NATIONALGEOGRAPHIC.COM/MAGAZINE OCTOBER 2005

NATIONAL GEOGRAPHIC

The Next Killer Flu

Can we stop it?

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signed: Dana A.

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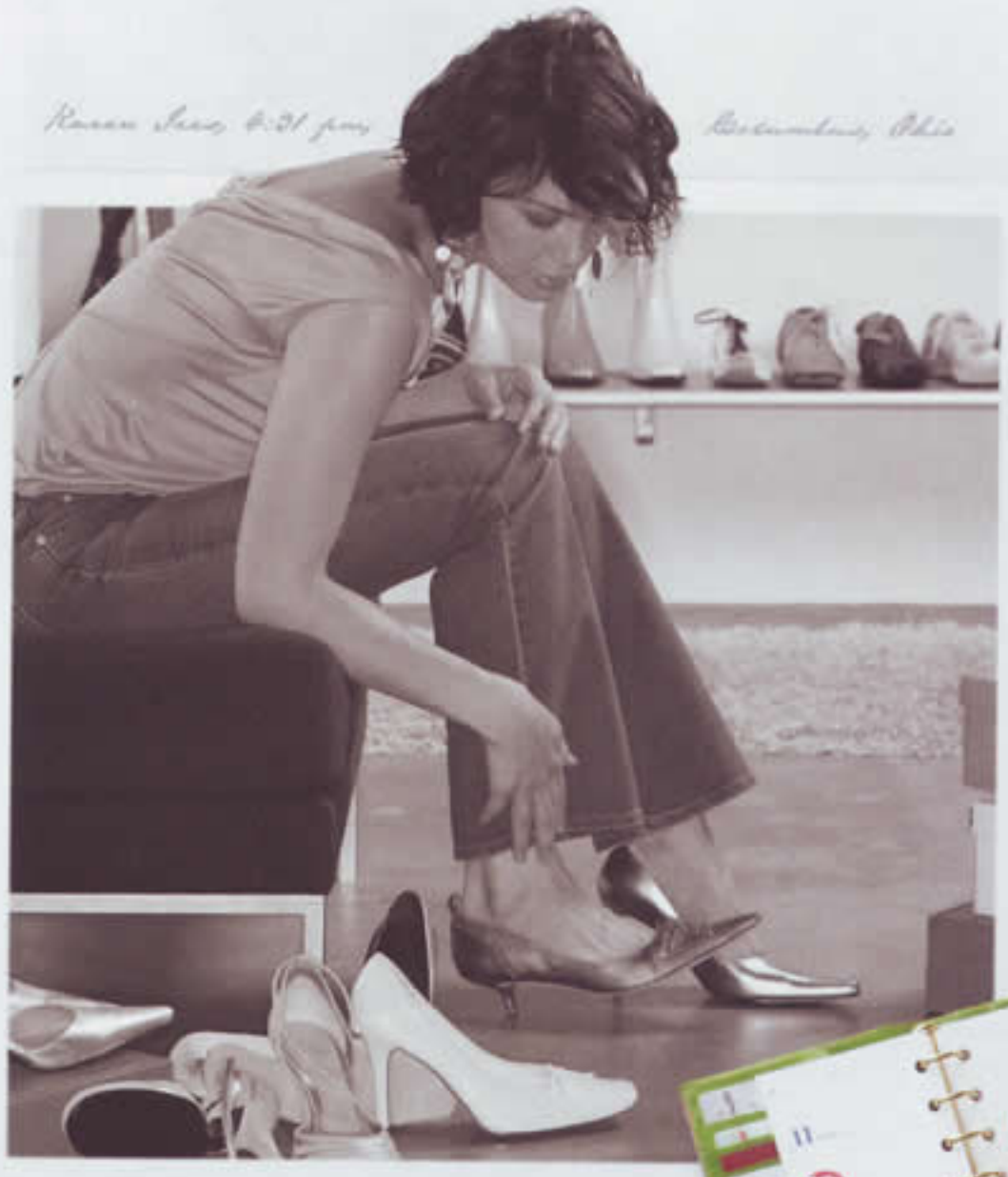

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BY LYNN JOHNSON

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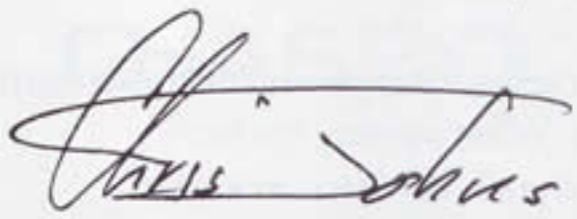
From the Editor

AFTER 82 DAYS IN A HANOI HOSPITAL, NGUYEN SI TUAN RECUPERATES AT HOME WITH HIS SISTER. BY CHAU DOAN, ONASIA

Flu season arrives every autumn as inevitably as the turning of leaves. Tens of millions of us fall ill and feel lousy for a week, but we assume that with proper care (and a dose of common sense) we'll be fine. We think of flu as more nuisance than disease. There is, however, a flu in Southeast Asia that is a killer.

This month our science editor, Tim Appenzeller, and photographer Lynn Johnson tell a high-stakes detective story that begins in the Vietnamese countryside with the death of a ten-year-old girl. A virus responsible for the death of 40 million chickens spread from farmyard fowl to this young child. How it made the leap from chickens remains a mystery, but then flu viruses have habitually stumped experts. Scientists are still trying to understand the 1918 flu pandemic, in the last year of World War I. "Everybody on Earth breathed in the virus, and half of them got sick," says Jeffrey Taubenberger of the Armed Forces Institute of Pathology. The flu claimed more victims than the war—at least 50 million.

Will this flu season, or the next, have tragic consequences for all of us? It's a disturbing thought, but our cover feature also provides some comfort. Brilliant scientists and dedicated doctors like those who helped bird-flu survivor Nguyen Si Tuan (above) beat the odds are working to head off the next killer flu. They're the heroes of this story.



North Island Kokako *(Callaeas cinerea wilsoni)*
Size: Length: 35 - 40 cm **Weight:** 180 - 270 g **Habitat:** Tall evergreen-hardwood forests on the North Island, Kapiti, Tiritiri-Matangi and Little Barrier Islands of New Zealand
Surviving number: Estimated at 1,700

Photographed by Dick Veitch

WILDLIFE AS CANON SEES IT

Sing like a bird...hop like a bird? The North Island kokako excels as a singer with haunting calls that carry far across the forest. Mated for life, males and females join in complex harmonies that can last more than half an hour. This spectacular singing more than makes up for the bird's lack of aerial grace. Although it can fly for short distances, it generally hops between trees on powerful legs. With short wings and a bold blue wattle, which is pink in young birds, the kokako is a distinctive presence that has attracted the attention of introduced possums and rats. Conservation measures are helping, and the kokako's song has not been stilled yet.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place—today and tomorrow.

Canon has teamed up with the Yellowstone Park Foundation to help scientists protect Yellowstone's wildlife through advanced imaging technologies.

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OnScreen & Online

NATIONAL GEOGRAPHIC CHANNEL

MONDAYS AT 10 P.M. ET/PT

Science of the Bible

Millions believe that Jesus lived on Earth as the son of God, but what might his daily life have been like? What did he sound like at the Sermon on the Mount? Did Jesus have children? Using the latest archaeological evidence and scientific tools, *Science of the Bible* unveils some surprises.

The series will also investigate the destructive deluge that may have been Noah's flood, follow the trail of an ancient tablet that some say could prove the existence of the biblical King Solomon, and probe the controversy over the Shroud of Turin (right). Could it be the work of Leonardo da Vinci?

Tune in as *Science of the Bible* brings you closer than ever to unlocking these ancient mysteries.

SUNDAYS AT 8 P.M. ET/PT

EXPLORER

One man is stranded for days in the desert with no water. Another battles freezing mountain temperatures and a broken leg, alone and desperate for rescue. An experienced outdoorsman finds himself hopelessly lost in the wilderness, suddenly battling for his life.

Explorer, National Geographic Channel's award-winning series, digs into survival stories to learn why some people overcome extreme peril while others succumb.

Also this month *Explorer* looks at Jamestown, Virginia, which was settled in 1607 by colonists dreaming of prosperity. What they found was a nightmare. *Explorer,* with host Lisa Ling, examines the true nature of what they endured.

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

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THE GENOGRAPHIC PROJECT **Who were your original ancestors?** New DNA studies suggest that all humans are related to a single African ancestor who lived about 60,000 years ago. ■ **UNCOVER** the specific paths that lead to you. ***nationalgeographic.com/genographic***

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Behind the Scenes

COLLECTOR'S EDITION PRINT OFFER

Visions of Earth

Scenes of creatures in the cold are featured in NATIONAL GEOGRAPHIC's first-time offer of a four-print portfolio: Brian Skerry's shot of a curious young harp seal venturing out for a swim in the icy Gulf of St. Lawrence; two white-on-white photographs by Norbert Rosing, one of an arctic fox curled up against winter's freeze, the other of a three-month-old polar bear cub at rest with its mother in Canada's Wapusk National Park; and Tim Laman's image of a red-crowned crane with its wings outspread, swooping in for a chilly landing on Japan's northern island of Hokkaido. Presented in a black portfolio specially embossed with the National Geographic logo, these four 16-by-12-inch prints are available for a limited time.

The portfolio costs $49.95 plus $9 for shipping ($14 for international orders). For holiday delivery, place orders by December 10, 2005 (December 1 if shipped outside the U.S. Additional duties may apply). Charges for later shipping will apply. Please add appropriate sales tax for orders sent to CA, DC, FL, KY, MI, PA, VA, VT, and Canada. Call toll-free: 1-866-820-5800 (outside the U.S. and Canada call 1-813-979-6845). Order by mail at PO Box 63035, Tampa, FL 33663-0035. Order online at *ngm.com*.

BOOKS

The Big Picture

Wide Angle: National Geographic Greatest Places explores the things that give a place its spirit. From the grand to the intimate, from the beautiful to the gritty, the book's 260 images span the decades to represent "what the National Geographic has stood for all these years—the world and all that's in it," says its editor, Leah Bendavid-Val. *Wide Angle*, third in the best-selling series that includes *Through the Lens* and *In Focus*, is available at bookstores and at *nationalgeographic.com*.

Calendar

SEPTEMBER

WildCam Go to *ngm.com/wildcamafrica* to see our live video feed from a watering hole at Botswana's Mashatu Game Reserve.

22-25 All Roads Film Festival Enjoy work by culturally diverse artists. Egyptian Theatre, Los Angeles.

28 "Napoleon: An Intimate Portrait" exhibit opens. Learn about Napoleon's life and view his treasured personal possessions. National Geographic, Washington, D.C.

29 All Roads Film Festival comes to National Geographic, Washington, D.C.

OCTOBER

11 Jared Diamond discusses theories introduced in his book *Guns, Germs, and Steel* at Chicago's Field Museum. For tickets, call 312-665-7400.

11 "Megaflyover: An Aerial Survey of Africa" lecture. J. Michael Fay shares results and images from his recent ecological reconnaissance flight over Africa. National Geographic, Washington, D.C.

25 "Lost Treasures of Afghanistan" lecture. Archaeologist Fredrik Hiebert speaks about the recovery of Afghanistan's archaeological heritage. The Field Museum, Chicago.

25 "Through the Eyes of the Gods" exhibit opens. See photographer Robert B. Haas's aerial images of Africa. National Geographic, Washington, D.C.

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

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Visions of Earth

ALTO GOLFO BIOSPHERE RESERVE, MEXICO

Like veins on a leaf or limbs on a tree, branching designs are one of nature's repeating patterns. These particular "branches" are actually alluvial channels etched into the mudflats of the Colorado River Delta by the receding tide. Covering many square miles of the delta, the channels are about 5 feet deep, up to 15 feet wide, and at least 100 feet long. I'm fascinated by such archetypal motifs in the natural world. They're what I'm always looking for. *—Jack Dykinga*

▶Decorate your desktop with this image of the Colorado River Delta, in Fun Stuff at **ngm.com/0510**.

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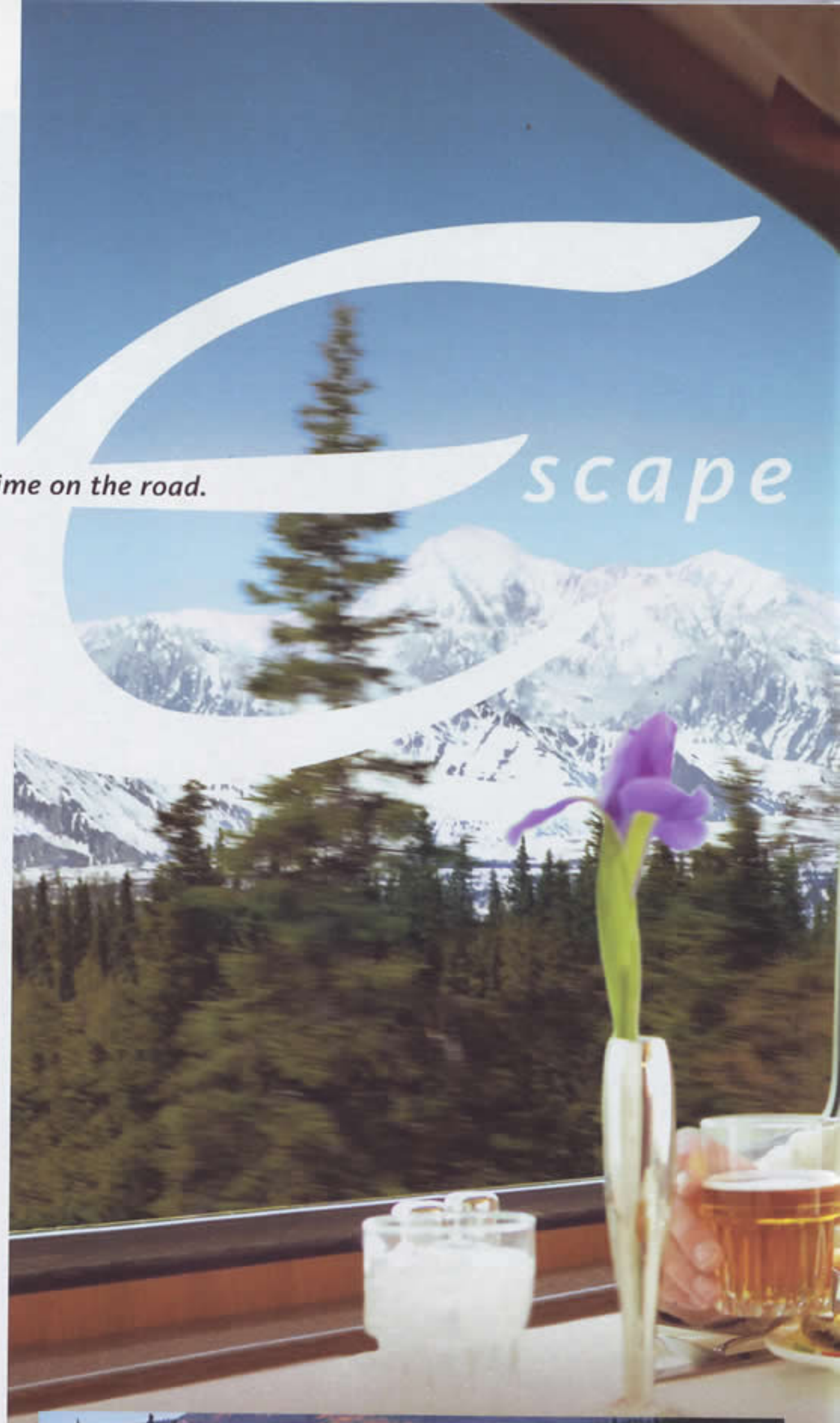

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Forum

June 2005

As Editor in Chief Chris Johns predicted in his June column, some readers were dismayed at our re-creation of Tutankhamun. Many letters reflected reader Jeffrey Carey's view: "I disagree strongly with National Geographic*'s version of the reconstructed face of King Tut. By calling his image Caucasoid, you are misleading many people."*

King Tut Revealed

I have always thought very highly of National Geographic. However, this edition has fallen far short of the reputation it has held for so many years. This misrepresentation of King Tutankhamun as pale skinned and ski nosed is once again an effort to Europeanize Egypt.

BONITA EVANS
Montclair, New Jersey

As someone of Egyptian descent, I was ecstatic to see National Geographic undertake such a tremendous project. King Tut perfectly fit my image of how he looked. His facial features were all correct and proportional, and he would certainly have fit in roaming around modern Cairo's Tahrir Square.

PATRICK ELYAS
Los Angeles, California

For those of us who are armchair Egyptologists, I appreciate the depiction of the winged goddesses from Tutankhamun's burial shrine on the photo foldouts. It shows a respect for his remains and religious beliefs.

INA CHANDLER-BENGE
Olaton, Kentucky

I wonder if the (re)excavation and scan of King Tutankhamun's remains were necessary. Other than possibly learning his age, cause of death, and facial contours, nothing of any real importance can be gleaned from the efforts. The pharaohs of ancient Egypt still have many secrets to divulge. But scholars are misguided when they seek the answers to questions that fail to shed light on the larger social and political changes that characterized King Tut's short reign.

NEAL A. NOVAK
Baton Rouge, Louisiana

Although your article on King Tut was fascinating, it contained an omission. Were any DNA samples taken and, if not, why not?

ANN MARIE ACKERMANN
Boennigheim, Germany

It is the policy of Egypt's Supreme Council of Antiquities not to do DNA testing on mummies. Some experts believe such tests are not yet accurate enough for ancient

FOR MORE INFORMATION

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FAMILY

Important information: VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems. Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So, tell your doctor about any other medications you are taking.

To learn more, call 1-877-VYTORIN or visit vytorin.com Please read the Patient Product Information on the adjacent page.

Continue to follow a healthy diet, and ask your doctor about adding VYTORIN.

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Patient Information about VYTORIN (VI-tor-in)
Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

What is VYTORIN?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. It is used for patients who cannot control their cholesterol levels by diet alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight.

Who should not take VYTORIN?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.

VYTORIN is not recommended for use in children under 10 years of age.

What should I tell my doctor before and while taking VYTORIN?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle break-down resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

How should I take VYTORIN?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

What should I do in case of an overdose?

Contact your doctor immediately.

What are the possible side effects of VYTORIN?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache and muscle pain (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with either ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), and rash; alterations in some laboratory blood tests; liver problems; inflammation of the pancreas; nausea; gallstones; inflammation of the gallbladder.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is <u>not</u> a complete list of side effects. For a complete list, ask your doctor or pharmacist.

General Information about VYTORIN

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

Inactive ingredients:
Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hydroxypropyl methyl-cellulose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

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remains and would only open the door for speculation.

Europe Supplement Map

It was disturbing to see that the map of Europe did not mention Bosnian in the Mother Tongues section. Bosnian, while in many respects similar to Croatian and Serbian, is nonetheless a distinct language spoken by over three million people in Bosnia and also in areas of Croatia and Serbia.

DAMIR ARNAULT
Washington, D.C.

The Mother Tongues map shows that the Hungarian language is spoken in the western part of Romania (more precisely, the region of Transylvania). This is incorrect. According to the most recent national census in Romania, the Hungarian-speaking population represents only 20 percent of Transylvania's population and 6.6 percent of the total population in Romania.

MIHAI ANGHEL
Montreal, Quebec

Both letters make valid points, and future printings of the map will include Bosnian and a corrected area for the Hungarian language.

Song of the Csángós

In 2002, at the request of Csángó minority representatives, the Romanian authorities facilitated access to education in Hungarian in schools in parts of Moldova, where large Csángó communities live. After this decision was taken, there were no more requests registered by the authorities.

SORIN DUCARU
Ambassador to the United States
Embassy of Romania, Washington, D.C.

As a teenager in America I rarely find myself able to connect on a personal level with any of your fine stories or photographs. But the photo on pages 82-3 [of a couple embracing] showed me that even in remote and exotic

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.

locales around the world, young people are fundamentally the same.

MIKE NAPPI
Vienna, Virginia

Saving the Chesapeake

How ironic that I was reading a December 1967 NATIONAL GEOGRAPHIC about the sailing oystermen of Chesapeake Bay when my June 2005 issue arrived with a feature on the Chesapeake. I was hoping to find out how the bay, its oysters, and its ecosystem were making a comeback. Sadness immediately set in after I started to read the 2005 article only to find the Chesapeake's health is continuing to head in the same direction as the oystermen and skipjacks of 1967.

PHIL PERRY
Indianapolis, Indiana

I couldn't have picked up the June issue at a more appropriate time. Through monies granted from the Chesapeake Bay Trust, a group of my eighth-grade students is installing a schoolyard wetlands. We need to make this generation aware, for the future of the Chesapeake is in their hands.

HELEN N. WINTLE
Smithsburg, Maryland

ZipUSA: Postville, Iowa

Abuses in kosher slaughterhouses are sickening, but not altogether surprising. Kashruth is designed to certify the spiritual, moral, and legal "acceptability" of our food. But that system breaks down in the face of high demand, ready supply, profit motives, and factory farming of livestock. What may once have made sense now can no longer be justified.

RABBI FRED SCHERLINDER DOBB
Bethesda, Maryland

Geographica: Plugged In

The answers I got from "Plugged In" satisfied my long-standing curiosity about electrical plugs. It is great to have an easy overall view of which countries use which designs.

NORBERT KROMMER
Lindsay, Ontario

GEOGR

THE PEOPLE, PLACES, AND

Researchers excavating a site overlooking Cumberland Bay (map) believe it was the home of Alexander Selkirk, who was marooned here in 1704 and is thought to be the model for Robinson Crusoe. Selkirk built two huts of wood covered with long grass and lined with goatskins.

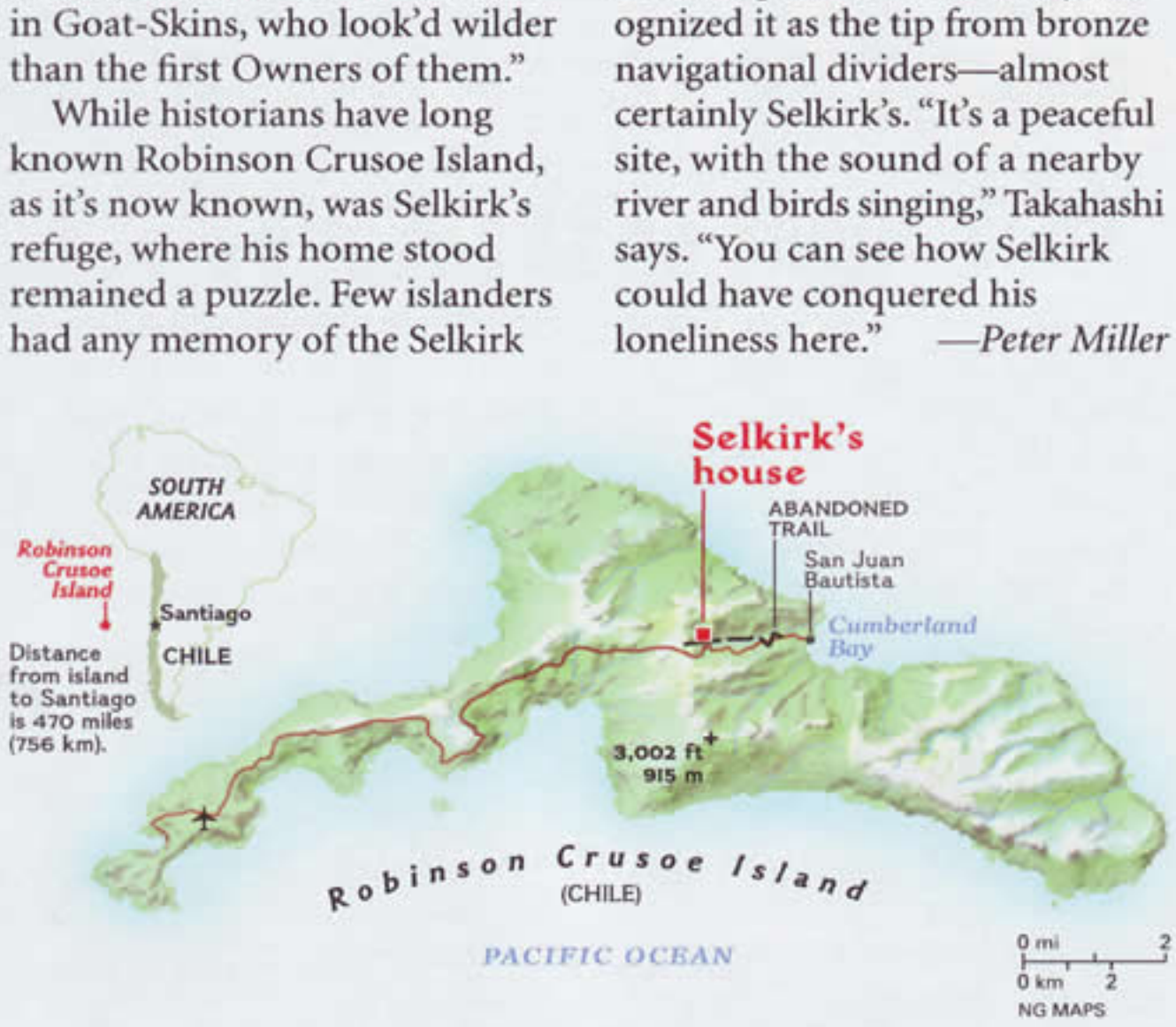
EXPLORATION

Finding Crusoe's Home

Chilean island offers up small but powerful evidence

If you were marooned on a Pacific island, where would you build yourself a hut? That was the question that nagged explorer Daisuke Takahashi for more than a decade. He knew that the ultimate survivor—Alexander Selkirk, the Scottish privateer who probably inspired Daniel Defoe's 1719 classic, *Robinson Crusoe*—had been stranded on an island far from the coast of Chile in 1704. Selkirk spent four years and four months there before two English ships, stopping for water and wood, found him. Upon first sight of the castaway, the captain of the ships described him as "a Man cloth'd in Goat-Skins, who look'd wilder than the first Owners of them."

While historians have long known Robinson Crusoe Island, as it's now known, was Selkirk's refuge, where his home stood remained a puzzle. Few islanders had any memory of the Selkirk story, but one man did recall seeing stone ruins high on an abandoned trail. In January, Takahashi and a National Geographic–funded team began excavating the site. When what looked like a small blue rock turned up in their sieve, they recognized it as the tip from bronze navigational dividers—almost certainly Selkirk's. "It's a peaceful site, with the sound of a nearby river and birds singing," Takahashi says. "You can see how Selkirk could have conquered his loneliness here." —*Peter Miller*



DAISUKE TAKAHASHI (OPPOSITE); ILLUSTRATION OF ROBINSON CRUSOE BY N. C. WYETH, THE WILMINGTON INSTITUTE LIBRARY, DELAWARE

THE COLOR OF MONEY

In 1935, when she was eight years old, the young Princess Elizabeth made her paper money debut on Canada's 20-dollar bill.

Profiles usually appear on coins and stamps, but this view of Elizabeth in her mid-twenties was used on bills in Bermuda and Cyprus.

A 1955 Pietro Annigoni painting showing the Queen in her Order of the Garter regalia was featured on nine different currencies.

The Queen's first appearance on English money in 1960 was derided as a poor likeness. It was soon replaced by a more flattering image.

Eight currency-issuing authorities from Belize to the Falkland Islands employed this image made during the Queen's silver jubilee in 1977.

Wearing pearls and a plain dark dress, the Queen in her late fifties is portrayed as a more informal royal on Canadian banknotes.

A 1992 image of the Queen in jewels she received as wedding gifts graced bills in Fiji, Gibraltar, Guernsey, Bermuda, and the Bahamas.

The Royal Bank of Scotland commemorated her 2002 golden jubilee with a five-pound note featuring an exuberant Queen.

She's Right on the Money

Though she was crowned Queen in 1952, Elizabeth II has only reigned on Bank of England bills since 1960—when she became the first royal ever featured on English paper money. Yet it's her portrait on the cash of other nations and territories—more than 30 since her first appearance on a Canadian bill in 1935—that has made Elizabeth a currency icon.

Historically depicted on legal tender of the empire, the Queen's image was removed from several colonies' bills as they gained independence from Britain. Today 16 authorities still issue bills with her portrait, including many remaining British dependencies as well as Commonwealth nations like Canada, Australia, and New Zealand.

The Queen is also "very popular among collectors," says Peter Symes, a vice president of the International Bank Note Society. This group of currency collectors voted the Canadian 20-dollar bill (below) "Bank Note of the Year" for 2005, calling it "probably the finest portrait of the mature monarch to appear on any bank note."—*Whitney Dangerfield*

PETER SYMES (ALL PHOTOGRAPHS AT TOP); BANK OF CANADA (ABOVE)

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Long a haven for free-spirited artists—many of whom built their own houses—Christiania has become one of Copenhagen's most colorful tourist destinations.

CULTURE

Free Love, Not Land

Copenhagen commune finally forced to pay the Man

The love may still be free, but the real estate is going to get pricey. That is if Danish politicians have their way in Christiania, an 84-acre commune located near the high-rent heart of Copenhagen.

Christiania counts roughly a thousand residents who live virtually rent free on prime waterfront real estate, thanks to a group of young Danes who in 1971 took up residence at an abandoned fort on Copenhagen's inner harbor. The founders set about building cottages and workshops and soon gained fame for their psychedelic murals, no-car policy, open hashish market, and willingness to let just about anyone join them.

In 1989 parliament recognized the enclave as a legal "social experiment" but retained the state's ownership of the land. Now Denmark's conservative government wants to change the experiment. Last year police shut down the commune's open drug market. This summer the government announced that the residents will have to pay rent in addition to the small fees they currently pay, which cover taxes, electricity, and maintenance.

Particularly onerous to Christianians is the government's plan to let private developers bid on new construction projects within Christiania, including expensive apartments. This won't work, says Mette Prag, an 18-year Christiania resident and a member of a team negotiating with the government.

"We've always welcomed new people who wanted to join our life in Christiania, but we don't want to be forced to accept outsiders who will create a separate community in our midst."

—Peter Gwin

GEO NEWS

CONSERVATION

■ **A new monkey species has been discovered.** Within months of each other, two teams of scientists working independently in the mountain forests of Tanzania identified the primate now officially known as the highland mangabey. The whiskered, three-foot-long tree dweller utters a loud call scientists have termed a "honk-bark." Fewer than a thousand of the animals are thought to exist.

ARCHAEOLOGY

■ **Found: the quarry that provided Stonehenge's stones.** Around 2500 B.C. a quarry in the mountains of Pembrokeshire, Wales, yielded the bluestone used to make the Stonehenge megaliths of England's Salisbury Plain, a new study says. Archaeologists had previously determined that the remains of seven bodies found in a grave near Stonehenge belonged to natives of Wales who may have transported the stones from the quarry to the Neolithic site.

FOOD SCIENCE

■ **Soon you'll be able to eat the whole bag of popcorn.** Unpopped kernels are a mystery no more. Scientists have learned why certain kernels never reach their true fluffy destiny: leaky hulls. When a popcorn kernel's thin, translucent skin allows moisture to escape during heating, the internal pressure needed for explosion—that essential "pop"—never builds up. Snack manufacturers are now seeking ways to improve kernel-hull structure in their popcorn products.

PHOTOGRAPH BY FINN HEIDELBERG, POLFOTO

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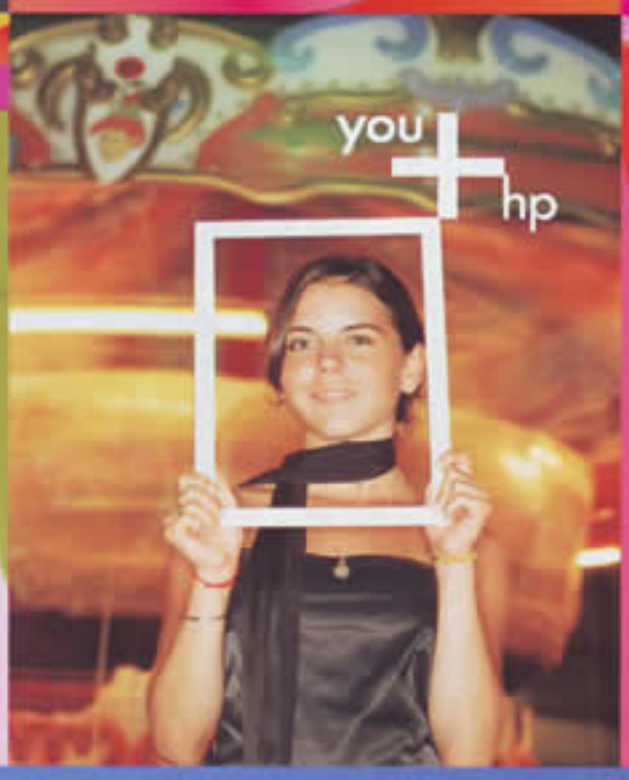

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GEOGRAPHY OF EVERYDAY LIFE

Tropical storms are named when they reach a sustained wind speed above 39 mph. When wind speeds reach 74 mph, storms are considered hurricanes to the east of the International Date Line, typhoons to the west, and cyclones in the Southern Hemisphere.

Naming Tropical Storms

Wind speeds may quicken, sea temperatures may rise, and storm paths may shift, yet in the erratic world of tropical cyclones, there is one variable meteorologists know will be certain—a storm's name.

Since 1950 American forecasters have identified storms using an alphabetical system of names. Beginning in 1953 those names were only female ones, but in 1979, at the urging of women's groups, male names were added. These days meteorologists plan ahead, compiling six years' worth of names—three male and three female for each letter of the alphabet except Q, U, X, Y, and Z. Every six years the lists of names repeat.

Recognizing the benefits of names in identification and warning services, storm centers worldwide, monitored by the World Meteorological Organization, began to adopt labeling plans. Now each of the storm-naming regions has its own name lists. While some lists begin each season at "A," others pick up where they left off the previous year. And unless the title of a particularly devastating storm is retired (2004's Charley, Frances, Ivan, and Jeanne were removed from the Atlantic list), names are used over and over.

On average 80 tropical cyclones form annually in the world. Yet since 1995 Atlantic numbers have jumped from about 10 to as many as 19 named tropical storms a year. So what happens if they run out of names? "If we have more than 21 storms," says Frank Lepore of the National Hurricane Center in Miami, "we have bigger problems than what they are going to be named."

