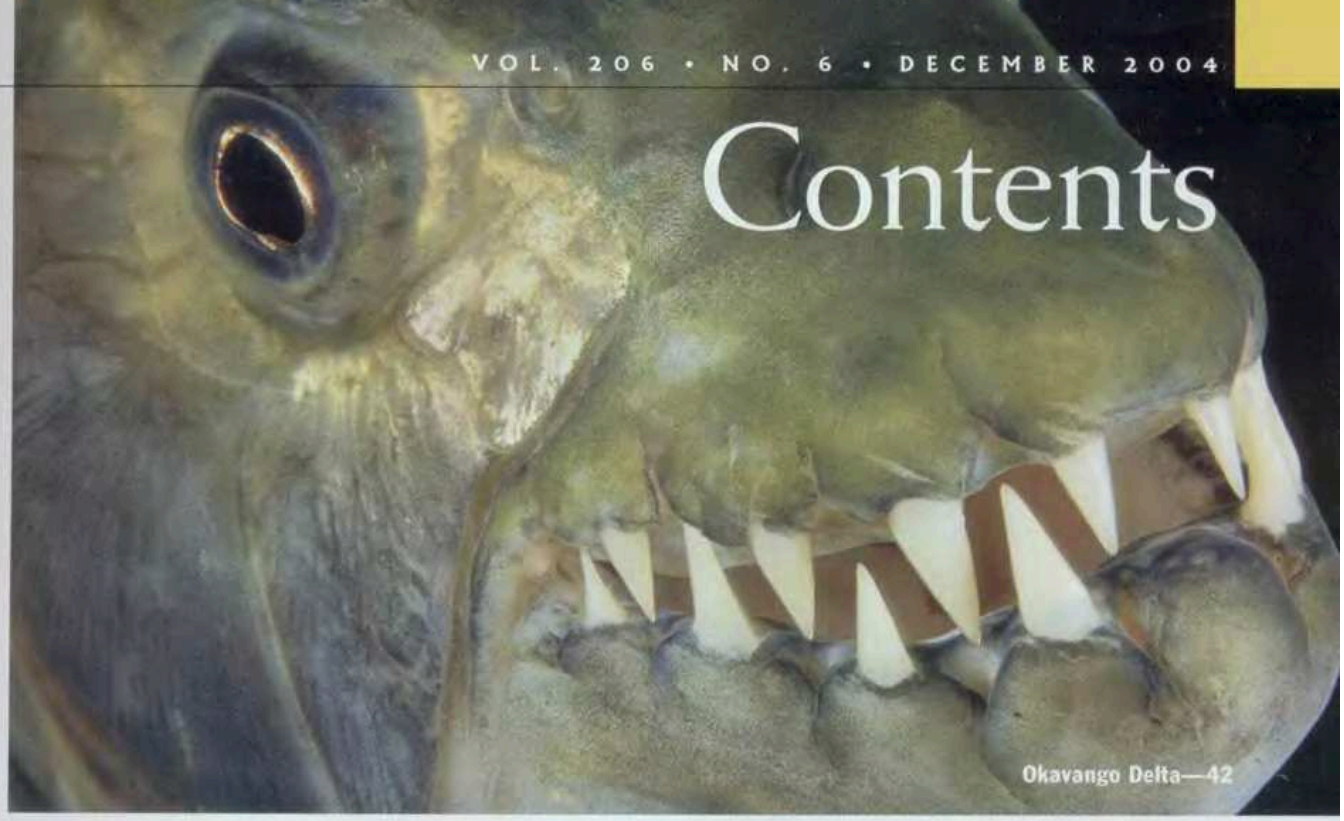
NATIONALGEOGRAPHIC.COM/MAGAZINE · DECEMBER 2004

# NATIONAL GEOGRAPHIC

## searching the stars for new earths

VOL. 206 • NO. 6 • DECEMBER 2004

# Contents




## FEATURES



## DEPARTMENTS



### THE COVER

A large moon ruptures under the gravity of a ringed planet.
ART BY DANA BERRY



### ON THE WEBSITE

nationalgeographic.com/magazine
SIGHTS & SOUNDS Experience the Okavango Delta underwater.
*TITANIC* Go deep with video.
YOUNG GUNS See everyday life in "Bin Ladenstan."
ARCHIVES Explore eight years of the online magazine.

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# OnScreen & Online

## NATIONAL GEOGRAPHIC CHANNEL

TUESDAYS, 10 P.M. ET/PT

### Interpol Investigates

Brazen art thieves strike fast, then disappear into a secret world. In the latest episode (right) of this riveting series, follow detective Mireille Ballestrazzi as she leads her team of investigators around the globe, tracking the masterminds behind the world's most notorious art heists.

THURSDAY, DECEMBER 16
9 P.M. ET/PT

### Titanic Untold

Nearly 20 years after discovering the sunken wreck of the legendary R.M.S. *Titanic*, National Geographic Explorer-in-Residence Bob Ballard returns to the site. Join Bob on his journey to the bottom of the Atlantic to see how, as he puts it, "the ship is being loved to death."

WEDNESDAY, DECEMBER 15
9 P.M. ET/PT

### Tycoon Toys

What would you buy if you had millions of dollars to spend? Bob Lutz (below), a former marine who now heads GM's North American operations, bought himself a decommissioned fighter jet. Flying


these million-dollar machines requires perfect concentration, but that's part of the appeal. The power players of the business world love their big toys—especially ones with military cachet. Fighter jets and tanks are just the beginning. Check out this two-part special and take a wild ride with thrill-seeking tycoons.

**Find out what's on and how to get the Channel in your area at *nationalgeographic.com/channel.*** Programming information is accurate at press time. Consult local listings.

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## nationalgeographic.com

EXPLORERS' SUCCESS STRATEGIES

**WHAT DO ADVENTURERS KNOW ABOUT THE DAILY GRIND?** In the latest edition of Pathways to Achievement, learn climber Ed Viesturs' (right) expedition-tested tactics. ■ FIND SUCCESS at ***nationalgeographic.com/pathways.***

BEST PICTURES OF 2004

**PREVIEW OUR SPECIAL ISSUE,** get photographers' tips, and register to win a cruise to Antarctica. (Find the official rules on our website.) ■ DECORATE YOUR DESKTOP with the issue's dazzling images. ***nationalgeographic.com/magazine/pictures2004***

MAPS GALORE

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CLOCKWISE FROM TOP: ANTHONY PLATT, NEW DOMINION PICTURES; JUDITH PARKER, PIONEER; VEIKKA GUSTAFSSON; EMORY KRISTOF

# Behind the Scenes

NG CHANNEL

## Film Reunites Family

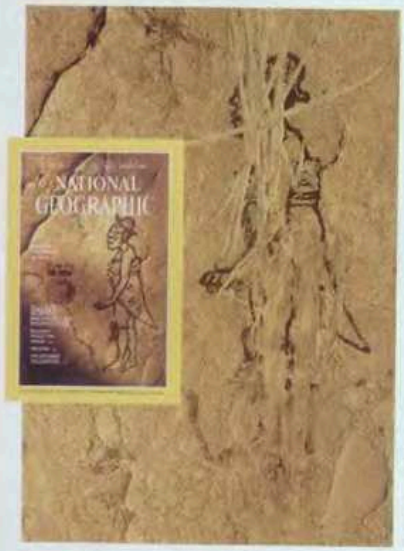
Two long-separated brothers (below) found each other again because of the National Geographic Channel film *Bridge on the River Kwai*—the story of the Thai-Burma railway built by prisoners of war during World War II. At first 75-year-old Paul Seker (right, at right) didn't recognize his brother Fred Seiker, at left, when he watched the documentary at home in Schoonoord, Netherlands. Then he felt a jolt of recognition when the film showed a picture of Fred as a young man. The brothers lost contact decades ago when Paul changed the spelling of his last name and was traveling with the Dutch navy—and Fred started working abroad as well. "I thought he was dead!" says Paul, who saw the film on the National Geographic Channel. Soon after calling the Channel's Dutch office to ask about his brother, he was on the phone with Fred. Four weeks later the Channel's U.K. office arranged a trip for Fred from his home in Worcester, England, to see Paul, who is ill with inoperable bone marrow cancer. "It's almost a miracle, isn't it?" says 89-year-old Fred. "It had to happen because he was dying. Here he was watching this program—and there I was."


HISTORY

## The Damage Done

The Maya paintings discovered in Guatemala's Naj Tunich cave were so intriguing that we put one—a ballplayer—on our August 1981 cover. But the site later suffered vandalism, covered in September 1991's Geographica column. Recently photographer Stephen Alvarez also documented the damage (left). "To see it in person was like getting hit in the gut," he says. No one knows who defaced the art, but guards are posted at the cave's locked entrance so that it won't happen again.

Sometimes GEOGRAPHIC photos are more than just good pictures. Images in our archives of works such as this Maya painting, Afghanistan's Bamian Buddhas, and Bosnia's 450-year-old Mostar bridge are now records of treasures gone—but not forgotten.




TITANIC REVISITED (PAGE 96)

## Get More

*To learn more about a subject covered in this issue, try these National Geographic Society products and services. Call 1-888-225-5647 or log on to* nationalgeographic.com *for more information.* ■ ***Return to Titanic: A New Look at the World's Most Famous Lost Ship*** Robert D. Ballard's book details the new threats endangering the legendary ship ($30). ■ ***Destination Titanic*** on the National Geographic Channel, Thursday, Dec. 16, at 9 p.m. ET/PT. Return to the deep with Ballard, nearly 20 years after his famous discovery.

## Calendar

DECEMBER

2 ***Return to Titanic*** **book signing and presentation with underwater explorer Robert D. Ballard** at Scranton Memorial Library in Madison, Connecticut. For reservations, call R. J. Julia Booksellers at 203-245-3959.

9 **Award-winning photographer Chris Rainier** lectures on his book *Ancient Marks*, sharing stories and pictures from his years documenting different tattooing and scarification practices around the world. National Geographic, Washington, D.C.

10 **Celtic Christmas Musical Celebration** Traditional band Boys of the Lough return by popular demand to provide a musical journey through the midwinter and Christmas traditions of Scotland, Ireland, and England's Northumberland at National Geographic, Washington, D.C.

JANUARY

9 ***Explorer*** comes to the National Geographic Channel. Watch it Sundays at 8 p.m. ET/PT.

16 ***Predators at War,*** a two-hour special, premieres on the National Geographic Channel on Sunday at 9 p.m. ET/PT. When their water source goes dry, the animals of South Africa's Mala Mala Game Reserve turn on each other to survive.

Calendar dates are accurate at press time; please go to *nationalgeographic.com* or call 1-800-NGS-LINE (647-5463) for more information.



COURTESY FRED SEIKER (TOP LEFT); MARK KOHN (TOP RIGHT); STEPHEN L. ALVAREZ

# Visions of Earth

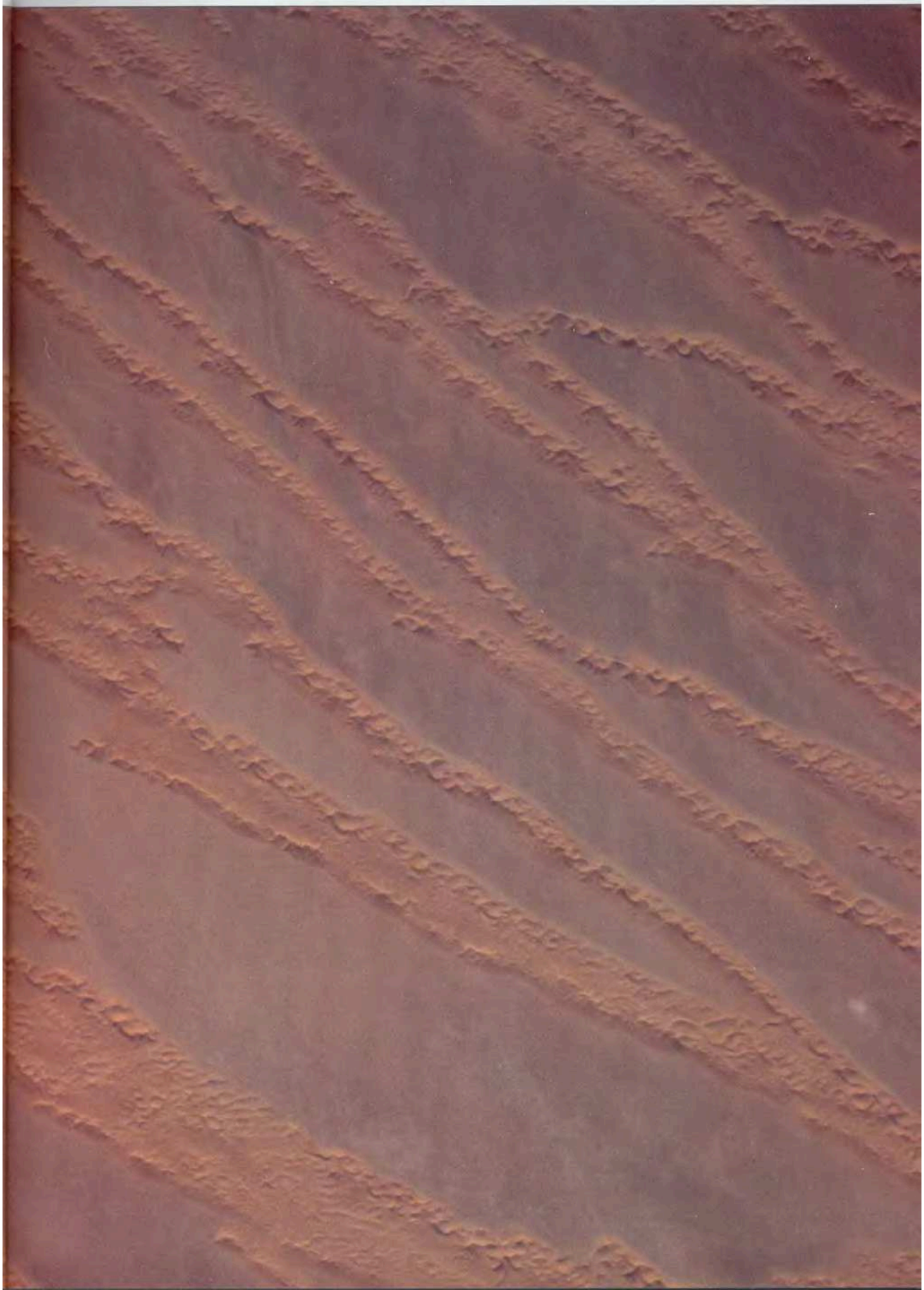
GREAT EASTERN ERG, ALGERIA

**Still photographs** can't fully capture the Earth's dynamism—a volcano exploding, the northern lights dancing. But this image of a dust storm in the Algerian Sahara, which we shot in 1994 aboard space shuttle *Discovery*, comes close. Sand whipping off the dunes had obscured North Africa and was even casting a haze over southern Europe. That day, we could watch as some of Africa was deposited in Europe.

*—Jerry Linenger*

▶ Decorate your desktop with this image taken from space at **nationalgeographic.com/magazine/0412**.

NASA



# Wild Woman

## Professionals prefer Canon

*Photographer and award-winning filmmaker Beverly Joubert has dedicated her work to the wildlife of her African homeland. She and her husband, Dereck, spend over 270 days a year in the bush, capturing natural history's most awe-inspiring moments.*

Canon

**How did Canon digital technology help you get this shot?**
This shot is a prime example of the ability of Canon's EOS-1D Mark II camera. This digital camera allowed me to take a series of test exposures in a matter of seconds.

**Why do you use Canon digital?**
Without a doubt, Canon is the market leader in digital. Lions move in and out of extremely difficult habitats and are hard to follow, and so I started experimenting with digital technology. When we do find the lions, they can walk into a very bright area and then retreat into a shady one within seconds. The EOS-1D Mark II has faster shutter speed, and the ability to create images of different exposures is of enormous benefit. The new Canon EF 600 IS lens is exceptional, it has an amazing image stabilizer. And the 1.4 converter is great for extra-close shots.

# From the Editor

KENNETH GARRETT

Where in the world is Osama bin Laden? As I write these words, it's been almost three years since he was last seen in the remote mountains and valleys along the Afghanistan-Pakistan border. Is he still sheltered there by Pashtun tribesmen honor bound to give sanctuary to anyone who asks?

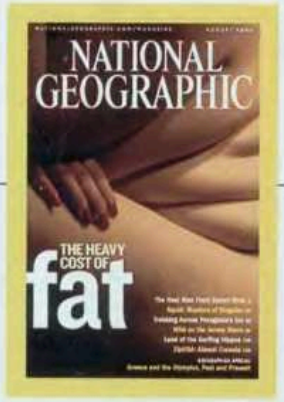
A proud people, the Pashtun have never accepted the border between Pakistan and Afghanistan—drawn by a British colonial diplomat in 1893—that divides them. And as writer Tim McGirk and photographer Reza found while preparing the story that begins on page 2, they're not exactly fond of "intruders."

Of course, Afghanistan's history is a history of intruders. For millennia the region has been a crossroads of Asia and a way station for traders and passing conquerors, from Alexander the Great to Babur, the Tiger, founder of the Mogul dynasty. These outsiders, as unwelcome as they were, left artifacts of their cultures behind.

The National Museum in Kabul has long housed the treasures of this cultural legacy, which are once again being unearthed by archaeologists (above). Protecting these treasures through years of civil war and rule by the Taliban required secrecy and sacrifice by dedicated people. In a place of such violence, theirs is a story of triumph. Turn to page 28 to read about the challenges still facing Afghanistan's cultural jewels and the rescue of the famous Bactrian gold—which, unlike Osama bin Laden, is no longer in hiding.

Bill Allen

# Forum




**August 2004**

*"Why Are We So Fat?" garnered a lot of attention this month. Readers wrote in with their own answers to the question, citing metabolic rates, the effects of high-fructose corn syrup, and large portions. Some decried society's focus on fat, in particular the negative pressures on women to stay thin. Others felt the story, especially the cover, had nothing to do with geography and did not belong in our magazine at all.*

## Why Are We So Fat?

I plugged Arnold Schwarzenegger's numbers into the body mass index table that was included in "Why Are We So Fat?" He's six feet two inches and weighs about 235 pounds. According to the BMI table, this puts him well into the obese category. I've seen the same table reproduced in many other articles, and it seems as though it should always carry a disclaimer that the results may be skewed depending on the muscle mass of the individual. I believe it is the table itself that carries too much weight.

DAN HANNA
*Santa Barbara, California*

The obesity epidemic is rapidly becoming a public health crisis in industrialized countries. The increase in obesity is appearing in disproportionately higher numbers among people of lower socioeconomic status. For the poor in wealthy nations, foods that are highly caloric and low in nutritional value (99-cent burgers, anyone?) are the most affordable, while the leisure time and resources needed for regular exercise are hard to come by. This is yet another example of the many disparities in health experienced by the most vulnerable members of our society.

RACHEL GOLD
*Portland, Oregon*

School age is the most important time to begin to stop obesity. Stop advertisements for fast food, sodas, and sweets during children's TV time and forbid selling such things at schools.

ANA POUZADA
*Oporto, Portugal*

FROM OUR ONLINE FORUM
**nationalgeographic.com/magazine/0408**

I was sorry to read the disclaimer suggesting that slow metabolic rates have little effect on obesity. Forty-six years of personal experience with people who have had to fight this problem show that metabolism definitely has a profound effect on obesity.

ROSCOE VAN DYKE
*Santa Ana, California*

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The magazine's website: **nationalgeographic.com/magazine**

For an online index of all National Geographic publications, go to: **nationalgeographic.com/publications**

**EMERGING EXPLORER ZEB HOGAN** Along the Mekong River, biologist Zeb Hogan is making the problem the solution. When Cambodian fishermen catch vulnerable species, he buys the live fish, studies and tags them, and releases them downstream from the fishnets. Here, and globally, the biggest threats imperil the biggest fish—many weighing more than 200 pounds. With his findings on migration and ecology, and conservation education for local children, he strives to save not only critically endangered species, but the food supply and livelihood of millions who share their habitats.

# Turning the tide on extinction

*"IT'S GREAT TO WORK IN REMOTE AREAS where studies haven't been done—creating a new body of information about fish behavior, migration, and ecology that was never known before. Every day I can make new discoveries and test innovative approaches to conservation using science, ecotourism, education, and photography. As we expand our programs from Cambodia to Mongolia and other threatened areas, we have a chance to bring species back from the brink of extinction and forge new partnerships to protect freshwater treasures across the planet."*
*—Zeb Hogan, Ph.D.*
*Aquatic Ecologist, Photographer*

*Around the world, National Geographic has identified Emerging Explorers who push the boundaries of discovery.*

NATIONAL GEOGRAPHIC
Mission Programs

Microsoft
Your potential. Our passion.™

***Microsoft recognizes the crucial role technology plays in exploration. Their support of the National Geographic Emerging Explorers Program is helping these new explorers realize their potential.***

## Jersey Shore

I thoroughly enjoyed reading Cathy Newman's postcards from the Jersey Shore. What a clever way to approach what obviously was a daunting task for her. For probably the first time ever in reading NATIONAL GEOGRAPHIC, I found myself laughing out loud.

TERRI COOK
*Belmont, California*

The Jersey Shore has so many marvelous things to showcase, from pristine beaches to mansions to family-oriented towns. Yet the article chose to focus on the bizarre. I found the piece derisive, mocking, and, in some places, downright insulting.

CLAIRE HARTY
*Spring Lake Heights, New Jersey*

You nailed the Jersey Shore with a home run. I left 30 years ago, leaving an adolescence "at the shore." Damn


AMY TOENSING

place has haunted me ever since, Florida beaches notwithstanding. Thanks for bringing me back in ways you are surely too young to remember, so evocatively immortalized in your concluding paragraph.

BOB BRUMBERGER
*Baton Rouge, Louisiana*

Your story lacked the depth I've come to expect from NATIONAL GEOGRAPHIC. Talk about trite and clichéd, yo fughedabowdit, the only thing missing was a *Sopranos* reference.

BOB REBACH
*Aberdeen, New Jersey*

Growing up in Beach Haven, crowded in the summer and a ghost town in the winter, I found it difficult to discover inspiration. Seeing this story sandwiched between an expedition in Patagonia and Gabon made me realize that unique culture, wildlife, and scenery exist in every corner of the world. Thank you for reminding me it's in my own backyard.

JESSICA ANDERSON
*Beach Haven, New Jersey*

I work with women who, regardless of their shape and size, have been pressured into believing that thinness is more important than emotional happiness and a full life. Fat is unhealthy, that's true. But our society must stop judging the worth of a person based on what he or she orders at dinner.

LIZ KISER
*Norman, Oklahoma*

I was amazed to read no mention of the pernicious effect of high-fructose corn syrup in the American diet. Americans consume more than 60 pounds of it a year. Between 1970 and 1990, the consumption of high-fructose corn syrup increased more than 1,000 percent. It's in everything from soft drinks to ketchup to barbecue sauce.

JOHN ADAMS
*Portsmouth, New Hampshire*

I found this month's cover photo not only in poor taste and unpleasant to look at, but completely inappropriate for a magazine whose stated aim is to increase and diffuse geographic knowledge. If I wanted to read about obesity, I would subscribe to a health magazine.

HEATHER KERR
*Brea, California*

Leave it to a GEOGRAPHIC photographer to turn ponderous rolls of billowing human blubber into a beautifully lit sea of sand-swept skin. Simply amazing!

GREGORY R. YOUNG
*Ellicott City, Maryland*

You point out that the world now has equal numbers of obese and malnourished inhabitants. Every day 30,000 children under the age of five die, mostly from preventable causes like malnutrition. We should certainly address health concerns here at home, but let's remember that we are not alone in the world. Whether by raising public awareness of poverty or by pushing to reform trade rules that keep millions of people hungry, together we can, and must, change this situation.

RAYMOND C. OFFENHEISER
*President*
*Oxfam America*
*Boston, Massachusetts*

**WRITE TO FORUM** National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

## Banjo Paterson

Working in Sydney for three years, I watched most tourists head for the Great Barrier Reef, Sydney Harbour, and the Melbourne cafés. Banjo Paterson discovered the real Australia, understanding that "the road is a place unto itself" with a vastness and isolation that defines the country and shapes its people.

EVAN DALE SANTOS
*Adelanto, California*

When many publications write about actors as if they're God's gift to the world, it is refreshing to see that GEOGRAPHIC covers the true celebrities of this planet: adventurers, explorers, scientists, and yes, even poets.

FREDERICK SU
*Bellingham, Washington*

If it was your intention to supply readers with the words of our iconic song "Waltzing Matilda," then I am afraid you have failed. In my 70 years I have never heard an Australian sing the version published in your article.

ANTHONY HEALY
*Willoughby, New South Wales*

*When we researched "Waltzing Matilda," we found that there were wide variations in the lyrics of the song. In 1895 Banjo Paterson and Christina Macpherson composed the song, and later that year it was sung in public. There was no official version of the song at the time. Even handwritten versions of the song by Banjo and Macpherson didn't match. In the early 1900s Banjo sold the rights to the song to his publisher, who then sold them to the Billy Tea Company. The company changed the lyrics and the tune. Though Banjo published his version of "Waltzing Matilda" in 1917, it was the Billy Tea Company's version of "Waltzing Matilda" that became popular. In our article, we stuck with Banjo's published version.*

## Gabon's Loango National Park

I have always thought that what Michael Fay and his team accomplished with the Megatransect was both insane and amazing. What a payoff. Fay, the Gabonese government, and its people must be proud of their tremendous investment in their new national park system. It is a legacy for future generations.

LARA GIBSON
*Brampton, Ontario*

You rightly criticize the activities of fishing vessels that operate illegally in Gabonese waters. We are all at one on the urgent need to combat illegal fishing practices wherever they occur. This will require closer cooperation between interested parties.

In accordance with international law, EU fisheries agreements are concluded with sovereign states on surplus stocks. The EU cooperates actively with the partner country to ensure proper control of fishing activities. Seventy percent of the financial compensation given to Gabon is earmarked for measures designed to strengthen the Gabonese fishing industry, including support for scientific research, protection and surveillance of fishing zones, and training and sanitary inspection of fisheries products. As we all know, many African countries lack the necessary resources to monitor fishing activities in their waters. This is why the EU provides support for the development of Gabon's capacity in this area.

JÖRGEN HOLMQUIST
*Directorate-General Fisheries*
*European Commission*
*Brussels, Belgium*

## ZipUSA: Point Roberts, Washington

I take great exception to Erla Zwingle's story calling Tsawwassen, British Columbia, a "Canadian strip-mall hell." Tsawwassen is anything but hell. As a matter of fact we are a community of 22,000 people. Our main street includes three shopping districts, not strip malls, beautifully landscaped medians with colorful flowers, and over 40 palm trees. We have beaches, golf courses, walking and biking trails, and an abundance of parks with exceptional views of Boundary Bay and the Gulf Islands. We are the shopping district for the residents of Point Roberts, who not only rely and depend on our abundance of services but also send their kids to enjoy our terrific school system.

DIANA COUSINS
*Executive Director*
*Business Improvement Association of Tsawwassen*
*Tsawwassen, British Columbia*

EXPLORATION

# A Stellar Year in Space

*Unmanned spacecraft probe new limits*

As 2004 ends, NASA's Voyager 1 spacecraft is approaching the boundary of our solar system. After a 27-year, eight-billion-mile journey, it's reached the place where the outer wisps of the sun's atmosphere collide with interstellar gas. Now the spacecraft is poised to enter the great void between the stars, becoming humanity's first interstellar probe.

From the inner solar system to its outer limits, NASA's unmanned explorations this year rival science fiction. "There's been nothing like this in the 30 years I've been in the business," says Jay Bergstralh, NASA's senior scientist for space science research.

In January two rovers landed on Mars, finding evidence the red planet once had water. June's arrival of the Cassini spacecraft at Saturn (above) may lead to revelations about conditions in our solar system billions of years ago. And the tireless Hubble continues to churn out dazzling images, like this glowing sphere of stellar dust surrounding a giant red star 20,000 light-years from Earth (right).

In the decade between 1979 and 1989, Bergstralh says, NASA launched no interplanetary explorations. But since then new technologies and approaches have spawned a fleet of lightweight, lower-cost unmanned craft. NASA is even considering a plan to service Hubble with

NASA (BOTH)

# APHICA

CREATURES OF OUR UNIVERSE

missions manned by humanoid "robonauts" (right).

Trips to Mars now occur with amazing frequency. In the past decade, the United States, Europe, Russia, and Japan have launched ten missions to the red planet. But none matched the spectacular achievements of Mars rovers Opportunity (below, on left at Endurance crater) and Spirit. Opportunity's landing in a crater with exposed layers of rock "was a bonanza moment," says Bergstralh. "The rock showed signs of wave action. That meant there were once standing bodies of water on the Mars surface. Liquid water means life is possible." Future missions, Bergstralh says, will dig deeper into rock to try to determine how long Mars had surface water and whether life ever evolved there.

In August a lightweight spacecraft named Messenger lifted off for Mercury, a planet visited once before in the mid-1970s, when the Mariner 10 probe made three flybys and imaged almost half the planet. Messenger will orbit the sunbaked planet in 2011, mapping its cratered surface. With no atmosphere, weather, or geologic processes churning up that surface, Mercury may still bear the imprint of what happened when the solar system was formed.

One disappointment this year occurred in September, when the parachutes that should have floated the spacecraft Genesis to a safe landing back on Earth failed to open. For nearly two years Genesis had hung in space a million miles away, capturing the solar wind—particles propelled from the sun at supersonic speed. Scientists are extracting atomic particles from the shattered debris. "We expect to find the original atomic recipe that went into the formation of the solar system," says Bergstralh.

One of the year's biggest thrills was the arrival of Cassini at Saturn after a seven-year flight. The spacecraft made a daring final approach through the outermost of Saturn's spectacular rings. Traveling at a top speed of nearly 70,000 mph, Cassini passed just 12,000 miles above Saturn's cloud tops as its engine fired, slowing it into orbit. "It was white-knuckle time," says Robert Mitchell, Cassini's project manager. Though the flight path through the rings had been carefully surveyed, even a pebble could have crippled the high-speed spacecraft, Mitchell says.

It will no doubt be white-knuckle time again on December 25, when Cassini—a joint effort by the European and Italian Space Agencies and NASA—launches Huygens to probe Saturn's moon Titan. Resembling a much younger and far colder Earth, Titan has large regions that may be oceans of liquid hydrocarbons such as methane and ethane. What Huygens finds on Titan could open a new chapter in understanding how our solar system—and life—originated.

*—Bill Douthitt*

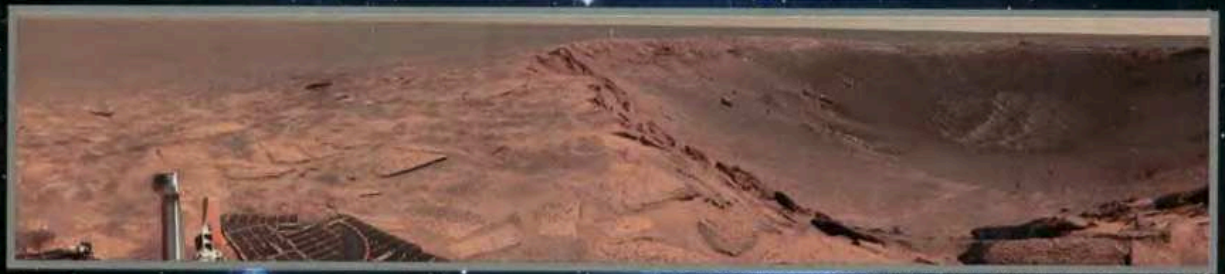
JOHNSON SPACE CENTER, NASA

## NASA's 40-Year Plan

**New Horizons** Set to begin a nine-year flight to Pluto and its moon in 2006, this spacecraft will continue to the outer solar system.

**Nuclear-electric propulsion** The first craft powered this way could lift off in 2015, bound for three of Jupiter's moons. The technology would allow spacecraft to explore faraway planetary systems.

**WEBSITE EXCLUSIVE** · Take a virtual space tour, download starry wallpaper, and test your space smarts with an interactive quiz at **nationalgeographic.com/magazine/space.**



NASA/JET PROPULSION LABORATORY/CORNELL UNIVERSITY (ABOVE); NASA (BACKGROUND)

THE GEOGRAPHY OF EVERYDAY LIFE

# A Work-Weary World?

Americans may think they work a lot, but the average employee in South Korea worked 2,390 hours in 2003. That's almost 600 hours more than the average worker in the United States and a colossal 1,053 hours more than Norwegian workers.

"It has a lot to do with culture," says Lawrence Johnson, chief of the employment trends team at the International Labour Organization. Differences in hours worked "also reflect varying stages of development."

Postwar South Korea's six-day workweek helped transform an agrarian economy into one based on services, manufacturing, and industry. It also helped raise the gross domestic product, from 75 billion dollars in the early 1980s to 477 billion dollars in 2002.

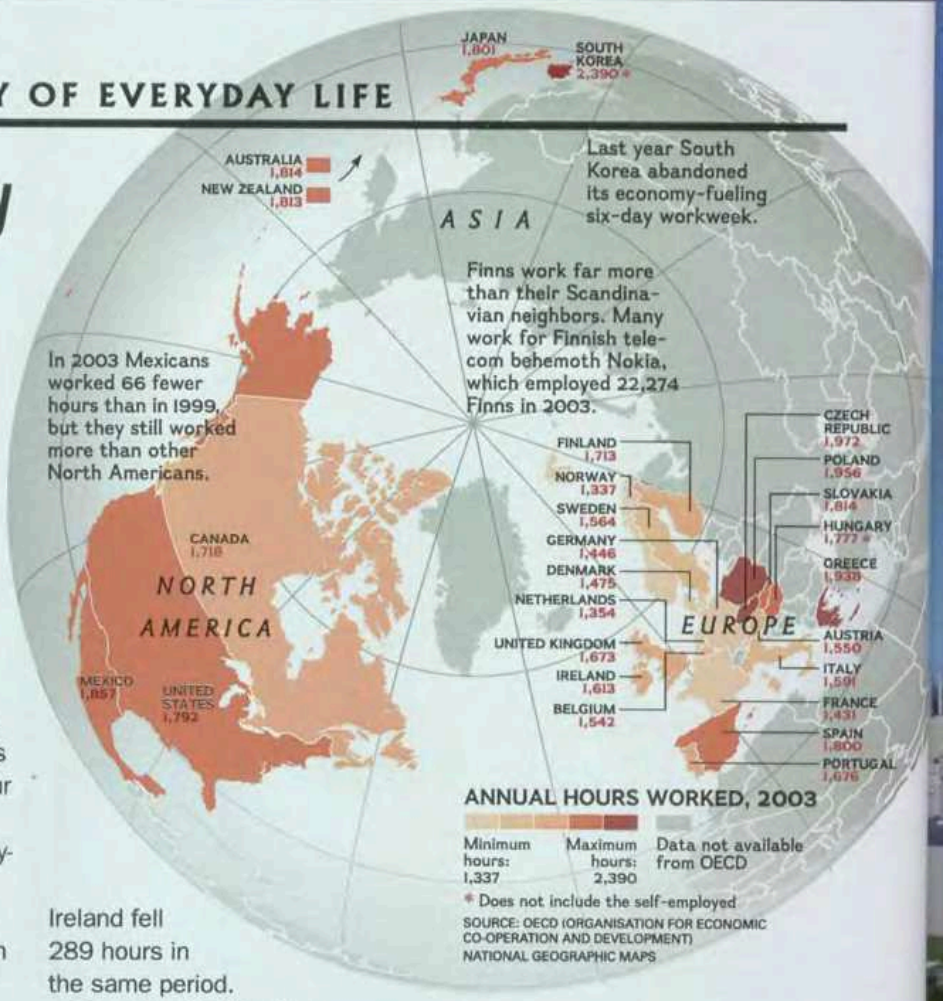
Once a nation cultivates wealth, work hours tend to drop. Last year South Korean workers put in 344 fewer hours than they did in 1983. Job time in Ireland fell 289 hours in the same period.

There's a limit to that trend, however. Germany and France—longtime economic giants of western Europe—slashed hours over the past two decades under the theory that fewer hours would create more jobs and increase productivity. With the Czech Republic, Poland, and six other former communist-bloc countries with lower wages joining the European Union this year, that theory is giving way to a demanding new reality. To stay competitive, some of Old Europe's corporate powerhouses are reversing course and increasing worker hours.

Despite the United States' overall wealth, many workers in industries such as mining and aluminum smelting (left) work long hours because they depend on overtime pay. And some office workers, tethered to their mobile phones and e-mail, likely work extra hours without compensation or official accounting of their time. (Accurate work statistics for nonindustrialized countries are almost impossible to secure.)

Globalization may force countries to adopt each other's most profitable practices. And that could mean longer hours for everyone.

*—Michael Boyer*




JIM RICHARDSON

PETER MACDIARMID, REUTERS/CORBIS

CULTURE

# It's a Bloomin' Bicentennial

*Britain's Royal Horticultural Society keeps growing*

In 1804 seven men met in a London bookshop to form a society "to collect every information respecting the culture and treatment of all Plants and Trees." The group included John Wedgwood of the famed ceramics firm; globetrotting naturalist Joseph Banks; and royal head gardener William Forsyth, whose name lives on via the yellow-flowering forsythia.

Two hundred years later, the Royal Horticultural Society they founded claims 340,000 international members and is firmly rooted as a leading institution in the science and practice of growing things. Its research covers subjects from geranium naming to global warming; the society also serves as the official registration authority for more plant categories than any other body in the world.

In the 1820s and '30s the RHS began its famous flower shows, instituted training programs in horticulture, and planted experimental gardens to test viability of plants in British soils—work that continues to this day. The site of those early gardens in Chiswick was given up in 1903 when RHS facilities moved beyond London's smoke to Wisley, Surrey—15 miles away. But today a street called Horticultural Place marks the original location, and pear trees grow in yards where orchards stood.

Three annual RHS flower shows were soon—and still are—part of the British social scene. Exhibitions are held each summer at Hampton Court Palace in Surrey and at Tatton Park in Cheshire. Yet the best known is the blockbuster Chelsea Flower Show (above), founded in 1913. This year the springtime event drew some 600 exhibitors and 157,000 spectators.

Tributes to the RHS—exhibits, lectures, commemorative stamps—have flowered all year in celebration of the bicentennial. But gardeners themselves offer the highest accolade: green thumbs up. —*A. R. Williams*

## GEO NEWS

EXPLORATION

■ **A new record depth in cave exploration has been reached by a National Geographic Society–sponsored expedition.** The Ukrainian Speleological Association team descended 1,823 meters (slightly more than a mile) into Krubera Cave in the Caucasus Mountains, surpassing the previous record depth of 1,710 meters, set in 2001.

PALEONTOLOGY

■ **Fossil hippopotamus bones have been found in England.** Larger than modern hippo skeletons, the bones are more than 500,000 years old and suggest that Britain once had a warmer climate.

MEDICINE

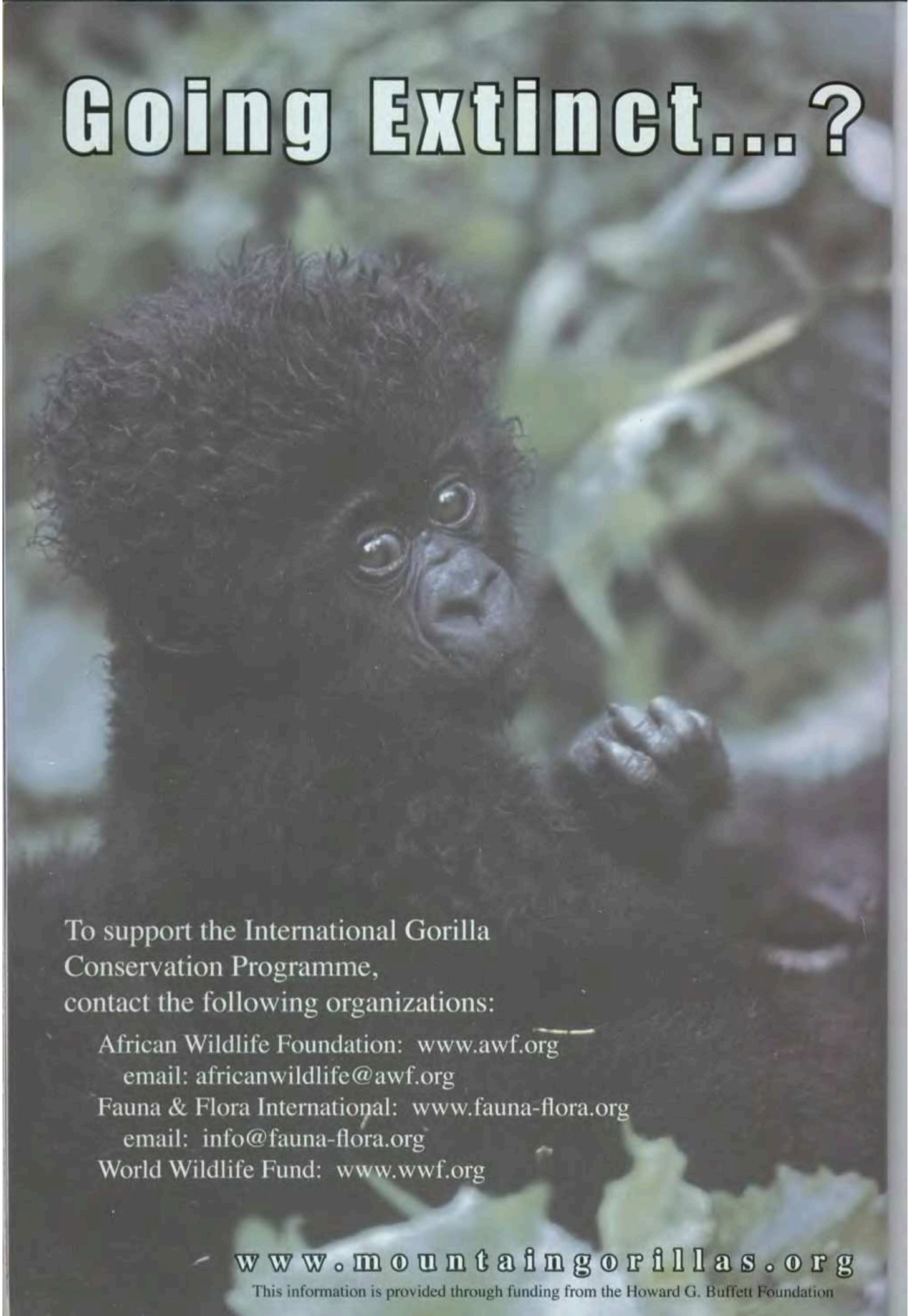
■ **Artemisinins are better than quinine at treating resistant malaria.** Drugs made from extracts of the herb called sweet wormwood offer hope for malaria victims. The disease threatens some 40 percent of the world's population.

ARCHAEOLOGY

■ **A thousand-year-old Viking burial site was discovered on farmland in Cumbria, England, by a local man using a metal detector.** Archaeologists spent months excavating the site, which held the remains of six high-status Vikings—four men and two women—as well as jewelry, weapons, and riding equipment.

ANIMAL KINGDOM

■ **Yawning's contagious—in chimpanzees.** A study says chimps' tendency to "catch" yawns as humans do may indicate an ability to empathize.



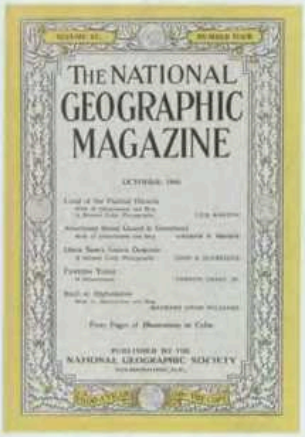
# Going Extinct...?

To support the International Gorilla Conservation Programme, contact the following organizations:

African Wildlife Foundation: www.awf.org
email: africanwildlife@awf.org
Fauna & Flora International: www.fauna-flora.org
email: info@fauna-flora.org
World Wildlife Fund: www.wwf.org

**www.mountaingorillas.org**

This information is provided through funding from the Howard G. Buffett Foundation

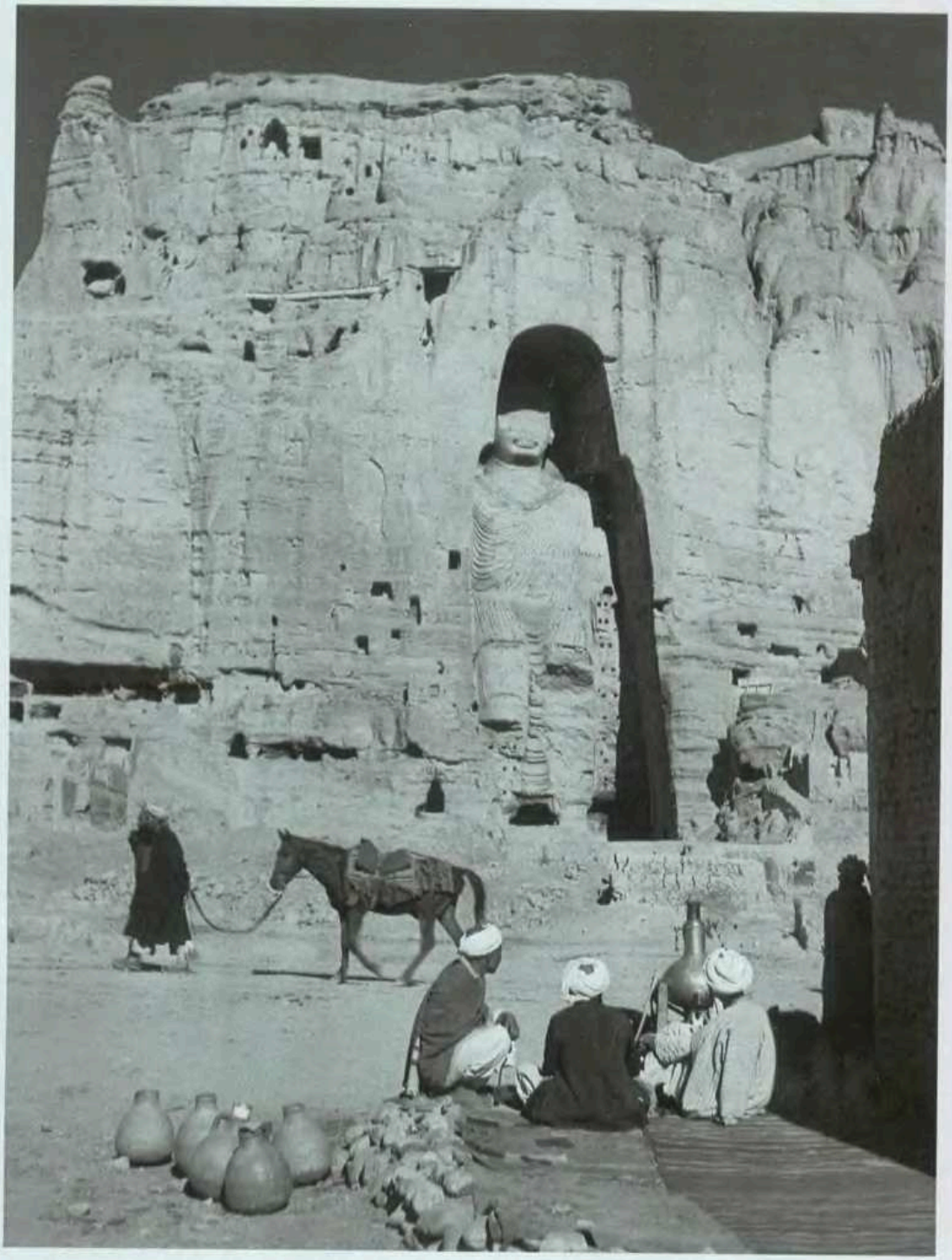



CENTRAL ASIA

# Back to Afghanistan

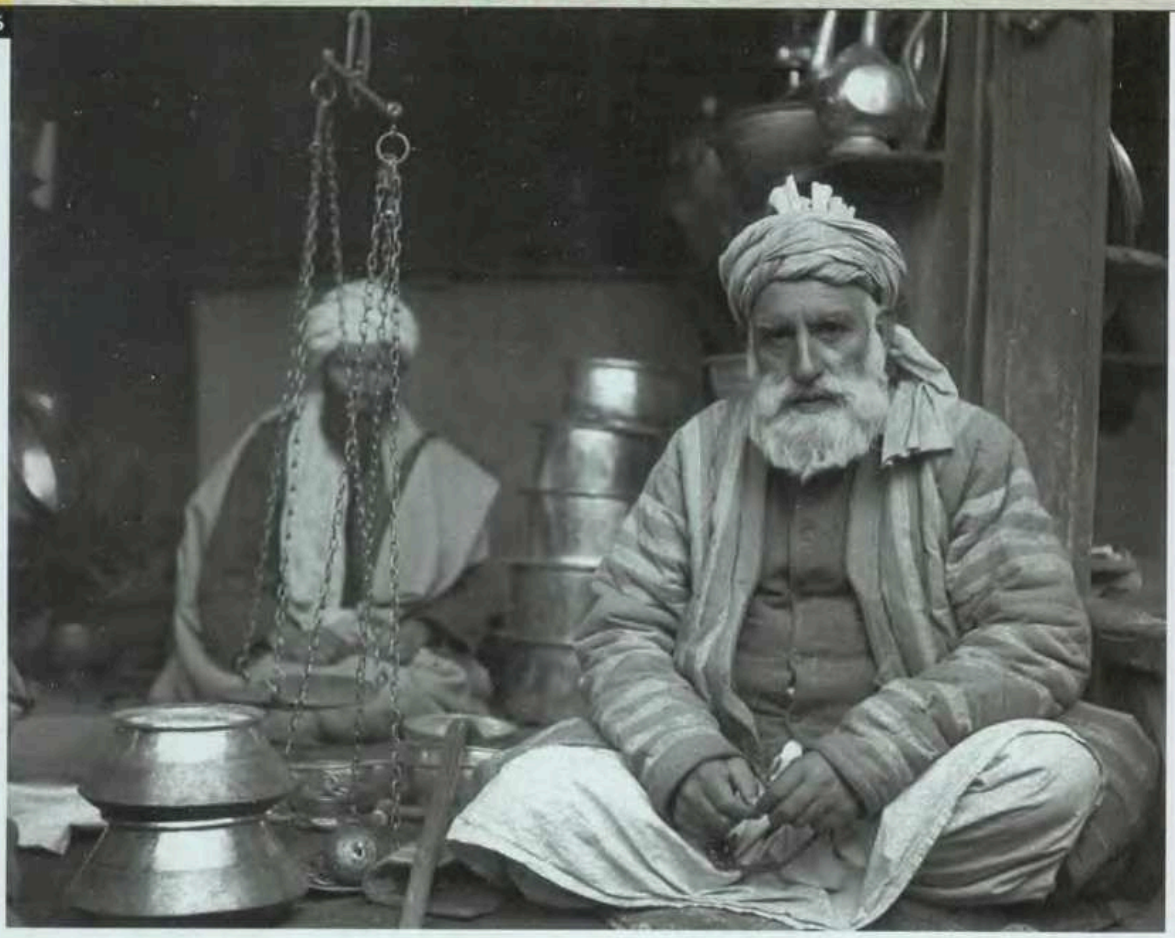
National Geographic has long chronicled the shifting political and cultural landscape of Afghanistan. As early as 1909, the magazine ran a two-part article on the Afghan borderland. Then in 1931 the Geographic's legendary Maynard Owen Williams covered Afghanistan and returned in the early 1940s to write and photograph "Back to Afghanistan," published in the October 1946 issue. In that article, adapted in the following pages, Williams depicted "a humble land where comfort is scorned, where ease is an effeminacy." Much had changed since his first visit: "The nation used to be a closed land . . . jealous of its independence, suspicious of change, true to Islam. . . . Now Afghanistan is educating its youth, building new roads." But much had not changed. In Kabul, Williams described the "ghostly formlessness" of women under "tentlike burkas." His lasting impression, though, was of "freedom-loving tribesmen caught in the toils of modern life." —*Boris Weintraub*

**Oxen and donkeys tread the bygone glories at Ghazni, seat of conquerors. To Ghazni, Afghanistan's great empire builder Mahmud carried back the plunder of India almost ten centuries ago. Ghazni's splendor died in 1152 when the Indian prince Ala-ud-Din gave it fire and sword. In 1839 the British stormed Ghazni and blew in this gate.** All captions adapted from the original October 1946 article in National Geographic.



