge. Over the thousands of years when the delta beneath the city was being formed, sea level was almost stable. But as climate change warms the oceans and melts glaciers, sea level is rising by three millimeters a year. In February a United Nations panel on climate change predicted that seas would be more than a foot higher by 2100. And one of the nation's top climate scientists thinks that forecast is far too modest. James Hansen, director of the NASA Goddard Institute for Space Studies in New York City, notes new data from satellites showing accelerated melting of the vast ice sheets in Greenland and West Antarctica. "If we go down the business-as-usual path," he says, "we will get sea level rise measured in meters this century."

The impact on New Orleans? A meter of sea level rise would be enough to turn New Orleans into the new Big Easy Reef—or a new Amsterdam, behind massive dikes. That's assuming that big hurricanes don't come more often; chances are they will. Hurricane frequency in the Atlantic waxes and wanes over a decades-long cycle that is now on the upswing. For this year, hurricane forecasters are predicting seven to ten hurricanes in the Atlantic Basin, with up to five reaching Category 3 or above—more than double the average from 1950 to 2000. The Gulf Coast faces

50-50 odds of being hit by a Katrina-size storm this summer. Already, tropical storms in the Atlantic are 50 percent more common than at the previous peak, in the 1950s, say Peter Webster and Judith Curry of the Georgia Institute of Technology. The frequency of truly monster storms —Categories 4 and 5—has doubled since 1970.

These trends have persuaded some researchers that the natural cycle is not the only factor driving up hurricane activity. Global warming is boosting sea-surface temperatures in hurricane alley—the tropical Atlantic and Caribbean—and warm seas are rocket fuel for stronger hurricanes. Before Katrina made landfall, it had exploded from a Category 3 storm to a Category 5 in 12 hours, partly because it stirred up a deep pocket of warm water in the Gulf. Only when it reached the Louisiana coast did the storm weaken again to a Category 3, sparing New Orleans an even greater catastrophe. If global warming produces stronger storms on top of the decadal cycle, 2005, with Katrina, Rita, and two other mega-hurricanes in the Atlantic, could be a stormy precursor of the coming century.

"The future of New Orleans looks bleak," says Ivor van Heerden, deputy director of LSU's Hurricane Center, who led the state's investigation of the Katrina disaster. "We have to recognize that global warming is part of our future, sea level rise is part of our future, more storms are part of our future. You flood those houses one more time, nobody is going to come back. And the rest of the country will lose interest."

For the moment, the city's prospects have brightened a little. Some of the 110 billion dollars in federal reconstruction funds is starting to trickle into homeowners' hands, and with the rebuilding plan issued in March the city finally has a blueprint for repairing its infrastructure and sparking a revival. The state has passed its first building code ever to help storm-proof future homes, while the fractious levee boards have merged into two state entities. The Corps of Engineers has 5.7 billion dollars to beef up the city's hurricane defenses and is releasing a long-awaited, supercomputer-generated, flood risk analysis that will help it craft a new hurricane-protection and coastal-restoration plan. Congress even gave the state a slice of oil and gas royalties from a new swath of the deep Gulf recently opened to drilling—to be used to restore the rapidly eroding wetlands, coastline, and barrier islands, which might one day provide some protection from future storms.

Torbjörn Törnqvist, a Dutch coastal geologist now at Tulane, is a rare scientist who is bullish about the future, seeing New Orleans' struggles with rising seas and stronger storms as a preview of what other coastal cities will soon face. He envisions a new urban landscape perfectly adapted to climate change, with restored wetlands, high-tech floodgates similar to those in the Netherlands, and a cleaner, greener, denser city. The entire pre-Katrina population, he contends, could live quite comfortably in the parts of the city that did not flood, transforming warehouses and blighted districts into new walkable, sustainable neighborhoods on the high ground.

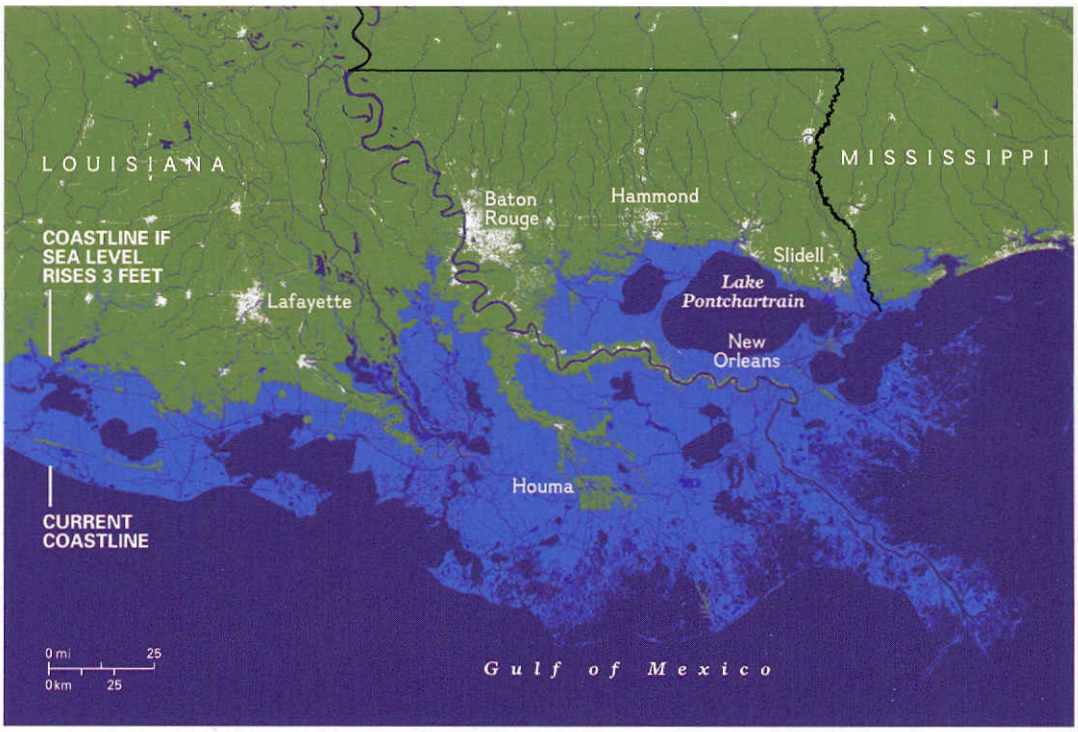
"The situation here is a huge opportunity for the city and the nation," says Törnqvist, who says he can't imagine Holland turning its back on Amsterdam, or Italy giving up on Venice. "If we walk away, we'll miss a fantastic opportunity to learn things that will be useful in Miami, or Boston, or New York in 50 years." That kind of revival, however, would require a massive infusion of federal help, better engineering than ever before, and more social and urban planning than regulation-loathing Louisianans have ever stomached.

But even if wind and water give the Big Easy a respite until the corps can guarantee legitimate 1-in-100-year hurricane protection, powerful social and demographic forces unleashed by Katrina may already be undermining the city's revival. Researchers have found that major disasters tend to accelerate existing social and economic trends. A booming San Francisco rebuilt bigger and better after its 1906 earthquake and fire; while the decaying industrial city of Tangshan, China, needed a huge infusion of aid from

is part of our future,

**SEA LEVEL RISE** is part of our future."

— IVOR VAN HEERDEN, Louisiana State University




SOURCE: JONATHAN OVERPECK AND JEREMY WEISS, UNIVERSITY OF ARIZONA

## The Coming Deluge

If sea level rises three feet, the south Louisiana coast will move far inland (green), erasing Lake Pontchartrain and stranding New Orleans far out at sea. Such a scenario is well within the realm of possibility by 2100, say scientists monitoring rising global temperatures and melting polar ice sheets.

the government to recover after a giant earthquake in 1976—and was ultimately saved by the country's burgeoning economy. It's a sobering precedent for New Orleans, which has been plagued for decades by economic decline—just a single *Fortune* 500 company is still headquartered there—shrinking population, failing schools, and high crime.

"So why protect it? Why protect a piece of history that's a cross between Williamsburg and Sodom and Gomorrah?" Oliver Houck sat in his office, hands locked behind his head, pondering the question on everyone's mind. "There are people who will fight to the death to stay here because it's such a damned joy to live here."

But at what price? Houck paused for a moment to gaze out his window at the oak-strewn Tulane campus. The university lost two departments and a quarter of its students to Katrina, while he and his family spent months in exile after the storm. "If two words characterize all of southern Louisiana now, they would be 'total uncertainty,'" Houck says. "It's the total talk around the table. It's the conversation you're having with friends and spouses, even strangers. What do we do now?"

**A Close Look** Listen to photographer Tyrone Turner's behind-the-scenes insights into the images he shot for this story at **ngm.com/0708**.

# NEW ORLEANS IN A MINOR KEY

KEY

Straight from heart to horn, trumpeter Kenneth Terry ends a song with the New Birth Brass Band at Preservation Hall. High rents and scarce housing in New Orleans forced three band members to drive from Houston and Atlanta to make their regular Thursday night gig. "What we do in New Orleans you can't find anyplace else," says Terry. "The jazz we play comes from the soul."

"We are going to come back, and we want the world to know it," says Lanier Hosford (above, in white hat). Less than two-thirds of its pre-Katrina size, New Orleans retains patches of vibrancy, from a gathering of arts patrons at a Garden District mansion to a Mardi Gras Indian parade on Claiborne Avenue (right) and a jazz musician's birthday bash in the French Quarter. "It's one of the most magical cities in the world," Hosford says. But is the magic strong enough to save it? "Absolutely, positively, yes, without a doubt."

who will **FIGHT TO THE DEATH** to stay here."

— OLIVER HOUCK, Tulane University

After she gutted two flood-damaged rooms of her childhood home in the Lower Ninth Ward, the memories got too strong for Nikkisha Neapollioun, so her son sat down to console her. Though she loves New Orleans, she has little confidence in the levees or the elected leaders. "It's like placing a Band-Aid on open-heart surgery and then saying come on back, it's OK!" □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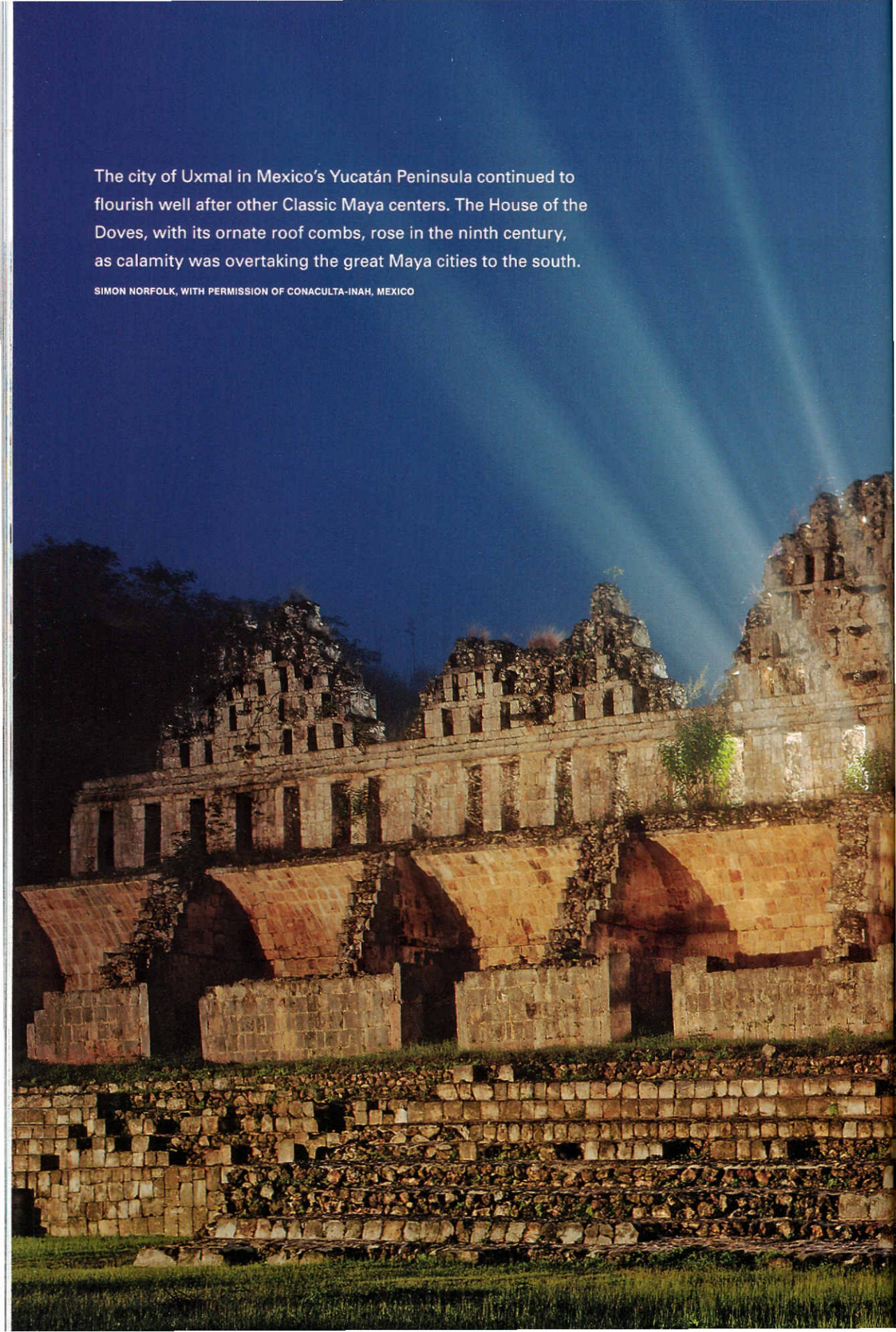
21-16

The city of Uxmal in Mexico's Yucatán Peninsula continued to flourish well after other Classic Maya centers. The House of the Doves, with its ornate roof combs, rose in the ninth century, as calamity was overtaking the great Maya cities to the south.

SIMON NORFOLK, WITH PERMISSION OF CONACULTA-INAH, MEXICO



# The Maya Glory and Ruin

Saga of a civilization in three parts: The rise, the monumental splendor, and the collapse.

BY GUY GUGLIOTTA
PHOTOGRAPHS BY KENNETH GARRETT
ART BY VANIA ZOURAVLIOV

Fashioned from 340 pieces of jade, a death mask immortalizes the face of King Pakal.

THE DOOMED SPLENDOR of the Maya unfolded against the backdrop of the rain forests of southern Mexico and Central America. Here, Classic Maya civilization reached improbable heights. To chart a culture whose Preclassic roots reach back 3,000 years, we begin with new evidence suggesting that the arrival of a warlord from central Mexico ushered in an age of magnificence and masterpieces such as the death mask of Palenque's King Pakal (above). Next, a photographic portfolio of temples rising from the dark tangle of jungle speaks to the sublime expression of Maya culture. But empires rise only to fall. In our concluding story, we look at the cascade of catastrophe—natural and man-made—that precipitated the Classic Maya collapse, leaving nature to reclaim the grandeur.


SOURCE: GEORGE E. STUART, BOUNDARY END ARCHAEOLOGY RESEARCH CENTER; RELIEF BY JOHN A. BONNER; LISA R. RITTER AND M. BRODY DITTEMORE, NGM MAPS
PHOTO: WITH PERMISSION OF THE NATIONAL MUSEUM OF ANTHROPOLOGY AND HISTORY, INAH, MEXICO CITY

THE RISE

# The Kingmaker

*Dispatched from Teotihuacan, the mighty city to the west, the warlord Fire Is Born founded new dynasties that brought unparalleled splendor to the Maya world.*

**THE STRANGER ARRIVED** as the dry season began to harden the jungle paths, allowing armies to pass. Flanked by his warriors, he marched into the Maya city of Waka, past temples and markets and across broad plazas. Its citizens must have gaped, impressed not just by the show of force but also by the men's extravagant feathered headdresses, javelins, and mirrored shields—the regalia of a distant imperial city.

Ancient inscriptions give the date as January 8, 378, and the stranger's name as Fire Is Born. He arrived in Waka, in present-day Guatemala, as an envoy from a great power in the highlands of Mexico. In the coming decades, his name would appear on monuments all across the territory of the Maya, the jungle civilization of Mesoamerica. And in his wake, the Maya reached an apogee that lasted five centuries.

Fire Is Born's foreign trappings, such as his goggles and the spear-thrower he holds in this modern painting, were adopted by Maya kings to affirm their ties to the legendary leader.

The Maya have always been an enigma. Decades ago the glories of their ruined cities and their beautiful but undeciphered script had many researchers imagining a

gentle society of priests and scribes. As epigraphers finally learned to read the Maya glyphs, a darker picture emerged, of warring dynasties, court rivalries, and palaces put to the torch. Maya history became a tapestry of precise dates and vividly named personages.

But deep mysteries remained, among them what spurred the Maya's final leap toward greatness. Around the time Fire Is Born's fame was spreading, a wave of change swept the Maya world. What had been a collection of inward-looking city-states expanded their ties with their neighbors and other cultures and reached the heights of artistic achievement that define the Classic Maya period.

New clues, unearthed from overgrown ruins and teased from newly deciphered texts, point to Fire Is Born as a central figure in this transformation. Though fragmentary, the evidence that has emerged over the past decade suggests that this mysterious outsider remade the political leadership of the Maya world. Mixing diplomacy and force, he forged alliances, installed new dynasties, and spread the influence of the distant city-state he represented, the great metropolis of Teotihuacan near present-day Mexico City.

Scholars disagree about the nature of his legacy—whether he ushered in a lasting era of foreign domination or catalyzed homegrown change. It is also possible that the Maya were already destined for greatness, and Fire Is Born just picked a lucky time to visit. But there is no question that his arrival marked a turning point. "I don't know if Fire Is Born invented the new system," says Nikolai Grube of the University of Bonn, "but he was there at the beginning."

Even before Fire Is Born, the Maya had risen to unlikely heights in a harsh land. Today, the lowlands of southern Mexico and Guatemala's Petén region yield little beyond bare subsistence to their inhabitants. "A high civilization," says Vanderbilt University Maya scholar Arthur Demarest, "had no business being there."

The setting of ancient Waka, now known as El Perú, is probably much as it was when the first Maya arrived, in perhaps 1000 B.C.—a dense rain forest where scarlet macaws, toucans, and vultures nest in towering tropical hardwoods. Spider monkeys swing from branches and vines, and howler monkeys bellow in the distance. When it rains in the Petén, mosquitoes swarm in such clouds that today's Maya have to drive them away with greasy smoke from torches burning cohune palm nuts. In the dry season, the heat bakes the swampy *bajos,* or bottomlands, the rivers fall, and drought threatens. It is a land of machetes and mud, serpents and sweat, and cats—most notably *balam,* the jaguar, lord of the jungle.