—Whitney Dangerfield

Atlantic Region Storm Names

A sample for 2005–2006

2005	2006
Katrina	Alberto
Lee	Beryl
Maria	Chris
Nate	Debby
Ophelia	Ernesto
Philippe	Florence
Rita	Gordon
Stan	Helene
Tammy	Isaac
Vince	Joyce
Wilma	Kirk

HURRICANE IVAN

NATIONAL GEOGRAPHIC MAPS (TOP); JACQUES DESCLOITRES, MODIS LAND RAPID RESPONSE TEAM, NASA GODDARD SPACE FLIGHT CENTER (ABOVE)

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NEW YORK

DOWN TO EARTH

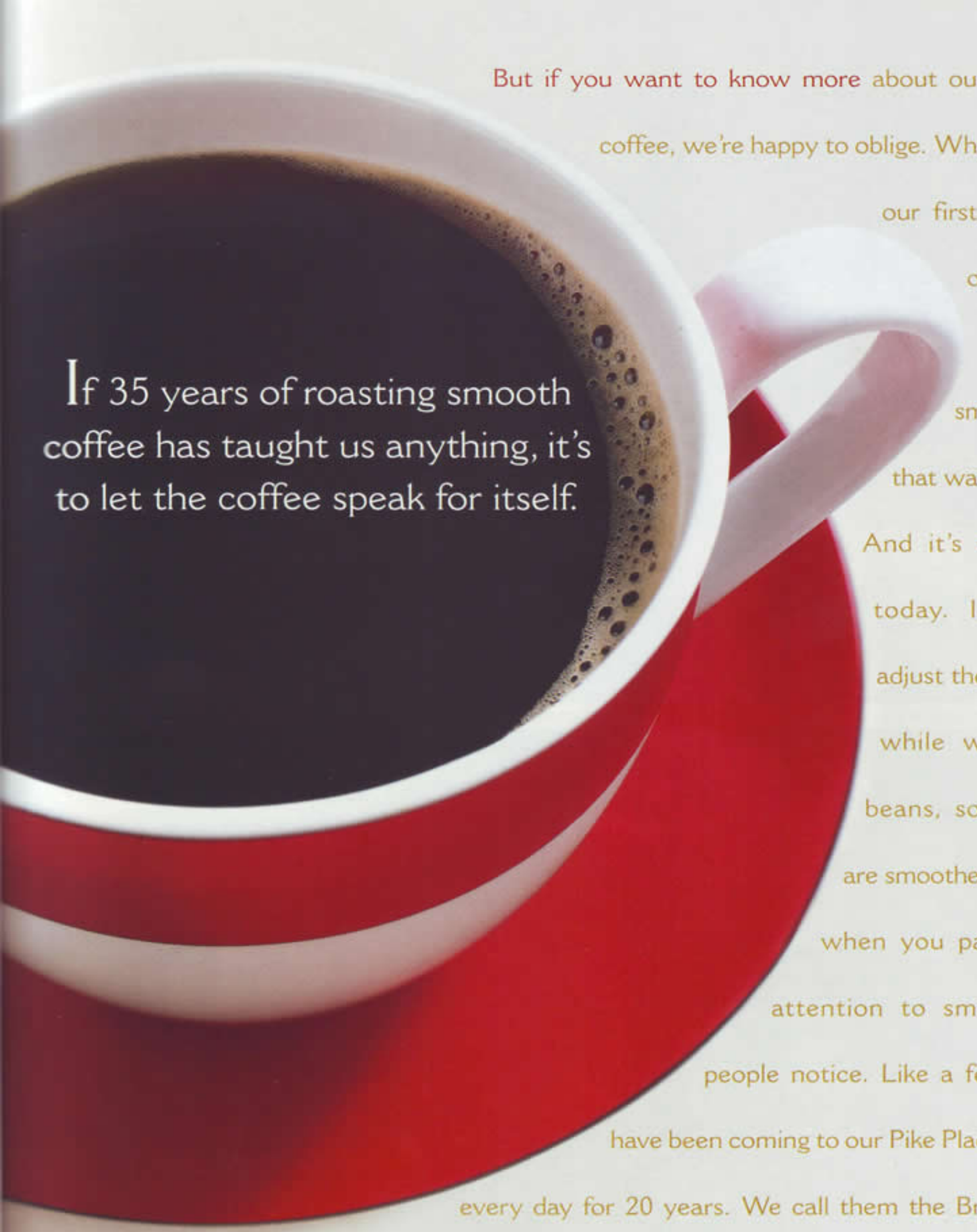
SPACE IMAGING

"Wonderful city. Streets full of water. Please advise."

The story goes that humorist Robert Benchley sent the above message back to his editor at the *New Yorker* more than half a century ago.

The historic city he was referring to began to rise from the water some 1,500 years ago. Built atop a soggy patchwork of islands, its centuries-old architecture is supported by wooden pilings driven deep into the silt-and-clay floor of a lagoon. Structures are frequently menaced by floods, the grandest route through town is a canal, and high water so often inundates one city square that its famous pigeons could be replaced by ducks. But none of this dampens Venice's charm.

—Margaret G. Zackowitz



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FLORIAN MÖLLERS

WILDLIFE

Hogs Wild in Berlin

Urban boar population on the rise in Germany

Freedom was in the air when the Berlin Wall came down in 1989—and not just for people. The barrier between East and West Germany had also confined a large population of wild boars within the eastern forests of Brandenburg. The Wall's collapse made it easy for the big pigs—a five-foot-long adult can weigh more than 300 pounds—to leave the woodlands and traipse into town. Warm winters and easy access to food have since helped the population soar. Now about 8,000 *Wildschweine* wander Berlin (above).

The nature of the beast has added to the boom. "Boars are intelligent," says Marc Franusch, a spokesman for the Berlin forestry department. "They learn to use the neighborhoods. They get used to people, dogs, and traffic."

The wily boars tend to travel in small groups and have been found rummaging through garbage and gardens, suckling their piglets in the shadow of parked cars, and crossing busy roads. On average, the animals are involved in one traffic accident every day. And despite the fact that it's illegal, some Berliners have been known to slip the boars food.

Though wild boars are protected under German law, the city's forestry department is permitted to cull up to 2,000 of the creatures annually, targeting mostly young adult animals in forests surrounding Berlin. Boars within city limits are only shot if they pose an immediate threat. No humans have yet been seriously wounded by boars, but local dogs have been the victims of their tusks. "The forestry department is not aiming to get rid of the boars," explains Franusch, "but we do have to minimize dangerous situations."

—Cate Lineberry

Wild in the Streets

Mountain lions in California have mauled 12 people—three fatally—since 1986.

Wild dogs roaming the roads of Queensland, Australia, threaten local livestock with disease.

Leopards wandering into Mumbai, India, from a national park outside the city killed 19 people in 2004.

WHAT IS IT?

Engraved Celtic shears

Where were they found? In a late Iron Age (20 B.C.–A.D. 70) settlement in Essex, England, discovered during excavation for a gas pipeline

How were they used? The four-inch scissors were probably used for trimming hair.

What are they made of? A copper alloy similar to bronze

Why are they significant? Portrayals of Celts often depict them as unkempt barbarians. Grooming tools suggest a more nuanced culture.

Why are the blades broken? Archaeologists believe that the tips were cut off and the shears were intentionally buried because Celts ritually "killed" objects they no longer used. *—Siobhan Roth*

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ARCHITECTURE

Taipei Towers Above All Others

Taiwan's capital goes to great lengths to claim record

In the grandiose game of architectural one-upmanship, Taipei lays claim to the world's tallest building—at least for now. At 1,670 feet, the 101-story skyscraper dubbed Taipei 101 eclipses by 187 feet what were until October 2003 the tallest buildings in the world: the twin Petronas Towers in Kuala Lumpur, Malaysia. The towers held their record for a mere five years, and Taipei 101 may not wear the laurels for long. Burj Dubai in the United Arab Emirates, expected to exceed 2,000 feet, is scheduled to open in 2008.

The U.S. long had a lock on record-breaking skyscrapers, but Asia's ambitious and locally inspired designs have displaced the U.S. in recent years. The Petronas Towers are based on an eight-pointed Islamic star, and Burj Dubai will take its geometry from a six-petal desert flower.

Described variously as a bamboo stalk, a pagoda, and a stack of Chinese food take-out containers, Taipei 101 may not be the most elegant of structures, but it boasts the world's fastest elevators, zipping upward at 38 miles an hour.

All skyscrapers sway in the wind. Taipei 101, however, was erected in typhoon country. To ensure occupants' peace of mind, its engineers suspended a giant pendulum with a 726-ton weight over the 88th floor. Integrated with a set of shock absorbers, the pendulum counteracts the winds, reducing the building's sway and keeping motion sickness at bay.

—Cliff Tarpy

20th-century Records

Petronas Towers Kuala Lumpur, 1,483 feet, 1998

Sears Tower Chicago, 1,450 feet, 1974

World Trade Center Towers New York, 1,368 and 1,362 feet, 1972 and 1973

Empire State Building New York, 1,250 feet, 1931

Chrysler Building New York, 1,046 feet, 1930

CHIEN-CHI CHANG, MAGNUM PHOTOS

It's time to turn up the heat on global warming.

Research We were the first major energy company to acknowledge the need to take steps against global warming, so we're investing in the Carbon Mitigation Initiative at Princeton. Our researchers are developing strategies to reduce global CO_2 emissions that will be safe, practical and affordable.

Implementation At our facility in Alabama, we're using recycled steam to generate power. This has boosted performance while eliminating over 50,000 tons of greenhouse gas emissions. At our facility in Indiana, we invested over $7 million in efficiency projects that reduced emissions by 200,000 tons.

Development Cleaner power stations are vital to meet the world's growing need for energy and help reduce the effects of carbon dioxide. BP is planning to convert a power station in Scotland to run on hydrogen that will produce enough electricity for 250,000 homes with 90% lower carbon emissions.

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GEO QUIZ

Middle East

The following questions are adapted from the National Geographic Bee. How well would you do against the 9- to 14-year-olds who compete in the annual Bee?

1. Farsi, also known as Persian, is the official language of what country?

2. Name the famous domed Istanbul museum originally built as a Christian church and later used as a mosque (below, at center).

3. What city is the chief pilgrimage destination for Muslims worldwide?

4. The Israeli port of Haifa lies at the foot of what peak?

5. The kingdoms of Najd and Hejaz were united into what country in 1932?

6. A 1970s civil war between Muslims and Christians turned what capital city on the Mediterranean into a battleground?

7. A causeway connects Saudi Arabia and what other country?

8. Name the country whose major agricultural region is located near the Tigris and Euphrates Rivers.

9. The strategic straits of the Dardanelles and Bosporus are controlled by what country?

10. Which one of the following does not border the Persian Gulf: Yemen, Kuwait, or Qatar?

11. The Shatt al Arab forms part of the border between which two countries?

12. Name the northernmost capital city on the Persian Gulf.

13. Aden, an important trading center since ancient times, is located on the Gulf of Aden in which country?

14. Cuneiform writing was developed thousands of years ago by the Sumerian people of Mesopotamia. This region is located in what present-day country?

15. Livestock herding and wheat farming are agricultural activities on what Turkish plateau?

16. Manama is a major seaport and the financial center of what Persian Gulf country?

17. The Zagros Mountains are located in the western part of what country?

18. The tomb of Muhammad is located in what city?

19. What peninsular country on the Persian Gulf shares a border with Saudi Arabia?

20. Portuguese and Arabs clashed in the 1500s for supremacy of the spice trade in this capital city on the Gulf of Oman. Name the city.

21. Name the Persian Gulf country that used to be known as the Trucial States.

22. Name the Israeli city that was incorporated in 1950 with the ancient port city of Yafo.

23. The Plain of Sharon is a major citrus growing region along the coast of what country?

24. What city has served as the capital of Yemen since 1990?

25. What race is held each year near Riyadh to help preserve Saudi cultural heritage?

26. Petra, once a thriving trading center on caravan routes, is in what present-day country?

27. Name the famous palace in Istanbul that houses treasures from the Ottoman Empire.

28. Naxçivan, an exclave of Azerbaijan, is separated from the rest of Azerbaijan by what country?

29. Al Jubayl is a major industrial complex on the west coast of the Persian Gulf in what country?

30. Name the large body of water bordering northern Iran.

31. What Jordanian city witnessed a population explosion in the late 1940s with the arrival of Palestinians displaced by Israel's War of Independence?

1. IRAN 2. HAGIA SOPHIA 3. MECCA 4. MOUNT CARMEL 5. SAUDI ARABIA 6. BEIRUT 7. BAHRAIN 8. IRAQ 9. TURKEY 10. YEMEN 11. IRAQ AND IRAN 12. KUWAIT CITY 13. YEMEN 14. IRAQ 15. ANATOLIAN 16. BAHRAIN 17. IRAN 18. MEDINA 19. QATAR 20. MUSCAT 21. UNITED ARAB EMIRATES 22. TEL AVIV 23. ISRAEL 24. SANAA 25. THE KING'S CAMEL RACE 26. JORDAN 27. TOPKAPI 28. ARMENIA 29. SAUDI ARABIA 30. CASPIAN SEA 31. AMMAN

ROBERT FRERCK, GETTY IMAGES

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CONSERVATION

A Growing Problem for Bamboo

Global deforestation threatens plant's wild ranges

Bamboo traditionally has been a Chinese symbol of good fortune, but the plant could be running short on luck. A 2004 report published by the United Nations Environment Programme (UNEP) warns that as many as half the world's 1,200 species of bamboo might face extinction because of habitat destruction.

Though most bamboo spreads prolifically by sending up new shoots each year, long-term survival depends on flowering. No matter where in the world they're growing, all bamboos of the same species flower simultaneously, produce seeds, and die soon afterward. Some species bloom yearly, others wait as many as 120 years. But however long it takes, flowering must happen in order for any given species of bamboo to perpetuate itself. As forests are cleared for agricultural or other use, the crucial flowering needed to produce seeds is not taking place.

This means trouble for many animals, including China's giant panda, which subsists almost entirely on bamboo (right), consuming some 30 pounds of the shoots, stems, and leaves daily. The plant is also a staple for Africa's endangered mountain gorillas. Madagascar's shrinking forests shelter three different species of bamboo-dwelling lemurs, as well as a frog that breeds in broken, water-filled canes of the plant.

Humans depend on bamboo too. International trade in bamboo—as a building material, textile fiber, food source, and more—is worth about two billion dollars annually. Cultivated bamboos—not the at-risk, wild varieties—are the source for most human uses.

—Beth Goulart

It's True That Bamboo . . .

Is botanically classified as grass.
Varies by species from six inches to more than 130 feet in height.
Is the fastest growing plant, with some species able to shoot up three feet in a day.

FORENSIC SCIENCE

Napoleon's Soldiers Unearthed in Vilnius

Construction workers who uncovered a mass grave in Vilnius, Lithuania, thought they had found Holocaust or KGB victims. As it turns out, the remains belonged to 3,000 members of Napoleon's Grand Army. The soldiers died of starvation, cold, and exhaustion while retreating from their ill-fated 1812 attack on Moscow.

On December 10 of that year Napoleon's commanders fled Vilnius, leaving their dead and dying soldiers behind. Russian forces arrived only hours later. Over the next few months, they buried the bodies in trenches the Grand Army soldiers had dug during their advance on Moscow.

French and Lithuanian scientists have been studying the remains of the multinational army, like this skull of a man in his twenties (left), and the thousands of artifacts left behind. "It's the largest mass grave of this period in Europe," says Rimantas Jankauskas of Vilnius University. Also found with the troops were the skeletons of about 30 women thought to have traveled as cooks, maids, and medical assistants.

The finds, Jankauskas says, promise new insights into life during the Napoleonic Wars. And this may be just a preview: Russian forces in Vilnius reportedly buried as many as 40,000 Grand Army troops that brutal winter.

—Cate Lineberry

KEREN SU, CORBIS (TOP); JEAN-LUC MOREAU DELERIS

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Ed Viesturs *Mountain climber*

Only 14 mountains in the world stand higher than 8,000 meters (26,240 feet); even fewer people have climbed them all. When Ed Viesturs summited Annapurna on May 12, he became the newest member—and the only American—of this lofty club. Though Ed has now achieved his goal, he's not ready to hang up his crampons. "I'll always climb," he says. These seven ascents are among his most memorable.

Summiting 26,360-foot-high Annapurna, Ed Viesturs reaches his goal.

1 Mount St. Helens, October 1977 I grew up in the flatlands of the Midwest, but after I read Maurice Herzog's *Annapurna* as a teenager, that was it for me; I knew I had to get out of Illinois. Just weeks into my freshman year at the University of Washington, I climbed my first mountain, Mount St. Helens. Once I got to the summit, I realized that climbing was exactly what I wanted to do with the rest of my life.

2 Mount Rainier, March 1978 In college, Rainier was my Everest. I could see it from my dorm, and I wanted my first ascent to be a winter climb. I've climbed it 191 times since.

3 Kanchenjunga, May 1989 Third highest peak in the world, Nepal's Kanchenjunga was my initial successful Himalayan ascent, and first of my 8,000-meter summits.

4 Mount Everest, May 1990 I've made six Everest ascents, but this was my first. I did it without supplemental oxygen, something I always try to do when I take on a mountain. It's more satisfying that way, when it's just my body against the challenge of the climb.

5 K2, August 1992 That was a really demanding expedition. We had bad weather, and our team fell apart around us. Still, my partner Scott Fischer and I were determined to stay as long as we needed to get the job done. It's rare to summit on your first shot at K2—the second highest peak in the world—but we did it.

6 Mount Everest, May 1996 When filmmaker David Breashears invites you to be involved with a project, it's hard to say no—and he invited me to help wrestle a 42-pound IMAX camera to the summit for his film *Everest*. We had a sad season on the mountain. Two friends, Rob Hall and Scott Fischer, were among eight who died when a storm caught their groups' descents. After a lot of thought, we went on with our own trip and succeeded in making both the summit and the movie.

7 Annapurna, May 2005 It was appropriate that Annapurna was my final 8,000-meter mountain, since reading about it as a kid first inspired me to climb. Earlier attempts hadn't worked out—if conditions are too dangerous, I won't proceed. But everything came together. After 16 years of work, I finally had my 14 mountains—and a dream come true.

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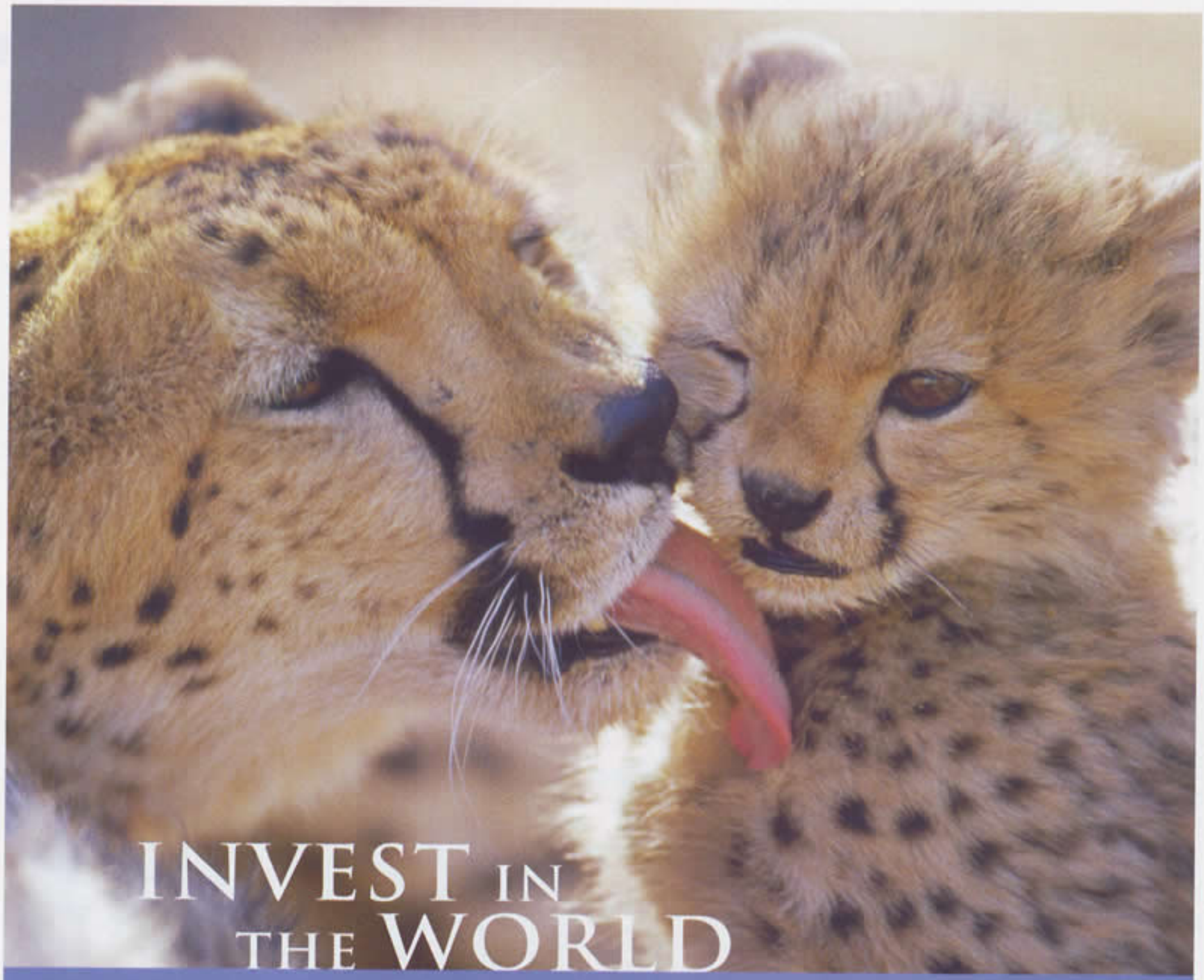

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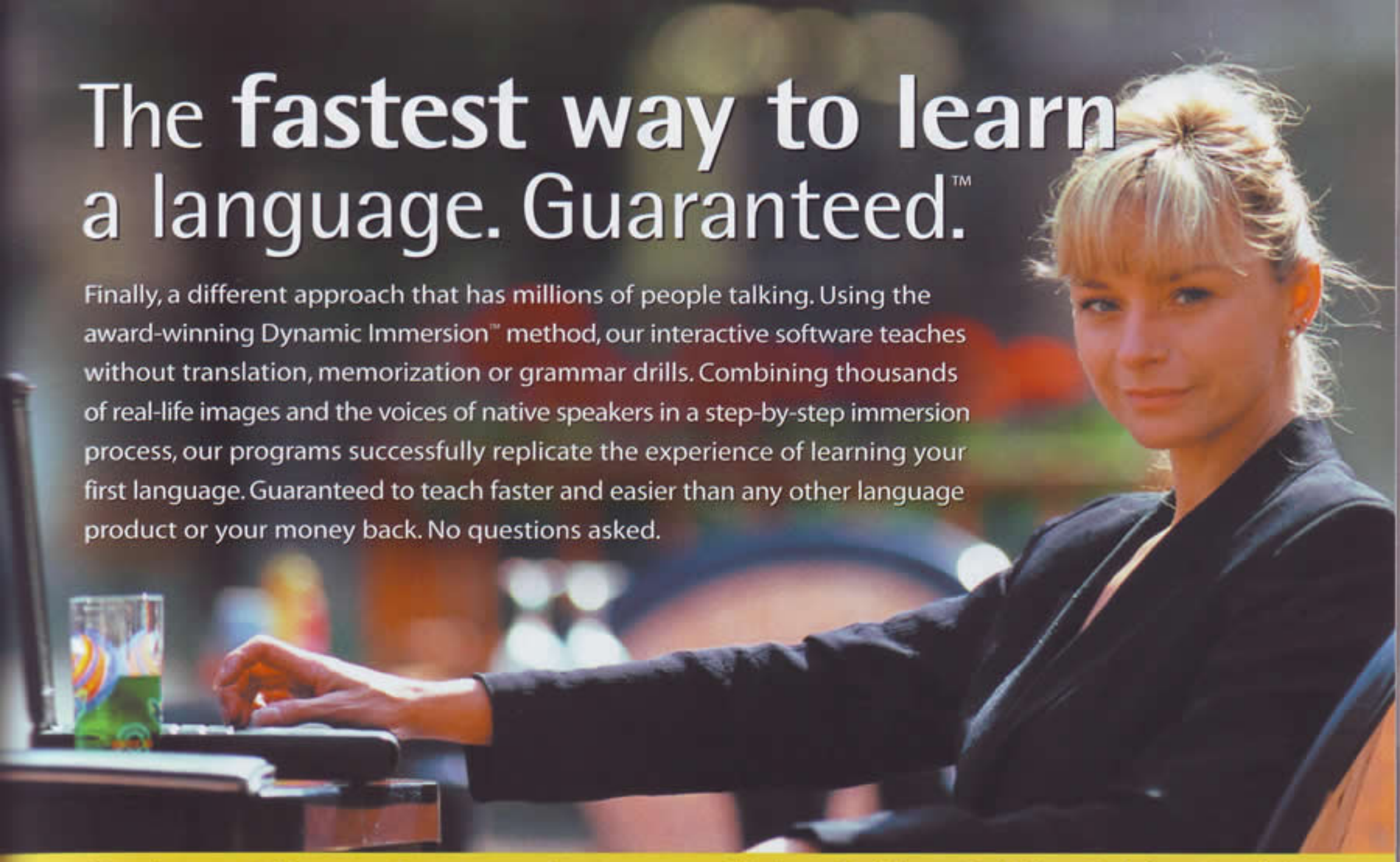

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Hanoi Fever

Keeping a low profile on the trail of bird flu

How do you track a virus through the streets of Vietnam's capital while keeping ahead of nervous officials? Catch one of the motor scooters that wait for fares on nearly every corner.

On assignment in Hanoi, photographer **Lynn Johnson** and writer **Tim Appenzeller** wanted to check out the live-poultry markets that can spread bird flu. Officials at one market turned them away when they arrived without prior warning. But when Tim and Lynn returned the next day with their government-appointed minder for a scheduled visit, they were welcomed.

"The place was crawling with police and health officials. One even carried a bullhorn to urge good hygiene," Tim says. "We had the feeling they were putting on a show for us." The following day he and Lynn hopped on a couple of scooter-taxis ("less likely to be noticed than a regular taxi, we hoped") and paid another visit. This time the bullhorn was gone and the uniforms were scarce. The place smelled so bad that many of the locals wore masks, but the stench was a small price to pay to get the story.

On his way to investigate the scene at a live-poultry market, Tim Appenzeller catches a ride on one of Hanoi's ubiquitous scooter-taxis.

PHOTOGRAPH BY LYNN JOHNSON

WORLDWIDE

Susan Middleton tallies the lethal stomach contents of a young albatross: 12.2 ounces of trash unintentionally fed to the chick by its parents.

HAWAII'S OUTER ISLANDS

"It was on Kure Atoll that we fully understood the perils of marine debris to wildlife," says photographer **Susan Middleton.** During the two months she and **David Liittschwager** camped and photographed on Kure, they watched the albatross class of 2004 reach fledging age. When one chick suddenly died, a necropsy revealed a stomach impacted with plastic bits and other debris the chick's parents had inadvertently fed it (above). Raising awareness of threatened wildlife has been the focus of the photographers' 20-year collaboration, and their portraiture style aims to show in the beauty of an individual animal or plant the irreplaceable value of a species. Says David, "We think anthropomorphism is a good thing."

TRAFALGAR

British boys grow up on stories about Admiral Lord Nelson. But in Nelson's quarters on H.M.S. *Victory* surprises awaited British-born writer **Simon Worrall.** A dainty white canopy decorated the admiral's hanging cot. "Its curtains had been embroidered with peonies, dog roses, and poppies," he says. "It was like a little girl's bed." Such canopies, embroidered by wives—or in Nelson's case, by his lover, Emma Hamilton—were common in Nelson's day, but Simon had a hard time imagining Nelson stepping out of that cot on the day he stood defiantly before the enemy muskets that took his life. "Now when I think of Nelson," Simon adds, "I think of him swinging like a baby in a cradle, in a cot embroidered with flowers, with the sea whispering in his ears."

THAI ELEPHANTS

"Elephants love taking baths in the river. But I think I might have liked it more than they did," says writer **Doug Chadwick,** who helped mahouts give the giants their baths whenever he could. "Each elephant radiates its own personality," he says. "I saw how sensitive they are to each other. When one gets stuck, instant help arrives. I watched a group of wild elephants use their trunks to push and pull a young elephant out of the mud. I look to them for inspiration—a model of how to take care of one another."

DANAKIL

In Ethiopia's Danakil Desert, writer **Virginia Morell** endured plenty of uncomfortable and even dangerous situations, but a few warm moments can sweeten a whole trip. At an Afar wedding celebration in a village near the Saba River, she joined in the *ke ke,* a dance in which a man and woman with eyes for each other move within a circle of other dancers.

"When you hear the ke ke song, you just fall down in love," an Afar woman named Hamilla told Virginia, dropping her hands helplessly to her sides and confessing that she'd met her husband while doing the ke ke.

"Hamilla told me that in the past single women couldn't do the ke ke because they were kept in their homes, but since democracy has come, women have more freedom. For Hamilla, democracy means women are equal to men."

Virginia Morell fends off the sun in the Danakil Desert.

TALES FROM THE FIELD Find more stories from our contributors, including their best, worst, and quirkiest experiences, in Features at **ngm.com/0510.**

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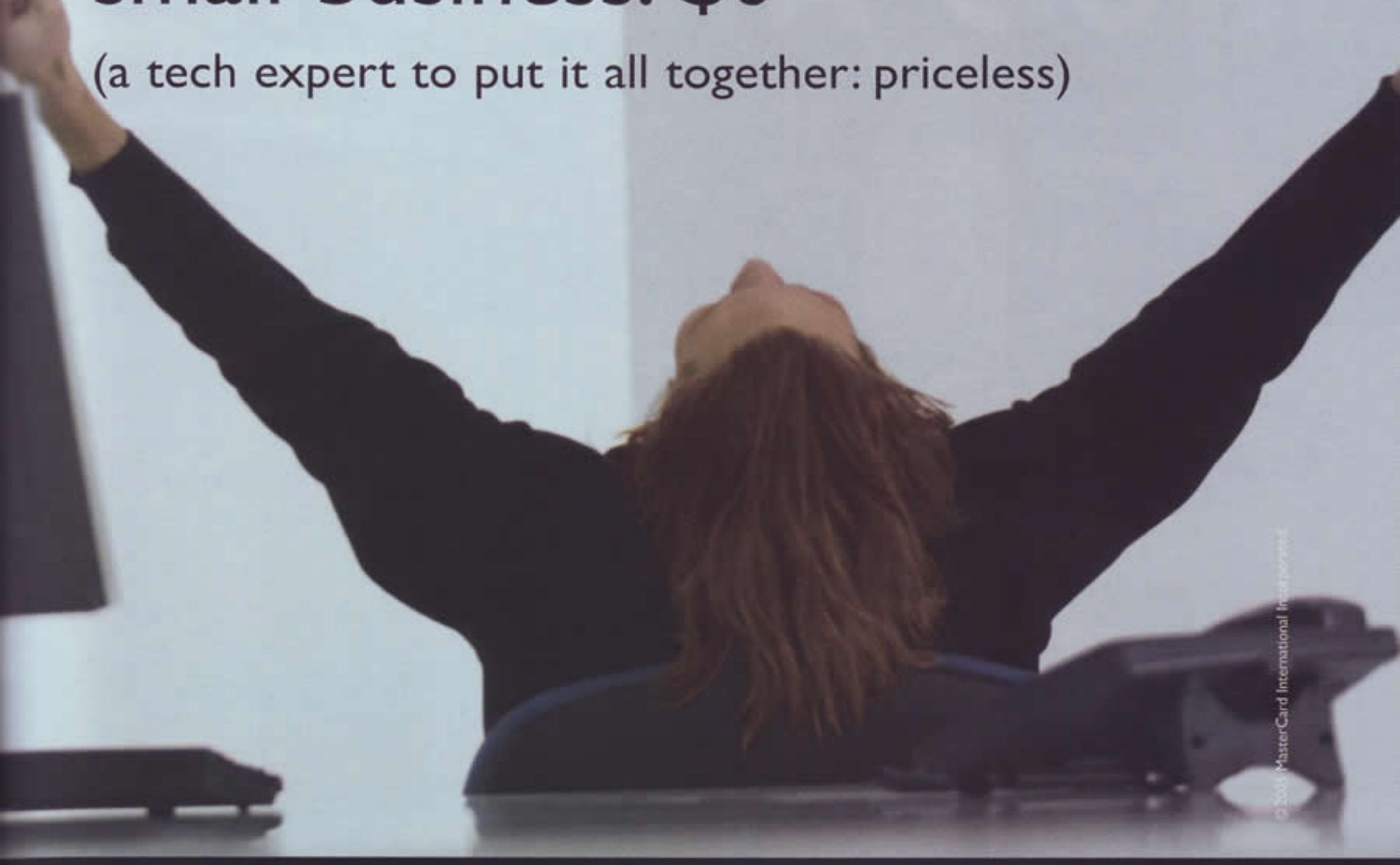

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Who Knew?

TECHNOLOGY

How Cool Is That?

On the rocks—or not

Astonishing technologies have a way of becoming, over time, so mundane as to be nearly invisible. So it is with the refrigerator, a modern marvel that has become roughly as thrilling as a toaster oven.

You can add external ice dispensers, a digital touch pad, and all the computer chips you want, but it's still just a fridge.

Here's the headline: Inventors are finding new and better ways to chill your beer. It's tempting to say that refrigeration technology is hot.

The evolution of the industry has been propelled in part by pollution. Two centuries ago refrigeration depended on natural ice. Entrepreneurs in New England hacked it from ponds—even Thoreau's Walden Pond—and shipped it in massive blocks to Calcutta or Singapore.

But even as industrialization spurred the ice industry, it also caused a crisis: Industrial wastes and sewage fouled those once pristine ponds. Increasingly nasty natural ice couldn't meet the world's demands. People turned to mechanically produced ice—and this new contraption, the refrigerator.

The physics of mechanical refrigeration are simple: A liquid refrigerant evaporates as it moves through pipes, sucking heat from an inner compartment and dissipating it through external coils. An electrically powered compressor then turns the gas back into a liquid, and the cycle begins anew.

Early refrigerants, such as sulfur dioxide and ammonia, were toxic, and their replacements, the "safe" chlorofluorocarbons introduced in 1930, turned out to be brutal to the planet's ozone layer. Their equally scary-sounding successors, hydrofluorocarbons and hydrochlorofluorocarbons, are greenhouse gases. Everyone would love to find a cleaner fridge.

Steven Garrett of Pennsylvania State University has helped develop a thermoacoustic refrigerator that uses sound waves to compress helium, a harmless gas. The gas doesn't have to go through a phase change into a liquid and back again, because just expanding and compressing does the trick of sucking heat out of the compartment. The fridge's engine is so loud it would set your hair on fire. But thanks to insulation, it barely hums.

Now look at something innovative at the other end of the technology spectrum: A women's organization in Sudan is distributing the *zeer* pot, a storage container that's essentially two nested clay pots with a narrow gap between them filled with sand. The sand gets soaked with water, which, as it evaporates, chills the inner container so effectively that food that would normally spoil in two days can last two weeks.

It's not complicated, and it works in the desert, a long way from electricity, thermoacoustic refrigerators, or anything as exotic as natural ice.

Next time you go to the boring ol' fridge, remember that it has changed our lives. Never mind threats to humanity like nuclear war and bioterrorism: Countless people today still die from spoiled food. As Steven Garrett puts it: "Refrigeration in the past hundred years has saved more lives than surgery."

—Joel Achenbach

WASHINGTON POST STAFF WRITER

WEBSITE EXCLUSIVE For more about refrigeration, and for links to Joel Achenbach's work, go to Departments at **ngm.com/0510.**

PHOTO ILLUSTRATION BY CARY WOLINSKY

SOONER OR LATER A DEADLY VIRUS THAT CAN JUMP FROM BIRDS TO PEOPLE WILL SWEEP THE GLOBE.

