

FREE POSTER Mauna Kea: Taller Than Everest

NGM.COM SEPTEMBER 2012



**ROMAN
FRONTIERS**

NATIONAL GEOGRAPHIC



WHAT'S UP WITH THE Weather

- SUMMER IN MARCH
- RECORD FLOODS
- ENDLESS DROUGHT
- SNOWMAGEDDON





Saiga (*Saiga tatarica*)

Size: Head and body length, 108 - 146 cm (42.5 - 57.5 inches); shoulder height, 57 - 79 cm (22.4 - 31.1 inches); tail, 6 - 12 cm (2.4 - 4.7 inches) **Weight:** Males, approx. 41 kg (90 lbs); females, approx. 28 kg (62 lbs) **Habitat:** Prefers open dry steppe grassland and semi-desert areas **Surviving number:** Estimated at 100,000 - 110,000



Photographed by Igor Shpiienok

WILDLIFE AS CANON SEES IT

Time traveler. The saiga is a relict species from the last ice age, evolutionarily distinct from other animals. Its unique nature is as plain as the nose on its face, which is thought to filter dust and warm the frigid air in the winter. This nomad has roamed the steppes for millennia, living in large herds when conditions allow. Thanks to a high birthrate, it has been able to bounce back following particularly brutal winters.

But poaching—for meat and for the males' amber horns—has greatly intensified, recently decimating populations by 90%. Meanwhile, disease also threatens. Could the saiga's time be up?

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.



Swimming in a forest of kelp, a harbor seal takes a break at a seamount off the coast of San Diego. Story on page 66.

BRIAN SKERRY

September 2012

30 **Weather Gone Wild**

Disastrous rains. No rain at all. Unexpected heat or cold. Is Earth's climate changing dangerously?

By Peter Miller

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The state has just suffered its driest 12 months.

Photographs by Robb Kendrick

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They rise from the ocean floor, rarely explored by humans. A new expedition offers a close-up look.

By Gregory S. Stone Photographs by Brian Skerry

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80 **Yemen's Day of Reckoning**

Its old ruler is gone. The new challenge: coming to terms with rebels, refugees, and al Qaeda.

By Joshua Hammer Photographs by Stephanie Sinclair

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Rome's walls helped set the outer limits of its power—and led to its downfall.

By Andrew Curry Photographs by Robert Clark

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Don't call them Gypsies—a derogatory term. And don't expect any of them to live in caravans.

By Tom O'Neill

Photographs by Karla Gachet and Ivan Kashinsky



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Not So Silent Spring

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A new ranking puts Vienna on top.

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To better regulate snake charmers, India implanted microchips in cobras.

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The sky isn't falling. But what about debris from outer space?



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Where the Trees Are ▶

A high-def map of U.S. forests is a window on our arboreal past and future.

Rolling Robo-Worm

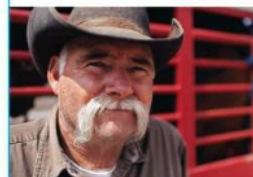
Next-generation robots will mimic larvae: form a ball and roll away.

Helping Whales Hear ▶

A curtain of bubbles can help drown out underwater industrial noise.

Champion Ears

The tarsier, a palm-size primate, hears sounds that most land mammals can't.



Dealing With Drought
Video

Meet the Texas farmers who won't give up.



Watery World
Video

Oceans pop out as a globe turns into a flat map.

PHOTO: SPENCER MILLSAP, NGM STAFF. MAP: NGM STAFF



On the Cover

Storm chaser Hollingshead caught this 130-mile-an-hour tornado on June 20, 2011, near Bradshaw, Nebraska. At close range, he admits, "my heart tends to get up in my throat a little."

Photo by Mike Hollingshead

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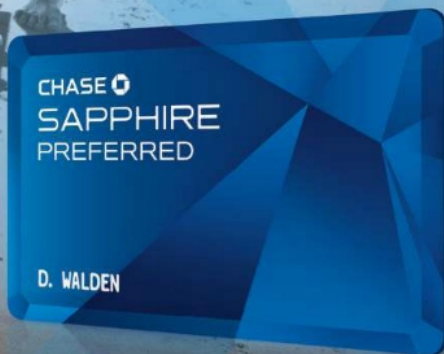
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THERE'S NO SUCH THING AS WORK?



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CHASE 

The Coming Storms

The sky felt bigger and more dramatic when I lived in Kansas. I appreciated how it dominated the landscape, especially when supercell thunderstorms arrived in May and the afternoon horizon turned black or an eerie dark green. The atmosphere would explode in deafening thunder, blasts of lightning, and frightening winds. Tornado warning sirens shrieked, but I paid no attention as I watched the spectacle unfold. I was seldom alone. Others were drawn to witness the drama, despite the risk of being drowned by rain, pelted by hail, struck by lightning, blown into another county, or sucked up by a tornado.

Last year in the United States there were a record-breaking 14 extreme weather events—from floods to drought—that caused at least a billion dollars in damages each. There was loss of life as well. Clearly it is perilous to ignore the sky, as this month's cover story on extreme weather explains.