The earliest arrivals probably had no choice—overcrowding elsewhere may have forced them into this forbidding environment. But once there, they mastered its challenges. Settling near rivers, lakes, and swamps, they learned to maximize the thin soil's productivity. They cleared the forest for maize, *(Continued on page 81)*

**Society Grant** Research described in these stories was supported by your Society membership.

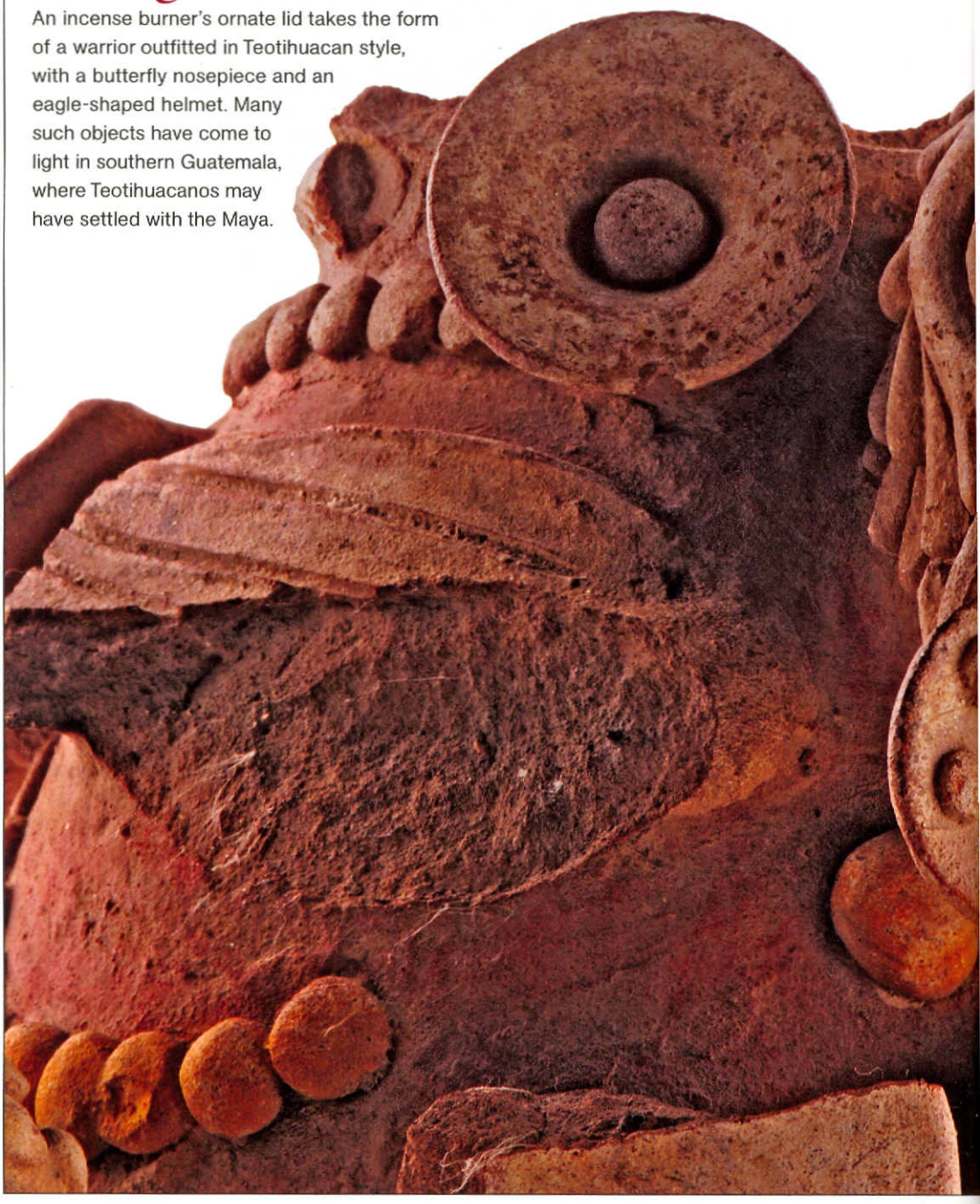
# Marking a New Era

A stone monument from the Maya metropolis of Tikal commemorates the arrival of Fire Is Born, in A.D. 378. Its shape recalls the feather-adorned ball-court markers typical of central Mexico, homeland of Fire Is Born. The writing on the shaft describes him as the envoy of a mysterious ruler named Spear-thrower Owl, represented in the medallion at the top by an owl with an atlatl, or spear-thrower. Other sources reveal that Fire Is Born installed Spear-thrower Owl's son as Tikal's new king.

MINISTRY OF CULTURE AND SPORT, GUATEMALA

# Foreign Influence

An incense burner's ornate lid takes the form of a warrior outfitted in Teotihuacan style, with a butterfly nosepiece and an eagle-shaped helmet. Many such objects have come to light in southern Guatemala, where Teotihuacanos may have settled with the Maya.



MINISTRY OF CULTURE AND SPORT, GUATEMALA

Under Fire Is Born's plan to conquer cities and eliminate rivals, a masked priest sacrifices a young king.

squash, and other crops by slashing and burning, much as today's Maya do, then re-enriched the land by alternating crops and letting fields lie fallow.

As populations grew, they adopted more intensive methods of cultivation—composting, terracing, irrigation. They filled in swamps to create fields and carried silt and muck from bottomlands to fertilize enclosed gardens. Artificial ponds yielded fish, and corrals held deer and other game flushed from the forest. The ancient Maya ultimately coaxed enough sustenance from the meager land for several million people, many times more than now live in the region.

Over the centuries, as the Maya learned to prosper in the rain forest, the settlements grew into city-states, and the culture became ever more refined. The Maya built elegant multiroom palaces with vaulted ceilings; their temples rose hundreds of feet toward the heavens. Ceramics, murals, and sculpture displayed their distinctive artistic style, intricate and colorful. Though they used neither the wheel nor metal tools, they developed a complete hieroglyphic writing system and grasped the concept of zero, adopting it for everyday calculations. They also had a 365-day year and were sophisticated enough to make leap-year-like corrections. They regularly observed the stars, predicted solar eclipses, and angled their ceremonial buildings so that they faced sunrise or sunset at particular times of year.

Mediating between the heavens and earth were the Maya kings—the *kuhul ajaw,* or holy lords, who derived their power from the gods. They functioned both as shamans, interpreting religion and ideology, and rulers who led their subjects in peace and war. Demarest and others have described the Maya centers as "theater states" in which the kuhul ajaw conducted elaborate public rituals to give metaphysical meaning to movements of the heavens, changes of the calendar, and the royal succession.

Behind the cloak of ritual, the Maya cities acted like states everywhere, making alliances, fighting wars, and trading for goods over territory that ultimately stretched from what is today southern Mexico through the Petén to the Caribbean coast of Honduras. Well-worn trails and stucco-paved causeways crisscrossed the forest, and canoes plied the rivers. But until Fire Is Born arrived, the Maya remained politically fragmented, the city-states charting their own courses in the jungle.

By 378 Waka was a prestigious center, boasting four main plazas, hundreds of buildings, temple mounds up to 300 feet tall, ceremonial palaces clad in painted stucco, and courtyards graced with carved limestone altars and monuments. A trading power, it occupied a strategic location on the San Pedro River, which flowed westward from the heart of the Petén. Its market was filled with Maya foodstuffs such as maize, beans, chilies, and avocados, along with chicle harvested from sapodilla trees to make glue, and latex from rubber trees to

## A Telltale Monument

Commissioned by a Tikal ruler named Stormy Sky, an inscribed stone pillar known as Stela 31 tells the story of Fire Is Born's arrival some 60 years earlier —and the death that same day of Tikal's king, surely ordered by the invading warlord. When this monument was discovered in 1960, Maya writing was just starting to be deciphered, so Fire Is Born's name glyph (above) was first read as Smoking Frog, a simple description of the design. Since then the Maya code has been cracked more fully, and Stela 31 has revealed its long-held secrets.

MINISTRY OF CULTURE AND SPORT, GUATEMALA

# Refined Taste

Objects such as this jade vessel crowned by a king's likeness testify to the Maya's artistic skills and far-flung commerce. Luxuries including jade, exotic pelts, and feathers were traded throughout the region and into central Mexico. Cacao beans—evoked by a ceramic goddess sprouting cacao pods (below right)—served as money.



MUSEO POPOL VUH, UNIVERSIDAD FRANCISCO MARROQUÍN, GUATEMALA (INSET); MINISTRY OF CULTURE AND SPORT, GUATEMALA

make balls for ceremonial games. Exotic goods found their way to Waka as well. Jade for sculpture and jewelry and quetzal feathers for costumes came from the mountains to the south, and obsidian for weapons and pyrite for mirrors from the Mexican plateau to the west, the domain of Teotihuacan.

A sprawling metropolis of 100,000 people or more—perhaps the largest city in the world at the time—Teotihuacan left no records that epigraphers have been able to decipher. But its motives in dispatching Fire Is Born to the Maya region seem clear. Waka sat on a promontory overlooking a tributary of the San Pedro with a protected harbor, excellent for berthing large canoes. "It was a perfect staging area" for military action, notes Southern Methodist University archaeologist David Freidel, co-director of excavations at Waka. Which may be precisely what Fire Is Born had in mind.

Waka appears to have been key to the envoy's mission: to bring the entire central Petén into Teotihuacan's orbit, through persuasion if possible, force if necessary. His principal target was Tikal, a kingdom 50 miles east of Waka. Tikal was the most influential city-state in the central Petén. Bring Tikal into the fold, and the other cities would follow.

Fire Is Born's soldiers were probably shock troops, designed principally to display his bona fides and demonstrate good faith. He needed reinforcements, and he had come to Waka to get them. In return, he could offer the goodwill of his patron, a mysterious ruler known from inscriptions as Spear-thrower Owl, probably a highland king, perhaps even the lord of Teotihuacan.

Waka's ruler, Sun-faced Jaguar, apparently welcomed Fire Is Born. Based on hints in texts from Waka and other sources, Freidel, project co-director Héctor Escobedo, and epigrapher Stanley Guenter suggest that the two rulers cemented their alliance by building a fire shrine to house the sacred flame of Teotihuacan.

Along with moral support, Fire Is Born probably secured troops. His expeditionary force likely carried the spear-throwers and javelins typical of Teotihuacan and wore backshields covered with glittery pyrite, perhaps meant to dazzle the enemy when the soldiers spun around to hurl their weapons. Now warriors from the Petén, equipped with stone axes and short stabbing spears, swelled their ranks. As armor, many wore cotton vests stuffed with rock salt. Eleven hundred years later, the Spanish conquistadores shed their own metal armor in the sweltering rain forest in favor of these Maya "flak jackets."

The military expedition most likely set out for Tikal in war canoes, heading east, up the San Pedro River. Reaching the headwaters, the soldiers disembarked and marched either along the river or on the canyon rim overlooking it.

Garrisons probably dotted the route. News of the advancing column must have reached Tikal, and somewhere along the stretch of riverbank and roadway, perhaps at a break in the cliffs about 16 miles from the city, Tikal's army tried to stop Fire Is Born's

advance. Inscribed slabs, called stelae, later erected at Tikal suggest that the defenders were routed. Fire Is Born's forces continued their march on the city. By January 16, 378—barely a week after his arrival in Waka—the conqueror was in Tikal.

The date is noted on Tikal's now famous Stela 31, which yielded early clues to Fire Is Born's importance when David Stuart of the University of Texas at Austin deciphered it in 2000. The second passage on the stela records what happened after the city fell: Tikal's king, Great Jaguar Paw, died that very day, probably at the hands of the vanquishers.

Fire Is Born appears to have dropped whatever pretense he had assumed as a goodwill ambassador. His forces destroyed most of Tikal's existing monuments—stelae put in place by 14 earlier rulers of Tikal. A new era had begun, and later monuments celebrated the victors. Stela 31, erected long after the conquest, describes Fire Is Born as *Ochkin Kaloomte,* or Lord of the West, probably referring to his origins in Teotihuacan. Some Maya experts have also suggested another meaning: that Fire Is Born represented a faction that had fled to the west—to Teotihuacan—after a coup d'état by Great Jaguar Paw's father years earlier and had now returned to power.

It apparently took Fire Is Born some time to pacify Tikal and its environs. But a year after his arrival, Tikal's monuments record that he presided over the ascension of a new, foreign king. Inscriptions identify him as the son of Spear-thrower Owl, Fire Is Born's patron in Teotihuacan. According to Stela 31, the new king was less than 20 years old, so Fire Is Born probably became Tikal's regent. He was certainly the city's de facto overlord.

In the years that followed the conquest, Tikal itself went on the offensive, expanding its reach across the Maya region. Fire Is Born appears to have masterminded the campaign, or at least inspired it. References to him have been identified in cities as distant as Palenque, more than 150 miles to the northwest. But the most poignant testimony to his empire-building comes from Uaxactún, just 12 miles from Tikal. There a mural shows a Maya nobleman giving homage to a warrior in Teotihuacan regalia —perhaps one of Fire Is Born's troops. A stela depicting a similar warrior guards a tomb where archaeologists found the remains of two women, one pregnant, a child, and an infant. Freidel and others have concluded that these were the remains of Uaxactún's royal family, slain by Tikal's forces. The king, presumably, was taken to Tikal and sacrificed there.

Decades after the arrival of Fire Is Born and long after he must have died, the aggressive rulers of Tikal continued to invoke Fire Is Born and his patron state, Teotihuacan. In 426, Tikal took over Copán, 170 miles to the south in present-day Honduras, and crowned its own king, Kinich Yax Kuk Mo, who became the founder of a new dynasty. A posthumous portrait shows him wearing a costume

Mourned by his wife, the deceased king Kinich Yax Kuk Mo (Shining Quetzal Macaw) lies amid offerings in his tomb at Copán, in present-day Honduras. Backed by Teotihuacan, he founded a dynasty in 426 that lasted almost four centuries.

typical of central Mexico—a reference to Teotihuacan—and like Fire Is Born, he bore the title Lord of the West.

Some Mayanists believe that Tikal was acting as a vassal state for Teotihuacan, expanding its dominion throughout the Maya lowlands, with Fire Is Born acting as a kind of military governor. Others see him less as a conqueror and more as a catalyst who spurred Tikal to expand its own power and influence.

His fate is a mystery. There is no known record of his death, and no evidence that he ever ruled a Maya kingdom. But his prestige lived on. The Waka stela recording his arrival there wasn't erected until a generation later, indicating that even a long-ago visit from the great Fire Is Born was a matter of civic pride.

The Maya were never the same after him. Later rulers transformed Tikal into what Nikolai Grube, and Simon Martin of the University of Pennsylvania Museum, have described as a Maya superpower. And in both religion and art, the Classic Maya began to embrace foreign motifs and themes, adding sophistication and cosmopolitan exuberance to an already flourishing culture.

Soon another political development fed this cultural flowering. In the sixth century, the *kan* (meaning "snake") lords of Calakmul, a city just north of the Petén, began their own expansion. In time Calakmul came to challenge Tikal, and the rivalry split the Maya world. Like the 20th century Cold War, this contest spurred heights of achievement even as it sowed tension and strife. But unlike our own, the Maya Cold War ended in catastrophe.

■ **The saga continues** with the collapse of the Classic Maya on page 97.

# Built to Awe

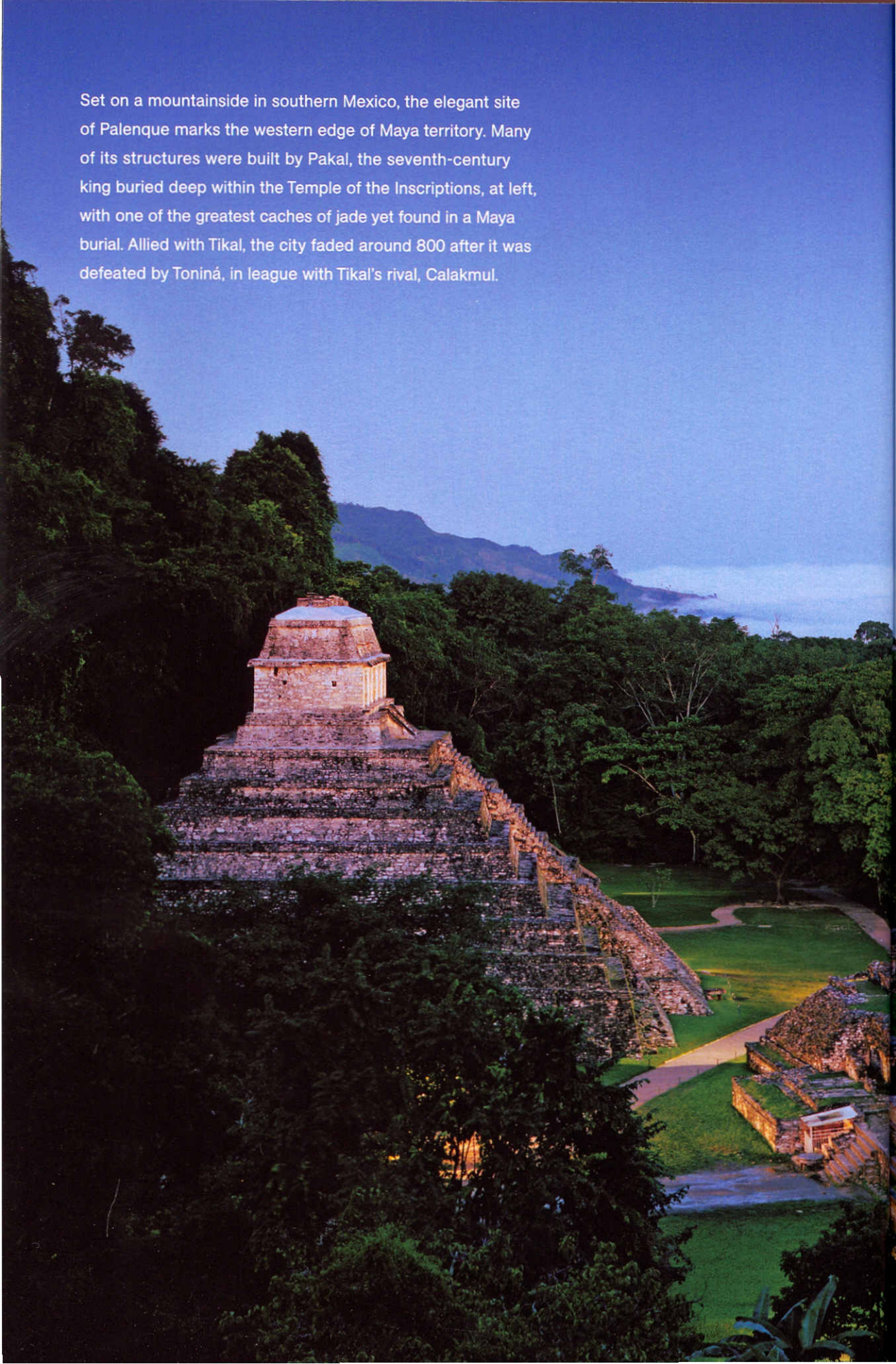
## Mesoamerica's grand monuments

PORTFOLIO BY SIMON NORFOLK

The ruins of Tikal's Temple of the Great Jaguar, rising amid the rain forest in northern Guatemala, still express the glory of the city's ancient rulers. Among the largest of the early Maya city-states, Tikal was the first target of a conquering army from central Mexico, which arrived on January 16, 378. During the next five centuries it became a superpower with alliances—and enemies—throughout the Maya realm.

To avoid daytime shadows at Tikal and other sites, Simon Norfolk photographed them after dark, bathed in floodlights.