FEATHERED THREAT *In Thailand ducks wait for a clean bill of health from veterinary workers, far left, gowned and masked against a flu virus that can lurk in ducks but kills chickens and sometimes people. Thai duck herders traditionally drive flocks from field to field to eat leftover rice—a practice that can spread the virus.*

TRACKING THE NEXT KILLER FLU


RESTING
JOHN PUTT

ONCE AND FUTURE PLAGUE *Nguyen Si Tuan, 21, fights for his life in Hanoi's Bach Mai Hospital (far left), lungs devastated by a virulent flu he caught from an infected chicken. John Oxford of Queen Mary's School of Medicine in London, who studies the 1918 flu, visits the grave of a victim, a World War I nurse named Phyllis Burn.*

BY TIM APPENZELLER
NATIONAL GEOGRAPHIC SENIOR EDITOR
PHOTOGRAPHS BY LYNN JOHNSON

LITTLE NGOAN WAS BURIED behind her parents' hut three weeks ago. Her grave, a bulky concrete tomb like others dotting the Vietnamese countryside, rests on high ground between a fishpond and yellow-green rice fields. At one end her family laid out her cherished possessions: a doll's chair, a collection of shells, plastic sandals. They painted her tomb powder blue.

While Ngoan's parents are off helping with the rice harvest, other relatives share their memories. "She was so small, just ten years old," says her grandmother, sitting on a hammock. "She was very gentle and a good student. If you look at her older sister"—the 17-year-old hangs back shyly—"you can imagine what she was like." Ngoan's grandfather, silent with grief, lights a stick of incense at her grave.

The loss of a beloved child has hit this family hard. But ordinarily, the wider world would pay little attention to a child's death from infectious disease in this remote corner of Vietnam's Mekong Delta. Old scourges like dengue fever and typhoid still take a toll here, and HIV/AIDS is on the rise.

Yet Ngoan's death and more than 50 others in Southeast Asia over the past two years have raised alarms worldwide. Affected countries are struggling to take action; other nations are sending aid and advisers while stockpiling drugs and developing vaccines at home. And scientists have stepped up their research into the fateful traffic of disease between animals and people.

Why? Because Ngoan died of the flu.

WARNINGS *John Oxford holds paraffin-embedded samples of tissue from people who died of the flu in 1918 and earlier years (opposite). He hopes the samples will yield traces of the virus, which might show how it honed its deadliness before the global pandemic erupted in 1918. Yi Guan, at the University of Hong Kong, is tracking the evolution of the H5N1 bird-flu virus (shown in the model on his desk, below). "This virus is bad news for us," Guan says. He fears it could spark a new pandemic.*

To most of us, flu is a nuisance disease, an annual hassle endured along with taxes and dentists. Some people think a flu shot isn't worth the bother. But flu is easy to underestimate. The virus spreads so easily via tiny droplets that 30 million to 60 million Americans catch it each year. Some 36,000 die, mostly the elderly. It mutates so fast that no one ever becomes fully immune, and a new vaccine has to be made each year.

That's ordinary flu. But the disease that is taking lives in Southeast Asia is no ordinary flu. Its primary victims have been chickens, more than a hundred million of them, killed either by the virus or in often futile control efforts. It's not unusual for chickens to get flu; in fact, avian-flu viruses far outnumber human ones. But Robert Webster of St. Jude Children's Research Hospital in Memphis has studied flu viruses for 40 years and has never seen the likes of the one that killed Ngoan.

"This virus right from scratch is probably the worst influenza virus, in terms of being highly pathogenic, that I've ever seen or worked with," Webster says. Not only is it frighteningly lethal to chickens, which can die within hours of exposure, swollen and hemorrhaging, but it kills mammals from lab mice to tigers with similar efficiency. Here and there people have come down with it too, catching it from infected poultry like the chickens that died on Ngoan's farm a few days before she fell ill. Half the known cases have died.

In those deaths many public health experts hear the distant rumblings of a catastrophe. So far this virus—classified as H5N1 for two proteins that stud its surface like spikes on a mace—isn't good at passing from birds to people, let alone from one person to the next. "It can make that first step across, but then it doesn't spread easily from human to human," says Webster. "Thank God. Or else we'd be in big trouble."

Maybe H5N1 will never learn the trick of racing from person to person like the milder flus that empty offices and classrooms each year. Maybe it simply can't. Or maybe efforts to eradicate the virus—largely fitful and underfunded so far—will succeed. But experts are urging the world to prepare for the worst.

What is known about flu viruses' remarkable capacity to change and jump species has led to a sense of inevitability, a conviction that even if this menacing animal flu doesn't explode into a global pandemic that kills millions, another one will. "It's going to happen, at some point, that

FOOT SOLDIERS *On the hunt for bird flu, animal-health workers make a routine inspection visit to a henhouse perched above a fishpond in Vietnam's Mekong Delta. Farmer Trang Thi My Dung says her chickens have never been sick. "But we don't have many customers because they are afraid of the bird flu."*

THE DISEASE THAT IS NOW TAKING

a virus like this changes to be able to transmit from one person to another," says Jeremy Farrar, an Oxford University doctor who works on the front lines of avian flu at the Hospital for Tropical Diseases in Vietnam's Ho Chi Minh City. "It's bound to happen. And when it does, the world is going to face a truly horrible pandemic."

After all, it has happened before.

IN 1918, THE FINAL YEAR of the savage trench fighting of World War I, something else began felling the soldiers. No one knows for sure when or where the Spanish flu emerged, though it certainly wasn't in Spain. As a neutral country, Spain had no wartime censorship, and the flu apparently got its false pedigree from news reports about outbreaks there in May 1918. In fact the disease was already spreading on both sides of the European front, laying low entire divisions through the spring and early summer. Then it seemed to subside.

In late summer, though, the Spanish flu returned, and this time its virulence was unmistakable. The sick took to their beds with fever, piercing headache, and joint pain. Many were young adults, exactly the group that normally shrugs off the flu. About 5 percent of the victims died, some in just two or three days, their faces turning a ghastly purple as they essentially suffocated to death. Doctors who opened the chests of the dead were horrified: The lungs, normally light and elastic, were as heavy as waterlogged sponges, clogged with bloody fluid.

After flashing through crowded military camps and troopships in Europe and the United States, the flu leaped out of uniform to ports and industrial cities. In Philadelphia, historian Alfred Crosby found, 12,000 people died of flu and pneumonia in October—759 in a single day. Schools and businesses were shut down and church services cancelled. Morgues overflowed.

By then the sickness had spread to the far corners of the planet, from the South Pacific to the Arctic. "Everybody on Earth breathed in the virus, and half of them got sick," says Jeffery Taubenberger of the Armed Forces Institute of Pathology in Maryland, who is trying to learn what made it such a killer. More than 50 million people died—at least three times as many as in the war. The best medical minds of the day could hardly believe that this was flu.

It was flu all right, but with a crucial difference that scientists are only beginning to understand. Scattered across Taubenberger's desk are translucent wax blocks the size of matchboxes. Borrowed from a pathology archive, they hold fingernail-size scraps of purplish tissue, sliced from the lungs of flu victims in U.S. military hospitals almost 90 years ago. In the mid-1990s Taubenberger and his colleagues realized that a sample from someone who died quickly, lungs still seething with virus, might still hold genetic traces of the killer. They were right: In 1996 lung tissue from a soldier who died in September 1918 at Fort Jackson, South Carolina, yielded pieces of the virus's genes.

The pickings soon got better. Inspired by Taubenberger's discovery, a retired pathologist named Johan Hultin traveled to a remote Alaska village and excavated a mass grave that had been hacked into the permafrost after the Spanish flu swept through in November 1918. One female body still contained intact lung tissue, preserved by the cold and sheer luck. Bit by bit, Taubenberger's group teased out the entire genetic sequence of the virus. They plan to finish publishing it this year.

So far this genetic blueprint hasn't revealed exactly what made the Spanish flu so deadly. No single gene or protein is the obvious culprit. But comparing the 1918 sequence to those of the flu viruses that wreak mild havoc each winter has confirmed what was long suspected:

LIVES IN ASIA IS NO ORDINARY FLU

The Spanish flu virus had recently crossed into people from some unknown animal, leaving victims with little immunity to this new threat.

ONE REASON you generally get over the flu after a few days' discomfort is that your immune system has seen it before and knows how to respond. This year's bug won't be a carbon copy of last year's, because the virus mutates constantly. But it will look similar enough that your body can almost always keep it in check.

Every so often, though, something new comes along from the animal world—a vast preserve of type A flu viruses, the ones that cause the most serious illness in humans. In far-flung studies in the late 1960s and 1970s, from Australia's Great Barrier Reef to lakes in northern Canada, Robert Webster and his colleagues tracked flu to its source. "Where do flu viruses come from?" he asks. "From the wild birds of the world, the wild aquatic birds—the waterfowl, the ducks, the shorebirds."

Dozens of flu subtypes inhabit the birds' guts, mostly harmless to their hosts or to any other creature. But occasionally one infects domestic poultry. Even more rarely, a bird virus or some of its genes slip into the much smaller pool of type A viruses that infect humans.

Normally a flu virus good at infecting birds can't attack humans because it isn't equipped to invade and grow in human cells. Until recently scientists thought avian viruses could gain that

TOO CLOSE FOR COMFORT *Chickens are tested for flu (opposite) at a small farm in southern Vietnam, where poultry, pigs, and people live in close quarters. It's a recipe for trouble, because pigs can catch flu viruses from both birds and people, then act as "mixing vessels," cooking up dangerous new strains. Live-poultry markets like this one in Hanoi speed the spread of the virus from farm to farm when vendors take leftover birds back home, along with any flu viruses they've picked up.*

EMPTY HAMMOCK *Pranom Thongchan and her daughter lost two of their family to bird flu last year. The chickens living under their house in rural Thailand infected Pranom's 11-year-old niece; while caring for the girl, Pranom and her sister also caught the disease, in a likely case of human-to-human spread. Only Pranom recovered.*

EVERY SO OFTEN A NEW FLU VIRUS

ability only by indulging in the viral equivalent of sex. Because flu viruses carry their genetic information on eight separate RNA segments, it's easy for different subtypes to swap genes if they happen to meet. The result: offspring with new abilities.

For an avian flu and a human flu to mix it up, they have to infect the same animal. Scientists have long considered the pig a likely mixing vessel, because pig cells have surface molecules that allow entry to both kinds of virus. A pig could conceivably catch a human flu from a farmer and a bird virus from, say, ducks at the same farm. The two viruses could then "reassort," creating a hybrid that—in the worst case—would now be able to infect human cells while still carrying bird-virus genes that would make it radically new to the immune system of the people who catch it, and unusually virulent.

Reassortment explains the two lesser flu pandemics of the 20th century, in 1957 and 1968. In each year a new flu subtype appeared, combining genes from the human virus that had been causing mild outbreaks in prior years with new genes from a bird virus. The new pandemic viruses raced around the world, together killing about two million people.

But in 1918, Taubenberger now believes, something different happened. "We think it's pretty likely that the virus was not derived from a previously circulating human virus," he says. All of its genes mark it as an animal virus, pure and simple, that somehow crossed to people without the help of genes from a previous human strain.

Now H5N1 is doing the same thing. So far, its steps across the species barrier are tentative, which is why it has caused tens of deaths, not millions. But as in 1918, doctors who have seen its effects close up are shaken.

THE X-RAYS TELL THE STORY as Tran Tinh Hien, a doctor at the Hospital for Tropical Diseases in Ho Chi Minh City, clips them to a light box. In the first image, made the day the 18-year-old girl was admitted with bird flu, a whitish cloud appears at the base of her rib cage. Her lungs were partly filled with fluid. In a second film, four days later, the haze has spread throughout her chest. "All the lung tissue was destroyed," Hien says. "The process still happened when we treated." A week later the girl was dead.

So it went for Hien and his staff throughout January, when the latest bird-flu outbreak reached its peak in southern Vietnam. They cleared a 50-bed ward normally reserved for malaria and dengue fever and turned it into an isolation unit. They sustained patients with oxygen masks and ventilators and treated them with oseltamivir, or Tamiflu, an expensive antiviral drug that can fight H5N1. Nurses worked 24-hour shifts, gowned, masked, and goggled for protection against the virus. As Hien says: "We were pushed to the wall."

He and his staff did everything they could for their nine bird-flu patients. "Unfortunately," he says, "we could not save any lives."

As an elite facility, the Hospital for Tropical Diseases saw the bleakest face of the disease. Only the sickest patients were sent there, and by then they may have been beyond help. In fact H5N1 doesn't always kill. Some infections may even be so mild that they go unnoticed. But every hospital that has treated people seriously ill with avian flu has recorded shocking death rates.

It has been that way since 1997, when an H5N1 virus strain—a cousin of the one now plaguing Asia—first jumped to humans. Early that year an outbreak of the virus killed chickens in Hong Kong's rural New Territories. At that point, no one thought bird viruses threatened people directly. But this one broke the rules.

In May 1997 a three-year-old boy was admitted to a Hong Kong hospital with a cough and

COMES FROM THE ANIMAL WORLD

fever. His symptoms worsened rapidly and he had trouble breathing. He was given a flood of antibiotics and put on a ventilator, but within six days he was dead. Flu experts were astonished when secretions from the boy's windpipe yielded an H5N1 virus. It turned out to be the same one that had killed the chickens.

Still, his death looked like it might be a fluke until late in the year, when another 17 people checked into hospitals around Hong Kong with similar symptoms, and tests confirmed infection with H5N1. Five died. Many of the victims had visited one of the island's live-poultry markets.

Public health experts converged on Hong Kong, fearing that a 1918-style pandemic was about to explode. They persuaded the Hong Kong government to kill every last bird—1.5 million of them—in the farms and markets. The mass slaughter worked. That particular H5N1 virus was never seen again, and a public health disaster had been averted.

But in 2001 another deadly strain of H5N1 cropped up in Hong Kong's markets, and the city again began killing poultry. This time the respite was shorter, and by the beginning of 2002 chickens were again dying of flu. The fact was, the drastic measures in Hong Kong had left the source of all these viruses untouched. They were coming from outside Hong Kong—just across the territorial border in southern China.

China's Guangdong Province teems with hundreds of millions of chickens, ducks, and geese,

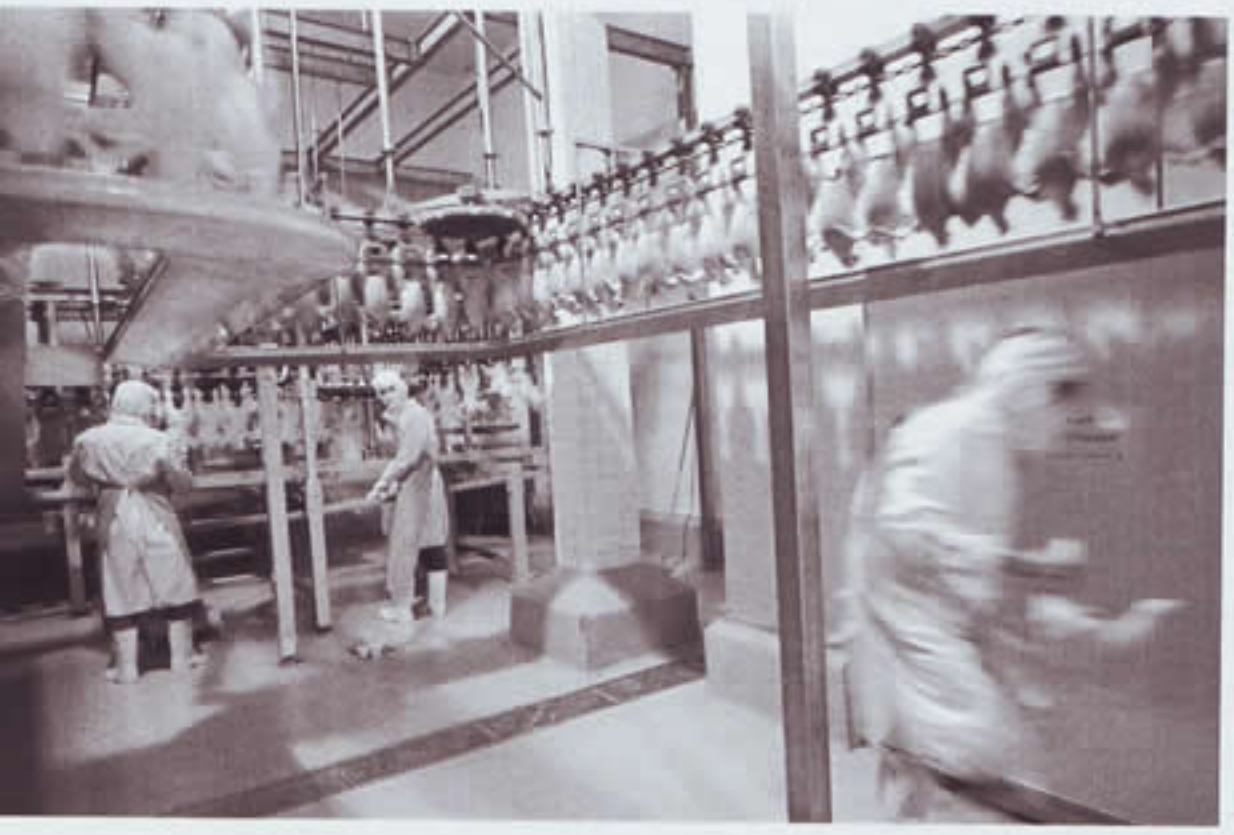
BELOVED BIRDS *Fear of bird flu is at war with tradition in Southeast Asia, where the chicken has a key place in culture and cuisine. In Ho Chi Minh City girls pose beside a giant straw rooster (opposite) during Tet, the Vietnamese New Year. The February 2005 festival ushered in the Year of the Rooster —and was followed by new bird-flu cases linked to holiday chicken meals. In Thailand worshippers bring statues of roosters to a shrine dedicated to a 16th-century national hero, who loved cock fighting.*

DANGEROUS LIAISON *Tenderly reviving his champion, Ea Khamjean risks his own health as he sucks blood from his fighting cock's wounds after a match. Thousands of Thailand's fighting cocks have died of bird flu or been destroyed to stop its spread, and at least one man died after catching the virus from his prized birds.*

H5N1 IS ALL THE MORE FRIGHTENING

many wandering freely through gardens, farms, and ponds. Flu viruses that rain into this sea of poultry in wild-bird droppings can spread and swap genes with abandon. The result: new strains not found in the wild. Among them was the H5N1 virus that gave rise to the bird flu now plaguing Asia.

Year after year it swapped genes with other avian-flu viruses, generating a plethora of new H5N1 variants. Year after year they besieged Hong Kong, which imports poultry from the



mainland. By the end of 2003, they were infecting and killing birds across half of Asia.

Radiating from China, H5N1 strains reached South Korea and Japan in the north; they swept through Southeast Asia as far as Indonesia. Some experts and officials have suggested that the viruses traveled in the guts of wild waterbirds—geese, ducks, herons—which might have picked up the infection from farms. Governments embarrassed by their failure to halt the flu's spread welcome that idea. "They get a free lunch," says Yi Guan, a virologist at the University of Hong Kong. "Each time there's an outbreak, they say, 'It's migratory birds. I cannot control them. I cannot lock my sky!'"

This summer the virus killed thousands of wild geese and gulls at a nature reserve in western China. It was the largest known outbreak in wild birds and a warning that in the future they might spread the disease far and wide. But Guan isn't ready to blame migratory birds for the spread so far. He thinks the virus has killed infected birds too quickly for them to fly long distances. Instead H5N1 probably hitchhiked across Asia in shipments of live poultry, in a disaster of our own making.

AS IT ADVANCED, the virus began killing people again—by August the count stood at 40 in Vietnam, 12 in Thailand, 4 in Cambodia, and at least 1 in Indonesia. And it inflicted economic losses that, by one estimate, amounted to more than ten billion dollars in 2004 alone. Exports from Thailand's industrial chicken farms collapsed when the world learned of the outbreak there. In areas of Indonesia hit hard by the virus, more than 20 percent of the workers on commercial poultry operations lost their jobs.

Small farmers are suffering too. As one animal health official in Vietnam explains, "The birds are big treasures for the farmers." They scavenge for themselves, costing next to nothing to raise and putting good meat on the table. Vietnamese farmers lost some 40 million of these treasures in 2004, dead of flu or killed in control efforts. Even farms untouched by the disease were hit as fearful shoppers began avoiding poultry.

It may take a long time for Vietnam to regain its taste for chicken. At a riverside restaurant in the southern city of Can Tho, six veterinary officials—men responsible for keeping the district's poultry healthy—order prawns and a fish stew for lunch. They admit it: Not one of them will touch chicken these days.

H5N1 is all the more frightening because so much is unknown, starting with how it kills people. In a chicken, the virus spreads everywhere—gut, lungs, brain, muscle. In humans, like the 1918 flu, it devastates the lungs first and foremost.

Researchers at the University of Hong Kong have found that a victim's own immune system may be part of the problem. It reacts to the virus with a flood of chemical messengers that draw white blood cells into the lungs, where they trigger a massive inflammatory reaction. "It's kind of like inviting in trucks full of dynamite," says Malik Peiris, who led the work. Healthy tissue dies and blood vessels leak, filling the lungs with fluid.

But H5N1 may have more than one way to kill. This year researchers in Ho Chi Minh City,

BECAUSE SO MUCH IS UNKNOWN

HIGH STAKES *Chickens are processed for export at a Thai plant (opposite), part of a billion-dollar industry devastated by bird flu in 2004, when outbreaks in Thailand led other countries to ban its poultry. In Hanoi, Anton Rychener of the United Nations Food and Agriculture Organization stabs the air in a meeting with Vietnamese and foreign officials as he urges quick changes in farming practices that raise the threat of a human pandemic. "The warning signs, the flags, are up," he says.*

including Jeremy Farrar, detected H5N1 in a little boy who died in a coma, his brain inflamed but his lungs healthy until the very end. To Farrar it suggests that the virus can spread throughout the body. Others aren't sure.

It's one more bird-flu mystery.

Ask Keiji Fukuda and Tim Uyeki, flu epidemiologists at the Centers for Disease Control and Prevention (CDC) in Atlanta, what they would most like to know about the disease, and the questions come tumbling out. "How many people are infected? How many animals are infected?" asks Fukuda. Since 2004 only four countries have reported human illnesses. "Have there been no others?" Uyeki asks. "It's pretty likely there have been, but we have no information about that."

Then there's the mystery of exactly how people get infected. "Right now we believe that most cases are related to people somehow being exposed to sick or dying or dead poultry," says Fukuda. "Well, what does that mean?" he asks, ticking off possibilities. Does that mean people touched it? Did they eat it? Did they breathe in dust containing chicken feces? He's frustrated at the often sketchy reports from Asia. "What is really going on?" he asks. "This has very practical implications" for fighting the disease.

The biggest question is whether the virus will start spreading like ordinary human flu. "Human to human—that's the one *(Continued on page 26)*


10
11

TOUCH AND GO *Comatose and hooked to a ventilator at Bach Mai Hospital in Hanoi last March, bird-flu patient Nguyen Si Tuan was not expected to live. The young man rallied and went home two months later—a lucky survivor. "It's a phenomenally destructive infection in the cases we've seen," says one doctor.*

1918

50-100 MILLION DEATHS

Bird origin suspected

1900 | 1910 | 1920 | 1930 | 1940

OVERDUE FOR A FLU PANDEMIC?

Three times in the 20th century a new flu virus spread through the world's population, causing an unusual number of deaths because people had little immunity to it. Nearly 40 years have passed since the last pandemic. The world may be ripe for a new one as a dangerous bird flu circulates in Asia.

SPANISH FLU 1918-19
The most deadly outbreak in history, the Spanish flu is believed to have originated in birds sometime before 1918. It swept the globe in 1918 and early 1919. Except for a few Pacific islanders, everyone on Earth was exposed to the disease, and half got sick.

50 million

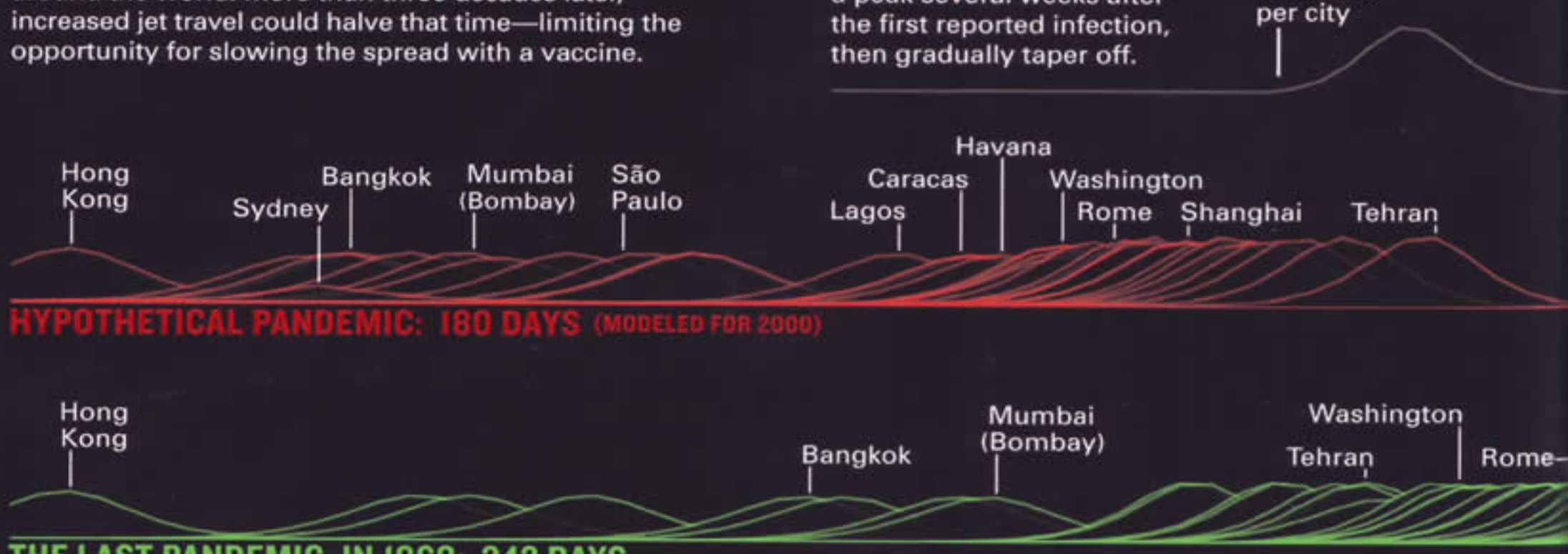
100 million

A VIRUS MOVES TWICE AS FAST NOW

The last pandemic, in 1968, took a year to spread around the world. More than three decades later, increased jet travel could halve that time—limiting the opportunity for slowing the spread with a vaccine.

KEY
In each city, flu cases rise to a peak several weeks after the first reported infection, then gradually taper off.

Flu cases per city



RESPONSE: DAY 1
As soon as a pandemic begins, countries with stockpiles of antiviral drugs can begin distributing them.

DAY 100
If a vaccine were developed and tested in advance, distribution could begin within three months of the start of the pandemic.

Bird and human viruses mix.

1,000,000 DEATHS

Bird and human viruses mix.

750,000 DEATHS

Since 1997, outbreaks of H5N1 bird flu have alarmed experts.

TODAY

180-360 MILLION COULD DIE

7.4 million

1960 1970 1980 1990 2000 ?

ASIAN FLU 1957
The pandemic emerged in southern China when a bird and a human flu swapped genes, probably after infecting a pig. The result was a new and deadly virus.

HONG KONG FLU 1968
A bird and a human flu again swapped genes, creating a new virus first seen in Hong Kong. Similarities to the 1957 virus meant people had some immunity, which helped reduce deaths.

THE NEXT KILLER FLU
The H5N1 bird-flu virus killing poultry and people in Asia could cause the next global pandemic if it gains the ability to spread quickly from person to person. Estimated deaths in such a pandemic range from 7.4 million to an apocalyptic 180 million to 360 million, extrapolating 1918 deaths to today's population.

180 million

360 million

52 CITIES
The flu could spread to these cities twice as fast as it did in 1968 (data graphed below).

DAY 250
It normally takes about this long to develop a vaccine, test it, amass the millions of fertilized eggs needed to make it, and get it to market.

PANDEMIC MORTALITY RATES (TOP): MICHAEL T. OSTERHOLM, UNIVERSITY OF MINNESOTA; WORLD HEALTH ORGANIZATION. SPREAD MODELS (BOTTOM): REBECCA F. GRAIS, J. HUGH ELLIS, GREGORY E. GLASS, JOHNS HOPKINS UNIVERSITY. NGM ART

NO ONE WANTS TO SIT AND WAIT FOR

that we don't want to see," says Robert Webster. But already, H5N1 has given experts a few scares.

NGUYEN THANH HUNG, a cement trader in Hanoi, says he feels well these days. He works, tends a small forest of potted plants, and spends hours a day jogging and doing breathing exercises. In his living room one day in February he shows off his hospital discharge papers as if they were his new lease on life. It's been just a month since Hung got over a serious bout of avian flu. "The doctor told me if I had been taken to the hospital one or two days later—no way," he says. His older brother, also infected, was not so lucky.

If Hung's survival is remarkable, so is the way he seems to have caught the disease. On a visit to their home village outside Hanoi he and his brother had shared a pudding made of raw duck blood, a Vietnamese delicacy. The duck must have been infected with H5N1, because Hung's brother came down with the flu a few days later. But Hung did not get sick for more than two weeks—not until the day after his brother died.

That's too late for the pudding to be the cause, Tim Uyeki believes. Hung probably got infected while caring for his brother in his final days.

H5N1 is also thought to have jumped from a girl dying of avian flu in Thailand to her mother and aunt, who nursed her. Several other cases of human-to-human transmission are suspected. But one step beyond the initial victim is all the virus seems to have managed. So far, sustained transmission—the chain-reaction spread of ordinary flu—is not in its repertoire.

It might gain that ability on its own, by mutating. Or it might swap genes with a human-flu virus. That could take place in an infected person who also catches ordinary flu, or in the classic flu mixing vessel, the pig. Still, no one knows whether the exchange would yield a nightmare virus or a dud.

Flu researchers at the CDC and in the Netherlands hope to find out in advance, by artificially breeding new viruses. In high-containment labs they are deliberately mixing and matching genes from H5N1 and human-flu viruses. Then they will test the hybrids to see whether any have inherited both the bird virus's virulence and the human virus's ability to spread. In effect, they are trying to create a pandemic flu strain in the lab.

Some critics think that's reckless, but Erich Hoffmann, a St. Jude researcher who helped develop a genetic engineering technique for flu, says the experiments are key to learning what we may eventually face. "It's basically the best simulation one could have in the lab of what possibly could happen in nature."

If we're lucky, he says, all the hybrid viruses will be harmless or won't thrive, suggesting that H5N1 may never spawn a pandemic. "That of course would be good news," says Hoffmann. And if the news is less reassuring? Then scientists monitoring H5N1 in Asia would have a clue about what to watch for—what genetic changes in the virus might signal big trouble ahead.

THAT KNOWLEDGE might buy some warning time, but no one wants to sit and wait for H5N1 to make its move. And everyone agrees on the best way to head it off: Eradicate H5N1 in poultry, so people can't catch it. It's simple—but not easy.

Howard Wong, a senior veterinary officer in Hong Kong, knows what it takes. Since 2003, after multiple outbreaks and two wholesale poultry slaughters, the territory has kept its farms and markets free of H5N1. Wong is proud of his success. "We were very happy in 2004, when it was everywhere else, and we managed to hold it back."

Here are some steps Wong and other officials took: vaccinating every chicken in Hong Kong against H5N1; regularly testing chickens, pet birds, even wild birds; shutting down the hundreds of live-poultry stalls twice a month to

THE VIRUS TO MAKE ITS MOVE

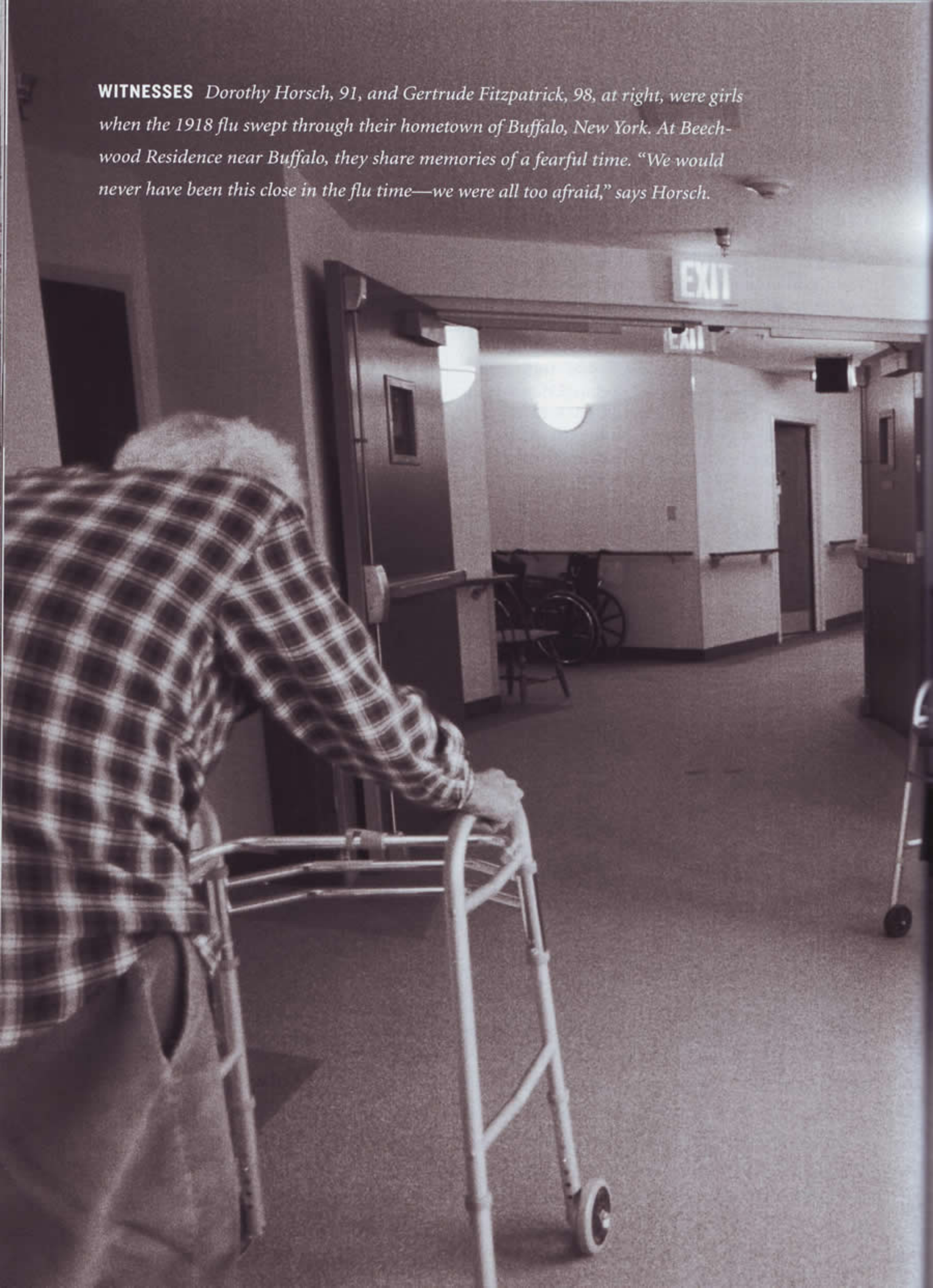
disinfect them; and inspecting farms and markets obsessively. "We're almost at the limit of what we can do," says Wong. "It's like holding up this wall, and this wall just gets heavier all the time."