Author Peter Miller knows this subject well. In the spring of 1986 he and I spent nearly three months chasing thunderstorms with a team from the National Severe Storms Laboratory for a story on tornadoes that ran in the June 1987 issue. Much has changed since then. Our planet has warmed up, there is more moisture in the atmosphere, heavy rains are more frequent, and droughts are more pronounced. Peter examines the causes and considers the future, which some say looks as ominous as a Kansas supercell in May.

Clearly it
is perilous
to ignore
the sky.



A tornado descends from a Kansas supercell.

A handwritten signature in black ink, appearing to read "Chris Johns". The signature is fluid and cursive, with a horizontal line extending across the middle of the name.

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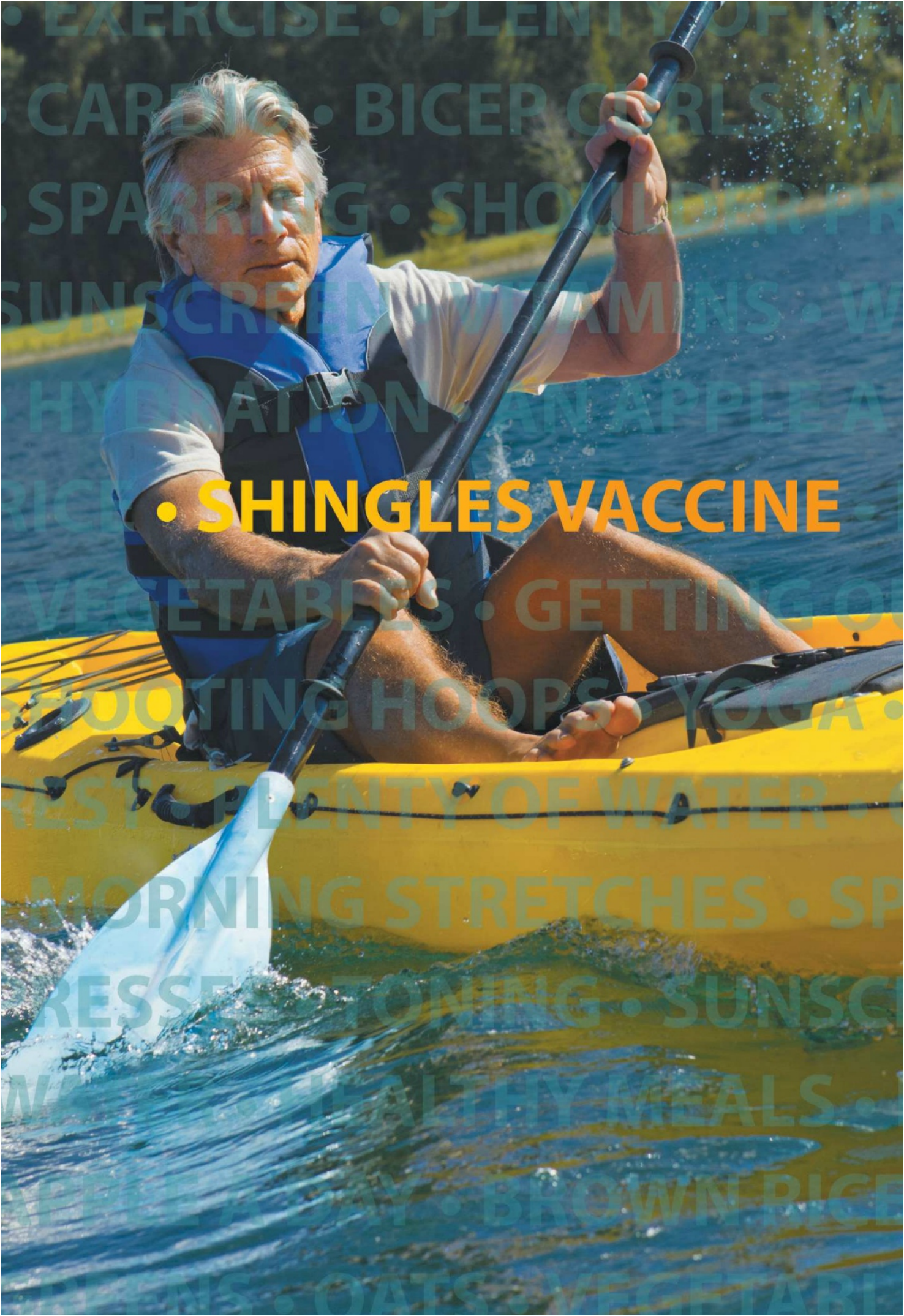
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Now's the time to help prevent Shingles with ZOSTAVAX® (Zoster Vaccine Live).

ZOSTAVAX is a vaccine that helps prevent Shingles in adults 50 years of age or older. Shingles is caused by the same virus that causes chickenpox. The virus stays in your body and can resurface at any time as Shingles—a painful, blistering rash. And no matter how healthy you feel, your risk increases as you get older.



The sooner you get vaccinated with ZOSTAVAX, the better your chances of protecting yourself from Shingles. In fact, the ACIP* of the CDC (Centers for Disease Control and Prevention) recommends that appropriate adults 60 years of age and older get vaccinated to help prevent Shingles.

Talk to your health care professional to see if ZOSTAVAX is right for you.

ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. For more information, visit ZOSTAVAX.com or call 1-877-9 SHINGLES.