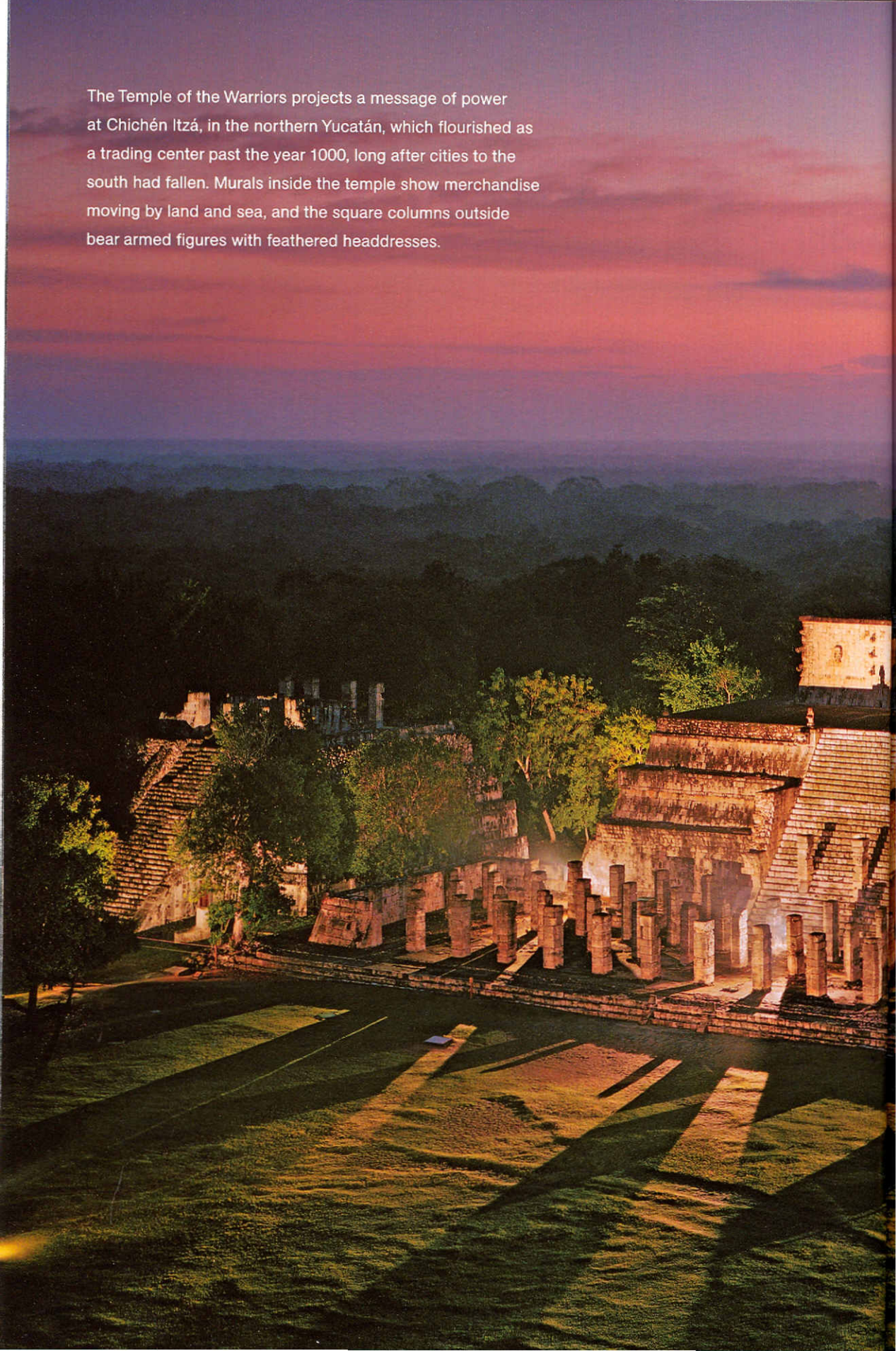
WITH PERMISSION OF THE MINISTRY OF CULTURE AND SPORT, GUATEMALA (RIGHT), AND CONACULTA-INAH, MEXICO (ALL OTHERS)



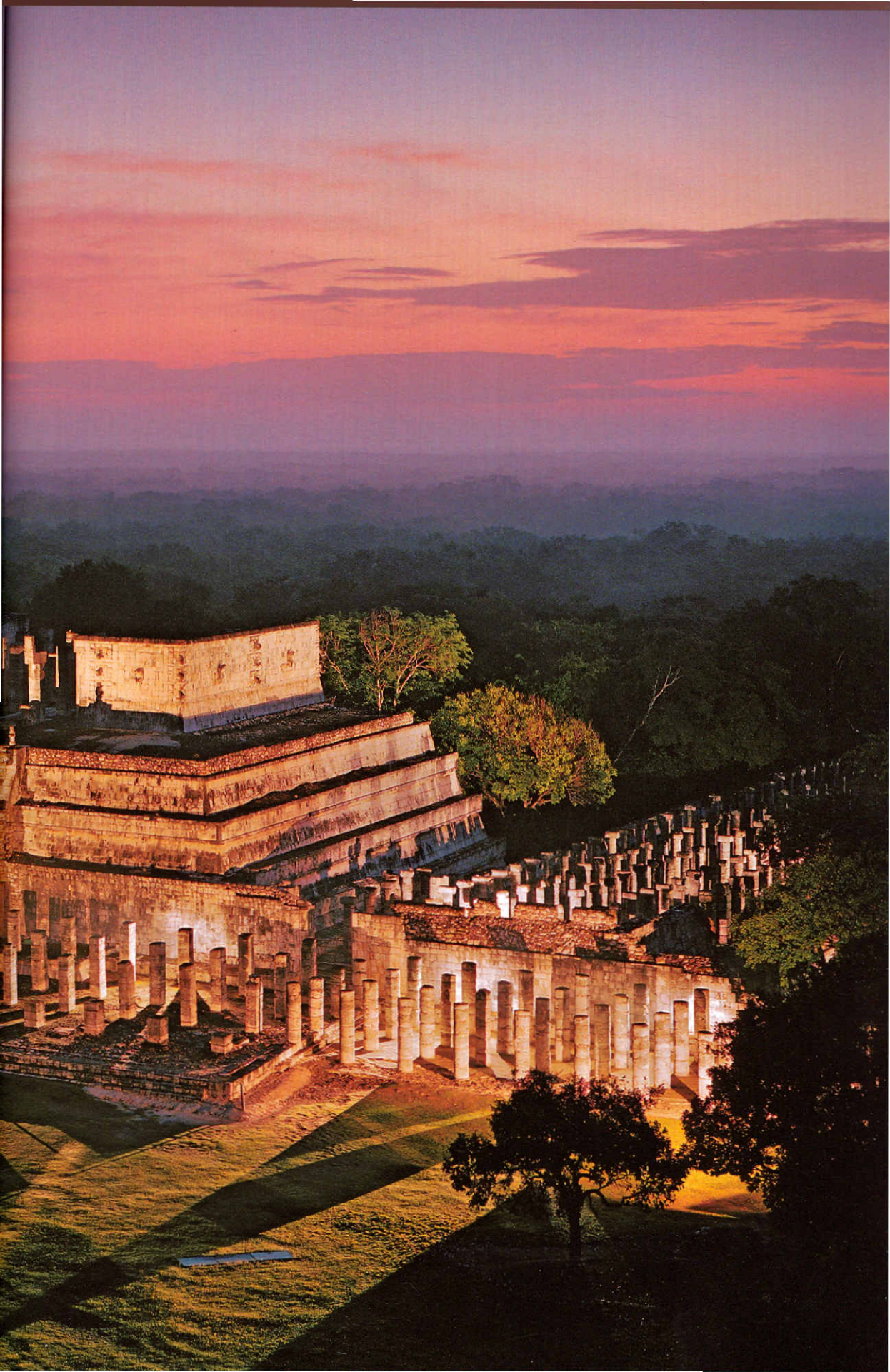
Set on a mountainside in southern Mexico, the elegant site of Palenque marks the western edge of Maya territory. Many of its structures were built by Pakal, the seventh-century king buried deep within the Temple of the Inscriptions, at left, with one of the greatest caches of jade yet found in a Maya burial. Allied with Tikal, the city faded around 800 after it was defeated by Toniná, in league with Tikal's rival, Calakmul.

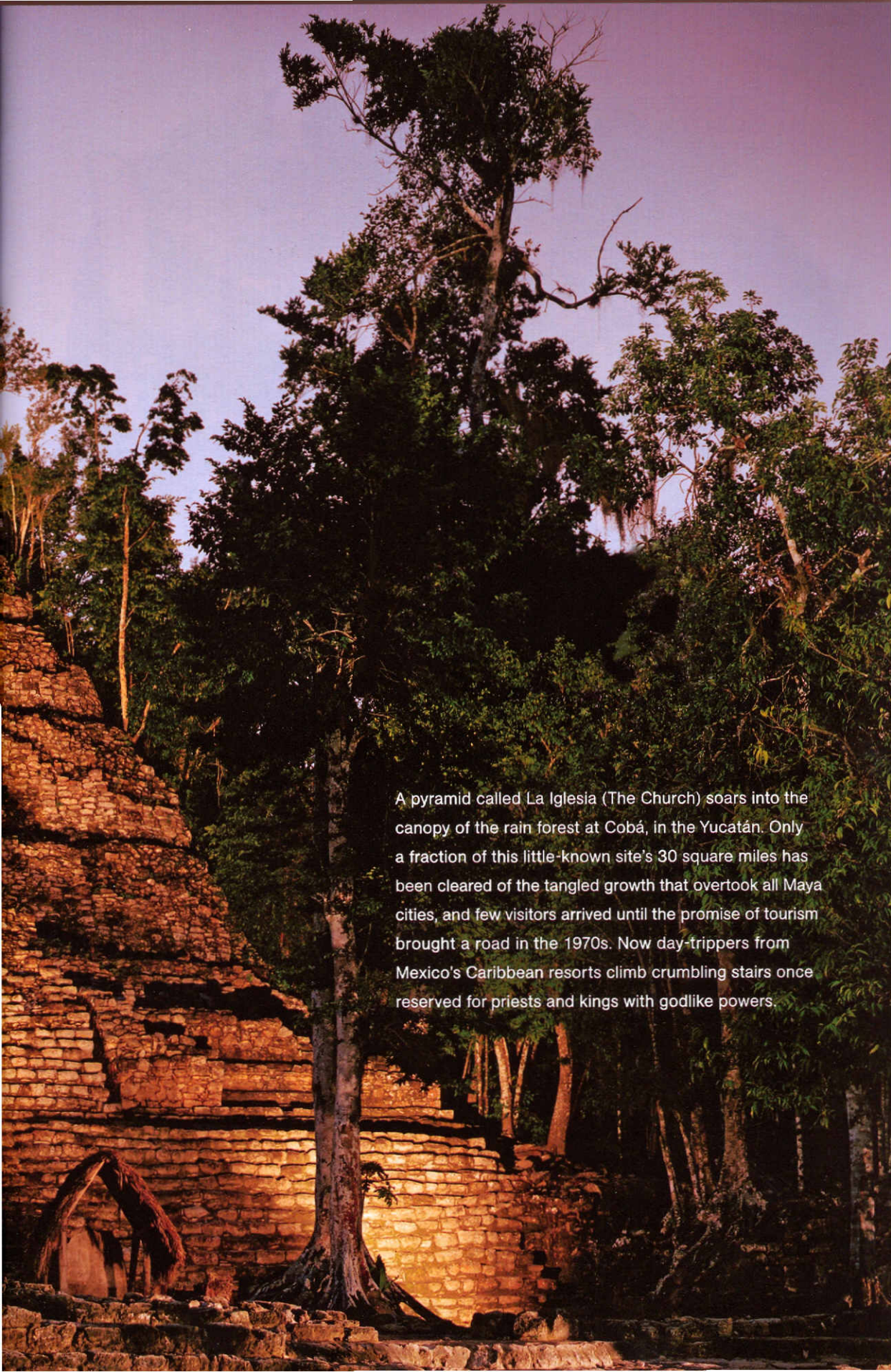
With Polaris as a hub, stars streak through the night in a time exposure of the House of the Magician at Uxmal. The Maya tracked celestial movements closely and created an accurate solar-year calendar based on their observations. They also made mystical connections between earth and sky, scheduling momentous events such as battles and sacrifices around the journeys of Venus and perhaps Jupiter.

Kabáh, in the Yucatán, shares the ornate architectural style of Uxmal, to which it was linked by a *sacbe,* or stone causeway. Its most famous monument, the Palace of the Masks, displays 260 images of Chac, the long-nosed rain god. Repeated on many buildings in this arid site, the motif was likely meant to summon rain. The snouts could have held offerings of sacred incense.



The Temple of the Warriors projects a message of power at Chichén Itzá, in the northern Yucatán, which flourished as a trading center past the year 1000, long after cities to the south had fallen. Murals inside the temple show merchandise moving by land and sea, and the square columns outside bear armed figures with feathered headdresses.





A pyramid called La Iglesia (The Church) soars into the canopy of the rain forest at Cobá, in the Yucatán. Only a fraction of this little-known site's 30 square miles has been cleared of the tangled growth that overtook all Maya cities, and few visitors arrived until the promise of tourism brought a road in the 1970s. Now day-trippers from Mexico's Caribbean resorts climb crumbling stairs once reserved for priests and kings with godlike powers.

# Fatal Rivalries

*Warfare raging out of control added to other stresses—overpopulation, environmental damage, drought, and extravagance—that pushed the Classic Maya civilization into decline and collapse.*

**ONE DAY IN THE YEAR 800,** the peaceful Maya city of Cancuén reaped the whirlwind. King Kan Maax must have known that trouble was coming, for he had tried to build makeshift breastworks at the approaches to his 200-room palace. He didn't finish in time.

The attackers quickly overran the outskirts of the city and streamed into Cancuén's ritual heart. The speed of the attack is obvious even today. Unfinished construction projects lay in tumbled heaps. Half-carved stone monuments littered the pathways. Pots and bowls were strewn about the palace kitchen.

Two kings, probably brothers, ended up on opposite sides of an epic conflict between Tikal and Calakmul. After a bloody battle one killed the other, setting off a devastating cycle of violence.

The invaders took 31 hostages. The jewels and ornaments found with their remains marked them as nobles, perhaps members of Kan Maax's extended family or royal guests from stricken cities elsewhere. The captives included women and children; two of the women were pregnant.

All were led to the ceremonial courtyard of the palace and systematically executed. The killers wielded spears and

axes, impaling or decapitating their victims. They laid the corpses in the palace's cistern. Roughly 30 feet long and 10 feet deep, it was lined with red stucco and fed by an underground spring. The bodies, accompanied by ceremonial garments and precious ornaments, fit easily. Kan Maax and his queen were not spared. They were buried a hundred yards away in two feet of construction fill intended for remodeling the palace. The king still wore his elaborate ceremonial headdress and a mother-of-pearl necklace identifying him as Holy Lord of Cancuén.

No one knows who the killers were or what they sought. Booty apparently did not interest them. Some 3,600 pieces of jade, including several jade boulders, were left untouched; household goods in the palace and ceramics in Cancuén's giant kitchen were undisturbed. But to archaeologists who have dug up the evidence over the past several years, the invaders' message is clear. By depositing the bodies in the cistern, "they poisoned the well," says Vanderbilt University archaeologist Arthur Demarest. They also chipped the faces from all the carved likenesses on Cancuén's stone monuments and pushed them over, facedown. "The site," says Demarest, "was ritually killed."

Cancuén was one of the last major dominoes to fall in the Pasión River Valley, part of the ancient Maya heartland in present-day Guatemala. Many other cities had already met similarly decisive ends, and throughout the southern lowlands of Mesoamerica, what came to be known as the collapse of the Classic Maya was well under way. The civilization that had dominated the region for 500 years was sliding into a prolonged, irrevocable decline.

While warfare obliterated some vibrant city-states, others simply faded. The *kuhul ajaw,* or holy lords, who had celebrated their every deed in murals, sculpture, and architecture, no longer commissioned new works. Public displays of hieroglyphic writing became scarce, and dates in the Long Count calendar system all but disappeared from monuments. Population fell drastically. Nobles abandoned palaces and squatters moved in, lit cook fires in the old throne rooms, and built lean-tos next to crumbling walls. And then even the squatters left, and the jungle reclaimed what remained.

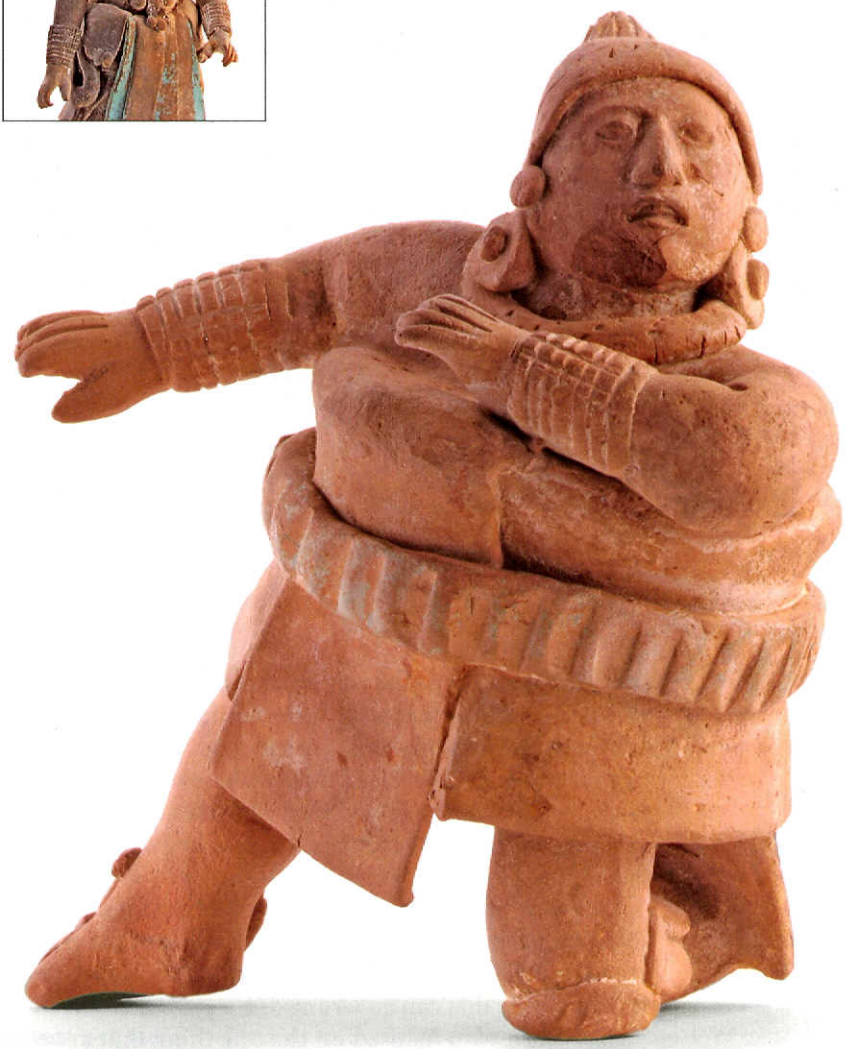
Elsewhere in the Petén lowlands of Guatemala and in southern Mexico, the collapse took longer. Even as Cancuén fell, rulers of the great city-state of Tikal in the northern Petén were building ceremonial structures. But 30 years later Tikal's population began to drop precipitously as well. Its last dated monument was inscribed in 869. By 1000, the Classic Maya had ceased to exist.

The question has fascinated scholars and the public since 19th-century explorers began discovering "lost cities" in the Petén: How could one of the ancient world's great civilizations simply dissolve?

Early speculation centered on sudden catastrophe, perhaps volcanism or an earthquake or a deadly hurricane. Or perhaps

# Costly Excess

Maya society strained as the ranks of the elite grew, increasing the demand for luxuries and elaborate rituals. Nobles like the man represented by a clay figurine from Jaina, in Mexico (left), wore richly decorated clothing, rare plumes, jade, shells, and fancy headdresses. The Maya ball game, sometimes played as a ritual war, required heavy padding (below)—and could end with the beheading of the losers.



NATIONAL MUSEUM OF ANTHROPOLOGY AND HISTORY, INAH, MEXICO CITY (BOTH)

it was a mysterious disease, untraceable today—something like the Black Death in medieval Europe or the smallpox that wiped out Native American populations at the dawn of the colonial age. Modern researchers have discarded these one-event theories, however, because the collapse extended over at least 200 years. "There isn't any single factor that everybody agrees on," says Southern Illinois University's Prudence M. Rice.

Scholars have looked instead at combinations of afflictions in different parts of the Maya world, including overpopulation, environmental damage, famine, and drought. "You come away feeling that anything that can go wrong did," says Rice.

They have also focused on the one thing that appears to have happened everywhere during the prolonged decline: As resources grew scarce, the kuhul ajaw lost their divine luster, and, with it, the

A painting based on ancient depictions shows a scene of revelry where richly adorned courtiers sip spicy chocolate in the presence of their king. Such extravagant indulgence may have blinded the Maya elite to the gathering storm of calamities.