And as one aid official in Vietnam puts it, Hong Kong is rich, and an island. Vietnam is neither. In the winter of 2003-04, H5N1 broke out in most of the country's 64 provinces. To fight it, the country slaughtered tens of millions of chickens. The epidemic seemed to decline, and in March the government declared victory.

But in late 2004 avian flu roared back, infecting birds and people along the length of the country. Cooler weather, which favors the survival and spread of the virus, had apparently brought it out of hiding. By February of this year Anton Rychener, the representative of the United Nations Food and Agriculture Organization (FAO) in Hanoi, was beside himself. "Why the hell are we sitting here a year later with literally the same pattern of outbreak?" he asked a roomful of officials. A year of meetings and emergency initiatives had done little to change the conditions that made Vietnam ripe for viral spread.

In the countryside, chickens peck in yards and stalk through underbrush, mingling with birds from other farms. Poultry markets act as viral swap meets, and unsold birds are taken back home with any viruses they picked up. Farmers with sick birds have little incentive to speak up and see their flocks destroyed: The government

OUR BEST SHOT *Lisa Chrisley at the University of Maryland Medical Center in Baltimore injects volunteer Christopher Tate with a trial vaccine against the H5N1 flu virus. In August the U.S. government announced that the vaccine appeared effective. Flu vaccines are made from virus grown in fertilized chicken eggs like those at Charles River Laboratories in Connecticut (opposite), where workers harvest virus-rich tissue from eggs to produce a test for detecting flu infections in poultry.*



WITNESSES *Dorothy Horsch, 91, and Gertrude Fitzpatrick, 98, at right, were girls when the 1918 flu swept through their hometown of Buffalo, New York. At Beechwood Residence near Buffalo, they share memories of a fearful time. "We would never have been this close in the flu time—we were all too afraid," says Horsch.*

IN A FEW WEEKS A NEW PANDEMIC

can afford to pay less than half of a bird's market value as compensation. And then there are the ducks.

The duck, says Webster, is "the Trojan horse of this outbreak." His group has found that unlike chickens, infected ducks often seem healthy, able to waddle, swim—and spread the virus in their droppings. In Vietnam and other parts of Southeast Asia, they spread it far and wide because duck herders drive their flocks from one rice field to the next, following the harvest, so the birds can fatten on leftover grains.

Inefficiency, tradition, and scarce funds have all slowed Vietnam's efforts to change such practices. And although officials gamely declare that they are making progress, last year's confidence has faded. When asked whether he expects his district to be hit by bird flu again next year, a veterinary officer in Can Tho says, "It's not my expectation, but I think it will happen."

Thailand has made more headway. Wealthier and more developed than Vietnam, it reimburses farmers more generously when birds are slaughtered. It tests ducks for H5N1 and allows only virus-free flocks to move around the countryside. And it has enlisted nearly a million village volunteers to watch for unusual chicken die-offs. By early this year it had driven the virus back into just a handful of provinces.

Even so, Wantanee Kalpravidh, the FAO's regional coordinator for avian influenza in Southeast Asia, says the country cannot rest easy. It has

LIFE IN THE BALANCE *Thai farmer Noi Tritanasombat waits for health workers to test his ducks for the H5N1 virus. Such measures have checked the spread of bird flu in Thailand, but outbreaks elsewhere in Asia pose a continuing threat. The virus could evolve into a form that passes easily from person to person—and could spread around the world by jet (opposite). "We know what we should do," says flu expert Yoshihiro Kawaoka. "Eradicate the virus in Asia. Identify infected poultry, and kill it all."*

WOULD HIT MAJOR CITIES

long borders with Laos and Cambodia, destitute lands struggling with their own avian-flu outbreaks. Thailand's efforts could quickly be undone if a crate or two of infected poultry slipped in. As Kalpravidh points out, "Birds need no visa or passport."

NOR DO VIRUSES. Suppose H5N1 lives up to the fears and picks up a new talent for contagion. Somewhere, probably deep in the countryside, a pandemic spark would ignite. A person sick with bird flu would infect his family, who would pass the disease to friends and neighbors. Exponential spread might follow.

Computer simulations suggest that public health officials just might be able to douse the spark by flooding the region with antiviral drugs, treating the hundreds of thousands of people who are at highest risk for infection. But the strategy could succeed only if the outbreak were detected within a few weeks and the virus spread slowly at first. And the infrastructure and skills required are lacking in much of Asia.

If containment failed, in a few more weeks the newborn pandemic would hit major cities. There it would infect people with passports and plane tickets. The rest of the world would be hours away.

Richer countries are scrambling to prepare. Because Tamiflu can protect against H5N1 as well as treat it, governments are building up stockpiles, and drugmaker Roche is hard-pressed to keep up with demand. The U.K. has ordered enough for 15 million people, a quarter of its population, and France almost as much. The U.S. has opted for a smaller stockpile—just 2.3 million treatments so far. It is also pinning its hopes on a vaccine.

Ordinary flu vaccines contain flu virus, grown in fertilized chicken eggs, then killed and split into pieces. But because it's so deadly, H5N1 requires expensive safety measures and tends to kill the eggs needed to grow it.

So Webster's group turned to genetic engineering, altering one gene to tame the virus and splicing in others to speed its growth. By August human tests of a vaccine made from the altered virus showed early signs of success. The U.S. government has already ordered two million doses.

Two million doses would be scant protection

for a country of nearly 300 million. But officials hope the vaccine formula will be fully tested and ready before it is ever needed. Makers would know how to produce it and could boost production fast, says Anthony S. Fauci, director of the National Institute of Allergy and Infectious Diseases. At the first sign of a pandemic, "We'll be able to say: Go, take off the brakes and make millions and millions of doses."

BUT AGAIN COMES THE REFRAIN, no one knows. No one knows whether an H5N1 pandemic strain—if it ever emerges—will be similar enough to the virus now stalking Asia for this vaccine to offer full protection. No one can even be sure H5N1 is the right threat to focus on. Several other bird-flu viruses have recently shown signs of infecting humans, though none has proved as deadly as H5N1.

Here is what we know for sure. One day a new flu pandemic will come, and one day it will pass. And then the killer strain, tamed by our immune systems and the passage of time, will fade into the background of nuisance flus.

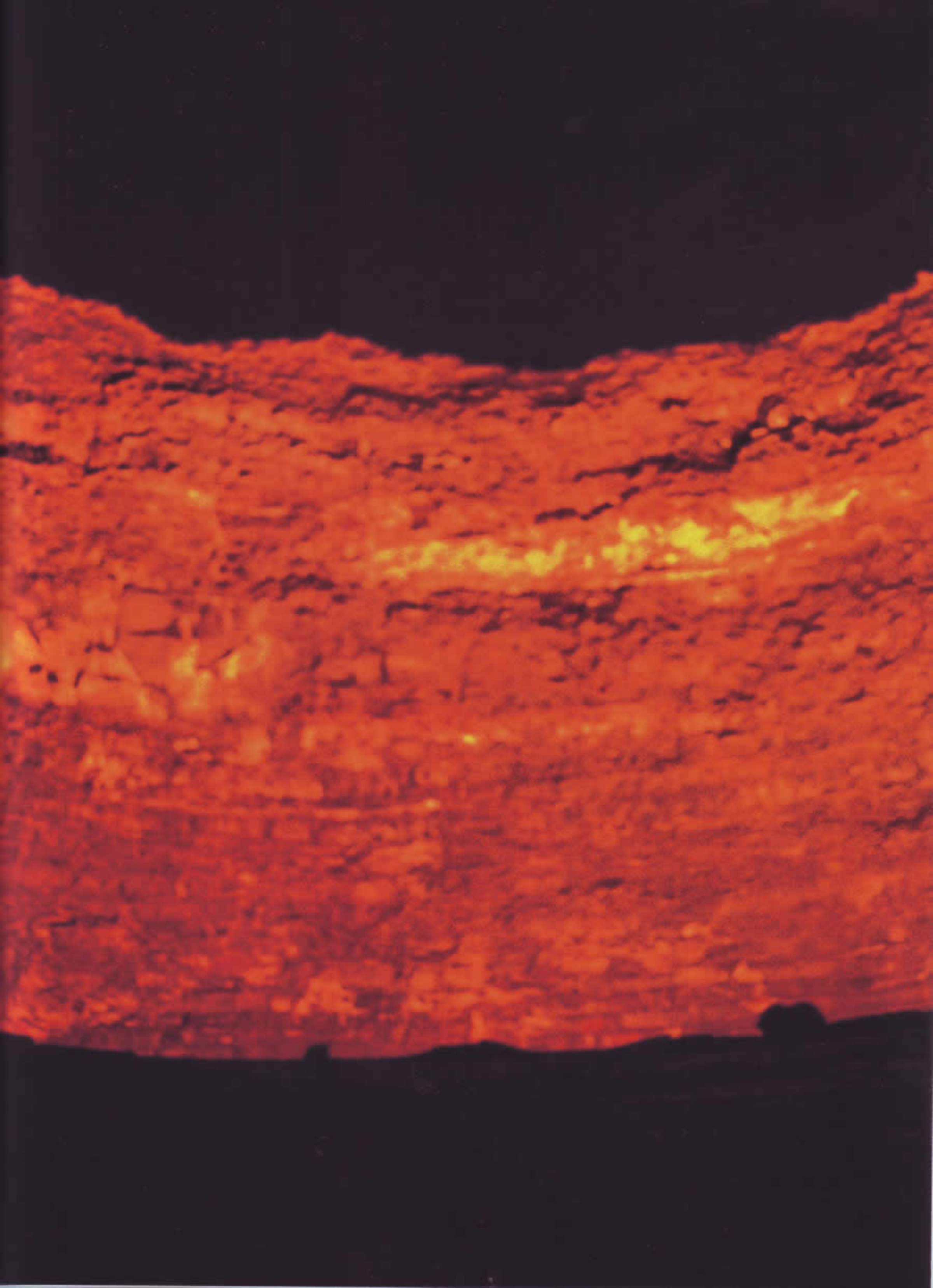
It even happened to the worst of them all. Did you catch the flu last winter? There's a chance it was a direct descendant of the Spanish flu. If so, you were lucky. The heir to 1918 is one of the milder flu strains around today. □

WHEN WILL IT STRIKE? What should we do to prepare for a global pandemic? Share your thoughts in our forum. Then travel across Southeast Asia with photographer Lynn Johnson in a special multimedia show at **ngm.com/0510**.

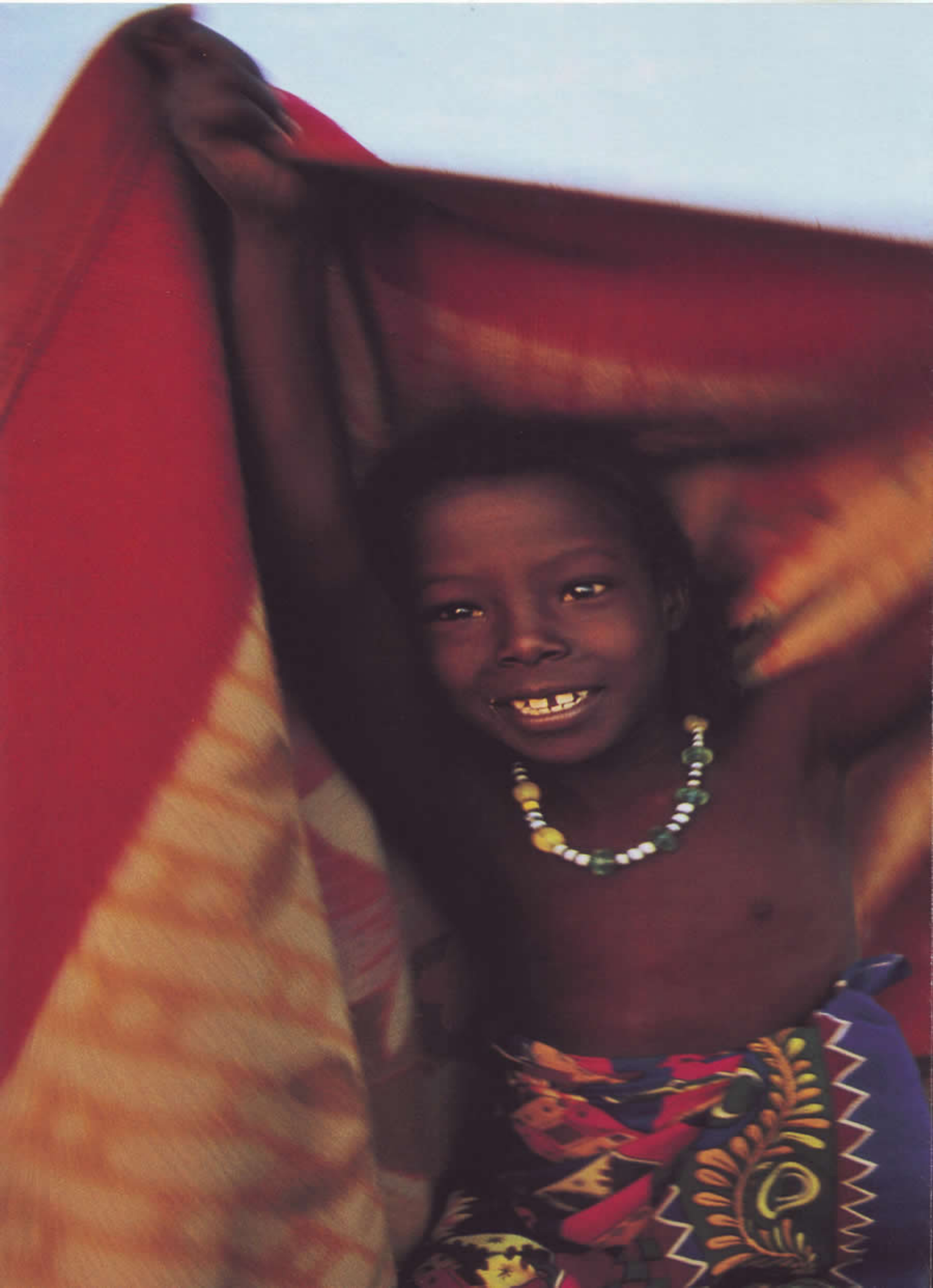
Africa's Danakil Desert

Cruelest Place on Earth

By VIRGINIA MORELL
Photographs by CARSTEN PETER



The glow from a lake of molten lava in the Danakil lights a crater wall on Ethiopia's Ertale volcano, active for almost a century. Eritrea and Djibouti also share this parched sweep of desert that sustains nomadic tribes and salt traders.



"I have news," Edris Hassan announced gravely. Seating himself on a boulder above Ethiopia's Saba River in the northern Danakil Desert, he propped his Kalashnikov assault rifle beside him. Edris was tall for an Afar, one of the pastoralist peoples who roam this harsh land, and built like what he was: a warrior and militiaman. For our small party of travelers he was also guard and guide, his reputation and weapon smoothing our way through the Afar, considered among the fiercest people in the world.

Another day on the move begins for a young girl of the Afar people. With her mother suffering from malaria, she led one of the family's camels on a daylong trek to find water. Travel here is perilous. Other tribes covet the Afar's homeland, and a group of Afar rebels called the Ugugumo prowl for conscripts in their fight to regain territory lost in the Eritrean-Ethiopian war.

In the town of Hamed Ela, while waiting to join the salt-trading caravan we were now traveling with, I'd learned from Edris that news, or *dagu* as the Afar call it, is a weighty subject, something to be pondered and assessed. It is more than a bush telegraph or village gossip, more than the latest headlines. Instead, in a ceremony of handshakes and hand kisses, the Afar pass along recitations of all they have seen and heard, a poetic litany that can be almost Homeric in its detail and precision. It is through dagu that they learn of any newcomers to their desert realm, of the conditions of water holes and grazing lands, of missing camels and caravans. They learn of weddings and funerals, of new alliances and betrayals, of the latest battles fought, and the conditions of the trail ahead. They learn about what has changed in a changeable land, and in the world at large, and from all this they pick a course of action. Those who pay the closest attention to the news, they say, may go on to survive, *Inshallah*—God willing.

Edris turned now to share the latest dagu with us—photographer Carsten Peter and me—speaking in Amharic, Ethiopia's lingua franca, through our interpreter, Zelalem Abera.

"I met a friend here," Edris said, tilting his head toward a small cluster of thatched huts that make up the Afar village of Asso Bollo. "He has news of trouble ahead. The Ugugumo are in the canyon. They're stopping all the caravans, asking for money, causing trouble. It's not safe for us to continue. If you go ahead, you're no longer my responsibility."

The Ugugumo: We'd heard rumors about these rebels (the Afar Revolutionary Democratic Unity Front) from the first day we set foot in the desert. They were, we'd been told, wild and unpredictable and as hard and unforgiving as the sands of the desert. But they were also heroes, men of courage, since they were fighting to regain Afar territory that was lost in the early 1990s, when Eritrea defeated Ethiopia and became a separate nation.

Edris sat back and uncorked his canteen, then upended it and symbolically emptied his water into the sand: He wasn't about to tangle with the Ugugumo. For him this was the end of the trail.

Carsten, Zelalem, and I looked at one another, stunned. We'd waited over a week in Hamed Ela to join these Afar salt caravans, which had ceased their long-distance journeys during the Muslim holy month of

Travertine chimneys fashioned by hot springs tower over women seeking pasture for their goats along the shoreline of Lake Abbe in Djibouti. When the brief spring and late summer rains come, grass sprouts in low spots holding rich volcanic soil.

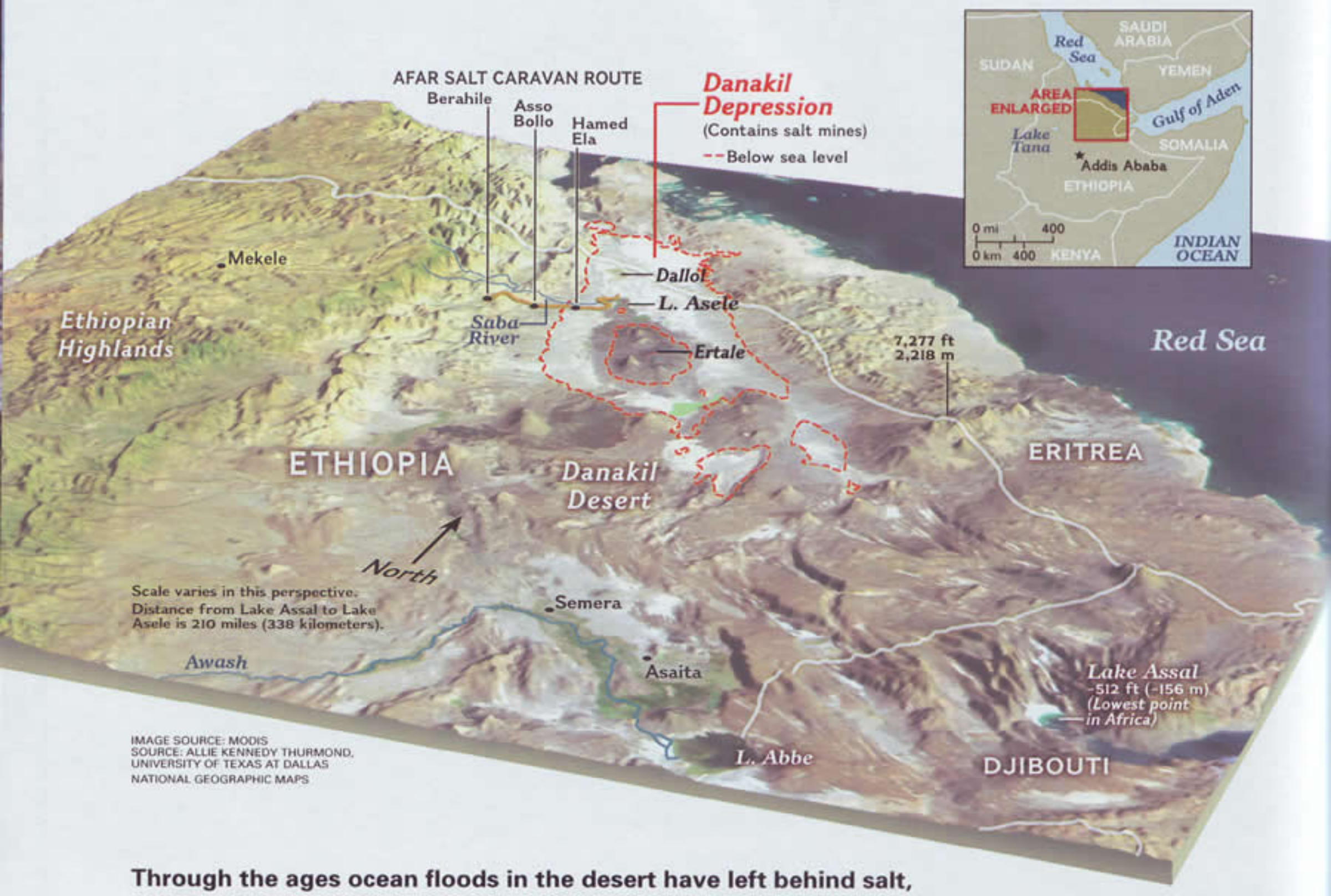


IMAGE SOURCE: MODIS
SOURCE: ALLIE KENNEDY THURMOND, UNIVERSITY OF TEXAS AT DALLAS
NATIONAL GEOGRAPHIC MAPS

Through the ages ocean floods in the desert have left behind salt, a commodity prized by the Afar for centuries. The author and photographer traveled a salt route between the mines near Lake Asele and the town of Berahile, where the caravans unload their haul. In the new Afar government center of Semera, a water tower rises (opposite) to gather another valuable resource.

Ramadan. And now that we were at last with them, we wanted to keep going. We'd been warned that the three-day trip would be hot and exhausting, a thirsty plod from the salt flats beyond Hamed Ela through rocky desert and canyons to the larger town of Berahile where the caravans unloaded their salt, but we'd never expected it to come to such a sudden end. What were we to do? It was nearly three o'clock in the morning. Below us, in the silky glow of starlight, the caravans we'd been with continued to make their way up the riverbank and disappeared around a bend into a sandstone canyon —pursuing the very route that Edris had declared too dangerous for us to follow.

Yet danger and hardship were what we'd come to the Danakil Desert for—or at least wanted to observe. By traveling with the salt traders, we hoped to gain insights into the Afar way of life. Already, following our week in Hamed Ela, a dust-and-fly-stricken hamlet, I'd formed some opinions. One was that people can and will live anywhere—even in the Danakil, a place of dry sands and even drier gravel beds, rocky lava flows, active volcanoes, burning salt flats, temperatures that often top 120°F, winds that choke you with dust, and suffocating days of no wind at all. Even worse, this place where rain falls sparingly at the best of times was now in the grip of a bad drought, and the half-mummified carcasses of camels and goats lay strewn across the sands.

And the Ugugumo wanted to liberate this land. What was there to be freed, I wondered? Why would anyone fight over this hellacious place? And how had it come to have such a hold on these people?

The salt merchants I'd asked the day before looked baffled by my question. "It's the salt," they said, hoisting blocks the size of encyclopedias onto their camels. "It's our corn; it's our gold. Of course we would fight anyone who tried to take it."

We'd met the merchants at the salt mines that lie beyond Hamed Ela and border Lake Asele in the heart of the northern Danakil. More than 300 feet below sea level, the salt lake and plains are one of the lowest points in Africa (the absolute lowest, at 512 feet, lies farther southeast in the Danakil at Lake Assal in Djibouti). Here, teams of Muslim Afar and Christian Tigrayans from the Ethiopian Highlands gather daily ten months out of the year to mine the salt and ferry it by camel, mule, and donkey to markets in Ethiopia's mountains and beyond into Sudan. In the past the salt blocks (called *amolé*) were used throughout Ethiopia as money. Although hard cash has replaced the salt, the trade itself remains the main livelihood of the northern Afar, and they guard their treasure—as well as every grain of sand in their desert—like the Argonauts of old.

The Afar make sure that no one robs them of their salt by studiously overseeing the mines and caravans. Every merchant must stop at the salt-tax collector's hut in the dusty enclave of Hamed Ela on the edge of the salt flats and pay a fee for each camel, mule, and donkey in his caravan. At the mines, every job—from levering the salt from the earth to running the outdoor tea kitchens—is assigned and managed by an Afar. Theirs is a strict monopoly, and it has made them proud and dictatorial. They do not hesitate for a minute to let you know that once you set foot in their salt kingdom, you are subject to their commands.

We found that out in Berahile, which sits about midway up the escarpment that rises above the desert. The government offices of the northern Afar region—a semi-autonomous part of Ethiopia—are located in Berahile, the main market town for the Afar caravans, which is presided over by the turbaned and dignified Ali Hassan Bore. Before venturing to the mines, Carsten, Zelalem, and I paid Ali a visit, joining him and his retainers on the veranda of one of the squat government buildings. In his 50s, Ali had the bearing of a sultan. He wore a beige polo shirt and green plaid sarong with a wide leather belt; a short dagger was discreetly tucked into it. Over his shoulder he displayed a not-so-discreet, but holstered, Colt .45-caliber pistol. His front teeth were chipped to points, crocodile-style, a cosmetic embellishment that Afar men and women consider beautiful.

Ali sat soldier-straight in his chair, while his assistants crowded close by, some squatting on their heels, others leaning against a wall. Like Ali, they were all heavily armed, and they listened carefully to our request to visit the salt mines; their eyes were narrowed and suspicious as they squinted against the sun.

The negotiations lasted a full afternoon, but at the end Ali granted us permission to enter the land of the Afar and to stay in Hamed Ela until we joined the caravans. We were their guests, Ali said. They would help us, but he made it clear that we would have to abide by their rules. He then assigned Edris to protect us and make sure we did what we were told.

Which is why now, in the wee hours of the morning, we couldn't very well say to Edris that we were simply going to continue our journey with the salt caravans without him. Besides, if the Ugugumo rebels were in the canyon, as Edris claimed, they knew full well that we were heading their way. We were, after all, part of the dagu, and news of us had undoubtedly been broadcast across the desert.

"I don't believe this story about the Ugugumo," said Carsten, as we pondered our dilemma. "None of the other caravans are stopping, and they must have heard the same news. We should find a new guide and go on."

I too wanted to continue, but I wondered what chance we had of finding a guide at 3 a.m., or of finding anyone to disagree with Edris's decision. Zelalem suspected Edris was simply tired, or that he just wanted more money, so he

took him aside and gently began to cajole him.

I took advantage of this enforced pause to rest my eyes. The previous morning we'd gone to the salt mines to meet the traders who'd agreed to let us join their caravans, then waited for them to load their animals with the blocks of salt. Just after noon, the merchants had urged their heavily loaded camels to their feet and turned them toward Hamed Ela.

The camels, linked nose-to-tail, crunched in a long line across a landscape that glistened and rippled like pack ice in the Arctic. Salt stretched away from us in all directions, but no one looked at it. Animals and men alike pointed their noses and eyes to the northwest, where the highlands rose like a rumpled fortress on the horizon. Over there, far beyond Hamed Ela, was Berahile; over there was rest.

Our own small party had stopped in Hamed Ela long enough to hire mules to ride behind the camels to the first night's campsite, nothing more than an empty stretch of rock and sand. Like the caravanners, we slept in a chill, howling wind for about three hours, then broke camp just after midnight. When I asked some of them how many times they'd made this journey, they'd laughed, "Always." There was never a time, they said, when they were not walking across the desert.

"We can go now," Zelalem said softly. I came to with a start. "Edris says we can go with the caravans. He just wanted us to hire his friend so he has someone else with him." We already had

hired another of Edris's friends in Hamed Ela, so we chuckled at this explanation.

"Why did he warn us about the Ugugumo, if that's all he wanted?" I asked.

Zelalem shrugged. "He still says they are there ahead of us. But he says he and his friend will protect us from them—the 'enemies.'" Zelalem smiled. "That's what he calls them, enemies."

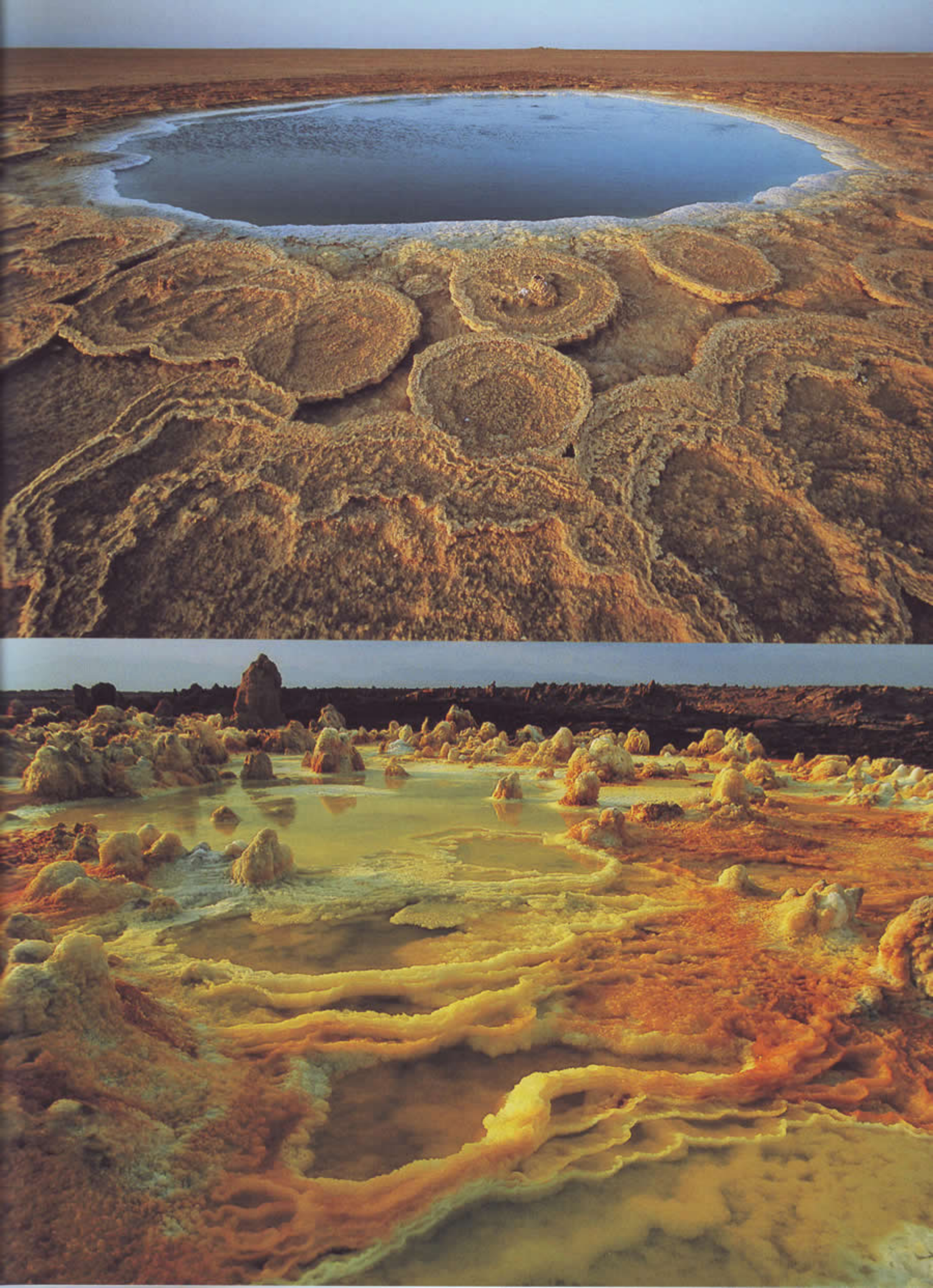
A few straggling traders were heading up the sandy riverbed with their camels, and we mounted our mules and fell in behind them. Edris took his position at the head of our party, walking with determined strides into the narrow darkness of the canyon, his Kalashnikov balanced across his shoulders. He would keep an eye out for the enemy, he promised. And then he began to sing.

Little is known about the origins of the Afar people, but linguists classify their language as Cushitic, deriving from an ancient tongue of the Ethiopian Highlands. Their wandering way of life has left no obvious archaeological record, yet scholars know from 2,000-year-old stone inscriptions in the highlands that nomads traveled with (and taxed and harassed) camel caravans in the Danakil Desert even then.

Today the Afar regard themselves as one ethnic group, but geopolitically their population of about three million is divided among three countries: Ethiopia, Eritrea, and Djibouti. It is a territorial reality that has split clans and families, spawning rebellious groups like the Ugugumo.

A child aims a toy pistol in Asaita, Ethiopia, a town (right) that is growing as farming increases. Many Afar fear that sedentary town life will destroy their culture. For the Afar guns play a central role in defense—and tribal identity. Says anthropologist Getachew Kassa: "Killing Issa Somali men and raiding their livestock is the dream of every young Afar man."

A delta spreads where the Awash River meets Lake Abbe (below). Disks of travertine ring a 12-foot-wide hot spring (right). Sulfur and minerals color the crater of Dallol (bottom right), at 157 feet below sea level Earth's lowest land volcano. A caldera simmers on the 31-mile-wide Ertale volcano (bottom).



Regardless of which country they live in, the Afar share a general lifestyle, traveling across the desert with their livestock.

"We are the people who move," one woman said. "From the beginning that has been our way."

Nor is there really any other way to survive in Afar Land, or Cafar-barro as the Afar call it, particularly if you depend on a diet of camel and goat milk as they do. Less than seven inches of rain falls each year in the Danakil, often in a sporadic manner, and the only fertile soil lies far to the south of the Lake Asele salt mines, along the Awash River, one of the unusual rivers on Earth that never make it to the sea. It sinks instead into another salt lake on the Ethiopian-Djibouti border. Aside from the garden strip of the Awash, the rest of the desert is as dry and sterile as a Martian plain.

"Because it's a hard land, we must fight. And when we fight, we use whatever we have: guns, knives, rocks."

Yet the Danakil is also a creative, hyperactive geologic wonder, its volcanoes, fissures, faults, hot springs, and steaming geysers all part of the birthing process of a new ocean. The Earth's crust is separating here, tearing apart along three deep rifts geologists call the Afar Triple Junction. One day in the very distant future (some scientists have calculated about a hundred million years), when the rifting is complete, the salty waters of the Red Sea will spill across Cafar-barro, erasing forever the camel trails of the Afar.

"That will happen if it is God's will," Ma'ar Mohammed, the chief salt-tax collector in Hamed Ela, had shrugged. He was a tall, thin man with sharp features and a beaked nose, and he had a wad of qat leaves, a mild stimulant, stuck in his cheek. We'd rented a palm-thatch house from Ma'ar while we explored the salt plains and mines near Lake Asele before joining the salt caravans, and some afternoons he stopped by to talk about Afar history and culture.