Muslims at a samovar gaze on the 175-foot Bamian Buddha, carved 1,500 to 1,700 years ago and disfigured by idol breakers. For centuries Bamian was a crossroads of Indian, Greek, and Chinese cultures. Past this spot, pilgrims carried Buddhism to China. The Buddhists have been gone a thousand years, but the shrines and cells they honeycombed into the rock here still provide living quarters for village folk. At upper left is a bridge by which the author reached the figure's head—and grew dizzy.

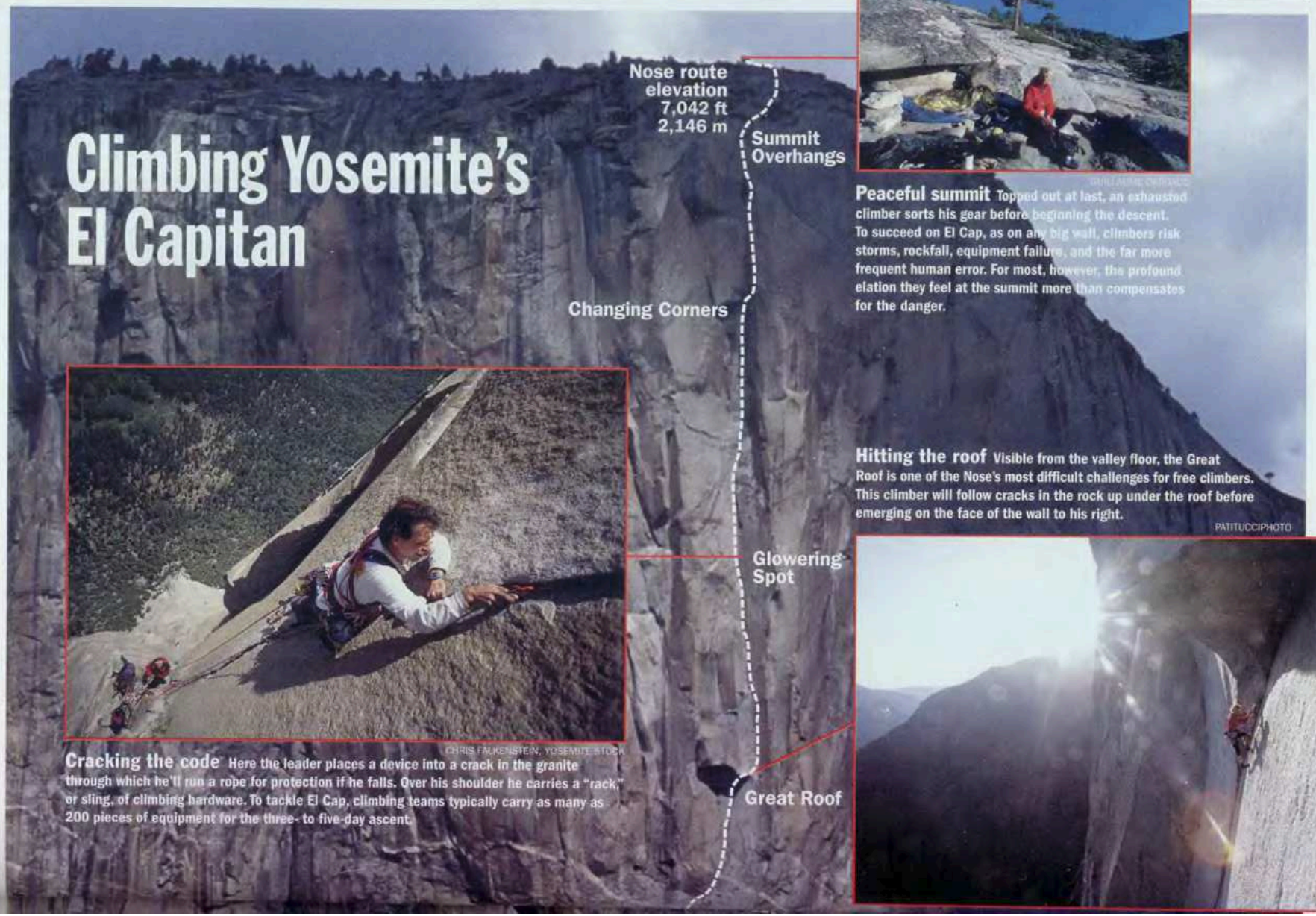
1946



In an open-air shop in Kabul, a coppersmith fingers his prayer beads, as his tolerant eyes take the measure of writer-photographer Williams. Were he to change his dress, he would be very much at home in an American country store. Below, the skilled toes of a Kandahar workman hold a broken cup in a living vise for busy hands to mend. With his bow drill, the workman bores small cavities for brads of soft copper to be hammered in, binding the pieces.


**Hollywood thrillers spell adventure to these Kabul boys. Vainly, the crowd tries to interpret "You'll gasp! You'll howl! You'll thrill!" Seeing the price of admission, they unwittingly fulfill the poster's promise. Sons of horsemen, they love the hard riding in American Westerns. The theater has a special section reserved for women, all discreetly veiled. Long a Central Asian bastion of rugged individualism, Afghanistan is now being swept into the world orbit of short-wave radios, motion pictures, gasoline rationing, and a shortage of transport for the skins of their karakul sheep.**

# Climbing Yosemite's El Capitan






GUILLAUME DARRAS

**Peaceful summit** Topped out at last, an exhausted climber sorts his gear before beginning the descent. To succeed on El Cap, as on any big wall, climbers risk storms, rockfall, equipment failure, and the far more frequent human error. For most, however, the profound elation they feel at the summit more than compensates for the danger.

**Hitting the roof** Visible from the valley floor, the Great Roof is one of the Nose's most difficult challenges for free climbers. This climber will follow cracks in the rock up under the roof before emerging on the face of the wall to his right.

PATITUCCIPHOTO

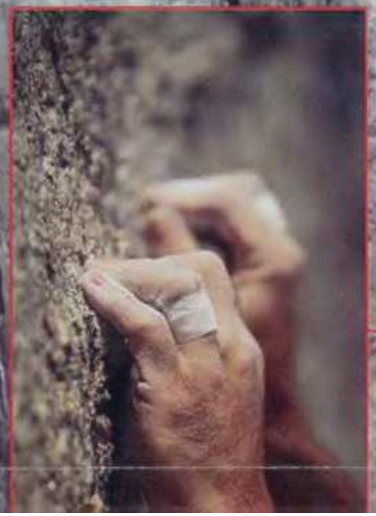


CHRIS FALKENSTEIN, YOSEMITE STOCK

**Cracking the code** Here the leader places a device into a crack in the granite through which he'll run a rope for protection if he falls. Over his shoulder he carries a "rack," or sling, of climbing hardware. To tackle El Cap, climbing teams typically carry as many as 200 pieces of equipment for the three- to five-day ascent.

CHRIS FALKENSTEIN, YOSEMITE STOCK

**Air mattress** On big walls like El Capitan, climbers often camp on light, portable platforms. This climber, his gear, and the platform are all securely anchored to the rock. Redundant, multiple-point anchor systems provide invaluable insurance against a single anchor's failure.



Boot Flake

Texas Flake

Jardine Traverse

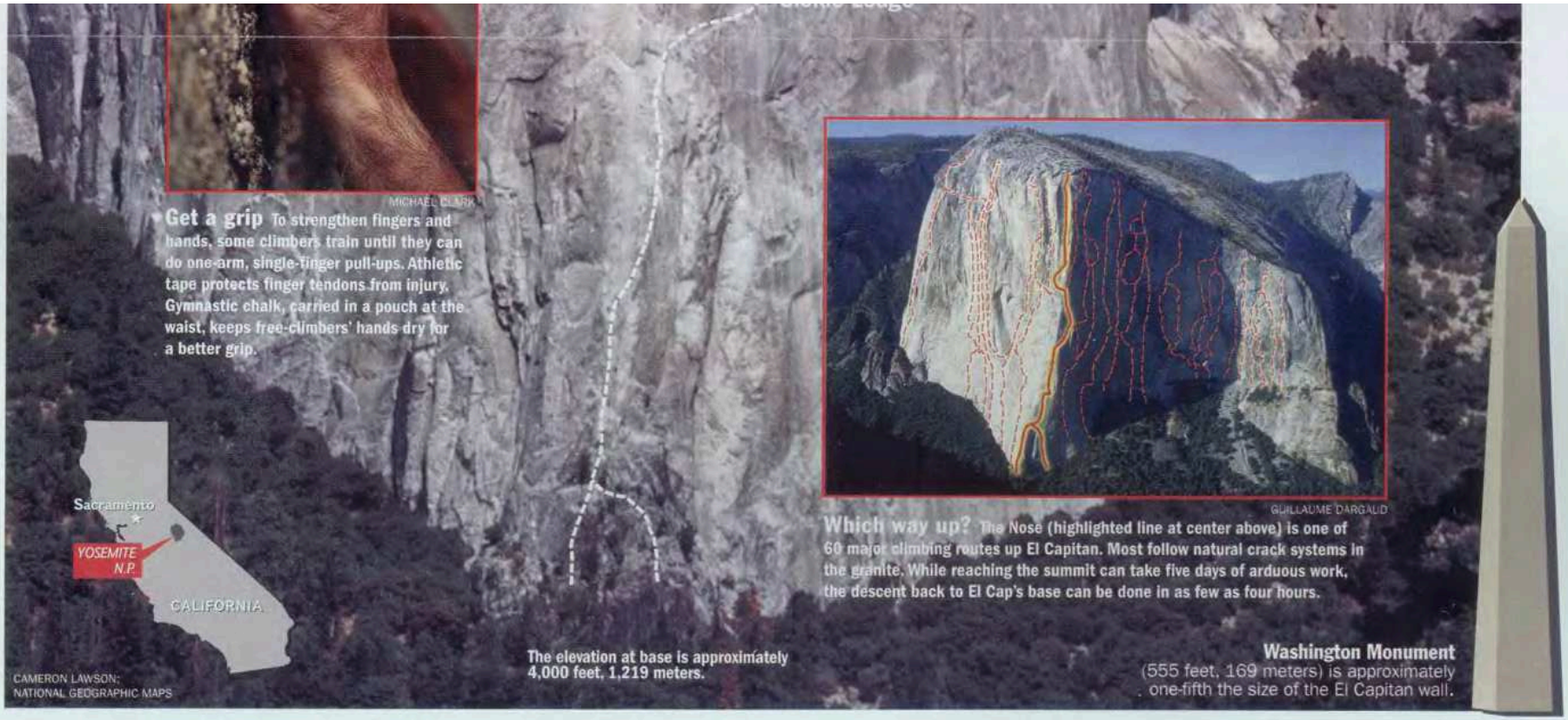
Dolt Tower

THE NOSE ROUTE

Stove Legs Crack

Sickle Ledge

**Moonlighting** To help avoid storms and reduce the need for gear, speed is a climber's ally. This team presses on past nightfall. After a few hours of rest, they'll likely rise before dawn to continue the ascent.




The soaring monolith of granite known as El Capitan is the crown jewel of California's Yosemite Valley. Reaching about 3,000 feet from its base, El Cap's exposed rock face is the biggest in the lower forty-eight and home to what many consider the finest rock climb in the world: the Nose (above), a route that typically takes three to five days to complete.

Famed rock climber Warren Harding led the route's first ascent, in 1958, with a kit that included four enameled stove legs to serve as oversize pitons. Embedding climbing hardware in the rock as they proceeded, Harding and his team made several attempts, climbing for 45 days over the course of 18 months to make that first ascent. Thousands of climbers would follow in succeeding decades, including the legendary Lynn Hill, who in 1993 was the first to climb the route "free," without mechanical aids such as ropes and pitons. The next year, Hill returned and repeated the route in 23 hours, making her the first to free-climb the Nose in a day.

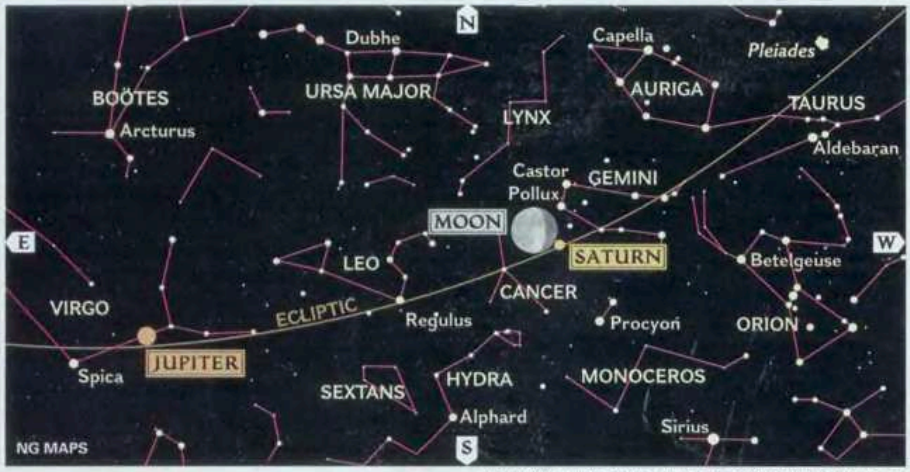
*—Andrew Todhunter*

**Yosemite National Park abounds with great places. For more on Yosemite's splendors, see the upcoming January issue, where the park will be featured in our American Landscapes series.**

**YOSEMITE UP CLOSE** Get the goods on traveling to Yosemite at nationalgeographic.com/magazine/resources/0412.

# Do It Yourself

## SEARCH FOR OTHER EARTHS (SEE PAGE 68)




SKY ABOVE MINNEAPOLIS, MINNESOTA: DECEMBER 1, 2004, 5 A.M.

TRY IT AT HOME

### Armchair Astronomy

On clear evenings the skies stage a star-filled show. But how to identify the characters in the nightly drama outside your own window? Check the Your Sky website at *fourmilab.ch/yoursky.* It allows you to generate sky maps similar to the one above, showing major objects visible in a given area at a given time. Just enter your latitude and longitude or the name of a nearby city to create a sky map with a view toward the horizon or overhead. A virtual telescope also lets you track comets and asteroids without ever leaving home.

GO THERE

### Seeing Stars

Astronomers today work on powerful computers and telescopes located at mountaintop observatories. Some of these welcome the public, including the following three stellar facilities. Be sure to check tour schedules before going.

LAURIE HATCH

■ **Lick Observatory** (right) near San Jose, California. Its Shane reflector is one of the major telescopes involved in the search for planets beyond our own solar system.

■ **Pic du Midi Observatory** in southern France, near the resort of La Mongie. You can take a cable car through the Pyrenees to visit this observatory, home of the Telescope Bernard Lyot (TBL).

■ **Mauna Kea Observatories** on the Big Island of Hawaii. Thirteen working telescopes perched atop a dormant volcano make it the world's largest. A visitor center offers other telescopes for sky gazing.

## PICKS

### 3 movies

Science writer and senior editor **Tim Appenzeller** recommends these three "futurist" space flicks, all of them filmed when walking on the moon was still in the realm of science fiction.

***Frau im Mond* (1929)** Director Fritz Lang's silent epic about a rocket journey to the moon has the first ever "3, 2, 1" countdown for liftoff.

***Destination Moon* (1950)** Written by Robert A. Heinlein and awarded an Oscar for special effects, it's still known for its attention to scientific accuracy.

***2001: A Space Odyssey* (1968)** Stanley Kubrick and Arthur C. Clarke's artful vision of dehumanized space travel stars a paranoid computer named HAL.




**PLANETS IN ACTION**

See the creation of a solar system at **nationalgeographic.com/magazine/0412.**

# My Seven

## The Inking Man's Magazine

**Kenneth Brown** *Tattoo artist, Fredericksburg, Virginia*

Turns out that NATIONAL GEOGRAPHIC is a source of inspiration for a lot of tattoo artistry. Ken says the magazine is an invaluable reference when clients request wildlife designs, and its coverage of human remains is another help. "In my business I get a lot of calls for skulls," he says. Here are seven favorite GEOGRAPHIC articles Ken has drawn from—literally.

NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN (ALL)

**1 Bald eagles** (July 2002 issue) The variety of bird postures makes this article an essential. In the past hundred years of modern electric tattooing, bald eagles have consistently ranked as a popular design among Americans.

**2 Mummies of Greenland** (February 1985) The haunting innocence of the mummified child (below and right) is inspiring. Also great skeletal images begging to be etched into skin as homages to our mortality.


**3 Jewel scarabs** (February 2001) The diversity of beetles in this story is such a help. Scarabs are powerful symbols of the hereafter and often requested as tattoos.

**4 Japan's winter wildlife** (January 2003) These pictures of wildlife fill the demand for traditional Japanese designs and can be reproduced almost exactly on skin.

**5 Great Barrier Reef** (January 2001) Underwater imagery is always a wonderful challenge. The stunning fish and vibrantly colored corals in the magazine are amazing.

**6 Spiders** (August 2001) Just the word can evoke fear. Maybe that's why so many people want spider tattoos. The article's extreme close-ups are great references.

**7 Moths** (May 2002) The natural coloration and the shadow effects of moths are far superior to those of butterflies, and the article's digital images of moths provide excellent details for the tattoo artist.

**WEBSITE EXCLUSIVE**

Learn about the history of tattooing and see excerpts and images from most of these tattoo-inspiring stories at **nationalgeographic.com/magazine/0412**.

# Who Knew?

ASTRONOMY

## Solar System Suburbs

*Location is everything*

Mike Brown found a world that wasn't supposed to exist. It was an icy planetoid, nearly the size of Pluto, and it was in the wrong place, in what had been presumed to be a relatively empty region of space with just some gas and dust—certainly no objects perhaps a thousand miles across.

It's not that the planetoid itself was a big surprise. Over a decade ago astronomers predicted that ice worlds smaller than planets would be found in a region named the Kuiper belt, roughly between the orbit of Neptune and a region of space a pretty good hike beyond Pluto. In 1992 astronomers in Hawaii found the first of what is now a list of nearly a thousand icy bodies in that region. Some are pretty chunky—hundreds of miles in diameter.

Brown, an astronomer at the California Institute of Technology, has found many of the largest planetoids himself. But the one he found in November 2003 —called Sedna, in honor of an Inuit sea goddess of the Arctic —not only is bigger than any known Kuiper belt object other than Pluto but also is many billions of miles farther from the sun than the Kuiper belt bodies. Sedna at its closest approach to the sun is still two and a half times as far away as Pluto. Its orbit will eventually take it more than 12 times that far away, into a dim exurb of the solar system where the sun looks more like an ordinary star.

Brown wondered if he had made the first discovery of a body in the Oort cloud, a hypothesized reservoir of comets forming a kind of shell around the solar system trillions of miles from the sun. Dutch astronomer Jan Oort theorized in the 1950s that certain comets come from this distant pool. But Sedna is much closer to the sun than those hypothetical comets.

Astronomers have been making new models of our solar system since Earth was thought to reside at its center. Brown thinks it's time for another. Perhaps the Kuiper belt and Oort cloud overlap. Icy objects may exist from here to there and everywhere in between.

"Sedna just blew us away. We had no idea that this intermediate population was out there," Brown says.

He suspects that there are larger worlds in our solar system. One, by his calculation, might be close to the size of Mars, around 4,000 miles in diameter, which would definitely bump it up to planet status. He estimates that another 60 bodies the size of Sedna will eventually come into view.

No one will be eager to relocate to an ice ball way beyond Pluto, but this kind of research helps us understand how planetary systems form and evolve. In the meantime, anyone who builds a new model of our solar system should make sure it has room for an extension.

*—Joel Achenbach*
WASHINGTON POST STAFF WRITER

### In Terms of Planets

Some things are the same in every solar system. **Planets** revolve around stars, and planets shine by reflecting the light of the star they orbit. And all planets are created from an aggregation of **planetesimals,** rocky or icy bodies born during the formation of a solar system. Beyond that, there's room for variation. In our solar system there are **major planets** (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune), two of which we call **inferior** because they orbit closer to the sun than Earth (Mercury and Venus) and most of which are **superior** (all the rest, starting with Mars). That leaves **minor planets** (which are the same as asteroids). In an ongoing debate over whether Pluto is a planet or an asteroid, some astronomers, such as Mike Brown of Caltech, choose to use the term **planetoid,** reserved for big minor planets—like some of Pluto's cousins out in the Kuiper belt and beyond.

*—Heidi Schultz*

**WEBSITE EXCLUSIVE** For more on solar systems, and for links to Joel Achenbach's work, go to Resources at **nationalgeographic.com/magazine/0412.**

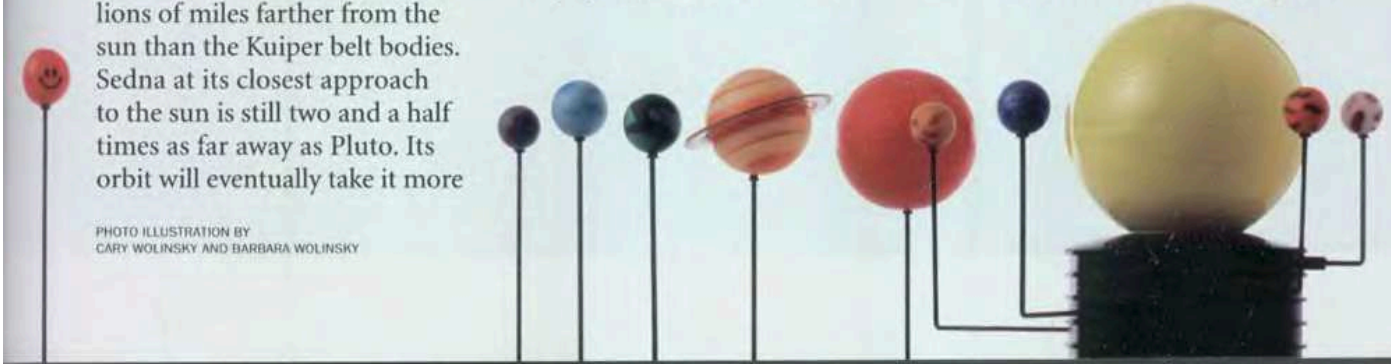
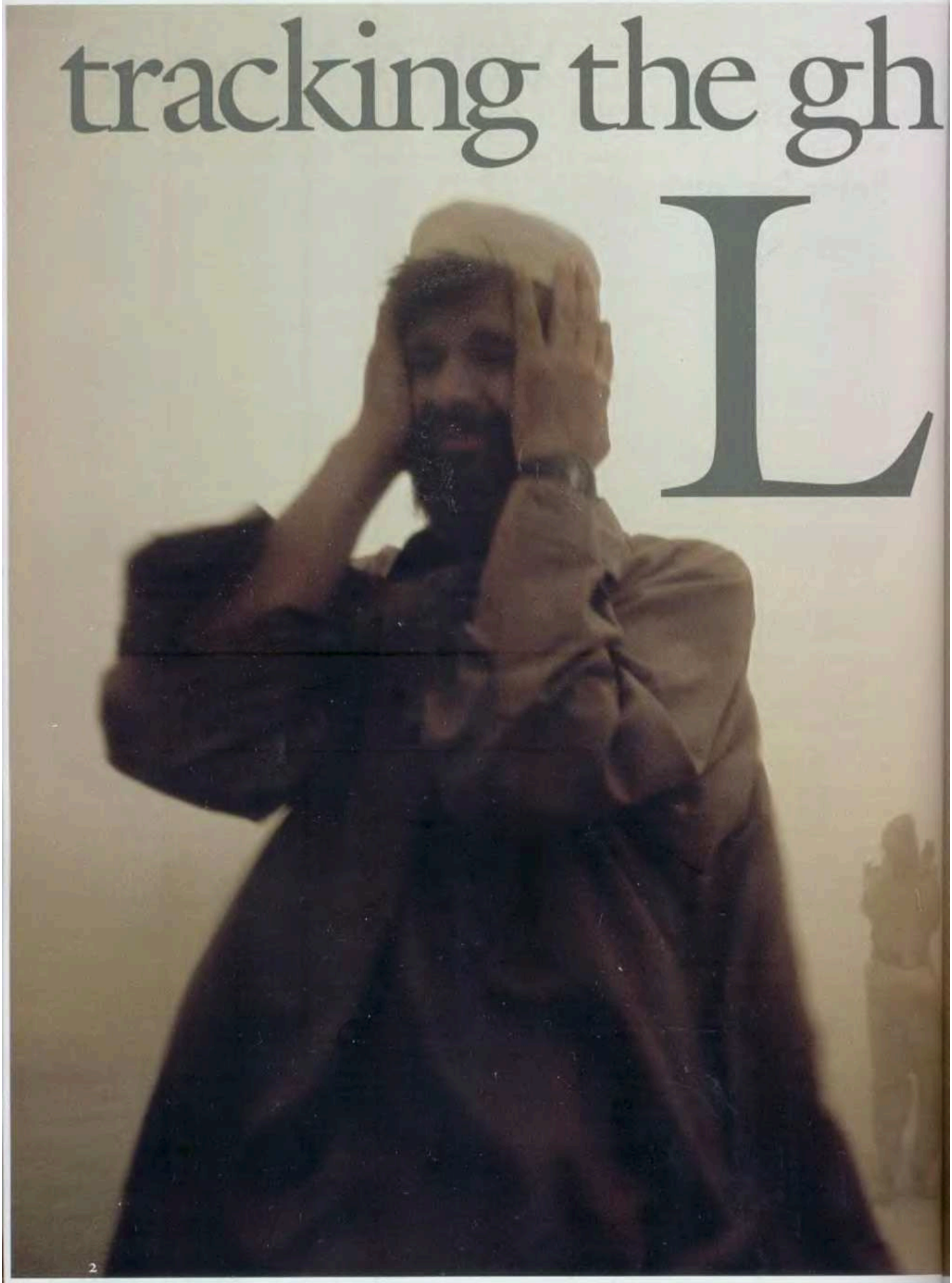


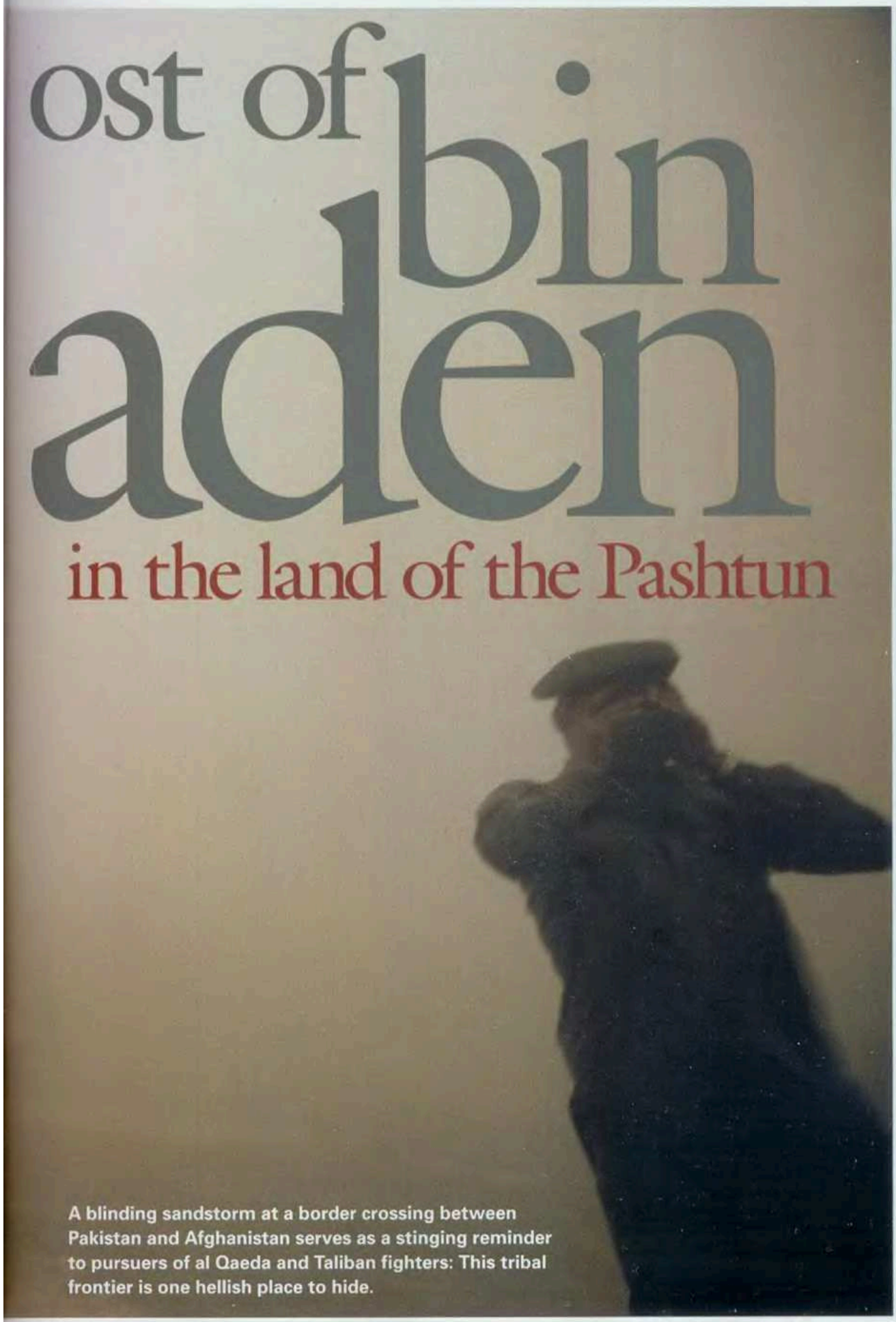
PHOTO ILLUSTRATION BY
CARY WOLINSKY AND BARBARA WOLINSKY

# tracking the gh L

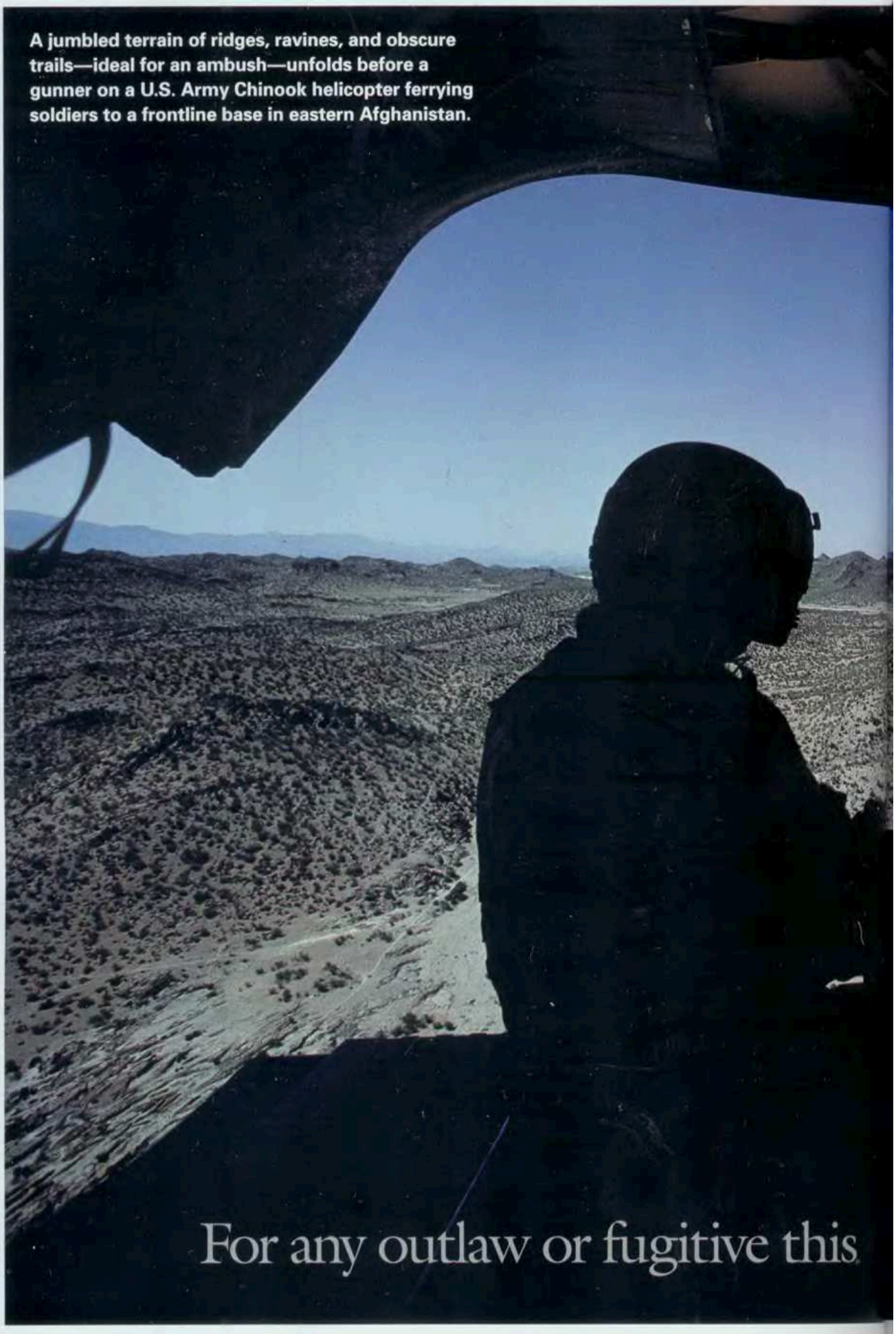


# ost of bin aden

## in the land of the Pashtun



A blinding sandstorm at a border crossing between Pakistan and Afghanistan serves as a stinging reminder to pursuers of al Qaeda and Taliban fighters: This tribal frontier is one hellish place to hide.

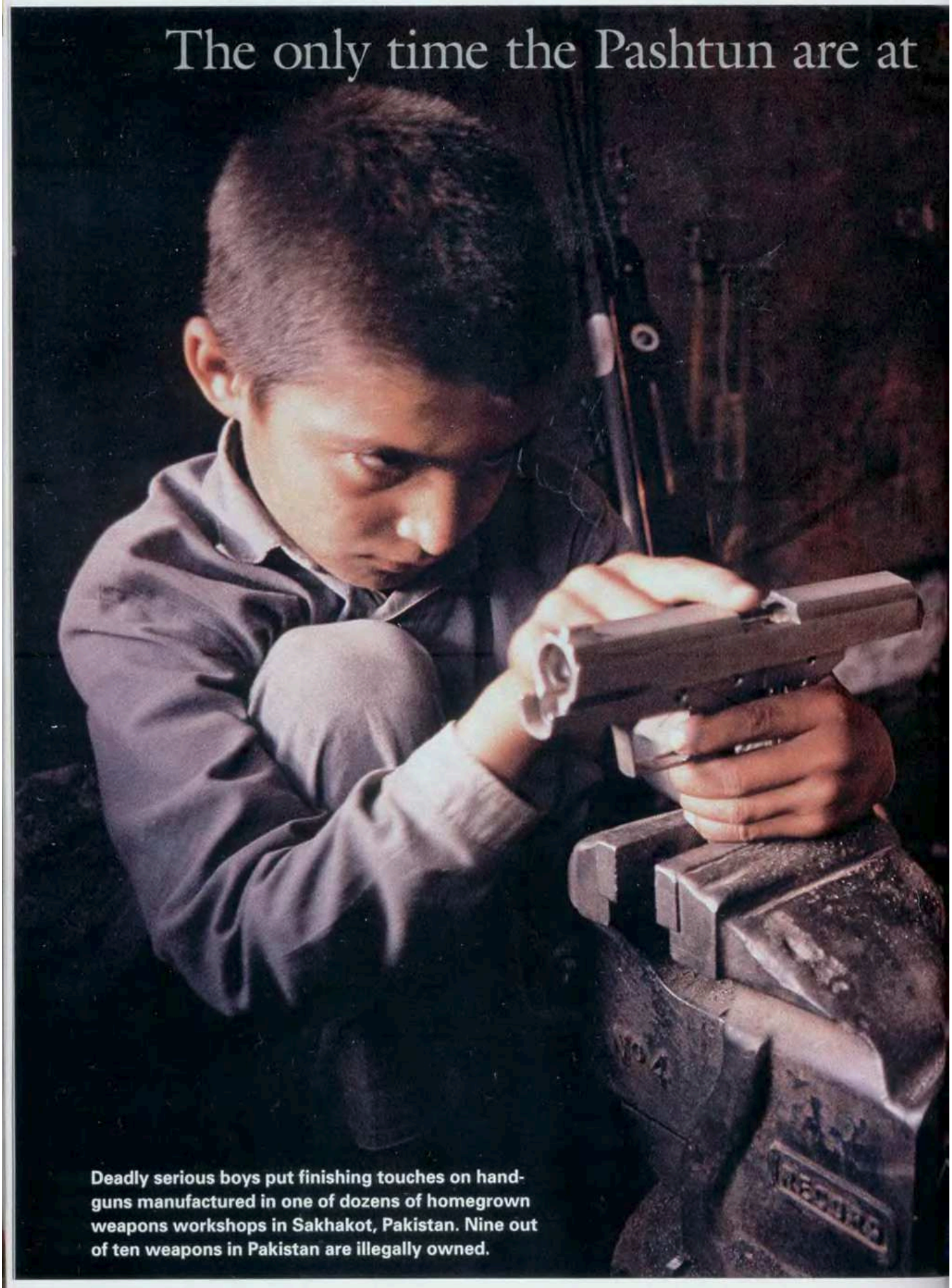


A jumbled terrain of ridges, ravines, and obscure trails—ideal for an ambush—unfolds before a gunner on a U.S. Army Chinook helicopter ferrying soldiers to a frontline base in eastern Afghanistan.

For any outlaw or fugitive this


landscape provides
the perfect hiding place.

# The only time the Pashtun are at



Deadly serious boys put finishing touches on handguns manufactured in one of dozens of homegrown weapons workshops in Sakhakot, Pakistan. Nine out of ten weapons in Pakistan are illegally owned.


peace with themselves
is when they are at war.

By Tim McGirk
Photographs by Reza

Faqir Shah sprays machine-gun fire across the black hills of Tora Bora, shooting at phantoms of al Qaeda. The shots echo through a forest of twisted holly trees, zigzagging up through the ravines to the granite peaks, as if searching for a reply. But there is no response, only the wind. Shah lowers his machine gun, smoke curling from the barrel. It's the first time the Afghan militiaman has gone back to Tora Bora since the fierce battle between al Qaeda fighters and the U.S. military in December 2001, and there is an equal measure of bravado and fear in his macho display.

"We fought al Qaeda here for two weeks in the snow," says Shah, who is wearing U.S. Army-issue camouflage trousers under a ragged gray coat. He points to a nearby bomb crater, 15 feet deep, left by one of the U.S. warplanes, and says, "See that hole? An American soldier tossed a piece of concrete in there from the World Trade Center, because he thought al Qaeda was all finished. I told him I didn't think so."

Shah leads me across the boulders of a narrow creek and up a hill into the Tora Bora caves. There are dozens of caves honeycombed into the hillside, all empty now, save for a few cartridges left over from the U.S. siege of three years ago. Next we venture back outside to the ruins of a mud-brick house, pulverized by bombs. I find fragments of an artillery shell, a prayer cap. "This was where Osama lived," says Shah.

I sit in the rubble, peel an orange, and check the coordinates on my GPS. North 34.07.080 by East 70.13.209. According to eyewitnesses, sometime before the siege of Tora Bora began in early December 2001, bin Laden stopped here for the night, gave a pep talk to hundreds of his fighters, and vanished.

As this article goes to press in early October 2004, the world's most wanted man has not been seen since, although rumors are flying that U.S. forces or their Pakistani allies have captured him and will produce him just before the U.S. presidential election.

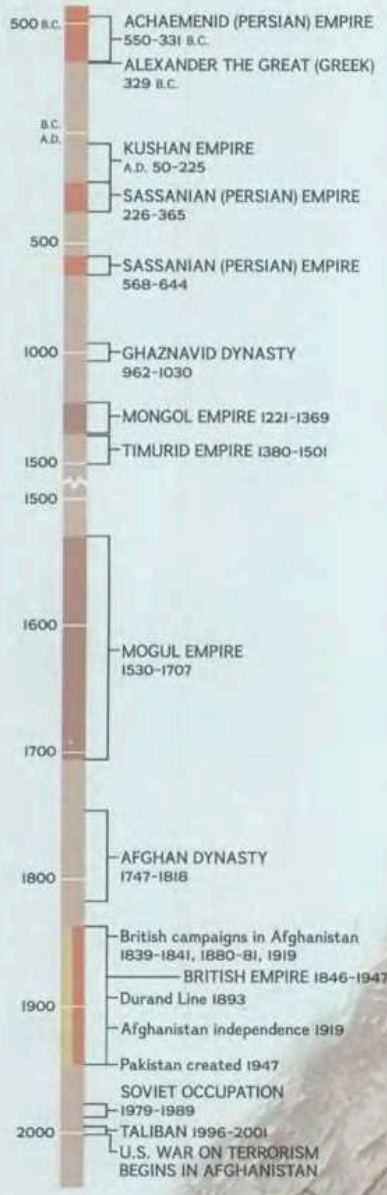
Where could he have gone? Since 9/11 I've asked that question nearly every day as I covered breaking news from my home in Islamabad, Pakistan. In search of an answer, I've trailed bin Laden along the smugglers' crossroads near Afghanistan's desert border with Iran, through the

## Trust No One

**Unending feuds, shifting loyalties among Pashtun tribes, and the presence of some 20,000 U.S. troops convince Afghan militia leader Gul Mohammad to keep an AK-47 at hand. Bribes to tribal elders helped al Qaeda leader Osama bin Laden flee from caves at Tora Bora (above).**

# Land of the Pashtun

## A natural fortress and barrier to conquest, along a wild and lawless frontier





HINDU KUSH

Durand Line (present-day border)

Invasions:
Mongol 13th century
Mogul 16th century
Soviet 20th century

AFGHANISTAN

KONAR

Bajaur

Kabul

Tora Bora (Osama bin Laden last seen here in late fall of 2001)

Jalalabad

Mohmand

Sakhakot

NANGARHAR

Madrassa Pir Baba

3,500 ft 1,067 m Khyber Pass

Peshawar

LOWGAR

Spin Range

15,600 ft 4,755 m

Safed Koh Range

Khyber

Dandar Kili

Darra

Orakzai

Gardiz

PAKTIA

Kurram

Invasion: British 19th century

KHOST

NORTH-WEST FRONTIER

North Waziristan

Rabat

Shkin

South Waziristan

Wana

PAKTIKA

PAKISTAN

Invasions:
Persian 6th century B.C.
3rd and 6th centuries A.D.
Greek 4th century B.C.
British 19th century

Pashtun area
PAKTIA Province
Kurram Tribal Area

Pakistan's Federally Administered Tribal Areas are only nominally controlled by the Pakistani government.

0 mi 50
0 km 50

TIME LINE SOURCE: THOMAS GOUTTIERRE, CENTER FOR AFGHANISTAN STUDIES, UNIVERSITY OF NEBRASKA AT OMAHA

NATIONAL GEOGRAPHIC MAPS

## Durand Line

**A jagged line through the mountains drawn by British diplomat Sir Henry Mortimer Durand in 1893, separating British India from Afghanistan, became the basis for the present-day 1,640-mile border between Pakistan and Afghanistan. Afghanistan hasn't formally recognized the border since Pakistan was created in 1947—and the Pashtun never have.**

craggy mountains of the Hindu Kush, and even in the high-rent districts of two Pakistani cities, Peshawar and Karachi, where a few al Qaeda chiefs have been found hiding in fancy villas.

It may turn out that bin Laden is hiding somewhere far away—in his family's ancestral homeland of southern Yemen, perhaps, or posing as a dreadlocked beachcomber in Costa Rica. There's no shortage of theories, some of them outlandish. But electronic intercepts, statements from captured al Qaeda fighters, and videotapes that show bin Laden in local surroundings are persuasive evidence that bin Laden is still right here, along the Afghanistan-Pakistan border, in a wild, mountainous region the size of Ireland that I've come to think of as "Bin Ladenstan" for its most infamous occupant.

For any outlaw or fugitive this is the perfect hiding place: a fortress-like maze of geography, defined by a great wall of mountains running a thousand miles from the Hindu Kush south to the Arabian Sea. Those formidable mountains form a natural barrier between Central Asia and the plains of India, as a parade of would-be conquerors, from Alexander the Great to 19th-century Britain, and more recently the Soviet Union, have learned the hard way.

Even more forbidding than rocks and snow are the locals, a bewildering array of tribes and clans known collectively as the Pashtun, who number more than 25 million and are sometimes referred to as the Pakhtun, or Pathan. Living on both sides of the border, the Pashtun share a language (Pashtu), a love of guns and jokes, a deep suspicion of outsiders, a passion for the green chewing tobacco called *naswar,* and belief in a strict and ancient code of honor, called *Pashtunwali.* One tenet of this code—*nanawateh,* or sanctuary—is particularly vexing to bin Laden's hunters. It means that every Pashtun is duty bound to help anyone who comes knocking at his door seeking refuge, even if it's his worst enemy. A Pashtun is expected to give his life defending a guest, and many have done so.

I recall a conversation with the urbane Col. Mohammad Yahya Effendi, one of the Pakistani spymasters who ran the Afghan rebels, or mujahideen, during the Soviet war in the 1980s. The Pashtun "can act with nobility and yet be absolute rascals," Effendi told me. "They'll do all sorts of treacherous things—even betray their fathers. But they're bonkers when it comes to giving sanctuary. It's like a sacred mission."

Anyone who hands bin Laden over to the Americans might be 25 million dollars richer in reward money, explained Effendi, but the disgrace would hang over this person, along with his family, clan, and tribe, for many generations. "Osama's a major Islamic hero," he added. "Whoever betrays him, why, his life wouldn't be worth an onion."

In a clearing near the ruins of bin Laden's Tora Bora house, I punch a few buttons on the GPS, broadening the map on my screen. Due south, directly over the Spin mountain range in front of me, is the crooked line of the Pakistan border, drawn by a British diplomat, Sir Henry Mortimer Durand, in 1893.

Northeast lies the Afghan town of Jalalabad. There are stories that bin Laden doubled back there from Tora Bora and spent a few days cloistered in the house of a wealthy landowner, even as U.S. forces and their allies were closing in. That seems unlikely: Returning to the Afghan war zone would have been foolhardy, and bin Laden has proved to be a cautious man.

Directly in front of me lies another possibility: a mule trail that threads through the holly trees, away from bin Laden's house up to a granite ridge, toward Pakistan. It's only logical that bin Laden would have headed for Pakistan; in December 2001, Pakistani troops were slow in sealing off the border, and dozens of al Qaeda fighters made a run for it up those mountains. Maybe bin Laden did too.