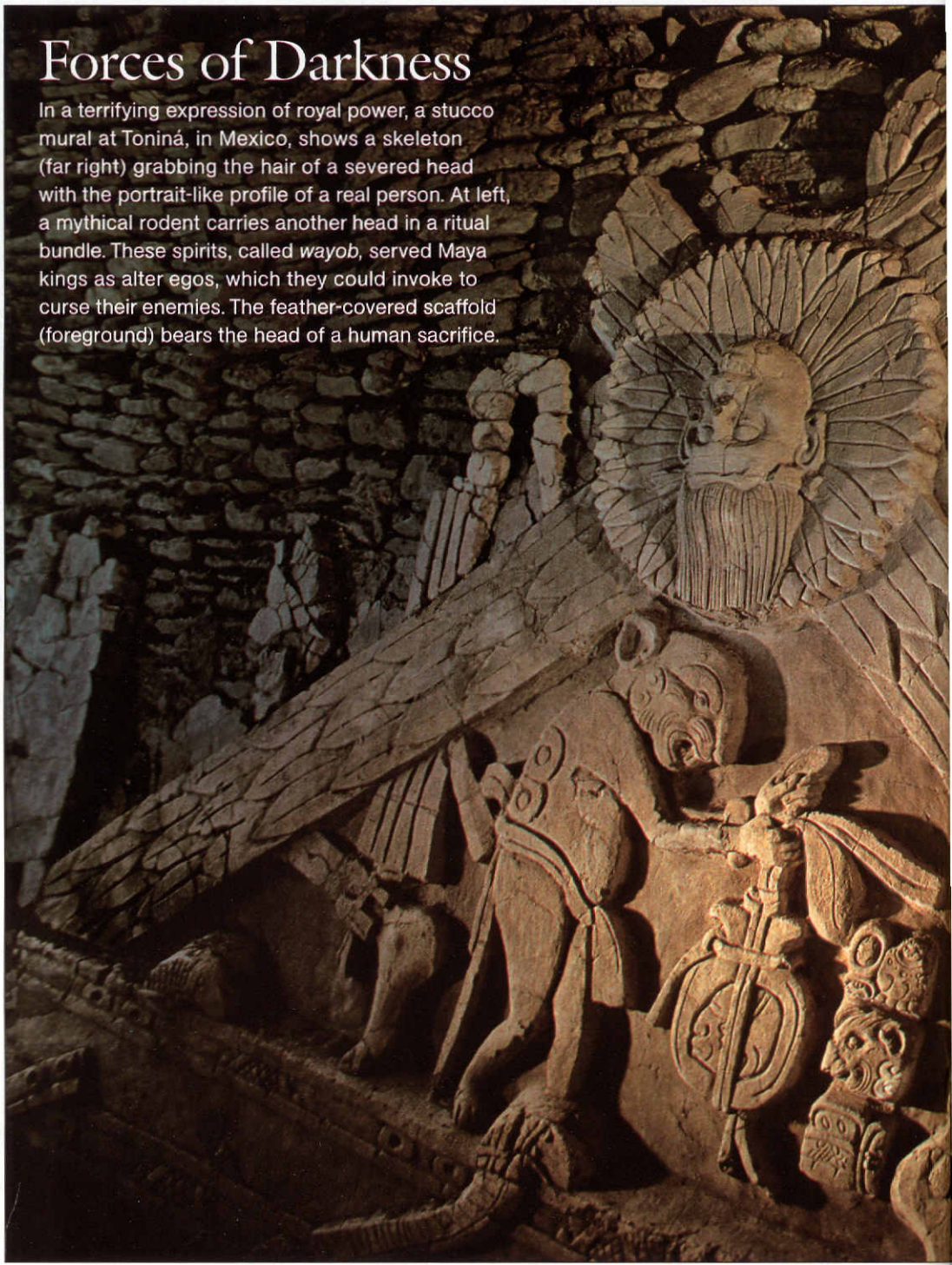
confidence of their subjects, both noble and commoner. Instability and desperation in turn fueled more destructive wars. What had been ritualized contests fought for glory or captives turned into spasms of savagery like the one that obliterated Cancuén. Says Simon Martin of the University of Pennsylvania Museum: "The system broke down and ran out of control."

For more than a millennium, the Maya had entrusted their religious and temporal well-being to their god-kings. These leaders displayed their might and majesty in lavish rituals and pageants, in opulent art and architecture, and in written records of their triumphs, inscribed on stone, murals, and ceramics.

The system prospered—indeed, its excesses created the artistic achievements and learning that defined the Maya as one of the ancient world's great cultures—as long as the land could satisfy

# Forces of Darkness

In a terrifying expression of royal power, a stucco mural at Toniná, in Mexico, shows a skeleton (far right) grabbing the hair of a severed head with the portrait-like profile of a real person. At left, a mythical rodent carries another head in a ritual bundle. These spirits, called *wayob*, served Maya kings as alter egos, which they could invoke to curse their enemies. The feather-covered scaffold (foreground) bears the head of a human sacrifice.



CONACULTA-INAH, MEXICO

people's basic needs. This was easy at first when cities were small and resources relatively plentiful, but over time, growing populations, an expanding nobility, and rivalry between the city-states strained the limits of the environment.

Today the Petén, geographically the largest province in Guatemala, has a population of 367,000, living in isolated towns scattered through a forested wilderness. In the eighth century, by some estimates, ten million people lived in the Maya lowlands. The landscape was an almost unbroken fabric of intensely cultivated farms, gardens, and villages, linked by a web of trails and paved causeways connecting monumental city-states.

Maya farmers were well schooled in sophisticated techniques designed to get maximum production from delicate tropical soils. But beginning in the ninth century, studies of lake-bed sediments show, a series of prolonged droughts struck the Maya world, hitting especially hard in cities like Tikal, which depended on rain both for drinking water and to reinvigorate the swampland *bajos* where farmers grew their crops. River ports like Cancuén might have escaped water shortages, but across much of the Maya region the lake-bed sediments also show ancient layers of eroded soil, testimony to deforestation and overuse of the land.

When bad times came, there was little the kuhul ajaw could do to help their people. Monoculture farming—growing one staple food crop that could be accumulated and stored for hard times or for trade—could not be sustained in the rain forest. Instead, each city-state produced small quantities of many different food items, such as maize, beans, squash, and cacao. There was enough, at least at first, to feed the kingdom, but little left over.

Meanwhile, Maya society was growing dangerously top heavy. Over time, elite polygamy and intermarriage among royal families swelled the ruling class. The lords demanded jade, shells, feathers from the exotic quetzal bird, fancy ceramics, and other expensive ceremonial accoutrements to affirm their status in the Maya cosmos. A king who could not meet the requirements of his relatives risked alienating them.

The traditional rivalry among states only made matters worse. The kuhul ajaw strove to outdo their neighbors, building bigger temples and more elegant palaces and staging more elaborate public pageants. All of this required more labor, which required larger populations and, perhaps, more wars to exact tribute in forced labor from fallen enemies. Overtaxed, the Maya political system began to falter.

The greatest rivalry of all helped propel the Classic Maya to their peak—and then tore their world apart. Beginning in the fifth century, the city-state of Tikal, probably bolstered by an alliance with the great Mexican highland state of Teotihuacan, expanded its influence, enlisting allies and vassal states in a swath southward through the Pasión River Valley to Copán in what is now Honduras. A century later a challenger arose: The northern city-state of

# A Final Countdown

The back of a stela from the city of Toniná records the date January 18, 909—the last known date in the Maya Long Count, a calendar system spanning centuries. The silence that followed testifies to the culture's decline. A clay warrior from Cancuén, bearing the kind of ax that invaders used to kill the city's elite, embodies the catastrophic upheaval of war and revenge that led to ruin.

MINISTRY OF CULTURE AND SPORT, GUATEMALA (INSET); TONINÁ MUSEUM, CONACULTA-INAH, MEXICO

Calakmul, in what is now the Mexican lowlands of Campeche, forged an alliance of city-states throughout the Petén, north to the Yucatán and east to what is now Belize. The two great alliances faced off in a rivalry that lasted more than 130 years.

This period marked the golden age of Classic Maya civilization. The kuhul ajaw were in full flower in these two great alliances, competing in art and monuments as well as in frequent but limited wars. Calakmul defeated Tikal in a major battle in 562 but destroyed neither the city nor its population. Eventually Tikal rebounded and defeated Calakmul, subsequently building many of its most spectacular monuments.

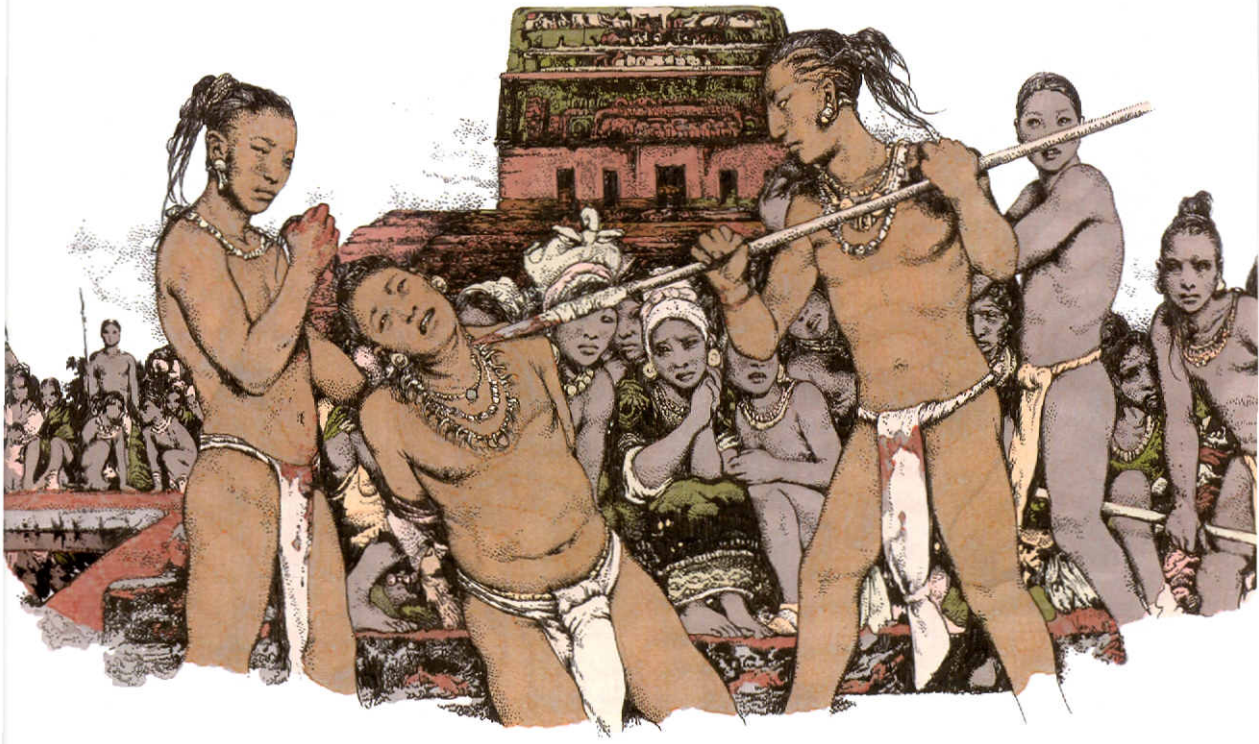
Simon Martin, with Nikolai Grube of the University of Bonn, compares the Tikal-Calakmul rivalry to the superpower struggle of the 20th century, when the U.S. and the Soviet Union competed to outdo each other in fields ranging from weaponry to space travel. With neither side ever able to gain the upper hand, the Cold War arguably brought stability, and so did the standoff in the Maya world. "There was a certain degree of destruction" because of the rivalry, says Guatemalan archaeologist Héctor Escobedo. "But there was also equilibrium."

It did not last. Martin suggests the balance may have been intrinsically unstable, like the competition among the city-states of ancient Greece, or the nervous grappling between North and South in the United States prior to the Civil War. Or perhaps an overstressed environment finally caught up with the proud Maya powers, bringing a new edge of desperation to their rivalry. Either way, the unraveling began at the small garrison state of Dos Pilas, near the Pasión River downstream of Cancuén.

In 630 Tikal, trying to reassert a presence along Pasión River trade routes increasingly dominated by Calakmul, expanded an existing outpost near two large springs—*pilas,* in Spanish. The site had little else to recommend it. Dos Pilas grew no crops and sold nothing. Scholars call it a "predator state" that depended on tribute from the surrounding countryside. War, for Dos Pilas, was not only a ritual to glorify kings and appease gods. War was what Dos Pilas did to survive.

The kingdom's history of violence and duplicity began when Tikal installed one of its princes, Balaj Chan Kawiil, as Dos Pilas's ruler in 635. The garrison slapped together a fancy-looking capital for the young prince, using carved facades to mask loose and unstable construction fill. But in 658 Calakmul overran Dos Pilas and drove Balaj Chan Kawiil into exile.

We know the next chapter thanks to a thunderstorm that toppled a tree at Dos Pilas six years ago, exposing a carved stairway hidden beneath its roots. Inscriptions on the stairway reveal that Balaj Chan Kawiil returned two years after his exile—but as a Calakmul surrogate. Dos Pilas's turncoat king helped Calakmul cement its control



In an imagined scene based on discoveries at Cancuén, invaders execute the city's nobles one by one, depositing the bodies in the sacred cistern in front of the palace. The king and queen were also killed and buried nearby in full regalia.

over the Pasión Valley during the next two decades. Then Calakmul delivered fateful news. Its rulers ordered Balaj Chan Kawiil to fight his brother in Tikal itself.

In 679 he attacked his native city. "Mountains of skulls were piled up, and blood flowed," the stairway records. Balaj Chan Kawiil triumphed, and his brother died in the battle. The victory brought Calakmul to apogee and transformed Dos Pilas into the overlord of the Petexbatún, the southwestern part of the Petén.

Tikal survived, rebuilt, and less than 20 years later attacked and defeated Calakmul. Stucco sculpture at Tikal's central acropolis depicts a Calakmul noble awaiting sacrifice. It was a defeat from which Calakmul never fully recovered, but Tikal itself was never the same after the wars finally concluded. "Even though Tikal wins in the end," says the University of Pennsylvania's Robert Sharer, "it's never in shape to control everything."

What happened next is not entirely clear. Calakmul's power was broken, yet its allies, including Dos Pilas, continued to battle Tikal in Calakmul's name. Dos Pilas consolidated its hegemony in the Petexbatún through alliances and war. Its rulers commissioned new monuments and built a second capital.

But in 761 Dos Pilas's luck ran out. Former allies and vassals conquered the city and sent its ruler into exile. Dos Pilas would

## A Royal Treasure

One of the last great kings of Cancuén, Taj Chan Ahk, presides over a ceremony in September 795 on a recently uncovered masterpiece of Maya art. With hundreds of sites still to be investigated, many more such testaments to the glory of the Maya civilization await discovery.

never be resettled, and with its obliteration the Maya world crossed a divide. Instead of reestablishing order, wars would create greater disorder; instead of one ruler emerging triumphant from a decisive battle, each conflict simply created more pretenders. Victories, instead of inspiring new monuments and temples, were transient and, increasingly, unremarked. Defeats spurred desperate citizens to rip apart their ceremonial buildings, using the stones and fill to build redoubts in hopes of staving off future invaders. Cities no longer rebuilt and rebounded. They simply ceased to exist.

Smaller states tried to assert themselves in the spreading chaos, but none could. Instead, the warring states sought temporary advantage in a land of dwindling resources. The commoners probably hid, fled, or died.

For a time, fleeing nobles could find refuge in Cancuén, a quiet port at the headwaters of the Pasión River. Even as downriver cities sank into chaos during the eighth century, Cancuén prospered by trading luxury items and providing sumptuous lodgings for elite visitors. The architect of this golden age was King Taj Chan Ahk, who came to power in 757 at the age of 15. Cancuén had a long history as a strategic trading post, but Taj Chan Ahk transformed the city into

In the guise of a jaguar, a dancer moves to the music of reed whistles and drums during El Pochó, a pre-Lenten dance in Tenosique, Mexico, that blends Catholic beliefs from the Spanish conquistadores with the enduring customs of the ancient Maya.

a stunning ceremonial center. Its heart was a 270,000-square-foot, three-story royal palace with vaulted ceilings and 11 courtyards, made of solid limestone and elegantly placed on a riverside promontory. It was a perfect stage for a Maya god-king, and Taj Chan Ahk was master of the role, even as it was dying out elsewhere.

There is no evidence that Taj Chan Ahk ever fought a war or even won a battle. Instead he managed to dominate the upper Pasión Valley for nearly 40 years by coaxing advantage through patronage and alliances. An altar monument at Cancuén dated 790 shows him in action, engaged in a ceremonial ball game with an unknown noble, perhaps to celebrate a treaty or a state visit.

Taj Chan Ahk died in 795 and was succeeded by his son Kan Maax, who sought to trump his father by expanding the palace. But pomp and ritual—the old trappings of kingship—could no longer hold the Maya universe together. Within five years the spreading chaos had reached the gates of the city. In one terrible day its glory winked out, another light extinguished in the world of the Classic Maya. □

**Ancient Excursion** Explore the ruins and artifacts of the Maya in our Photo Gallery, download images, and learn about National Geographic Society–sponsored research on the ancient Maya at **ngm.com/0708**.

MINISTRY OF CULTURE AND SPORT, GUATEMALA (OPPOSITE)

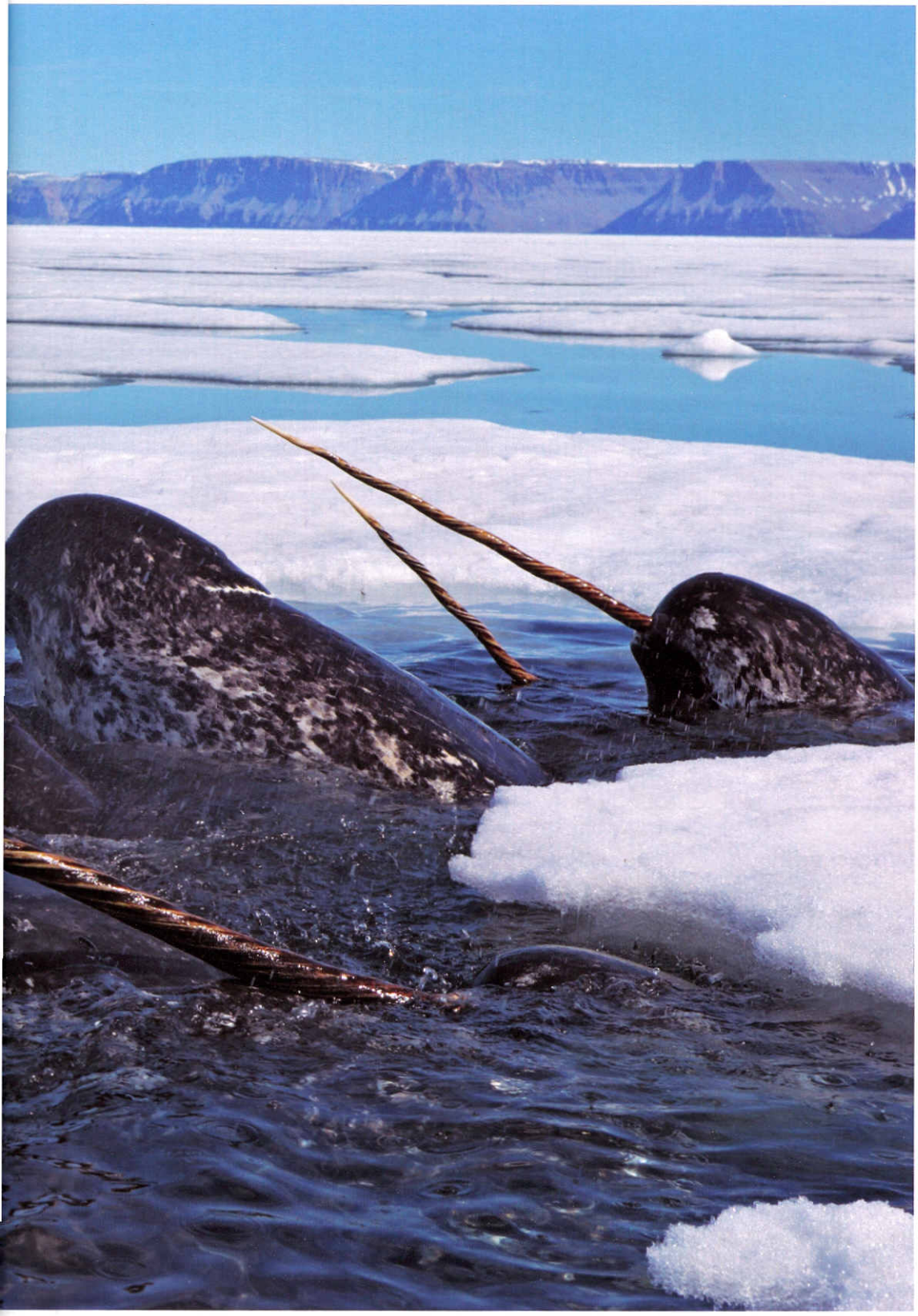
Prized by medieval royalty, inspiration for unicorn myths, narwhal tusks have driven men to extremes for centuries. Today the quest for tusks and skin threatens some populations.