ABOUT ZOSTAVAX

ZOSTAVAX is a vaccine that is used for adults 50 years of age or older to prevent Shingles (also known as zoster).

Important Safety Information

- ZOSTAVAX does not protect everyone, so some people who get the vaccine may still get Shingles.
- You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin or neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. You should not get ZOSTAVAX to prevent chickenpox.
- Talk to your health care professional if you plan to get ZOSTAVAX at the same time as PNEUMOVAX®23 (Pneumococcal Vaccine Polyvalent) because it may be better to get these vaccines at least 4 weeks apart.
- Possible side effects include redness, pain, itching, swelling, hard lump, warmth, or bruising at the injection site, as well as headache.
- ZOSTAVAX contains a weakened chickenpox virus. Tell your health care professional if you will be in close contact with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care professional can tell you what situations you may need to avoid.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

Please read the Patient Information on the adjacent page for more detailed information.

*ACIP=Advisory Committee on Immunization Practices

Before you get Shingles, get vaccinated.



Having trouble paying for your Merck medicine?
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ZOSTAVAX®
Zoster Vaccine Live

9989115

**Patient Information about
ZOSTAVAX® (pronounced "ZOS tah vax")
Generic name: Zoster Vaccine Live**

You should read this summary of information about ZOSTAVAX before you are vaccinated. If you have any questions about ZOSTAVAX after reading this page, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 50 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles.

If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people. ZOSTAVAX does not protect everyone, so some people who get the vaccine may still get shingles.

ZOSTAVAX cannot be used to treat shingles, or the nerve pain that may follow shingles, once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including non-prescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

Can I get ZOSTAVAX with other vaccines?

Talk to your health care provider if you plan to get ZOSTAVAX at the same time as the flu vaccine.

Talk to your health care provider if you plan to get ZOSTAVAX at the same time as PNEUMOVAX®23 (Pneumococcal Vaccine Polyvalent) because it may be better to get these vaccines at least 4 weeks apart.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, hard lump, warmth, or bruising where the shot was given.
- headache

The following additional side effects have been reported with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- chickenpox
- fever
- hives at the injection site
- joint pain
- muscle pain
- nausea
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX. For a complete list of side effects, ask your health care provider.

Call 1-800-986-8999 to report any exposure to ZOSTAVAX during pregnancy.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

This page summarizes important information about ZOSTAVAX. If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

Rx only

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Inspire Future Generations



The Zajics included National Geographic in their estate plans.

Former U.S. Marine and aviation engineer, J.C. and his wife Ann, have had *National Geographic* magazine in their home since 1950. “We rely on *National Geographic* as a source of timely, current, and balanced reporting,” says J.C. “We love the wide-ranging topics, international scope and that the information is accessible to everyone young and old alike. We are proud to be sending our great-granddaughter Isabella the children’s edition. Your stories have a unique cross-generational reach and appeal.”

“When we reviewed our long-term charitable plans, we created a stand-alone Charitable Remainder Unitrust in which National Geographic is the major benefactor. It is our way to ensure that future generations will be able to explore our amazing world and universe. We would encourage others who have charitable trusts or are planning on setting one up to think of including National Geographic. Your gift, like ours, will be well used and make a real difference.”

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Civil War

Why was not some mention made of the young boys who were involved in the Civil War? One of my relatives was one of those boys. He was a ten-year-old named John Joseph Klem (born Newark, Ohio, 1851) who served with the 12th and 22nd Michigan Volunteers. During the Battle of Shiloh

- ▶ his drum was shattered by an artillery round. During the Battle of Chickamauga, in 1863, while riding a caisson, he shot a Confederate who tried to stop him. This earned him the name Little Drummer Boy of Chickamauga. Maybe some future writings will reflect the young boys' contributions.

YURBA E. HILLYER MILLER
Redding, California

Harry Katz describes how dangerous the work of a sketch artist was during the Civil War, including Anglo-Italian Frank Vizetelly's experience at First Bull Run. Having survived Garibaldi's campaigns in Europe and his time in America, Vizetelly eventually went a campaign too far. He is believed to have been killed on November 5, 1883, at the Battle of Shaikan in the Sudan while marching with Hicks Pasha's expedition against the Mahdi. The risks are perhaps

greater for today's war photographers. The need to understand through visualization is still great.

ALAN WATERS
Braintree, England

No matter how carefully the reenactment is done, one crucial character is always left out: Death. The late George Carlin said anyone wanting to reenact a battle should use live ammunition.

STEVEN SABOTTA
Fukuoka, Japan

Before Abe said it, Jesus did: "If a house is divided against itself, that house will not be able to stand" (Mark 3:25, et alia).

FERNANDO MIGNONE
Burnaby, British Columbia

When Abraham Lincoln accepted the nomination to be Illinois's Republican candidate for U.S. Senate in 1858, he used Jesus' words in his speech without attribution, knowing his audience would understand whom he was quoting. He didn't have to add, "as Jesus said to the Pharisees."

The photos were excellent in simulating the technology of the mid-19th century and in showing the meticulously attired figures, but were set up for ridicule by the inclusion of artifacts of modern-day life.

WILLIAM LEAHY
New Forest, England

Corrections

MAY 2012, CIVIL WAR POSTER
Austin C. Wellington should have been identified as a corporal, not a private.