"Only Allah knows these things," Ma'ar said on the possibility of waves lapping across the Danakil. Like his fellow Afar, Ma'ar is a Muslim. Islam seldom came up as a topic, but the Afar clearly regard their faith as the one true religion. "But there are things a man can do, and even though we Afar are men of peace, we should fight for our unity like Osama." Despite the remoteness of the Danakil, the Afar know all about Osama bin Laden. "There is only one Afar," Ma'ar continued, raising his index finger high in the air, "not three. We must fight to be whole again."

But few outside observers expect the Afar to be reunited—at least not in the near future. They are very territorial, even between clans, and inward-looking, not outward. Although they're well known as determined fighters (despite Ma'ar's disclaimer), who don't think twice about killing their enemies, they don't have a history of strong leaders, men capable of holding their clans together in some common cause, largely because of fierce rivalries among their clans.

It was that lack of leadership that Ma'ar fulminated against. Getting an Afar to fight and die for the Danakil, for Cafar-barro, or for their clan was the easy part. The desert may have struck me as hellish, but for them it was their gift from Allah—land and grass and water that gave them life and that they, in turn, would lay down their lives for. And, indeed, young Afar men were dying for it regularly; we heard of battles and killings throughout our six-week stay in the desert. In that context Ma'ar's reference to Osama bin Laden made sense since the Afar associate him with bravery and aggressiveness, two skills an Afar man needs in quantity. In fact, strength of mind and body were really all anyone required for survival in the desert, Edris and Ma'ar had told me. For them it was perfectly natural to live in a land of firebrick-red and black stones, where it hadn't rained in over a year, where every Afar had lost most of his camels because of the severe drought, and where any living green thing popped out at you like the Hope Diamond. There was really nothing to it, except that you must be brave and you must fight.

"In our history we have always been fighters," Edris said one afternoon, joining in Ma'ar's discussion. "We live in the desert, and because it's a hard land, we must fight, even though killing is against the law of Allah. And when we fight, we use whatever we have: guns and knives, rocks and sticks. We will even bite with our teeth. You use everything when you fight against your enemies."

It was that kind of ferocity and tenacity that by the 20th century had European explorers almost reflexively combining the word "castration" with the Afar, as if any man unlucky enough to fall into their hands was certain to lose his manhood. "I was prepared to accept the fact that they would kill a man or boy with as little compunction as I would shoot a buck," wrote the British explorer Wilfred Thesiger about his 1933 expedition along the Awash River. "Invariably" the victim was then "castrated. . . . It was impossible to exaggerate the importance that the [Afar] attached to this practice, rating as they did a man's prowess by the number of his kills."

Such passages, of course, have made their way into every guidebook, together with sweaty-palmed descriptions of the instrument used in the operation—the 16-inch curved dagger *(gille)* most Afar men wear strapped below their waists. But not one Afar man we met would own up to ever using it for anything other than dispatching a goat. (Other recent visitors have reported seeing dried human male genitalia hanging from the rafters in Afar homes, or in one case used as a snuff pouch.) The Afar intensely dislike the image of themselves as murderous barbarians and especially as masters of castration. It's a bald-faced lie their enemies spread about them, they insist, and if they'd ever done such a thing, it was only because their enemies had done it to them first.

The enemies. This is a favorite term among the Afar, and they apply it to anyone who hungers for their land. As strange as it seemed to me, there are other people who want this desert terrain, and not just for the salt. Although limited, there is grass after it rains, and the oasis-like valley of the Awash River offers year-round crops and water. The Issa Somali, nomads like the Afar, have pushed into the desert from the southeast, and west of Djibouti's Lake Assal the Afar and Issa Somali regularly kill each other over animals and pastureland. But these battles mean nothing, Ma'ar said; they would not lead to a united Afar.

And the Ugugumo? Ma'ar gestured indifferently, as if waving away a fly. "They're fighting, but without support. It's not like a real war; it won't bring us together."

Ma'ar had checked his watch. It was nearly sunset, and it was time to collect the taxes on the salt caravans. There was gold in the desert, all right, and he wasn't about to let any of it slip past him.

Our caravans had paid the tax too—seven Ethiopian birr (about 80 cents) for each camel, five for each donkey and mule (and twice that sum if you were not an Afar). With hundreds, sometimes thousands, of animals passing through Hamed Ela each day, the taxes amounted to a princely sum. As we rode through the night with the salt traders, it occurred to me that an underfunded liberation army like the Ugugumo might want a share of that money.

Edris walked just ahead of us, taking the canyon rocks and sand in long, steady strides. Starlight showed steep red walls, in places scoured into hollows, clefts, and caves from flash floods. Edris shot his flashlight into these and other secret hiding spots, ever watchful of the enemy. But if he saw one, or if some were spying on us from the canyon rim, we never knew it. The caravans didn't pause, nor did we.

"The girl I love is not the short one, not the tall one," he and his friend Abdallah sang, their voices echoing up the canyon. "The girl I love is the perfect height: medium."

When they stopped singing, the only sound was the splashing and squishing of camel, mule, and donkey hooves in the Saba River as the caravans climbed up its banks and farther into the canyon. Sometimes a man would utter a few quick commands to a camel, or swat a mule's backside with a stick, but then the silence fell over us again—the quiet of hard labor and tired men and beasts. It was difficult keeping sleep at bay, and more than once I nearly tipped off my saddle. Then I knotted my fingers in my mule's mane and bit my lips to force myself to stay awake.

Edris had said the salt traders would stop to rest soon after dawn, and as the sun peeked over the canyon rim, I began to hope "soon" was now. But the merchants traveled on for another hour, finally halting where the canyon widened into a broad, sandy gulch. Curiously, no caravans had passed us in the opposite direction—toward Lake Asele—and none were resting here either. Where were they?

"Maybe they're farther up the canyon," said Zelalem. Now that day had come without any enemy attack, we were further inclined to disregard Edris's warning about the Ugugumo. "Maybe they have a different place to rest."

The last few camel teams in our caravan came slowly up the canyon, and the merchants led their animals up a gentle slope above the river, then

Salt breakers pry up thick slabs (below) at Lake Asele in the Danakil Depression, the region's most desolate area. Here salt deposits reach more than half a mile deep. Workers cut manageable blocks (left) for distribution throughout northeast Africa. At village markets families buy blocks as salt licks for their animals, and smaller portions for household use.

ordered them to kneel. Each man had a task: Some unloaded the salt blocks and hobbled the camels and mules, some lit small fires for brewing tea and baking bread, while others fetched sacks of hay from a cave to feed their animals.

"Assabah—yassaboh," they sang as they worked. "Be strong—I'm strong."

When the men finally fell asleep, they did so where they sat drinking their tea. Their bodies spilled across the rocks as if they were resting on pillows of eiderdown.

Edris joined in the work. "I would be traveling with the caravans too, if my camels had not died," he said when he returned to our campfire. He had lost five out of his herd of six in the year-long drought, one so severe aid organizations were now trucking in sacks of grain to help. Edris's loss wasn't something exceptional, he added—all the Afar were suffering similarly. Besides, they were accustomed to times of hardship.

"Sometimes the drought comes because of war or politics," Edris said, explaining that government intervention at border crossings had on occasion prevented the Afar from following the rains and the greening of the grasses. "Then you can blame men for it. This time, the drought is from Allah. It's a blessing He's chosen to give us." In the gift were lessons of survival. In the desert, you accepted what came your way; you learned to live with loss and to live without material desires.

Four hours later, just after noon, we got under way again. The route led slowly upward, taking us into the first tier of mountains, but there was

no respite from the sun. Its searing heat danced over the rocks and up the canyon walls, and there was still no sign of the other caravans.

And then, in the late afternoon, we rounded a bend and came face-to-face with the merchants bound for Lake Asele. There wasn't a single line of camels and mules like ours. Instead they were arrayed like a wall, with lines of animals three and four abreast. In an instant we were engulfed in a brown sea of men and animals and dust. For the rest of the day there was no end to the caravans—it was a migration of biblical proportions.

"Where have they all come from?" I asked Zelalem.

"I don't know. They're Tigrayans," he replied.

Now the canyon widened into a landscape of pointed hills and dry plateaus. The trail split, and Edris led us away from the Lake Asele–bound caravans, up a sandy wash where there was at last some shade. An Afar man stood alongside the canyon wall, and Edris went over to greet him—to get, I thought, the latest dagu. The man was not like the salt merchants, sweaty and disheveled; his green plaid sarong and polo-style shirt looked fresh. And unlike traditionally dressed Afar men, he had a fully loaded hand-grenade belt strapped around his waist, instead of the curved gille. He balanced a Kalashnikov on his shoulder and gave Edris a welcoming smile. They stood close, laughing, kissing the backs of their hands, and pressing their shoulders together.

"He's Ugugumo," Zelalem whispered.

Putting differences aside, Muslim Afar and Christian Tigrayan traders form an armada of donkeys on a four-day slog to take on salt at Lake Asele. The purest product—the region's "white gold"—brings about two dollars a block.

"The enemy?" I asked. "But Edris knows him. They look like friends."

"Maybe Edris once fought with him," said Zelalem. "Maybe that's why he knows the enemy's habits. Maybe sometimes Edris is also Ugugumo."

I took this news in silence. At times the desert was full of shifting shapes—the dancing figures of mirages on the salt flats, the dust devils that spun out of nowhere and vanished into nothing. It did not come as a surprise that the Afar, so much a part of their land, had learned the desert's tricks. Three other men, armed like Edris's friend, came walking down the wash. They nodded pleasantly at us and stopped to give Edris more hand kisses. If these were the enemies Edris had wanted to protect us from, they certainly didn't seem hostile or intent on causing us any trouble.

The desert may have struck me as hellish, but for them it was their gift from Allah that gave them life.

"But they might have," said Zelalem, who had gathered his own dagu from the passing Tigrayan caravans. The Ugugumo—these men whom Edris was now embracing—had formed an armed blockade in the canyon, right at this very point, for two days. They'd refused to let any caravan pass until Ali Hassan shared some of the salt-tax wealth—the Afar's gold—with them.

"They need money for bullets, guns, and grenades," said Zelalem. "They want to fight the Eritreans."

Ali Hassan had given the Ugugumo what they wanted, and they'd released the caravans. That explained the masses of caravans we'd encountered.

Would the Ugugumo have harmed or robbed us if Ali Hassan hadn't negotiated with them?

Zelalem shook his head, as mystified as we were by the mixture of enmity and friendship among these Afar men. "They have their own ways," he said.

Edris came up to join us. He was smiling, as one does after meeting friends. He rested his Kalashnikov across his shoulders. He hadn't lied to or cheated us. He'd given us reliable dagu about the Ugugumo—they'd been in the canyon causing trouble for the caravans, just as he'd said, and hiring another person to help him protect us had probably been a wise move. He was now ready to guard and guide us the rest of the way to the salt market at Berahile.

Tired of the long ride, I slid off my mule and fell in behind him. Twilight was settling over the desert, turning it soft blue and gold. Somewhere in the hills ahead of us, other members of the Ugugumo were plotting, readying their weapons for a skirmish, trying to make the border disappear with bullets, to make the Afar one again.

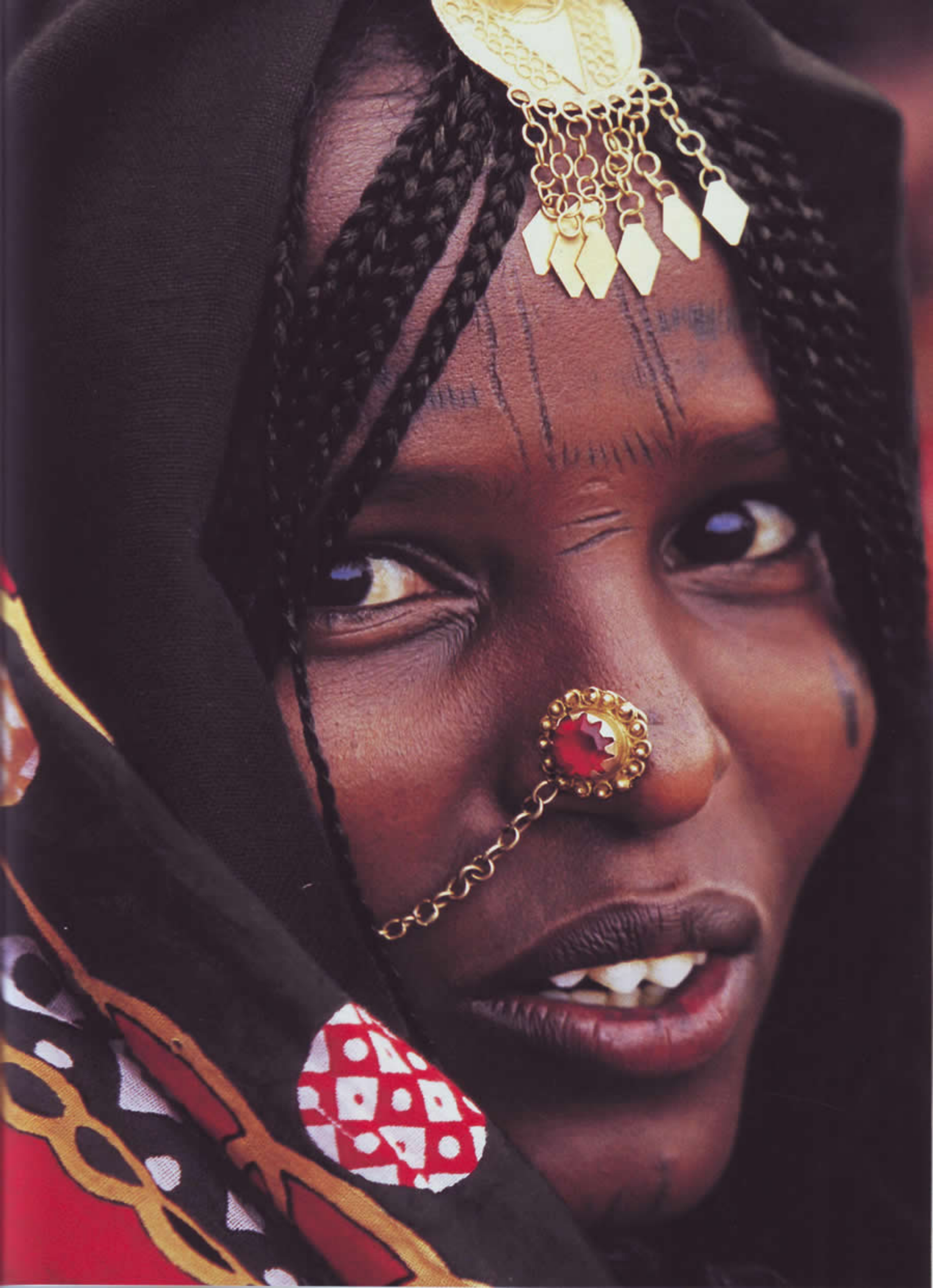
"Allah put us here," Edris said, when I asked why they loved their desert. "It is a hard life, but this was His biggest blessing to us, Cafar-barro."

The desert has shaped the Afar, and it would shape us too, if we stayed long enough, Edris said. Then we would come to know it not simply as a place of harsh rocks, gravel, and lava but as a shelter, a home, an open stretch beneath the sky that offers all a man and his family need: grass for the livestock, palms for weaving the thatch of a home, special shrubs for making a toothbrush or curing a stomachache, and canyons with deep, cool water holes. In time we would come to be like the desert, spare in our needs, sharp in our wit, fierce in defense of our family. We would become, like the Afar, independent and self-reliant, a people who regard strangers warily. We would trust no one but other Afar and, even then, only those in our *kedo,* our clan.

We would have dozens of words for water and rain, and we would smile and thank Allah for His blessing when the sky poured, even when it brought floods. For after the rain summer would come. The grasses would sprout. And we would, like the Afar, move to those green pastures. □

UNFORGIVING LANDSCAPE Zoom in on more images of the Afar people and the Danakil in a photo gallery. Then find technical advice, from lens size to camera type, from photographer Carsten Peter at **ngm.com/0510**.

The *hijab* covering the head of a woman attending a wedding proclaims her own married state. Males dominate Afar society, but women possess their own jewelry, reluctantly sold for food when killer drought hits this unyielding land.



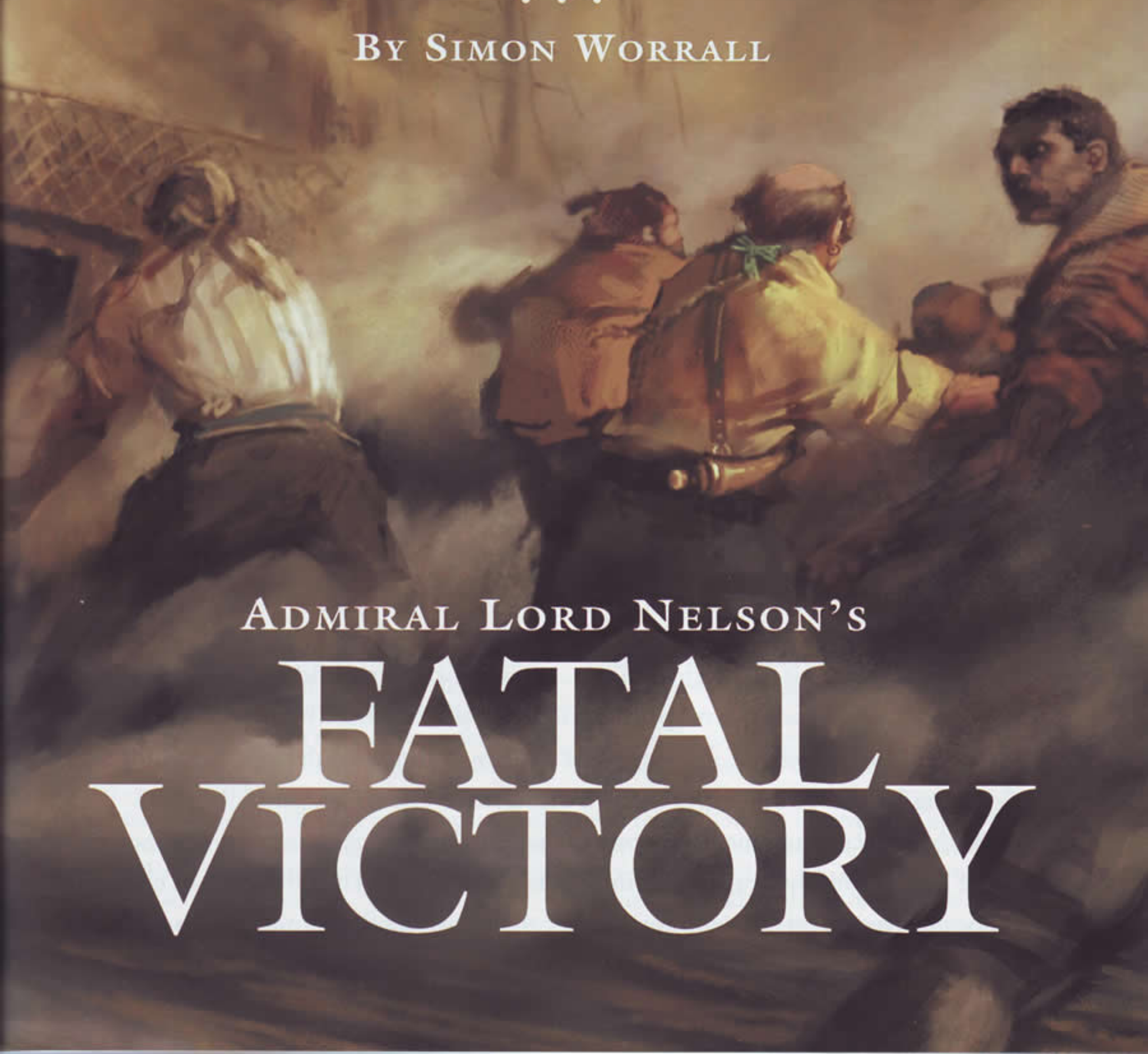
Leading from the front, Horatio Nelson takes a sharpshooter's musket ball in his left shoulder, a wound that caused his death—and sealed his place in history. Nelson's tactics at Trafalgar won Britain its greatest naval victory 200 years ago this month.

ART BY JUSTIN SWEET

NEARLY 5,000 MEN DIED
IN ONE OF THE LAST GREAT BATTLES
OF SAILING SHIPS, AMONG THEM
BRITAIN'S LEGENDARY NAVAL HERO

✣ ✣ ✣

BY SIMON WORRALL



ADMIRAL LORD NELSON'S

FATAL VICTORY

As Lt. Paul Nicolas stood on the forward edge of the poop deck of H.M.S. *Belleisle*, a 74-gun ship of the line, the only thing he could think of was lying down. It wasn't that he was tired. But he was only 16 and new to the ship. Now he was about to get his first taste of battle. It was shortly after midday on October 21, 1805, near Cádiz in southern Spain. As *Belleisle* plowed slowly toward the enemy, Nicolas could see a crescent-shaped line of 33 French and Spanish ships stretching for miles along the coast from Cape Roche in the north to Cape Trafalgar in the south.

Belleisle's crew was in boisterous spirits. They'd been waiting more than two months to have a go at Johnny Crapaud, as they called the French. The gunners had chalked "Victory or Death" on their cannon. Earlier that morning the ship's band had played

WILLIAM CLARKSON STANFIELD, THE CROWN ESTATE/BRIDGEMAN ART LIBRARY

A 19th-century painting captures the havoc of Trafalgar on October 21, 1805, when 27 British ships defeated Napoleon's Combined Fleet of 33 French and Spanish vessels, ending France's bid to rule the seas. Nearly 8,000 men were killed or wounded.

patriotic tunes like "Hearts of Oak" and "Britons, Strike Home!"

William Hargood, *Belleisle*'s captain, ordered the crew to lie down as the first incoming shots tore through the rigging. A young recruit near Nicolas was decapitated by a cannonball. Blood and body parts spattered the deck. Nicolas would have given his eyeteeth to lie down, but he was second in charge of a detachment of marines, and as an officer he had to stay on his feet. So he moved next to John Owen, a junior lieutenant, who was slightly older. Years later, Nicolas would write that Owen's spirit "cheered me on to act the part it became me."

It also cheered him that across the water he could see the towering outline of H.M.S. *Victory*, the 100-gun flagship of the British fleet, commanded by Admiral Lord Nelson. Nicolas had never met Nelson. But like everyone in the Royal Navy, he knew the stories—how Nelson had taken a Spanish ship, then used it to board and capture a second one; how he had lost his arm leading a nighttime raid on Tenerife; how he had

annihilated the French fleet at Aboukir Bay seven years earlier. With Nelson in command the outcome was certain. Earlier that morning Nelson had run signal flags up *Victory*'s mast spelling out the words "England expects that every man will do his duty." The whole fleet had cheered.

But it was going to be a bloody fight. Not like the textbooks, where the fleets lined up side by side and bludgeoned it out with broadsides. Nelson wanted what he called a "pell-mell battle." He had split the fleet of 27 British ships of the line into two columns and ordered them to sail straight at the enemy line, cutting it in two places, like a pack of wolves running at a herd of deer.

Following *Royal Sovereign*, *Belleisle* was the second ship in the lee squadron, which was commanded by Cuthbert Collingwood, or Old Cuddie as the men called him behind his back. He was a reserved, bookish man who longed to be back home in his Northumberland garden planting cabbages and potatoes and who preferred the company of his dog, Bounce, to most men. Bounce went everywhere with him, sleeping beside his cot or trotting beside him on the quarterdeck. Earlier that morning, Collingwood's servant, John Smith, had taken Bounce down to the hold and tied him up for safekeeping.

Nelson's plan had one potentially fatal flaw. By sailing head-on at the enemy fleet, he would be doing something that every naval manual warned against: He would be crossing the T. For the last 20 minutes of the approach, his ships would be in range of the enemy's broadsides. With a strong wind behind them, that time might be reduced to ten minutes, but the wind had died. *Belleisle* was moving at an agonizing pace.

Smoke erupted from the enemy guns, followed by a roar like thunder as several ships opened fire on *Belleisle* at once. Spars came crashing down. Men screamed. Seeing the carnage, 1st Lt. Ebenezer Geale suggested to Captain Hargood that he swing round and fire a broadside, if only to throw up a smoke screen. Hargood's reply rang out across the deck. "We are ordered to go through the line, and go through she shall, by God!" Paul Nicolas held his breath and tried not to think about lying down.

Britain had been at war with France off and

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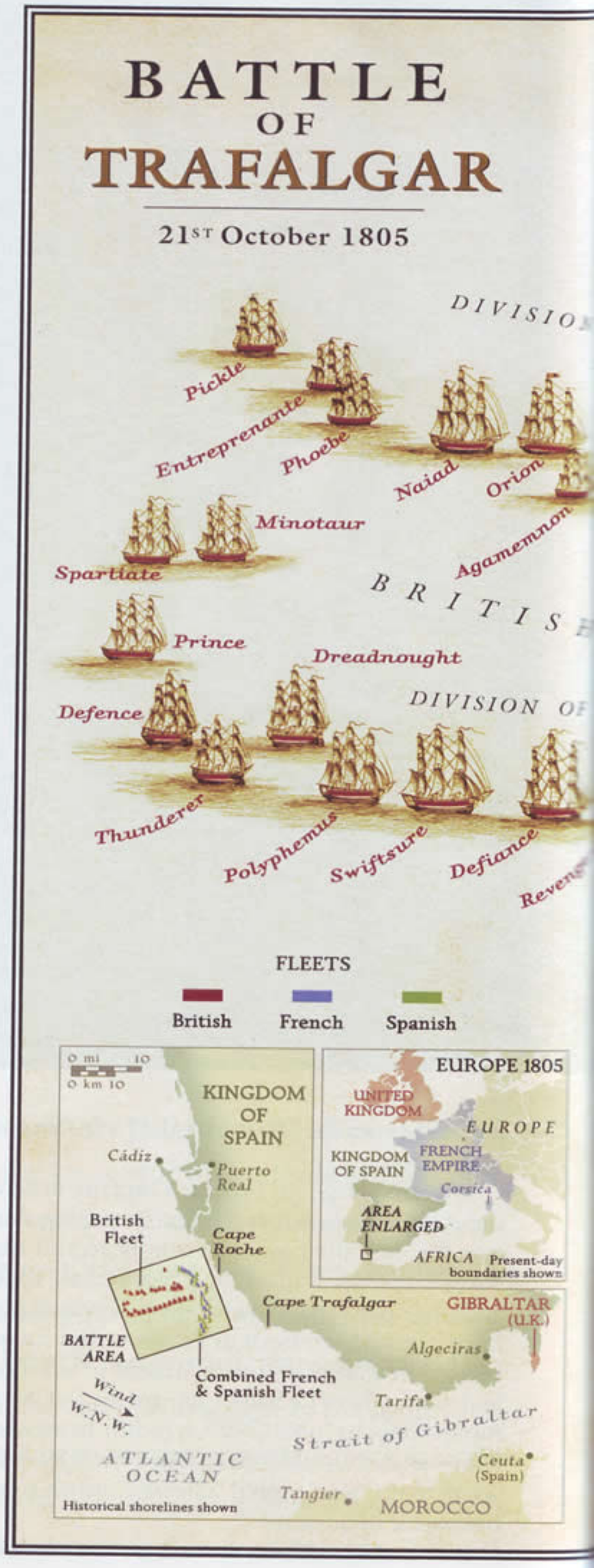
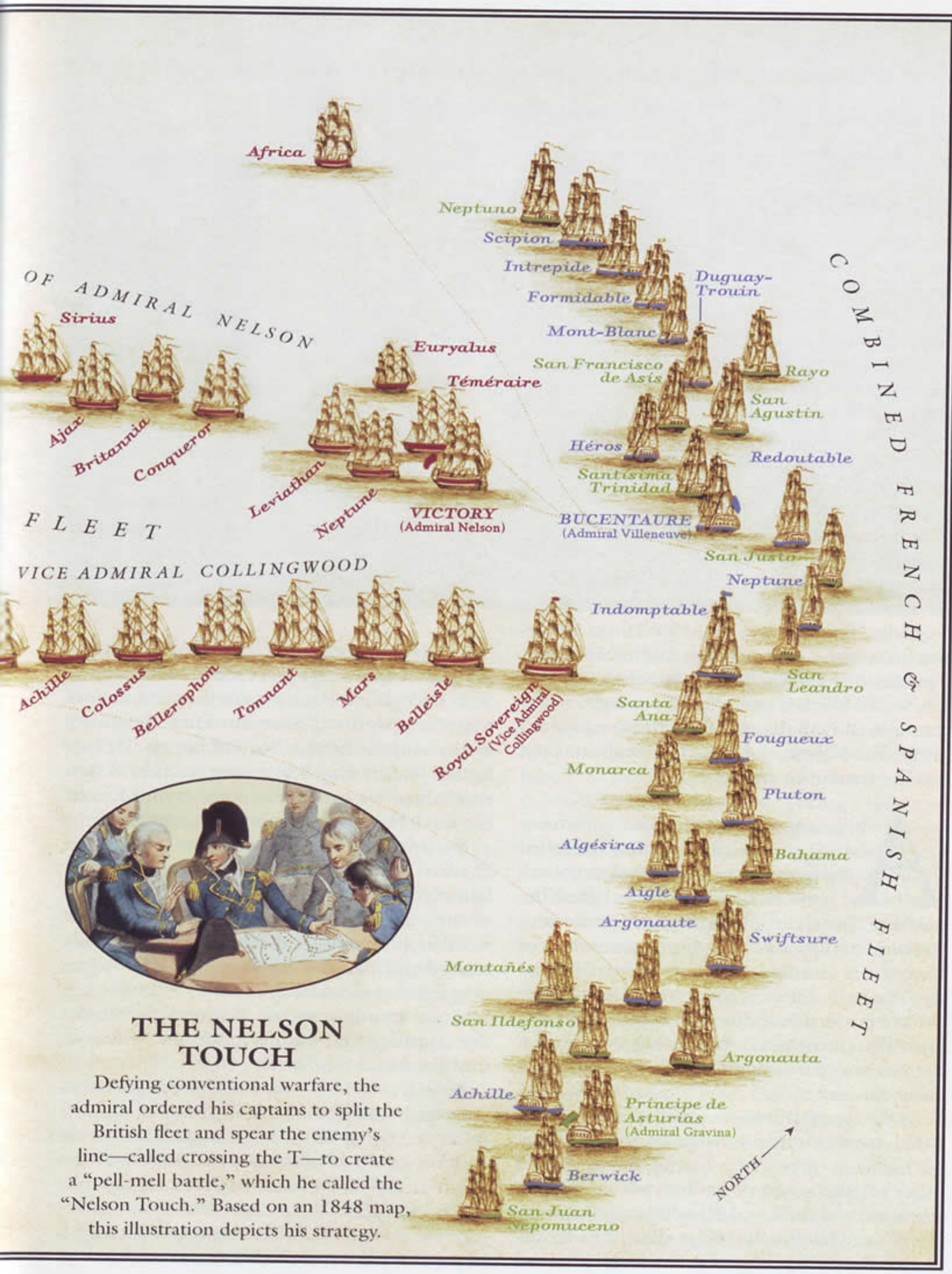


ORIGINAL MAP BY A. K. JOHNSTON, *ATLAS OF ALISON'S HISTORY OF EUROPE* (1848), ROYAL GEOGRAPHICAL SOCIETY. MODIFIED BY NATIONAL GEOGRAPHIC MAPS, CONSULTANT COLIN WHITE. INSET: W. M. CRAIG, NATIONAL MARITIME MUSEUM, LONDON



THE NELSON TOUCH

Defying conventional warfare, the admiral ordered his captains to split the British fleet and spear the enemy's line—called crossing the T—to create a "pell-mell battle," which he called the "Nelson Touch." Based on an 1848 map, this illustration depicts his strategy.

Nelson's naked body was covered with sailcloth. With each heartbeat, blood gushed into his lungs. He had no sensation in his lower body. He called for a fan. He asked for lemonade.

on since 1793. There was a brief peace in 1802, but a year later hostilities flared again. The Napoleonic Wars, as they became known, were a new kind of conflict: a war of ideology prosecuted in a spirit of deep animosity. For Nelson, Napoleon represented what Joseph Stalin—or Osama bin Laden—would mean to our age. Nelson passionately believed he had been called by his country, and by God, to defend England from tyranny.

By the summer of 1805, Napoleon had massed 90,000 troops in Boulogne for an invasion across the English Channel. But he had yet to assemble the naval power to protect his troops during a crossing. "England was in the middle of a total war for national survival," says Andrew Lambert, a professor of naval history at King's College London. "More taxes were raised per capita in the war against Napoleon than in the war against Hitler. For Nelson, the French were the enemy, and they had to be annihilated."

Annihilate was one of Nelson's favorite words. "It is annihilation that the country wants, not merely a splendid victory," he told his officers before the Battle of Trafalgar. The word was almost certainly on his lips as he paced the quarterdeck of *Victory* that morning, with his closest friend, the ship's captain, Thomas Masterman Hardy. They made a curious pair. Hardy was six feet four, a burly Dorset man of farming stock. Nelson was five feet six, narrow-shouldered and built like a ballet dancer.

At the age of 47, Nelson was the most famous British naval commander since Sir Francis Drake. He had won three major battles and fought 50 other engagements, more than any admiral in the history of the Royal Navy. His highly publicized—and adulterous—love affair with Emma Hamilton, a British diplomat's wife Nelson had

Glorified in art, Nelson wore the stars of knighthood awarded for his many naval victories. His amputated right arm and a sightless eye were war wounds that earned him the respect of the ranks. Nelson spent his last agonizing hours belowdecks on* Victory *(right) before paying the ultimate price. Says historian Andrew Lambert, that was the moment "when Nelson ceased to be a living hero and became a god."

met in Naples, only added to his star wattage. "Nelson was the first great modern hero," says Tom Pocock, a Nelson biographer and former war correspondent. "Everyone knew the stories of his battles, and the story of Emma. He had toured Britain a lot. There were pictures of him everywhere. He was the first celebrity of the modern kind. He was everyman and superman."

He bore little resemblance to the apple-cheeked dandy of his official portraits. At sea since he was 12, Nelson had spent only two of the past dozen years on land. His face was weather-beaten, his teeth rotten, and his body scarred and mangled. It was common for sailors or gunners to lose limbs, be shot or burned. It was rare among admirals. Nelson led from the front, putting his own life on the line while asking others to do the same.

Nelson's wounds were the true badges of his courage, more than the four orders of knighthood and two gold medals that glittered on his coat on ceremonial occasions. In 1794, at the siege of Calvi on the island of Corsica, a cannonball smashed into the parapet next to him, driving sand and gravel into his right eye. (Contrary to popular portrayals, Nelson never wore an eye

WILLIAM BEECHEY, GUILDHALL ART LIBRARY/BRIDGEMAN ART LIBRARY (ABOVE); A. W. DEVIS, NATIONAL MARITIME MUSEUM, LONDON (RIGHT)

patch.) To shade his remaining good eye from the glare of the sea, he had a green felt visor made for him, which stuck out from under his cocked hat like the bill of a baseball cap. Nelson's right arm was amputated six inches above the elbow after he was hit by a musket ball while leading a special-forces-type operation at Tenerife. Other ailments included concussion, rheumatic fever, scurvy, malaria, probably a hernia, possibly tuberculosis.