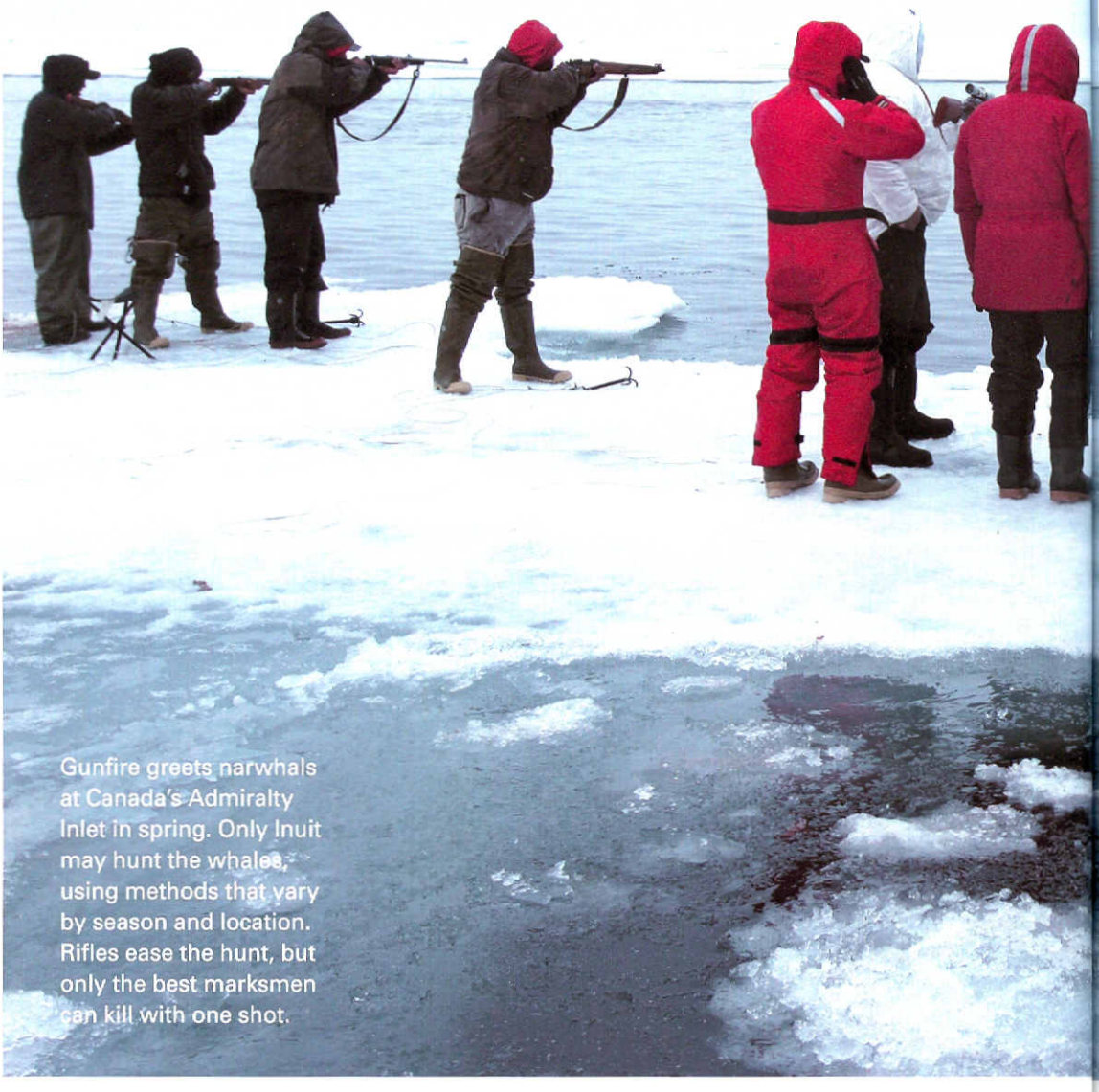
# ARCTIC IVORY

## HUNTING THE NARWHAL

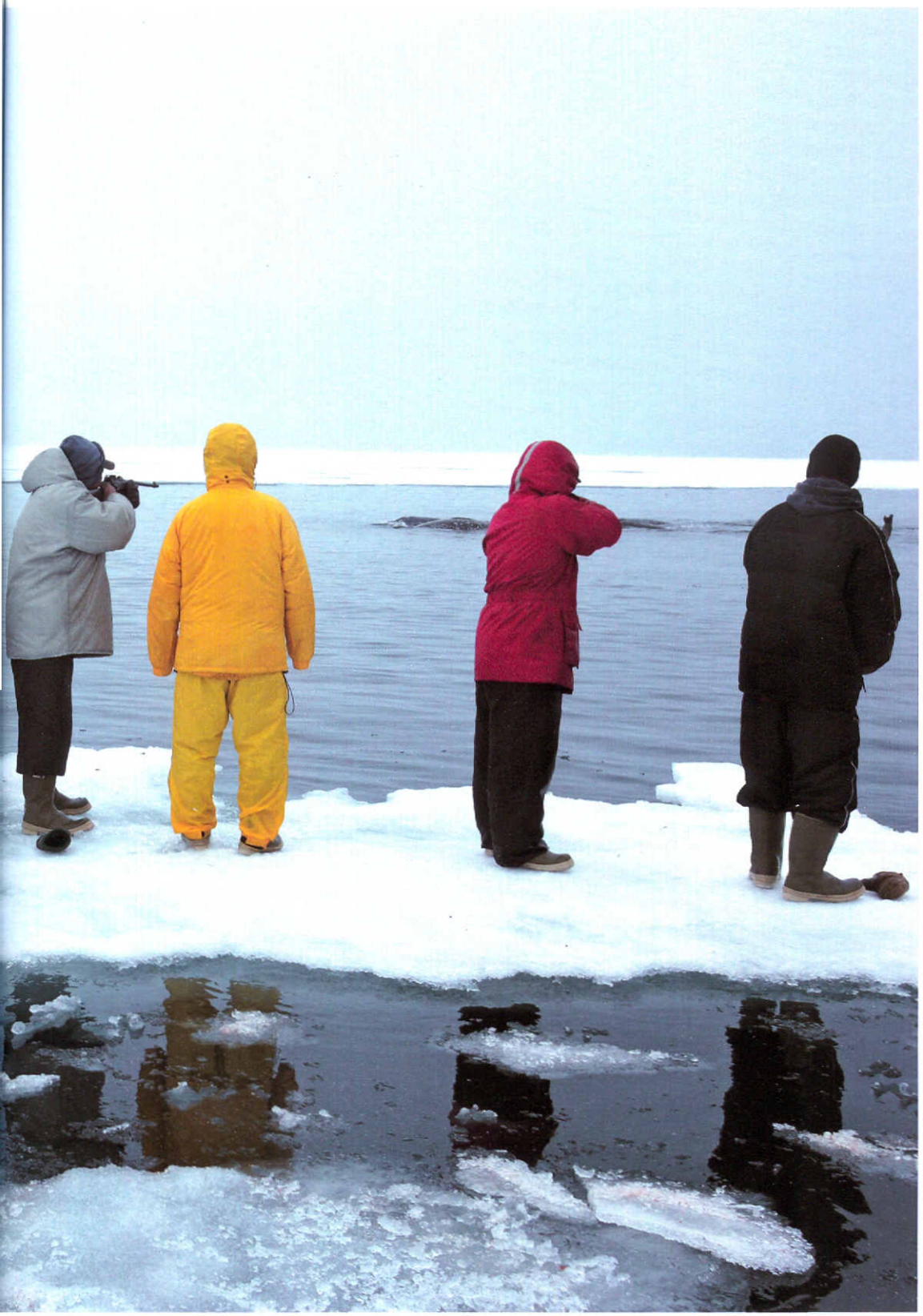
In spring, as the ice pack recedes, narwhals push into cracks and holes as they migrate. Their compact size (13 to 16 feet long) and lack of dorsal fins aid travel beneath the ice. The annual migration also brings them within range of human hunters.

Swarming into an ice hole, males wield their tusks with care. The tusk, a tooth growing out of the upper jaw, is almost exclusively a male trait. Scientists believe it serves a display function, much like the antlers of a stag.

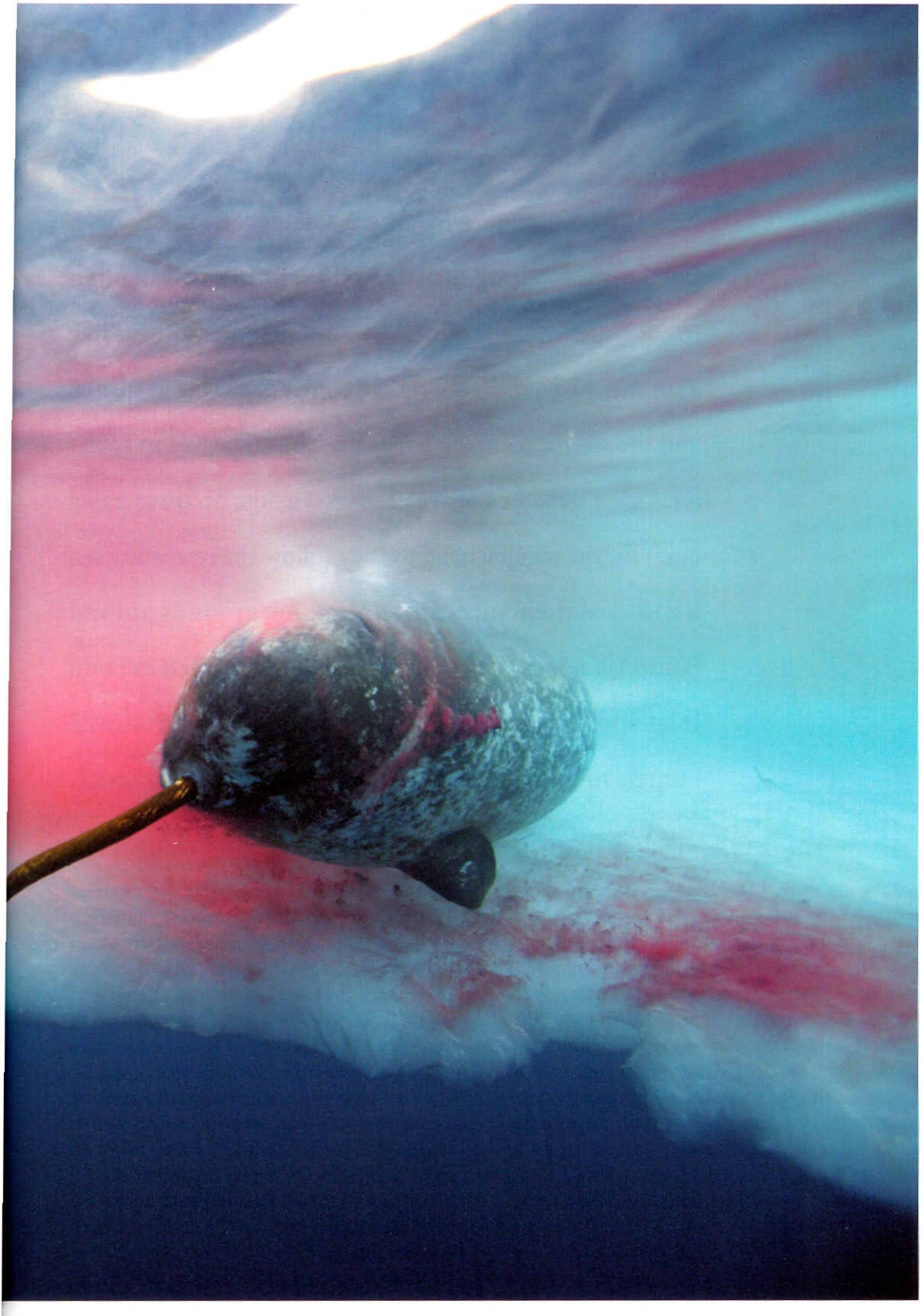




Gunfire greets narwhals at Canada's Admiralty Inlet in spring. Only Inuit may hunt the whales, using methods that vary by season and location. Rifles ease the hunt, but only the best marksmen can kill with one shot.



During hunts at the ice edge, many narwhals are shot—but not all are retrieved, as this one was. Some whales sink; others escape, wounded. Estimates suggest high numbers of the whales are lost, but the claim remains controversial.



TEXT AND PHOTOGRAPHS BY PAUL NICKLEN

The return of the narwhal, the tusked whale of northern polar seas, is a long-anticipated event in the Canadian Arctic. After months of darkness and temperatures as low as minus 40 degrees Fahrenheit, winter gives way to spring, and the sea ice covering Lancaster Sound begins to splinter. Open stretches of water, called leads, become travel lanes for the small whales as they follow the retreating sea ice toward their ancestral summering grounds around Baffin Island. In remote Inuit communities such as Pond Inlet and Arctic Bay, news of the narwhals' arrival stirs hunters to reach for their rifles and head for the ice edge.

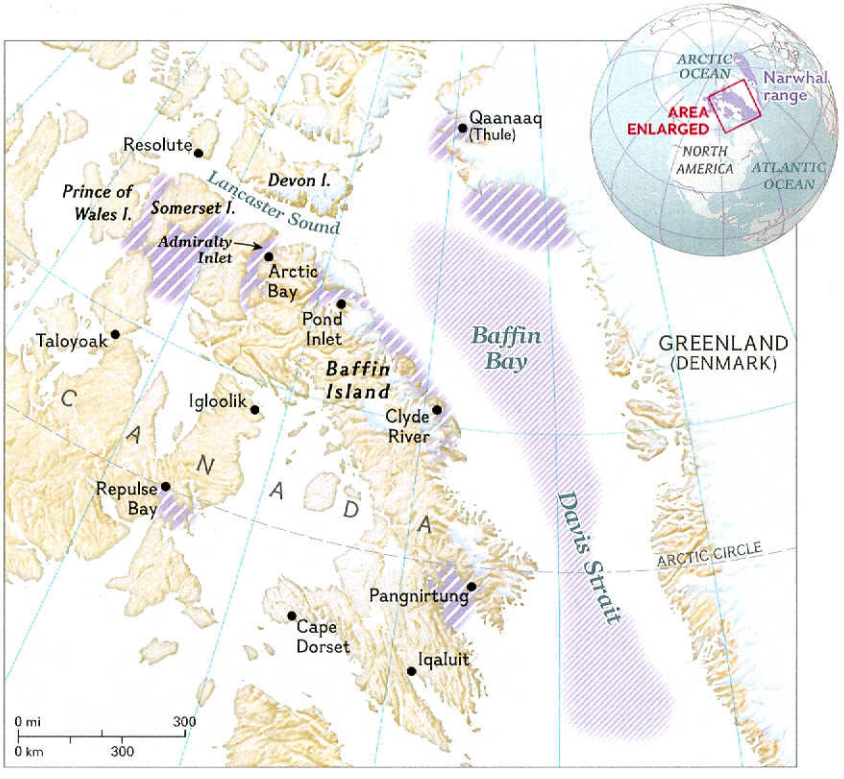
Like the Inuit, I too am eagerly awaiting the return of the tusked whales. For most of June, my guide and I have camped on the frozen surface of Admiralty Inlet, waiting out blizzards and moving our tents to escape the disintegrating sea ice. When finally we hear the squeaks, squeals, and blows of these vocal whales, we climb a large block of ice and cheer their arrival.

At first the narwhals parade past in pods of eight or ten, then in grand processions of hundreds. As news of their return spreads over the local field radio, Inuit hunters, many of them good friends I've known for years, begin arriving on snowmobiles carrying camping gear and high-powered rifles. Taking up positions along the ice edge, they watch and wait for narwhals to surface near enough to shoot with a rifle and retrieve with a grappling hook thrown by hand.

The Inuit have looked forward to this moment all winter. Each man waiting on the ice hopes to land a whale with a tusk that could sell for more than a thousand dollars, a windfall in a remote region where jobs are scarce and the cost of living high. The hunters also look forward to fresh *muktuk,* the top layer of blubber and skin, which is prized as a traditional delicacy.

But like most of life in the Arctic, hunting narwhals requires patience. The open water is wide here, and the whales stay beyond reach. So we light camp stoves, brew tea, and share stories and laughter. In the endless daylight of spring, our vigil continues around the clock. Cries of *Tuugaalik! Tuugaalik!*—Narwhal! Narwhal!—ring out as big males lift their tusks skyward. Then comes word over the radio that narwhals have been spotted moving up a newly formed

One of the few whales adapted to year-round life in the Arctic, narwhals roam with the seasons, feeding on cod and halibut across a vast, ice-clotted range. They return to the same summering grounds yearly, despite ambushes by hunters.




lead 20 miles to the west. We quickly relocate and see that the crack in the ice is narrow. It's a can't-miss situation. Yet even at this close range, making a clean kill as the whales surface for air will be difficult.

The gunfire begins in the afternoon and goes on all through the twilit night. Over the span of 12 hours 109 rifle shots ring out, but something is wrong: In the morning only nine narwhals lie dead on the ice. Surely more were hit, I think, and begin asking each hunter how he fared.

"I hit two, but they didn't die."

"I sank seven and landed none."

This was not the first time I had heard reports of many narwhals being shot but few landed. Just weeks earlier, a man I know to be a skillful hunter confided that he had killed 14 narwhals the previous year but managed to land only one.

For even the best hunters, killing and retrieving a narwhal at the ice edge is a formidable challenge, one that requires near-perfect aim and timing. The whale must be shot in the spine or brain (an organ the size of a cantaloupe) the instant it fills its lungs with air. Kill it at the wrong moment, and it will sink. Wound it, and it will swim away and possibly die later—though many narwhals apparently survive. I've seen more than a few bearing multiple bullet wounds.

Even whales killed with a perfect shot often float beyond reach of the hunter's hook and sink. So much ivory rests on the seafloor, said one hunter, that a salvager could make a fortune.

Until the mid-20th century, narwhals and other sea mammals were the mainstay of Inuit existence. The tusked whales provided meat and blubber for food, oil for fuel, and raw material

for everything from thread and tools to tent poles and sled runners. Hunters took the game they needed, and used all they took. But as more and more Inuit left the seminomadic life of their ancestors and settled in towns, narwhal ivory became a coveted source of cash. As the number of whales killed has increased, so have concerns about the species' long-term health.

No one knows just how many narwhals live throughout the Arctic—estimates range from 40,000 to 70,000—but there is general agreement that the whale is not at risk of extinction. Even so, the Convention on International Trade in Endangered Species, or CITES, lists *Monodon monoceros* among the animals that could be threatened with extinction if trade in their parts is not monitored and controlled. The United States and Mexico ban imports of all marine mammal products, including narwhal ivory. But demand for the spiral tusks in other parts of the world continues to fuel the trade.

For centuries narwhal tusks were linked to the legend of the unicorn and believed to have medicinal, even magical, powers. At its peak during the Middle Ages, "unicorn horn" was worth ten times its weight in gold. Queen Elizabeth I reportedly received one valued at 10,000 pounds, a sum that in her day would buy a castle.

Today prices paid to hunters for narwhal tusks run about $125 a foot. Don Oliver, manager of the Northern Store in Arctic Bay, bought 75,000 dollars' worth of tusks from hunters in 2005, including a rare double tusk for which he paid $11,000. Oliver packs the ivory in a box and ships it to North Bay, Ontario, where it's sold at auction to art dealers and collectors.