FEEDBACK Readers reacted to our coverage of the hazards koalas face in today's Australia.

"It was difficult to read of the plight of the koalas without feelings of horror."

"I never dreamt that Australia's beloved koala bear was threatened."

"My wife, my college-age daughters, and I feel that the dead koalas picture was totally unnecessary."

"Thank you for raising awareness about the threats to Australia's koalas."

Sartore took of the deceased koalas."

"Never before has a mere photograph moved me to tears like the one Joel



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Include name, address, and daytime telephone. Letters may be edited for clarity and length.

How to Outsmart a Millionaire

Only the "Robin Hood of Watchmakers" can steal the spotlight from a luxury legend for under \$200!

Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his \$22,000 watch made it okay for him to be rude. That's when I decided to roll up my sleeves and teach him a lesson.

"Nice watch," I said, pointing to his and holding up mine. He nodded like we belonged to the same club. We did, but he literally paid 100 times more for his membership. Bigshot bragged about his five-figure purchase, a luxury heavyweight from the titan of high-priced timepieces. I told him that mine was the *Stauer Corso*, a 27-jewel automatic classic now available for only \$179. And just like that, the man was at a loss for words.

Think of Stauer as the "Robin Hood of Watchmakers."

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VISIONS



Indonesia

Empty-handed after a trip to a feeding area, Doyok the orangutan hangs out in Borneo's Tanjung Puting National Park. The rehabilitated primate was released into the wild some 20 years ago but occasionally returns for a bit of banana and milk.

PHOTO: ANUP SHAH, NATURE PICTURE LIBRARY





China

A Mongol boy's ebullience bubbles over on a traditional swing made of rope and a pillow seat. The afternoon flight takes place under his brother's steady hand in Hemu, a rural village in the north-west region of Xinjiang.

PHOTO: RICKY ALEXANDER





United States

A chocolate chip cookie tempts a wild raccoon from the forest to the steps of a bed-and-breakfast near the Oregon coast. In the Pacific Northwest the mostly nocturnal mammals typically range between 10 and 25 pounds.

PHOTO: COREY ARNOLD

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EDITORS' CHOICE **Romeo Doneza** Long Beach, California

The scene: Sunday morning at Hilltop Park, in the city of Signal Hill. Doneza, 57, waits for a man and his dog to pass by and meld with a concrete sculpture. The painted shadows of an oil derrick and worker commemorate the area's oil-rich history.



READERS' CHOICE

Blerta Zabërgja
Prishtina, Kosovo

Zabërgja was 22 when she watched this sunset from a rooftop. "I was feeling like Alice in Wonderland, all grown up and facing the chaos of the real world!" says the painter and photographer, now 28. "I love heights and took this self-portrait to capture the feeling it gives me."



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Spring Awakening

In the 50 years since marine biologist Rachel Carson's *Silent Spring* was published, the Environmental Protection Agency was born and the U.S. has tightened its use and regulation of toxic chemicals. The 1962 classic focused on the pesticide DDT's alarming effects on wildlife and its longevity in the food chain. Scientists blamed the dramatic decline of bald eagles on their consumption of DDT-laden prey, which caused some bird species to produce ultrafragile eggs.