Nelson made light of his wounds—"She fell into my arm," he famously said of his first meeting with Emma Hamilton—but they made his men feel he was one of them. They also gave him what we now refer to as instant brand recognition. "He called his amputated arm his fin," explains Colin White, a naval historian at the National Maritime Museum in London. "And he used it to say: This is me, Nelson. In the Baltic, in 1801, as he was being rowed in an open boat, he was challenged by a ship from his own fleet. He threw back his cloak and said: 'I am Lord Nelson, and here is my fin.'"

There were 820 men on board *Victory,* including 14 commissioned officers, 70 petty officers, and 665 seamen and marines, 31 of whom were boys. One of the first shots to hit the ship cut Nelson's personal secretary, John Scott, in half. There was no time for a proper burial, so his body was simply thrown overboard. Moments later a double-headed bar shot, a foot-long length of iron shaped like a dumbbell mowed down a party of marines, killing eight and wounding dozens more. Another shot passed between Nelson and Hardy and slammed into a wooden brace. A splinter ripped off the buckle on Hardy's shoe, bruising his foot. The two men looked anxiously at each other. Then Nelson smiled. "This is too warm work, Hardy, to last long," he said.

Beneath the humor was real fear. "He expected the French to be on the run," White says. "He didn't expect them to stand and fight. And he knew the danger of his plan of attack: If the French gunners had been any good, they would have shot the *Victory* to pieces."

Initially Nelson had been aiming for a gap behind the giant battleship *Santísima Trinidad.* The Spanish were reluctant allies of the French. Several captains had fought with the British a

British children behold W. L. Wyllie's "Panorama of the Battle of Trafalgar," reflected in a glass partition. Twelve feet high by 42 feet wide, this largest painting of the showdown anchors the Trafalgar Experience, an exhibit at the Royal Naval Museum in Portsmouth, England.

ROBERT CLARK

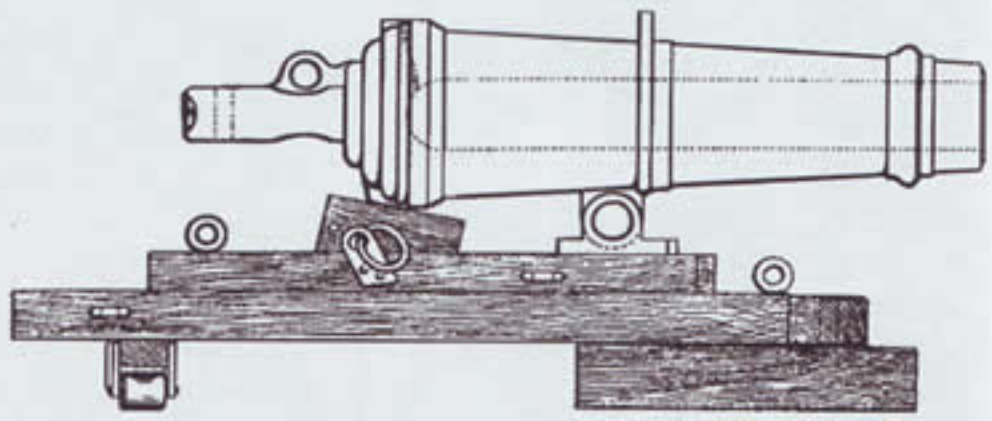
Alcalá Galiano's telescope was knocked out of his hand by a musket ball. His coxswain picked it up and was cut in half by a cannonball. Seconds later grapeshot blew off the top of Alcalá Galiano's head.

dozen years earlier against Napoleon's navy. Now they found themselves dragged into a battle for which they had little appetite because of an alliance they did not believe in, with Napoleon, a man many of them despised. They counted among their numbers men like Cosmé Damián Churruca, a Basque sea captain and navigator, who had sailed to Patagonia as a young man and now commanded the 74-gun *San Juan Nepomuceno,* and Dionisio Alcalá Galiano, one of the first Europeans to explore the Pacific Northwest, captain of *Bahama.*

But it was a Frenchman that Nelson was gunning for as he sailed toward the enemy line: Adm. Pierre Villeneuve, commander of the Combined Fleet. Seven years earlier, at the Battle of the Nile in Egypt's Aboukir Bay, Villeneuve had watched as Nelson had reduced Napoleon's navy to charred wreckage. One of Nelson's captains gave him a coffin made from the timbers of *L'Orient,* the French flagship, as a souvenir of his victory. During the trip back to England, Nelson kept it in the great cabin of *Victory,* behind the chair where he ate dinner with his officers.

In March, Villeneuve had combined his force with a Spanish fleet based at Cádiz and led them across the Atlantic as a diversion to draw Nelson away from Europe, so Napoleon's Army of England could cross the Channel. It worked. Nelson chased Villeneuve to the West Indies and back, narrowly missing him off Martinique. Back in Europe, Villeneuve headed for Brest, in Brittany, where he was to rendezvous with the rest of the French fleet. But on July 22, off Cape Finisterre, he met a British squadron. In a battle in thick fog he lost two Spanish ships. Spooked and demoralized, he fled south to Cádiz, foiling Napoleon's invasion plan.

There was a profound geopolitical logic why the defining battle of the age of sail was being fought here. Cádiz was the hinge between the



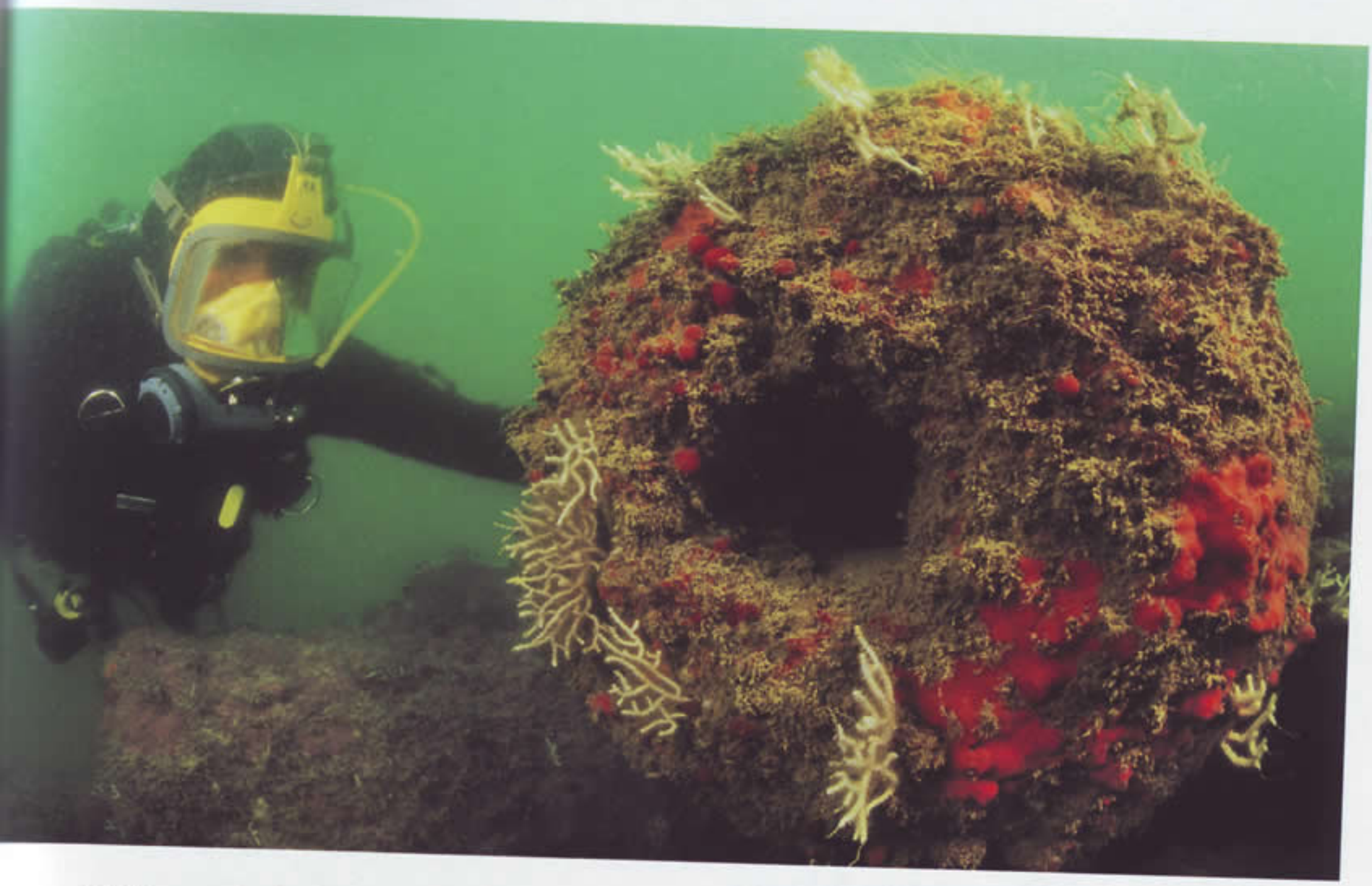
The snub-nosed carronade (above) spewed cruelty from* Victory*'s deck—hundreds of bone-shattering musket balls at once. Enemy sailors called it the "devil gun." Such a gun ravaged the decks of the French flagship* Bucentaure. *It limped back to Cádiz, where it sank in a storm. A diver from an international team of maritime archaeologists inspects an encrusted cannon from that ship.

Old World and the New. "The role Cádiz played in the larger strategic fight between the powers for control of the Atlantic was not fortuitous," says Javier Fernández Reina, director of the Municipal Archives of Cádiz. "Nor was the fact that the battle took place here. Trafalgar was not an isolated event. It was the final act of a drama that had been playing out for nearly a decade."

Nelson was certain Villeneuve was in one of four ships clustered around *Santísima Trinidad.* At first Villeneuve didn't raise his flag. Then a giant Tricolor appeared on the 84-gun *Bucentaure.* Nelson had chased Villeneuve across the Atlantic and back. Now he had him in his sights. Shifting course away from *Santísima Trinidad, Victory* headed for the gap behind *Bucentaure.*

A ship of the line like *Victory* had more firepower than an entire land army. As it passed behind *Bucentaure,* it opened fire with what was the most powerful weapon in the world, a wide-mouthed, short-barreled cannon known as the carronade, after the Carron Company, in Glasgow, Scotland, where it was manufactured. *Victory* had two of the 68-pound guns on the forecastle. At

E. BOWNESS AND G. F. CAMPBELL, SPECIAL INTEREST BOOKS, LTD., 2004 (ABOVE); COURTNEY PLATT (RIGHT)



12:25 p.m. the larboard carronade, loaded with round shot and a canister of 500 musket balls, fired straight into Villeneuve's cabin windows, blowing out *Bucentaure*'s stern.

Into this gaping hole *Victory* then poured a raking broadside: 50 cannon, double-shotted, firing one after the other in a ripple action. Because *Victory* was moving so slowly, and the British gunners were so fast—it has been estimated that for every one shot from the Spanish or French the British could get off two or three—by the time Nelson had crossed *Bucentaure*'s wake each gun had fired twice. At the end of that first ten-minute broadside, about 200 men, or a quarter of *Bucentaure*'s crew, had been killed or disabled, and its gun decks were badly mauled.

But the cheers of *Victory*'s crew were soon drowned by the crashing of timber as she rammed into one of the best manned, best run ships in the Combined Fleet: a 74-gun, two-decker called *Redoutable.* Her captain, Jean-Jacques-Étienne Lucas, was even smaller than Nelson (a *petit bonhomme,* or little man, as Remi Monaque, a French naval historian and onetime captain of a minesweeper, called this impeccably dressed, four-foot-eight-inch-tall officer), but he was one of the few enemy captains who had thought about how he was going to fight. He knew he couldn't win a broadside duel with the better trained, better equipped British gunners. But if he could kill everyone on deck, especially the officers, he could board and take the ship.

While waiting in Cádiz, Lucas had drilled his men in the art of boarding, musketry, and grenade throwing. His deadliest weapon was a team of specially trained sharpshooters. As *Redoutable*'s grappling irons locked *Victory* in place alongside her, Lucas's sharpshooters, hanging in the mizzen tops like crows, poured fire down on *Victory*'s quarterdeck.

At 1:15 p.m., a little more than an hour into the battle, one of Lucas's sharpshooters fired what historian Tim Clayton calls "the most infamous musket ball in British history." It smashed into the top of Nelson's left shoulder, traveled downward through his body, shattering two ribs, puncturing his left lung and severing his pulmonary artery before lodging in his spine. Nelson fell to the deck at the spot where his secretary, John Scott, had been killed. Their blood mingled on Nelson's breeches and coat.

Nelson's body was brought home in a barrel of brandy in the great cabin of *Victory*. His funeral at St. Paul's Cathedral was one of the grandest in British history.

Her mizzenmast shot away, Victory *was towed into the port of Gibraltar by H.M.S.* Neptune *(above) after the battle.* Victory *eventually sailed to Chatham and was refitted. In dry dock in Portsmouth since 1922, the vessel (right) now welcomes 400,000 visitors a year and still serves as a fully commissioned warship with captain, crew, and memories of triumph.*

He was carried down to the cockpit, and his clothes cut away, his naked body covered with sailcloth. Then he was placed, half-sitting, half-lying, with his back propped against the timbers of *Victory,* in the only position that afforded any relief from the pain. With each heartbeat, blood gushed into his lungs. He had no sensation in his lower body. He called for a fan. He asked for lemonade. He repeatedly asked where Captain Hardy was.

As Nelson lay dying, scenes of horror and heroism were enacted in equal measure. On *Belleisle,* Paul Nicolas was helping to run out a carronade when he heard a cry: "Stand clear there! Here it comes!" Moments later *Belleisle*'s mizzenmast came crashing down. *Belleisle* had been attacked by four French ships. She was unmaneuverable, but still refused to surrender. When her colors were shot away, a sailor hung a Union Jack on a spike and waved it at the French.

But the Combined Fleet was taking terrible losses. On *San Juan Nepomuceno,* pounded by seven British ships, Cosmé Damián Churruca hemorrhaged to death after his right leg was shattered by a cannonball. On *Bahama,* Alcalá Galiano was hit in the face by a piece of splintered ship but refused to go below. His telescope was knocked out of his hand by a musket ball. His coxswain picked it up and was cut in half by a cannonball. Seconds later grapeshot from the same broadside blew off the top of Alcalá Galiano's head.

Later there were moments of black comedy. When a surgeon on the British ship *Defiance* attempted to amputate the leg of a young Irishman named Jack Spratt, Spratt held out his other leg and cried: "Never! If I lose my leg, where shall I find a match for this one?"

By the time Nelson died at 4:30 p.m., the British fleet had captured, sunk, or driven off one of the largest fleet of ships of the line that had ever put to sea. Nelson's death in his moment of glory, and a hurricane-force storm after the battle that drowned thousands of sailors, dampened celebrations. But Trafalgar remains the most resounding naval victory in England's long and storied seafaring history.

Two reasons stand out for the ease of that victory: morale and better gunnery. Many of the Combined Fleet's crews, especially on the Spanish ships, were hastily pressed landsmen who had never been at sea. Many had been sick with yellow fever, which had ravaged the southern coast of Spain from 1801 to 1805. "It was like Manchester United playing a second division team riddled with injuries and self-doubt," says David Cordingly, a British naval historian. "The opposition never really believed they could win. So morale collapsed early in the battle."

Then there was the Nelson factor. "His very name was a host of itself," wrote the future king George IV, who served with Nelson as a young man. "Nelson and *Victory* were one and the same to us, and it carried dismay and terror to the hearts of our enemy."

Trafalgar was one of the last great sea battles

ROBERT CLARK (RIGHT); WILLIAM CLARKSON STANFIELD, NATIONAL MARITIME MUSEUM, LONDON (ABOVE)

of the age of sail. The next time the British fought on this scale in the Atlantic, it was between steam-powered dreadnoughts in World War I. This year England marked the bicentennial of the battle with an International Festival of the Sea. But Trafalgar holds very different meanings for the three nations who met off Cádiz. For the Spanish, Trafalgar was, and is, a glorious defeat. There is even a street in Madrid called Trafalgar.

Yet the battle was the beginning of the end for Spain's empire in South America. "The loss of captains like Federico Gravina, Churruca, and Alcalá Galiano was significant for Spain," says José González-Aller, a Spanish naval historian in Madrid. "After that, we lost the hope of continuing to be a great naval power."

Napoleon's only comment on a debacle that resulted in more than 8,000 casualties was: "A storm has occasioned us the loss of a few ships, after a battle imprudently fought."

A few months later the man responsible for that loss, Admiral Villeneuve, locked himself in his room in a hotel in Rennes, Brittany, and after a lunch of chicken and asparagus washed down with a bottle of Médoc, stabbed himself in the heart with a table knife.

"Trafalgar is still a deep wound," says Remi Monaque, "always bleeding in the heart of the French."

Nelson's body was brought home in a barrel of brandy in the great cabin of *Victory* and laid in state for three days in the Painted Hall at Greenwich. His funeral at St. Paul's Cathedral was one of the grandest in British history. The battle he won remains, with Waterloo in 1815, and the Battle of Britain in 1941, one of the nation's finest hours. The name of its hero, once described as "a little man, and none too handsome," continues to be, with only a small group of other Britons, like Shakespeare, Churchill, John Lennon, and Princess Diana, a name that every British schoolchild knows.

"Nelson is our national icon in times of adversity," says Andrew Lambert. "We don't need him much at the moment. But if you look at the 1940s, he is in every other sentence of Churchill's. He's our totem, our talisman of war." The consequences of his greatest victory are with us today. "Trafalgar saw the triumph of the Anglosphere," writes Tim Clayton. "As a result of Trafalgar, English became the global language of maritime trade."

But Nelson's was a triumph dearly bought. "I was on board our prize the *Trinidada* [*Santísima Trinidad*] getting the prisoners out of her," midshipman John Badcock wrote to his father in London a few days after the battle. "She had between 3[00] and 400 killed and wounded, her Beams were covered with Blood, Brains, and pieces of Flesh, and the after part of her Decks with wounded, some without Legs and some without an Arm; what calamities War brings on, and what a number of Lives were put to an end too on the 21st."

Paul Nicolas, the young midshipman who had wanted to lie down, was one of the lucky survivors. So was John Franklin, a junior officer on *Bellerophon,* or Billy Ruffian as it was known, who went on to make history with a disastrous expedition in search of the Northwest Passage across the Canadian Arctic.

Old Cuddie was made a baron for his role in the victory, was given command of the Mediterranean fleet, and continued pacing the quarterdeck with his faithful dog at his side.

"I am out of all patience with Bounce," Collingwood quipped in a letter to his wife, Sarah, a few

JOIN THE BATTLE ZONE Zoom in on the action in a high-resolution image of the painting on pages 56-7, then view an exclusive photo gallery at **ngm.com/0510.**

PHOTO BY ROBERT CLARK

Royal Navy operator mechanics observed Trafalgar Day last fall on the anniversary of the battle. Halyard in hands, they raised signal flags up Victory*'s mainmast to spell out Nelson's timeless words: "England expects that every man will do his duty."*

months after Trafalgar. "The consequential airs he gives himself since he became a right honorable dog are insufferable. He considers it beneath his dignity to play with commoners' dogs, and truly thinks he does them grace when he condescends to lift up his leg against them."

Sadly, Collingwood never made it back to his cabbages and potatoes. He died at sea five years later, four days after finally being recalled home, and was buried at St. Paul's alongside Nelson.

"His loss was the greatest grief to me," Collingwood had written his wife from the frigate *Euryalus* 11 days after the battle. "There is nothing like him left for gallantry and conduct in battle. It was not a foolish passion for fighting for he was the most gentle of all human creatures and often lamented the cruel necessity of it, but it was a principle of duty which all men owed their country in defense of her laws and liberty. He valued life only as it enabled him to do good, and would not preserve it by any act he thought unworthy. . . . He is gone, and I shall lament him as long as I remain." □

hawaii's outer kingdom

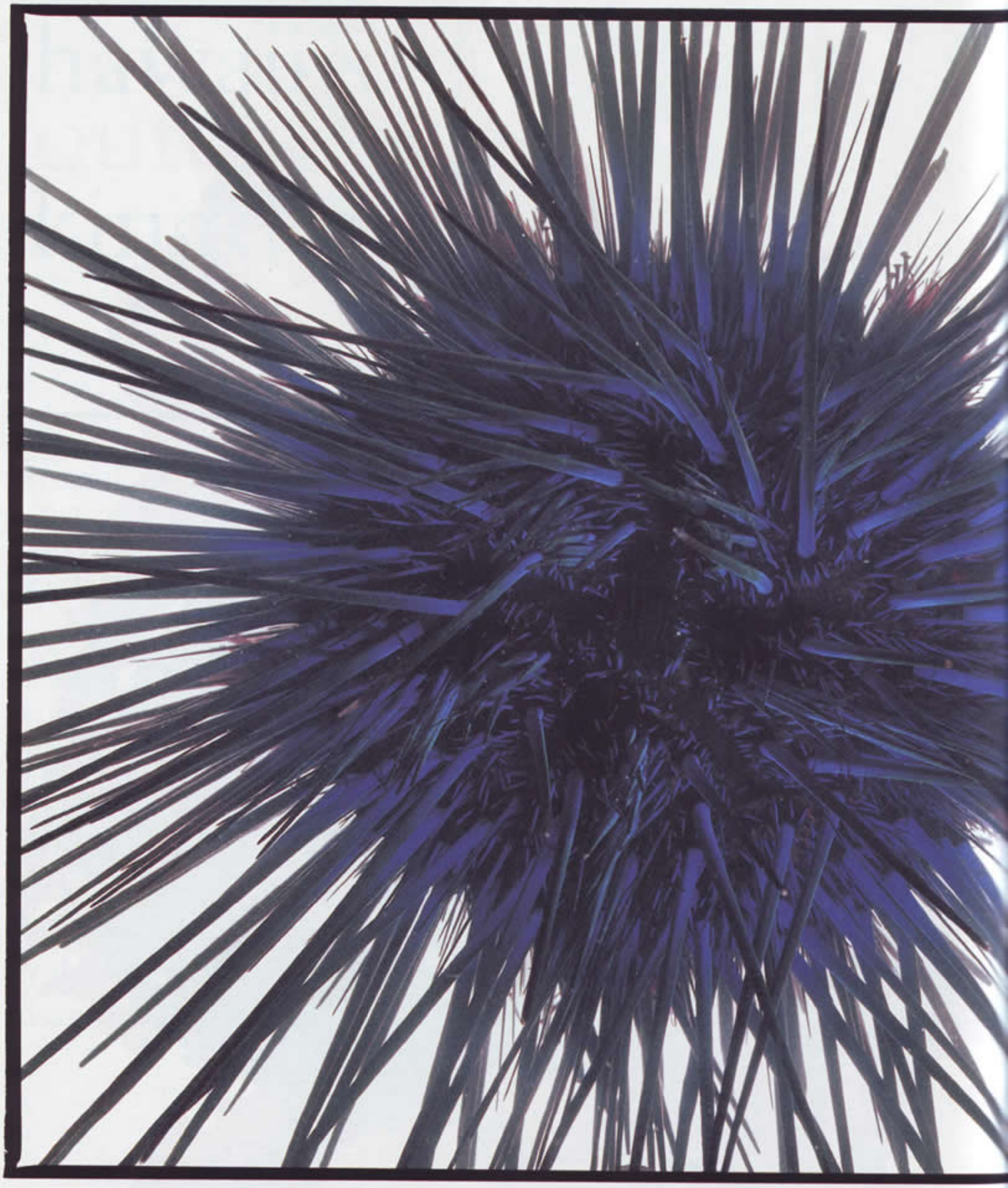
portraits from the world's most remote archipelago

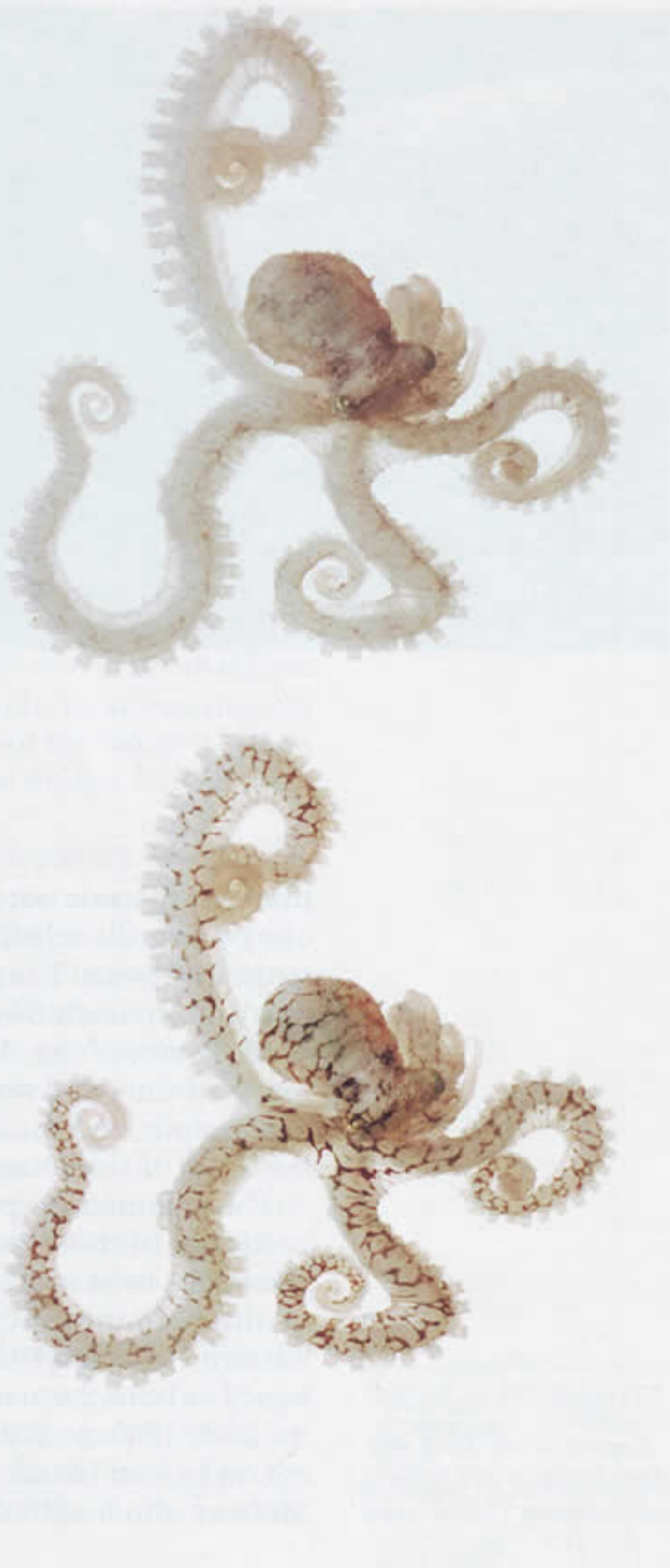
Beyond the Hawai'i of human domain, the island chain stretches another 1,200 miles into an older world. Here wildlife reigns: vibrant, sensuous, abundant, and vulnerable. To truly see these creatures, like a young moray eel entwined in red algae, we photographed them against a white background in aquariums and field studios on location, then returned them unharmed to reef or shore.

text & photographs
by david liittschwager &
susan middleton

French Frigate Shoals: Gymnothorax sp. (moray eel); Kallymenia sessilis (red algae). Size of image: 3.2 X life-size

Midway Atoll: Echinothrix diadema (urchin), 1.8 X. Kure Atoll: Octopus sp., 1.5 X





The cobalt fortress of a blue-black urchin cracks only under the jaws of a few specialized fish. If threatened, it brandishes its spines toward the attacker. A very young octopus will soon regenerate the four legs likely lost to a reef predator. Pale when we first saw it (top), it flashed an excited pattern when offered a shrimp.

One by one, the islands of Hawai'i were born from the volcanic hot spot that still fires eruptions on the Big Island. And one by one, the relentlessly moving Pacific plate has carried the islands to the northwest. The plate travels on average less than four inches a year, so it's taken nearly 30 million years for Kure Atoll to reach its spot as the most distant of the Northwestern Hawaiian Islands. Along the way the forces of time and sea reshape and level the islands into volcanic remnants, atolls, and shoals—all destined to keep moving and sink and join the chain of seamounts that stretches submerged beyond Kure.

These outliers are politically part of the state of Hawai'i, except for the islands of Midway Atoll, which remains a U.S. territory. Though early Hawaiians from southern Polynesia left signs of worship and occupation on the close-in islands of Necker and Nihoa, nothing about the Northwestern Hawaiian Islands invites permanent settlement. Yet they bear a legacy of heavy human impact: hundreds of thousands of birds killed in the early 1900s to feather the international millinery trade; guano mining on Laysan Island; the thousands of military personnel stationed on Midway who fought decisive battles during World War II.

Protection and restoration have come to the islands in layers over the past century. First in 1909 when President Teddy Roosevelt responded to the bird slaughter by declaring most of the islands a wildlife refuge. Most recently, in 2000, President Bill Clinton created the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, not only because these islands hold the majority of the coral reefs in U.S. waters, but because coral reefs worldwide are so imperiled. Here is a chance to study and save some of the healthiest reefs left on the planet. It now looks promising that the waters of the Northwestern Hawaiian Islands will soon be further protected by becoming a national marine sanctuary.

Researchers keep year-round field camps on Midway Atoll, French Frigate Shoals, and Laysan, with seasonal monitoring on the other islands. Except for scientific and conservation work, the islands are virtually off-limits to people. We were allowed to go as photographers with a conservation mission: documenting wildlife by focusing on the sheer wonder of a creature's form. Our portraits cover a fraction of the more than 7,000 species, a quarter of them found nowhere else: teeming fish, corals and other invertebrates, and threatened green sea turtles that have scant success nesting on the main Hawaiian Islands. Fourteen million seabirds breed and nest here, including almost all of the world's Laysan and black-footed albatrosses. And this is the refuge of the last 1,300 Hawaiian monk seals on Earth.

To be on these islands is to feel like a visitor in someone else's home. The islands are owned by wildlife—it is clearly their place, not ours—even though human intervention is needed to ensure protection. Everyone permitted on the islands bears that responsibility, and it begins with strict quarantines to keep alien seeds and insects from hitching a ride from the outside world or from one island to the next. All soft goods such as clothing and backpacks must be bought new, then frozen for 48 hours. Hard gear must be carefully cleaned and inspected.

Managing the islands' welfare falls to three groups: the U.S. Fish and Wildlife Service, NOAA, and the Hawai'i Department of Land and Natural Resources. With biologists aboard the NOAA research vessel *Hi'ialakai*, we surveyed reefs the entire length of the chain. Wildlife researchers and managers taught us how to live lightly on the ground with minimal impact on nesting birds and sea turtles, seals, and vegetation. Over the course of two years we were immersed in an extravagance of life as we compiled a book, *Archipelago*, for the National Geographic Society. Because few people will ever be able to experience these islands directly, we welcomed the challenge to reveal their riches and share the treasure.

The Northwestern Hawaiian Islands (map) are all protected and hold most of the coral reefs in the U.S. The six-mile-wide lagoon of Kure Atoll (far left) laps on the most distant and oldest land. The youngest island, 190-acre Nihoa (near left), is home to 19 bird species, two of them found only here.

SOCIETY GRANT

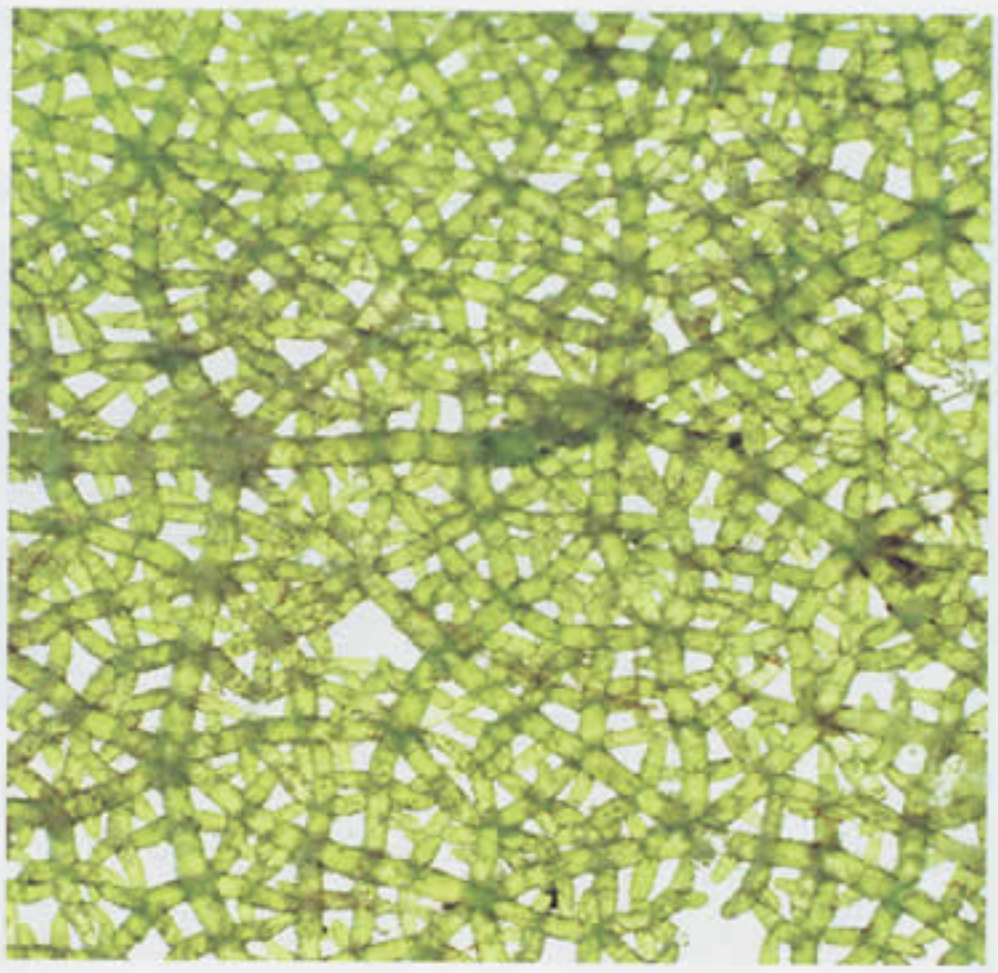
This Expeditions Council project was supported by your Society membership.

Eastern Island, Midway Atoll: Sterna fuscata (tern). Maro Reef: Heteractis malu (anemone), 0.7 X

We were advised to wear earplugs when visiting Midway's sooty tern colony, but then we would have missed the chaotic chorus of tens of thousands of birds. Congregating here to breed, sooty terns spend half of each year at sea.