While scientific surveys seem to indicate that narwhals remain abundant overall, at least one stock is in serious decline, owing mainly to overhunting. Along Greenland's west coast, narwhals plummeted from 10,500 in 1986 to 1,500 in 2002. Throughout those years Greenland's Home Rule government imposed no limits on the number of narwhals hunters could take. Catch rates in Greenland during the 1990s averaged 750 narwhals a year.

As the severity of the situation became apparent, scientific bodies sounded the alarm. A commission of marine mammal experts stated in a report, "New information seriously challenges our previous confidence that the hunting has been sustainable." In 2004 the same group was adamant in its call for action: "West Greenland narwhal are heavily depleted, and substantial

Appearing to grin even in death (above), the narwhal fills important cultural and economic roles in Inuit life. A hunter packs slabs of *muktuk,* narwhal skin and blubber, into a skin bag for the journey home. Considered a delicacy, muktuk is also a rich source of vitamin C in a land where fresh vegetables are flown in at high cost.

Hunters shot this whale, then lost it when it sank. Later the body floated to the surface. Another hunter hauled it onto the ice, reclaiming what would have gone to waste.

reductions in catch are required immediately to arrest the decline in numbers." If the whales were to have any chance of recovery, the scientists stated, the annual kill would have to be slashed to no more than 135.

The Greenland government responded by setting a quota of 300 narwhals. Scientists and conservation groups complained that the limit was far too high. But rather than lowering the limit the government has increased it to 385, all but assuring that the stock will continue dwindling.

In Canada, concern centers on Admiralty Inlet. In 1984 the inlet's summering population was estimated to be 15,000 strong. An aerial survey in 2003 counted just 5,000 narwhals. Canada's Department of Fisheries and Oceans (DFO) notes that the survey missed large groups of whales, casting doubt on its accuracy. Even so, after reviewing all the available research, a select committee of scientists decided to bump the narwhal's status in Canada from "not at risk" to "special concern."

Running like a refrain through the committee's report are laments about the absence of solid data to answer vital questions: How many narwhals summer in Canadian waters? How many distinct groups exist? What number do Inuit hunters kill each year?

In recent years the annual reported kill in the Canadian Arctic has averaged about 500 narwhals, but hundreds more may go unreported. No one knows how many are "struck and lost," meaning shot but not landed. The number varies from year to year, depending on ice conditions and hunting methods. Researchers who observed hunts in the 1970s and early 1980s reported that in some cases, more than 70 percent of the whales killed or wounded were lost. More recent surveys indicate the average rate may be closer to 30 percent, but figures remain unreliable.

Sending outside observers to monitor hunts in remote communities has its limitations. Building trust takes time, and the DFO staff is stretched thin. During the month that I accompanied narwhal hunters on northern Baffin Island, a DFO biologist and a fisheries officer flew in and observed the hunt for only a few days. After they left, hunters remarked that they had been careful to take only sure shots when the monitors were watching, underscoring one of the weaknesses of such surveys.

Hoping to get a better handle on the hunt—and in the process turn over more regulatory functions to the self-governing Inuit—wildlife agencies and hunting groups in 1999 embarked on a cooperative program called community-based management. Inuit hunter and trapper associations were empowered to set their own rules and expected to monitor hunts and police their own ranks. The pilot program ends this fall, and the DFO plans to meet with the groups soon thereafter to assess its pros and cons and decide on a future course.

All agree that one of the most pressing needs is training young and inexperienced hunters to reduce the number of whales struck and lost. Killing a narwhal is a badge of honor for a young hunter, but many Inuit don't grow up learning hunting skills. "With all the changes in Inuit society," one official commented, "communication between the young and old is breaking down."

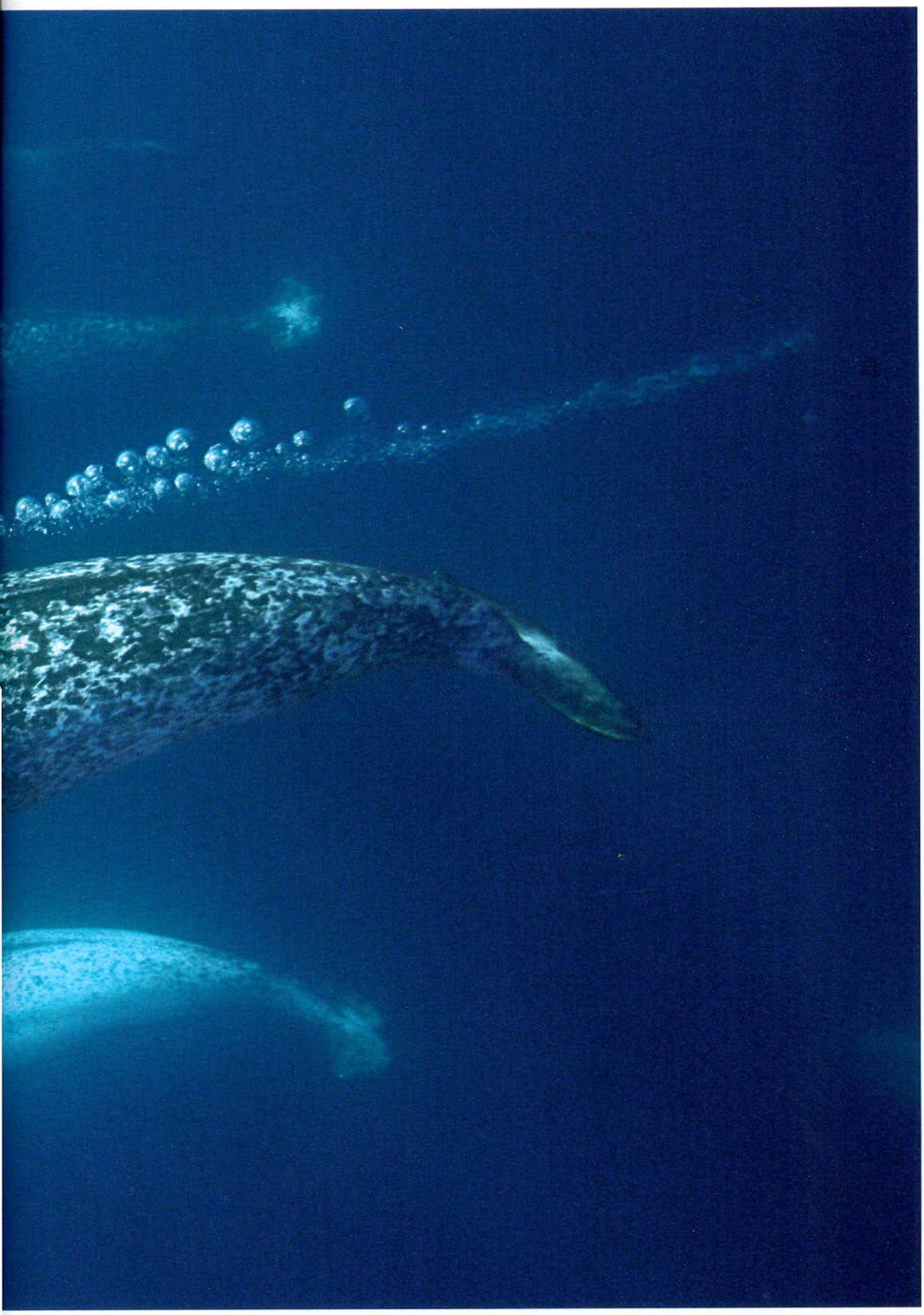
This fact hit home as I watched a 13-year-old boy armed with a .30-06 rifle shooting narwhals all day, wounding many but landing none. Elders stood nearby but said nothing.

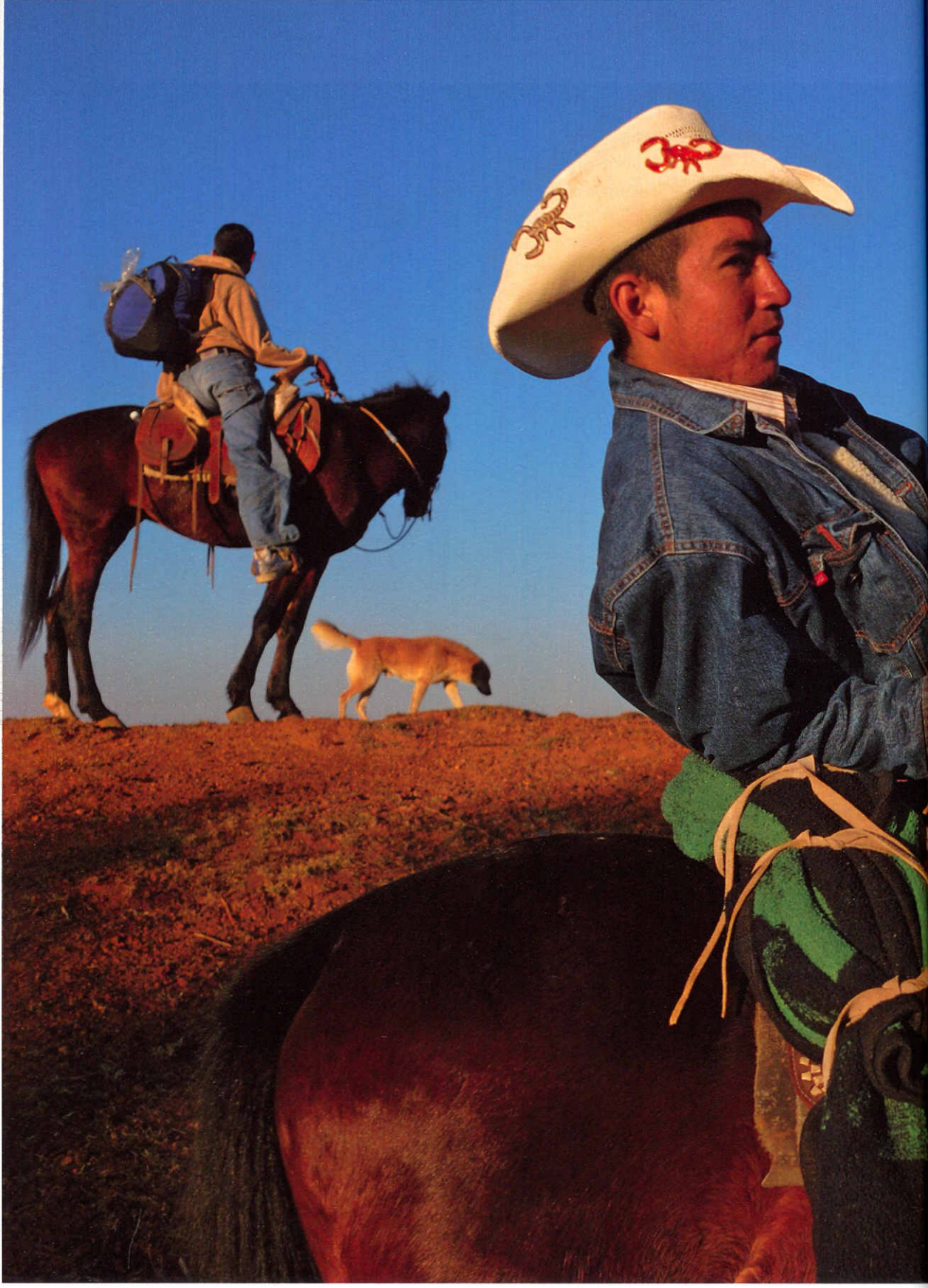
Inuit culture has always been a hunting culture, but the coming of rifles changed the rules. Turning a blind eye to obvious abuses serves neither the Inuit nor the animals whose lives are intimately bound up with their own. As wildlife officials and hunters meet later this year, now seems an opportune moment for change. In the light of new realities, every hunter must rediscover the old wisdom of conserving game. Failure to do so denies their own proud heritage.

**Close Call** How did Paul Nicklen react when his plane's engine died? Find out at **ngm.com/0708**.

Brisk strokes of a wire brush remove dark algae from a tusk, revealing its ivory gleam. Sold on the international market, tusks bring welcome cash to Inuit communities facing high poverty rates. Longer tusks fetch higher prices: A nine-foot specimen in prime condition may earn $2,000 for a hunter, then $5,000 for a retailer.

In a rare underwater photo of males, bubbles stream from one's blowhole. Large gaps in our understanding of narwhals complicate management decisions and cloud predictions about their future. ▯

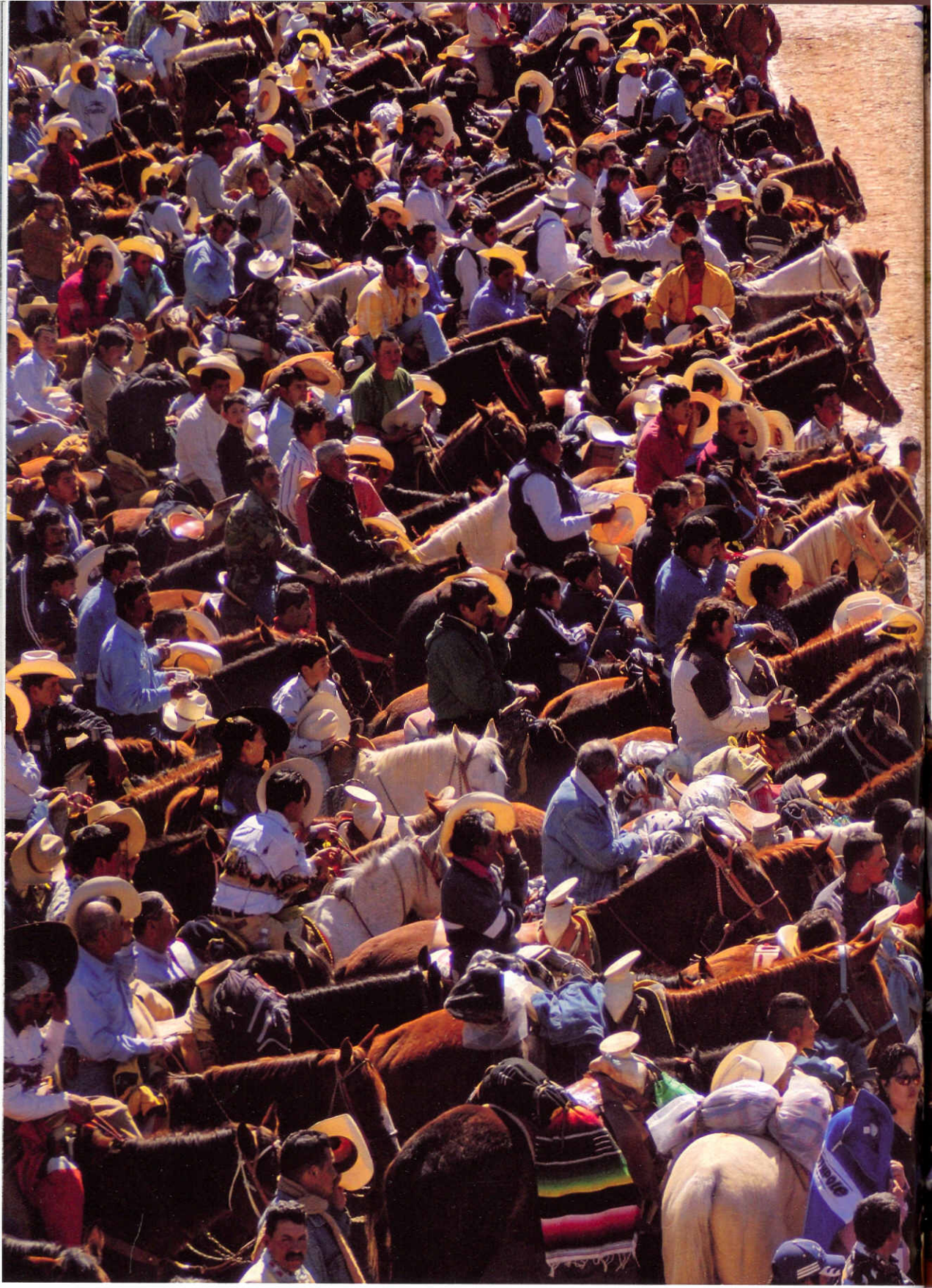




*by* ALEXANDRA FULLER *photographs by* DAVID ALAN HARVEY

# *Mexico's* PILGRIM COWBOYS

*A brotherhood of horsemen in crisp white hats converges each January on a mountain in central Mexico. The journey honors Jesus Christ.*



*At the top of the mountain, riders assemble to be blessed. The stillness of the worshippers is part reverence, part exhaustion from the long climb—and nearly miraculous in itself, with people and*

*animals packed so tightly together. The smell is horse, sweat, and blue-gray drifts of incense. Rituals of prayer and song celebrating Epiphany go on for hours, at midday and midnight, dusk and dawn.*

*Clusters of riders—dozens, hundreds in a group—cross Guanajuato state. Where they stop to rest, men like Aurelio Vallejo of La Concepción (seated, in hat) help make sure horses have food and water, and riders a few camp comforts. This pilgrimage has no official routes, no central organization, but it's been happening for more than half a century, and it's growing.*

# In central Mexico, time and place are fluid, and history runs into the present, and the present is always straining into the afterlife so that nothing is only what it seems. For example, at dawn on January 5, the day before Epiphany, on a dusty rancho in El Rodeo

just east of the city of Guanajuato, roosters are insulting one another and shouting for the sun to come up, and a handful of cowboys on fresh horses are dressed as if for church, in white cowboy hats, shirts with faux-pearl buttons, and boots that still bear a literal resemblance to the animal from which they were made: snake, lizard, alligator. There is an edge of cavalry about the way the cowboys spin their leather-and-silver-clad mounts in the orange-blue dust, but next to them is a skin-and-bones mare whose foal was recently killed and eaten by the dogs. She hangs her head beside the cactus to which she is tied, absorbed in the constant, anonymous scrabble for life that is everywhere here, and there is nothing of cavalry in her. The air is scented with cooking smoke and drying laundry.

It's as if everything may happen (the mare may revolt, the cowboys may burst into prayer, miracles may ensue), or nothing will happen at all (the mare will take one breath after another, the cowboys will dismount and make for their construction jobs, the roosters will find a dusty nest and fall asleep). In the end, because this is central Mexico, something entirely other happens. Like rocks being tumbled under a great river, the road that leads from here to Guanajuato begins to clatter, and out of the dawn, thousands of cowboys on a mix of mounts from eager stallions to a black-and-white-spotted donkey appear. With less flourish than you would think, the cowboys from El Rodeo jog out of the rancho onto the road and join the procession.

CHRIST THE KING—or a 65-foot-tall depiction of him—stands on top of Cubilete mountain in the state of Guanajuato, thousands of feet up cobbled switchbacks from the high plateau, which is nonetheless called *el bajío,* the lowland. It is to this statue's feet that three or four thousand cowboys are riding, just as the three wise men are supposed to have ridden to the manger in Bethlehem on this day roughly 2,000 years ago. It is said that this statue of Cristo Rey is most famous for his expressive hands, the way they are held out from his sides, as if the son of God were about to quell a riot.

Pilgrimages to Cristo Rey, to Our Lady of Guadalupe, to depictions of saints elsewhere in the country, are common in Mexico. But seldom is there such a massive *cabalgata*—a horseback gathering—of faith; it swells by hundreds of riders each year, a word-of-mouth event of magnificent proportions. "It's no one important who rides," one cowboy says, "but it is all of us who have the Lord in our hearts no matter where in the world we go." It is true the riders include construction workers from Chicago, rig workers from Texas, gardeners from Guanajuato, laborers from San Miguel de Allende, farmers from Jalisco. "We are *el pueblo,*" the cowboy says.

Some of the cowboys are euphoric, a little drunk and shouting, *"¡Viva Cristo Rey!"* as they crack the last energy out of their exhausted animals with whips.