Silent Spring is often cited as the primary reason

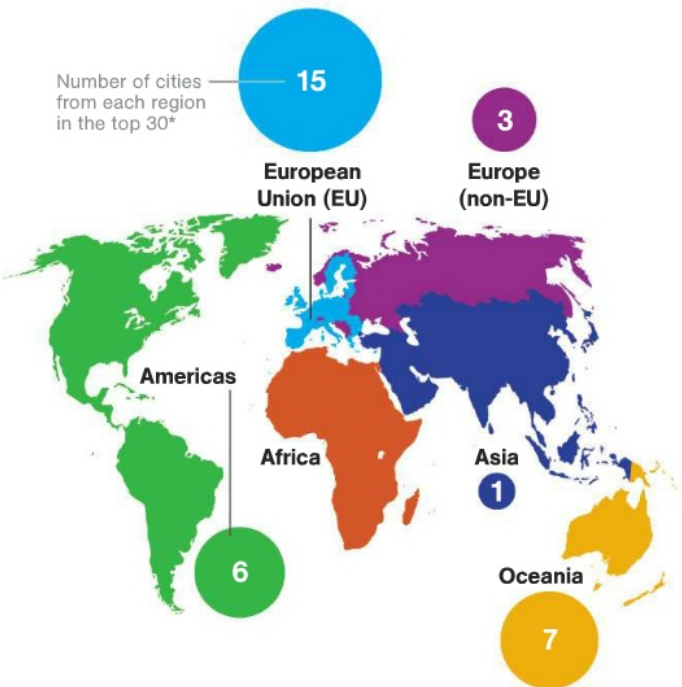
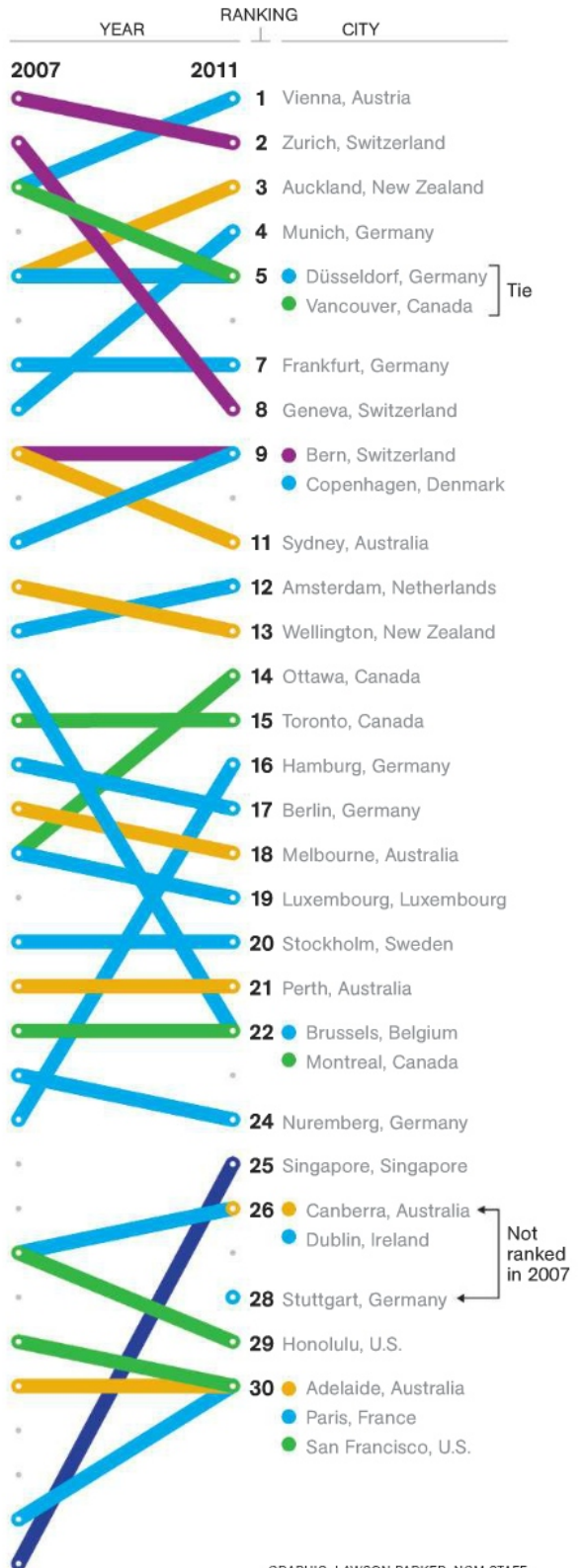
the EPA banned DDT in 1972. While Carson, who died in 1964, urged more cautious use of pesticides, she didn't advocate specific policies, says biographer Linda Lear. Environmental historian Thomas Dunlap notes the book prompted research that led to major policy shifts, such as increased oversight of federal projects and a 1972 overhaul of regulations on the sale and use of all pesticides. "She was the catalyst for the modern environmental movement," says Dunlap, "and in that sense we are all children of Carson." —John Briley

Frank Rankings

Ranking cities for “livability” grows more complicated each year. Just think of the urban scene in 2011: violent protests in Athens and elsewhere over economic issues, continuing unrest in Arab capitals, terrorist attacks on government buildings in Oslo and a summer camp nearby. All that strife prompted Mercer, a human resources consultancy, to add a separate personal safety section to its annual ranking of more than 200 cities, which helps companies determine cost of living adjustments for employees transferred overseas. Baghdad ranked dead last overall; Luxembourg was first for safety, due to a low crime rate and stable political situation.

Mercer weighs many factors in its overall rankings (right): education, public health, censorship, mass transit, culture. Economists and other rankers take a different tack. The Cato Institute’s urban planning expert Randal O’Toole favors looking at which cities draw the most newcomers. To him, that’s a sign of affordable, livable cities. He reports that in the U.S., Houston, Dallas, and Atlanta are tops. —Catherine Zuckerman

World city livability



*Numbers add up to 32 because of ties.

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Sweeping the Sky

At dusk in winter the sky above Rome fills with hundreds of thousands of European starlings moving and twisting like a giant, single organism. Such avian displays have long mystified human observers; one British naturalist believed the birds used a kind of telepathy to move in sync.

Italian physicist Irene Giardina and colleagues concluded that each starling's movement directly affects six or seven neighbors. Now they've measured the strength of these interactions. Just as metallic atoms align to create a magnet, the effect ripples across the entire flock almost instantaneously. Still unknown: why the birds gather like insect swarms in the first place. Some scientists surmise that the massive gyrations help protect individuals from predators. But then, Giardina wonders, "why wouldn't they remain in trees rather than dance in the sky?" —Luna Shyr

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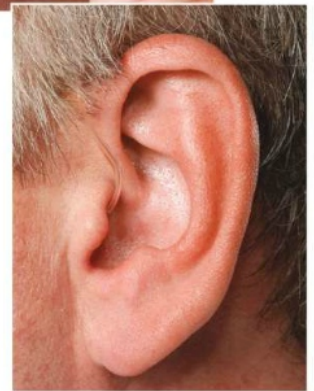
New Personal Sound Amplification Product is an affordable alternative

Over the years, technology has made the way we live easier, safer and more convenient. In many cases, it's even made many products more affordable... (remember how much the first VCRs used to cost?). Unfortunately, the cost of hearing aids never seemed to come down. Now, a new alternative has been invented... it's called Perfect Choice HD™.