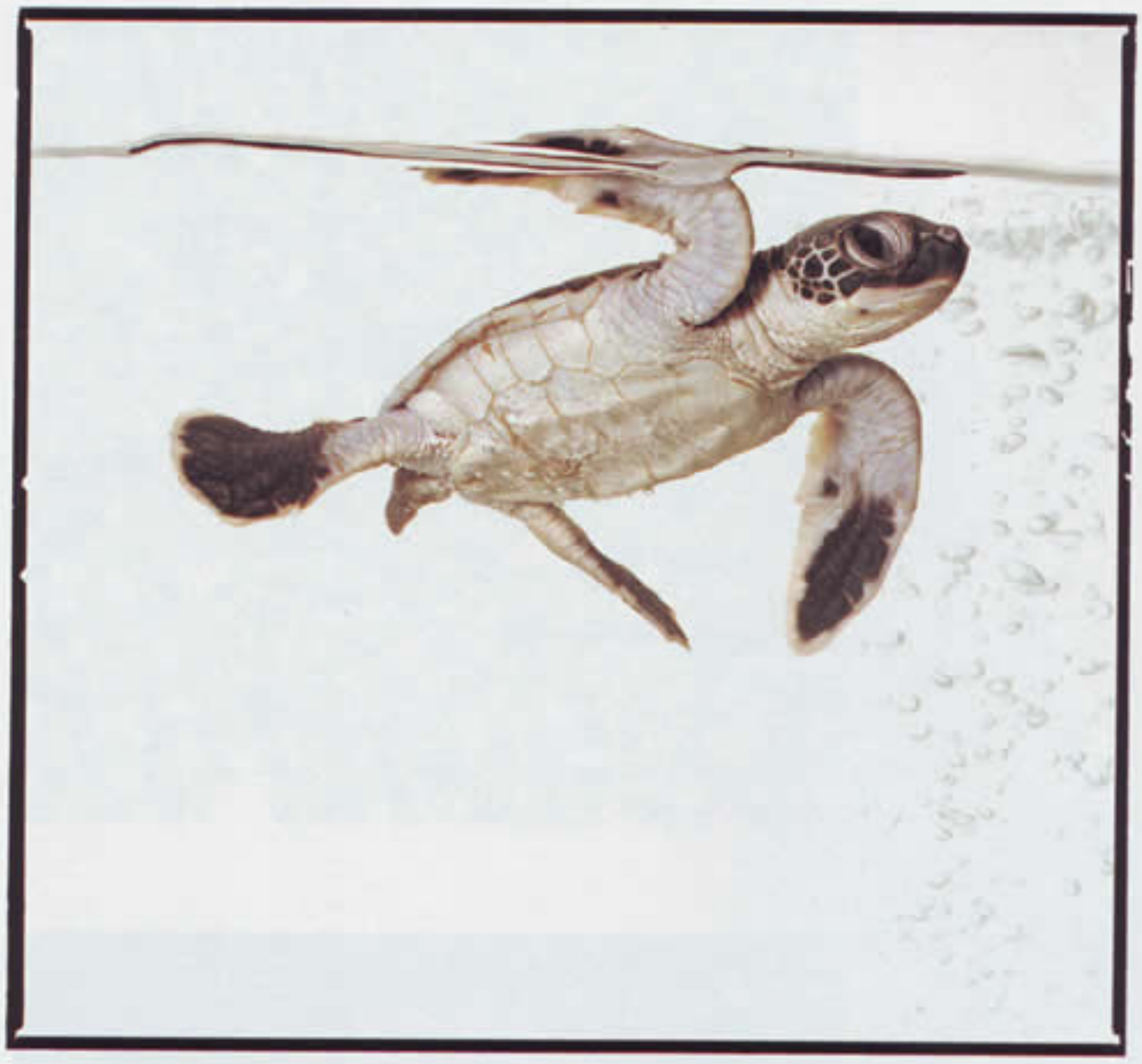
Reef pebbles clinched in the muscular foot of a sand anemone (above) fell around it as the animal slowly relaxed out of a tight protective ball, raised up on its foot, and bloomed with rosy tentacles.

Pearl & Hermes: Forcipiger flavissimus (fish), 4.5 X. Kure: Microdictyon setchellianum (green alga), 4 X. Laysan: Martensia flabelliformis, 1.3 X



Lithely swimming toward us, a common long-nose butterflyfish seems anything but common. The intricate lattice of a green alga (top) is only one cell thick. Another reef alga (above) looks no more special than a blob of brown slime when seen in the sea on a cloudy day. But in sunlight, or lit against a black backdrop, its colors pop, down to the iridescent blue fringe.

French Frigate Shoals: Chelonia mydas (turtle), life-size. Kure: Dardanus gemmatus (crab), Calliactis polypus & Anthothoe sp. (anemones), 2 X



Hermit crab with attitude, a jeweled anemone crab gains defense and camouflage by covering its shell with stinging anemones—an astounding 11 on this specimen. When it outgrows the shell and finds a new one, it will detach the anemones and bring them along.

We lent a hand to a green sea turtle hatchling (above) who, disoriented, headed inland when the rest of the brood went to sea.

Kure: Sula leucogaster (brown booby), 0.3 X. Sand Island, Midway: Gygis alba (white tern), 0.4 to 0.6 X

Against the night sky, a brown booby claims a distance marker on Kure's abandoned airstrip. On Midway we followed white terns' transformation: egg, two days, two weeks, and full grown at two months, soon to turn completely white. The small birds build no nests, tending one egg at a time in cradling vegetation or rocks.

The calligraphy of beach morning glories writes its free-form message on the leeward side of Laysan Island, nesting ground for two million seabirds as well as the endangered Laysan finch and Laysan duck. The message on Laysan's windward side (right) is repeated on all the Northwestern Hawaiian Islands: No place is remote enough. The bottles, the floats, the TV screen—all fell off ships at sea or washed off distant shorelines and were carried here by currents. Across the islands, researchers and wildlife managers haul off the most dangerous debris (below)—fishing lines, nets, and ropes that easily strangle birds, turtles, and monk seals. Since 1996, nearly 500 tons have been removed.

Kure Atoll: Phoebastria immutabilis, 0.2 X

Victim: Laysan albatross chick. Age: six months. Cause of death: starvation due to a full stomach. Contents of stomach (right): cigarette lighters, pump-top sprayer, nut shells, shotgun shell, broken clothespins, hundreds of plastic bits.

The food an albatross parent regurgitates into a chick's mouth should be squid, fish, and fish eggs. Adults fly thousands of miles to gather this food where it concentrates—in mid-ocean gyres created by currents. But trash trapped in gyres gets gulped down too, then fed to chicks. Before fledging, chicks naturally vomit the squid beaks and other organic undigestibles they've stored. It's rare now to see one of these masses that doesn't contain marine debris. Starvation associated with marine debris is a significant cause of death in chicks that don't fledge.

Kure: Physalia physalis (Portuguese man-of-war), 2.3 X. Midway: Fimbristylis cymosa (sedge), 0.4 X; Scaevola sericea (flower), 2.5 X

Trailing stinging tentacles, fleets of Portuguese man-of-wars sail at the mercy of the wind. Each individual is a complex colony of polyps and medusas that grows from one egg. An indigenous Hawaiian sedge called mau'u 'aki'aki (top) battles shoreline erosion. Appearing to be half a flower, the beach naupaka (above) inspired a Hawaiian legend of two lovers parted by the gods.

Lisianski Island: Pseudoceros dimidiatus (flatworm), 1.6 X. Midway: Charonia tritonis (snail), 0.5 X

Conspicuous color of a divided flatworm (above) signals that it's toxic. It picks up poison by ingesting reef invertebrates through a tube hidden near its head, at top. Triton's trumpet, a marine snail with a fierce appetite for sea stars, helps keep a reef in balance. Overcollecting has reduced its numbers; the rare 18-inch length of this shell proclaims long life in a protected place. □

HEAR THE BIRDS OF MIDWAY in Sights & Sounds at **ngm.com/0510**, and link to the NG store to find the photographers' Northwestern Hawaiian Islands book, *Archipelago*.

NATIONAL GEOGRAPHIC RESEARCH AND EXPLORATION

GRANTEE
Neal Lopinot
Archaeologist
Missouri State University
"We have practically the entire prehistoric record of North America in this one site."

Missouri's Sac River flows over the broken halves of an unfinished spearpoint crafted some 13,000 years ago and discovered at a nearby dig site dubbed Big Eddy for the river's potent swirls. Researchers have found even older artifacts that may date back 14,600 years. If true, it would mean people lived here a thousand years before the arrival from Asia of the Clovis people, long thought to be the first Americans. Workers at the site must dig fast to learn more: Periodic surges of water from an upstream hydroelectric dam are washing away Big Eddy's remaining clues.

No Small Find at the Big Eddy

By Cynthia Barnes
Photographs by David McLain

THE PROJECT

DIG BEGINS: 1997

BIG FIND: An "anvil stone" for cracking bones, perhaps 14,600 years old

WHY SO RICH? This area attracted native peoples because of a nearby spring and abundance of chert, used for making stone tools.

HISTORY IN STONE: Because of the site's damp and acidic soils, organic materials like wood and hides had little chance of surviving for millennia as they might have in a desert.

Hard by the Sac River in southwestern Missouri, Neal Lopinot and his dirt-smeared team are engaged in an urgent rescue attempt. All are sharply aware that time is running short, that the victim they are toiling to save can't hold out for much longer. That victim, Big Eddy, is a trove of North American prehistory, named after a large natural whirlpool that swirls nearby. The threat: A hydroelectric dam six miles upstream at Stockton that spews some three million gallons of water a minute when generating at full tilt, turning the sluggish Sac into a sluiceway and eroding the riverbank at a rate of four feet a year. "We're losing the site faster than we can excavate it," laments Lopinot. "In less than 15 years, maybe even sooner, Big Eddy will be gone."

On the day of my visit a team of archaeologists is working at the bottom of an excavation pit roughly 110 feet on each side and a mere 10 feet from the riverbank. Here, 12 feet down at the floor of the pit, it's as if the archaeologists have gone back more than 13,000 years.

Before the Sac was dammed, seasonal floods regularly covered this area with silt, burying

At high water during a hydroelectric release, the Sac River (left) flows in perilous proximity to the dig. The Big Eddy crew (above) delves for further evidence to support the controversial hypothesis of pre-Clovis habitation of the area. The river itself uncovers many Native American artifacts, so Lopinot (below) frequently scours its banks for ancient stone tools.

whatever tools or trash Native Americans and their distant ancestors left on the ground. Those stacked layers, or strata, are well defined at Big Eddy, affording archaeologists the rare opportunity to place ancient artifacts and cultures in clear chronological sequence.

"At times this place was a workshop, a factory," says Jack Ray, the project's field director. "People returned here intermittently for thousands of years, and when they were here, they made tools from local chert."

The site's layered record of life is remarkable not only for its completeness but also for its reach. Stone implements unearthed at Big Eddy are among the oldest ever found in North America, stretching back to the frozen age when fur-clad hunters tracked mastodons and woolly mammoths.

The finds have sparked excitement and added to current debates on when the earliest Americans arrived. Conventional theory holds that the first arrivals were the so-called Clovis people, whose oldest artifacts, from the Trinity River Basin in Texas, are about 13,500 years old. But Lopinot's team has turned up what may be signs of earlier human activity. An oblong stone and fragments of a sandstone boulder could have been used as a hammer and anvil, based on their location and similarity to anvil stones discovered at other sites. Radiocarbon dating of

A firefighter by training and amateur archaeologist in his off hours, Clark Montgomery displays the fruits of decades of artifact collecting on his family's farm near the Sac River. His careful record of each find makes him a resource for professional archaeologists at the nearby Big Eddy excavation. The sense of the area's long history is palpable, Montgomery says. "If I find a point, I might be the first person to touch it in 10,000 years."

charcoal found at the same depth yielded ages of 14,000 to 14,600 years—predating the oldest Clovis artifacts by at least 500 years.

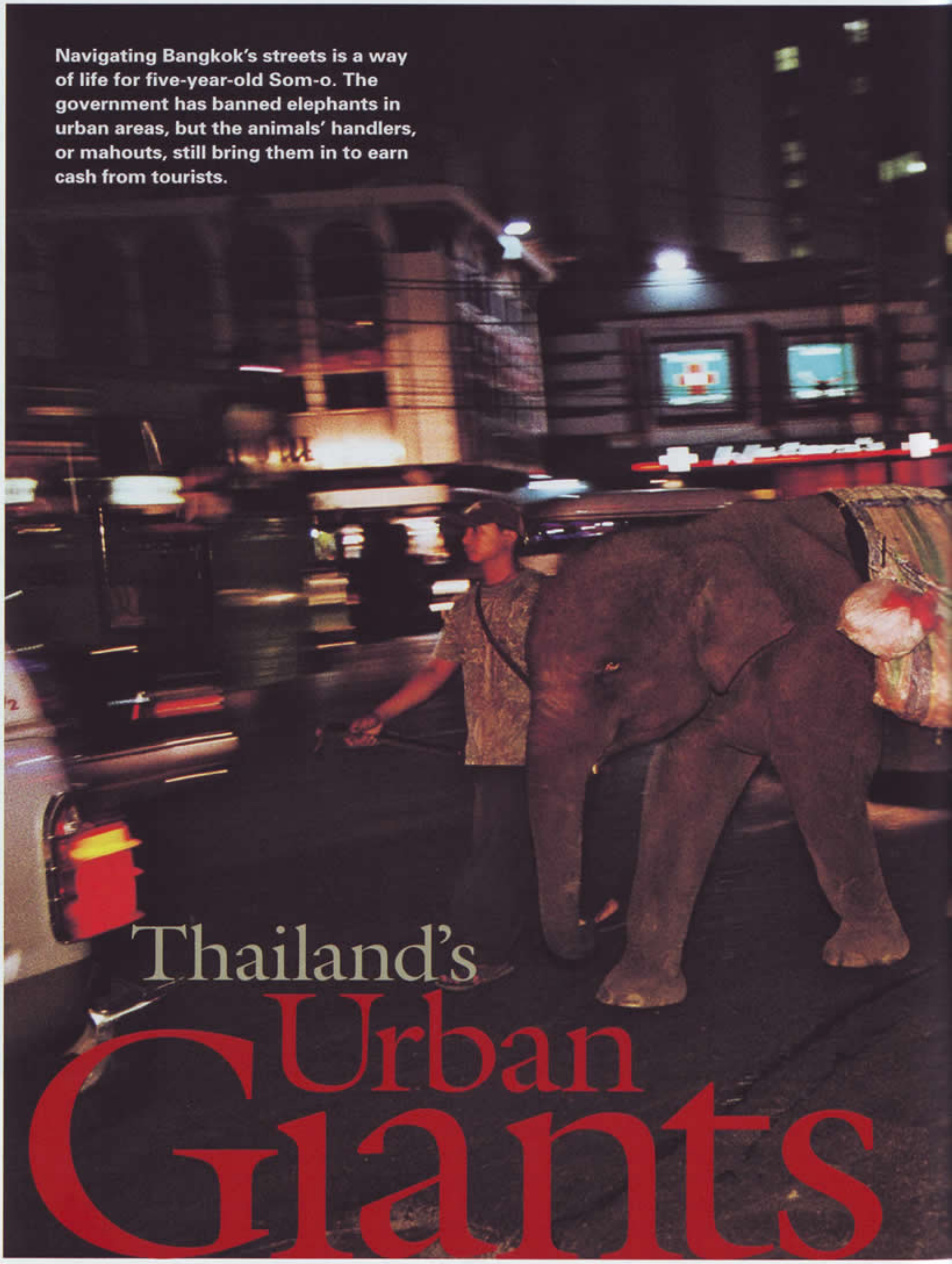
In their race against the river, Lopinot and Ray have reached out to local collectors such as Clark Montgomery, whose family owns land along the Sac.

"Guys like Clark are our eyes and ears," says Lopinot. "They collect artifacts along the eroding riverbanks year-round. Their findings enhance our knowledge." In return the archaeologists help the collectors identify and record what they find.

Late in the afternoon, work ends, and as in times past, Big Eddy becomes a campsite.

After supper Lopinot and Ray settle by a fire to discuss the day's discoveries. Tonight the distant thrum of Stockton Dam is punctuated by the nearer cries of a pileated woodpecker and a screech owl. In the moonlight the eddy is a silvery swirl that reverses the river's flow, but only for a moment. The archaeologists sit in silence, listening to the water and wondering what pieces of the past will be washed away before dawn. □

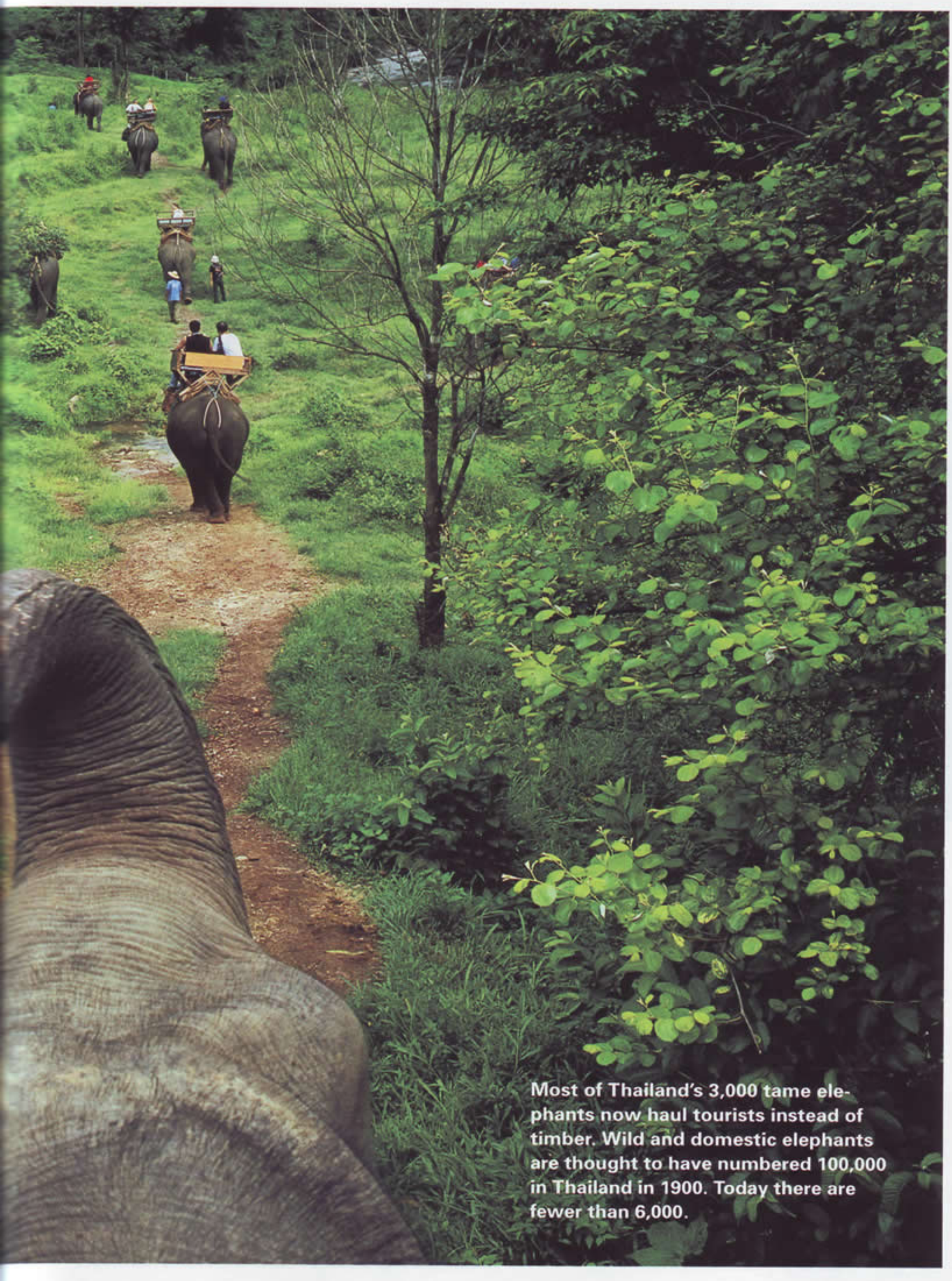
WEBSITE EXCLUSIVE Zoom in on artifacts from other ancient American sites in a photo gallery at **nationalgeographic.com/ngm/0012/feature3.**



Navigating Bangkok's streets is a way of life for five-year-old Som-o. The government has banned elephants in urban areas, but the animals' handlers, or mahouts, still bring them in to earn cash from tourists.

Thailand's Urban Giants

Too big to ignore, too tame to set free, Thailand's elephants have lost the logging jobs they were trained for. What's an unemployed pachyderm to do?



Most of Thailand's 3,000 tame elephants now haul tourists instead of timber. Wild and domestic elephants are thought to have numbered 100,000 in Thailand in 1900. Today there are fewer than 6,000.

By Douglas H. Chadwick

Photographs by William Albert Allard

NATIONAL GEOGRAPHIC PHOTOGRAPHER

In the hills of northern Thailand two strong-minded females share a hut built on stilts in the forest. One, named Jokia, is 42 years old and weighs three tons; the other, named Sangduen, is also in her 40s and weighs 86 pounds. Elephant and woman, their lives linked. When a meal is being prepared, Jokia, standing below, lifts her great nose, which then writhes along the bamboo floor like a plump python until Sangduen hands over some vegetables or a bit of fruit. Before the two met, Jokia had been employed in an illegal timber-cutting operation. Forced to keep dragging logs while pregnant, she struggled up steep slopes pulling heavy loads and suffered a miscarriage. Jokia went on strike. Her handler, or mahout, took to shooting her with a slingshot to get her up and moving, a practice mahouts call "using the remote." He missed his mark one day, blinding her left eye. Jokia's funk deepened. When the man who owned her came by to deal with the situation, she broke his arm with a swing of her trunk. In revenge he shot her remaining eye with an arrow, then put her back to work in chains, hauling freshly felled teak in darkness.

On a visit to the logging site, Sangduen saw the elephant being beaten for bumping into trees. When she was told Jokia's history, she knew she wouldn't rest until she could raise the money needed to buy her. The daughter of a traditional healer, Sangduen Chailert runs a travel agency in the city of Chiang Mai, but her passion is caring for animals in distress. A sort of one-woman humane society, she has accumulated more than 30 injured or

abandoned dogs at her home and feeds another 200 strays. Jokia is one of 17 adult elephants Sangduen has rescued over the years, now passing their days on a 955-acre forest reserve 35 miles north of Chiang Mai, land that she owns or leases from the government. "I can't seem to stop myself," she says as we walk among towering gray bodies in the lush landscape of the Elephant Nature Park. She calls the place Elephant Haven, and it has put her at the forefront of a growing movement for more humane treatment of the animals.

Although shrinking wildlands, poaching, and conflicts with farmers have hit elephants everywhere hard, those in Asia are in far greater peril than even Africa's threatened giants. Once abundant from China to Iraq, Asian elephants now total no more than 50,000, including 15,000 in captivity. Thailand alone is believed to have had an estimated 100,000 elephants a century ago—half of them tamed to plow fields, transport goods, and muscle teak and other valuable hardwoods out of the jungles. Today about 3,000 tame elephants and a roughly equal number of wild ones remain. Images of elephants are part of the national decor, adorning everything from billboards and beer bottles to gilded palaces. Referring to 16th-century battles using elephant cavalry against arch rival Myanmar (Burma), Thais say their country won its freedom on these animals' backs.

Yet such reverence is at odds with the current condition of Thailand's working elephants. Logging and agriculture have robbed wild elephants of as much as three-quarters of the country's forest and put domestic elephants on the unemployment line, since most worked in the timber industry. And tame elephants, unlike their wild counterparts, are not covered under Thailand's Conservation Act of 1992; instead, they're classified as a type of livestock, like oxen or water buffalo. That means owners stuck with animals that can no longer produce income but still need as much as 500 pounds of forage and 60 gallons of water daily are free to sell them to be slaughtered for their meat or, in the case of bulls, for their ivory tusks.

"Elephants are pushed to the edge," says activist Sangduen Chailert, who runs the Elephant Nature Park, a sanctuary north of Chiang Mai. Once common throughout the country, wild elephants now live in small, isolated groups.

The bond between a mahout and his elephant is among the strongest, most complex unions ever forged between *Homo sapiens* and a fellow mammal—the only one that can last a human lifetime because elephants also live to be 70 or older. But as the blind elephant Jokia shows, the bond is badly in need of repair. Many Thai mahouts are not the elephants' owners but simply men who hire on with tourist camps or rent the animals to panhandle on the streets, drawn by what looks like easy money. Panhandling has

At the Surin Elephant Round-Up Festival held each November, 200 elephants dance, re-create battles, and play soccer and tug-of-war. Their displays of strength and agility draw thousands.

TURNING TO TOURISM

Sheets of colored paper crafted from elephant dung will become photo albums and bookmarks for elephant-loving tourists. Near Bangkok, mahouts tend their charges and themselves at a makeshift camp between trips into the city to beg.

THE MAHOUT-ELEPHANT BOND IS among the strongest, most complex unions ever forged between *Homo sapiens* and a fellow mammal. But it's a bond badly in need of repair.

become so lucrative in tourist centers like Bangkok and Pattaya that the entrepreneurs who rent out the animals are sometimes referred to as "elephant lords." These keepers have no emotional ties to the elephants and little experience in how to care for or control them. The consequences can be tragic for both parties. By one estimate, perhaps a hundred mahouts are killed by elephants in Thailand every year.

IN THE CITY OF Khon Kaen, rising from the plains of the northeastern Thai region of Isaan, I visit a 40-year-old street elephant called Bom and her three-year-old offspring, a big, pushy boy named Minimax. They've been rented out by their owner to two mahouts and three assistants. Although mother and son look to be in fair condition, I notice raw scars on Minimax's forehead and holes in his ears—wounds caused by an ankus, the baton with a hooked metal tip used to enforce commands.

Working the streets is a simple racket: The elephants march along under their mahouts' guidance, extending trunks toward passersby, occasionally adding a curtsy or head waggle while assistants fan out, hawking overpriced bananas or sugarcane to feed the giants. Onlookers pay out of kindness and amusement, and also because of ancient traditions that link elephants to fertile rains and prosperity. Thais still walk under an elephant's belly three times for luck, or to ensure an easy birth.

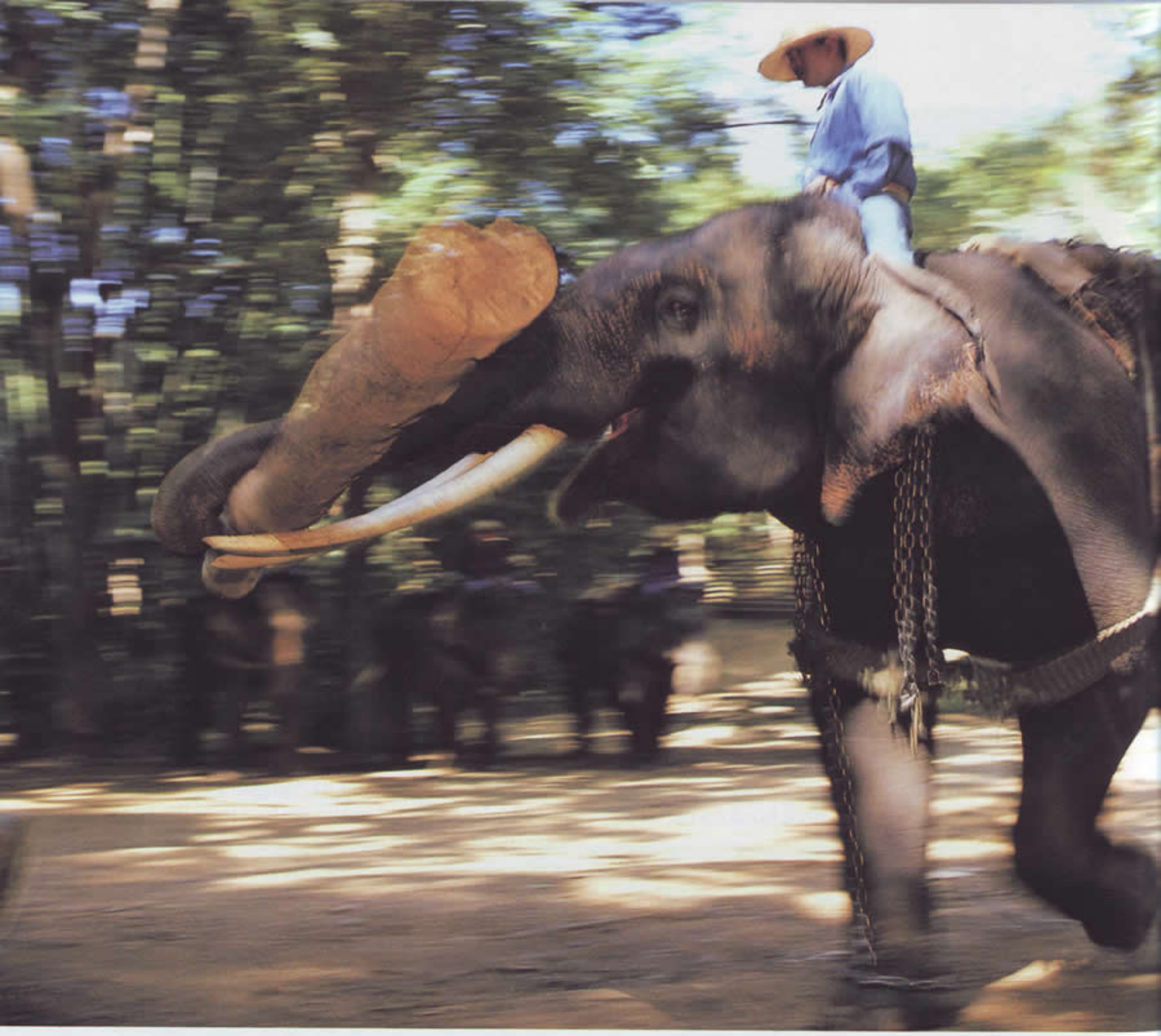
The midday temperature is sweltering, too hot for the crew to begin working the streets yet, so we linger where the men have strung a tarp over some weeds in a vacant lot. Plastic bags holding rice, chilies, and fruit dangle from branches. The tarp, a fire pit, and a small shrine fashioned from scraps of corrugated metal will be their home for the next month. Bom and Minimax are tethered with a long chain to keep them from wandering while the men doze; they've been up all night watching the elephants forage, making sure they didn't tear into the tasty trees of nearby yards. A ringing sound awakens the sleepers. "Yes, OK," I hear a groggy mahout say, answering his cell phone. "I can take Bom to do a wedding if you get the truck here the night before."

After the men bathe the elephants, we set out to shake some coins loose from the neighborhood. "*Zu gluay liang chaang, bor krub!*—Please buy bananas for the elephant!" the mahouts cry. "Just one bunch for the little one!" The men duck into shops and restaurants, waving bananas through wrought iron gates at people in courtyards. Minimax pokes his trunk in as well, bobbing his head up and down and squeaking encouragement at potential buyers as he's been taught to do. But few people are about, and after two hours and five miles, the men have sold just three bunches of bananas for a total of 60 baht—less than $1.50.

The money was better in Bangkok, where Bom and Minimax could make up to a hundred dollars a night. But the government has begun cracking down on street elephants in cities, and this crew was run out of the capital. The behemoths slow down already jammed traffic and compete with streetside stores for people's pocket money. Forced to walk long distances to reach city centers each day, the elephants get sick from breathing exhaust fumes, drinking polluted water, and having to snatch meals from trash-filled ditches. They also break legs clambering over concrete abutments and get smacked by automobiles. Though enforcement of the ban was casual at first, pressure from the public and Thai organizations demanding more humane treatment of elephants forced city after city to follow through on the rules.

Still, the elephants have to earn their keep somewhere. Many have simply been diverted to suburban areas, where they bide their time before filtering back into the cities. Bom and Minimax are working in Khon Kaen only because local police look the other way as long as they keep to the fringes of town.

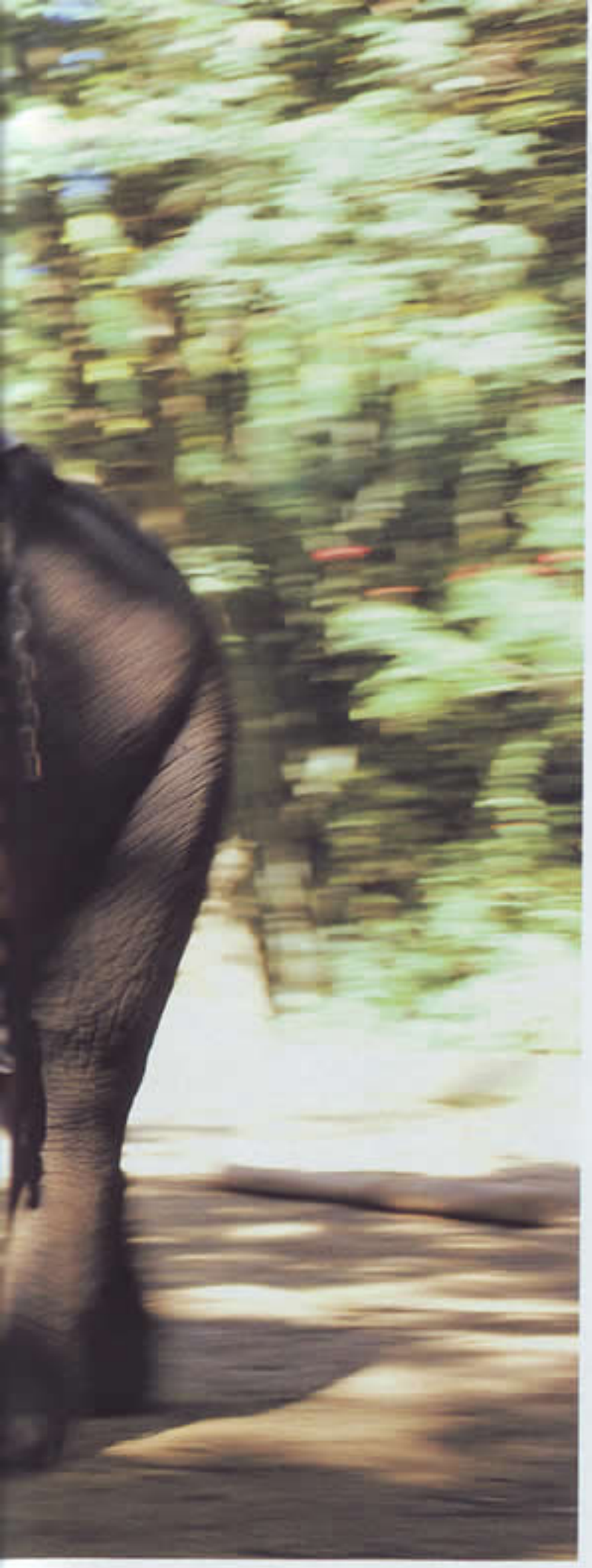
As dusk descends, the two elephants plod ahead on the paved road, oblivious to speeding



With long tusks and little effort, 25-year-old Ning Nong and Artou, his mahout of three years, show tourists at Chiang Dao Elephant Training Camp how timber was once hauled from forests. Although Thailand banned commercial logging of natural forests in 1989, illegal operations continue.

motorbikes, barking dogs, and tag-a-long knots of shrieking kids. One resident gives money to have Bom suck up a trunkful of water and spray it through his doorway as a blessing upon the house. One of the mahouts ties a flashing red light to her long tail and reflective tape to Minimax's so the animals are visible to cars passing in the darkness. Vendors begin opening their streetside stalls. Several give Minimax melons and squash from their own wares. Parents buy bananas and pass them to toddlers to hold while colossal Bom, watched by some of the widest eyes ever to appear on a child's face, plucks the treats carefully from their hands.