The easiest way for National Geographic photographer Reza and me to enter Pakistan is simply to follow that trail. Bad idea, says Shah, the machine gunner; he wasn't just firing at shadows. The night before we arrived, some bad guys, probably Taliban with a few al Qaeda

# Frontier Profits

**Behind the fruit stalls and shop fronts of Darra, in Pakistan's North-West Frontier Province, you can buy everything from assault rifles and grenade launchers to hashish and opium. Lawlessness also thrives on the Afghan side of the border, where a bubble-blowing villager pays no heed to the harvesting of poppies for heroin, despite a national ban.**

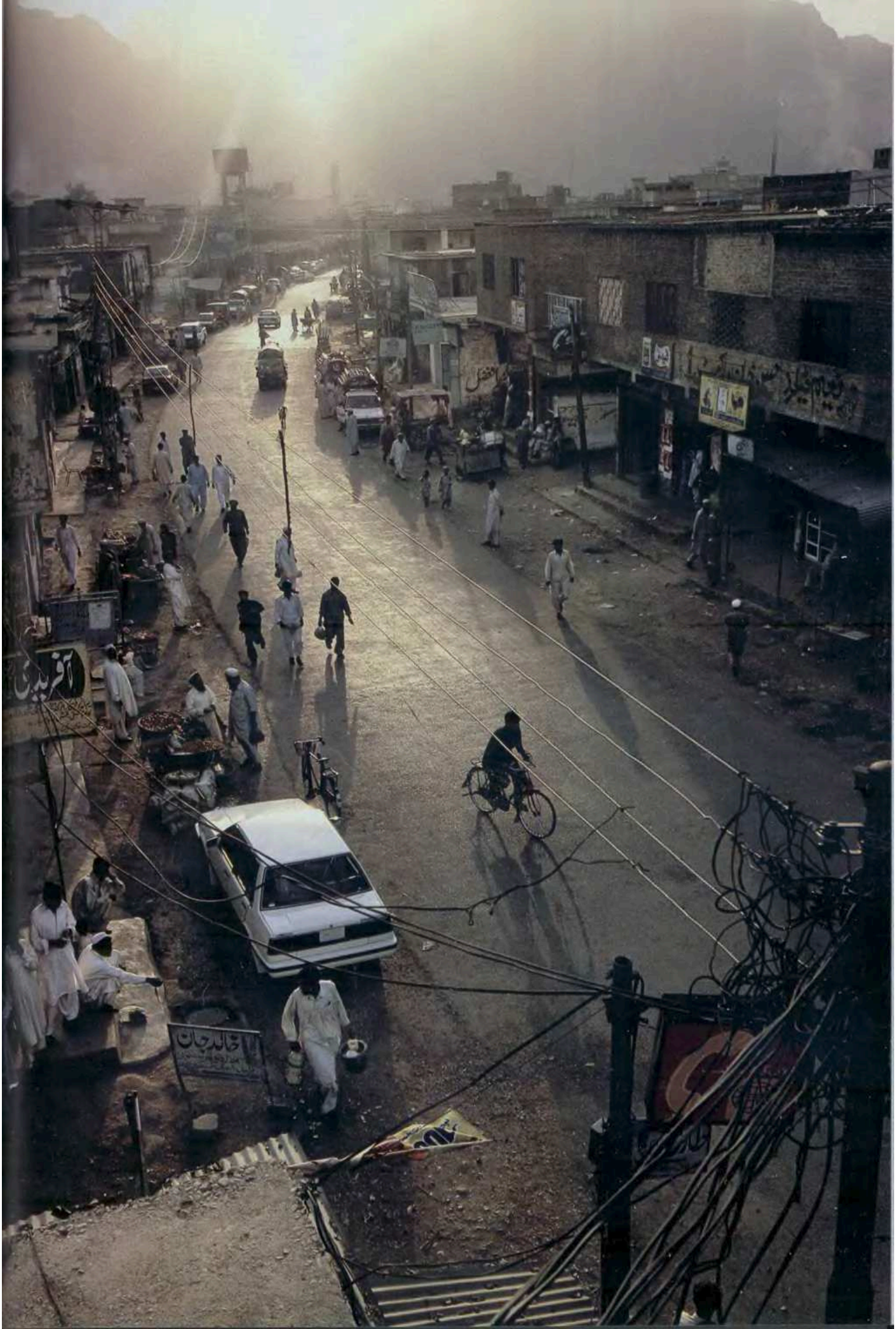
thrown in, had attacked the Afghan border police nearby with rockets and gunfire. The Taliban are probably still watching, and the Afghan commander in charge of our safety, Sher Ghulam, waits until nightfall before he moves us out of camp, without flashlights, to a safe house in a nearby mountain village. "Our enemies come from Pakistan," Sher Ghulam says. It is a refrain we would hear time and again, wherever we traveled in Afghanistan.

Even if Reza and I managed to cross the Pakistan border, we would probably be in just as much danger on the other side. Most of Pakistan's North-West Frontier Province, along the border with Afghanistan, is semiautonomous tribal land. In the 19th century the British, after many bloody campaigns to pacify the Pashtun tribes there, ended up leaving them alone, to serve as a buffer zone between the wilds of Afghanistan and the British colony of India. After Pakistan was founded in 1947, successive Pakistani governments also thought it wise to leave the tribes ungoverned—at least before 9/11.

The Pashtun may be the most ungovernable people on Earth. They are divided into dozens of tribes and hundreds of clans, which are usually at war with each other. The presence of an invader (even a pair of journalists from National Geographic) unites the tribesmen just long enough to drive out the interlopers. Then they go back to shooting at each other. The only time the Pashtun are at peace with themselves, it is said, is when they are at war.

In the tribal areas, the typical Pashtun home is built like a fortress, with high watchtowers and 20-foot walls. And no self-respecting Pashtun is without his personal armory. A powerful household might have an antiaircraft gun mounted in the watchtower, a mortar or two, a .50-caliber machine gun, a dozen or so AK-47s, and a stack of rocket-propelled grenades. With all this firepower, a spat between neighbors often turns into a pitched battle.

What saves the Pashtun from mutual annihilation is a tribal council of elders known as a *jirga.* Chosen by their respective clans, these sages are the supreme interpreters of Pashtunwali, and their collective judgments on land disputes, blood vendettas, and the fine points of sanctuary are final and binding. It's a democratic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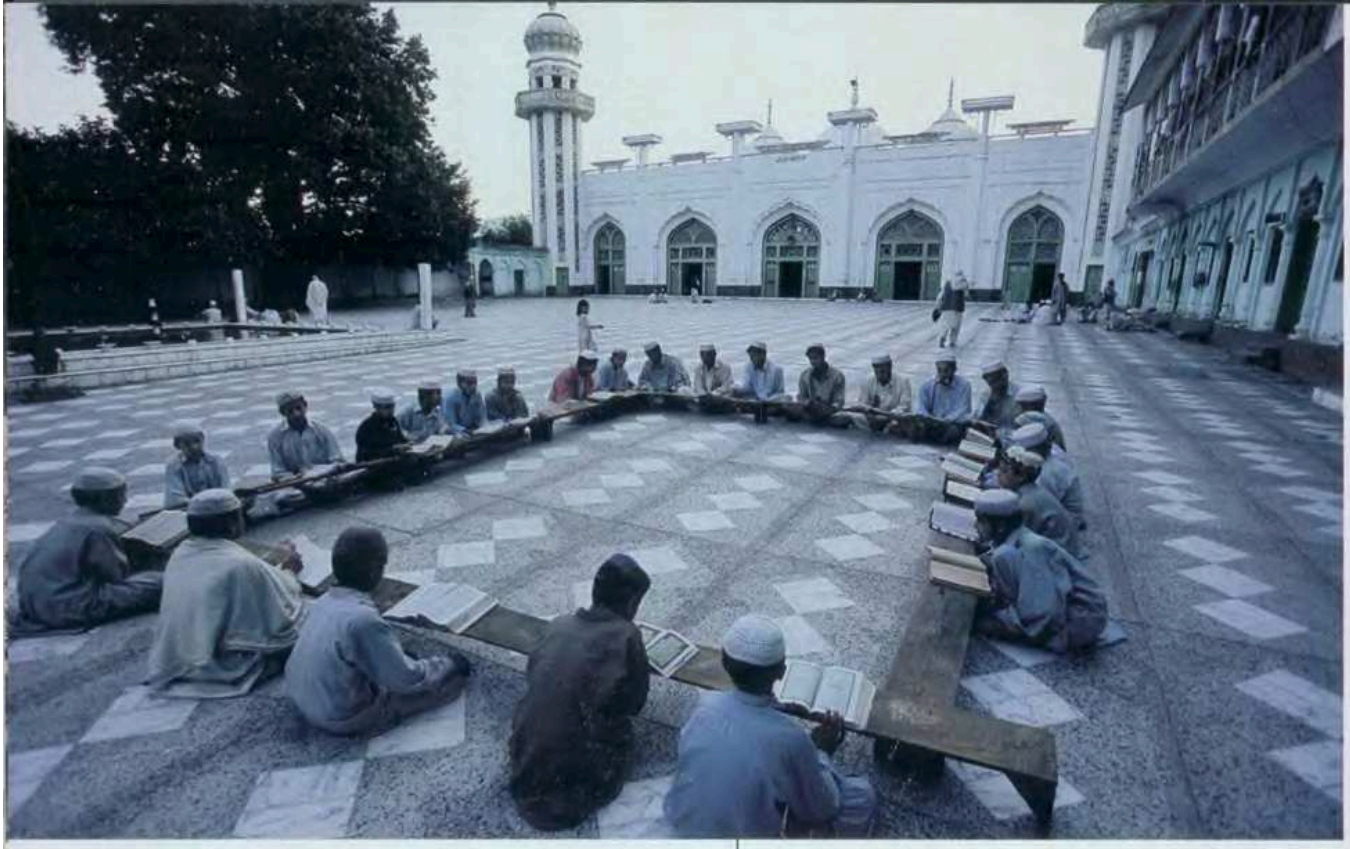


## Growing Up Devout

**With the Koran as their textbook, young Muslims study at Madrassa Pir Baba in Buner, one of 10,000 Islamic schools in Pakistan. Radical madrassas there produced the Taliban, or "students," who seized power in Afghanistan in 1996; they were ousted in 2001.**

system because every Pashtun refuses to accept anyone but the jirga as his superior.

In the end Reza and I decide to seek official permission to visit the tribal areas in Pakistan, rather than just walk across the border. We travel to Peshawar and present ourselves to the local secretary for security, Brig. Mahmood Shah, a sad-eyed man with a soft voice and a burgundy silk scarf tucked rakishly into his vest pocket.

Brigadier Shah is a Pashtun himself, from the Yusufzai tribe, and it is important to note, he says, that not all Pashtun are terrorists and killers. They make fine soldiers, doctors, sea captains, poets, truck drivers, and dashing movie stars whose fame extends throughout Asia. They are men of their word, the brigadier says, and you can go as far as Calcutta and find Pashtun moneylenders whose informal system of banking relies entirely on trust. The brigadier has an impressive array of four colored telephones on his desk, but it is his cell phone that rings, to the jaunty tune of "The Hokey Pokey."

"Hello?" the brigadier answers. He listens and then says: "This man must be eliminated. Use the element of surprise. A night attack. If he gets away, it will be a catastrophe."

His voice is so bland and weary that he might be ordering up a supply of paper clips, not the death of a tribal troublemaker. "Now," he says, turning to us, "what can I do for you?" We explain that we need travel permits and an introduction to the Pakistani government representatives, called political agents, in each tribal district. In their colonial-era bungalows with English rose gardens, the political agents deal with the tribal elders, rewarding them with money, roads, and jobs if they behave. And if they don't, the agents punish the tribesmen with collective fines, arrests, and by occasionally leveling their houses with a charge of dynamite. A final option available to the agents was the brigadier's deadly command: Eliminate the man.

The repercussions of such an order, of course, are hard to predict. In March the Pakistani Army, under pressure from Washington, launched an operation in the mountains southwest of here, a Pashtun tribal region called Waziristan, to clean out hundreds of foreign al Qaeda fighters (known hereabouts as simply the "Arabs"), who were taking advantage of nanawateh.

At one point it was thought that bin Laden and his second-in-command, Ayman al-Zawahiri,

# "Whoever betrays [Osama], why, his life wouldn't be worth an onion."

were hiding near the town of Wana, but these reports later proved false. When we arrived a few weeks into the fighting, the Pakistani Army's offensive wasn't going well, and it had taken dozens of casualties. Convoys were ambushed. Garrisons came under rocket attack, and a dozen Pakistani soldiers who had fled into a mosque were dragged out by al Qaeda fighters and slaughtered.

With Waziristan in flames, Brigadier Shah wants us out of the crossfire. So Reza and I set out instead for Kurram, a long river valley facing Tora Bora that is bounded on one side by snowy mountains.

Guiding us is Rahimullah Yusufzai, a scholarly frontiersman with a white beard and owlish glasses who is the voice of BBC Radio in these parts and the doyen of Pashtun journalists. He had interviewed bin Laden twice and the Taliban chief, Mullah Mohammad Omar, several times, and knows the physical and cultural contours of Bin Ladenstan as well as any man alive. (He had also helped National Geographic track down Sharbat Gula, whose haunting green eyes were familiar to readers all over the world; see "Found," in the April 2002 issue.) And then we have our six bodyguards, scruffy frontier militiamen whose AK-47s often seem to be nonchalantly aimed at us. For our own protection, of course.

Our first destination is Dandar Kili, a village of woodcutters where a group of 50 al Qaeda fighters, many of them frostbitten and wounded, had staggered over the mountains from Tora Bora in December 2001. Sipping green tea in the house of a 100-year-old tribal chieftain, Tajmir Daradar, we ask about that story and are met with stony silence. Later, in the next village down the valley, we find out why.

"Did you notice that in Dandar all the houses were new?" says one villager, Noor Mohammad. "That's because we burned the old ones to the ground." Apparently the al Qaeda fighters had indeed spilled into Dandar and were sheltered in the village mosque. Then the old chieftain Daradar himself had rushed in, warning that the Pakistani Army was on its way and urging the fugitives to stash their guns and hide. The al Qaeda men complied.

"It was a trick," explains Noor Mohammad. "The people of Dandar robbed the Arabs of everything, all their belongings, their dollars. The Arabs came to us limping barefoot through the snow. Even their socks had been stolen." This mistreatment of al Qaeda was seen as such a violation of the Pashtun code of sanctuary that the surrounding villages gathered a 4,000-man army, or *lashkar,* and attacked Dandar, burning down the houses, killing their livestock.

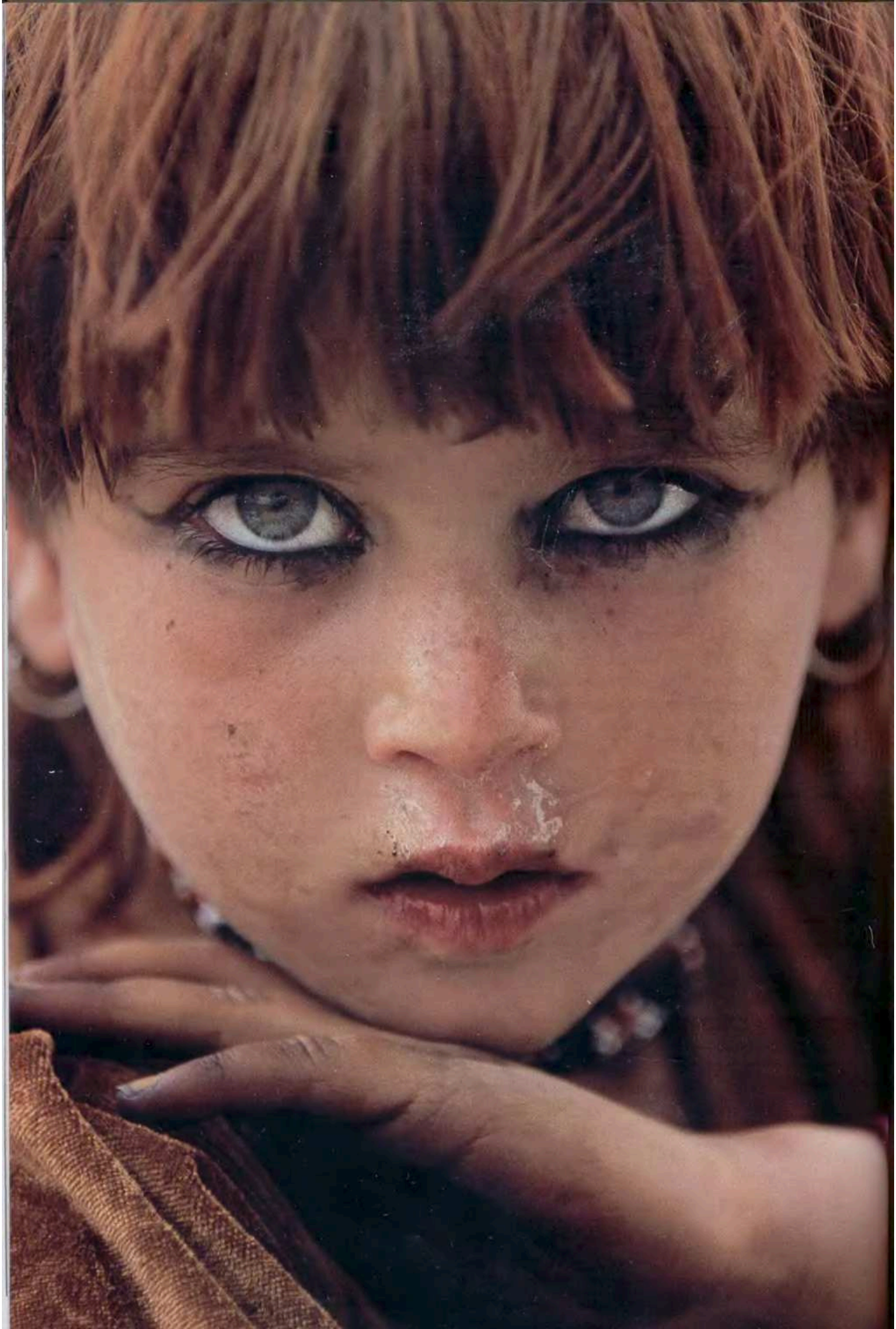
And what happened to the al Qaeda fighters?

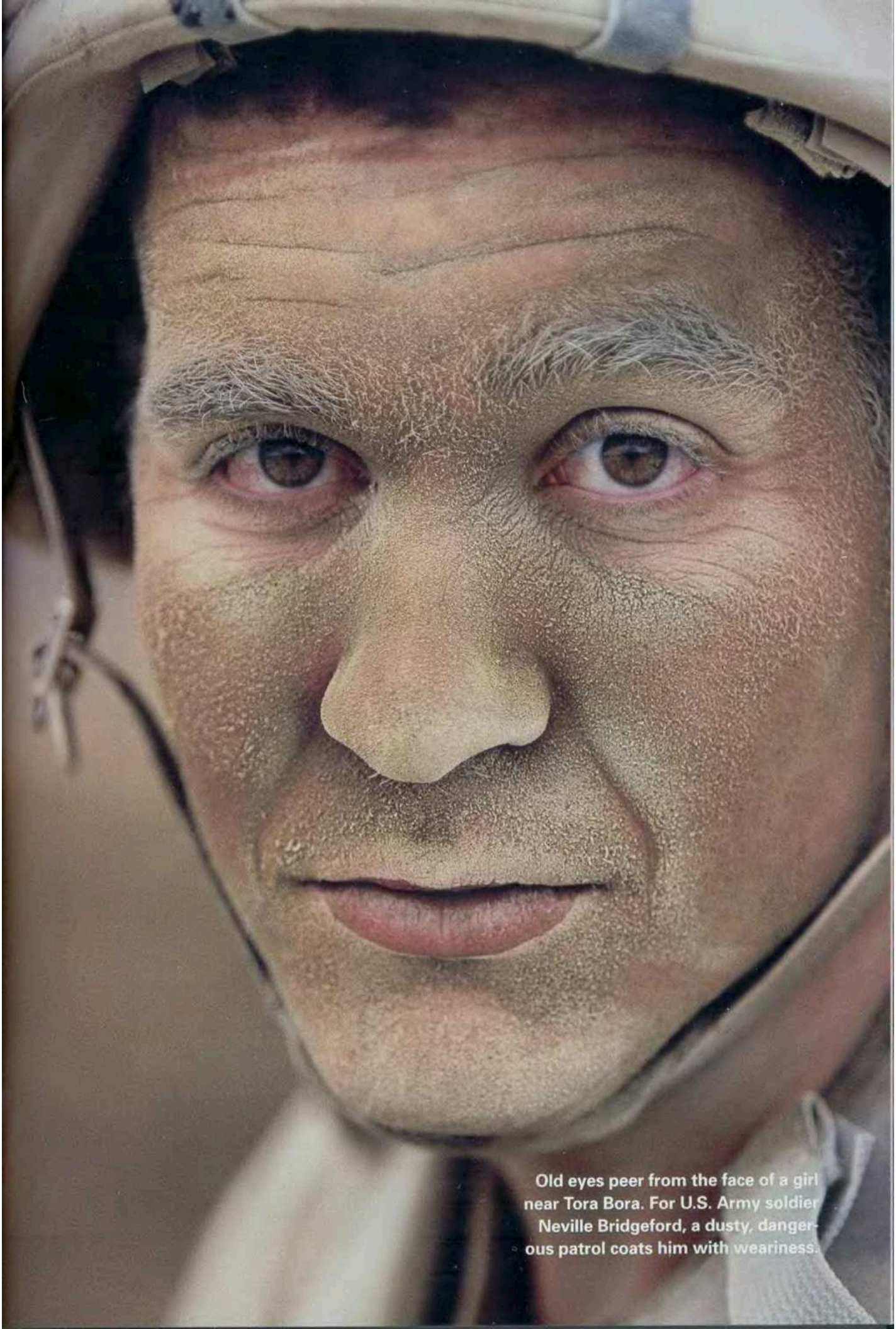
"You have to understand," says Noor Mohammad, eyeing me coolly. "If an American soldier comes to my house asking for protection, I will give it to him. And if Osama comes, I will also give him refuge. This is our Pashtun way." That was as close as I got to an answer.

On the road back to Peshawar, at twilight, we stop at the hillside grave of an al Qaeda man. His body had been found by a shepherd boy and buried by villagers. Flags on sticks—signifying a martyr's burial—snap in the wind, and jagged spears of lightning crash around us with supernatural accuracy. I feel like an intruder, and half-expect bin Laden himself to come gliding down the hill.

During our travels, we saw over a dozen al Qaeda graves. They have become places of pilgrimage for the Pashtun: Women pray there to give birth to brave sons; others honor the fallen fighters in florid poetry, just as they did the mujahideen who died battling the Soviets in Afghanistan.

That decade-long conflict, sparked by the 1979 Soviet invasion, was a tipping point of modern history. To fight its Cold War archenemy, the U.S. made a covert alliance with Pakistan's intelligence services to run the war. Pakistan funneled guns, money, and eventually Stinger surface-to-air missiles to a group of Afghan rebels, who saw the struggle as a jihad, or holy war, to expel the Soviet infidels from Muslim lands. Soon other Muslim countries,





Old eyes peer from the face of a girl near Tora Bora. For U.S. Army soldier Neville Bridgeford, a dusty, dangerous patrol coats him with weariness.

especially Saudi Arabia, began exporting fundamentalist clerics into the Pashtun tribal regions, along with Arab volunteers for the war, including bin Laden.

Meanwhile, independent-minded Afghan elders who resisted Pakistani control were assassinated, one by one, by Pakistan's agents. This weakened the tribes' social order and gave rise, in 1994, to the band of Pashtun warrior-zealots known as the Taliban, or "students," who came out of Pakistan's Saudi-funded religious schools. Supported by Pakistan, the Taliban put together an army, marched on Kabul, and seized effective control of the Afghan government in 1996.

After 9/11 most of these black-turbaned Taliban and their al Qaeda mentors fled back into Pakistan's tribal area, beyond the reach of U.S. warplanes. Using trails known by smugglers and mujahideen who had fought the Soviets, they also launched cross-border raids against the U.S.-led coalition forces, which continue to this day—aided and abetted, some say, by supporters in the Pakistani military.

There are persistent reports of al Qaeda fighters in the Mohmand Agency west of Peshawar, so Reza and I set out to visit that remote region, keeping our eyes peeled for one very tall Arab and his entourage. We have an entourage of our own, including our six bodyguards and a Pakistani Army intelligence officer who's been assigned by Brigadier Shah to "protect" us. Our friend Rahimullah will follow the next morning.

On the steep mountain road we encounter a long procession of gaily painted flatbed trucks carrying huge boulders of white marble from a quarry. This marble—and opium—are two main sources of income for the local people. Later we pull over at a shrine to a Pashtun freedom fighter and outlaw, Haji Turangzai, who was sheltered from the British by local tribesmen for nearly 20 years. In the early 20th century, the Brits mounted 17 operations to grab him and

## Danger Zone

**The gnarled mountain wall between Afghanistan and Pakistan relents at the Khyber Pass, where for centuries armies have advanced and retreated in efforts to control Central Asia and India. Modern traffic is mostly routine—trucks and buses, here grinding down switchbacks toward Afghanistan. But each outbreak of war in the region creates new streams of refugees and combatants.**

failed every time. The bin Laden of his day, Turangzai died in his sleep at age 81.

Verses of the Koran, written in slivers of black glass, surround Turangzai's expansive marble mausoleum. Through an arched window I see a hard-eyed, turbaned man, possibly Taliban, lurking in the shadows of a mulberry tree, watching me as I watch him. He is gone when we leave the shrine.

The next day Rahimullah arrives late, with six bullet holes in his pickup truck. Just 20 minutes out of Peshawar, two gunmen had stepped out of a sugarcane field onto the road and flagged down his vehicle. It was either a robbery or a kidnapping, but the driver didn't wait to find out. He sped away, and the gunmen opened fire. Later, the police told Rahimullah, "Are you crazy? We never go on that road. It's too dangerous!"

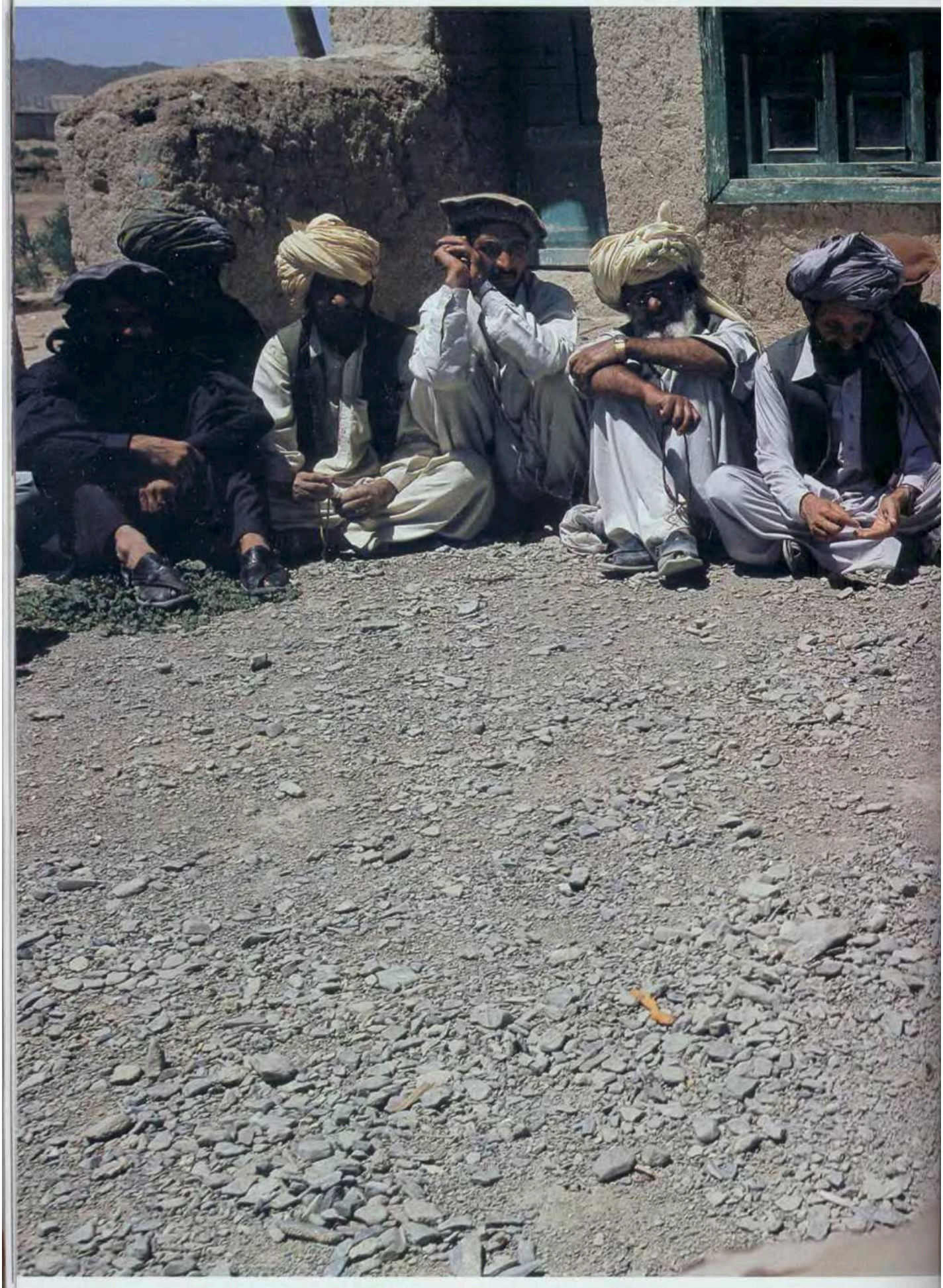
Mohmand is not a friendly place either. Nearly every house is a castle built on steeples of rock, and every farmer toiling in his field has a rifle strapped to his back. Still, the rules of hospitality apply, and one day a local chieftain named Iftikhar Chandar invites us, and our police escort, to his house for lunch. Rope-strung cots are set out in a courtyard under the shade of an ancient grapevine arbor, and we feast on roasted goat and okra. Bees drone lazily around us.

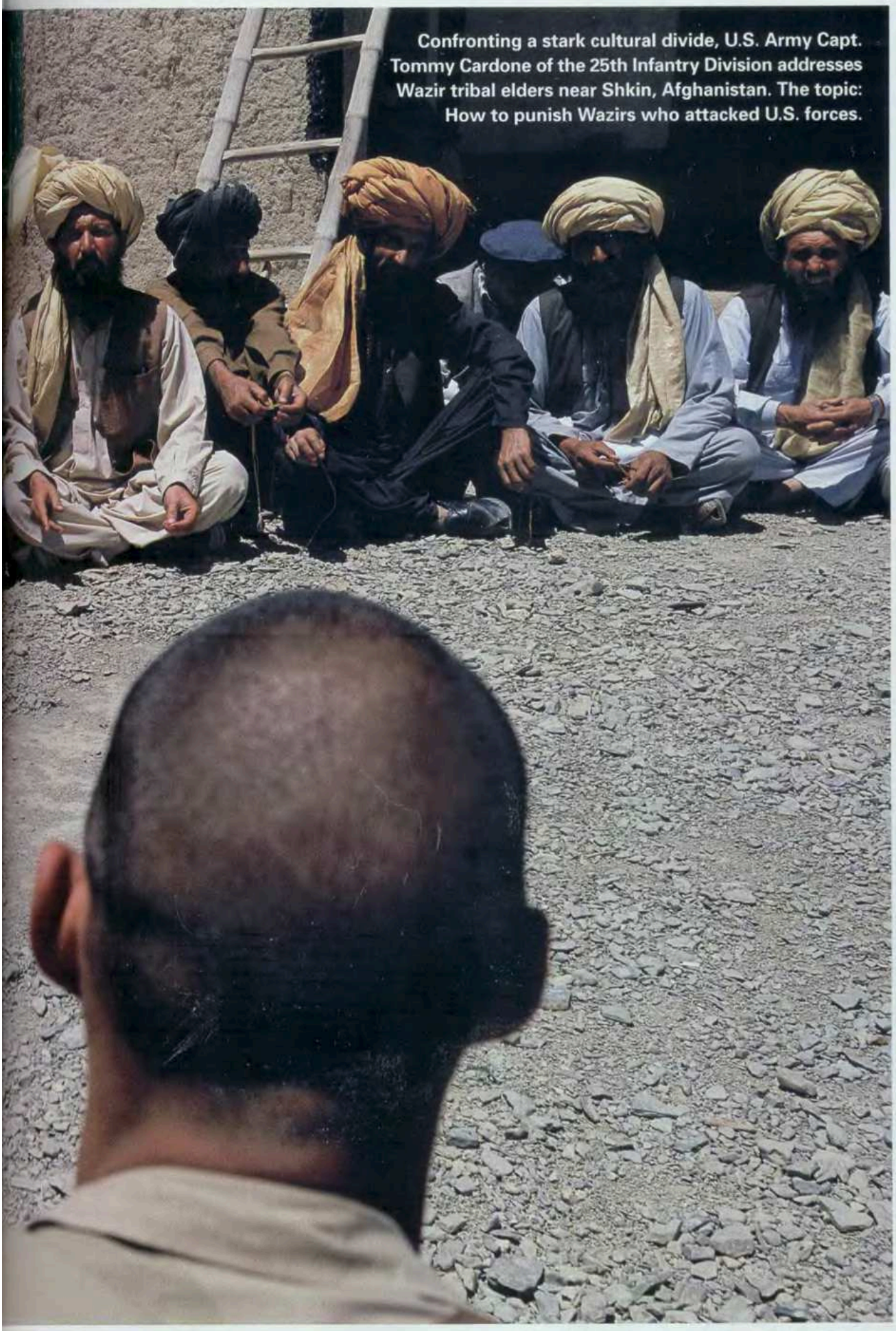
Finally, as discreetly as I can, I ask Chandar what he thinks of his new neighbors, the Pakistani Army. He turns to a gaunt man with pale eyes and a beard like steel wool who is sitting apart from us, playing with a child. "Sher Khan," the chieftain calls out, "perhaps you'd like to grace us with one of your couplets."

His eyes sparkling, Sher Khan leaps up and delivers a poem in Pashtu. It ends with an obscene gesture that has our army escort looking extremely uncomfortable and Rahimullah doubled over laughing. "Oh, he's good. Very critical of the government," Rahimullah says. By having the court jester deliver the truth to us in a poem, he explains, the Mohmand tribesmen get their message across without fear of retribution, as Pashtun poets are beyond reproach. Sher Khan wanders back to his corner, and our host says apologetically, "You have to excuse Sher Khan. He's a bit mad. But a fine poet!"

There is another theory about bin Laden that I'm curious to explore. Soon after 9/11, the story goes, a chieftain of the Kuchi nomads approached Taliban leader Mullah Omar and volunteered to take bin Laden under his protection. This might have appealed to bin Laden: The Kuchis, with their herds of goat, sheep, and camels, are Pashtun who drift around Pakistan, Afghanistan, and sometimes Iran. They're rarely stopped at borders, and their ferocious mastiffs and fabled marksmanship keep snoopers far away from their campfires. Avoiding towns and following their ancient pathways through the hills and deserts, the Kuchis are said to have an intelligence network that is the envy of any Western spy agency. And there are more than a million of them, making it easy for bin Laden to lose himself among them or to be passed from tribe to tribe.

One day in Kabul, I go around to meet a Kuchi leader, Hashmat Ghani Ahmadzai, from the influential Ahmadzai tribe. "I'm a camel jockey and proud of it," says Ghani, a wryly combative





Confronting a stark cultural divide, U.S. Army Capt. Tommy Cardone of the 25th Infantry Division addresses Wazir tribal elders near Shkin, Afghanistan. The topic: How to punish Wazirs who attacked U.S. forces.

# These guys have no particular allegiance to al Qaeda—or to the U.S., for that matter.

man with a close-cropped beard who speaks English and four other languages. The Ahmadzais, he tells me, own a long-distance trucking business and 340 gas stations around Afghanistan. "We're like ants," Ghani says gleefully. "Working together we can rip the skin off a tiger."

An hour later I'm climbing out of Ghani's bulletproof Mercedes limousine at the family farm in Lowgar, south of Kabul, where we've come to test Ghani's new Turkish-made shotgun. It's spring, and the blossoms are drifting off an apple orchard as we stroll down to a stream. Fanned out around us are half a dozen men with guns; they are Ghani's bodyguards. It's like a scene from *The Godfather.*

Could a fugitive take refuge with a Kuchi family? I ask. Ghani nods. "Happens all the time. He has to explain why he's on the run and promise that he won't commit a crime when he's with the Kuchis."

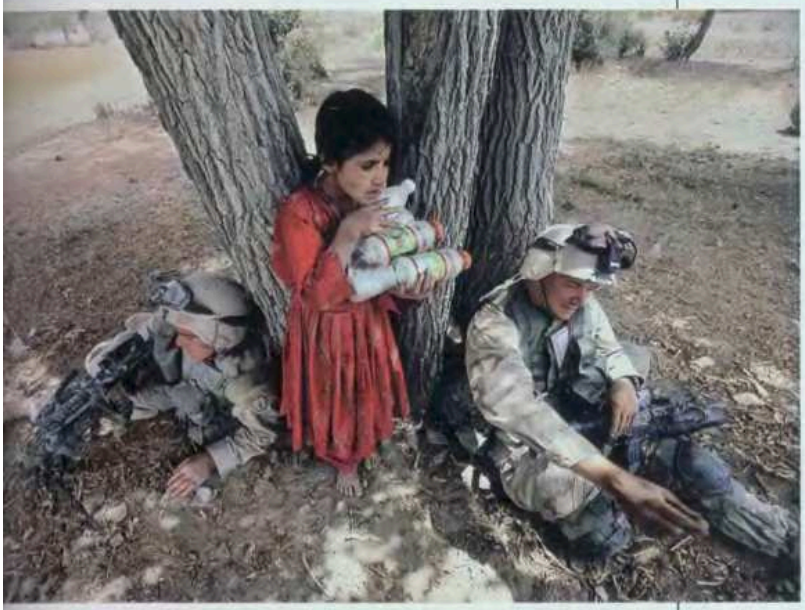
And bin Laden, could he be among the Kuchis? "Of course not," he says, "although a few people from the CIA have stopped by to ask me that."

Ghani blasts away with his Turkish gun at a floating branch in the stream, hitting it both times. He signals to his bodyguards, and in silence we walk back through the orchard, through a snow of blossoms. His face darkens, and I recall the words of Colonel Effendi: Whoever betrays bin Laden, why, his life wouldn't be worth an onion. And the shame of that treachery would last for generations.

With a deft sweep of his arms, my guide Gul Mohammad winds a long, broad flag of ash-colored cloth around my head—a Wazir turban. As a finishing touch, he pulls a tail of the cloth up through the turban so that it stands like a jaunty cock's comb. "You are ready to meet the Wazirs," Gul Mohammad

## Americans Were Here

**Residents of Rabat, Afghanistan, won't forget when the 27th Infantry Regiment came on patrol. Men resented being searched for weapons (opposite), despite the troops' efforts to show respect: "I tell them to act like state troopers pulling over their mothers," says their commander. Besides plastic bottles (below), the soldiers left behind new generators.**



says, stepping back to eye my floppy turban. "It is all arranged." Reza and I are on our way to a jirga—a tribal council—and we have to look our best.

Things are temporarily quiet in Waziristan. Near the town of Wana, the Pakistani Army had granted amnesty to the pro–al Qaeda tribesmen they'd been fighting all spring in hopes that the Wazirs might be coaxed into turning over their foreign "guests."

It didn't work, and now all the Pakistani general in charge has to show for his truce is a rusty old sword, given to him by rebel leader Nek Mohammad, an ex-Taliban commander with long black locks and a sly grin. (Mohammad enjoyed his fame, and he was always giving interviews via his satellite telephone. This may have led to his downfall. The calls were reportedly tracked, and a month after we left, Nek Mohammad was killed by a single missile that came arcing out of the sky.)

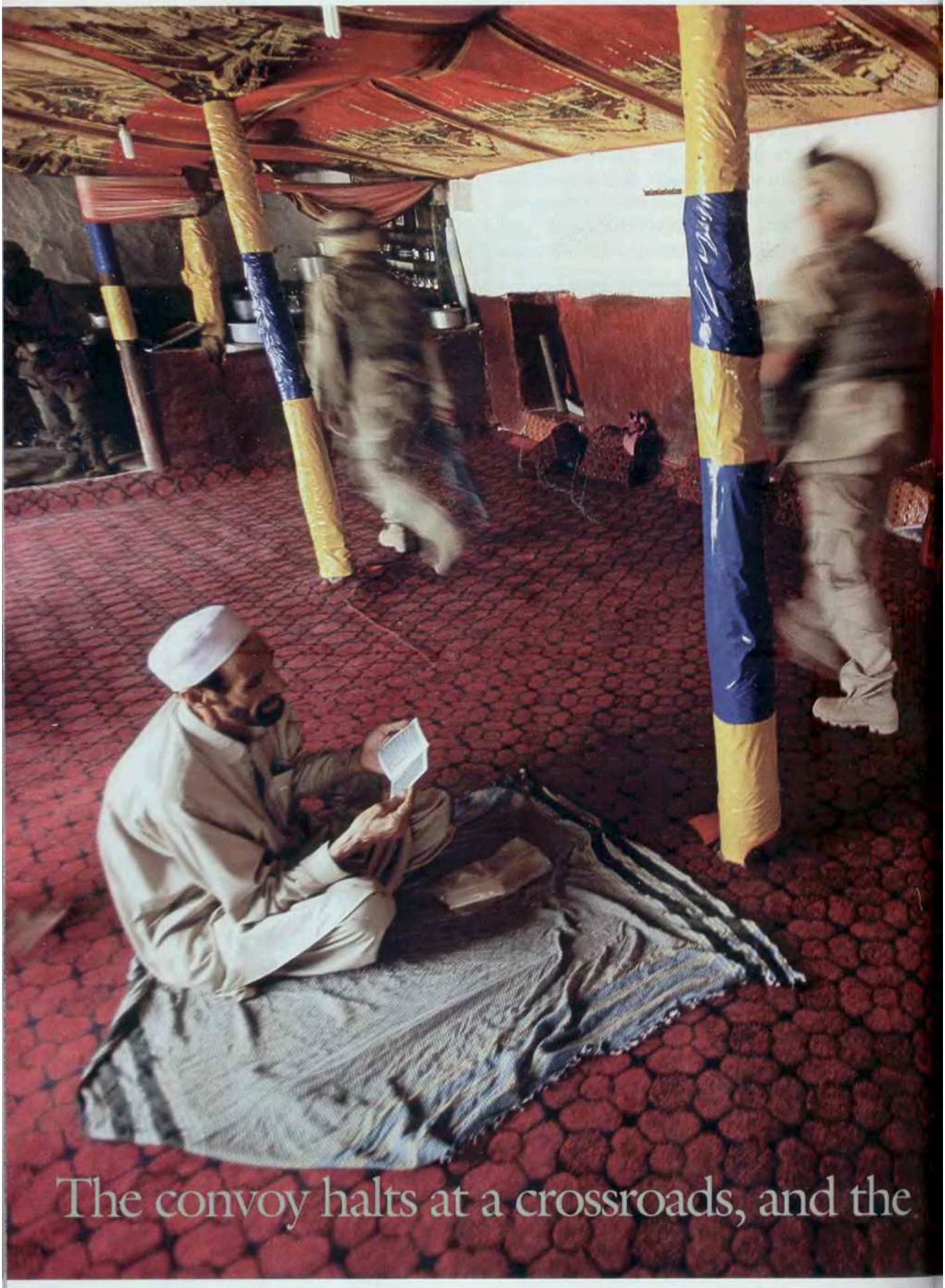
We are heading south on the Afghan side of the border, which is perilous since al Qaeda and Taliban fighters constantly cross this border to ambush American patrols in Afghanistan. It is only because we are traveling with a few Wazir tribal elders—and a mob of gunmen—that we are allowed into Wazir territory, after a 12-hour ride from Kabul through ravines and narrow defiles and forests of glimmering silver pines. All perfect places for an ambush.

The Wazir jirga takes place in the back room of a gas station, a few hundred yards from the Pakistan border. Our hired guns patrol outside. The Taliban and al Qaeda have spies everywhere, I'm told. Inside the gas station, crammed with Wazirs, I make a little speech, by way of introduction. Americans don't hate Muslims, I say; they are in Afghanistan seeking *badal*—revenge—for the 9/11 attacks. A young Wazir interrupts me. "This isn't about Islam," he says, rubbing his fingers together. "It's about money." The Wazirs are growing rich, he explains, because al Qaeda is throwing around thousands of dollars for terrorist recruits and war supplies. Even that has little to do with politics, he adds; it all comes down to a feud between tribes.

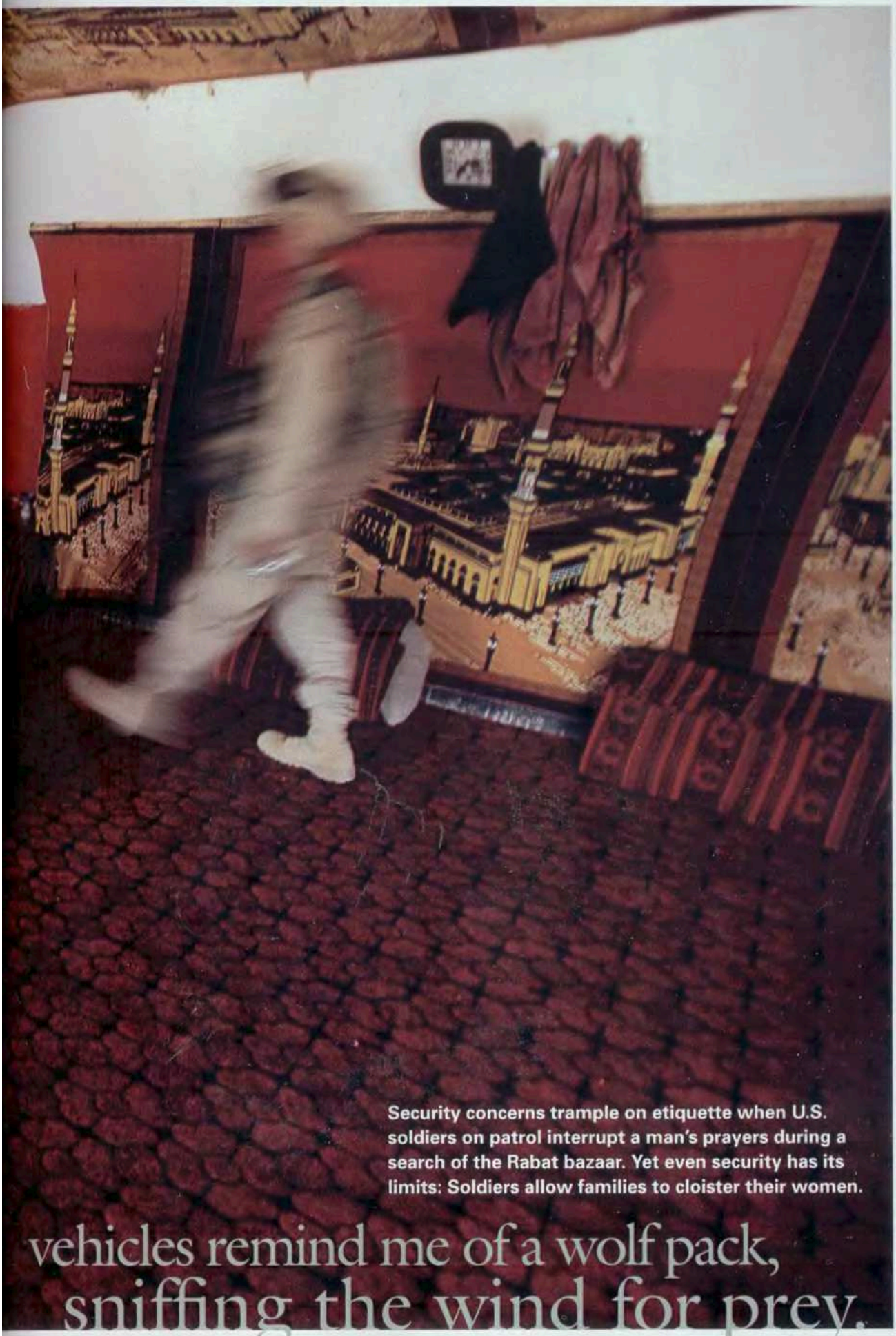
As voices rise in agreement, I begin to understand. These guys have no particular allegiance to al Qaeda—or to the U.S., for that matter—but they are prepared to use either side to fight against their real enemy, a neighboring tribe called the Kharotis. For centuries the Wazirs have been locked in a struggle over land with the Kharotis, and the balance of power has tipped back and forth.

After the Soviets were chased out in 1989, the Kharotis gained the upper hand because one of their tribesmen, Gulbuddin Hekmatyar, rose to become prime minister, backed by Pakistan with guns and money. In 1995 the Wazirs sided with the Taliban, who chased away Hekmatyar, and they rose to power together. Then along came the Americans, and the Kharotis cleverly sided with them, handing over a "terrorist" to curry favor.

"They gave the Americans an Uzbek captive," says one Wazir scornfully, as murmurs of disgust fill the crowded room. After that the Kharotis were trusted by the U.S. military and given jobs as militiamen and workers at the local American firebase at Shkin. And, he adds, the Kharotis used the



The convoy halts at a crossroads, and the



Security concerns trample on etiquette when U.S. soldiers on patrol interrupt a man's prayers during a search of the Rabat bazaar. Yet even security has its limits: Soldiers allow families to cloister their women.

vehicles remind me of a wolf pack, sniffing the wind for prey.

Americans to take revenge against the Wazirs. The Wazirs, he says, had no choice but to side with al Qaeda and the Taliban, who gave them weapons to attack the Kharotis as long as they killed a few U.S. soldiers in the bargain.

As we drive away from the jirga at dusk, we come across a 15-vehicle U.S. armed convoy. "Hey! How's it going?" I yell out. But in my baggy *shalwar kameez* and turban, I get a chilly response. To them I look like a Wazir, and the words coming out of my mouth may not even register as English. The convoy halts at a crossroads, and the vehicles remind me of a wolf pack, sniffing the night wind for prey, before they rumble off into Wazir territory.