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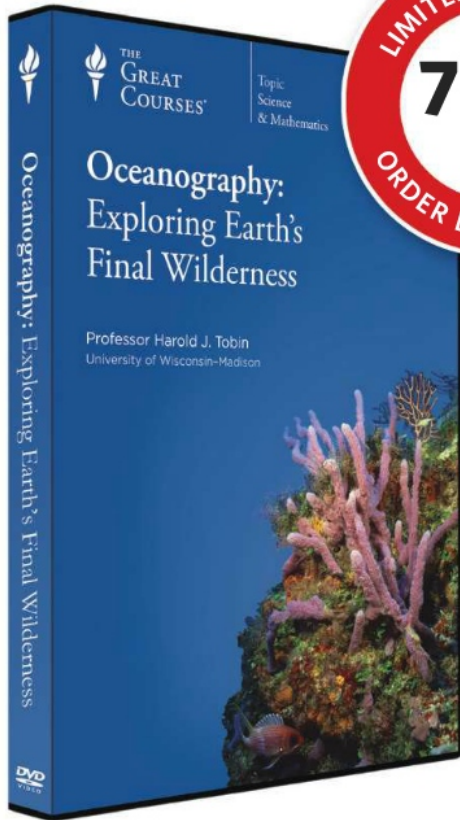
Charms and Chips It's a culture clash for the ages: mystic snake charmers versus high-tech bureaucrats. Last year 43 snakes—cobra, python, rat snake, boa—owned by ten Delhi charmers were implanted with ID microchips. Officials hope the procedure will, among other things, help them keep tabs on who owns which snakes. Noncompliant charmers, who call the measure unfair, could be jailed.

Yet even chipped snakes are illegal based on a 1972 law, says Kartick Satyanarayan of Wildlife SOS. He urges reform, not regulation: Instead of defanging and mistreating snakes, charmers could use their skills for conservation work. Herpetologist Romulus Whitaker agrees, but wonders about widespread change. Snake charming has largely left urban India, he says, though in superstition-steeped rural areas, "it's not going away for the next hundred years." —Jeremy Berlin

One 2009 estimate placed 800,000 snake charmers in India—like this one in New Delhi, with a king cobra.



IT CAME FROM OUTER SPACE Is it possible to get hit by something falling from orbit? It's happened only once, but NASA estimates that man-made debris lands on Earth nearly every week—mostly in water. Debris can be anything from the fiber-glass rocket scrap that struck an Oklahoma woman in 1997 (she was fine) to the 350-pound satellite chunk that fell into the Pacific last year. Orbital junk is under constant watch, and no one's been hurt in 50-plus years. "It's amazing but statistically consistent," says NASA's Nick Johnson. "The world's a big place." —Luna Shyr



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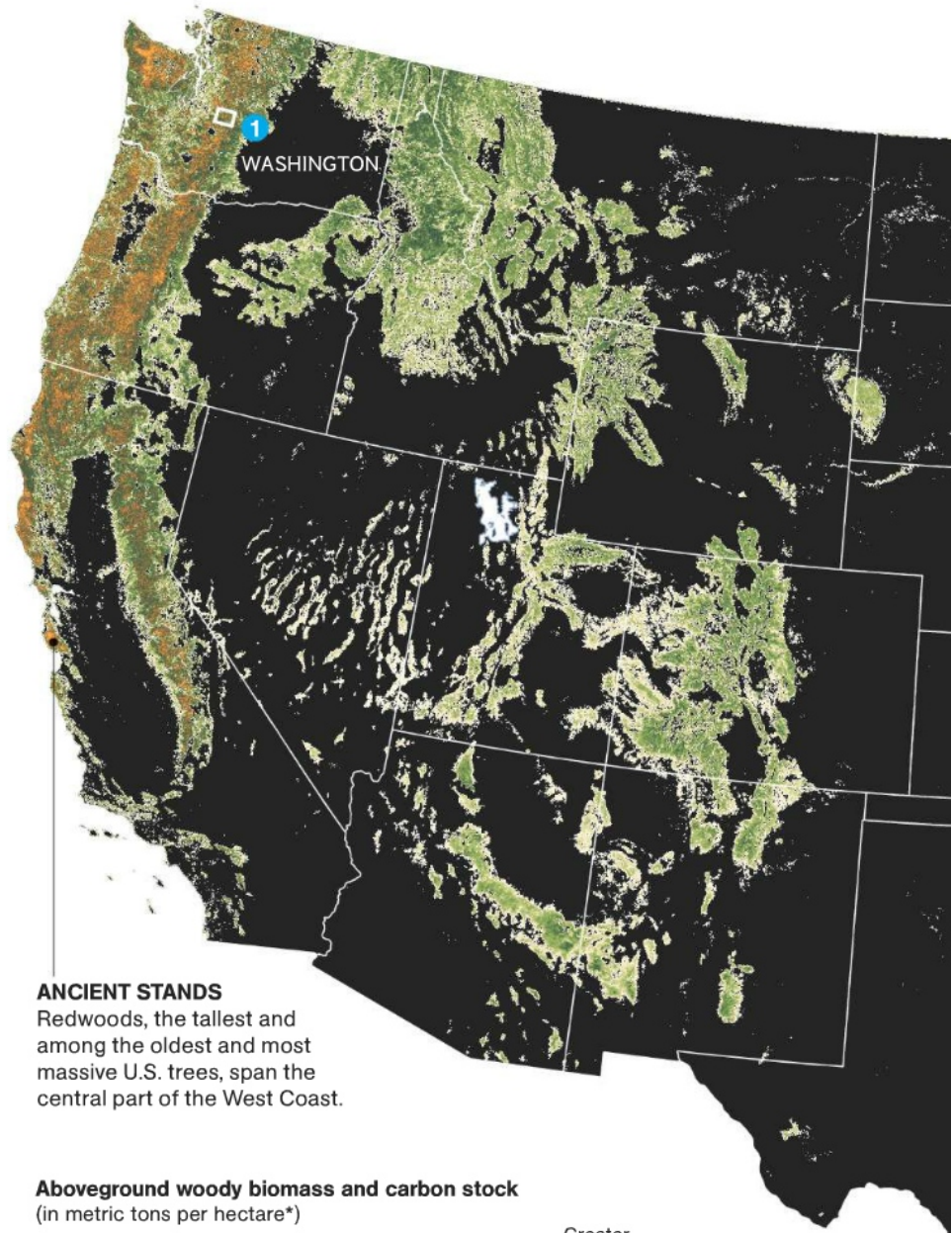
NEXT