THE RIDERS PROCEED under winter-bright skies. There is blue agave planted on blood orange soil; there are cornfields stacked with pyramids of harvested stalks; there are bright tangles of lush alfalfa. A river, sluggish with sewage and decomposing garbage, is crossed, and the horses stop to drink deeply, for the sun has risen completely by now. Another quilt of cornfields appears and, beyond that, a blond meadow. A dust devil picks up a spiral of foam plates, an empty beer box, swaying plastic bags, and the lively dance of rubbish spooks a horse. Now, the ride clatters through a village whose squat, brightly painted houses sprout rebar out of the tops of their walls in hope of a more prosperous and elegant future, at which time they will grow a story or two taller. Dogs bark from the rooftops, and children run between the horses' legs and shout up at the cowboys for candy. A boy runs up to one of the El Rodeo cowboys with a letter for the three wise men, whose inspiration the cowboys are following. "I send you this letter to ask that you bring me a racetrack," the child has written in agonized Spanish (careful lettering over erased mistakes). "I hope that you bring it to me. Thank you."

Nicolás García Diosdado is 84, and he has tears in his eyes when he surveys the multitude of cowboys riding up the mountain. The horses are struggling now, their flanks pumping, coats soaked, mouths frothing. Some of the cowboys are euphoric, a little drunk and shouting, *"¡Viva Cristo Rey!"* as they crack the last energy out of their exhausted animals with whips. Most have settled into a kind of saddle-weary, sunstruck meditation. The old man with the spotted donkey has got off to lead his flagging mount the final steep miles.

García says, "Fifty-two years ago, I had no hope, no health, no future. I was likely to die. The doctors did not know what was wrong with me. Then I had the idea to perform a pilgrimage on horseback to Cristo Rey and to ask for just one year of health. Although I was so ill, still I came, and it was difficult back then, for there were no roads. But look for yourself. A miracle was performed, and my life was saved. Now, I am an old man, and I am still here, still standing, still walking, still praising the Holy Child. And look now at all these riders." He breaks off, momentarily distracted by the grand spectacle of a rider outfitted to resemble Pancho Villa, resplendent on a shiny black stallion. Then García adds, "That first year, just 25 riders from my village came with me to praise Cristo Rey and ask for his blessing. Now, it is thousands of people from all over." The old man looks ecstatic in the real sense of the word, as if his pulse is attached to the rays of the sun, which beat down now with afternoon force. "It's a miracle," he says at last, his voice shaking.

IN CENTRAL MEXICO, stories of miracles seem always to include, at their inception, heroic sacrifice and awful bloodshed. Blood has been so liberally spent in this country that it is no wonder the soil has taken on the hue it has. In 1924, Plutarco Elías Calles became Mexico's president (dictator, you might say). The illegitimate son of an alcoholic, he was himself an agnostic and abstemious man. Almost as soon as he took power, Calles set out to neutralize the Roman Catholic Church in Mexico, enforcing laws from the 1917 constitution that made it illegal to teach religion in schools or hold open-air Masses, and he denied the Catholic clergy the right to vote or criticize public officials. Bishops ordered the churches closed in protest, and for the first time in 400 years, there was nowhere for the people of Mexico to worship.

On New Year's Day, 1927, the war cry went up from the faithful, *"¡Viva Cristo Rey!"* By the


*Pilgrimage is devotion made physical: Thousands of cowboys meet at the foot of Cubilete, facing the steep cobblestone twists that rise to its 8,500-foot peak. Some riders even dismount near the summit and finish the climb on their knees.*

time this holy war—*la Cristiada*—ended two and a half years later, at least 70,000 people had been killed, including some 90 priests, agricultural production had dropped sharply, and 450,000 people had emigrated, most to the United States. The original statue of Cristo Rey erected here (in the mythical, if not the actual geographic, heart of Mexico) had been blown up, supposedly by federal agents, but by some coincidence—or miracle—the heart and head of the statue survived the explosion, and the two placid chunks of carving now sit in a glass case in a tiny museum near the present statue. Pilgrims file past the glass case, and it is here that they leave their petitions, little scraps of paper that say, "Keep my boy safe as he crosses the frontier." Or, "Cure my little mother of her cancer."

"They even shot a boy in those days," a priest tells the weary, dusty pilgrim cowboys (he himself is weary and dusty, having ridden for three days to the summit of the mountain with others from his village). "He was on the ground playing marbles in the dust, and he was wearing a white cowboy hat with the words 'Cristo Rey' written on the brim. The federal agents told him to take his hat off, and he wouldn't. They shot him through the head."

Grown men cry. Someone passes a flask

*Arms outstretched, the 65-foot likeness of Cristo Rey—Christ the King—welcomes the faithful to the mountaintop. "No one sells T-shirts saying, 'I survived the 51st Annual Cabalgata,'" says first-time rider David Pearson. "When it's over, there are only memories, and for those lucky enough, the glorious feeling of fulfilling a covenant with their God."*

"We have endured something together. This has made us forget our differences, so we pray for peace in ourselves, for peace in Mexico, for peace in all the world." —*Marco Antonio González Guerrero*

of tequila, although alcohol is not thought well of on the mountain. The priest looks over his shoulder and accepts a sip, wipes his mouth, passes the flask along to a teenager with wet eyes. Then, someone quotes a line or two from the *Ballad of Valentín of the Sierra:* "Before he went up the hill, Valentín cried, 'O Mother of Guadalupe! For your religion, they will kill me.'"

THE MASSES BEGIN on the eve of Epiphany and recur with a frequency that seems calculated as a further test of the cowboys' endurance. Under the statue, from the mouth of a tiny chapel, a young, severely handsome priest drones at the thousands of cowboys who have crammed their horses nose-to-tail, flank-to-flank, at the chapel's steps. The riders tip their Stetsons against the sun and close their eyes. At least one cowboy has collapsed over his saddle horn and is sleeping deeply. The horses slump on cocked haunches. Incense trails blue against the priest's robes. Soon, the cowboys will take turns to dismount from their horses and climb the steps into the chapel to fall on saddle-weary knees in front of el Niño Dios. They kiss the image of the Christ Child with gentle reverence, and the doll's face, as if made flesh by all those lips, begins to shine real sweat.

AT NIGHT, THE COWBOYS SLEEP in tents, on hay, on saddlebags, or on the ground next to their horses, which call to one another without cease. One horse, shaking with the shock of colic, has been tied to a wall so that he is unable to sink to his knees or even touch his mouth to his stomach. His eyes gleam in panic. Elsewhere, some horses have found enough room on their ropes to lie down.

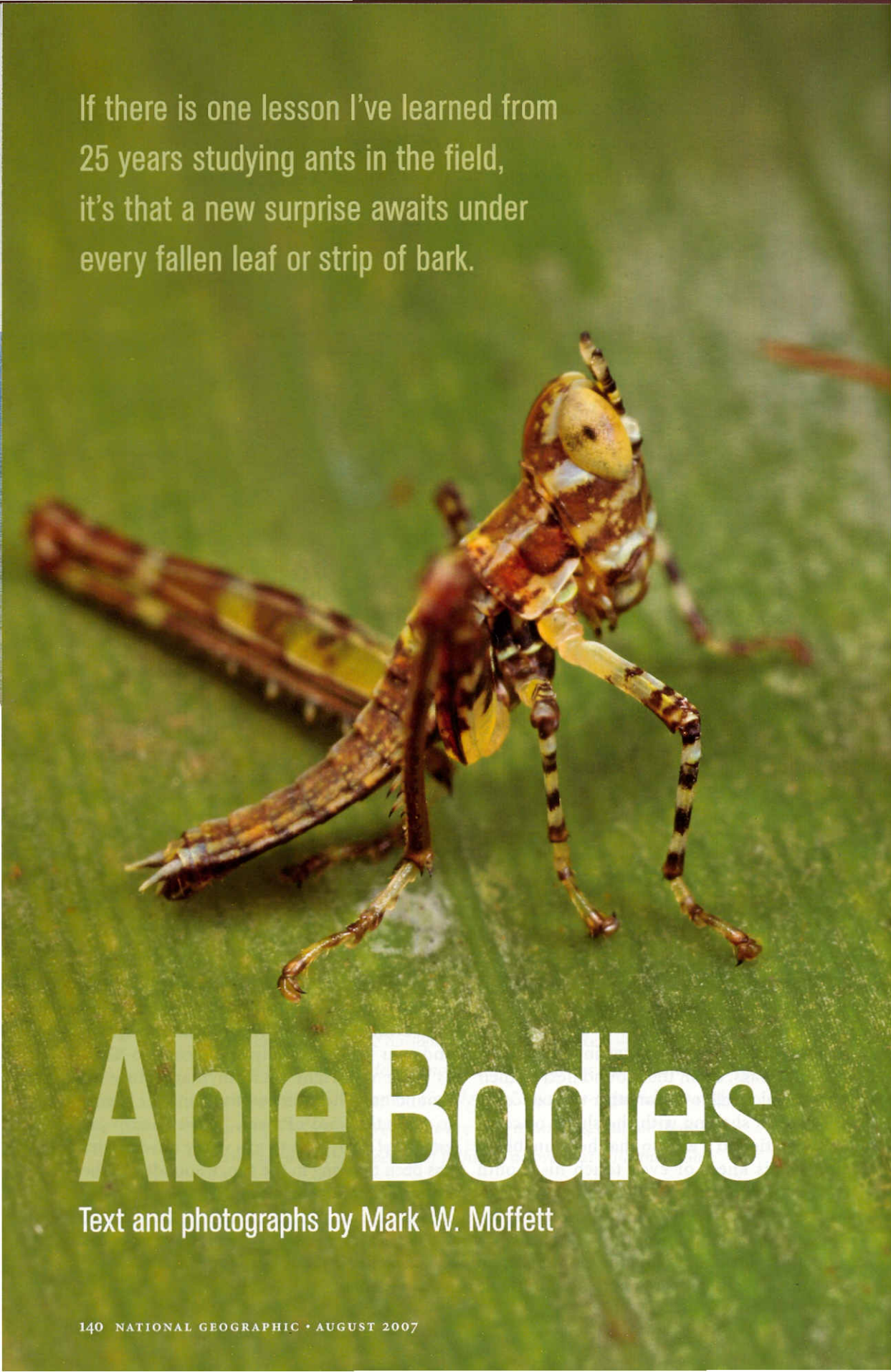
Against the night's chill, the González men have made their pampered horses comfortable in blankets and with bales of alfalfa. A fire has been built in front of a canvas tent, and there is meat on a grill. This is Marco Antonio González Guerrero's third ride in the cabalgata, and he is with his father (who has ridden ten times), his two brothers, three cousins, his nephew, his son, and an encampment of friends. They have ridden for three days from dawn to dusk from the family ranch at San Diego de la Unión.

González uses lilting Spanish-tongued English. "I came back from Texas to ride in this cabalgata. A lot of these people come back from the States to show their faith here today. I brought my son"—the American son, a hefty student of architecture, looks worn out—"so that he can see for himself what our faith means to us. In another way, we are saying even though this is our faith, we want to pray for all people. All people are equal under God. We have come here, tired and sore, and we have endured something together. This has made us forget our differences, so we pray for peace in ourselves, for peace in Mexico, for peace in all the world. Whoever you are, Muslim, Jewish, Catholic—we pray for you here, now." For a long time, no one else speaks; the fire dances warmth between the men.

Afterward, González says, "Look, I don't drink a lot. But I had a little tequila out there in the hills where all those oak trees grow, and you know, I really felt closer to God, as if he was right there in that nature all around us." Then, very softly, González begins to recite the Lord's Prayer, "*Padre nuestro que estás en el cielo . . .*" And to a weary traveler who has been too long in the sun, it sounds like the beginning of hope in a song. □

**Spirited Ride** Author Alexandra Fuller relates her experiences riding with the cowboys at **ngm.com/0708.**

If there is one lesson I've learned from 25 years studying ants in the field, it's that a new surprise awaits under every fallen leaf or strip of bark.



# Able Bodies

Text and photographs by Mark W. Moffett

Set off by the touch of a prey insect against sensitive trigger hairs, the mandibles of the trap-jaw ant *Odontomachus hastatus* snap shut in the fastest reflex ever recorded in the animal kingdom. The ant's jaws accelerate from zero to 143 miles an hour in 0.13 milliseconds—2,300 times faster than the blink of an eye. When sprung against a hard surface or the body of a predator, the explosive thrust of the jaws flings the ant into the air and out of harm's way.

*ODONTOMACHUS HASTATUS,* 16 MILLIMETERS (APPROXIMATE SIZES GIVEN)

## Intimate Strangers

Most ants are highly fastidious, and some species spend over half their time cleaning themselves or grooming nestmates. But until last year I'd never witnessed what appears to be cleaning behavior across species. While observing seed-harvester ants in the desert flats west of Portal, Arizona, I noticed workers would approach a nest of a tiny, unnamed species of the genus *Dorymyrmex*. A harvester would rise up on her legs with abdomen lifted and jaws agape, seemingly frozen in place. Soon one or more of the little *Dorymyrmex* would climb aboard, licking the harvester here and there. This odd behavior brings to mind the interaction between some reef fish species and typically smaller "cleaner fish." The bigger fish strike a rigid pose, which attracts the cleaners to come and pick parasites off the reef fishes' bodies and even inside their mouths—a danger zone visited by my "cleaner ants" as well. The cleaner fish may get a meal of parasites, which presumably helps keep the reef fish healthy. Whether or not harvester ants tolerate the cleaner ants for the same symbiotic reason is unclear, but after a couple of minutes they seem to tire of the intrusion, especially when a cleaner ant gets carried away and nips a leg (right). The harvester responds by kicking everybody off.

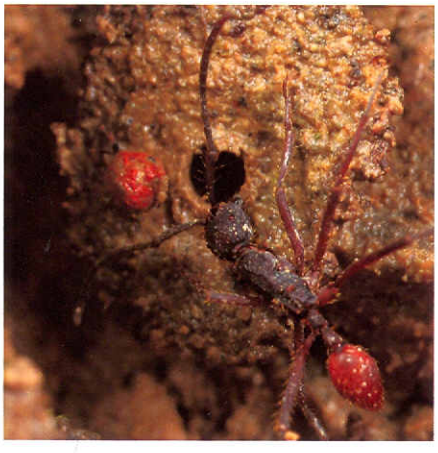
*DORYMYRMEX* N. SP., 3 MM; *POGONOMYRMEX MARICOPA*, 7.5 MM

**Society Grant** This Expeditions Council project was supported by your Society membership.

## Slow Motion

One species of ant that will never win a prize for cleanliness is *Basiceros singularis* of Ecuador. Once thought to be rare, they are in fact fairly common ants that are uncommonly dirty, camouflaging themselves with mud held in place on their bodies by feathery hairs. Workers move at a snail's pace—not a problem if your favorite prey is, in fact, snail. The chase ends—finally—with a strike. The ant then drags her booty home to a nest in the rain forest leaf litter composed of only a dozen or so workers and their queen. Stooped over a little colony I'd captured in a petri dish, I photographed a worker feeding a snail to a larva, which gobbled it up from its shell with the enthusiasm of a child lapping ice cream from a cone.

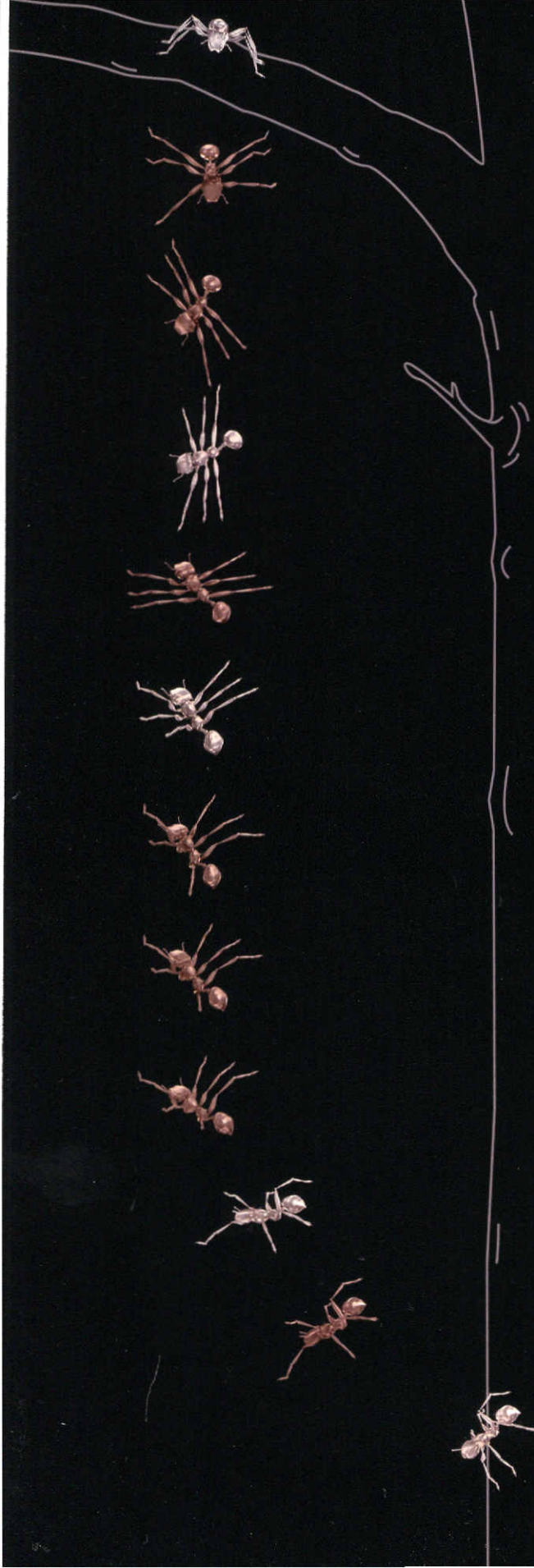
*BASICEROS SINGULARIS*, 4.5 MM



## The Tiniest Tool User

A rain forest ant I call the "doormaker ant" *(Stenamma alas)* fashions a defensive stronghold to elude army ants and other predators. On a clay bank in Costa Rica, National Geographic Society grantee Jack Longino of the Evergreen State College discovered that these sophisticated builders construct slightly elevated nest entrances with a pebble always placed nearby. Alerted to the presence of invaders, an *S. alas* worker in Ecuador pulls the pebble over the opening to make an impregnable stone door (above). The ants will create multiple doorways leading to empty nests in order to confuse marauding army ants, such as the one I saw investigating a false lead (left).

*STENAMMA ALAS,* 3 MM



## Skydivers

Ants running along branches or leaf surfaces in the forest canopy are in danger of being swept off by wind, rain, or a passing monkey. Two years ago Steve Yanoviak of the University of Texas Medical Branch in Galveston showed that the turtle ant species *Cephalotes atratus* in Peru survives a fall by "hang gliding." Falling *C. atratus* adopt a spread-eagle strategy similar to skydiving humans, who control their descent by tilting their limbs and body. The ants glide with their hind legs and abdomen oriented toward the tree trunk, often making 180-degree turns toward the target in midair. With support from the National Geographic Society, Steve and his colleagues Robert Dudley of the University of California, Berkeley, and Michael Kaspari of the University of Oklahoma have documented the same behavior in other arboreal ants in lowland forests in Peru and Panama. Among the team's objectives: solving the mystery of how the ants manage to steer so well.

*CEPHALOTES ATRATUS* (AT LEFT) SHOWN ACTUAL SIZE

SOURCES: STEPHEN P. YANOVIAK; ROBERT DUDLEY, UNIVERSITY OF CALIFORNIA, BERKELEY

ART BY MARIEL FURLONG, NGM ART

## How to Prep a Porcupine

Devouring a millipede demands unusual prep work for the elusive ant I call "Hannibal Lecter" *(Thaumatomyrmex).* This fearsome but fussy predator has pitchfork-like mandibles that when retracted form a formidable face mask (above). When extended, the prongs of the pitchfork are used to grasp polyxenid millipedes, seemingly the ant's only prey. Polyxenid millipedes are covered with long, densely packed bristles, like miniature porcupines. Before the ant can feast, it grips the millipede with its jaws and strips off these unpalatable bristles with its forefeet, aided by the mandibles (right). Once the prey's body is plucked clean, Hannibal chows down, starting at the millipede's head and working toward the tail. □

*THAUMATOMYRMEX* SP., 2.5 MM

**Ant Exclusive** See how Mark Moffett's "Hannibal Lecter" ant preys on a bristly millipede, witness ant hygiene, and more at **ngm.com/0708**.