Back at Gul Mohammad's house for the night, I wander out into the courtyard to call my wife on a satellite telephone. Suddenly, I hear a Predator drone circling overhead, and I wonder, with horror, whether I had summoned it with my phone call. I cut off my wife abruptly and pray that I hadn't called a missile with bin Laden's name on it down on our host's farmhouse. After a few long minutes the Predator moves on across the field of stars, and I fall into a restless sleep.

The next day, as Reza and I approach the U.S. firebase at Shkin, the Kharoti militiamen who guard it eye us and our Wazir companions with open hostility, but they finally let the two of us—but not our bodyguards—through the giant coils of razor wire.

Inside I reel with culture shock. Rap music pours from a sandbagged gym where soldiers of the Second Battalion, 27th Infantry Regiment, are lifting weights, which clang along with the music. Inside the chow hall all the soldiers are eating next to their guns, watching baseball on a giant TV screen. A few Kharotis mill around the kitchen, wearing plastic shower caps for hygiene instead of turbans. Later Reza points out a dozen tribesmen who have gathered, gape-jawed, to watch a woman soldier sawing a plank.

## Stiff Resistance

**Green flags honoring Islam snap above tombs of historic martyrs in the Afghan city of Gardiz. Such flags are appearing increasingly in the border area, marking the fresh graves of Muslims who died fighting U.S. troops. Whether or not bin Laden and his followers are uprooted here, life and death remain close companions in a land that defies conquest.**

She is wearing gym shorts and a T-shirt. "This is very strange to us," remarks one worker.

Reza asks several Kharoti workers if they are still loyal to their chieftain, Hekmatyar, who is high on the U.S. most wanted list in Afghanistan, along with bin Laden and Mullah Omar. To a man, they reply yes. Worrying news. For now, Hekmatyar may want his men inside the camp spying on the Americans and collecting a paycheck. But the day may come when he tells his Kharotis to rise against the Americans if for no other reason than they were forced to parade around in plastic shower caps or watch women in shorts do woodwork.

The Shkin camp commander is Capt. Tommy Cardone, 32, from Memphis, Tennessee. He's quick-witted and energetic, seeming to run on five-times-normal voltage. Captain Cardone came to Shkin thinking that his job would be chasing al Qaeda up and down mountains. He still does that. But to hunt down his enemies, Cardone has to first know where they're hiding, and that sort of intelligence comes only with understanding the Pashtun tribes and their complex weave of loyalties and vendettas.

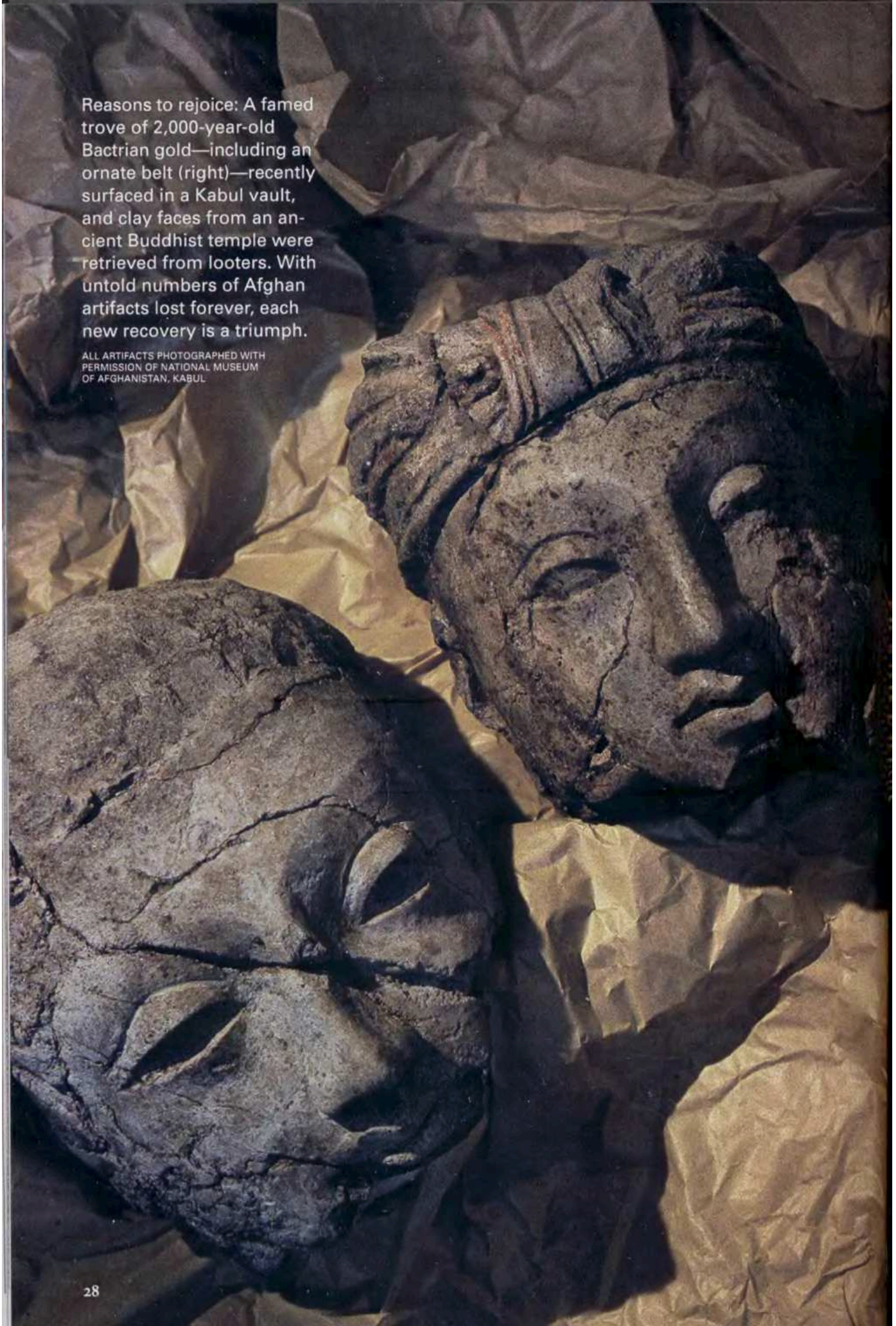
Next morning Captain Cardone takes us out on patrol. The mission is to visit a few villages, give away a few generators, and also to see if the patrol can prompt al Qaeda to ambush us. If that happens, the convoy, backed by air support, will respond with scorching firepower, at least in theory. I climb into the back of a Humvee, and off we go. As we rumble through one village, I notice a guy on a rooftop using a mirror to signal our presence to others—perhaps Taliban—on a distant hilltop ahead of us. As we pass it, I brace for an attack. When nothing happens, the soldiers are disappointed; I start to breathe again.

An hour later, over brackish green tea with village elders, Cardone explains that U.S. troops in Afghanistan are more sensitive now about Pashtun culture. During house searches the men of the family are given time to cloister their women in one room before the soldiers enter. Nakedness is a great shame for the Pashtun, he explains, so no man is strip-searched in public by the soldiers. Gifts help too, and the generators are a big hit. One village elder hugs Cardone and says, "I would die for the U.S. soldiers now."

"Let's hope that isn't necessary," Cardone replies. A few miles away, at a village where the U.S. gave away generators and a tractor, the Taliban came down out of the hills and warned that from then on, anyone who took American gifts would be shot dead.

Slowly, the Americans are making inroads in Bin Ladenstan. Intelligence on al Qaeda has improved, and in one village square Captain Cardone noticed a change in the scenery: Before, the walls of a tea shop had a primitive drawing of al Qaeda stick people shooting at helicopters. Now those figures of gunmen were erased, and in the drawing the U.S. helicopters were flying unharmed over the land of the Pashtun. It's a happy picture. But among these wild-hearted warriors, and with the world's most elusive ghost still at large, it may be nothing more than an illusion. □

**GRASSROOTS GUNMAKERS** Experience the Sights & Sounds of kids making bullets and grownups building guns from scratch in a Pashtun village, then discuss the hunt for bin Laden in our forum at **nationalgeographic.com/magazine/0412**.



Reasons to rejoice: A famed trove of 2,000-year-old Bactrian gold—including an ornate belt (right)—recently surfaced in a Kabul vault, and clay faces from an ancient Buddhist temple were retrieved from looters. With untold numbers of Afghan artifacts lost forever, each new recovery is a triumph.

ALL ARTIFACTS PHOTOGRAPHED WITH PERMISSION OF NATIONAL MUSEUM OF AFGHANISTAN, KABUL

# saving

Against all odds, a country shattered by more than two

decades of upheaval begins to rescue its ancient treasures.

# afghan culture

by andrew lawler • photographs by kenneth garrett

He feared for his life, all because he found an inscribed slab of stone near his village. Mohammed Mokhtar Ahmadi had challenged a warlord's demand that he turn over the valuable object, and so he was hiding out in Kabul, afraid to return to his home in the central highlands of Afghanistan. "Everywhere I walk, I worry they will kill me—kill me!" he said as we plowed slowly through the capital's traffic of honking cars, belching trucks, ramshackle donkey carts, and daring pedestrians.

Ahmadi's trials began in 1995 when he and his brother stumbled on an ancient Buddhist shrine near their small town of Tangisafedak. Inside they found a stone box with a book, gold coins, and a gemstone; an outer wall bore an inscription with strange letters. Word of the discovery spread, and soldiers loyal to the local warlord, Abdul Karim Khalili, took away the box and its contents.

After the stone inscription was removed from the wall, Ahmadi, a village leader, held on to it for safekeeping. By 2002 Khalili had become a vice president of the post-Taliban Afghanistan, and his private militia returned to demand the stone. Ahmadi only relented when they agreed to give him a receipt. Then he promptly went to Kabul to notify the Ministry of Information and Culture. When Khalili was questioned by local media, he initially denied knowing about

# Gold Rush

As civil conflict loomed over Afghanistan in 1978, Soviet archaeologists uncovered the find of a lifetime: six gold-laden tombs of Bactrian nomads. They sped the treasure to Kabul, but as chaos seized the country, the priceless trove vanished—until now. In August 2003, with the Taliban ousted and Hamid Karzai's

*(Continued on page 33)*

Evidence of a cultural crossroads, a brooch nicknamed the "Bactrian Aphrodite" shows Greek, Indian, and Asian influences; horned lion heads (opposite) curve into bracelets.

either the box or the stone. A Kabul newspaper, however, published a copy of the receipt backing up Ahmadi's story, and Khalili delivered the stone to the National Museum. The whereabouts of the box and its contents remains a mystery—and Khalili has refused to discuss the matter.

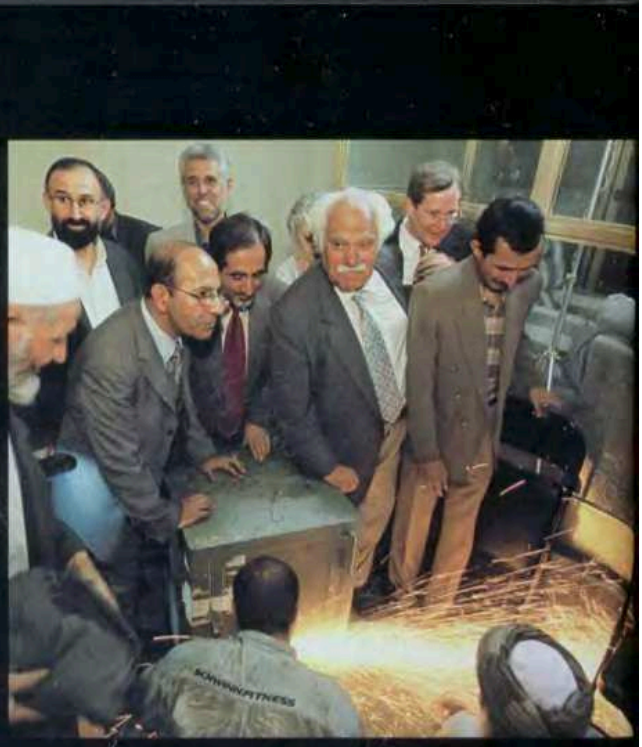
Ahmadi was afraid that the artifacts from his country's breathtaking cultural heritage would be sold and vanish from Afghanistan forever. In an interview before the October elections, a senior government official shared his concern, saying that Khalili was only one of many warlords with a taste both for antiquities and vengeance. Upstanding citizens who complained about looting, he added, could face arrest or worse. Ahmadi was right to fear for his life.

And Afghans are right to fear for their country's treasures. Yes, in a stunning piece of good news last April, the famed Bactrian gold—more than 20,000 pieces feared to be missing—emerged intact from a sealed underground vault at the presidential palace in Kabul (see "Gold Rush" sidebar). But still at risk are thousands of works of art and archaeological artifacts—evidence of the area's rich and complex history.

Long a hub of trade flowing from east to west and north to south, Afghanistan is where caravans of bundled Chinese silk passed camels loaded with glass from ancient Rome. It's where classical Greek art fused with the sinuous sculpture of India. The storied city of Balkh at the foot of the central highlands is the legendary home of the great prophet Zoroaster, who lived here centuries before Alexander the Great arrived. And it was in this region that Buddhism was transformed into a vibrant world religion.

Nowhere is the past so evident as the remote valley of Bamian, northwest of Kabul at the edge of the Hindu Kush mountain range. A vast Buddhist community of devout monks and nuns thrived here in the early centuries A.D. Two giant Buddhas once towered over the valley and its sprawling monasteries, gleaming in gilt and bright paint, possibly gesturing with wooden arms and attracting pilgrims from as far away as China. Rain and snow and marauders robbed the Buddhas of their faces and arms, but they remained magnificent sentinels of the province until 2001, when the ruling Taliban blasted the Buddhas into dust, causing a global outcry.

"We want to see the statues rebuilt," says Abdul Halek Zaliq, deputy governor of the



"We just hoped the

*(Continued from page 30)*
interim government in place, officials found six locked safes in a vault in Kabul. Many suspected that these safes held the Bactrian gold.

After months of legalities, a team assembled last April (left) for an old-fashioned safecracking to solve the mystery. Since the keys had disappeared, a workman applied a hammer, a crowbar, then a power saw to the first safe. Sparks flew amid an anxious crowd that included Viktor Sarianidi, with white hair at center, who first discovered the Bactrian graves, and Sayed Raheen, the minister of culture, at left with hands on the safe. I was there, second from right, on behalf of the National Geographic Society, which had agreed to inventory the findings—if any. (The National Endowment for the Humanities also pledged funds.) At last the door opened, and we saw gold! One by one the safes revealed the entire trove—some 20,000 glittering objects restored to the world.

*Fredrik Hiebert*
NATIONAL GEOGRAPHIC FELLOW

heat wouldn't melt anything." —*Fredrik Hiebert*

An intricate crown of gold—easy to disassemble for travel—adorned the skull of a highborn Bactrian nomad in her grave. Part of a clasp inlaid with turquoise (above) helped fasten one of her inner garments.

Neglect, theft, war, and vandalism have long plagued Afghan antiquities. In Kabul's National Museum (left) a conservator pieces together smashed Buddhist sculptures. Pockmarks deface a portrait of Buddha (right) at Bamian, where 80 percent of the paintings have been ruined.

A banner over the National Museum proclaims, "A Nation Can Stay Alive When Its Culture Stays Alive." It's a quixotic statement in a poor land devastated by invaders and ideologues.

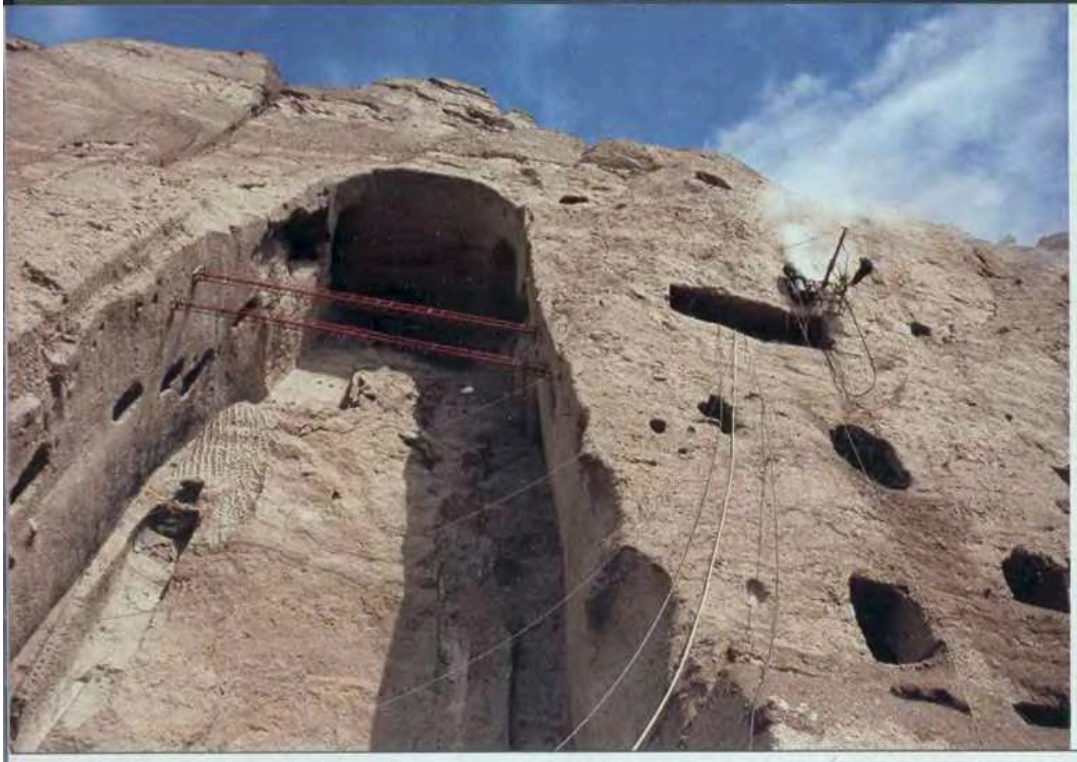
region, eyeing the battered niches hopefully. "We're confident Bamian will become a tourist center." Such a reconstruction is unlikely, since rebuilding ancient sites is frowned upon by archaeologists and preservationists.

Zaliq's zeal for tourists, and the revenue they bring, is understandable. What is less clear is how to attract them. Three years after the Taliban were ousted by U.S.-led forces, the country is still badly in need of money and security. Nearly a quarter century of invasion and civil war have transformed archaeological sites into barren wastes of looters' pits, left ancient buildings in ruins, and destroyed or scattered thousands of statues, carvings, and paintings. "Illegal digging is going on in many provinces—even around Kabul," says Abdul Wasey Feroozi, former director of Afghanistan's Institute of Archaeology. "It's difficult to stop it. We have 2,800 known sites, but I think there are more than 4,000. Many sites have yet to be registered. We need to explore and survey these."

Warlords and their militias control most areas outside Kabul, and Afghanistan is once again the world's leading opium producer. But while poppies may be Afghanistan's prime export, UNESCO officials warn that antiquities—looted and illegally spirited out of the country—may be second on that list. A single Buddha statue can bring tens of thousands of dollars in the art markets of London, Paris, New York, or Tokyo. And unlike poppies, antiquities are harvested in all seasons, and cannot be replanted.

Saving antiquities can appear an irrelevant luxury amid the hardships of daily life in Bamian, which one U.S. State Department official calls "the Appalachia of Afghanistan." Most of the farmers in this impoverished province are ethnic Hazara, a Shiite Muslim people long at the bottom of the Afghan tribal hierarchy. In 1999 the Taliban—largely ethnic Pashtun who practice Sunni Islam—damaged or destroyed a third of all the houses in Bamian. Crops were burned, livestock stolen, and four out of five people fled. Some of the homeless found shelter from the brutally cold winters in the many cliff caves where the two big Buddhas stood.

In May 2002 Bamian provincial officials—fearing that poor people living in the caves might put off prospective tourists—evicted 105 families, giving them tents and promising to build houses. After a scramble by international aid organizations, the homes finally were finished



Beside the remnants of a giant Buddha blown up by the Taliban in 2001, Italian workers prepare to stabilize the fragile Bamian cliff face with injections of cement. Buddhist monks carved the 125-foot-tall statue and the surrounding monastic caves in about the fifth century A.D.

The question facing Afghanistan is this: Can a country in such turmoil really afford to save its heritage—or must it choose between feeding and housing its people and preserving its history?

last year. In the meantime another batch of 85 families—most of them from provinces outside Bamian—had moved into the caves. In October 2003 the government sent troops to evict another set of cave dwellers.

Sayed Nabi was among the second group to be evicted. "I know the caves are historic, and it's not right to stay in such an old place," said the short 40-year-old man as he leaned on a rough wooden staff. "But we had no other hope for shelter." As winter approached, with temperatures dipping far below freezing, Nabi and dozens of other families were camped out in makeshift tents in a desolate valley a few miles west of the city of Bamian. "They took us out by force," he said. "One of us died from the cold. Now our kids are sick, we are hungry, and the government has given us nothing yet. We may all die from the cold." The government had promised to sell them parcels of land for 5,000 afghanis apiece—about $115. "But we don't even have money for food or tents," he said. A few weeks later, Nabi and his compatriots scattered to seek sturdier shelter for the winter.

Zaliq defends the evictions as necessary. "We gave them warning," he says. "No one has the right to stay in such historic places. It's better to endanger 85 families than destroy something of historical value for the whole world." But the incident aroused outrage among international aid workers—and UNESCO—bringing into focus a central question facing Afghanistan as it struggles to salvage its past while forging a new future: Can a country in such turmoil really afford to save its heritage—or must it choose between feeding and housing its people and preserving its history?

"Culture is not just monuments. It's a living thing. Without people these caves are dead," says UNESCO's Christian Manhart, as he scrambles up the crumbly cliffs. UNESCO scientists working to save what's left of the site got along well with the cave dwellers, he adds. "We employed some of them, and we had them on our side."

In Bamian UNESCO is leading the effort to shore up the unstable Buddha niches and save what remains of the statues and the vibrant paintings that once decorated the huge circular halls, balconies, and stairways that honeycomb the cliffs. Wooden doors and iron padlocks now secure 24 of the caves. Within, only a few of the hard-to-reach walls and ceilings still show faded Buddhas in reds and blues, standing out against the pale rock. Most of the paintings have been looted in the chaos of the past decade:



PETER MAXWELL, UNAMA BAMIAN (TOP)

Robbers' knives and chisels were found by Japanese archaeologists working to restore the few remaining. The archaeologists also stumbled on broken bits of images scattered on the floors.

Meanwhile Italian experts have been working with UNESCO to stabilize the fragile cliff face around the smaller of the two Buddha niches. It is no ordinary task. Seasoned climbers must rappel down the high mountain, attach a heavy piece of equipment to a large fissure in the cliff face, and then inject a cement mixture into the crack. Heading the project is 57-year-old Gedeone Tonoli, an engineer who worked on the successful effort to stabilize the Tower of Pisa. Passing by spent bullet casings littering the base of the Buddha niches, Tonoli climbs up the steep interior stone stairs and points to a crack—a massive block of cliff face that threatens to crash to the valley below. The first step is to attach sensors to measure any change in the crack. Then steel bolts must be inserted 50 feet into the cliff to strengthen the rock. "But this is difficult rock to anchor," he says, rubbing the pebbly conglomerate inside the stairwell. Looking out through the cracks at the mound of rubble below, it's hard to imagine that the glorious Buddhas of Bamian will rise again.

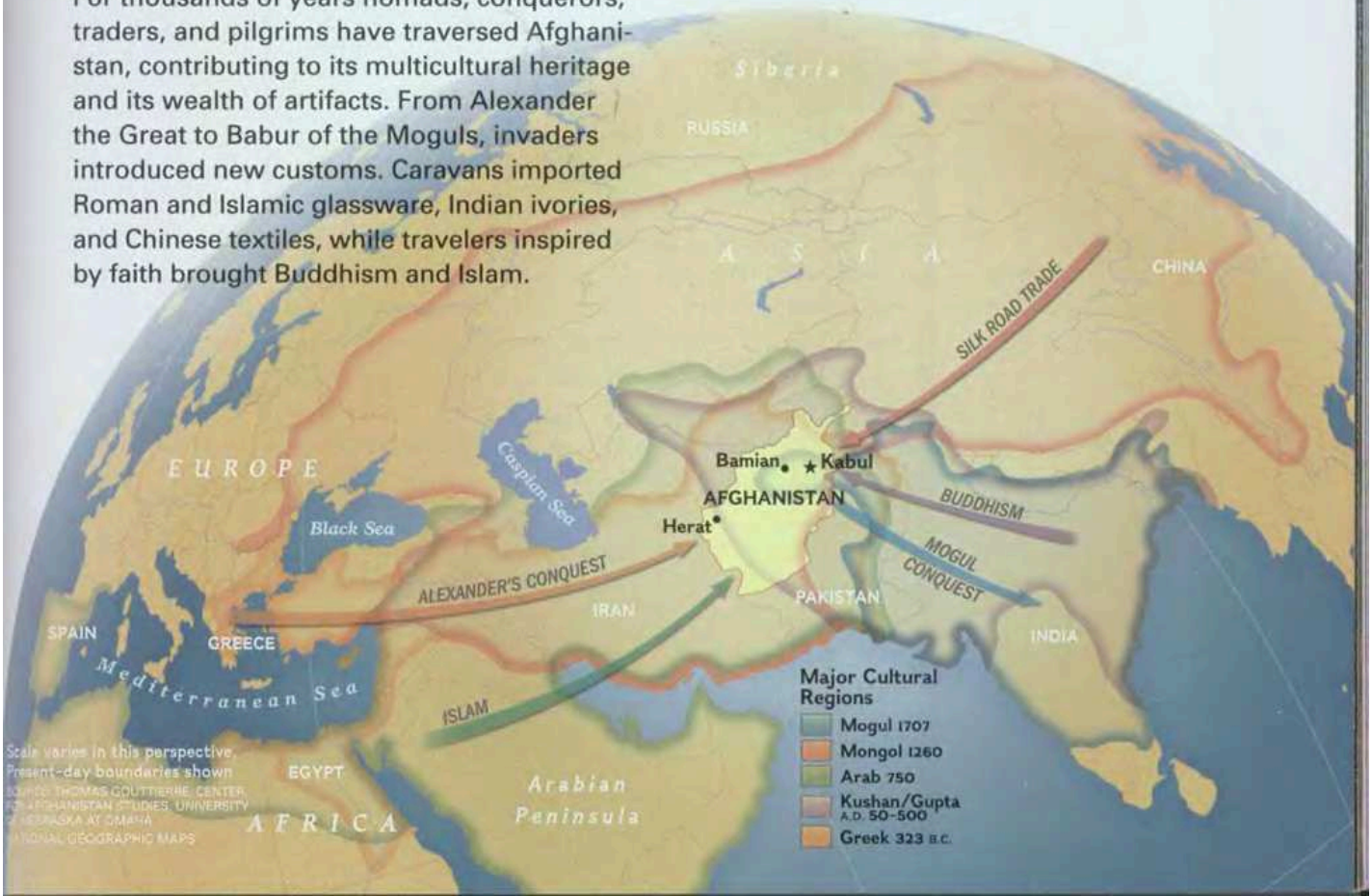
In the western city of Herat, UNESCO's Manhart has kicked off the most ambitious restoration project in Afghanistan—hoping to prove in the process that it's possible to straddle humanitarian and cultural needs. Thanks to a $120,000 donation from the German government, some 60 young men, ranging in age from 16 to 22, are learning the craft of mosaic tilemaking. They earn $34 a month, on par with wages for adult government workers.

Led by Mazhar Wahidi, director of Herat's monuments office, the workers will turn out 200 square feet of tile to repair part of Herat's Musalla complex, commissioned in the 15th century by one of Islam's most celebrated women, Queen Gowhar Shad. At the center of what was once a magnificent garden stands her mausoleum, a boxy building that conceals three domes, the outer one mostly bare of tiles. Only a few flashes of blue and white hint at its original beauty.

On this morning the apprentices are busy shaping individual tiles into complex patterns in a cavernous workroom, sunlight filtering in to illuminate the glazed tiles fired in an adjacent courtyard. The Gowhar Shad project is both a cultural and aesthetic challenge. Finding the right shade of blue is particularly hard, says

## Where East Meets West

For thousands of years nomads, conquerors, traders, and pilgrims have traversed Afghanistan, contributing to its multicultural heritage and its wealth of artifacts. From Alexander the Great to Babur of the Moguls, invaders introduced new customs. Caravans imported Roman and Islamic glassware, Indian ivories, and Chinese textiles, while travelers inspired by faith brought Buddhism and Islam.



Using traditional techniques, apprentices in Herat (left) shape new ceramic tiles to restore the mausoleum of Queen Gowhar Shad, a 15th-century patron of the arts. Repairing a nearby minaret, now supported by steel cables, will take modern technology and money.

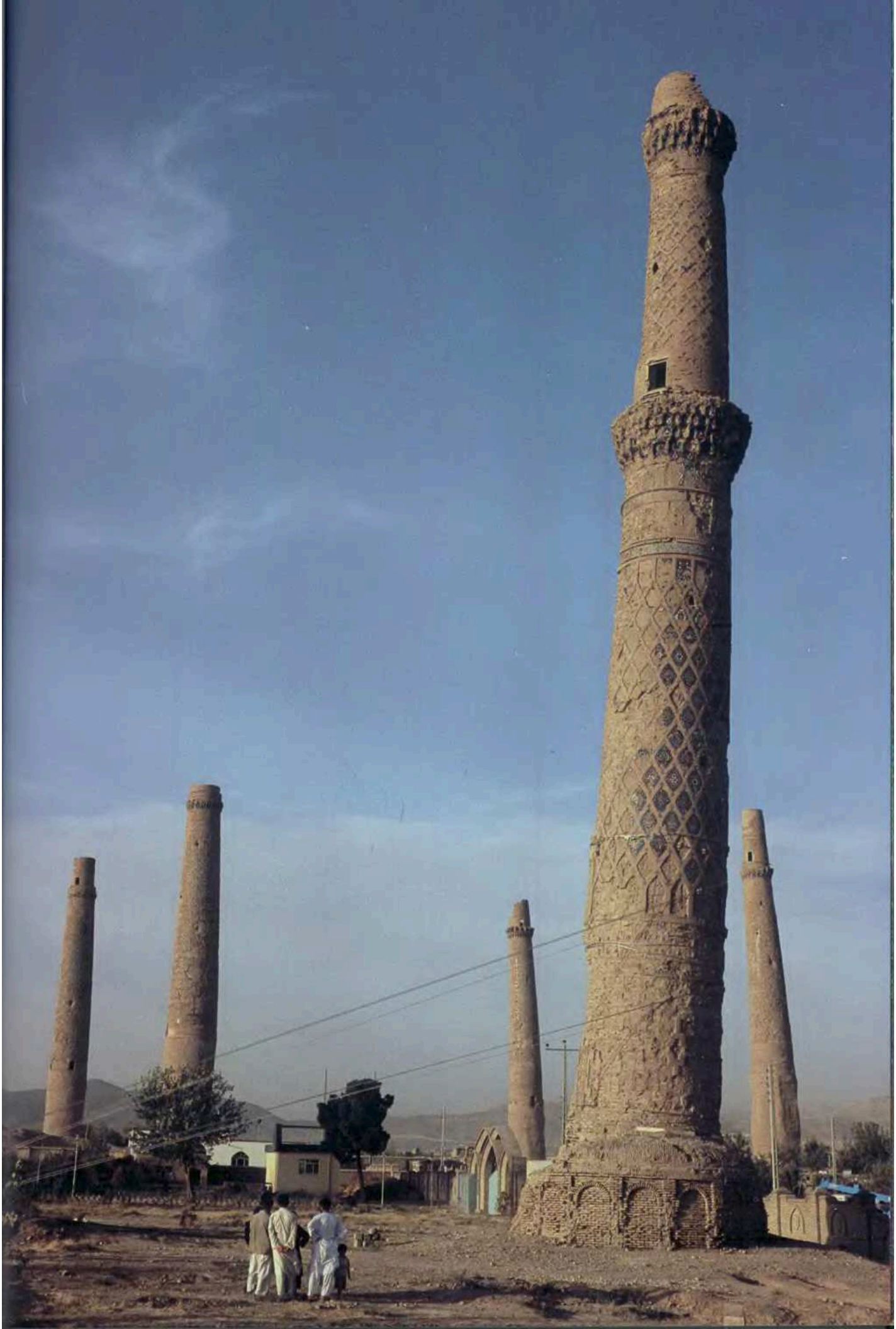
Earthquakes toppled four of the minarets. One survivor, shot at by a Soviet tank, came perilously close to collapsing. "It's a miracle it hasn't fallen," says a UNESCO official.

Manhart. But perhaps more difficult is his request that the Afghans choose the best 30 apprentices to work on the new line. Each will receive $100 a month on top of his current salary. "With $100, oh we are very happy!" says Touryalay Kalendari, a 17-year-old apprentice who has been chosen as a team leader. But he and Wahidi are reluctant to name the top 30. In a tribal culture influenced by socialist Soviets, the concept of an individual receiving more pay for better work does not come naturally.

Unlike in remote and poor Bamian, the greatest threat to cultural heritage in Herat is not refugees or poverty, but economic progress. "Take a picture, quick!" yells Manhart as we walk on the outskirts of the city. A heavily laden truck is lumbering between four massive towers the size of modern-day smokestacks—all inlaid with delicate diamonds of blue. The road is supposed to be closed to protect these fragile, leaning minarets of the Musalla complex, a hint of what was a pinnacle of Islamic architectural achievement. Instead, an Iranian contractor is widening the road that leads to the Iranian border. British cannon, Soviet tanks, and centuries of decay have taken their toll on these magnificent buildings. Now the more mundane ravages of commerce threaten to destroy even these remnants. "At the end of the Taliban time, the road was closed, but now it is reopened—the Iranians want the quickest route into Herat," explains Ghulam Haidar, the grizzled caretaker of the Musalla.

Relative to the rest of the country, Herat is blessed with signs of peace and prosperity, in part because of the trucks, which pay hefty tolls as they pass from Pakistan toward Russia or Iran and back. But there is good reason to fear that truck vibrations will mark the end of the magnificent minarets. A century ago there were nine, but earthquakes have since toppled four of them. A few hundred feet away, a fifth minaret is secured with cables to arrest a dramatic lean. Shot at by a Soviet tank during the 1980s, the structure in recent years came close to collapsing. "It's a miracle it hasn't fallen," says Manhart.

Armed with the digital picture of the truck passing between the minarets, Manhart goes to see the mayor, Mohammad Rafiq Mojaddadi, who invites him into his reception room. After pleasantries, Mojaddadi bridles at the suggestion that the road through the minarets is open to anything but the occasional small car. When he sees the picture, he shifts tactics. Too many children were being killed in the road's circuitous



detour around the monuments, he says, so some vehicles are allowed to pass. He vows to look into the matter.

The next day Mazhar Wahidi of the historical monuments office dismisses that promise as empty. "The mayor wants to connect Herat and Iran with a highway," he says, fuming. A small man with a black beard and striking sky-blue eyes, he has already complained about the road to the governor of the province. "I said it was equal to destroying the Buddhas of Bamian," he says.

Fame and notoriety may save what is left of the Musalla minarets and Bamian's paintings, though security concerns have suspended all UNESCO work in Bamian until after the 2005 parliamentary elections. Afghanistan's minister of information and culture, Sayed Makhdoom Raheen, has finally won a promise from the Herat government to divert the road around the minarets. Raheen has also pledged to send 500 armed guards to safeguard other important monuments. For many sites, however, it is too late. Ai Khanum, a city built by Alexander the Great's followers in the fourth century B.C. that boasted the largest gymnasium in the Greek-speaking world, is now a pockmarked field of holes. The once bustling town of Robatak, a Buddhist center in the first century A.D., is covered in fresh bulldozer tracks made by well-equipped looters eager to turn up salable artifacts. Never scientifically excavated, its secrets are now irretrievably lost.

And even at Balkh, which remains an inhabited town, men with a ladder removed tiles from an ancient religious school a mere hundred yards from a security post. "Now you tell me who is involved," says a frustrated government official in nearby Mazar-e Sharif. "It's like the Mafia. We need rule of law, not guns." He fears the consequences if the looting continues. "If something isn't done, we'll lose our historical sites," he adds. "I'm angry. My heart is burning."

The passion to rescue Afghanistan's rich heritage must contend with the harsh realities of a country still on the edge of chaos. One senior

official says that prominent members of the government are clearly involved in looting. That fact makes citizens hesitant to report acts of destruction. "If they are fearful, then no one will give us information," laments the official.

Mohammed Ahmadi is one of the few who have been willing to step forward. But his courage has come at a price. He has received some financial assistance from anonymous donors. Government officials offered him a job as police chief in his region, but he said local leaders loyal to Khalili refused to let him assume the position.

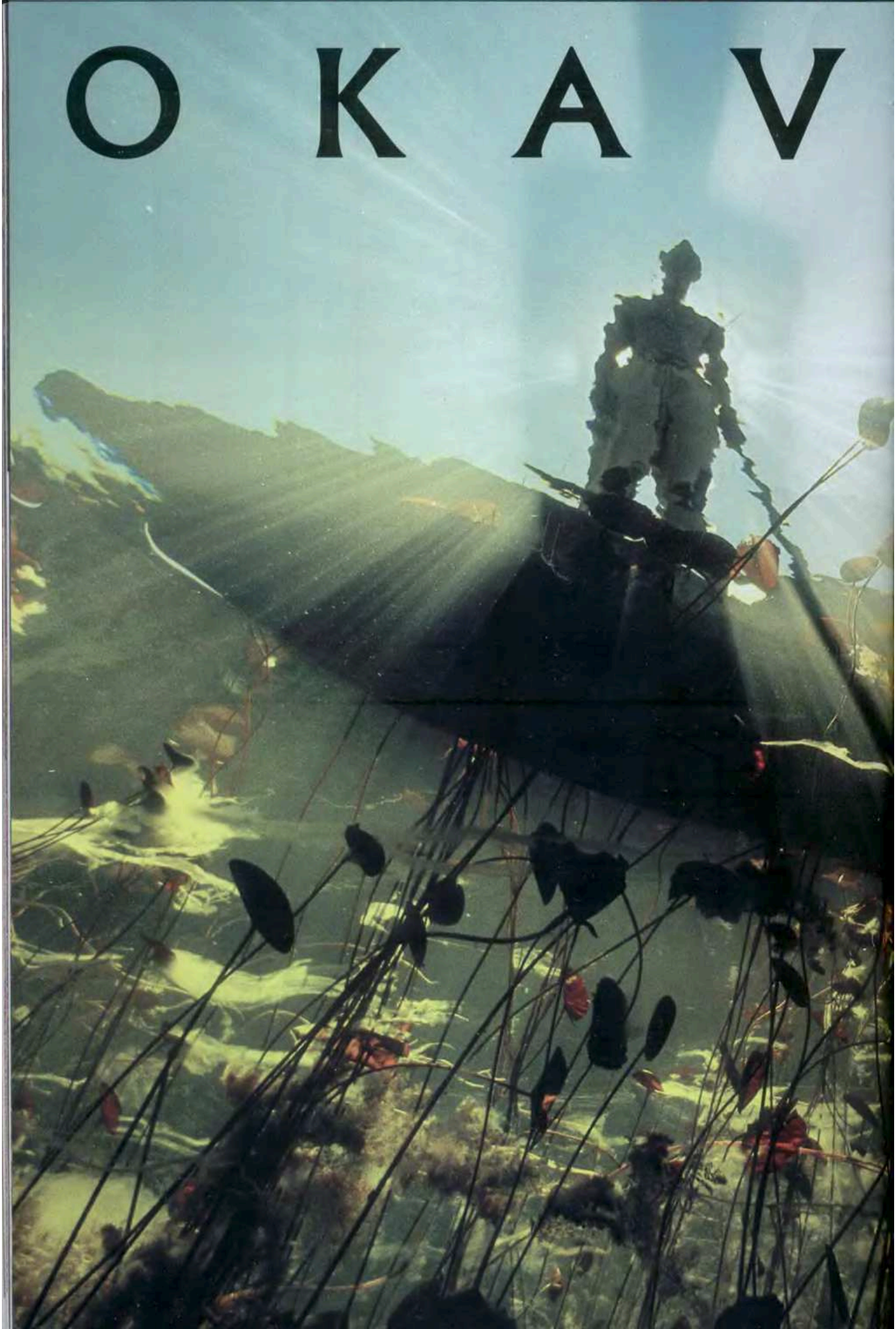
"I'm confused," Ahmadi said, as we stopped to let him out of the car following our interview. "Everyone knows my story, but I don't know what to do. These objects are for all Afghans. Right now they're under the control of the people with guns," he added, before vanishing into the maelstrom of Kabul's bustling downtown. My interpreter turned to me. "He's a dead man," he said. (Ahmadi has since fallen ill and fled the country with his family.)

Down the road at the National Museum, scarred by rockets and gunfire, a banner over the entrance proclaims "A Nation Can Stay Alive When Its Culture Stays Alive." It is a quixotic sentiment in a poor land devastated in turn by invaders, ruthless warlords, and religious ideologues. I recall a night in Kabul when I attended an evening of traditional music—a cause for celebration itself given that the Taliban forbade such exhibitions and destroyed musical instruments. The crowd of men and women, foreigners and Afghans, were delighted when a child of no more than five played the lute-like rebab with amazing skill and beauty. Spontaneously, a handsome young man rose and spun gracefully to the sounds, smiling softly. For that moment, the guns and the greed seemed far away, and Afghan culture seemed very much alive. □

**SAFECRACKING, LOOTING, AND TREASURE** Get the inside story of rescued gold in a video interview with photographer Ken Garrett; then view a gallery of his images and a list of related websites at **nationalgeographic.com/magazine/0412**.

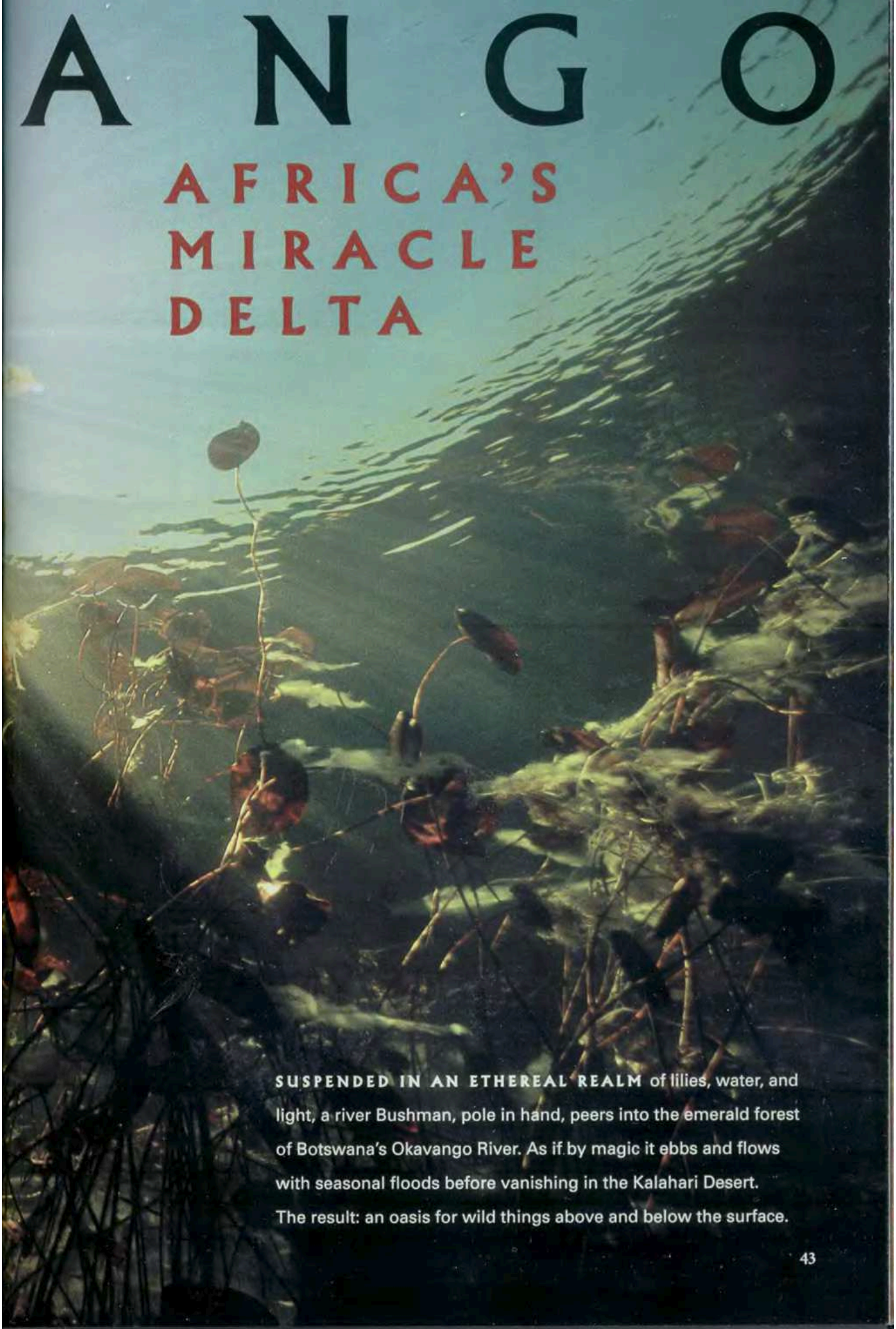
A prosperous trade center until Genghis Khan razed its palaces in 1220, Balkh is now the target of organized looters. Amid ongoing turmoil, the Afghan people face the challenge of rescuing their national treasures—and preserving history for us all.

# O K A V



# A N G O

## AFRICA'S MIRACLE DELTA



**SUSPENDED IN AN ETHEREAL REALM** of lilies, water, and light, a river Bushman, pole in hand, peers into the emerald forest of Botswana's Okavango River. As if by magic it ebbs and flows with seasonal floods before vanishing in the Kalahari Desert. The result: an oasis for wild things above and below the surface.

**IN THE FISH-EAT-FISH WORLD** of the Okavango's deeper channels lurks the toothy tigerfish, a

distant cousin of the piranha. An aggressive predator, the tigerfish will even eat small mammals and birds.

TIGERFISH *(HYDROCYNUS VITTATUS)*

BY KENNEDY WARNE

PHOTOGRAPHS BY DAVID DOUBILET

# THE MIRACLE IS THIS:

Under cloudless skies at the driest time of Botswana's year, when rain is both a fading memory and a distant promise, a flood comes to the Okavango Delta. Generated by rainfall 500 miles and two countries away in the highlands of Angola, the flood wave snakes down the Okavango River and spreads across the delta, swelling its lagoons and channels and spilling outward to inundate its floodplains. In a land withered by drought, this gift of water is like unction, and all nature responds to it.

The miracle happens in slow motion, for this part of southern Africa is so flat that the floodwaters take three months to reach the delta and four more to traverse its 150-mile length. Yet by the time its force is spent, the flood has increased the Okavango's wetland area by two or three times, creating an oasis up to half the size of Lake Erie at the edge of the Kalahari Desert.

JENNIFER HAYES (OPPOSITE), AFRICAN BUFFALO *(SYNCERUS CAFFER)*

The flood moves on multiple fronts like the columns of an army. I caught up with it in an area where P. J. Bestelink and his wife, Barney, run horse safaris. P. J. had tracked the flood's advance to a grassy plain between two channel systems, the Matsibe and the Xudum. The water glided across the heat-shimmering landscape like a silver tongue. Up close it was the color of ginger ale, and it bubbled as it seeped into the dusty hollows and runnels of the soil. Only a few yards back from the tip, small fish swirled along in the current—front-runners of a spawning horde that would soon turn the floodplains into a fish nursery.

Bull elephants came from the south, blocks of basalt moving through the tawny grasses. They lumbered toward the widening ribbon of water, trunks cocked in an *S*, snuffing the sweet elixir. Standing at the water's edge, the thirsty animals sucked up trunkfuls and gushed it into their mouths, spilling barely a drop.

As the seeping floodwater soaked into the thatch of dry grass stalks, it triggered an awakening of frogs that had been dormant in the dry conditions. They immediately began calling, some with loud Geiger-counter clicks, others tinkling like glass bells. P. J. said that catfish too can survive a temporary dry spell—by burying themselves in mud. He knew a place where this happened, a large shallow pan that often dried up in the weeks before the flood's arrival. We drove to a nearby hunting camp and walked across a sun-crisped stubble of grass and rushes

**AFRICAN BUFFALO** wade through the shallows of the Okavango Delta, a wetland that spreads across northern Botswana. From its source in the Angolan highlands, the Okavango River snakes through the Panhandle (opposite), lined by dense thickets of permanent papyrus swamp.

toward the center of the pan. The broken shells of aquatic snails lay bleaching on the ground. Openbill storks had obviously dined well here as the water in the pan evaporated.

"We're too late," said P. J., as we reached the middle of the pan. The mud had dried up and was littered with catfish skeletons. Some of these fish would have weighed 20 pounds. Marabou storks, known as undertaker birds, picked among the bones for scraps of flesh. The flood was less than a mile away and would soon transform this place into a broad lagoon, but it had not arrived in time to save the catfish from death by dehydration. Their blunt skulls, eyeless and desiccated, underscored the central truth of the delta: Water is life.

**From space** the Okavango Delta looks like the footprint of a bird. Water flows into the system through the leg, called the Panhandle, a strip of land 60 miles long and 9 miles wide along which the Okavango River meanders in lazy loops. Forward-pointing toes—six of them—channel water through the delta and, ultimately, into the sands of the Kalahari. I set out to follow this journey of water in flood tide and ebb, above water and below, from source to sand.

The delta's deepest, most diverse underwater habitats lie in the Panhandle. The flood peaks here in April, raising the level of the Okavango River by six feet. In May the level has started to drop. Sediment borne on the flood wave has settled, and the water in Ncamasere channel, an offshoot of the main river midway down the Panhandle, becomes clean and clear.