Business is picking up, but it looks as if the day's net will be under $20. Between a third and a half of that will go to the elephants' owner. The rest will be split five ways, with enough kept out to buy fresh bananas for the next day. It's a competitive situation: In Khon Kaen, a city of 150,000, there are a dozen other elephant crews trying to eke out a living the same way.

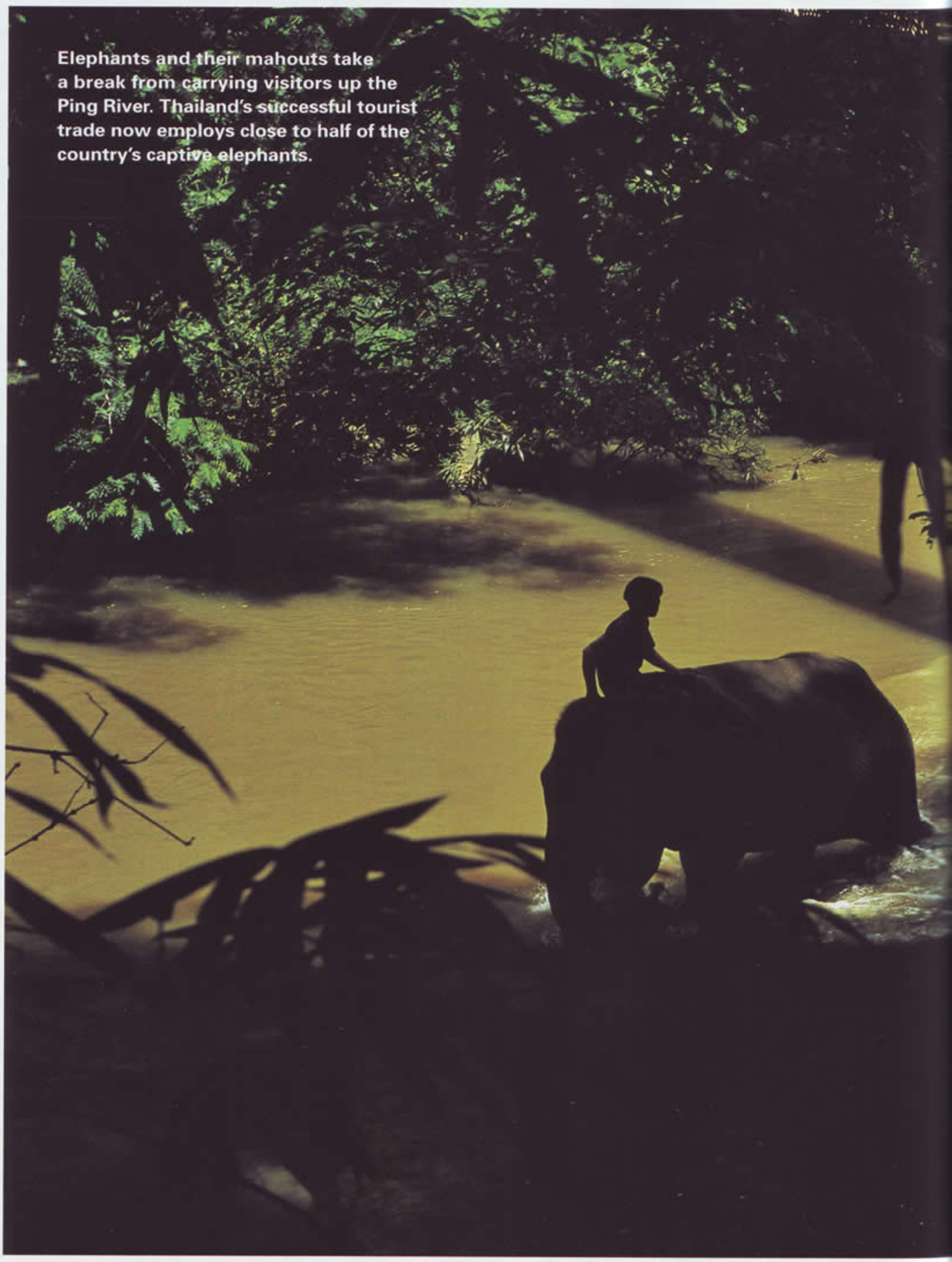


WITH THE STREET BUSINESS drying up, more elephants and their mahouts are finding work in tourist camps. In the seaside resort of Pattaya, visited by more than a million people annually, the number of camps has increased from three to nine in recent years, with one keeping nearly 80 animals on hand. All told, about half of Thailand's domestic elephants now spend their days giving rides to visitors in a howdah —a strapped-on bench seating two or three people—or performing in shows. The acts range from demonstrations of timber work to circus-like spectacles in which the animals dance, do handstands, pedal oversize tricycles, play soccer, and shoot basketballs. Whether you view the stunts as thrilling or degrading, they supply daily proof of an elephant's keen intelligence, coupled with a surprising degree of finesse.

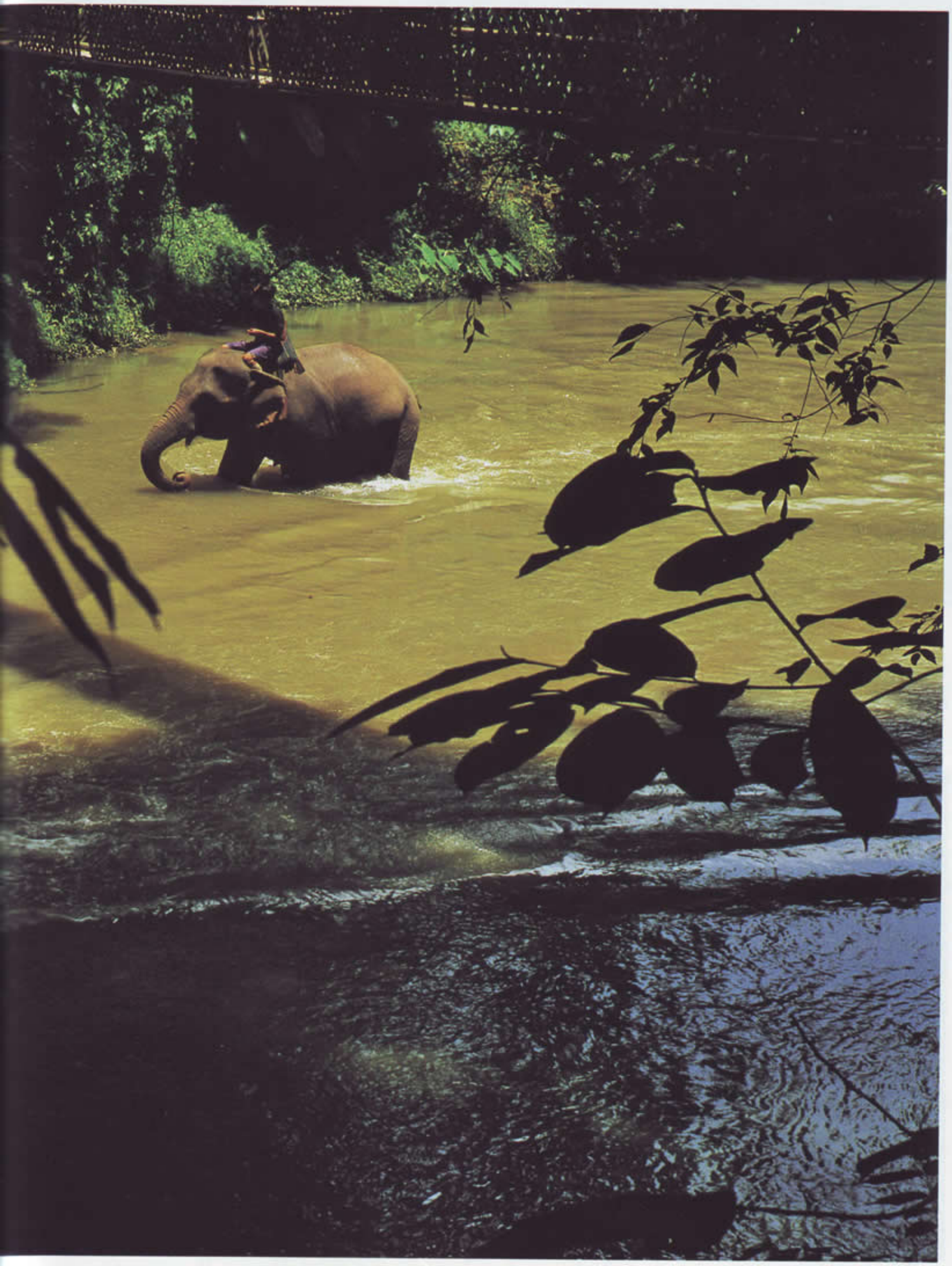
Phairat Chaiyakaham is the owner of Pattaya Elephant Village, a tourist camp where the ringmaster's spiel during daily performances is unusual in its emphasis on elephant welfare and conservation. Chaiyakaham grew up in Bangkok enthralled by the elephants he saw moving cargo onto trains, and over the years he's watched as the lives of working elephants have been transformed by changing circumstances. He introduces me to the bull Boon Num, whose life story can be traced through documents that must be filed after an elephant is taken from the wild and each time it is sold. His tale mirrors the long journey of Thailand's elephants from forest dwellers to labor force to tourist attractions.

Ten feet tall, four tons thick, and around 70 years old when we meet, Boon Num used to work for the Suay people of eastern Thailand, traditionally the country's foremost catchers and trainers of wild elephants. Getting fresh stock from the wild is considered more expedient than breeding elephants in captivity because pregnancy keeps a captive female out of work for 20 to 22 months. Boon Num's job was to chase free-roaming herds in Cambodia until one of the two mahouts on his back could lasso the quarry, usually a baby elephant, with a rope of braided water buffalo hide. Boon Num would then hold off the mother and other relatives trying to come to the tethered animal's aid. Afterward the captive would be placed in a "crush"—a tightly confining pen—and subjected to a will-breaking ceremony called *phajaan*, still practiced in places today. The taming process can be brutal, involving days of torment with spike-tipped poles until the elephant learns to move in response.

After his career of capturing wild elephants, Boon Num abruptly found himself in another part of the country with a new owner, a new mahout, and a new job: logging. Though Thailand outlawed further cutting of its forests in 1989, clandestine logging continues in remote areas, particularly near the Myanmar border. Hauling timber required less speed but every bit of Boon Num's power—and it took a toll. Injuries from



Elephants and their mahouts take a break from carrying visitors up the Ping River. Thailand's successful tourist trade now employs close to half of the country's captive elephants.



A HUNDRED MAHOUTS
are killed by elephants in Thailand every year—men with little experience drawn by what looks like easy money.

toppling trees, runaway logs, and falls on steep terrain are common. Once, Boon Num lost the end of his tail to a bite by a co-worker—a frequent occurrence among elephants thrown together in random groups. One rear foot also became torn and infected; no longer able to work, he was at risk of being rendered for parts like an old truck. Instead he changed hands again and wound up in Pattaya.

Chaiyakaham didn't set out to make his tourist camp a facility for abused elephants, but like Sangduen Chailert, he just kept stumbling across animals whose stories he couldn't ignore. When Chaiyakaham encountered yet another elephant in distress, named Boon Lai, she was in her late 20s and in withdrawal from a serious drug addiction. Mahouts engaged in illegal logging often take *yaabaa* (methamphetamine) so they can work long hours, skipping food and sleep, and they slip it to their elephants for the same purpose. Some animals fed the drugs are forced to toil by day for one part owner and through the night for another.

"Why," Chaiyakaham asked the man trying to sell Boon Lai, "should I buy a dead elephant?" Beyond exhausted, Boon Lai was a skeleton lost in the folds of her own skin, standing on legs that trembled constantly but could no longer walk. "We had to spray her with water for two hours just to wake her up," Chaiyakaham says. Now, five years later, when I greet Boon Lai, hand to trunk, her back has taken on the graceful shape Thais call *garn gluay,* curved like a banana stem. She is the friendliest animal in camp.

Restoring health to such mistreated elephants is only half the battle. It takes gifted mahouts to restore their spirits as well. After Boon Num's leg healed (it took six months and three veterinarians), Chaiyakaham says, "the mahouts did not want to get up on him because he can be moody. Then I got the right man."

That's Gas Pasuk, 24, a Suay handler who sits atop Boon Num during shows and takes tourists for rides on him. "Boon Num is quite gentle," Pasuk insists. "But he needs the sweet talk to soothe him. You have to have confidence in yourself and pay attention, know how he thinks, what he is feeling. When he doesn't want to be ridden, he will turn his back on you and growl."

Looming overhead as we speak, Boon Num crunches bushels of pineapple leaves from a nearby plantation. He pauses to break off a short stick. Gripping it like a pencil in his trunk, he guides this simple tool to a hard-to-reach spot behind one foreleg and gives it a thorough scratching. The intensity that sometimes flickers in his brown eyes melts away. Pasuk strolls over to rub the elephant's tummy and, in the Suay language, mumbles something like, "Hey Sonny Boy, how ya doing?" My guess is: Just fine.

I TRY MY HAND at mahout work at the Thai Elephant Conservation Center in the northern town of Lampang. Opened in 1992 by the state-run Forest Industry Organization (FIO), the center's goal is to help preserve knowledge about elephants accumulated over many lifetimes and make sure it's passed on to the new generation of mahouts. Recruits enroll in a lengthy program that covers the essentials of daily maintenance, diet, and medical care. They learn a long list of commands and ways to gauge an animal's emotional state and are advised on when to enforce control and when to ease off. While they're trained in use of the ankus to apply pressure to sensitive points such as the base of the ear, they're also taught that a skilled rider uses this sharp-tipped goad less as a club than as a wand, scarcely touching skin.

For a modest fee, the center offers abbreviated courses in elephant training for the public. My lessons come from Shinakorn Phongsan, nicknamed Jawn, who shows me how to order Prathida (Princess) to kneel so I can mount. But even using her foreleg as a step, I can barely reach her back with my hands. "Try this," Jawn says. Commanding Prathida to lower her head onto the ground, he runs up her trunk and leapfrogs straight over her forehead onto her neck. As I practice the move, stumbling around on her

LIVING AMONG GIANTS

Whiskey and bamboo flutes (below) end the mahouts' day at the Elephant Nature Park. The sanctuary tends to 17 adult elephants, including Boon Khum (above), whose right tusk cavity still has not healed 16 years after ivory poachers cut off the tusk.

With her foot in ruins from a land mine, Ma-nguay-low receives care at the Elephant Hospital in Lampang. An antiseptic is applied to the wound every day, aiding a slow recovery. Run by Friends of the Asian Elephant, the hospital is the first of its kind in the world.

huge face, her patience eases my qualms about what it will be like to actually ride her.

I've been drawn to elephants for years. Despite misgivings about keeping them in captivity, I know of no better way to grasp the extraordinary combination of sensitivity, strength, and intelligence that defines these animals than to be as close as possible to them. Rising a dozen feet off the ground astride Prathida's neck, I feel the stiff hairs on her skin prickle my legs as I practice steering by wriggling my toes behind her ears while calling out *ben* (turn), *soc* (back up), and other commands from the more than 40 to which she responds. For a few moments I feel like the Master of the Mightiest of Beasts, invulnerable, watching the ordinary world pass far below my feet. More often, I simply cling to her neck while she shuffle-trots around investigating whatever catches her interest, hurrying over to a faucet, turning it on, taking a drink, turning it off, then veering away to greet an elephant buddy.

At nine years old, Prathida has yet to experience a day of hard work. Another reason she's called a princess is that she's a budding beauty and seems to know it. To label her spoiled would be unfair, but no one would deny she is a little on the willful side—insistent, curious, with a lot of bounce in her gait, and very, very noisy.

"She's the one you hear trumpeting on our CD," says Richard Lair, an FIO adviser to the center who's earned the informal title Acharn Chaang—Professor Elephant—during a lifetime spent studying them. Lair is talking about the center's recording of elephants playing along to Beethoven's Sixth Symphony with 50 school kids and a marching band, a rendition that makes up in enthusiasm for whatever notes go astray. Like many zoos and camps, the center encourages the elephants to paint, but, Lair says, sound and smell, rather than sight, are their most important senses. So he and Dave Soldier, a visiting neuroscientist from New York's Columbia University, started the world's first elephant orchestra, complete with jumbo-size drums, gongs, chimes, and a xylophone. "How large is this orchestra of yours?" a visitor asks. Lair has his reply ready to go: "Well, by weight, I'd guess three times the size of the Berlin Philharmonic." The straight answer is about 12 elephants.

"Once, while I was conducting," he continues, "we were coming to the part for the big gong,

JENNIFER HILE (BOTH)

TAMED BY TORTURE

Behind many of the circus tricks and tourist rides in Thailand is a training ritual known as *phajaan,* documented by journalist Jennifer Hile in her award-winning film, *Vanishing Giants.* The video depicts villagers dragging a four-year-old elephant from her mother into a tiny cage (above) where she is beaten and deprived of food, water, and sleep for days. As the teaching progresses, the men yell at her to raise her feet. When she missteps, they stab her feet with bamboo spears tipped with nails. The prodding continues (top) as she learns to behave and accept people on her back.

"Tourists from around the world pay top dollar to take elephant rides in the forest or watch them perform in shows," says Hile. "But the process of domesticating these animals is something few outsiders see."

Thailand is not the only country using this method. Says Carol Buckley, founder of the Elephant Sanctuary in Hohenwald, Tennessee, "In virtually every place that has captive elephants, people are doing this, though styles and degrees of cruelty vary."

"I became a mahout because I needed work, but I now have a true love for my elephant," says Duve Nahore, who bathes the animals at the Elephant Nature Park. Owner Sangduen Chailert wishes everyone felt this way. "We need both the government and the people to get more involved," she says. "We need strong laws to protect this endangered species."

and a mahout forgot to hand his elephant the mallet. That elephant reached up and tapped him on the knee, as if to say, 'Hey, heads up. I'm on!'" Singling out Prathida for praise, Lair adds, "She's perfect keeping up with the music. She'll trumpet to accompany a violin and chirp when she hears a cello."

Like a proud father, Prathida's mahout basks in her accomplishments. Jawn was a groundskeeper at the center before deciding he liked elephants so much that he wanted to sign on as an apprentice, then train to become a full mahout. "The best part is getting over your fear and making a friend," he says. Now if he visits his family for several days, he returns to find Prathida acting mopey. "The funny thing is, I miss her too," he says. "I think about her a lot when I'm away."

But while training mahouts to take better care of their charges is an essential first step in improving conditions for Thailand's working elephants, it doesn't solve the animals' current unemployment problem. Government officials

talk up plans to use trained elephants and their riders to shepherd wild ones back into natural habitats when they come into conflict with farmers, and to hire street mahouts and their mounts to guard the country's parks and forest reserves against poaching. But only a handful of programs have made it past the discussion stage. One that attempted to recruit 200 elephants and mahouts who had been panhandling in urban centers to patrol parks fell far short of the mark. A hundred mahouts signed up—but 80 soon dropped out. The men were unable to adapt to daily life in the forest, complaining of rough paths and low pay. For now, mahouts and their elephants are more likely to seek work entertaining tourists. There are also proposals for one day reintroducing tame elephants into the wild.

The elephants at Sangduen Chailert's reserve in the hills will not be logging or panhandling or performing for onlookers ever again. They spend their days foraging in the forest, splashing in a nearby stream, and playing with friends, both animal and human.

Using my novice mahout skills, I ride uphill on the neck of Mae Perm, the first elephant Sangduen took under her care, in 1992. Trailing behind us is her best friend and constant companion, Jokia, the blind elephant. If Jokia nears a hole or precipice, Mae Perm sends out warning squeals or blocks the way with her body. She directs her friend through the forest with contact calls, and when Jokia is alarmed by some unexpected noise or scent, Mae Perm reassures her with low rumbles and touches of the trunk.

Mae Perm isn't the only one who worries about Jokia. Her mahout, a Burmese refugee named Kum, who also lost an eye in a logging accident, gets nervous about where she and Mae Perm wander at night. They sometimes cross into other valleys, and he's had to search for hours to find them. Once Jokia took off alone. When she finally turned up at a nearby jungle trekking camp, I am told, she not only arrived in good shape but had located a boyfriend from her logging days—the very male thought to have fathered the baby she lost—and mated with him. Kum tells me how Jokia, hearing him come to look for her, often hides in a thicket and uses her trunk to stifle the clapper on the wooden bell she wears. "You are such a sweet girl," he croons to her. "Why must you also be so tricky?"

Telling Jokia to raise her trunk, Kum hangs on to it and dangles in the air, laughing. I put away my notebook and do the same with Mae Perm, swinging from the trunk of the gentle old caregiver as if from a worn tree branch, happy to be in the presence of greatness. □

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BRIDGEWATER, NEW JERSEY

The Catrambone triplets (in blue shoes) of Bridgewater, New Jersey, mix it up with three sets of twins on their block. "We were told we might never have a family," says their mother, Lisa (center right). "It's all we ever wanted."

Is there something in the water?

08807

Triplet Epidemic

Why New Jersey leads the nation in multiple births.

BY JUDITH NEWMAN PHOTOGRAPHS BY NINA BERMAN

After five rounds of fertility treatments, three months of bed rest, a nauseating drug that stopped premature labor, and regular sonograms of her triplets (above), Jennifer Pipala, 36, gave birth about two months early. "They're healthy now," she says. "It all was worth it in the end."

SONOGRAM IMAGES COURTESY JENNIFER PIPALA

Here's a list of things you don't plan for: 1) Being unable to get pregnant. 2) Going for fertility treatments. 3) Having those treatments be unsuccessful. 4) Having those treatments be a bit too successful.

And there, in a nutshell, is the story of most women who've had triplets. Women like Kathy Rusiecki, who weighed 125 pounds before she got pregnant and gained 100 more before giving birth to her three daughters. By the end of her pregnancy she was gaining six pounds a day. "I had no knees," she says. "My legs looked like tree trunks." Or Lisa Catrambone, who cheerfully endured three months of bed rest while awaiting the birth of her three sons. "We know we did something with our time before these guys came along, but we've forgotten what it was," jokes Catrambone. Watching her energetic 18-month-old sons, Michael, Matthew, and Daniel, gum the furniture and toddle around the living room of her Bridgewater, New Jersey, home, it's hard to imagine that not one of them weighed more than three pounds at birth.

But here's the thing too: If, like Catrambone and Rusiecki, you happen to live in the New Jersey suburbs, you'll have lots of company. Because New Jersey has the highest ratio of triplet births in the United States. Between the years 1998 and 2002 the state recorded 358 sets of triplets (and higher-order births) per 100,000 live births. This might not seem like many, except when you consider that the national average is 186 per 100,000. Meaning that a New Jersey resident has twice the chance of having triplets as the average American.

So what's special about New Jersey? Two words: Fertility clinics—specifically, the fact that New Jersey has a lot of them, more per capita than almost anywhere else in the country. Of some 400 clinics nationwide, 5 percent are in New Jersey, a state with only 3 percent of the total population.

The goal of a fertility clinic is to give a woman one healthy child at a time. Twins are not considered a significant health risk, but triplets are—frequently resulting in low birth-weight babies and maternal health problems. But here's the little secret of the fertility clinic game: If a

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TRIPLET BIRTHS IN U.S.: 1 in 585
TRIPLET BIRTHS IN NEW JERSEY: 1 in 298
U.S. TRIPLET BIRTHRATE, 1980-2002: Up 500%
AVERAGE COST OF ONE IVF TREATMENT: $12,400
PERCENTAGE OF TRIPLETS BORN PRETERM: 90
DIAPER BUDGET FOR THREE BABIES: Don't ask.

Bridgewater (above) is one of several New Jersey towns undergoing a triplet boom. Daniel, Michael, and Matthew Catrambone kick back with their bottles and an educational video before bedtime (top). "Without my kids," says their mother, Lisa, "I'd have had a hole in my heart for the rest of my life."

woman is going to get pregnant at all, her chance of having twins or triplets increases exponentially. The probability of having triplets naturally is about 1 in 8,000, or about one-hundredth of one percent. In 2002—the last time statistics were compiled—the chance of a woman under 35 having triplets after undergoing treatment at, say, the East Coast Infertility Clinic in Little Silver, New Jersey, was 21 percent.

That's because a number of embryos are created through in vitro fertilization, then deposited into a woman's uterus. The number transferred depends partly on the woman's age; younger women generally receive fewer embryos than older patients. But some clinics have been a little more Wild West about their methods, transferring three or more embryos into even a young woman's uterus to increase her chance of getting pregnant. "A couple of clinics in New Jersey have been very aggressive to try and get the highest pregnancy rates by transferring lots of embryos," says Jamie Grifo, director of New York University's fertility clinic. Such practices, though frowned on by the medical establishment, may suit a woman anxious to get pregnant just fine.

Why are so many New Jersey women showing up at these clinics in the first place? One popular explanation, whispered among infertile couples, is that pollution might be lowering fertility in the state. But scientists say such worries are unproven. The more likely culprit is the state's high concentration of women starting families later in life. It becomes increasingly hard to get pregnant after 35.

"This is the land of the working woman," says Serena Chen, director of the division of reproductive medicine at Saint Barnabas Medical Center, where most of the babies conceived at local clinics are delivered. "There

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Sorting out who's who at the Stavrakis home can scramble the mind of even their mother, Lisa. "They laugh when I call one of them," she says, "because I often go through the whole list of names"—Brianna, Nicole, and Eliana (with younger brother, Nicholas, above). She joins 15 other triplet moms once a month for dinner, talk . . . and drinks.

are so many high-powered females here who've delayed childbearing," Chen says, "and unfortunately nature planned to have us barefoot with babies in the kitchen by age 25. That's just not the norm here."

Kathy Rusiecki is typical: busy sales manager, nearing 40, four miscarriages. She wanted to maximize her chances of one healthy pregnancy, and so did her doctor. Four embryos were transferred. Three of them are now her 8-year-old daughters, Kristin, Nicole, and Melissa. New Jersey's triplet boom is helped along by insurance, says Rusiecki, who's also president of Central Jersey Triplets & More, a support group for mothers of multiples. New Jersey is one of only a handful of states mandating that insurance companies cover fertility treatments under certain circumstances—a lure for family-minded couples who could not afford to do in vitro otherwise. "People who live and work in New Jersey have more access to fertility treatments because their health insurance does help pay for it," Rusiecki says.

But trios of toddlers in strollers may soon become a rarity again. The triplet rate has declined in the past few years. The East Coast Infertility Clinic in Little Silver, for instance, has dialed back its double-digit triplet rate to less than one percent. That's because it and other fertility clinics have begun transferring fewer embryos. "The idea is for the technology, and the quality of the embryos, to be so good that you can achieve high birthrates with even one embryo transfer," says Chen. "That's the direction we're going in."

But even if medical experts see triplet births as a risk of fertility treatments, none of the triplet parents I talked to had any regrets. "We're so happy our boys will each have two best friends they can always count on," Jeff Catrambone says, as his three New Jersey miracles dive-bomb a plate of animal crackers. "Thank God for modern medicine." □

WEBSITE EXCLUSIVE View more triplet images and nominate your own favorite zip code for coverage in the magazine at **ngm.com/0510**.

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THE NEXT KILLER FLU

A Virus Stalks the Zoo

Asia's bird flu showed an ominous face last October at this tiger park near Pattaya, Thailand. More than a hundred of the big cats died or had to be put to death after they ate raw, infected chickens. It was a rare case in which an avian flu virus remained an efficient killer as it jumped from birds to mammals —and a warning about the threat to humans. Lynn Johnson's unsettling photograph of the remaining tigers with African attendants, hired as an exotic touch according to the zoo's publicist, "is definitely worth a second look," says picture editor Todd James. But as the human toll from the disease rose this year, the tiger deaths seemed less relevant, and "the image began to look somewhat distracting," says James. In the end he chose more straightforward photos to tell this fast-changing story.

ONLINE PHOTO GALLERY View Web-exclusive images with tips from photographer Lynn Johnson at **ngm.com/0510.**

POSTPONE CELLULAR AGING.

The Science of Aging.

Today scientists are attempting to challenge fate by investigating the secrets of aging. Dr. Bruce Ames, a renowned geneticist, leading biochemist and University Professor has been instrumental in researching the relationship between diet, maintaining healthy cells, and the aging process. His research links aging to tiny structures found inside cells called mitochondria.

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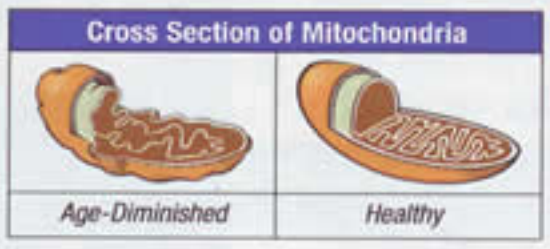

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TRAFALGAR (SEE PAGE 54)

GO THERE

Visit Cádiz

Though the 1805 Battle of Trafalgar raging off its shores foreshadowed the decline of Cádiz, the architecture of the city still echoes the affluence of its 18th-century heyday. Located on Spain's southern coast, Cádiz is a city of watchtowers. Used in the 1700s to track shipping, friendly and otherwise, the towers now offer views of the ports on Cádiz Bay. The famous watchtower known as the Torre Tavira is surrounded by shops and tapas bars and houses a camera obscura that projects live images of the cityscape. For more information go to *torretavira. com.*

Sacramento Street (top) is still dominated by the Torre Tavira, built in the 18th century. Sun sets over the Atlantic (above), where the French flagship *Bucentaure* sank after the Battle of Trafalgar. Before the battle, as the Spanish fleet sailed from Cádiz, sailors turned in prayer toward the Iglesia del Carmen (right).

COURTNEY PLATT (ALL)

PICKS

3 sea battles

British writer **Simon Worrall,** author of this month's story on Trafalgar, reflects on other strategic British victories at sea.

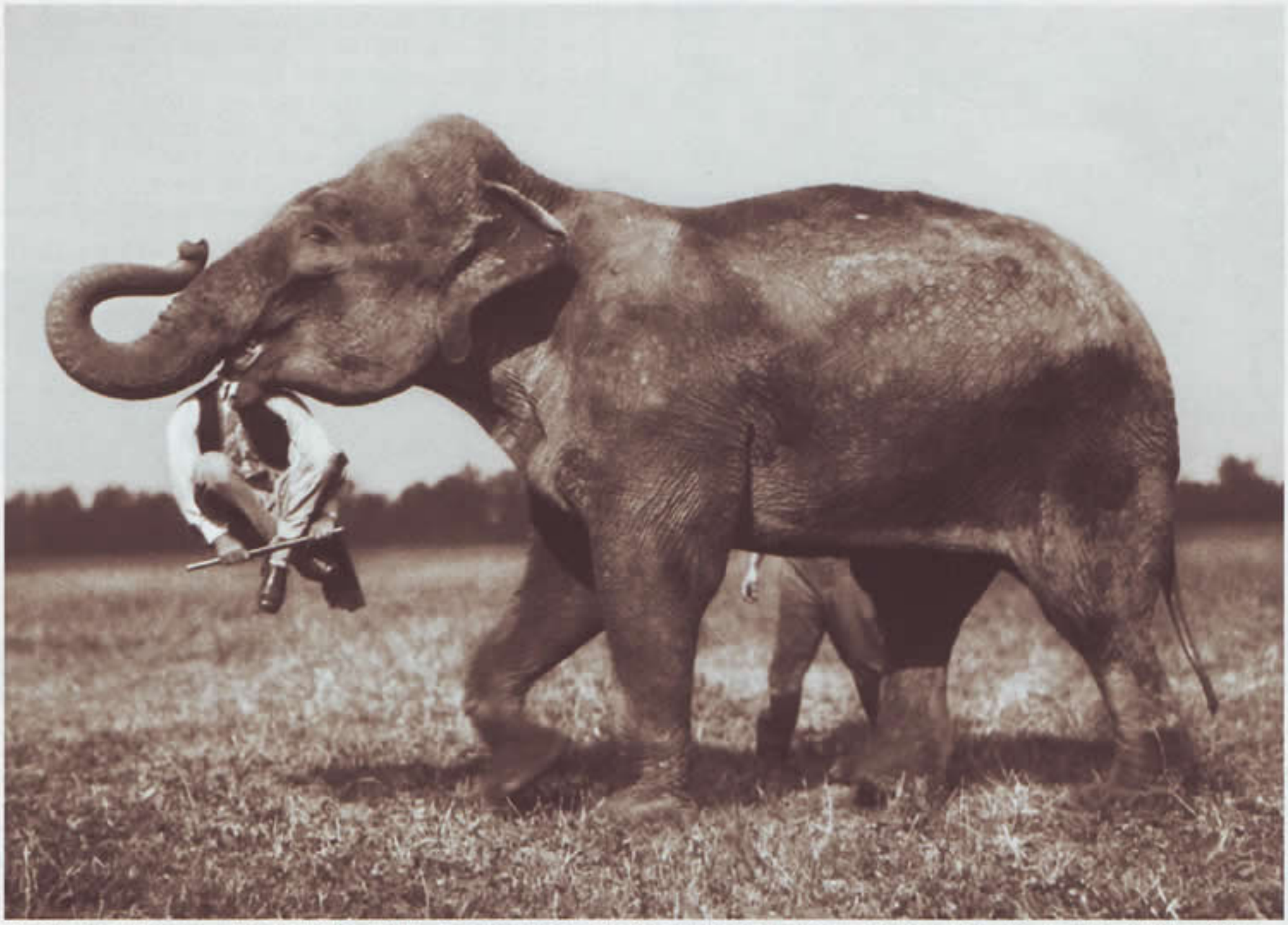
1588 Defeat of the Spanish Armada Hostilities between Britain's Elizabeth I and Philip II of Spain finally came to a head when Philip ordered his fleet to attack Kent. Foul weather and poor leadership led to Spain's defeat.

1798 Battle of the Nile Admiral Horatio Nelson led this decisive victory for the British, who gained control of the Mediterranean by destroying or capturing most of Napoleon's French fleet off the coast of Egypt.

1940 Second Battle of Narvik Small but significant, this early World War II battle took place off Narvik, Norway, a major shipping port for Swedish iron ore and an important strategic location for both the British and the Germans. The battle's outcome marked Britain's first major naval victory over Germany in the war.

WHAT HAPPENED to the Spanish warships after the British victory at the Battle of Trafalgar? Find out at **ngm.com/0510/feature3.**

Flashback



Blanche the elephant swung trainer "Cheerful" Gardner from side to side while holding him by the head in this trick for the Hagenbeck-Wallace Circus.

URBAN GIANTS

Don't Try This at Home

"The animal first learns to hold thus gingerly a ball the size of a human skull," notes this photo's caption in an October 1931 GEOGRAPHIC article on circus life. "Then gradually enough, weight is added to duplicate that of a man. Finally the performer substitutes his head for the dummy."

This elephant's trainer, "Cheerful" Gardner, was admitted to the International Circus Hall of Fame in 1981, but the human pendulum trick is no longer performed in modern circuses—people might lose their heads. —*Margaret G. Zackowitz*

E-GREET A FRIEND with this image and find past photos, in Departments at **ngm.com/0510.**

PHOTOGRAPH BY LINTZ BROTHERS

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