# HOW TO HELP

Charcoal adds flavor (and greenhouse gases) to a barbecue.

**THE GREEN GUIDE** **Good Grills** Perhaps the only kind of barbecue that won't irk Mother Earth is a solar grill. But you won't find one at the nearest hardware store; only a few websites sell the solar cookers. There's no smoke, but there are mirrors, which focus the sun's rays on the grill tray.

None of the familiar fuel sources are as noble as the sun. Gas, electricity, wood, and charcoal each has downsides, but gas puts out the least carbon dioxide (list at right).

The charcoal-wood crowd can cut the toll. Fans of wood's smoky flavor might consider a hybrid grill, powered by gas with a small area to burn fragrant wood chips. Charcoalists can seek brands that don't add undesirable ingredients like coal dust, sodium nitrate, and borax. And instead of a squirt of lighter fluid, which emits volatile chemicals, try an old-school chimney starter: a metal cylinder with a small compartment at the bottom for paper. Light the paper and the coals above come to a hot glow.

The price tag matters. A cheap, short-lived grill has a more damaging eco-footprint than a durable solid metal model. Stainless steel and porcelain-enameled cast iron not only outlast but also cook more efficiently than chrome-plated aluminum. Besides, chrome is prone to corrosion. And that definitely doesn't go well with ribs.

**What's Cooking?** Learn eco-friendly options at **thegreenguide.com**.

**BURNING QUESTIONS**

**The four main fuel sources for grills all get mixed grades.**

- **Gas** Both natural gas and propane are efficient to produce, and natural gas is the cleanest burning fossil fuel. But they are nonrenewable resources and give off some pollutants.
- **Electricity** Unless sun or wind is involved, it's not as efficient to produce as gas. But electric grills burn cleanly.
- **Wood** Trees are felled. Ash and smoke are exuded. But wood is a renewable resource.
- **Charcoal** Most is made from leftovers: scrap wood and sawdust. But charcoal's manufacture creates greenhouse gases.

PHOTO: REBECCA HALE, NGS STAFF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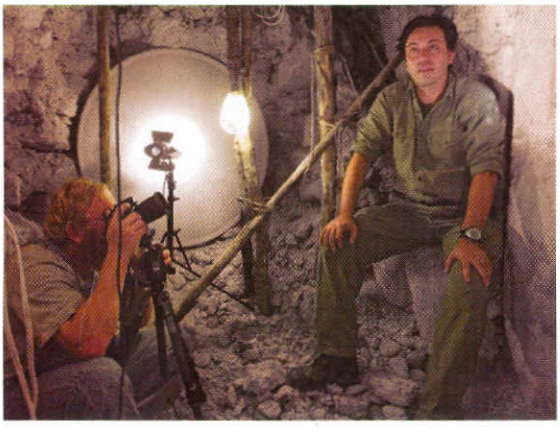
Think again.

Simon Norfolk (above, front row, in hat) and crew pause at the Palace of the Masks in Mexico. Kenneth Garrett (below, at left) makes a portrait of Society grantee Francisco Estrada-Belli of Vanderbilt University at Guatemala's Holmul site.

ON ASSIGNMENT

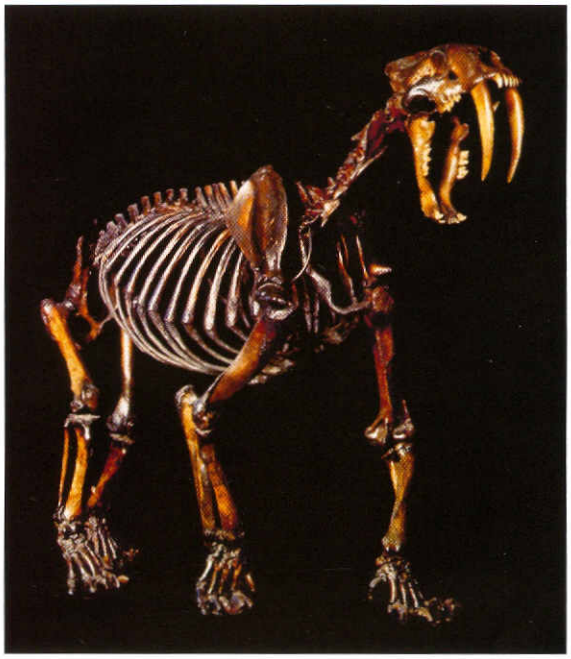
## Shedding Light on the Subject

Simon Norfolk was keeping himself in the dark. Working at night to photograph temples for this issue's Maya story, he used lights to emphasize the massive structures, pick out details, and create shadows to conceal modern tourist signs. The generators used for his lighting were left behind at seven of the sites he visited, donated by the GEOGRAPHIC. None of the places had possessed significant sources of electricity before. By day, Norfolk and his team scouted for spots to shoot and to put their lights. They'd sleep a bit before twilight, then work into the wee hours, dodging errant bats and sweating it out in a climate so humid that it warped the mahogany on Norfolk's camera. Because of the long preparation, one picture could take all night. Bystanders stared skeptically. But when the lights went on, they'd say, "I've never seen that before!" Norfolk himself was too busy to share their awe: "I was thinking logistics. I never got the chance to walk around and appreciate this amazing place." He'd like to go back—as a tourist.



Photographer Kenneth Garrett—who shot the artifacts for the story—has spent plenty of time contemplating Middle America's ancient cultures. He shot his first Maya story for the GEOGRAPHIC in 1989.

PHOTOS: JESÚS EDUARDO LÓPEZ REYES



## Prehistoric Predators

Eleven thousand years ago, Earth bid adieu to the saber-toothed cat and the dire wolf, two of the most ferocious creatures of the Ice Age. The sabertooth (skeleton at left), also known as the *Smilodon,* was a 400-pound killing machine. The dire wolf was the largest canid known to have existed in the Ice Age. Heavier and more powerfully built than the gray wolf of today, it may have run in packs of up to 30 animals and had a bite so forceful it could take down a horse. Why did the dire wolf and the sabertooth—two very successful predators—suddenly disappear? The blame may fall to, among other things, the rise of human hunters and the power of germs. Airing this month on National Geographic Channel, *Prehistoric Predators* probes the mystery of these extinctions.

NATIONAL GEOGRAPHIC CHANNEL

## August Contributors

**NEW ORLEANS,** page 32

**Joel K. Bourne, Jr.**'s October 2004 GEOGRAPHIC article described a storm surge flooding New Orleans—a year before it happened. He is the magazine's senior editor for the environment.

**Tyrone Turner** hails from New Orleans and has often photographed his native region for the magazine, most recently for the July 2006 story on the U.S. coasts.

**MAYA MYSTERIES,** page 68

**Kenneth Garrett,** a longtime contributor to NATIONAL GEOGRAPHIC, specializes in photographing cultural heritage.

**Guy Gugliotta** has spent more than 15 years reporting from Latin America. He is co-author with Jeff Leen of *Kings of Cocaine,* a study of the Medellín drug cartel.

**Simon Norfolk** is an award-winning photographer. His book *Bleed,* published in 2005, deals with the aftermath of the war in Bosnia.

**Vania Zouravliov** is a Russian artist based in London. His illustrations for the Maya story mark the first appearance of his work in NATIONAL GEOGRAPHIC.

**NARWHALS,** page 110

**Paul Nicklen** has long been familiar with the creatures of the north; raised on Canada's Baffin Island, he counts himself as one. An image from his GEOGRAPHIC coverage of leopard seals won a first place in the 2007 Pictures of the Year competition.

**PILGRIM COWBOYS,** page 130

**Alexandra Fuller** followed her book *Don't Let's Go to the Dogs Tonight* with another: *Scribbling the Cat.* Born in England and raised in Rhodesia (now Zimbabwe), she makes her home in Wyoming.

**David Alan Harvey** has photographed more than 40 stories for the GEOGRAPHIC. His most recent was "Hip-Hop Planet" in April.

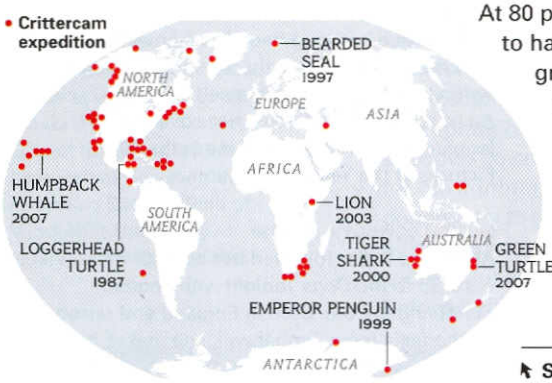
**FANTASTIC ANTS,** page 140

**Mark W. Moffett,** ecologist and photographer, received an Explorers Club's Lowell Thomas Award in 2006 for his studies of rain forest canopies.

**Tales From the Field** Learn more about our contributors in Features at **ngm.com/0708.**

PHOTO: KAREN KUEHN

Rodney's camera weighs 2.4 pounds. But in the water it feels weightless.

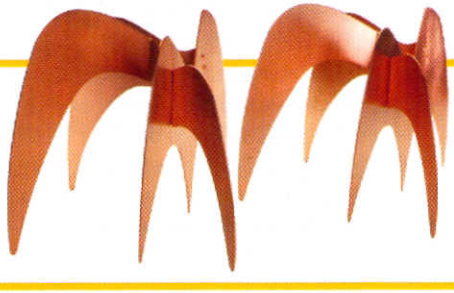



**NG EXHIBITS** **Crittercam** Rodney the emperor penguin (above) didn't mind being his own cameraman. At 80 pounds, his kind are among the smallest of animals to have carried Crittercam, invented by National Geographic's Greg Marshall to record video, audio, and environmental data. Even with the cameras, the birds stuck to their routine: diving 120 feet under Antarctic ice, then rocketing up to strike prey. A traveling Crittercam exhibit, opening August 31 at National Geographic headquarters in Washington, D.C., shows how 50 species of camera carriers live when humans aren't looking, and what can be done to protect them.

**Swim with penguins** and others at **ngm.com/crittercam**.

## Awards

**National Magazine Awards** In May, GEOGRAPHIC Editor in Chief Chris Johns accepted two "Ellie" awards (right)—for general excellence and for photography—at the American Society of Magazine Editors' National Magazine Awards ceremony. "Receiving these awards was a pleasure," he says, "but there is no greater pleasure than helping our readers understand and appreciate our world."



PHOTOS: GREG MARSHALL (TOP); REBECCA HALE, NGS STAFF. MAP SOURCE: NG MISSION PROGRAMS, REMOTE IMAGING, NGM MAPS

# FLASHBACK

**Little Revels** Their masks only part of their mystery, children in New Orleans pause during Mardi Gras for photographer John Hypolite Coquille of the *Times-Picayune*. Today no names or dates accompany this image (which never ran in the GEOGRAPHIC), but Coquille shot for the newspaper between 1912 and 1920. The mystery deepens: Though dressed alike, the pair may not be sisters. They might not even be girls. "It was not unusual at the time for men and boys to cross-dress on Mardi Gras," says historian John T. Magill of New Orleans' Williams Research Center. "But not necessarily in the same sense as modern French Quarter drag." *—Margaret G. Zackowitz*

**Flashback Archive** See all the photos plus e-greetings at **ngm.com/0708**.

PHOTO: CONVENTION AND TOURIST BUREAU, NEW ORLEANS

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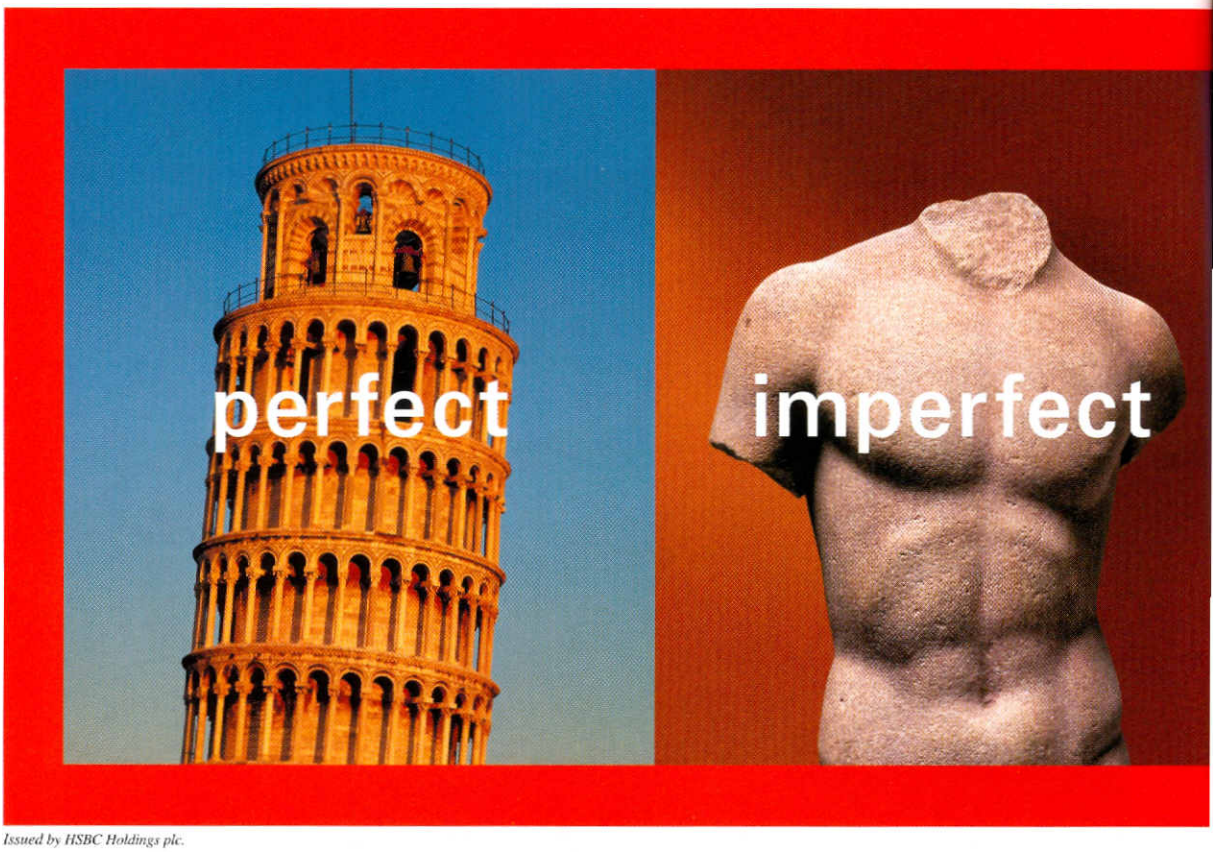


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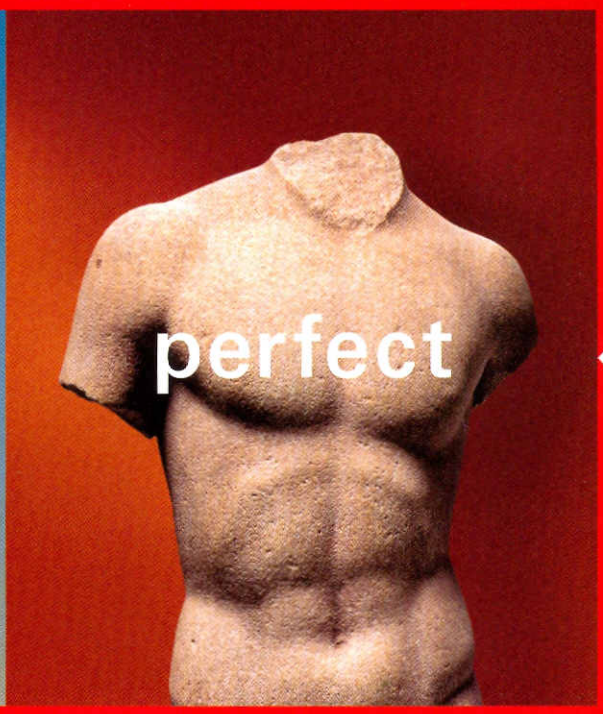


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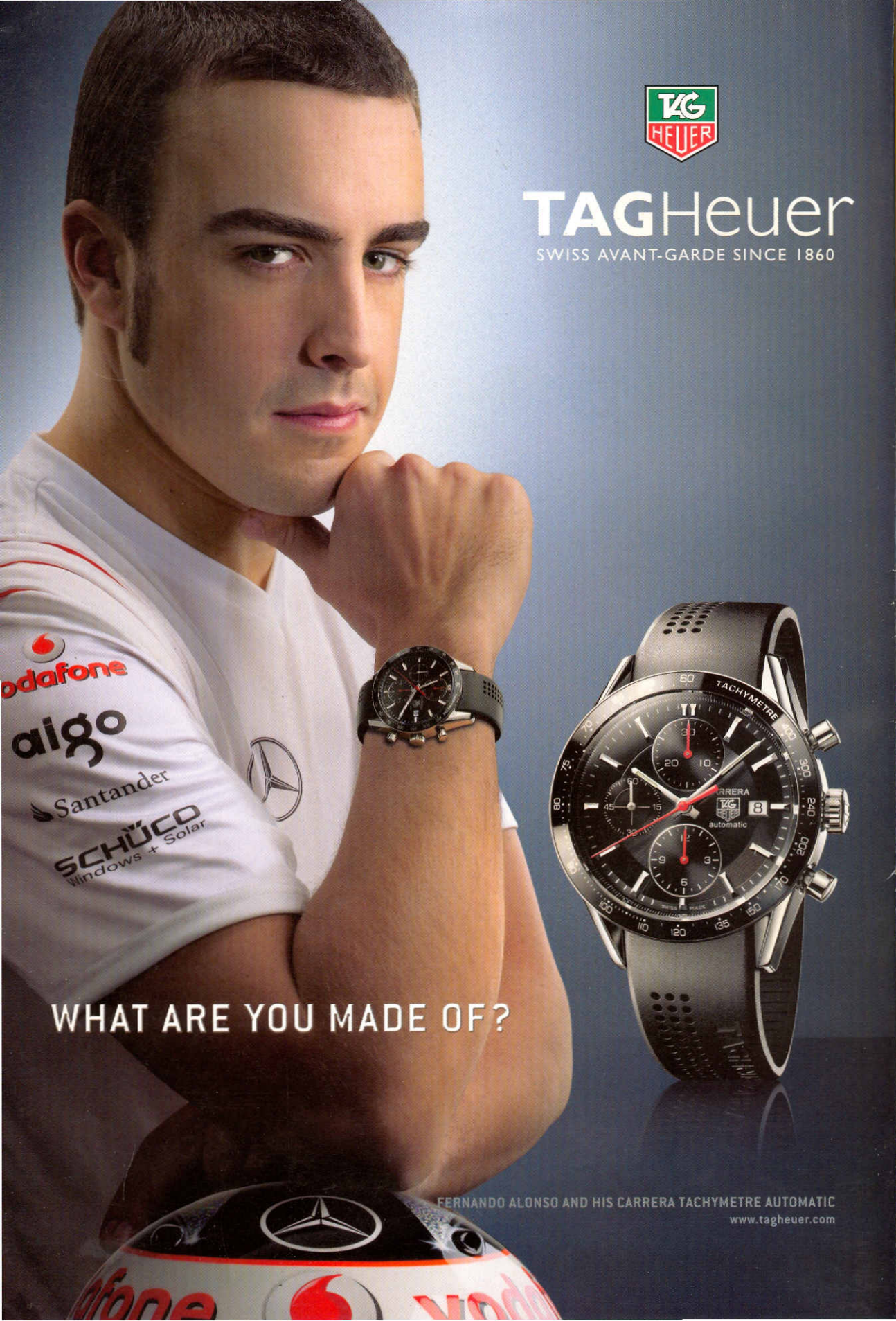
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