American forests tell the history—and likely future—of human habitation.

WHISPERING PINES

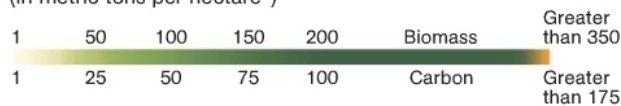
WHEN RADAR ON BOARD the space shuttle measured treetop instead of ground elevation, geologists were disappointed. Forest researchers weren't. "One scientist's noise is another's data," points out Josef Kelldorfer of the Woods Hole Research Center. With colleague Wayne Walker, he combined the treetop data with computer models and tree surveys to build the first high-definition map of U.S. forest biomass. It boasts pixels showing areas the size of a baseball infield.

There's a lot more to the forests than the trees—the map says as much about the people who live among them. In the timber-rich West straight-edged scars reveal the work of loggers. Sparse woods in the Midwest tell of farmers who planted trees on the prairie for building supplies. The East's stands relate the success story of reforestation centuries after colonists stripped the land. Today's land managers are translating the map's shades of green into timber resources, forest fire risk, and 13 billion tons of carbon storage. Says Kelldorfer, "The map is an inventory of history and our future." —*Juli Berwald*



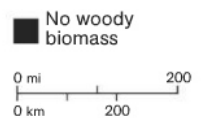
ANCIENT STANDS
Redwoods, the tallest and among the oldest and most massive U.S. trees, span the central part of the West Coast.

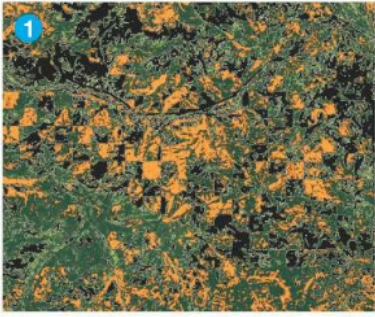
Aboveground woody biomass and carbon stock
(in metric tons per hectare*)



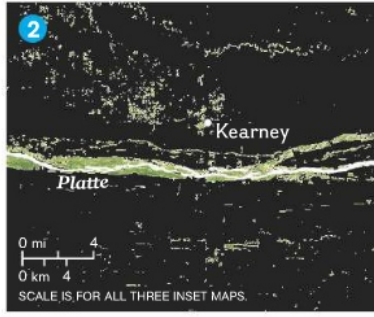
Forest biomass is the weight of trees, computed from height and girth, and is directly related to carbon storage.

*One hectare is nearly 2.5 acres.





President Lincoln's exchange of square plots for railroad track led to checkerboard logging in the West.



Belts of forest straddle rivers surrounded by farms dug into the nearly treeless Midwestern prairie.



Cities like Bangor, Maine, inch into postcolonial regrowth that covers 80 percent of New England.



RICH FLOODPLAINS
The Mississippi River fertilizes a wide corridor where forests give way to corn, cotton, and soybean fields.

FOREST BANDS
Development proceeded in stripes along the Appalachian range. Woods remain on slopes too steep for building.

TREE FARMS
In the Southeast fast-growing trees are planted as crops. Some softwoods, like pine, are harvested every 20 years.

MAP: JEROME N. COOKSON, NGM STAFF; GREG FISKE, WOODS HOLE RESEARCH CENTER; THEODORE A. SICKLEY. SOURCES: NASA; U.S. FOREST SERVICE; USGS

Rolling Robo-Worm

Stop, drop, and roll. Firefighters teach this to kids, but for some species of caterpillars it's a defense reflex. Confronted by a predator, the larvae spring into the air, assume a spiral shape, and hit the ground at top speed to wheel away from danger. The motion is thought to be one of the fastest wheeling behaviors in nature.