## THE BAYEI PEOPLE SAY: "I AM THE RIVER. MY SURFACE GIVES YOU LIFE. BELOW IS DEATH."

And deadly. The waters of the delta are full of crocodiles. The Bayei people, one of several Okavango tribes, say as much in a poem they teach their children: "I am the river. My surface gives you life. Below is death." For photographer David Doubilet and me, going below the surface was an essential part of our work. We wanted to see the delta as few had dared to see it before—a croc's-eye view. People in passing boats, noticing our wet suits and scuba gear, didn't hesitate to give their opinion on croc-watching: They tapped their temples as if to say, you're out of your minds. Perhaps we were, but it was winter, and we reasoned that because crocodiles are reptiles, their metabolism would be sluggish. Torpidity was certainly to be hoped for in a 15-foot reptile with teeth as big as thumbs.

The larger crocodiles spent much of the day basking on the riverbanks in well-used haul-outs, usually with chutes down which they slid into the water if disturbed. Some lay with their mouths open, a behavior once fancifully thought to allow a "cleaner" bird to pick the meat from between their teeth but now considered an aid to regulating body temperature and a way of relaxing jaw muscles. In the cool of the night the warmth-loving crocs came to life for the hunt, floating at the water's edge. Their eyes gleamed blood-red in our spotlight as we motored up the channel.

Although Nile crocodiles are one of only a handful of predators that actively hunt humans, I figured that if I initiated an encounter, thus denying the animal its advantage of surprise, I would retain the upper hand. And so one night I slipped into the water to observe a six-foot croc that had submerged as our boat approached. Pulling myself through a tangle of water lilies, I reached a position directly above the crocodile, then dived down for a closer look.

Magnificent! The vivid black-on-fawn markings; the two lines of upraised scutes on the back, merging into the serrated keel of the tail, jagged as a ripsaw; the gorgeously veined irises of the unblinking eyes; teeth like a white zipper. I was less than two feet from the animal, and my nervous system was awash with the adrenaline of the moment.

The crocodile moved. I followed it through the underwater foliage, playing my torch beam on its squat, muscular legs. Then, with a scythe of its tail, it sped away into the deep.

Crocodiles are the delta's most feared aquatic predator, but locals say that hippopotamuses cause more deaths and injuries. Accidental meetings in narrow channels are often the trigger for an attack. Hippos can bite a canoe in half with one snap of their jaws, and their teeth can

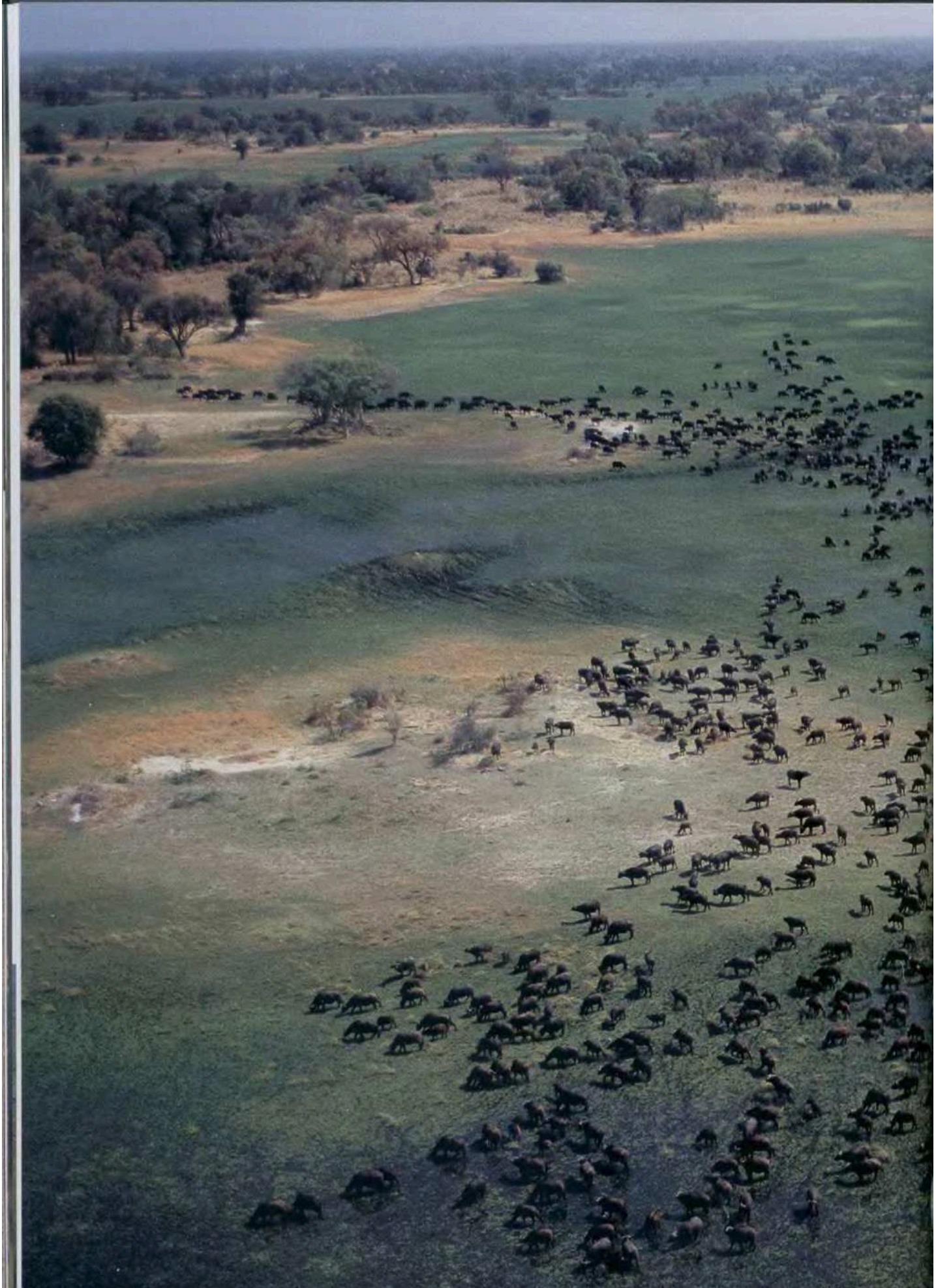
puncture an aluminum boat as if it were a beer can. The two-ton vegetarians aren't slowpokes, either. Guy Lobjoit, an Okavango fishing guide, told me he once had a hippo keep up with him while he was doing nearly 20 miles an hour in his runabout. "The boat was planing, and this thing was pushing up a bow wave right next to me," he said. "Gave my ticker a bit of a flutter."

**People have been living** with the dangers and the bounty of the delta for at least 100,000 years. The seasonal floodplain, the webbing between the delta's toes, is a rich part of the Okavango larder. Here the floodwater forms a lake six inches to a foot deep, dotted with countless islands. The water brings a flush of plant growth, which in turn attracts wildlife into these fertile, sun-warmed shallows. The local people make good use of the *molapo*, as the floodplain is called. During the flood they fish, and in the dry season they graze cattle. All year round they harvest fruits, cut thatching grass and reeds, and hunt game on these productive lands.

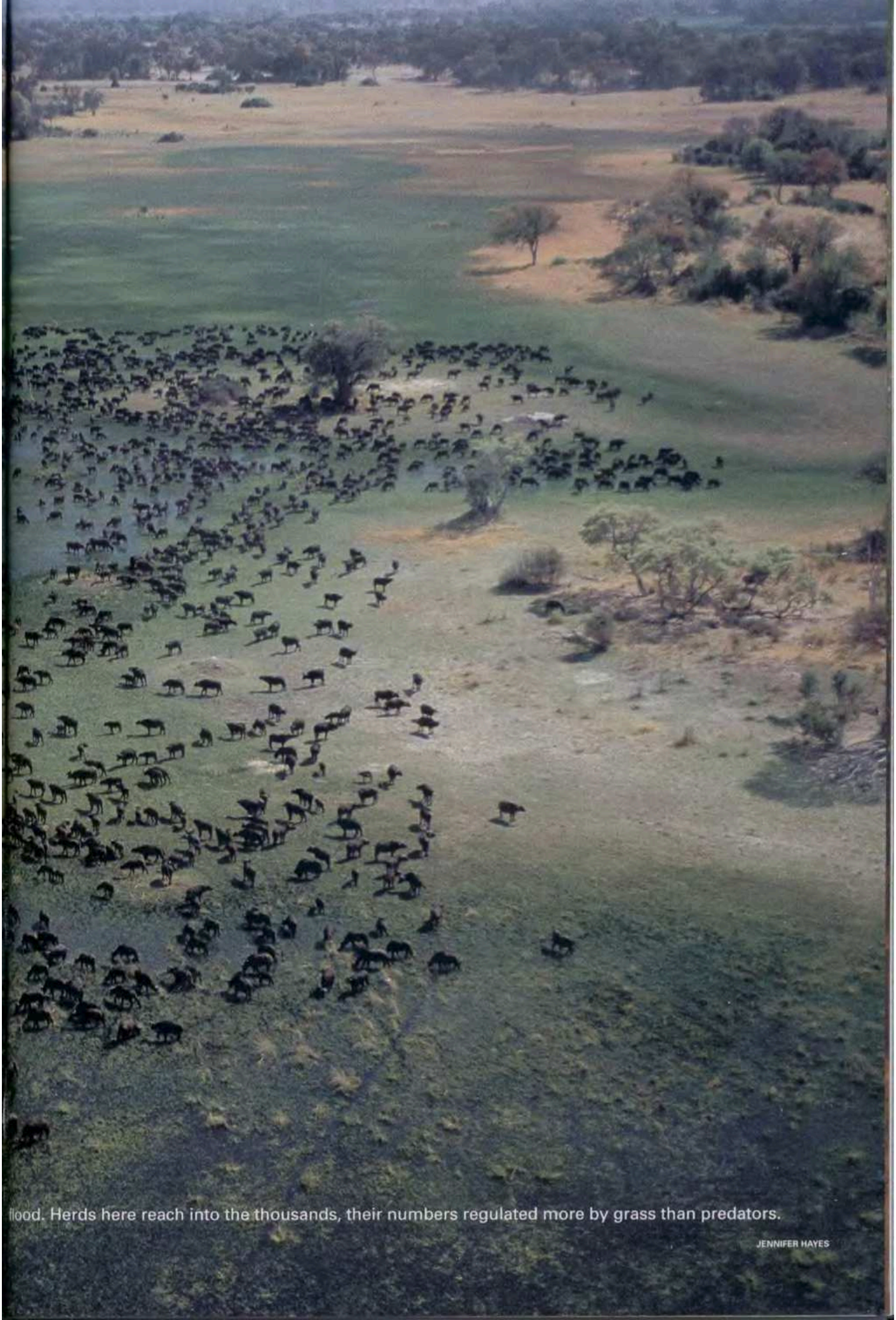
At Guma, near the top of the delta, a Bayei man known simply as Madala, Old One, and a young fishing guide called Fish took me into the molapo during the flood season to show me something of their way of life.

We journeyed by *mokoro*, or dugout canoe, the ubiquitous mode *(Continued on page 59)*

**FED BY LOCAL RAINS** in the southern summer, the Okavango River swells in winter with a huge pulse of water from Angola, flooding one of the largest inland deltas on Earth—an alluvial fan of more than 10,000 square miles. The flooded area varies widely year to year and season to season (right), creating a shifting landscape of channels and islands that sustain a rich diversity of life.

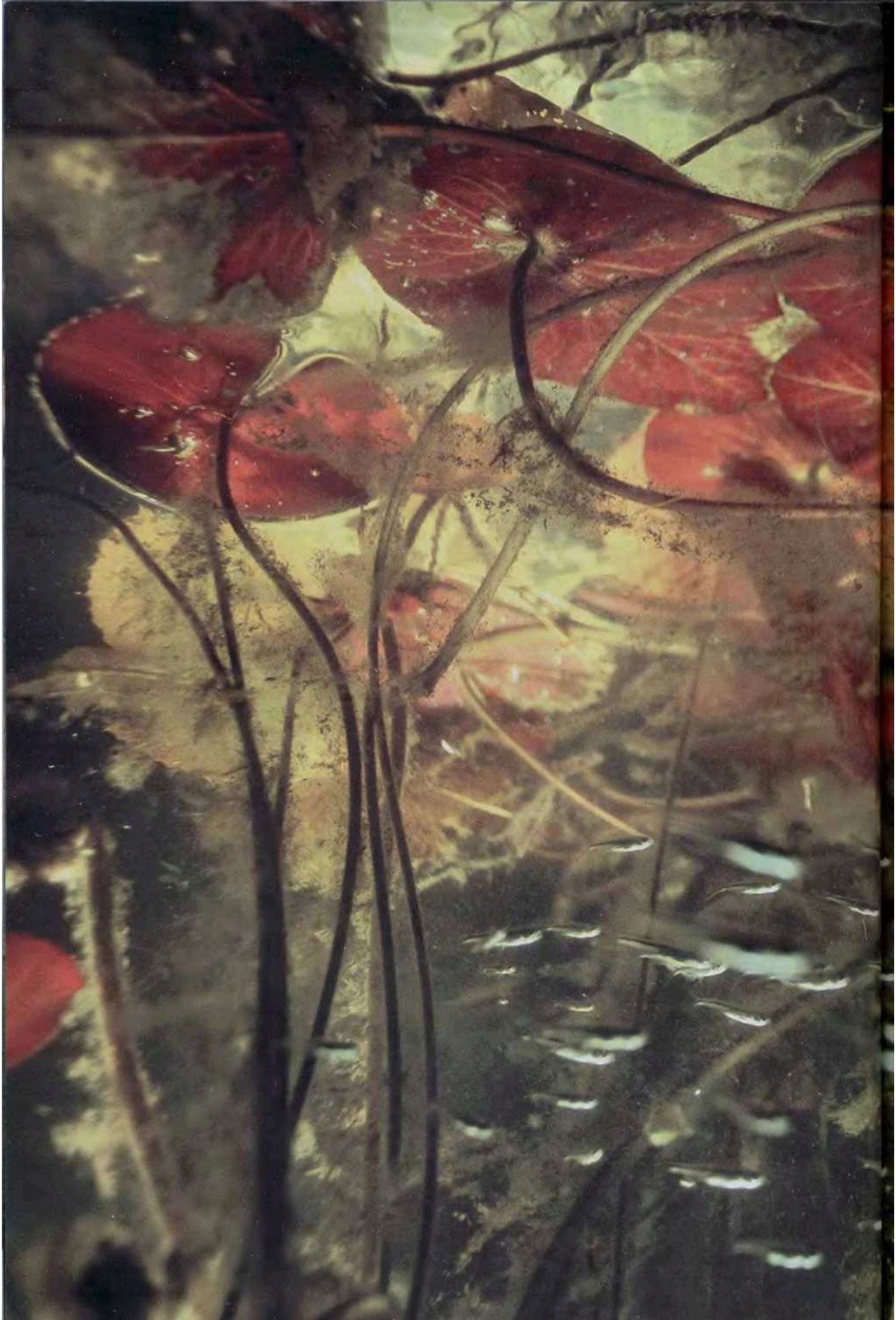



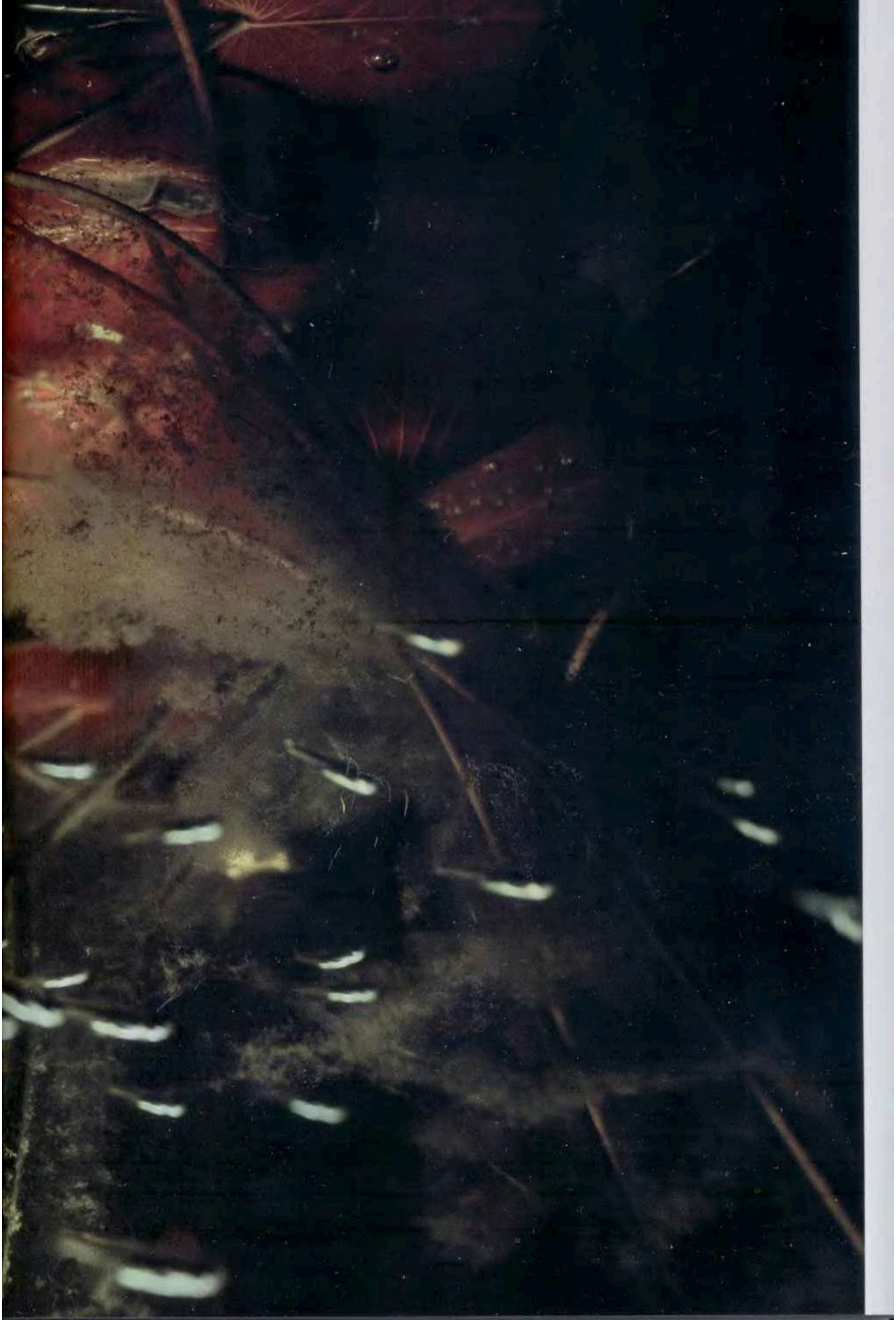
**FOLLOWING THE WATER,** hundreds of African buffalo graze in the lower delta during the



flood. Herds here reach into the thousands, their numbers regulated more by grass than predators.

JENNIFER HAYES



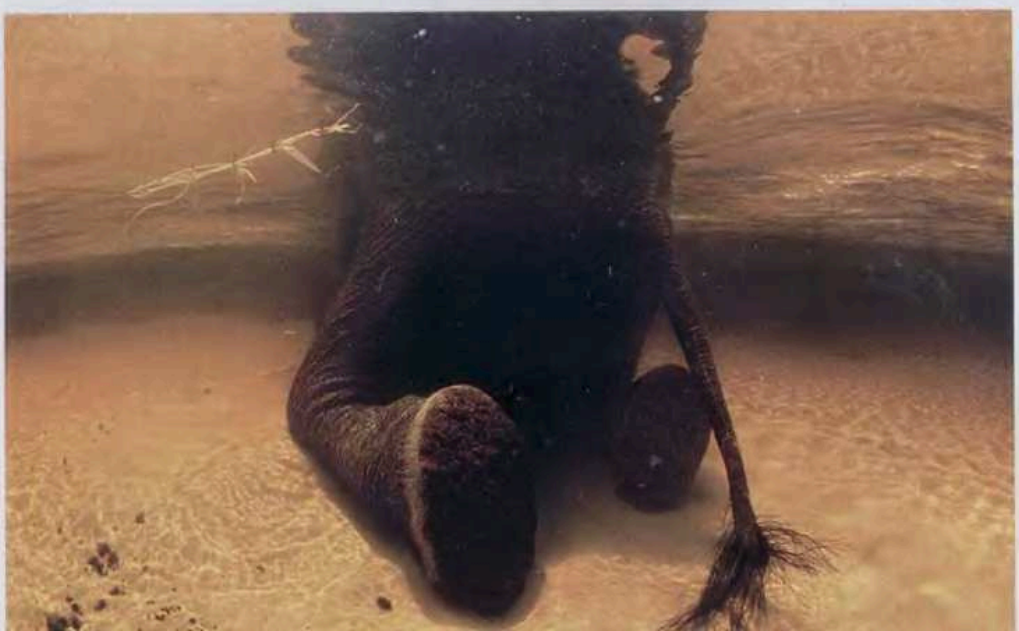


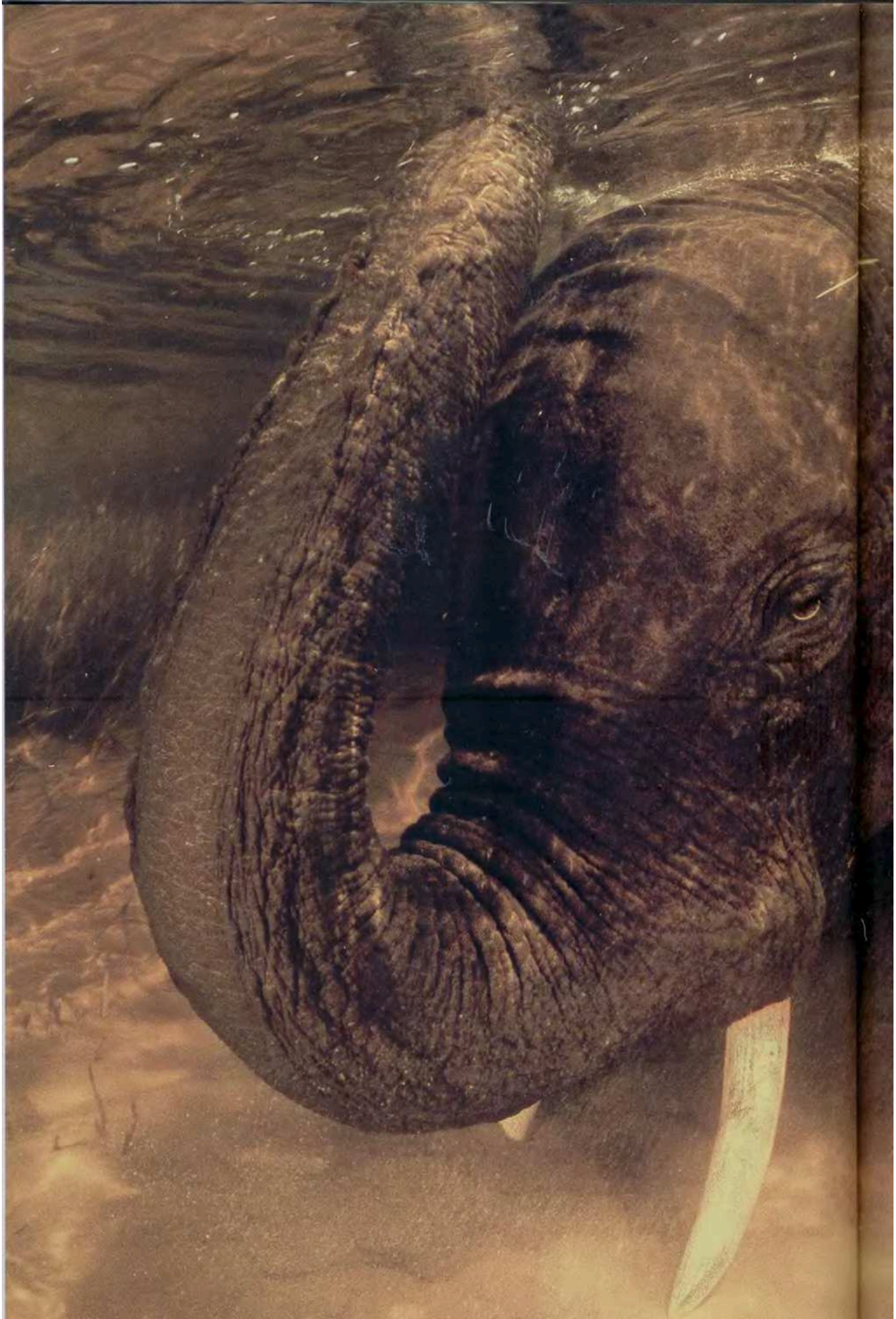
DAY WATER LILY *(NYMPHAEA NOUCHALI CAERULEA)*

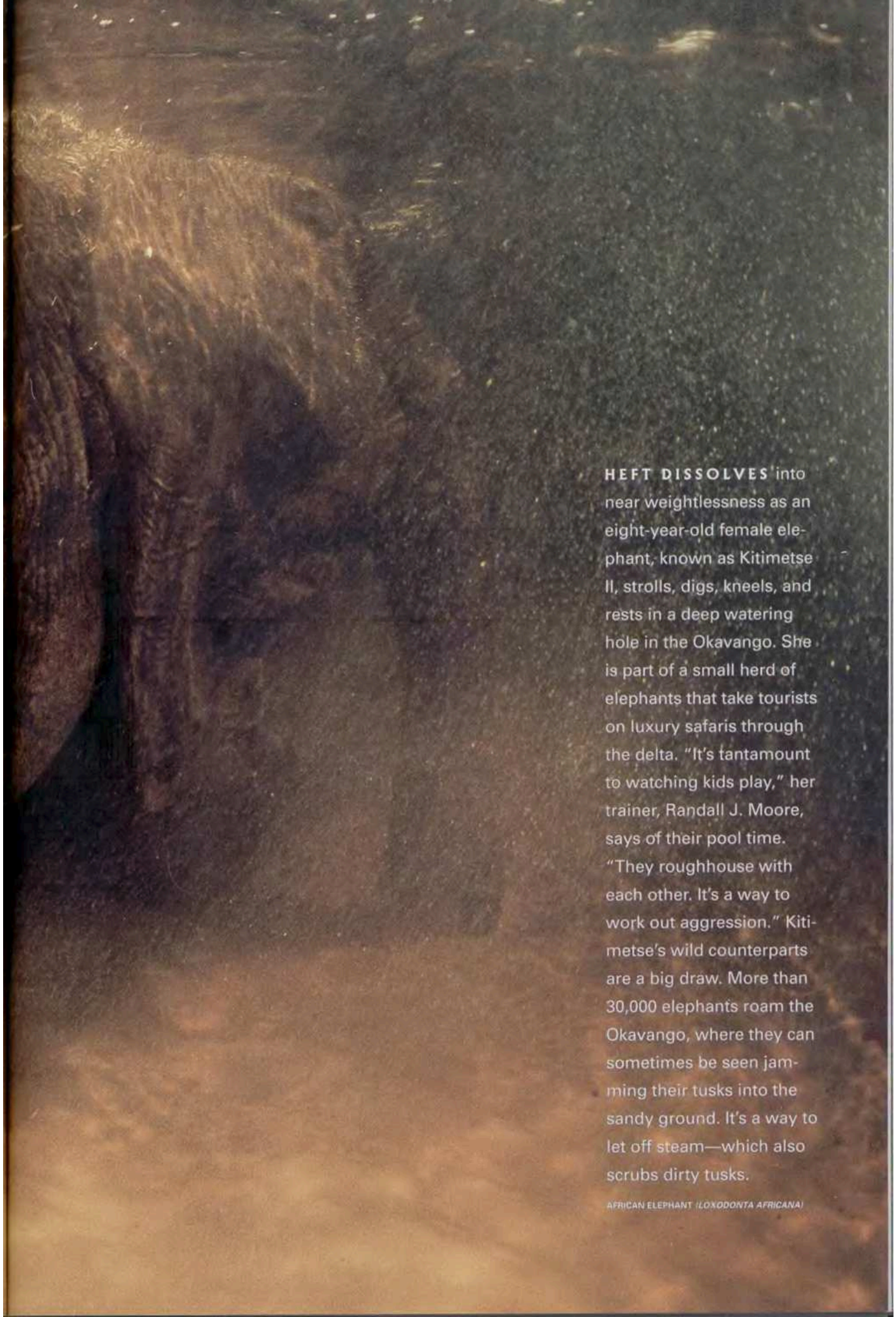
JENNIFER HAYES, CATFISH (SILURIFORMES)

**NIGHTTIME IN THE LILY GARDEN** brings a host of species to life, including the quicksilver streaks of juvenile silver robbers (opposite) swirling beneath the pads. A catfish (above) hides in lily detritus along the bottom by day. At night, some catfish species swim inverted on the surface hunting for insects to munch. Spangled with bubbles of air, a day water lily sinks underwater, perhaps pulled by a bit of flotsam flowing in the current or by its own stem, which begins to contract after pollination.

SILVER ROBBER *(MICRALESTES ACUTIDENS)*, OPPOSITE





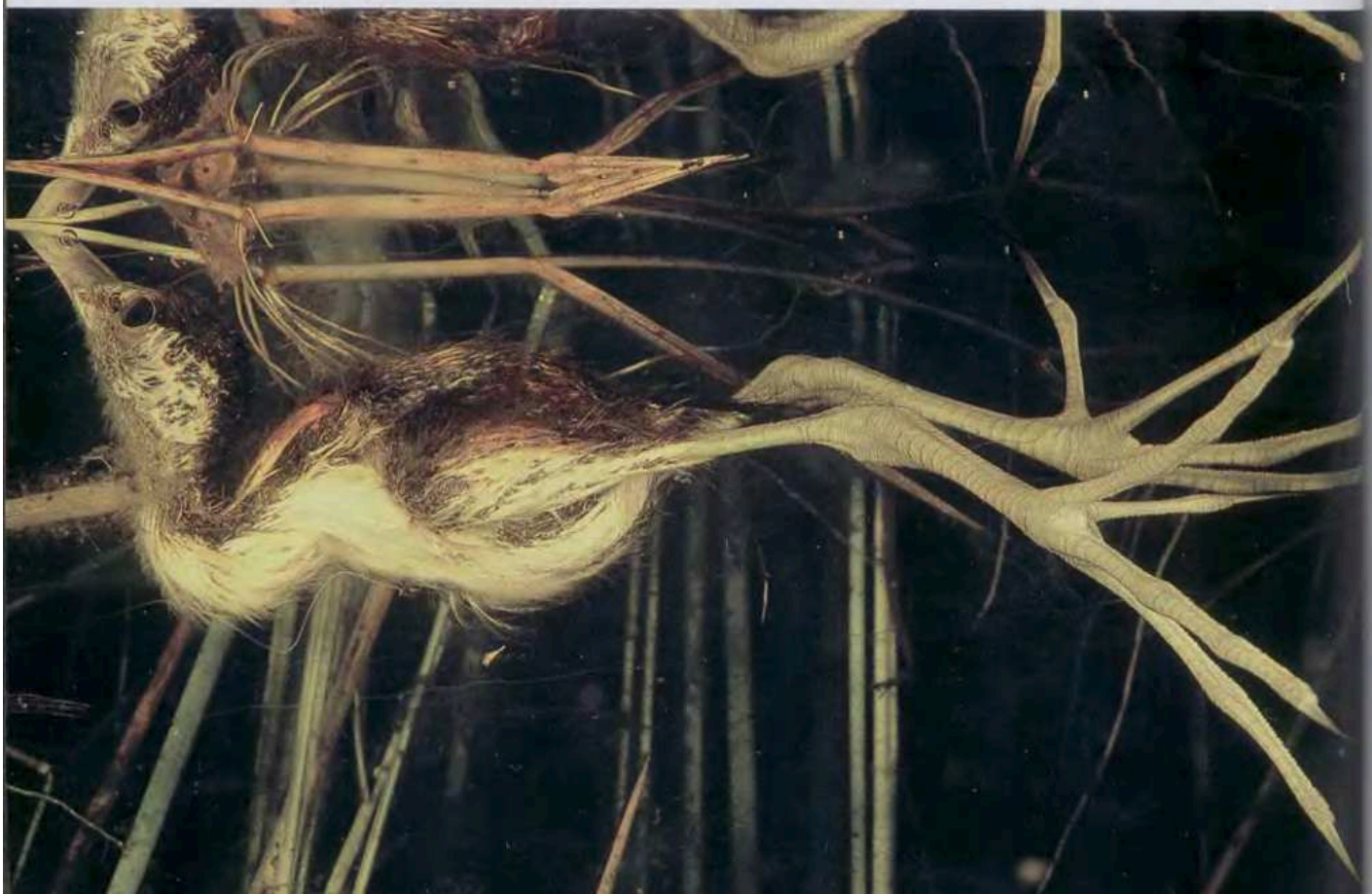


**HEFT DISSOLVES** into near weightlessness as an eight-year-old female elephant, known as Kitimetse II, strolls, digs, kneels, and rests in a deep watering hole in the Okavango. She is part of a small herd of elephants that take tourists on luxury safaris through the delta. "It's tantamount to watching kids play," her trainer, Randall J. Moore, says of their pool time. "They roughhouse with each other. It's a way to work out aggression." Kitimetse's wild counterparts are a big draw. More than 30,000 elephants roam the Okavango, where they can sometimes be seen jamming their tusks into the sandy ground. It's a way to let off steam—which also scrubs dirty tusks.

AFRICAN ELEPHANT *(LOXODONTA AFRICANA)*

SILVER CATFISH *(SCHILBE INTERMEDIUS)*, ABOVE; JENNIFER HAYES, AFRICAN JACANA *(ACTOPHILORNIS AFRICANUS)*

**SHARP SPINES AND POISONOUS MUCUS** are the first lines of defense for silver catfish, which at times are so thick in the channels that local people can catch them in the traditional manner with baskets. A young jacana (below) flees by diving under the lily pads with only its beak protruding for air. The bird's splaying feet, with their greatly elongated toes and claws, enable it to walk where others can't easily tread, earning it the nickname "lily-trotter."



(Continued from page 49) of transport in the delta. The mokoro that Fish poled was made from kiaat, a teak-like timber, with metal patches covering cracks he called its wounds. Madala's canoe was fiberglass. He explained that the new synthetic canoes are more stable than the traditional wooden ones. More sustainable too, as trees suitable for mokoro-making are a limited resource in the delta.

Poling is a hypnotically beautiful way to travel. Each thrust of the wooden pole moved the mokoro through beds of reed and sedge that rustled against the hull. Grasshoppers jumped into the canoe and then jumped back out again. I trailed my fingers in the warm water and studied the microcosmos of water striders, backswimmers, whirligig beetles, and frogs no bigger than a fingernail. Birds called jacanas, or lily-trotters, picked their way across fields of water lilies, dipping the floating pads beneath the surface with each long-toed step. The foghorn snort of a hippo warned us to avoid its channel. A herd of red lechwe, a species of antelope with long hooves adapted for swamp travel, splashed away at full gallop when we came into view.

As we poked along, stopping here and there at wooded islands, Fish would point to various plants and describe their properties. The root of the star apple makes an excellent toothbrush; the bark of the rain tree can be ground up and thrown into the water to paralyze fish; chewed sickle bush leaves are good for treating snakebite. Madala cut a tall papyrus stem and pounded the fleshy white base against his palm to soften it before handing it to me to eat. It was sweet, fibrous, and refreshing, reminiscent of fresh coconut. He gave me the rubbery pith of bulrush to try—Okavango chewing gum, it's called—and pulled up water lily fruits for cooking later.

We made camp under the boughs of a sycamore fig. While Madala set his net in a lagoon thick with water lilies, Fish waded into the floodplain to spear small fish with a porcupine quill. It's a technique small boys learn, along with such tricks as sticking a thorn into a poison apple to make a spinning top. I climbed a baobab tree to collect its maraca-shaped fruits containing a white pulp that substitutes well for cream of tartar. Madala mixed it with water to make a tangy sauce.

That night we rolled balls of cornmeal porridge with our fingers and dipped them in a casserole of freshly caught bream, water lily fruit, and heart of palm. In the firelight Madala told stories about the Bayei people: How, for example, they won't eat crocodile meat because crocodiles eat people. To keep the mosquitoes at bay, Fish lit a football-size lump of elephant dung, which smoked aromatically for hours.

**SHARP-TOOTHED CATFISH RAMPAGE UP THE CHANNELS. THEY THWACK THE PAPYRUS STALKS WITH THEIR TAILS.**

We heard lions in the distance, and I thought of Laurens van der Post's observation that the lion's roar "is to silence what the shooting star is to the dark of the night." The frog chorus rose and fell (though the effect was spoiled somewhat by a group of French tourists on a neighboring island singing "Frère Jacques" at the tops of their voices).

Other than the presence of a few tourists—and a carton of long-life milk for our tea—I suspected that little in this scene had changed since the first European explorers visited the Okavango over 150 years ago.

**One thing that has changed**—and continues to change—is the path the water takes through the delta. When David Livingstone made his first journey to the region, in 1849, much of the flow was down the western channel system and into Lake Ngami—a "fine-looking sheet of water," according to Livingstone. In the 1880s the water flow, responding to a range of subtle landscape cues, began to favor the eastern channels. The sluggish western channel became choked with vegetation, and Lake Ngami dried up. The Batawana people, Botswana's dominant tribe, followed the water, shifting their main settlement to a lush site on the delta's southern edge. They called the place Maun, "place of reeds." Today Maun is a town of 45,000, with barely a reed to be found. Water flow seems to be moving westward once more, and floods, which follow a natural cycle of

SITATUNGA (*TRAGELAPHUS SPEKEI*), BELOW

**IN THE CROCODILE'S LAIR,** photographer Jennifer Hayes explores caverns formed by floating mats of papyrus in the deep waters of the Ncamasere channel in the Panhandle (above). Croc tracks were everywhere, says guide Brad Bestelink (below), examining the remains of a big male sitatunga. Bestelink pioneered diving in the Okavango's clear, croc-infested waters, counting on cool winter temperatures to keep the reptiles lethargic. "Any other time," he says, "we'd be lunch."

higher and lower volumes, have diminished in size. The result is that Maun—commercial gateway to the delta—has a water shortage. The place of reeds has become a place of dust.

Not surprisingly, when the annual flood does reach Maun (though there is no guarantee that it will), the whole town celebrates. On a breathless July day—the sky the eggshell blue of the Botswana flag, the air full of the smell of wild sage—I watched as the flood crept down the broad, dry bed of the river that runs through town. Children dug furiously with sticks in the sand to encourage the trickle to run faster. Some leaped back and forth across the steadily widening stream, laughing for joy. Others just let it run over their bare feet, looking at it as if it was the first time they had seen water. "The water is coming," I heard a father explain to his daughter. "The fish are coming. The water lilies are coming. Life is coming."

On a bank of the river, behind a twig fence that didn't look as if it could keep out a goat, let alone a cow or a hippo, a man who told me his name was Flay Million Dube walked around his vegetable plot. With a smile as broad as the straw hat that shaded his eyes, he told me, "I'm not working today because I'm so happy." He had just been down to the river to wash his face and hands in the new water, he said. Tomorrow he would put fresh, cool mud around his beds of spinach, broccoli, and kings onion. Maybe he would win a prize in the horticultural show. The water was late, he said, but it had come, and that was all that mattered.

In a thatch-roofed bar a few hundred yards upstream, Maunites who had driven out from town sipped sundowners and toasted the flood's arrival. "The English discuss the weather; we discuss the water," one told me. "Before it comes, we drink beer and talk about when it will arrive. When it's here, we drink beer and talk about how much has come. When it's gone, we just drink beer and feel sad."

By October the time of sadness has come. The flood has vanished, ten billion tons of water sucked up into the atmosphere whence it came. People cast thirsty glances at the sky, where glowering thunderclouds build in the afternoons, but the summer rains are still two months away. The floodplains dry out, and water levels in the channels and lagoons drop to their lowest levels.

As the delta shrinks, life retreats. Small fish born in the floodplains when the water was high withdraw to the permanent channels, and this influx of flesh triggers an Okavango phenomenon: the catfish run. Sharp-toothed catfish, locally called barbels, rampage up the channels in a noisy, pre-breeding snack fest. They thwack the papyrus stalks with their tails—probably to flush prey fish out of hiding—and gulp air from the surface with an explosive popping sound. Their sinuous bodies churn the water into a thick brown soup.

**AT NIGHT THE CROCS CAME TO LIFE. THEIR EYES GLEAMED BLOOD-RED IN OUR SPOTLIGHT AS WE MOTORED UP THE CHANNEL.**

Maun broils in temperatures of 100 plus. Hot winds sandblast the town, and the sky becomes white with dust. The tambourine symphony of cicadas is deafening. Maunites call October suicide month. Even the jaywalking donkeys look more weary of living than usual.

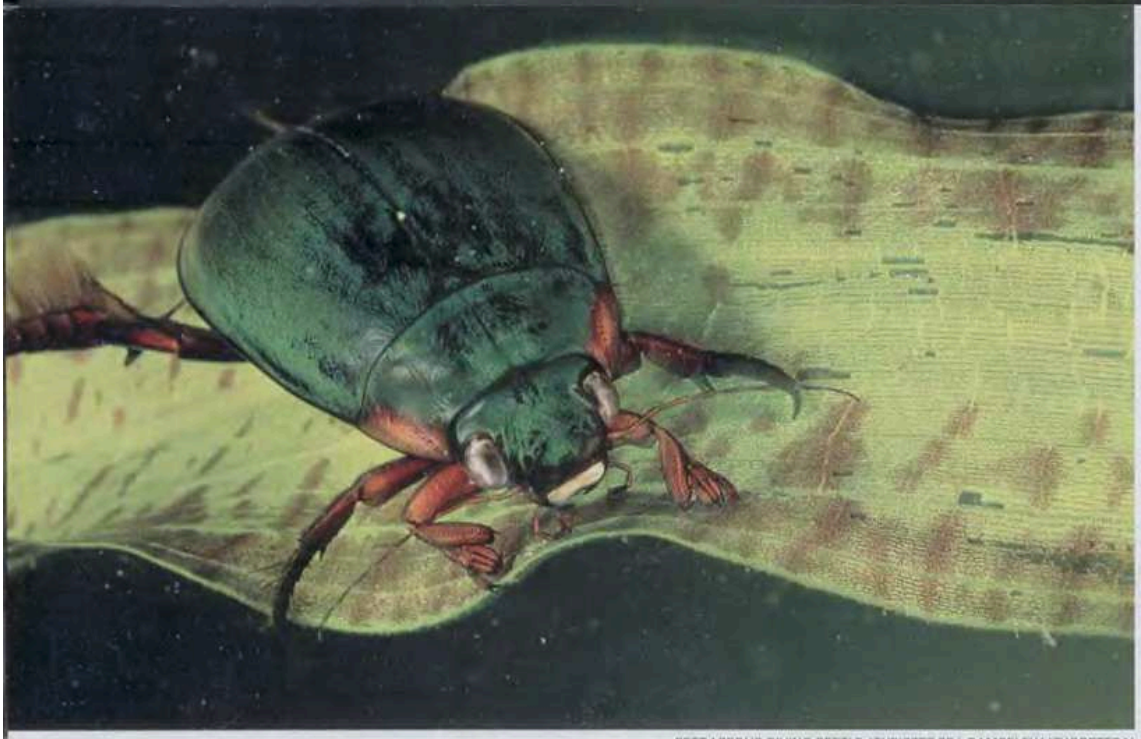
This is the flip side of the flood: the Okavango in ebb. The Thamalakane River, where I had witnessed the arrival of the new water three months earlier, was again bone-dry. Flay Million Dube's garden was bare soil, not a plant to be seen. No children played in the riverbed. Only a few dust devils whirled in the heat haze.

Not since the 1960s has the Thamalakane flowed all year round, delivering water to the delta's outlet, the once mighty Boteti River. Fifty miles southeast of Maun, at a camp called Meno A Kwena—"tooth of the crocodile"—I climbed a hundred feet down the Boteti's crumbling banks to its broad, cracked bed. It was like visiting Ezekiel's valley of dry bones. Strewn about were carcasses of zebras and wildebeest, their sun-blackened skin stretched tight over bone, jaws frozen in a last gasp. These animals, following a genetically imprinted map, had come to this place expecting to drink, but had found a dry riverbed instead. Today all that remains of the Boteti at Meno A Kwena is groundwater, the legacy of floods past. Larger animals can dig for it, but with each successive year of low flood volumes

**WARY OF STRANGERS,** a young Nile crocodile makes for the cover of

darkness in the Ncamasere channel—the element of surprise belonging for once to the diver.

NILE CROCODILE *(CROCODYLUS NILOTICUS)*



PREDACEOUS DIVING BEETLE *(CYBISTER* SP.*)*; DAMSELFLY (ZYGOPTERA)

**WAITING TO POUNCE,** a predaceous diving beetle shines green in the aqueous light. A voracious hunter of tadpoles and small fish, the silver-dollar-size beetle is part of the Okavango's aquatic tapestry of insects. Encased in a silvery skin of air, the female damselfly (below) is equally at home underwater, using her sharp ovipositor to inject eggs into a lily stem. Like the legendary first Bushman, her young will be born on a water lily plant.

the water table drops a little farther out of reach.

David Dugmore, who runs the camp, has made it a personal mission to provide water for at least some of the thirsty animals—which he does by pumping groundwater to fill a small water hole. But he can't afford to keep the pump running continuously, and his is only one small relief station in a vast arid landscape, so animals continue to die. Maintaining the supply line is also a problem, he told me, pointing to lion tooth marks in the black plastic pipe that runs from pump to pool. "The lions are so desperate for water they bite into the pipe, working their way along until they reach the water hole."

An hour's drive down sandy tracks brought us to another poignant sight: a pod of hippopotamuses stranded in a syrupy pond. There was no water for miles upriver or down, so the hippos were marooned. There was little grazing to be had in this place of thorn trees and sand, and it was with relief that we saw a wildlife ranger drive up and unload half a dozen hay bales, which he cut open and spread beside the pool. The hippos trotted out of the water and began to munch. Were it not for their daily handout, they would starve.

I wondered how long it would take for this pool to go the way of the catfish graveyard P. J. Bestelink had shown me. And what does it say about the delta that once healthy rivers are drying up? Is climate change casting its long shadow over the miracle delta?

**Apparently not,** according to hydrologists and climate researchers, who have detected an 18-year oscillation in rainfall in the region and an 80-year cycle of high and low flood volumes. We're reaching the end of the 40-year low part of the cycle, they say, and should see larger floods in the future, peaking in mid-century. Rainfall should also increase over the next few years.

River and rain contribute in roughly equal measure to the delta's water budget. The summer rains have the function of recharging the groundwater aquifer—of priming the system in anticipation of the flood. If the rains are good, little floodwater is needed to bring the water table to the surface, and the bulk of the inflowing water then spills into the seasonal floodplains, creating a large flooded area. If the rains are poor, much of the floodwater soaks into the ground, filling the gap left by lack of rain, and the area of inundation is reduced.

The waxing and waning of water volumes in the Okavango is an expression of natural variability in the system—as organic as breathing. Indeed, Terence McCarthy, a professor in the School of Geosciences at the University of the Witwatersrand, in Johannesburg, speaks of the delta as a living organism, with a circulatory system in which the water channels function as arteries and capillaries.

**IN A LAND WITHERED BY DROUGHT, THIS GIFT OF WATER IS LIKE UNCTION, AND ALL NATURE RESPONDS TO IT.**

McCarthy and his colleagues, who have been studying the delta since 1985, have discovered that one of the largest contributions to the life of the delta is made by one of its smallest inhabitants: termites. Termites are a lot more than pasty white bugs that gnaw on dead plants and manage subterranean fungus farms. Their colonies are giant construction companies that have transformed the Okavango Delta from a piece of flat real estate into a mosaic of an estimated 150,000 islands.

It all stems from the termites' need for air-conditioning. Some species build above-ground air vents to control the temperature in their networks of galleries and tunnels. These turrets, sometimes ten feet high, and their surrounding earthworks are above flood level, providing dry, fertile sites on which trees can become established.

Trees can be thought of as kidneys of the delta, cleansing the system by removing its salts. They do this by sucking water out of the ground and pumping it into the atmosphere by transpiration. In the process, soluble salts are deposited around the tree roots—a "toxic waste storage system," McCarthy calls it. Without the delta's millions of tree pumps (enabled courtesy of Termites Inc.), the 400,000 tons of salts carried in yearly by the Okavango River would be precipitated across the surface of the land, poisoning the delta. By concentrating salts in

the soil and groundwater beneath them, trees not only keep the water in the delta fresh but also expand the size of their island platforms. Thus what the termites start, the trees continue, engineering not just a landscape but an entire ecosystem.

Just as termite mounds are nuclei around which islands form, hippo paths are the precursors of water channels. Most channels in the delta have a life expectancy of about a hundred years. During that time sandy sediment gradually raises the height of the channel bed, slowing the current and allowing the fringing stands of papyrus (which are not rooted in soil but linked together in floating mats) to spread into the channel. Clumps of papyrus eventually break off and jam the channel until, like a clogged artery, it becomes completely blocked.

At this point the hippos come to the aid of the delta's circulatory system, breaking through papyrus jams and forming new channel connections. It is only because the delta is so flat (a gradient of about a hundredth of a degree) that water follows such randomly created corridors. The path of least resistance turns out to be the path the hippos have trod.

**Termites, hippos, and papyrus**—these three biological influences are part of a system as intricate and responsive as any on Earth. Yet the delta is not immune to human disturbance, even to eventual destruction. The chief threats lie upstream, in the two countries with which Botswana shares the inflowing water. Angola and Namibia both experienced long, brutal wars in the latter part of the 20th century and now look to rivers to help build their economies. Two aspects of development, the increased use of agricultural fertilizers on riverine land and the production of hydroelectricity, could have disastrous downstream effects on the delta. While neither threat is imminent, their potential impact on so finely balanced an ecosystem has many people worried.

**REFLECTION OF AFRICA,** an elephant trumpets above Okavango's looking-glass waters.

"Fertilizer!" Map Ives, environmental manager for a large Okavango tourism company, spat out the word distastefully. "It's a word I dislike more than any other. Fertilizers have a horrible habit of leaching into waterways. If a lot of phosphate gets into the Okavango River, the papyrus is going to go wild."

Papyrus can thrive in nutrient-poor conditions. Enrichment of the delta through fertilizer runoff from irrigated farmland upstream could cause rampant growth of papyrus and lead to wholesale channel blockage. "If the Panhandle becomes blocked," said Ives, "it's good night Okavango Delta."

Damming the rivers that supply the delta would be equally catastrophic. Namibia's national power utility, NamPower, is studying the feasibility of generating electricity at Popa Falls, just 30 miles upstream of the Panhandle. The scheme is opposed by scientists such as Terence McCarthy, who points out that dams deprive rivers of sediment and that sediment is vital to the functioning of the delta. More than 200,000 tons of it is deposited in the delta's upper reaches each year, raising the channel beds and starting the process of channel switching by which the Okavango renews itself. Without an annual injection of sand, channels would be scoured out instead of built up, becoming ever deeper and swifter. Sandbars, which are breeding sites for threatened birds such as the African skimmer, would disappear. Channel switching would cease. Like limbs that have lost their blood supply, whole sections of the delta would be lost.

In 1996, in recognition of its value as one of the last pristine river systems in Africa—and in the world—Botswana registered the Okavango Delta as a wetland of international importance under the Ramsar Convention, an intergovernmental treaty binding signatories to the conservation and wise use of wetlands. But most of the Okavango River lies in Angola and Namibia, where it enjoys no special protection. Safeguarding a wetland but not its water supply is like protecting an endangered species but not its food source.

Botswana has strong economic as well as political reasons for wanting to keep the delta pristine: Okavango tourism is second only to diamond mining as a foreign-exchange earner. The delta is a golden egg, but Botswana neither feeds nor owns the goose.

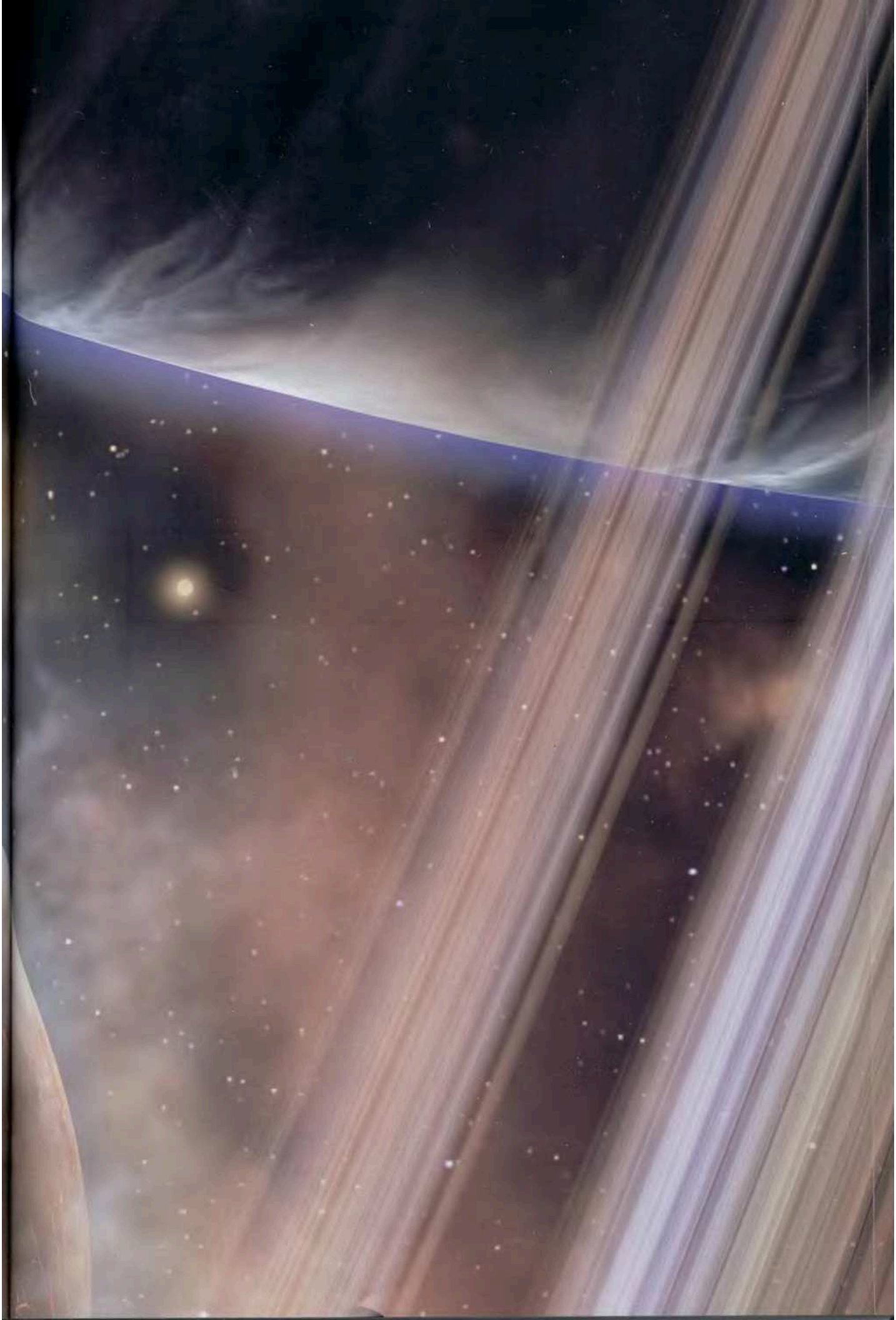
A decade ago the three governments formed a commission to oversee the management of the Okavango basin, but how the pursuit of disparate national interests will play out is anybody's guess. Some observers have suggested that Botswana could compensate Angola and Namibia for limiting, or even abandoning, projects such as hydro schemes that would have a negative impact on the delta. However, such a level of cooperation would be rare in global politics.

**When David Livingstone** asked the Bayei people to explain the phenomenon of the Okavango flood, they told him that every year a chief who lived to the north—Mazzekiva by name—killed a man and threw his body into the river, after which the water would flow. Livingstone never investigated the claim, but a century and a half after he posed his question to the Bayei, I stood on a bullet-pocked concrete bridge in the Angolan highlands and watched boys fishing in the headwaters of the Rio Cubango, one of the two main tributaries that feed the Okavango River. I wondered how many bodies—sacrifices not to water but to battle—had been thrown into this river during Angola's 27-year civil war, which had only recently ended.

I was near the town of Sambo, in the verdant grazing country of the Bié Plateau. It was November, and the summer rains were starting. The landowner, Celestino Jolomba, pointed to two military vehicles rusting under a eucalyptus tree. They had belonged to Jonas Savimbi, he said. Savimbi had been the head of UNITA, the antigovernment faction in the bloodshed.

Driving here, I had passed gangs of workmen daubing white and red paint on stones along the roadside to warn of land mines. Millions of mines remain in Angola, reaping their bitter harvest of limbs and lives. In this place of death it was strange to think that the water flowing beneath me was bringing life to a distant delta. But it was: In a few weeks the flood would start to rise in the Panhandle. Relief would come to the Okavango's parched plains. The miracle would begin again. □

**ADRENALINE RUSH** Give yourself a croc's-eye view of the miracle delta's deadly dangers and stunning beauty in Sights & Sounds. Then find out what the assignment was like for the author and photographer at **nationalgeographic.com/magazine/0412**.



## giant squeeze

*In the glare of dual suns, an Earth-size moon (far left) is caught in the grip of a giant ringed planet the size of Jupiter. Kneaded by gravitational forces, the moon's surface has shattered and its interior is melting. The artist's vision shows how nearby giants can destroy Earth-size worlds. But at greater distances they can shield smaller planets from debris and even help them form. Spotting such giants—like most of the alien planets found so far—is a step toward finding other Earths.*

ART BY DANA BERRY


Astronomers are more certain
than ever that other planets like
our own exist in the universe.
Now they just have to find them.
Search
for other earths

by tim appenzeller
SENIOR EDITOR

photographs by mark thiessen
NATIONAL GEOGRAPHIC PHOTOGRAPHER

It's past midnight in the dim telescope control room, but Dominique Naef's day has suddenly brightened. He twitches his computer cursor over a wavy line. "I like it," the Swiss astronomer says, beaming. "I like it a lot. Wow."

Fifty light-years away in the night sky, a star like our sun is doing a stately dance, stepping toward Earth and away again. From the La Silla Observatory in the mountains of Chile, Naef and his colleagues have stolen glimpses of the dance for months. But for much of that time their view was blocked by clouds, a foot of snow, and, this August night—midwinter in Chile—humidity so high that the telescope dome had to be shut to keep out frost. Earlier in the evening, between cups of espresso and cigarette breaks, Naef gloomily eyed a display of weather data. He feared another lost night.

Then the humidity dropped, and the telescope operator gave the go-ahead. Naef and Christoph Mordasini, a graduate student from Bern, huddled at their screens. They captured

*Metaphor for an astronomical quest, a mechanical firefly is just a glimmer next to a five-foot-wide searchlight. Astronomers hoping to capture the light of an Earth-size planet around a star billions of times brighter compare the feat to picking a firefly from a searchlight's glare 3,000 miles away, on a foggy night. The fog—artificial in this case—represents dust shed by the swarm of asteroids and comets likely to surround the star. The challenge for Earth hunters: blocking the starlight so the planet can be seen.*

one more reading of the star's motion before, minutes later, the humidity shot up again and the operator called a halt for the night.

It's just another glimpse, but it's enough to turn a suspicion into a near certainty. The excited jiggle of Naef's cursor shows that the reading has fallen just where it should if an unseen planet is tugging the star to and fro. The next day the team leader, veteran planet hunter Michel Mayor of the University of Geneva, decides that it's time to announce the discovery. If it stands up to the scrutiny of other scientists, this planet, around a star called Mu Arae, will be a milestone in the quest for another Earth.

When Mayor and another colleague, Didier Queloz, found the first planet around another sunlike star a decade ago, it was a stunning feat. By now, astronomers tracking the wobbles of nearby stars have detected more than 130 alien planets. It's a strange harvest: gas-shrouded giants, mostly hundreds of times more massive than Earth, some in weirdly elongated orbits and others so close to their star that they circle it in days or even hours. But Mu Arae's planet, and two others reported at about the same time by U.S. groups, are far smaller than their predecessors and could be made largely of rock. With their discovery, the planet hunt has taken a turn toward the familiar.

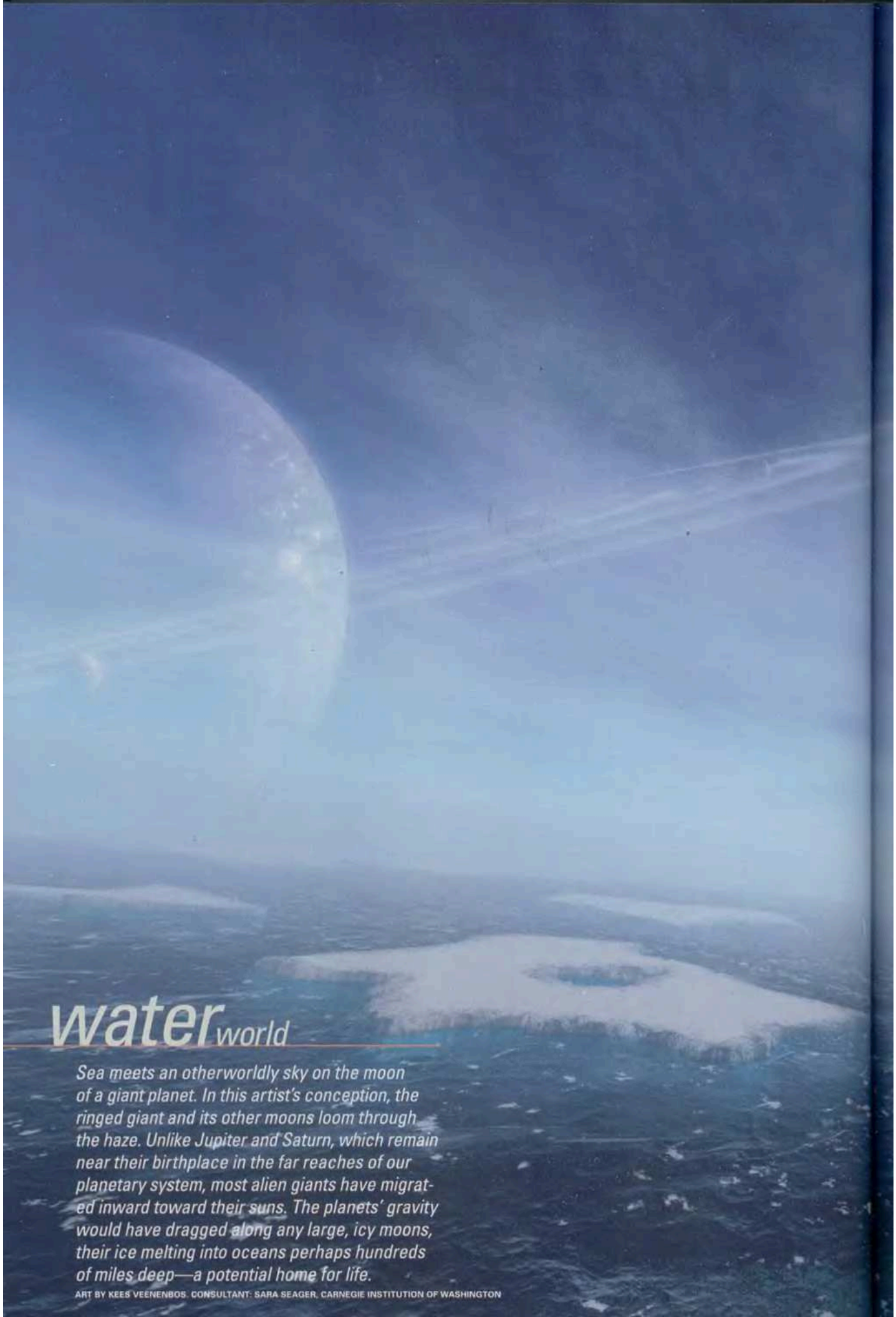
These new planets are still no place for life as we know it. The planet around Mu Arae weighs at least 14 times as much as Earth—"an Earth on steroids," says one astronomer. It is scorchingly close to its star, completing an orbit every 9.5 days. But astronomers are convinced they will soon be finding solar systems where small, temperate planets like Earth could form and where some kind of life might flourish. "We're really on the doorstep of seeing systems like ours," says Debra Fischer of San Francisco State University, a member of the U.S. team that has found more than half the planets.

What they'll pick up first, they believe, are hints of giant planets in circular orbits far from their sun, like Jupiter—bodies that astronomers believe would raise the odds of Earthlike planets forming and surviving closer to the same star. The next step is actually taking a picture of an alien planet. At labs and mountaintop domes, engineers are at work on technologies capable of recording a planet's meager glow next to the glare of its sun. From the ground this optical wizardry could see a Jupiter-size planet. In space, aboard a multibillion-dollar mission called the Terrestrial Planet Finder that's scheduled to fly in a decade or so, it could pick up the light of a planet no bigger than Earth.

It's hard to overstate the excitement scientists feel at the prospect of seeing that faint blue dot. If it told of a watery, temperate place, humanity would face a 21st-century version of Copernicus's realization nearly 500 years ago that the Earth is not the center of the solar system. The discovery would show "that we're not in a special place, that we might be part of a continuum of life in the cosmos, and that life might be very common," says Michael Meyer, an astronomer at the University of Arizona. "To find oxygen, ozone, to see variations [in brightness] due to continents—that would be really exciting," says Sara Seager of the Carnegie Institution of Washington, who is developing techniques for

*Michel Mayor's group tracked a sunlike star to discover an alien planet, the first of its kind, ten years ago. Pulled by the unseen planet, the star 51 Pegasi (in image) approaches and recedes from Earth every 4.2 days. A color change betrayed the wobble: The star's light gets slightly bluer as it moves closer and redder as it moves away.*

Astronomers have detected more than 130 alien planets at latest count. It's a strange harvest



# water world

*Sea meets an otherworldly sky on the moon of a giant planet. In this artist's conception, the ringed giant and its other moons loom through the haze. Unlike Jupiter and Saturn, which remain near their birthplace in the far reaches of our planetary system, most alien giants have migrated inward toward their suns. The planets' gravity would have dragged along any large, icy moons, their ice melting into oceans perhaps hundreds of miles deep—a potential home for life.*

ART BY KEES VEENENBOS. CONSULTANT: SARA SEAGER, CARNEGIE INSTITUTION OF WASHINGTON

interpreting that first glimpse of an Earthlike planet. "That's why I work so hard every day. Because that's what I want. I want to find that."

None of this would be happening if not for the winter nights that Didier Queloz, then a Ph.D. student at the University of Geneva, spent a decade ago at a telescope high on a plateau in southern France. Queloz and his mentor, Michel Mayor, were searching for hints of companions to nearby stars. They hoped to find dim, failed stars called brown dwarfs. But they were also trying their luck in a game that had disappointed many other astronomers before them: hunting for alien planets.

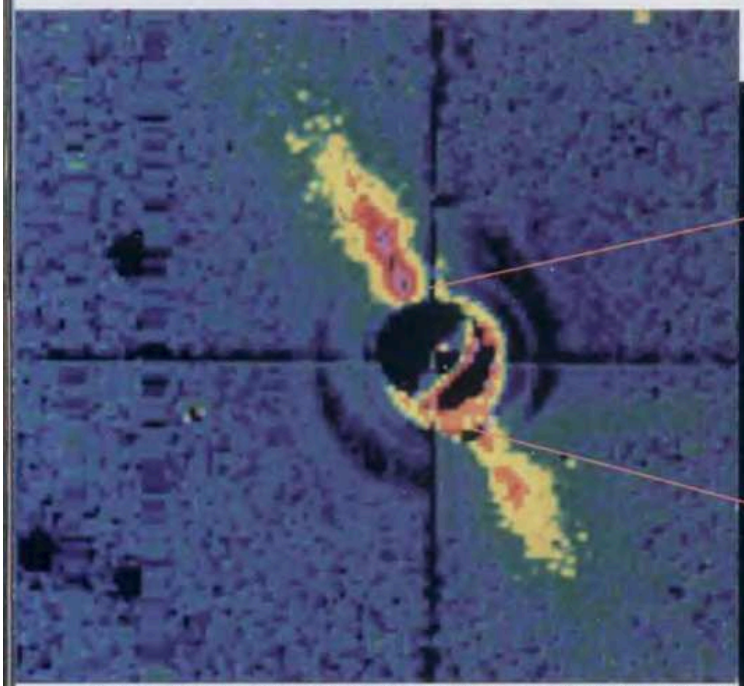
Their strategy was to break the light of each star into all its colors, producing a spectrum, banded with dark lines like a bar code. Each dark line indicates a wavelength of light soaked up by gases at the star's surface. If the star is moving toward or away from Earth, the lines shift to slightly shorter or longer wavelengths. It's the same effect you hear in an ambulance siren: As it approaches, the sound waves are squeezed to shorter wavelengths, raising the siren's pitch; after it races by, the sound is stretched out and its pitch drops. A rhythmic wavelength shift in a star's spectrum, back and forth, can mean that the star is heading toward us, then away. Something massive must be orbiting it, tugging it this way and that. The extent of the shift is a rough gauge of the object's mass, and the timing tells how long it takes to complete an orbit.

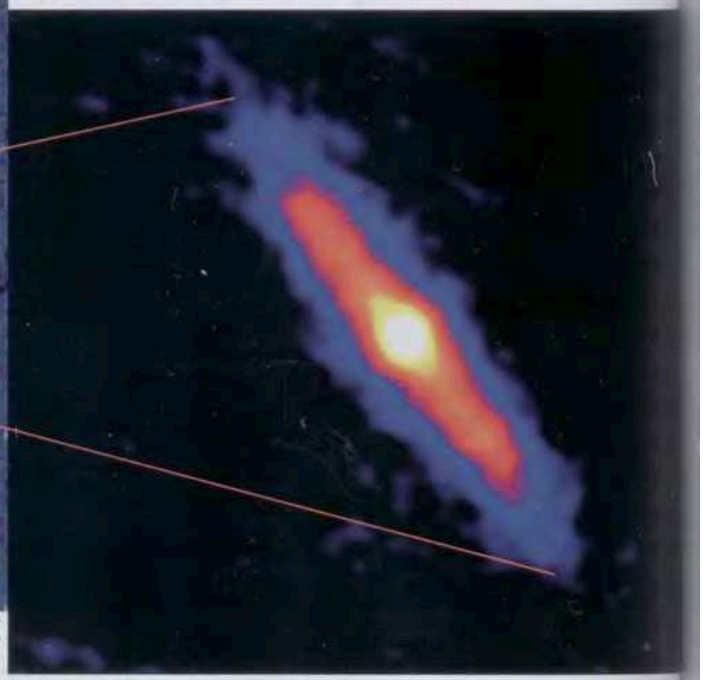
"The principle is simple," says Mayor, "but the devil is in the details." The telltale shift in the lines can be minuscule—no more than the width of a dozen or so atoms on a detector, for planets as small as his group's latest prize.

Back in 1994 astronomers also believed that it would take years, maybe decades, to see a star moving under the spell of a planet. The only planets able to yank their star fast enough to register on the instruments of the day would be the mass of Jupiter or more—hundreds of times heavier than Earth. And theorists believed that, like Jupiter, giant planets would only be found far from their stars in orbits taking years to complete.

closer look

*A vast cloud of dust, perhaps kicked up by colliding asteroids, envelops the young star Beta Pictoris in images from 1984 (left) and last January. Both images give a side view of the disk-shaped cloud and indicate brightness with false color. The earlier one, made in visible light, reveals only the disk's edges, but the new infrared view homes in on a smaller region about twice the size of our planetary system. The part of the disk colored red looks lumpy, perhaps because unseen planets are displacing the dust.*





BRADFORD SMITH, UNIVERSITY OF ARIZONA, AND RICHARD TERRILE, JET PROPULSION LABORATORY (ABOVE); CHARLES TELESCO, UNIVERSITY OF FLORIDA, AND SCOTT FISHER, GEMINI OBSERVATORY

To Queloz's astonishment, one of the stars he watched that winter was rocking back and forth every 4.2 days. It could have been a fluke, but just maybe it was a planet half the mass of Jupiter in an orbit no one thought possible—so close that the planet was practically skimming its parent star. With Mayor's encouragement, Queloz stuck with it, building up data until he was sure. "Maybe it was intuition, maybe it was luck," he says. "Maybe it was because I was young and naive."

Some astronomers thought the planet, called 51 Peg b for its parent star in the constellation Pegasus, was too bizarre to be real. But it turned out to be the first of an avalanche. After Mayor and Queloz announced it in the fall of 1995, other planet hunters who had come up empty took another look at their data, alert for fast-paced wobbles. They also expanded their search to hundreds of other nearby stars. More giants quickly turned up, some in searingly close orbits —"roasters," as some astronomers now call them—and others careering near and far with each orbit, on wildly eccentric, or oblong, paths.

These discoveries told of planetary turmoil—giants swept from remote birthplaces into hot, close orbits, and planetary siblings playing gravitational tug-of-war until one was flung into deep space. As Greg Laughlin, an astronomer at the University of California, Santa Cruz, says, "We're seeing the staggered, surviving remnants of systems that went berserk early in their history."

A few roaster planets have even been glimpsed more directly when they transit their star, crossing its face and dimming its light like a beetle crawling across a lamp. In the early years, skeptics argued that something other than planets might explain why the stars appeared to wobble. "The first transiting planet killed that idea," says David Charbonneau of the Harvard-Smithsonian Center for Astrophysics, one of the planet's discoverers.

Found in 1999 orbiting a star named HD 209458, that first transiting planet also gave astronomers their first reading of an alien planet's dimensions. Although lighter than Jupiter, this one is bloated to a diameter 35 percent greater. Subtle color changes as starlight shines through the planet's heat-swollen atmosphere are also yielding hints about what this alien world is made of—hydrogen, helium, and sodium, for starters—as well as signs that it is slowly evaporating in the heat. All in all, says Laughlin, "it's a bonanza if you can find a planet transiting a bright star." So astronomers are eager to find more. A group including Charbonneau has set up a network of small telescopes that scan thousands of stars night after night, watching for any transits—and recently detected another giant planet crossing the face of its star.

Roasters and eccentric giants are nothing like the planets we know, and the gravitational tug of these rampaging giants could threaten the survival of Earthlike planets. Yet planetary scientist Jonathan Lunine, flashing computer models of planet formation on a monitor in his University of Arizona office, isn't dismayed by these freakish worlds. "They're common in the best possible way," he says. "They're common enough that it looks like planet formation is a normal process." But they're not so common that solar systems like our own, where Earths can coexist with giants that move in wide, circular orbits like Jupiter's, won't turn up. So far, astronomers have found planets around only about 10 percent of the sunlike stars they've inspected. That leaves plenty of room to find alien Jupiters as searches become more sensitive.

Computer models by Lunine's colleagues show why that matters: Jupiters help Earths take shape. In the disk of gas and dust that surrounds a newborn sun, giant planets are thought to form first, in a million years or so. The leftovers provide the raw material for smaller planets. Dust clumps together into gravel, gravel to rocks, and rocks to hundreds of planetary embryos about the size of Earth's moon. But then the process grinds to a stop, at least in most computer models, because the embryos stay in tidy circular orbits like freeway drivers keeping to their lanes. They don't smash into each other, so they don't grow.

"That's where Jupiter comes in," says Lunine. With its powerful gravity, "Jupiter is going to gradually pull on them and make their orbits more eccentric." He clicks through a few screen images, leapfrogging through tens of millions of years. Frame by frame a Jupiter's influence churns an orderly set of embryos into an unruly, colliding swarm. A handful of Earth- and Mars-size planets take shape in the turmoil.

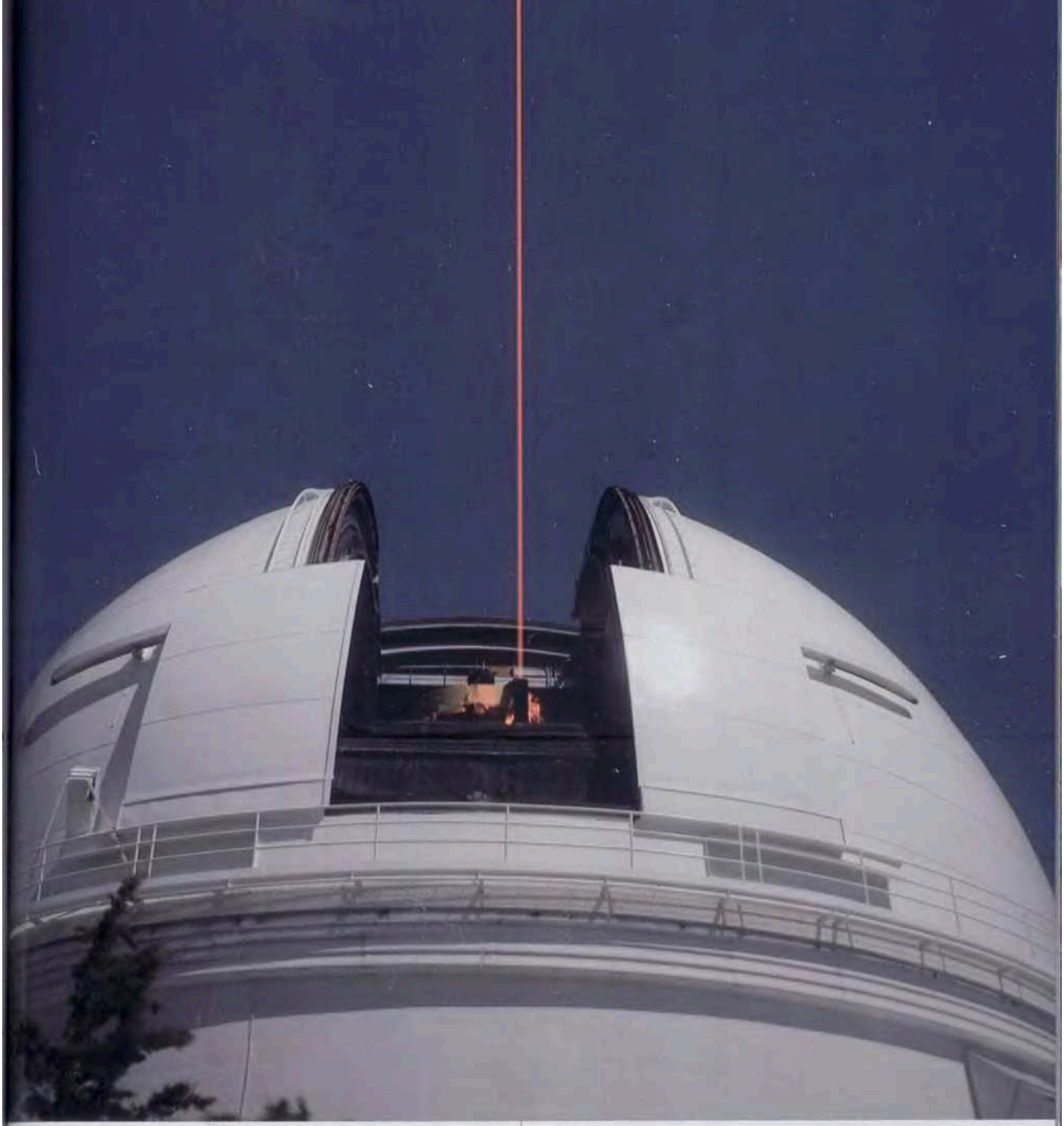
Jupiter bestows a second blessing, the computer models show. At an Earthlike distance from

# mirror mirror

*To sharpen their view of faint, distant objects like planets, astronomers rely on adaptive optics, a technology that takes distortion out of telescope images. Adaptive optics expert Bruce Macintosh demonstrates the basic idea: bouncing a distorted image—here created by a fun-house mirror—off a smaller mirror shaped to create equal and opposite distortions (below). Seen in the second mirror, Macintosh has his normal proportions. In astronomy, Earth's turbulent atmosphere creates the distortions; a flexible mirror in the telescope changes shape hundreds of times a second to compensate. To measure the atmospheric distortion of light, the system has to monitor a bright star near the telescope's target. What if no star is handy? At California's Lick Observatory (right) a laser is fired into the upper atmosphere to create a glowing spot—an artificial star.*

a young star, the disk is too hot for water to survive in the planet-forming material, leaving any planet embryos bone-dry. The newborn planetary system's water would be locked up in icy embryos several times farther out—too cold for life. But a Jupiter would cause distant embryos to veer inward toward the star, delivering a generous splash of water to any newborn planets they collide with. On Lunine's computer the planet embryos at an Earthlike distance start out red, for dry. As Jupiter stirs the pot and the embryos give way to full-fledged planets, the color shifts to blue or green—sopping wet.

Later on, Lunine and others believe, Jupiters would act as bodyguards for these small, watery worlds. In a newborn planetary system, chunks of leftover rock and ice big enough to devastate an Earth would probably be on the loose for hundreds of millions of years. In our solar system, Jupiter helped clean up the neighborhood. With its powerful gravity, it took hits from some of the troublemakers, flung some into deep space



or the sun, and herded most others into the asteroid belt. The result is a protected zone where Earth survives.

So the road to another Earth, it seems, leads through another Jupiter. But detecting the wobble that would reveal a Jupiter means monitoring a star for a decade or more, while the giant completes its stately orbit.

By now, the wobble-watchers have been at it for long enough to be getting close. Last year a group led by Paul Butler of the Carnegie Institution of Washington reported a giant with a nearly circular, six-year orbit, about half the size of Jupiter's. Butler and his colleagues, including Geoff Marcy of the University of California, Berkeley, and Debra Fischer, may be just a few measurements away from announcing the real thing. "They probably have several very beautiful true Jupiter analogues in their data, and they're just waiting to get more data so they're really sure," says Laughlin.

There ought to be a more direct way to find

# birth theory

## slow


### Core Accretion

*The first planets to emerge from the whirling disk of gas and debris that surrounds a newborn star are gas giants like our Jupiter and Saturn. Most astronomers think they take shape slowly by growing step by step from the rocky material in the disk (top). First, tiny dust grains stick together (1), forming larger grains that collide to form still larger lumps. The growth process eventually yields solid cores roughly ten times the mass of the Earth (2). Their powerful gravity sucks in gas from the disk to create a giant, gas-cloaked planet (3).*

*Making a planet this way could take several million years. That's too slow, say some theorists, who argue that the gas needed for planet growth may not linger that long in the disk. They favor a fast alternative (facing page). Either way, smaller, Earth-size planets would form much later, from the leftover disk material.*


ART BY MOONRUNNER DESIGN. CONSULTANT: ALAN BOSS, CARNEGIE INSTITUTION OF WASHINGTON

## *Gravitational Instability*

*Many young stars have bright neighbors whose intense radiation can strip gas from a planet-forming disk. That would force giant planets to form faster than the gas disappears. "I don't think core accretion can do that," says astrophysicist Alan Boss, lead supporter of a speedier recipe for planet formation. In this theory, gravity causes the disk of gas and dust to collapse into dense clouds, shown at top as bright clumps. Each cloud shrinks (1) and solid material falls to the center, creating a core within a few thousand years (2). Then the rest of the cloud contracts, forming the gas giant (3). The process could take less than a million years. "It's a pretty picture," says Boss, though he admits, "it's still just a fairy tale." That could change if giant planets (now known to orbit some 10 percent of sunlike stars) turn out to be much more common, implying that they regularly win the race against disk erosion.*

these Jupiters: Take a picture of one through an extraordinarily powerful telescope. But that means finding some way to vanquish the glare of the star.

In a workshop under the bleachers of the University of Arizona's football stadium in Tucson, a telescope mirror the size of a small skating rink rests in a cradle. Frosty white and sightless, it's in the midst of three months of grinding, as a diamond-coated wheel carves the 27.5-foot expanse into a near-perfect shape for final polishing. When it's done, it will be trucked to the summit of Mount Graham, 70 miles to the northeast, joining an already completed twin. There the Large Binocular Telescope (LBT) is taking form. Starting in 2006, its dual mirrors will peer into space side-by-side like the saucer eyes of an owl, looking for Jupiters.

Sheer size will allow the LBT to see fainter objects than all but a handful of other telescopes in the world. But the real trick is the twin mirrors, which open the way to a feat of optical alchemy that can transmute starlight to total darkness.

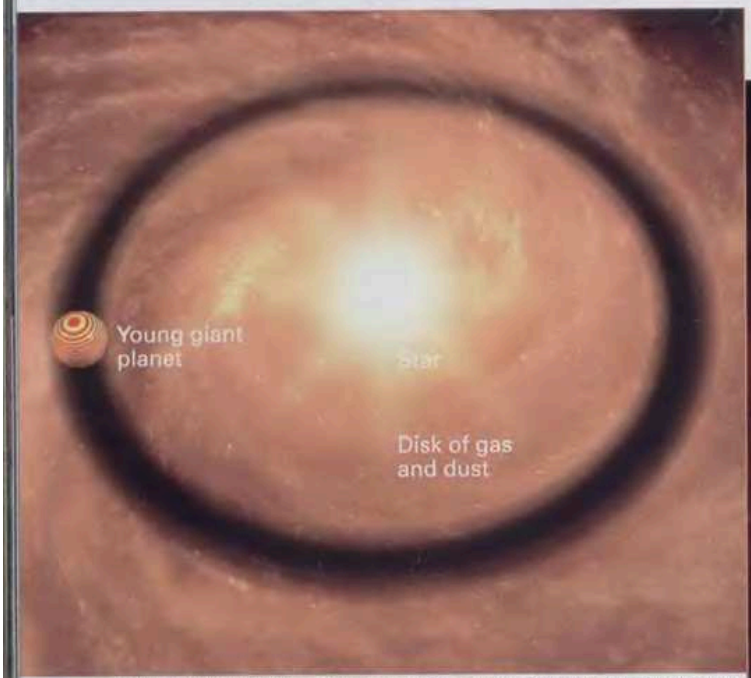
That feat, called nulling interferometry, relies on the fact that light waves have crests and troughs, just like waves on water. By precisely aligning the light waves gathered by the two mirrors from a particular point in the sky, astronomers can overlap the wave crests from one mirror with the troughs from the other so that the light simply cancels out. Noise-canceling headphones use the same principle to deaden sound waves; with light, the result is a patch of darkness.

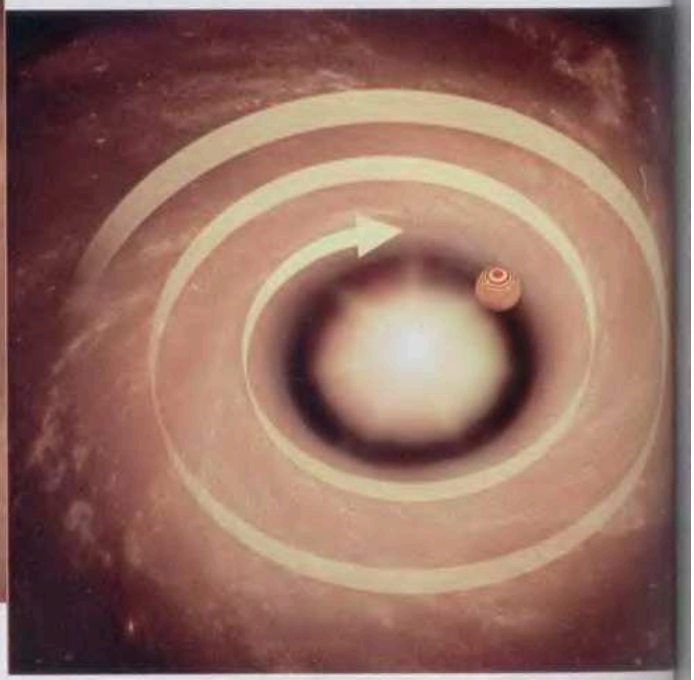
For this scheme to succeed, the light beams have to be guided and merged with exquisite precision. The payoff: blotting out the light of a star so that a giant planet, hundreds of thousands of times fainter and only a hairbreadth away on the sky, can be seen.

Even then the LBT probably couldn't see an exact counterpart of our Jupiter, dimly lighted by its distant sun. To be visible to an earthbound telescope, an alien Jupiter would have to be several times bigger or much younger—say half a billion years old instead of nearly five. Still warm from its violent birth, a young Jupiter would glow in infrared light, like a distant heat lamp.



*Giant planets take shape far from their star, where raw material is abundant. But astronomers have found scores of giants that apparently migrated inward after forming. In one theory, the process begins as a newborn giant carves a gap in the disk of gas and dust swirling around a young star (below left). The gap doesn't stay put: Friction between particles and gas molecules gradually slows down the disk. The material spirals inward, carrying the gap—and the planet—with it (below).*



ART BY MOONRUNNER DESIGN. CONSULTANT: DEREK C. RICHARDSON, UNIVERSITY OF MARYLAND

Nulling has plenty of rivals as a Jupiter-finding tool. "This is a technical arms race," says Laird Close of the University of Arizona, who is pursuing a different approach. Working with telescopes in Arizona and Chile, he is exploiting subtle color differences between a star and a young Jupiter. With the right filters, he hopes to dim the star and make any planet pop out. Ben R. Oppenheimer of the American Museum of Natural History is trying something else. He has fitted a telescope on Maui with a set of precisely sized masks that physically block the starlight. "It's all just about deleting that star," he says.

None of this star subtraction would be possible without adaptive optics—a means of sharpening telescope images. In a perfect image a star would appear as a crisp point that could be neatly deleted, or just ignored, by astronomers searching for planets next to it. Instead, even the best earthbound telescopes ordinarily see a star as a fat smudge. Earth's atmosphere is the culprit: In the last few miles of light's journey from star to telescope, air turbulence scrambles and distorts it. Adaptive optics measures the scrambling with a special sensor, then sends the information to a flexible mirror that deforms and undulates many times a second—a frenetic funhouse mirror—to tidy up the image of the star.

Most of the world's big telescopes are already equipped with adaptive optics, and some planet hunters are trying their luck on existing systems, without any other tricks to mask out the star. A very young, red-hot giant planet just might be visible if it orbited at least ten times farther out than Jupiter. Even that "is sort of a long shot," admits Bruce Macintosh, an adaptive optics expert at Lawrence Livermore National Laboratory, who is carrying out his search at the giant Keck II telescope on Hawaii.

A group at the Very Large Telescope in Chile has already glimpsed what may be a newborn giant planet near a dim brown dwarf. But it would be harder to spot such a planet in the glare of a normal star. Macintosh says that after examining a hundred stars, "we have candidates"—faint spots that might be a planet but could also be a star in the background—"but nothing I would describe as an obvious smoking gun."

Macintosh and others are working on a new version of adaptive optics that could deliver smoking guns by the dozen. Called extreme adaptive optics, it would replace the hundreds of tiny pistons that reshape current flexible mirrors with thousands of smaller ones, and correct the light not hundreds but thousands of times a second. "That would get us a bunch of real planets," Macintosh says—hot young Jupiters at a Jupiter's distance. Each one would mark its star as a place to look for Earthlike planets once the search begins in earnest.

## Some astronomers aren't waiting

until planets as small as Earth are in reach. They're hoping that current tools will reveal worlds that might be habitable, although quite unlike our home. That's one mission of HARPS, the instrument responsible for the Swiss team's latest discovery. Its lair is inside the concrete base of a telescope dome at La Silla.

Outside is the daytime brilliance of northern Chile's mountainous desert. Inside, darkened corridors lead to a door that Michel Mayor opens with a magnetic card. Behind it is another door, massively padlocked. Mayor, proud father of HARPS, has no key. At the moment, no one on the mountain does. "People will say we are completely crazy—that we believe it is a Swiss bank," he jokes. In fact, the way is barred because it would be all too easy to perturb the exquisite temperature control, high vacuum, and optical stability that allow HARPS to sift starlight for hints of planets smaller than any yet detected.

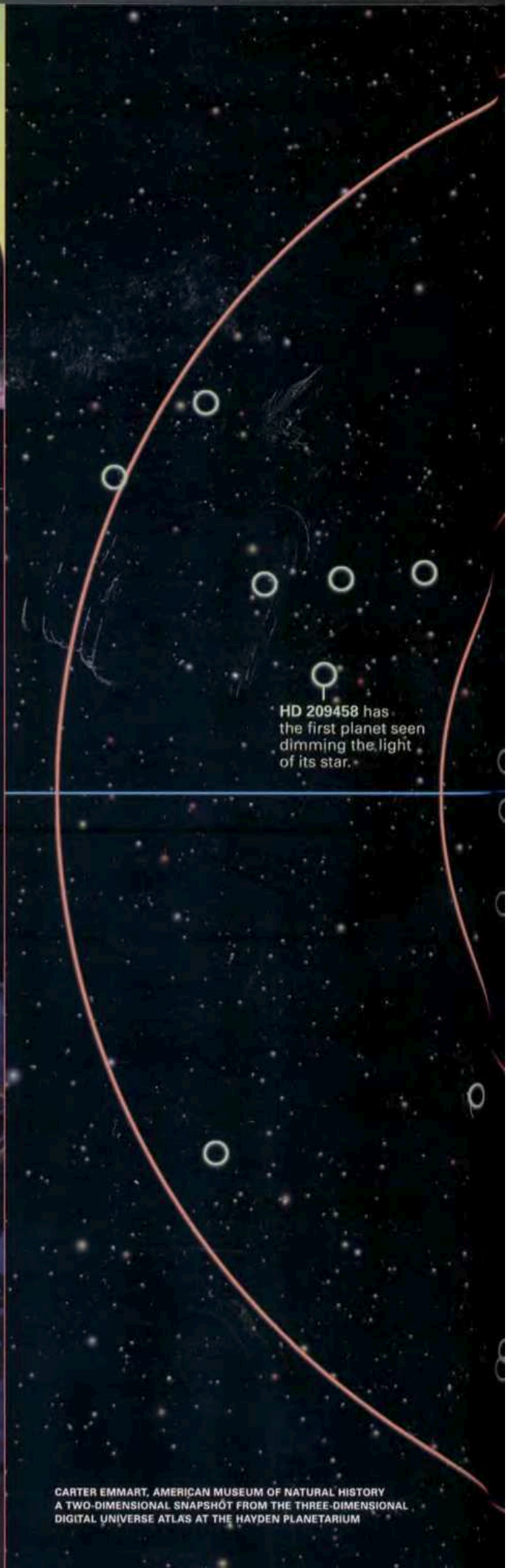
Silvery optical fibers snake into the innermost room, carrying starlight from the 3.6-meter telescope above. HARPS, sealed in a ten-foot-long vacuum tank, splits the light into a spectrum and monitors thousands of lines for wobbles. It's the same strategy that has yielded nearly all the planets found to date. But HARPS, up and running since late 2003, brings many times more precision to the task than Mayor's earlier instruments—precision enough to tell when a star tens of light-years away is moving toward or away from Earth at a speed no greater than a walk.

That sensitivity was key to glimpsing the Mu Arae planet, so small it exerts only a feeble tug on its star. It just might allow HARPS to detect similar planets—say 20 times Earth's mass, or roughly the mass of Neptune—in orbits the size of Earth's. No one knows what such worlds would be like, but planets like Mu Arae's have raised hopes that they exist. The Neptune we know is a ball of ice *(Continued on page 90)*

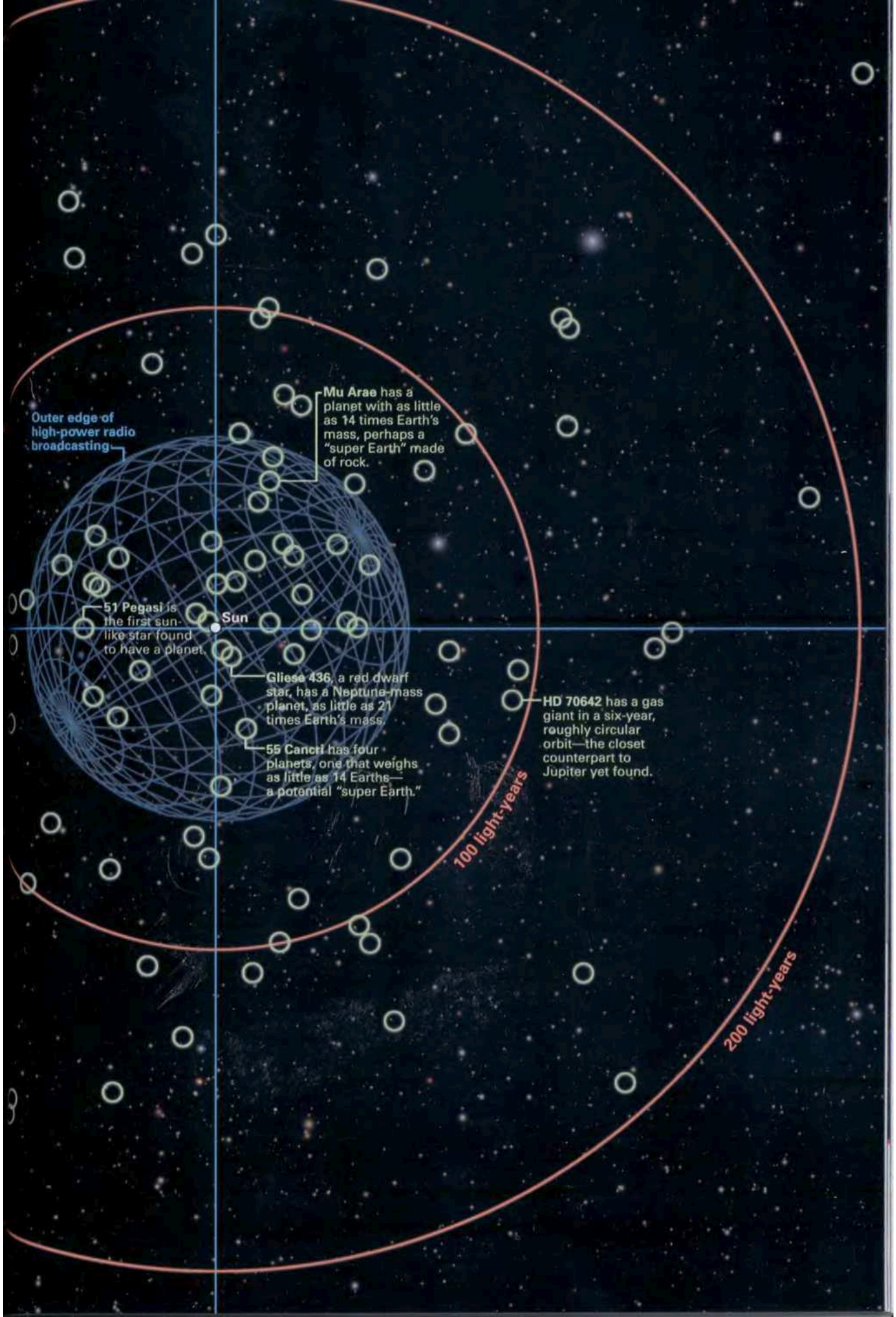
# planet hunters

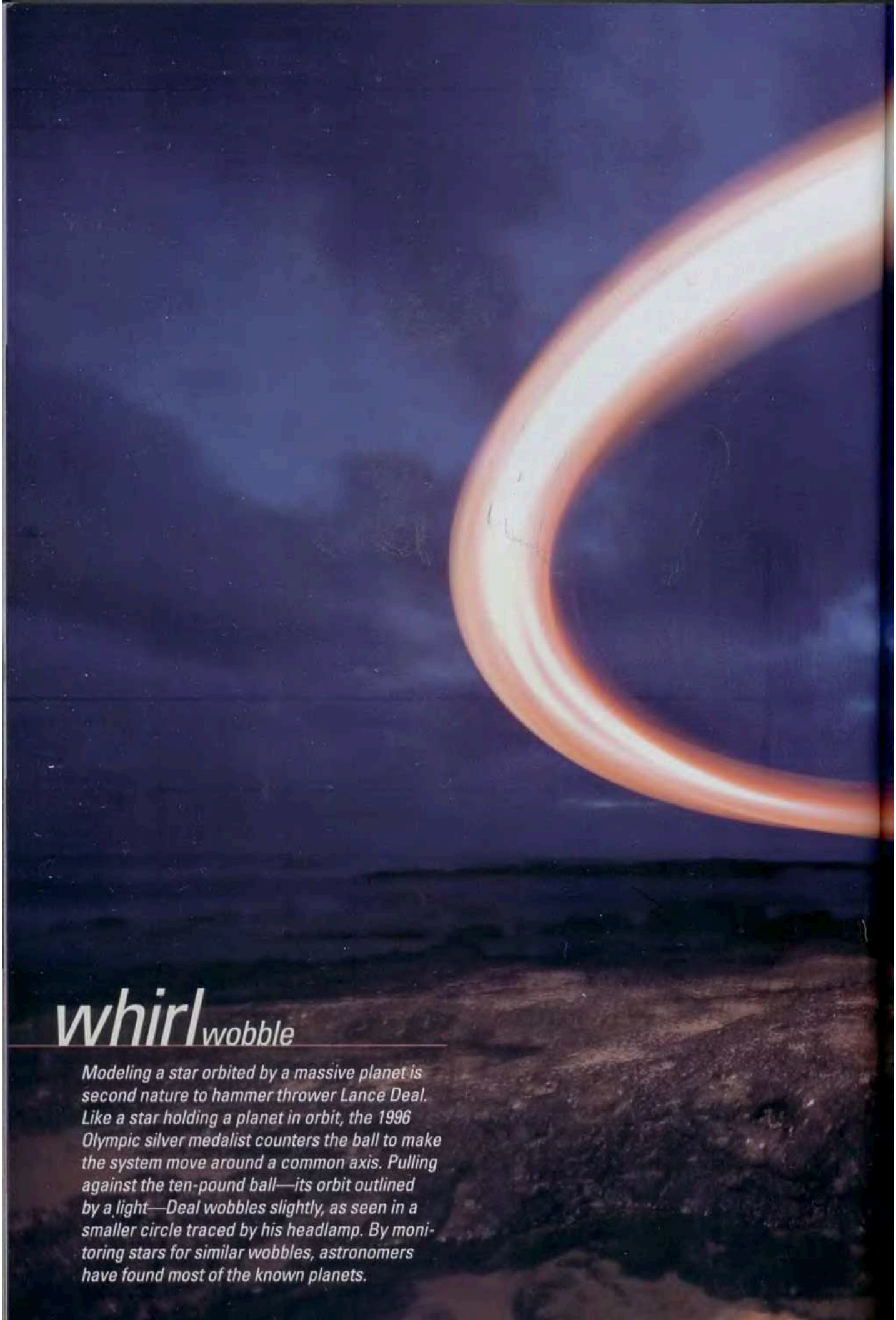
*Astronomers inspecting nearby sunlike stars have found more than 130 planets. This map, centered on our solar system, indicates most of the stars with one or more known planets and highlights notable discoveries. Nearly all lie within 200 light-years of Earth. For comparison, the blue sphere shows how far radio waves have traveled since high-power transmissions began in 1939.*

*Swiss astronomers found the first of these planets a decade ago. Since then a U.S. team has made more than half the discoveries. The team includes Paul Butler (above, at right), Geoff Marcy, holding a copy of the iodine-filled cylinder they use to sift starlight for signs of planets, and Debra Fischer, catching light projected from an antique telescope at the Chabot Space & Science Center in Oakland, California.*



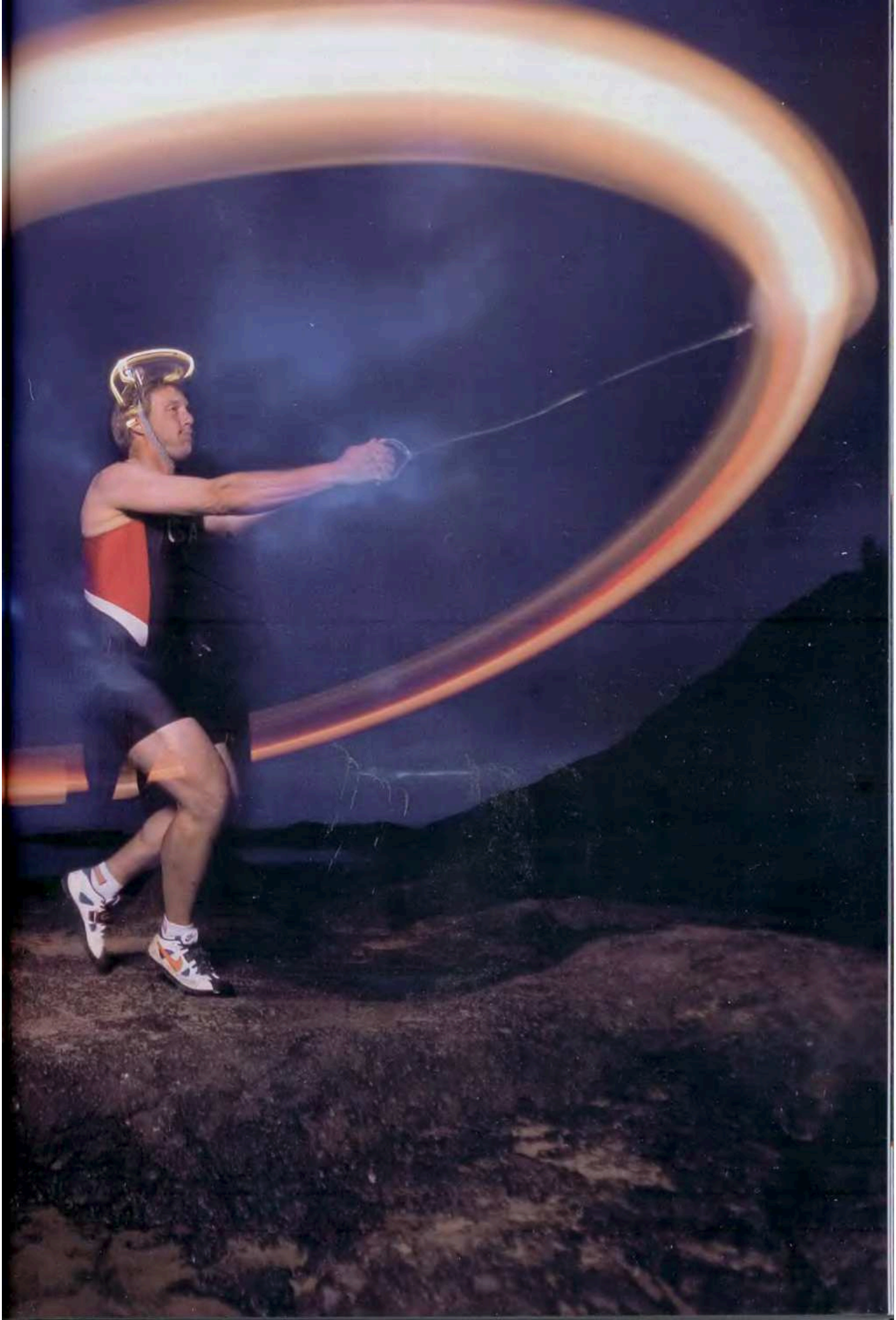

CARTER EMMART, AMERICAN MUSEUM OF NATURAL HISTORY
A TWO-DIMENSIONAL SNAPSHOT FROM THE THREE-DIMENSIONAL DIGITAL UNIVERSE ATLAS AT THE HAYDEN PLANETARIUM


Outer edge of high-power radio broadcasting
Mu Arae has a planet with as little as 14 times Earth's mass, perhaps a "super Earth" made of rock.
51 Pegasi is the first sun-like star found to have a planet.
Sun
Gliese 436, a red dwarf star, has a Neptune-mass planet, as little as 21 times Earth's mass.
55 Cancri has four planets, one that weighs as little as 14 Earths—a potential "super Earth."
HD 70642 has a gas giant in a six-year, roughly circular orbit—the closet counterpart to Jupiter yet found.
100 light-years
200 light-years



## whirl wobble

*Modeling a star orbited by a massive planet is second nature to hammer thrower Lance Deal. Like a star holding a planet in orbit, the 1996 Olympic silver medalist counters the ball to make the system move around a common axis. Pulling against the ten-pound ball—its orbit outlined by a light—Deal wobbles slightly, as seen in a smaller circle traced by his headlamp. By monitoring stars for similar wobbles, astronomers have found most of the known planets.*



(Continued from page 85) and rock near the edge of the solar system, but a similar planet closer to its star might resemble an oversize version of Earth, with a rock surface. Or it might have an ocean hundreds of miles deep. "We can dream," says Queloz.

So can Mayor and Queloz's competitors. Weeks before the Swiss team was sure of the Mu Arae discovery, two U.S. groups had quietly firmed up the case for other small worlds. Barbara McArthur of the University of Texas's McDonald Observatory found a planet weighing as little as 14 Earth masses—as small as the Mu Arae find—racing around the star 55 Cancri every 2.8 days. Paul Butler and his colleagues added their own bantamweight, at 21 Earths. Now, at the Lick Observatory near San Jose, California, their group is building a special-purpose telescope aimed at finding Neptune-size worlds far enough from their star to be habitable.

Robotically controlled for efficiency, the 2.4-meter Automated Planet Finder will capture every glimmer of starlight with mirrors plated with silver instead of the usual aluminum. Next year Debra Fischer will set it to work inspecting a hundred stars night after night for hints of worlds compact enough that they just might host life on a solid surface or in a deep ocean.

A planet as small as our own, however, will remain out of reach for both teams. That's because stars pulse and roil, creating surface motions that would make it impossible to detect a star's tiny drift—barely a crawl—under the spell of an Earth. But there are other ways to parse starlight for hints of real Earths.

Forty years ago William Borucki helped design heat shields for the Apollo moon missions. Not far from his office at NASA's Ames Research Center near San Jose, parachutes for the Mars landings in January were tested in the silvery wind tunnels that run between buildings like oversize air ducts. But Borucki's ambitions have vaulted far beyond the solar system. At an age when many people think about retirement, he's planning a four-year, 400-million-dollar space mission to hunt for Earth-size planets.

*The search for planets around other stars is a march toward devices able to capture the light of an Earth-size planet. Modest telescopes were enough to indirectly detect the first planets, gas giants about the size of Jupiter. But actually making an image of an alien giant requires powerful instruments attached to the biggest telescopes, like the Kecks in Hawaii and the Very Large Telescope in Chile (below)—actually four huge telescopes plus smaller, movable scopes that can merge their light for a sharper view. Starting in 2007, a series of space missions may realize the ultimate goal of finding other Earths.*

"This is really pure exploration," he says. "This is sending the *Niña* and *Pinta* out to see how many dragons there are on your way to India." Borucki's vessel is Kepler, a space telescope half the size of the Hubble but designed for the single purpose of planet finding. To be launched in 2007, it won't capture light from other Earths. Instead, from a vantage far beyond the moon, it will chase their shadows. Like the astronomers watching from the ground for giant planets crossing the face of their stars, Kepler will watch 100,000 stars in a broad patch of sky—as wide as two hands held at arm's length, says Borucki—for a dimming that signals a planet the size of Earth, or even smaller. "I'm looking for this dip that repeats, and repeats exactly," he says.

The dip due to an Earth would be so tiny—less than one part in 10,000—that it could be seen only from space. Even then more than 99 of every 100 Earths would elude Kepler, because it will be able to detect only the half a percent that have orbits aligned so they pass directly in front of their stars. Spacecraft vibration and "sunspots" on the target stars could throw off the brightness measurements. But Borucki is confident in his instrument. The real uncertainty, he says, is "whether there are no Earths at all or tens of thousands" around the stars Kepler will watch.

He's quick to add that everything astronomers have learned about giant planets so far suggests these smaller siblings are out there too. By 2011 or so he expects Kepler to have detected a few dozen Earth- or Mars-size planets set just far enough from their stars to be comfortable for life. The shadows won't say much about what these worlds are like. But the flicker of distant Earths would galvanize the next step in the quest: actually capturing their light.

"That's a hard, challenging technology problem," says Charles Beichman, the project scientist for the Terrestrial Planet Finder (TPF) mission. He's putting it mildly. Seeing alien Jupiters is proving hard enough, and a planet as small as Earth would be far more elusive, snuggled right next to a star shining ten million to ten billion times brighter, with an unknown amount of interplanetary dust adding its own distracting glow. Earth hunters like Beichman compare the challenge to that of seeing a firefly hovering next to a lighthouse searchlight 3,000 miles away—with a little fog rolling in.

The key is to blot out the lighthouse while leaving a clear view of the firefly. The project can draw on the technology already being tested for spotting Jupiters from the ground. But the stakes are vastly higher, because TPF will cost so much—upwards of a billion dollars—and generate so much anticipation. "You'd like not to have zero [Earths]," says Beichman, adding wryly, "Zero is a bad number, because you get called up in front of Congress and asked how come you spent a billion dollars and didn't find anything."

For now his team is betting on a pair of technologies. First to fly, in 2014, would be a single telescope, with a mirror perhaps 21 feet across and clever masks to banish starlight from the spot where a planet might appear. A nulling interferometer—multiple smaller infrared telescopes that merge light to create an optical dead zone blocking the star—would follow by 2020.

A possible joint project of NASA and the

**1992 Arecibo Radio Telescope**
*Scientists announce the discovery of planets around a pulsar —a spinning neutron star. They are unlike any known planets and almost certainly hostile to life, but are the first alien planets to be found.*

**1995 Haute-Provence Observatory**
*Astronomers discover a planet around a sunlike star, 51 Pegasi, by tracking stellar motions. The same technique has revealed more than 130 planets.*

**1999 STARE Project**
*For the first time the shadow of a Jupiter-size planet is detected as the planet passes across the face of its star, HD 209458.*

**2001 Hubble Space Telescope**
*By observing light from HD 209458 as its planet passes, astronomers see hints of a planetary atmosphere containing sodium.*

**2003 Keck Interferometer**
*The interferometer combines light from the two existing Keck telescopes, eliminating atmospheric "noise" with adaptive optics. It will search for debris disks around stars, which could signal planet formation, and look directly for giant planets.*

**2006 Large Binocular Telescope**
*Its twin mirrors will search for debris disks and for newly formed Jupiter-size planets.*

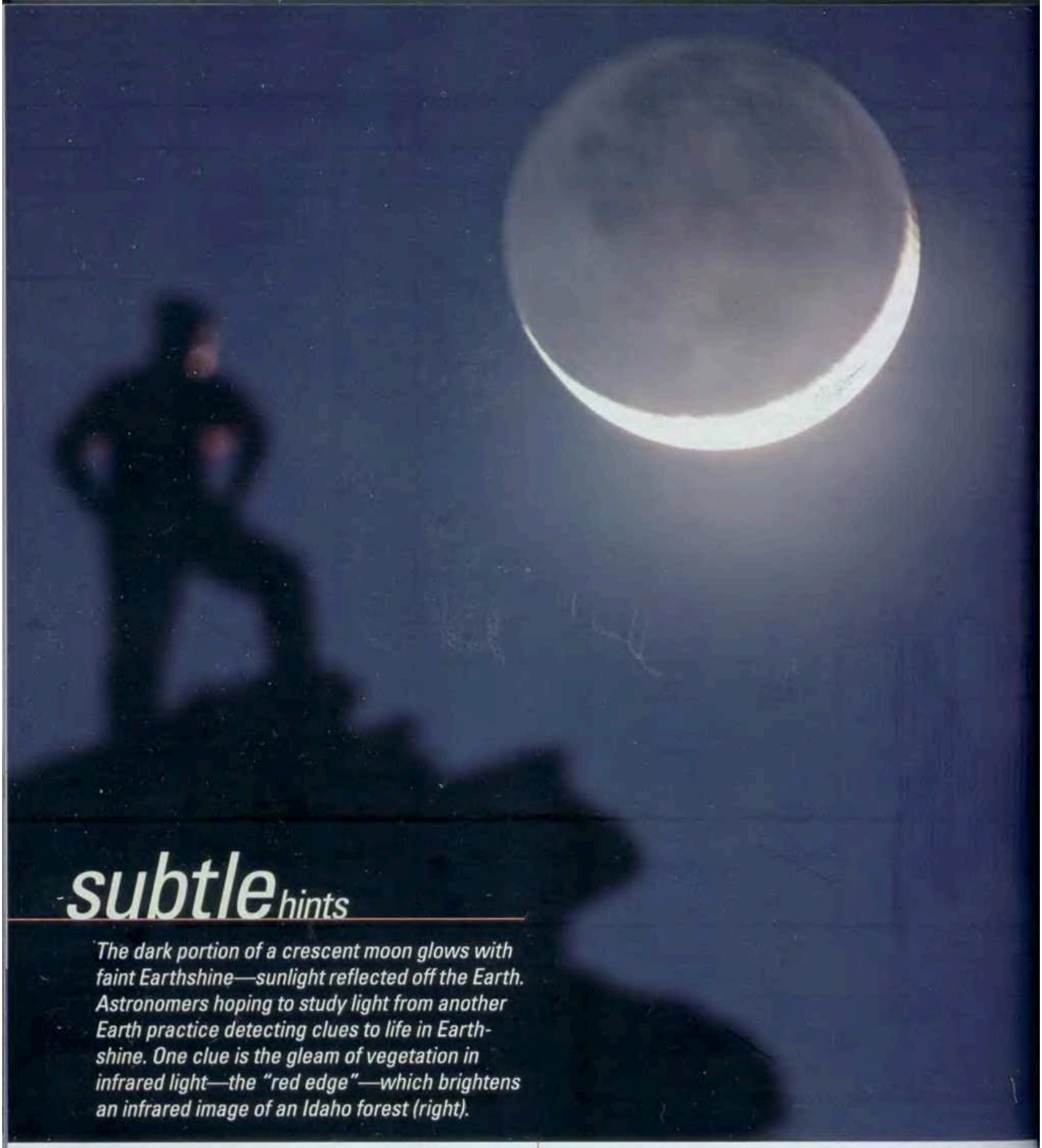
**2007 Kepler Mission**
*This space-based telescope will survey more than 100,000 stars for dimming that hints at the presence of Earth-size planets.*

**2009 Space Interferometry Mission (SIM)**
*SIM will combine light from multiple telescopes to map stars and seek planets almost as small as Earth.*

**2014-2020 Terrestrial Planet Finder (TPF)**
*A two-part space mission, TPF will detect light from Earth-size planets and search for signs of habitability.*

**2025? Life Finder**
*The space-based Life Finder will search newfound Earths for signs of biological activity.*

CONSULTANT: CHARLES BEICHMAN, MICHELSON SCIENCE CENTER, CALTECH



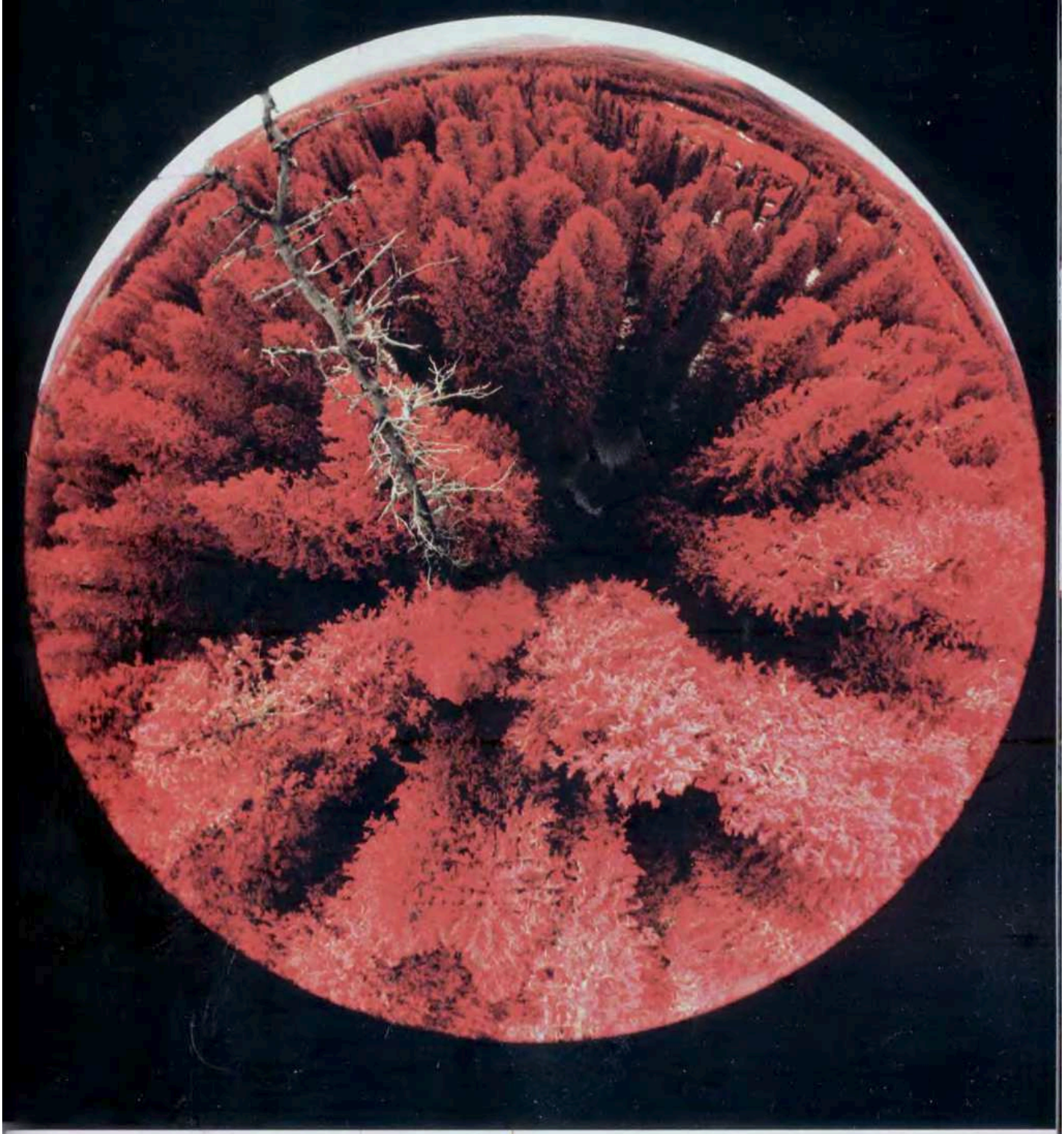
## subtle hints

*The dark portion of a crescent moon glows with faint Earthshine—sunlight reflected off the Earth. Astronomers hoping to study light from another Earth practice detecting clues to life in Earthshine. One clue is the gleam of vegetation in infrared light—the "red edge"—which brightens an infrared image of an Idaho forest (right).*

European Space Agency, the interferometer telescopes would fly independently, in a small fleet trading light beams. Free-flying telescopes could fan out across hundreds of feet, sharpening their combined view. But keeping them in near-perfect formation so that their beams mesh precisely would add to the technology challenges.

How masks, nulling, and other tools perform in the ground-based Jupiter hunt will help the TPF team refine their plans. Kepler's discoveries will feed into the planning as well: Knowing how common Earth-size planets are will help scientists decide how many stars to inspect.

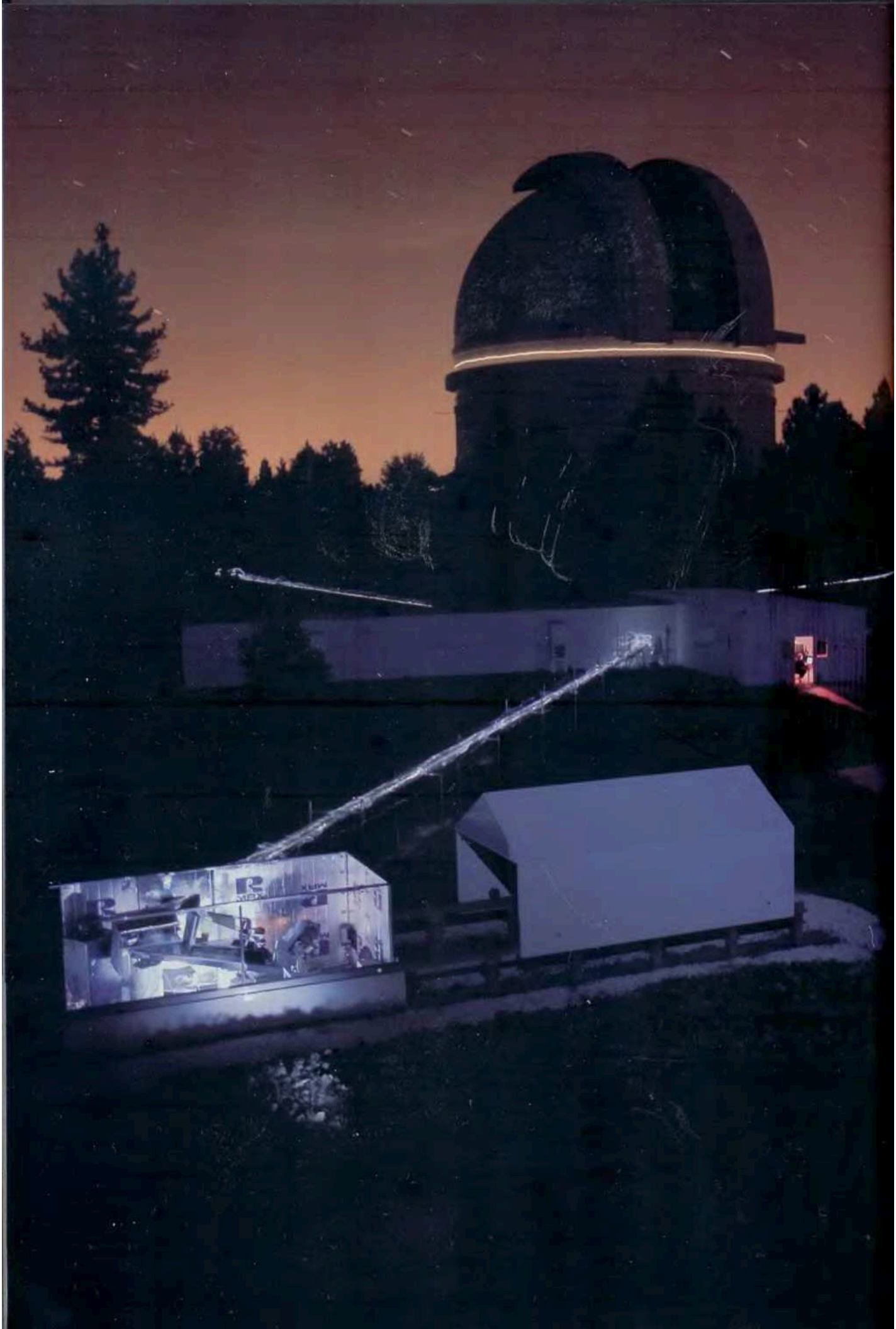
By the time TPF is launched, astronomers should also have an idea which stars are the best prospects. As early as 2009 NASA hopes to launch another ambitious mission, called the Space Interferometry Mission, or SIM. SIM, like one version of TPF, is an interferometer—a set of small telescopes, in this case mounted on a single spacecraft. The 900-million-dollar mission is not designed to see an Earth directly but to



monitor the positions of thousands of stars with painstaking precision. "Picture an astronaut on the moon holding a nickel edge on," says Stephen Edberg, a SIM scientist at the Jet Propulsion Laboratory (JPL) in Pasadena. SIM should be able to pick up a change in a star's position on the sky no greater than that nickel's thickness.

Suppose SIM sees a nearby star sidling back and forth by that tiny amount over many months. Like the oscillations that planet hunters watch from the ground, this subtle shimmy would imply an unseen dance partner—a planet that might be only a little bigger than our own. That star would be a prime target for TPF. "If SIM can detect a planet," says JPL's Michael Shao, the project scientist, "it can tell TPF when and where to look" for the light of an Earth.

If TPF does see that faint point of light, scientists will wring every bit of information they can from it. They'll want to learn whether



## farsighted

*The Palomar Testbed Interferometer forms a crossroads for light near the 200-inch scope on California's Palomar Mountain. Starlight gathered by mirrors in the open sheds is piped to the central building, where it merges to reveal details too fine for a conventional telescope. Says astronomer Charles Beichman, "PTI is the first step on the path that is going to find Earthlike planets."*

that distant world has an atmosphere and a surface anything like Earth's—which means knowing what our own planet would look like if its light were reduced to a single point.

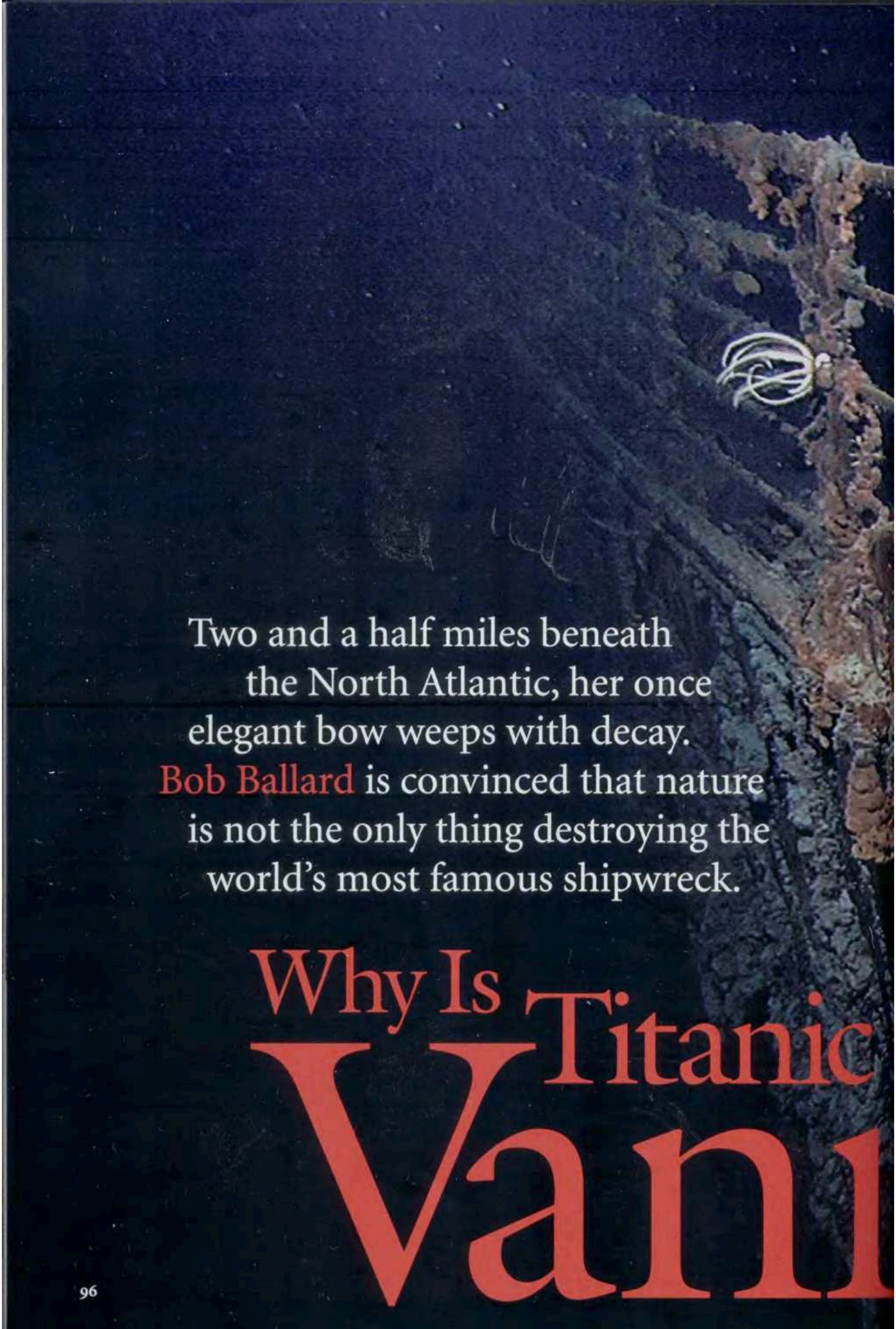
One clue, says Nick Woolf of the University of Arizona, comes from the pale glow seen on the dark part of a crescent moon. Called Earthshine, it's sunlight reflected from Earth onto the moon's rough surface and then back again. Earthshine is a jumble of light from our atmosphere, clouds, oceans, and continents, just as the faint light from an alien Earth would combine light from all of its surface features and atmosphere.

Woolf and others have found they can unscramble Earthshine to see the imprint of gases in our atmosphere, the color of the oceans, and the blue of the sky. They can even discern a signature of vegetation called the red edge: a jump in brightness at the boundary between red light —which plants absorb—and infrared, which they reflect.

The shine from another Earth could be millions of times fainter, and would be far less informative, at least to a first generation planet finder. But if that far-off world has an atmosphere like ours, TPF should be able to see signs such as carbon dioxide and water vapor. If the atmosphere is rich in oxygen or its chemical cousin, ozone, TPF should detect it. And that would be an epochal discovery. As astrobiologist Vikki Meadows of JPL explains, "That would give us a good clue that something funny is going on, because we don't think we can create large amounts of oxygen without life."

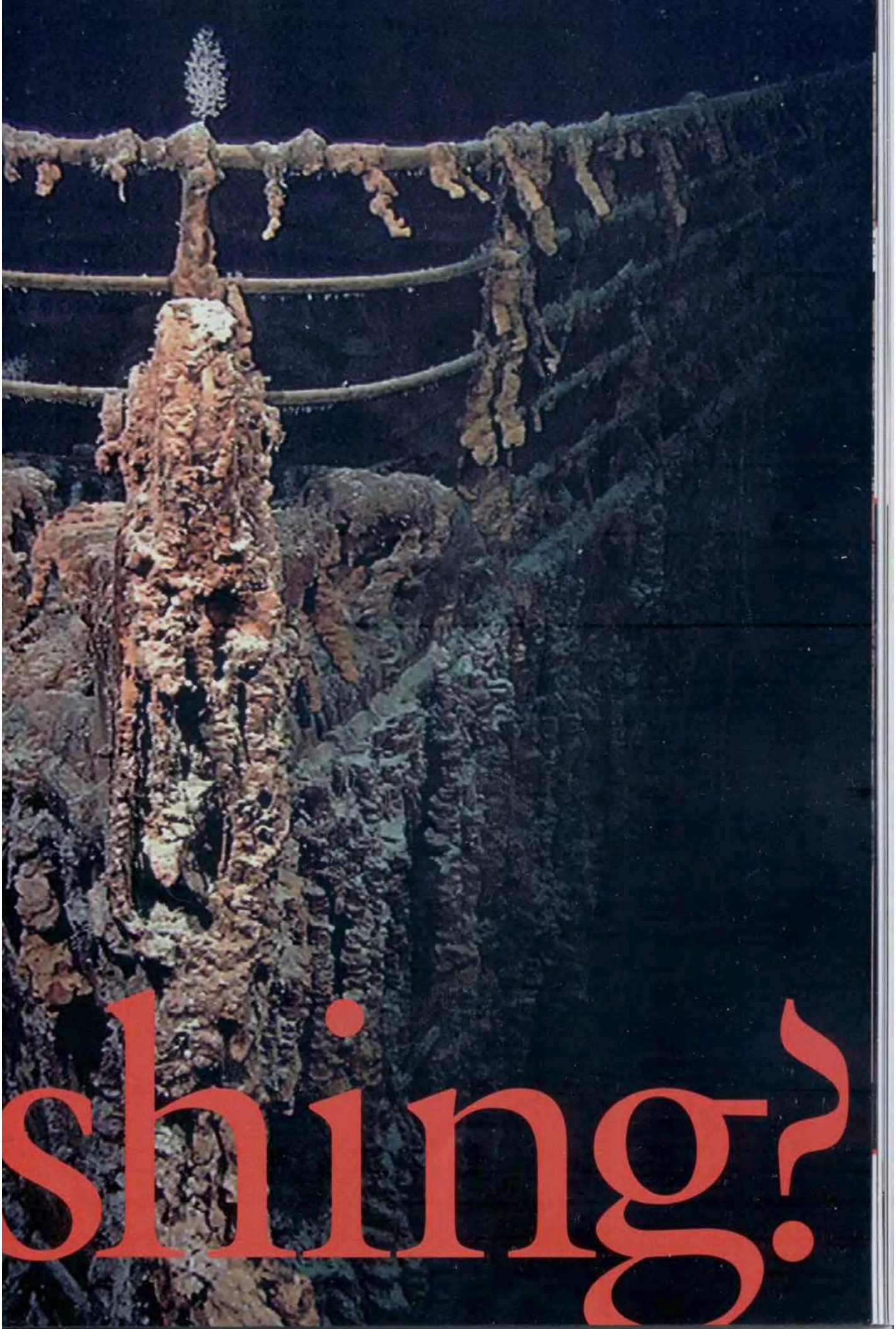
The gas's source might be just a green tinge in an otherworldly ocean, or a crust of microbes on alien soil. But that first inkling of life across the light-years would amount to a curl of smoke on the horizon, a first hint that the universe may not be as lonely as it has seemed. Nick Woolf is 72, a mentor to a new generation of astrobiologists. When he began working on concepts for an Earth finder nearly 20 years ago, worlds beyond our own were no more than a dream. "Now," he says, "finally there has come a chance to really see what's out there." □

**VISIT OTHER WORLDS** Watch the animated creation of a solar system, view 3-D landscapes of imaginary Earth-size planets, and ponder the possibility of life elsewhere in the universe at **nationalgeographic.com/magazine/0412**.



Two and a half miles beneath the North Atlantic, her once elegant bow weeps with decay. Bob Ballard is convinced that nature is not the only thing destroying the world's most famous shipwreck.

# Why Is Titanic Vani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# grave site or gold mine?

**Nature has obliterated flesh and bone, but the possessions of *Titanic*'s more than 1,500 victims are still scattered on the seafloor. Such artifacts became the targets of salvagers soon after the wreck was discovered in 1985. A new treaty signed by Great Britain and the U.S. will help protect the wreck, though it does not prevent legal salvaging.**

ABOVE AND PRECEDING PAGES: INSTITUTE FOR EXPLORATION/INSTITUTE FOR ARCHAEOLOGICAL OCEANOGRAPHY, UNIVERSITY OF RHODE ISLAND (IFE/IAO)

By Robert D. Ballard

DIRECTOR, INSTITUTE FOR ARCHAEOLOGICAL OCEANOGRAPHY,
UNIVERSITY OF RHODE ISLAND

# The debris field hit me hardest. Here in that ghostly expanse of seafloor 350 miles off Newfoundland, the people who died during the frigid early hours of April 15, 1912, spoke to me again.

A case of champagne lay on the bottom, its bottles still corked—a reminder of *Titanic*'s role as a floating palace of the rich and powerful. The box holding the bottles had long ago disappeared, consumed by wood-eating mollusks. Next to them were tiles decorated with a red-and-white design, possibly from a public room. Suddenly my eye was drawn to a woman's shoe, lying on its side. Nearby were three large combs and a pair of smaller shoes that may have belonged to a child. And beside them was a hand mirror.

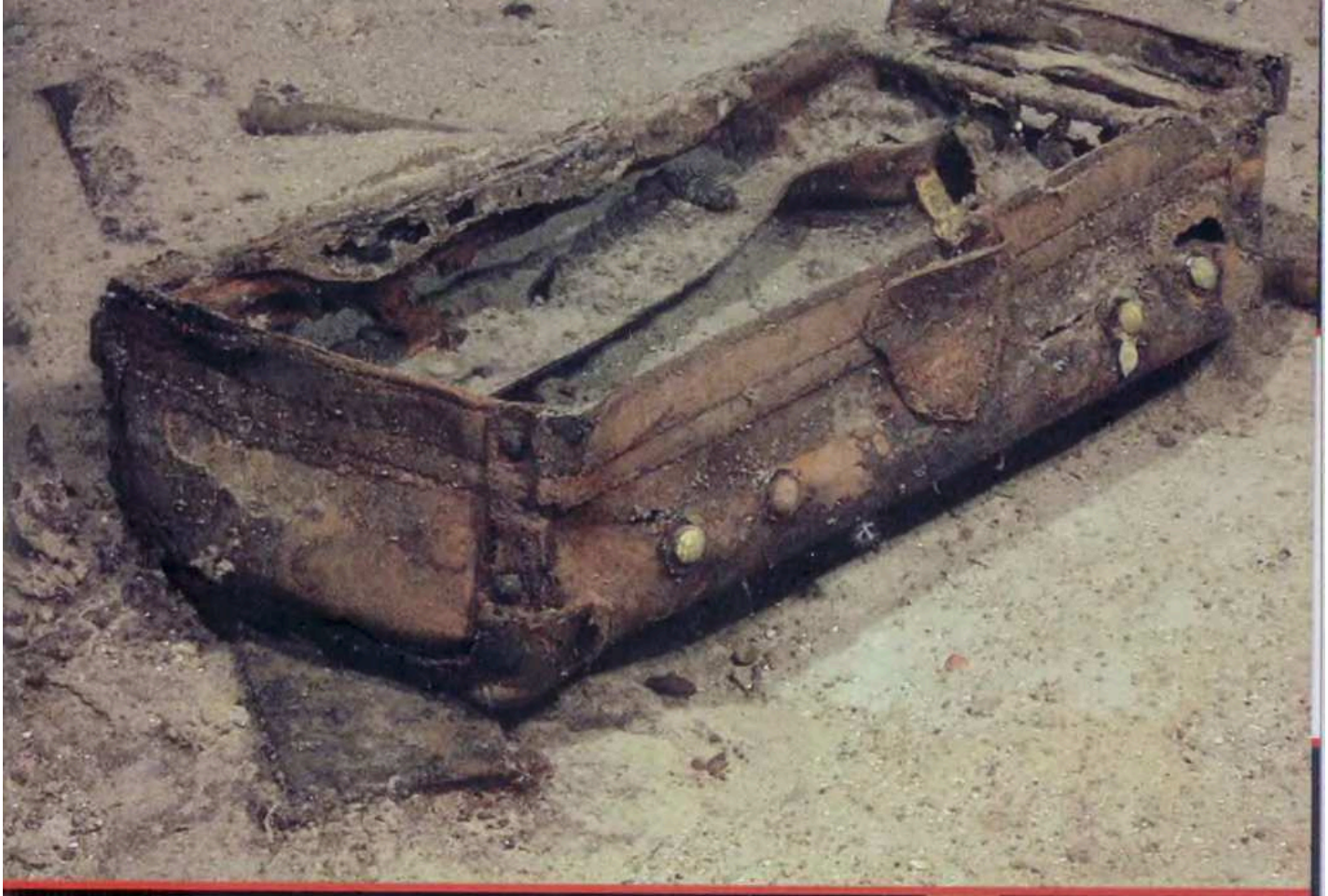
How did these objects find themselves together on the bottom? Did the larger shoe belong to a mother, who combed her daughter's beautiful long hair? What did the girl's face look like that may once have been reflected in this mirror? A short distance away were more shoes, a pair from a young girl, and another pair near what looked to me like a sailor's black slicker. A pair of shoes cannot fall 12,500 feet by themselves and land like this. Their journey was together.

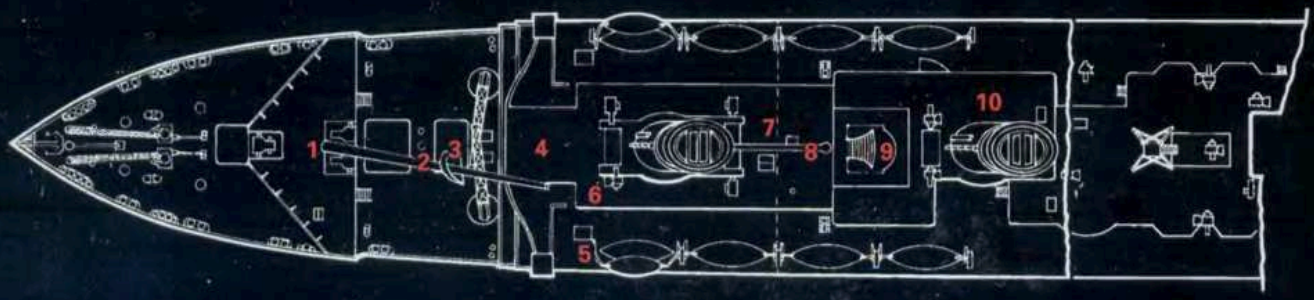
It had been 19 years since I'd discovered *Titanic* as part of a French-American team. I'd come back to see how she'd changed. I knew that a private salvage company, RMS Titanic, Inc., had dived on her many times, legally removing thousands of objects from what I consider a sacred grave. Russian submarines had taken Hollywood filmmaker James Cameron and others to the wreck, also breaking no laws but reportedly colliding with the hull. Cruise ships had circled the site while RMS Titanic, Inc. tried to raise a 20-ton piece of the ship. A beer company had sponsored sweepstakes to watch the salvagers recover bottles of ale. And a New York couple had even plunked down on *Titanic*'s bow in a submersible to be married. It was all such a comedy—exactly what I had hoped would not happen. *(Continued on page 108)*

**Capt. Edward J. Smith commanded both a ship and a world-class hotel. A well-preserved leather trunk resting on the seafloor (right top) may have held the formal dress of one of *Titanic*'s many wealthy passengers, some of whom dined with Smith on the night of the disaster. A collapsed wall exposes the captain's private bathtub (right), now filled with rust, to the lens of an undersea camera.**



SOUTHAMPTON CITY MUSEUM; IFE/AO (BOTH RIGHT)






**1 FORECASTLE** Three yellowish smudges were probably left behind here by submersibles landing on the deck.

**2 FOREMAST** Weakened by corrosion, the mast has further collapsed and splayed open like split bamboo.

**3 CROW'S NEST** Visible in the 1987 mosaic (foldout), the crow's nest has disappeared, probably having fallen into a hatch.

**4 TELEMOTOR** Visitors have placed five plaques on the bridge near the telemotor that once held the ship's wheel.

**5 LIFEBOAT DAVIT** Like much of the ship, this davit, from which lifeboat number two was launched, is decaying with rust.

**6 OFFICERS' QUARTERS** The bulkhead that was standing in 1987 has fallen down, exposing the compartment.

**7 FISHING DIP NET** Was this small net, found on the deck near the expansion joint, used by looters to scoop up artifacts?

**8 MARCONI ROOM** The deck above this room, from which distress calls were radioed, is full of holes, likely from sub landings.

**9 GRAND STAIRCASE** Another favorite spot for submersibles to land, the deck near the first class staircase appears to be collapsing.

**10 GYMNASIUM** The roof of the gym, where passengers exercised on rowing equipment, has disintegrated.

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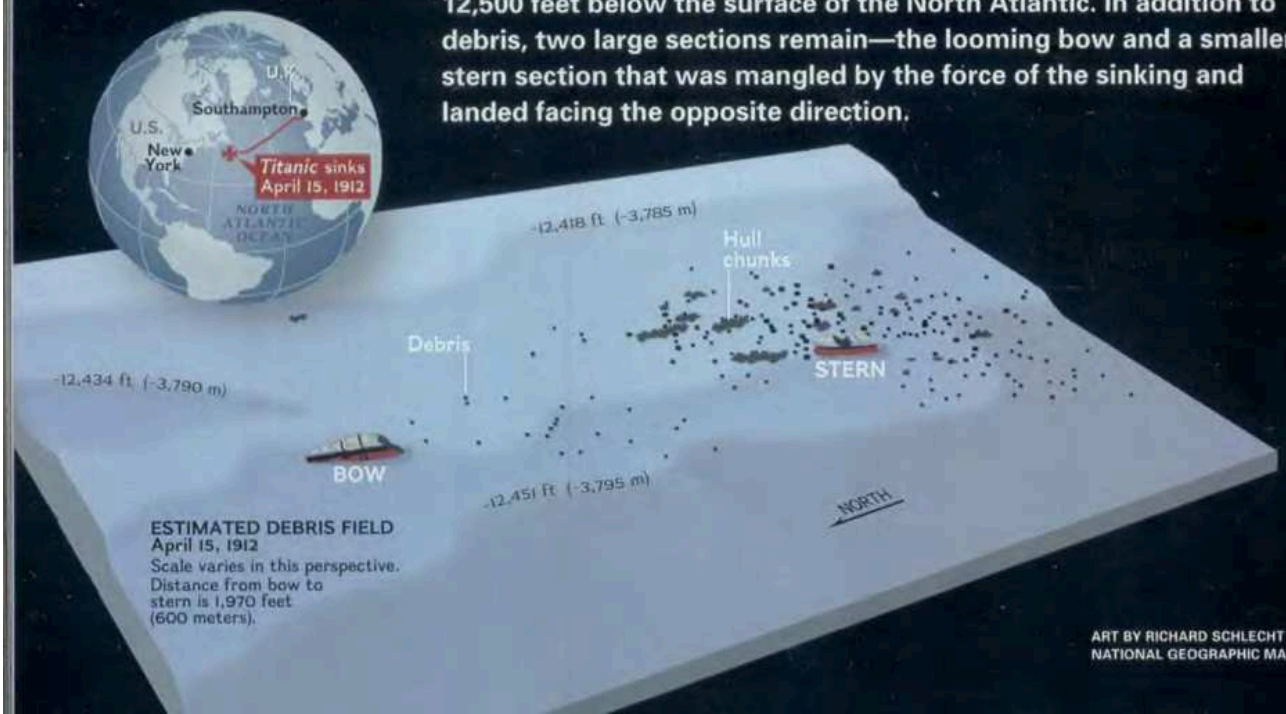
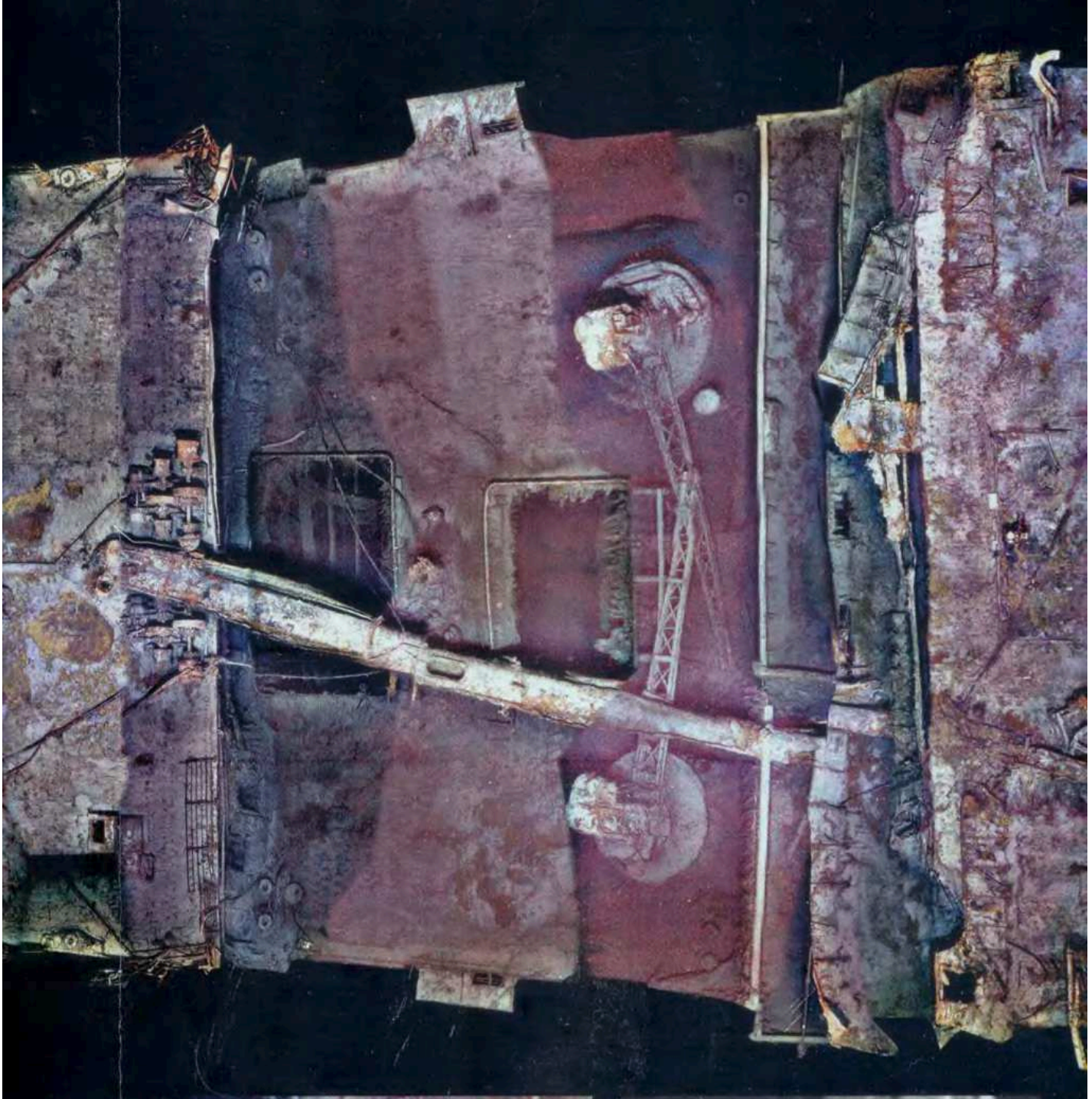
**FINAL RESTING PLACE** Pieces of the ship settled on the seafloor 12,500 feet below the surface of the North Atlantic. In addition to debris, two large sections remain—the looming bow and a smaller stern section that was mangled by the force of the sinking and landed facing the opposite direction.



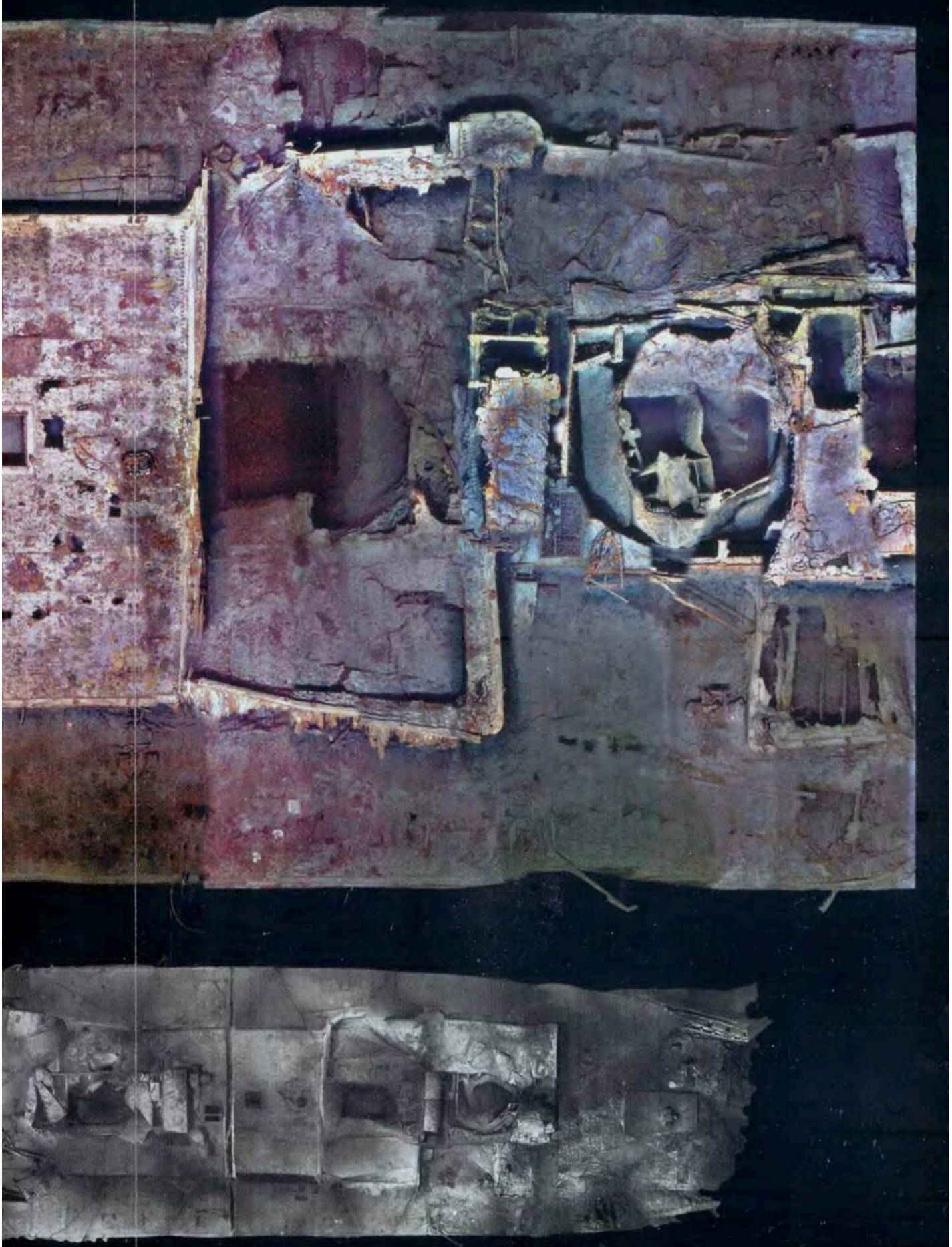

ART BY RICHARD SCHLECHT (TOP); NATIONAL GEOGRAPHIC MAPS


# Titanic today

**The remains of the luxury liner have deteriorated during the past two decades, as seen in a new high-resolution color mosaic of the bow section (above). Created from 756 images made by the remotely operated vehicle *Hercules,* the mosaic shows many changes since a black-and-white mosaic (far right) was made in 1987. Variations in color among the mosaic strips reflect differences in the camera's height over the deck. One of the most dramatic changes: the disappearance of the crow's nest (middle right), exposing the lookout's hatch in the fore-mast (near right). The wreck's salvagers say such decline makes it urgent to collect artifacts before they disappear. Ballard sees their efforts as disturbing hallowed ground.**



1987



2004 MOSAIC AND DETAIL (FAR LEFT): HANUMANT SINGH, WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI) AND IFE/IAO; 1987 MOSAIC AND DETAIL (NEAR LEFT): WHOI AND BALLARD FAMILY

**FAILED MANEUVER** Near midnight on April 14, 1912, a lookout in the crow's nest spots an iceberg dead ahead. *Titanic* is steered hard to port too late to avoid the floating ice, which ruptures the ship's starboard side beneath the waterline.

**UNTHINKABLE** Watertight bulkheads fail to keep the sea from flooding one compartment after another and the bow plunges as it fills with water. Passengers desperately scramble aft as the stern is wrenched aloft. With the stern rising higher and higher, *Titanic*'s hull buckles in a weak area aft of the third funnel.

**BOW DOWN** The forward section of the ship breaks free and hurtles toward the bottom (right), where it plows into the seafloor and pushes up a wake of mud that conceals the iceberg damage (below). Despite the impact, the bow section remains relatively intact. The stern remains afloat for a time, with doomed passengers clinging to it in final moments of terror. Then it dives two and a half miles to the seabed.

▶ See an animation of this art depicting the sinking of *Titanic* at nationalgeographic.com/magazine/0412.

ART BY RAYMOND V. WONG (TOP THREE); ART BY SKARAMOOSH, LTD.

# going under

(Continued from page 100) I'd urged others to treat *Titanic*'s remains with dignity, like that shown the battleship *Arizona* in Pearl Harbor. Instead they'd turned her into a freak show at the county fair.

To make matters worse, some of these visits were reportedly damaging *Titanic*. In order to see for myself, I teamed up with Capt. Craig McLean, director of ocean exploration at the National Oceanic and Atmospheric Administration, to co-sponsor an expedition. For the past few years NOAA had been quietly working to create an international treaty to protect *Titanic*. I believed our expedition could contribute to that effort by surveying the ship's current condition. (As it turned out, the U.S. signed a treaty with Great Britain only two weeks after we visited the wreck site.)

Besides weathering the impact of human visitors, *Titanic* has suffered from natural decay. Communities of iron-eating bacteria are consuming her hull. I'd even read a report theorizing that fishing on the Grand Banks has so diminished fish stocks that uneaten plankton is falling on the ship, feeding the microbes. The best way to assess such impacts would be to carry out the kind of disciplined mapping effort that oceanographers do best.

And so now we were back with *Hercules*, our newest robotic vehicle, gliding a few meters off *Titanic*'s famous bow. When the luxury liner had smashed into the bottom, her bow had pushed up a great wave of mud, as if she was still under steam trying to complete her maiden voyage to New York.

It surprised me, at first, how little had changed on the bow, the best preserved part of *Titanic*. The stern section, by contrast, is a twisted pile of rusted wreckage, having imploded as it spiraled to the bottom.

But now as *Hercules* passed over the foredeck, I spotted a black blemish on the forward anchor boom that may have been caused by the glancing blow of a passing submersible. Just aft of the number one cargo hold I saw three separate submersible landing sites. I'd landed not far from here myself in 1986 in *Alvin*, a three-person submersible operated by the Woods Hole Oceanographic Institution, before I became aware of the possible effects of such contact. The damage to the steel deck was obvious, bright yellowish blotches of fractured iron with a central black oval that exposed new hull plating to bacterial attack.

I was curious to see what had happened to the crow's nest, from which 24-year-old lookout Frederick Fleet had shouted, "Iceberg right ahead!" I suspected the worst. The last time I'd seen the crow's nest in 1986, it was dented but still clinging to the foremast. I'd heard rumors that it was now gone. And sure enough, when we passed over the mast, which was collapsed on the deck, there was no sign of the crow's nest, which had probably fallen through a hatch into the hull.

Farther aft we found new damage to the captain's quarters and the chief officer's quarters. Photographs by the Russian subs *Mir I* and *II* in 2003 had revealed deterioration along the side of the captain's quarters and the collapse of the bulkhead. Inside we saw the captain's bathtub, with its shiny brass faucets.

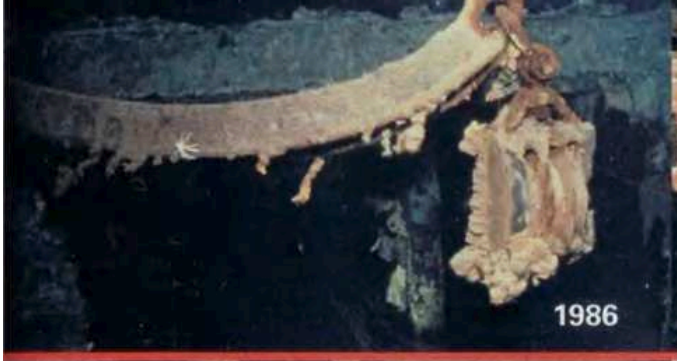
**LONG GOODBYE** **Helped along by human interference or not, *Titanic* will one day disappear, perhaps deteriorating on the schedule (below) laid out by microbiologist Roy Cullimore, who has studied the ship's decline. He estimates that growths of bacteria and fungi, nicknamed "rusticles" because they resemble icicles, are sapping a hundred or more pounds of iron from the wreck each day.**


ART BY D. ROY CULLIMORE (ALL)

1996

# melting away

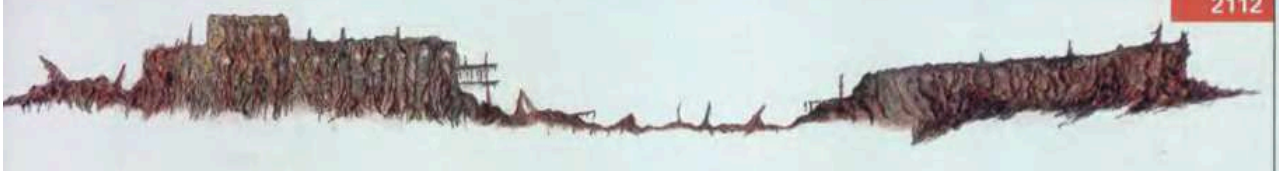
2012





**SCENES ON A GHOST SHIP** Empty windows on the promenade deck (far left)—disintegrating under a crust of rusticles—look out on the deep sea. A davit that once held a lifeboat (above) has succumbed to rust in the two decades since discovery. Modern trash (left), perhaps from a passing ship, litters the wreck. Thick, braided rusticles (below) are claiming one of the ship's massive bow anchors.

1986 IMAGE (TOP LEFT): WHOI; ALL OTHERS: IFE/IAO



Aft of the expansion joint we found additional damage to the deck above the Marconi room, from which distress calls had been sent by wireless telegraph the night of the disaster. The destruction was just as bad near the entrance to the grand staircase, a popular landing site for submersibles, where the deck is collapsing. These heavy craft are like bulls in a china shop, and *Titanic*'s china is getting broken.

Then there was the debris field, with its haunting evidence of human loss. When *Titanic* sank, bodies had rained down on the seafloor, perhaps hours after the heavy wreckage of the stern had thundered to the bottom. Each victim had struck its own repose, some face down, others on their sides, and still others facing upward. Within a very short period of time Mother Nature had reclaimed the bodies, leaving only their treated leather shoes as tombstones.

We knew that the salvagers had taken thousands of objects from this hallowed ground, including gold coins, silver dinnerware, fine china, lamps, a compass, a ship's bell, a stock certificate, paper money, playing cards, rings, cuff links, brooches, necklaces, and even love letters. It reminded me of that old television game show where contestants had minutes to race down supermarket aisles, filling shopping carts as quickly as they could. Now I found the debris field littered with refuse: discarded piles of chain and ugly bags of sand used as ballast.

For a long time I'd resisted the urge to return to *Titanic*. My discovery of her in 1985 had changed my life, and not all for the better. But I'm grateful I got the chance to see her once more. The deep sea remains the largest museum on Earth with many treasures yet to be found, and *Titanic* is still a grand old lady, even if grave robbers have made off with some of her jewels. I'm certain the database we collected during our expedition—the most comprehensive mapping effort to date—will aid future preservation studies. And I accept the fact now that, as long as she needs protection, *Titanic* will always be a part of my life. □

**ZOOM IN** on an interactive image of *Titanic* and explore the wreck section by section, including the grand staircase. Watch an underwater video of the ship, then join our forum: Should artifacts from *Titanic* be salvaged or left alone on the seafloor? Go to **nationalgeographic.com/magazine/0412**.

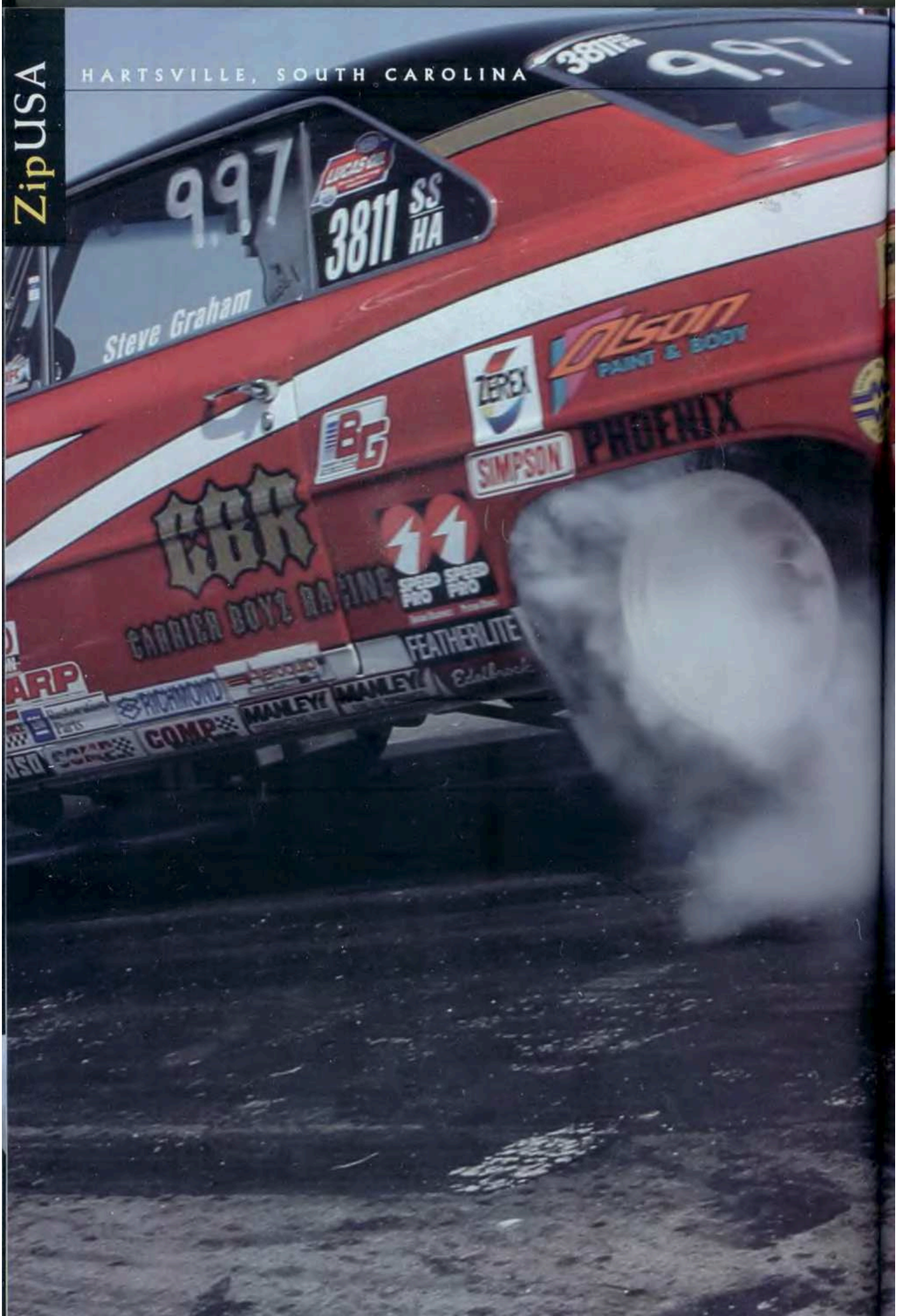
# capturing images

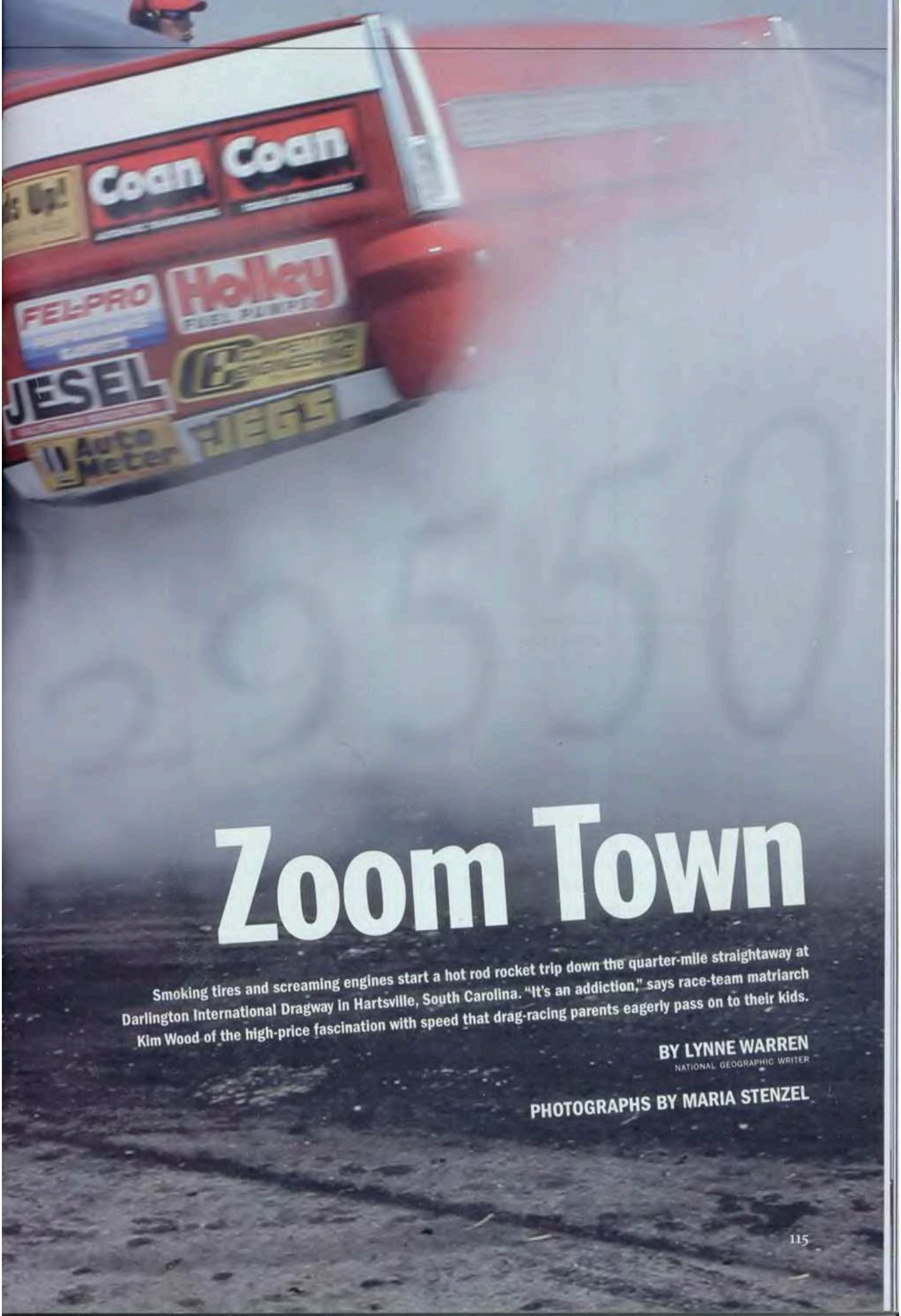
**Ballard was miles deep in the manned submersible *Alvin* when he first saw *Titanic* with his own eyes. From there he watched *Jason Jr.* (below) inch around the wreck with a video camera. Today there's no need to risk lives. A newer ROV, *Hercules* (above), is controlled from the National Oceanic and Atmospheric Administration ship *Ronald H. Brown,* where Ballard and NOAA scientist Catalina Martinez (right) view the bow through *Hercules*'s high-resolution camera. ROVs are the future of exploration, says Ballard. The question is whether the technology will be used to study and preserve historic wrecks or to plunder them.**



IFE/AO (TOP); WHOI (ABOVE); BERT L. FOX, NGS STAFF

HARTSVILLE, SOUTH CAROLINA



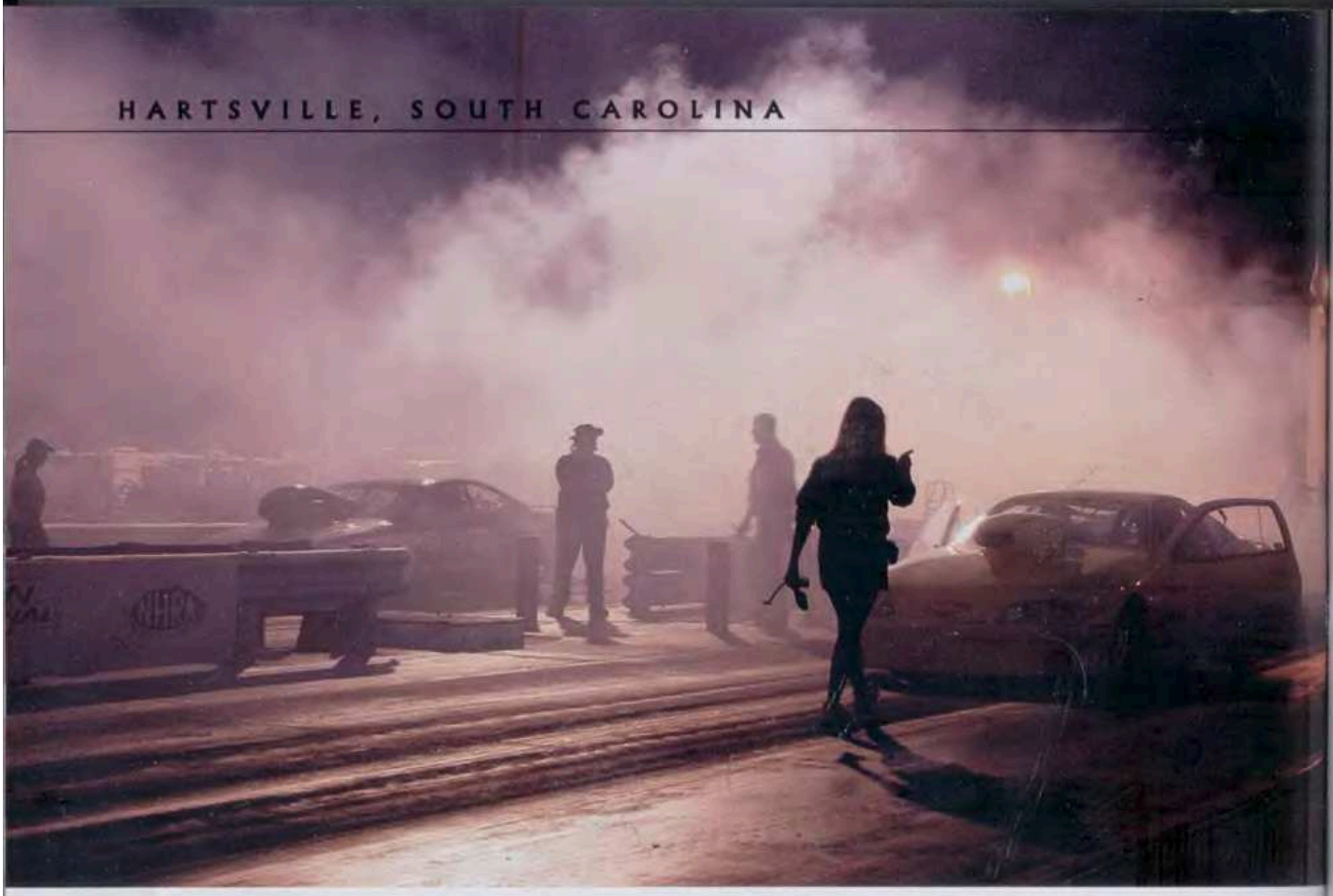



# Zoom Town

**Smoking tires and screaming engines start a hot rod rocket trip down the quarter-mile straightaway at Darlington International Dragway in Hartsville, South Carolina. "It's an addiction," says race-team matriarch Kim Wood of the high-price fascination with speed that drag-racing parents eagerly pass on to their kids.**

BY LYNNE WARREN
NATIONAL GEOGRAPHIC WRITER

PHOTOGRAPHS BY MARIA STENZEL



Most days Darlington International Dragway doesn't look like much: battered chain-link fencing, coarse asphalt, and weedy dirt surround a few cinder-block buildings and two quarter-mile-long lanes of pavement. But overnight a miniature city has sprung up here along Highway 151 southeast of Hartsville, South Carolina. This is opening day of the three-day Lucas Oil Carolina Nationals, and clusters of motor coaches, tow rigs, cars, pickups, SUVs, and 18-wheelers, from as far away as New York and California, pack the grounds.

More than 350 hot-rodders will drag race this weekend, and hardly anybody came alone. Husbands, wives, children, grandchildren, grandparents, even pets are part of the scene. Drag racing demands a lot of time, says Kim Wood, whose family operates a high-performance auto parts business in northern Florida. "When we're not at a race, my husband, my son, my daughter, they're practicing at our local track, or they're in the garage working on the cars. The whole family's got to be committed to the sport, or it just won't work."

**Women in drag? They're everywhere, from directing traffic at the starting line (top) to suiting up for a fast blast down the track.**

Car nut. Speed freak. Gearhead. They're titles of honor among drag racers. All the citizens of this temporary internal-combustion metropolis share a passion for cars, engines, horsepower, speed—and winning. "I like going fast," Kim's daughter, Lindsey, says, "but I like winning better than anything." The 20-year-old especially relishes beating men more than twice her age. "I'm a girl and I'm young, so some people don't expect me to be very good," she says. "But you earn a lot of respect by winning."

Hot rod passion comes with a hefty price tag—another investment that demands whole-family support. Jason Cannon's dad gave him his first go-cart when he was three-and-a-half years old; the horsepower and expense of Cannon family speed machines have climbed ever since. Jason's


**29550**

**POPULATION:** 31,300
**NUMBER OF CARS IN THE 2003 CAROLINA NATIONALS:** 367
**HIGHEST PRICED CARS:** $150,000
**QUICKEST QUARTER MILE OF THE WEEKEND:** 5.388 seconds (268.33 mph)

friend Will Hanna is his crew chief. "Every time we go down the track, it costs us a thousand dollars," Hanna says, "and that's if nothing goes wrong."

With its needle-nosed, 25-foot-long body riding scant inches above the pavement, the dragster Cannon now races is less a car than a projectile, an alcohol-fueled rocket built to fling the 30-year-old driver forward at speeds routinely exceeding 250 miles an hour. Engine parts like connecting rods ($1,200 a set) and crankshafts ($2,500 each) last for fewer than 15 racing miles. A $1,000 pair of racing tires lasts maybe ten runs. Accelerating flat-out to the finish line, dragsters "operate under tremendous stresses," says Bill Holt, southeast division director for the National Hot Rod Association (NHRA). "Just keeping up with maintenance is a major financial commitment."

Sometimes commitment isn't enough. After two long days of qualifying runs, a disappointed Lindsey Wood hasn't made the final cut, so when Sunday morning comes, her mother, father, and brother help her pack for the 420-mile trip home. Other racing clans spend Sunday morning in church, which here in zoom town means a trackside chapel service conducted by ten-year veteran driver Tom Ratliff. He's part of a nondenominational group called Racers for Christ, which sends chaplains to all NHRA weekend competitions. A couple hundred people pack the first ranks of bleachers. "This is a substitute for their home church for some racers," Ratliff says, "and for some it's the only church they have." Pacing the walkway between the front-row seats and the track wall as he preaches about "rods in the Bible," the lean Baptist minister wears dark sunglasses and a wireless headset microphone that make him look a little like a Secret Service agent and a little like a pop star. Scriptural rods were shepherds' crooks, not race cars, he grants, but insists that owners of both kinds identify powerfully with their tools. "A shepherd's crook says who he is, just like our cars tell the world who we are as racers."

"Moses," Ratliff reminds the crowd, "worked miracles with his rod."

**Racing's a team effort: A pint-size crew member (top) inspects a bit of hot rod fuselage, and bigger kids roll a stripped-down VW to the starting line (above). Whether they're covered in custom flames or sporting plainer stock finishes (below), every car gleams. "These vehicles are extensions of the people who race them," says driver Tom Ratliff. "Even if you lose, you want to lose with style."**


Eight hours later Jason Cannon is in the Top Alcohol Dragster final, and he's hoping for a miracle of his own: a win to resurrect a racing season battered by a broken chassis in July and a broken hand in August.

Cannon eases his 3,000-horsepower vehicle into the staging area, until the rear tires sit in the burnout box, a constantly watered section of pavement where drivers spin their wheels to throw off debris and heat up the tread surface for optimum grip. His engine shifts into a howl, his back wheels blur into a fume of water vapor and scorched rubber, and the dragster jolts forward in a hot rod ritual that seems powered as much by adrenaline as by methanol. Fans cheer, reveling in the noise and the stink.

The crowd and their tires warmed up, Cannon and opponent Fran Monaghan, Jr., back up to the head of the track, then roll slowly toward their final confrontation. Cannon's father, Phil, watches intently, standing just a few feet from the edge of the track. "Jason's been doing this since he was 16," he says. "Racing's something we've always done together."

Starting lights flash, and two thunderbolts hurtle into the gathering dusk. Cannon and his midnight black dragster hit 258.24 miles an hour, catapulting down the quarter mile in 5.474 seconds. Monaghan trails an endless tenth of a second behind, and faster than you can read this sentence, Jason Cannon claims his victory.

As darkness settles, winners cluster near the control tower, hugging, backslapping, making a flurry of good-news cell phone calls. Cans open pop, pop, pop, and the Cannon team celebrates, showering a grinning Jason in cold beer.

Within hours, the bustling race town evaporates, mothers, daughters, fathers, sons, and their gleaming machines headed for distant homes. Darlington International Dragway stands empty, waiting for speed lovers to return for the next big race and bring its grounds to life once more. □

**After three days of qualifying runs and head-to-head elimination duels (top), winners each claim a Wally (left), the National Hot Rod Association trophy named for founder Wally Parks. Champ of the alcohol dragster competition, Jason Cannon (above) finishes with a smile a quarter-mile wide—fueled by victory, a big hug, and a cold beer.**

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# Final Edit

AFRICA'S MIRACLE DELTA

## Shall We Dance?

After months of diving among crocodiles as he explored the aquatic jungle of Botswana's Okavango Delta, photographer David Doubilet found himself swimming with much friendlier companions: a small herd of safari elephants and their mahouts. Doubilet snapped frame after frame of the elephants frolicking in the water, when suddenly a pair of skinny legs caught his eye.

"If you start with the golden light and white sand," says Doubilet, "and add something as incongruous as the biggest legs on the planet next to the graceful legs of the mahout, it becomes quite funny."

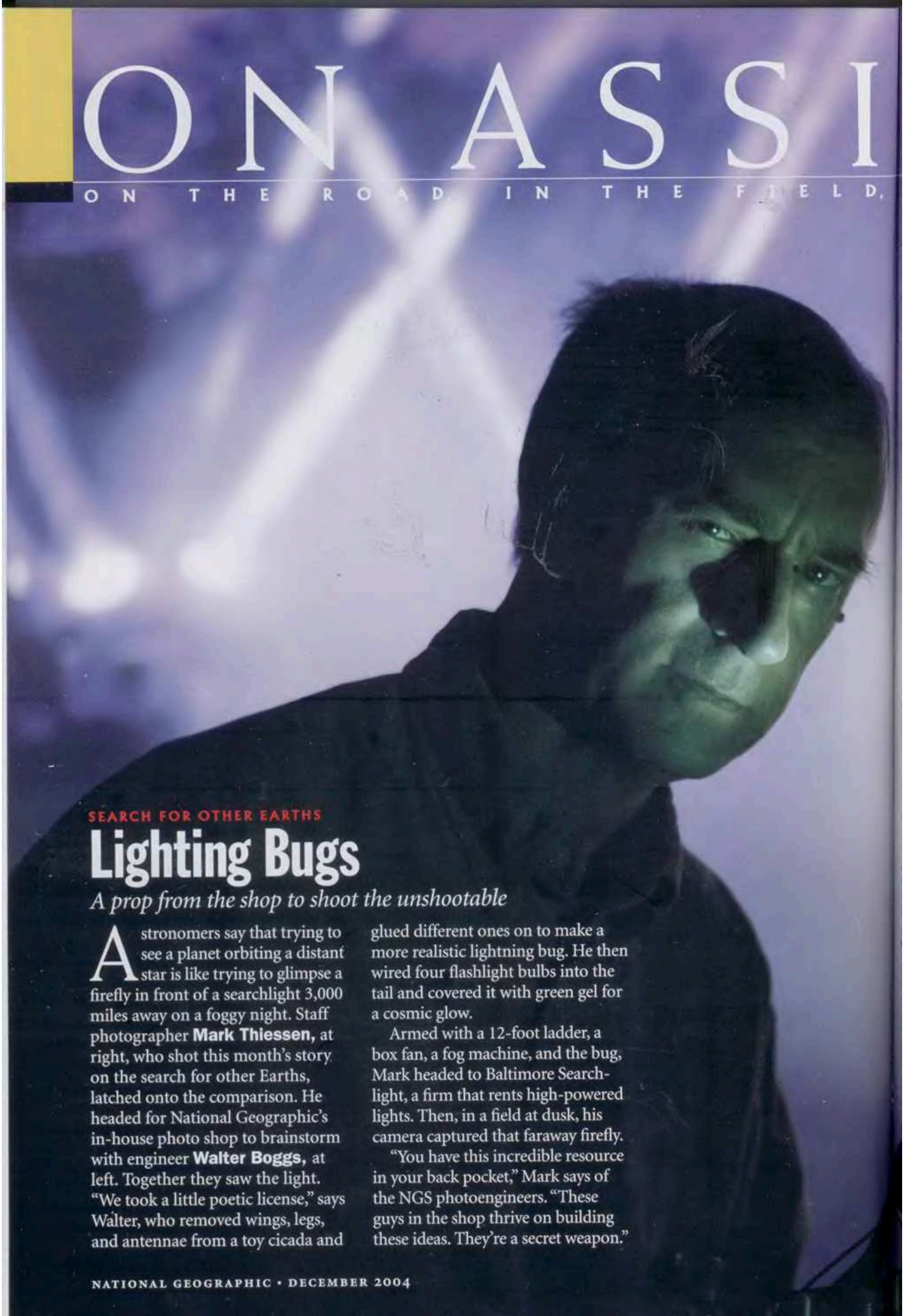
The editors loved the quirky juxtaposition of limbs but were more drawn to the energy and movement of other images depicting the world's largest land mammal delighting in watery weightlessness (pages 55-7). "We exhausted the elephant underwater look," says photo editor Bert Fox, adding with a straight face, "we felt the legs would have to stand alone."

**WEBSITE EXCLUSIVE**

Cut it or keep it? Find out more about what tipped the balance for this photo and send it as an electronic greeting card in Final Edit at **nationalgeographic.com/magazine/0412**.

# ON ASSI

ON THE ROAD. IN THE FIELD.



SEARCH FOR OTHER EARTHS

## Lighting Bugs

*A prop from the shop to shoot the unshootable*

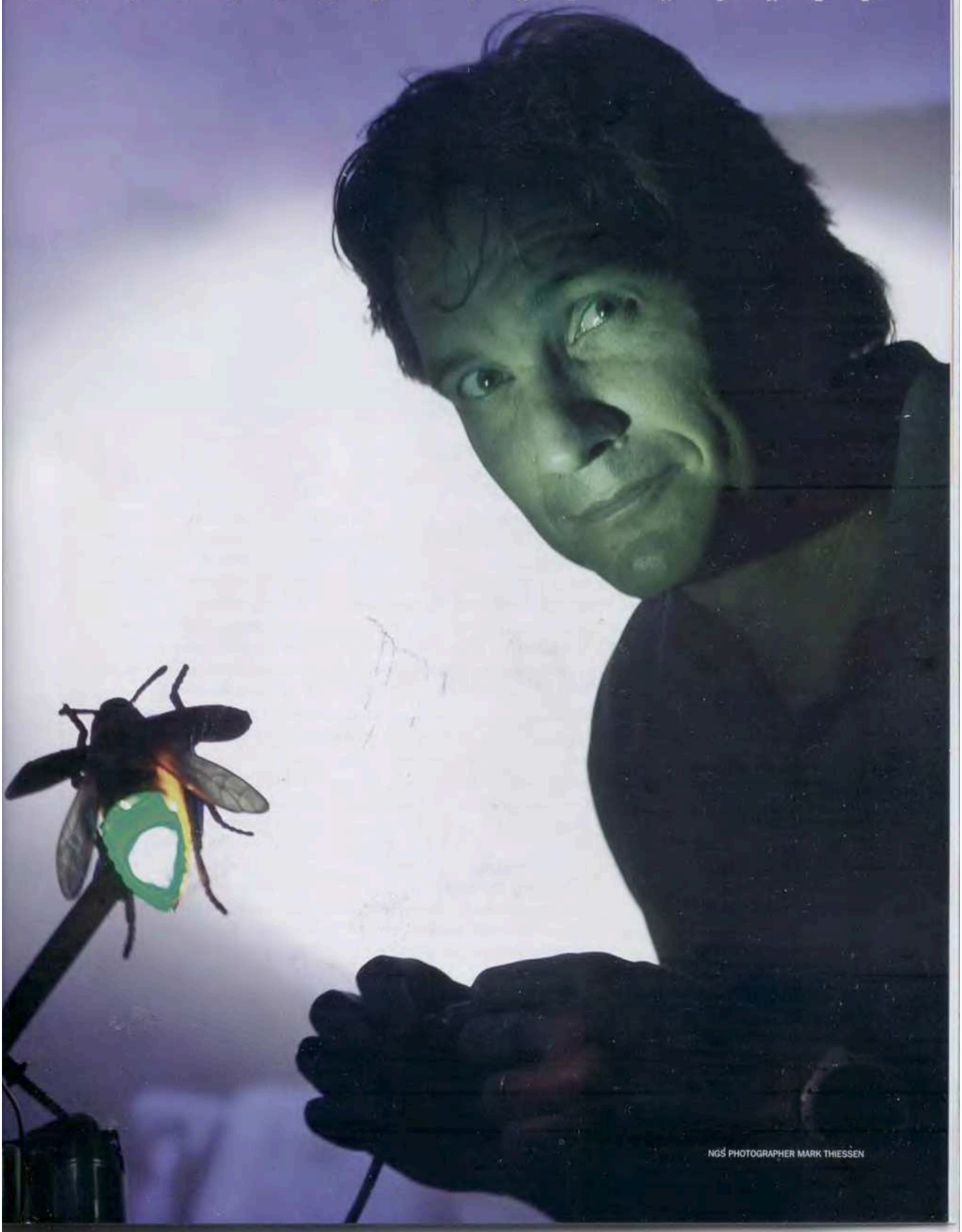
Astronomers say that trying to see a planet orbiting a distant star is like trying to glimpse a firefly in front of a searchlight 3,000 miles away on a foggy night. Staff photographer **Mark Thiessen,** at right, who shot this month's story on the search for other Earths, latched onto the comparison. He headed for National Geographic's in-house photo shop to brainstorm with engineer **Walter Boggs,** at left. Together they saw the light. "We took a little poetic license," says Walter, who removed wings, legs, and antennae from a toy cicada and glued different ones on to make a more realistic lightning bug. He then wired four flashlight bulbs into the tail and covered it with green gel for a cosmic glow.

Armed with a 12-foot ladder, a box fan, a fog machine, and the bug, Mark headed to Baltimore Searchlight, a firm that rents high-powered lights. Then, in a field at dusk, his camera captured that faraway firefly.

"You have this incredible resource in your back pocket," Mark says of the NGS photoengineers. "These guys in the shop thrive on building these ideas. They're a secret weapon."

# GNMENT

COVERING THE WORLD



NGS PHOTOGRAPHER MARK THIESSEN

HAHIM HASHIM

ON BIN LADEN'S TRAIL

## Turban Outfitters

Covering the tribal areas along the border of Afghanistan and Pakistan means covering your head. Photographer **Reza,** at left, wore 11 different turbans in three months of shooting this issue's feature on the region. "Turbans are very important signs of cultural and ethnic ties," he says. The longtime contributor, shown here in a Wazir-style wrap, has decades of experience in Afghanistan. He was a friend of the late mujahideen leader Ahmad Shah Massoud and has known President Hamid Karzai for many years. He also founded Aina, a nonprofit media organization in Kabul. Writer **Tim McGirk,** at right in a Kandahari turban, is the Pakistan and Afghanistan bureau chief for *Time,* which loaned him to us for this story. Tim's rich credentials come with an appreciation for the basics. "You learn these sartorial nuances," he says. "You've got to be dressed a certain way."

WORLDWIDE

"The image a lot of people have of drag racing is adolescent guys in leather jackets illegally racing their cars on the street," says staff writer **Lynne Warren.** "But real drag racing isn't like that in pretty much every way you can imagine." While covering the Darlington International Dragway in Hartsville, South Carolina, she found a high-tech, family-oriented, and interracial mix of adrenaline junkies. At the weekly Wednesday night Test-N-Tune, when the average guy gets to race, "I was tempted," Lynne confesses. "I'd like to claim that I didn't try it out of respect for the 'no drag racing' clause in my car rental contract. But really it was the public humiliation I'd have felt putting the hammer down in a four-door, four-cylinder sedan better suited for grocery getting than for motor-sport glory."

"We risked our lives for the pictures every day," contributing photographer-in-residence **David Doubilet** says of shooting in Africa's Okavango Delta. "I'd try to approach the crocs at night. I'd swim up to them and make a flash shot." David says that he, writer **Kennedy Warne,** and the rest of their six-member team watched each other's backs. The 61°F water may have held the crocs' metabolisms (and appetites) in check too. Still, he says, "It makes 30 years of working with sharks seem like peanuts."

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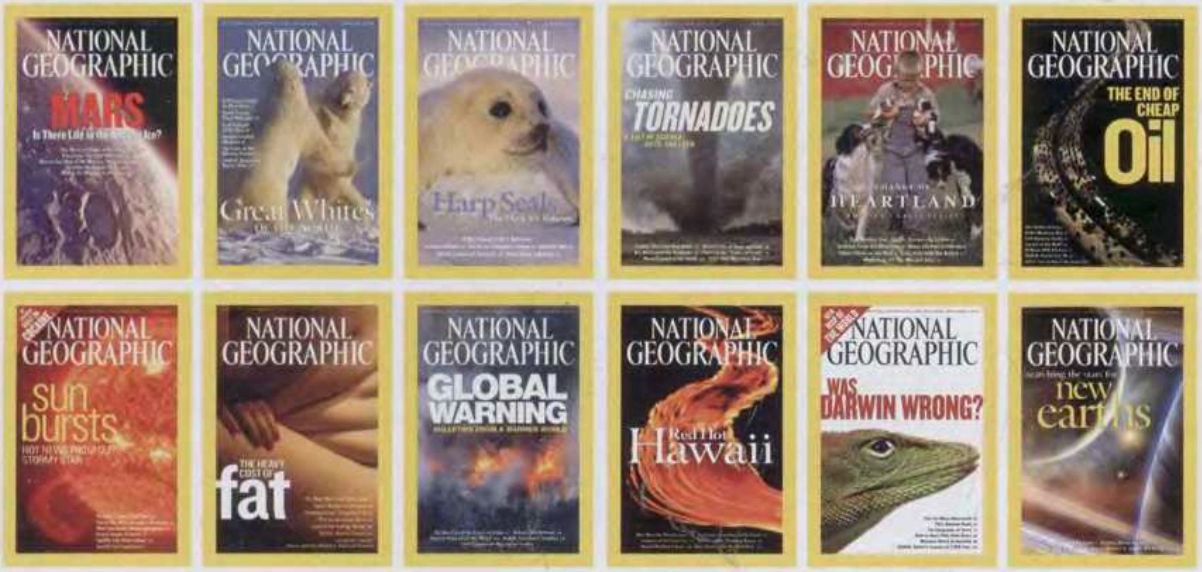
# 2004



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# Flashback


HARRY A. CHASE

MENDING AFGHANISTAN

## Sign of the Times

"We had just come through the Khyber Pass, where murders and hold-ups are common occurrences," observed globetrotting journalist Lowell Thomas. Traveling to Afghanistan in 1922, he and his team ignored the posted warning above and crossed the border anyway.

Mountain driving was difficult even without the threat of bandits. One of Thomas's group "remarked that if the blankety-blank caravan track got any rockier we should have to trade our Buick for a burro. . . ." The team photographer, Harry Chase, "always looking at the sunny side," said at one point, "It must have been about here that one of the last Europeans to enter Afghanistan had been murdered."

Thomas survived the trip. Though his byline—and this photo from our archives—never ran in the GEOGRAPHIC, his book *Beyond Khyber Pass* was published in 1925. His career in broadcasting had yet to begin. —*Margaret G. Zackowitz*

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