Hoping the technique will enable next-generation robots to go places that conventional crawling ones can't, researchers at Tufts University have built a soft-bodied robot that replicates the spiraling actions of larval *Pleuroptya ruralis*, a species from the U.K. Made of silicone rubber, the robot's four-inch-long body (below) is undergirded by metal coils that contract into a circle when electrified, propelling the contraption forward at nearly eight inches a second.

As in nature, the ballistic rolling motion can send the body in unpredictable directions. But, says lead researcher Huai-Ti Lin, the robot's ability to crawl or roll, depending on terrain, could one day have practical applications in environmental monitoring, building inspection, or even disaster search and rescue. —Bruce Falconer



In less than half a second, this caterpillar-inspired robot springs into a spiral—a defensive move in nature.



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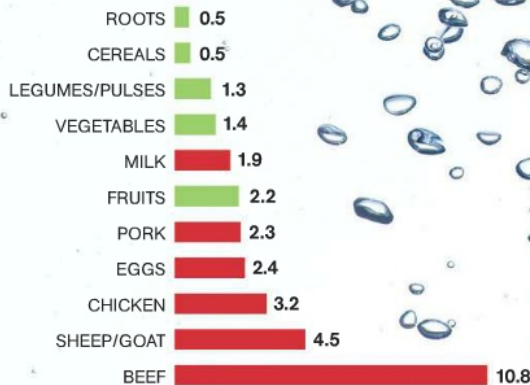
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Precious Water Many farmers already struggle to get enough water for their crops. Foods like beef, which people crave as they become more affluent, take far more water to produce than fish or plants. Water-efficient techniques like drip irrigation, conservation tillage, and mulching help make the most of a dwindling resource. New, less thirsty varieties of crops will help too. But ultimately we will have to learn to sip where we once gulped. —Nancy Shute

WATER COSTS

Animal production (in red) requires large volumes of water for feed, drinking water, and maintenance.

Water footprint* per unit of nutritional value, quarts/kcal



*Defined as the total volume of fresh water used to produce each item

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92%
OF HUMANITY'S
WATER
FOOTPRINT



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On behalf of Céline Cousteau, O-I made a donation to the World Resources Institute's Reefs at Risk Initiative.

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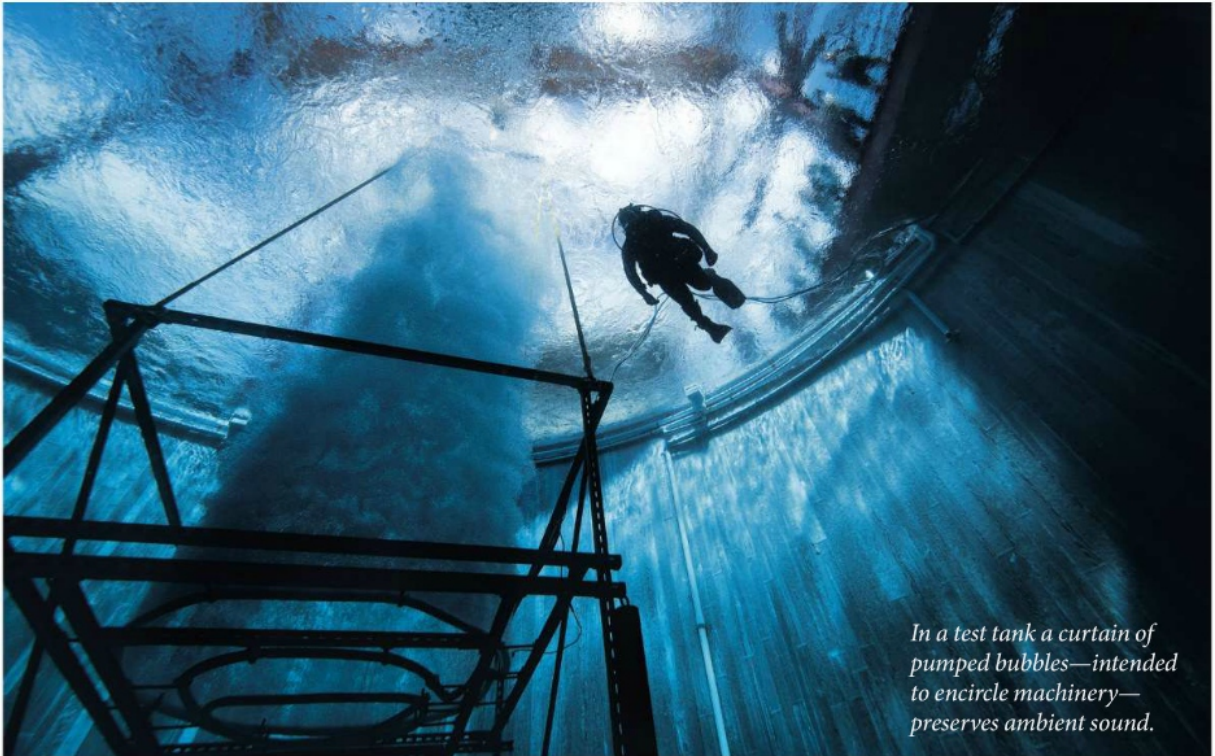
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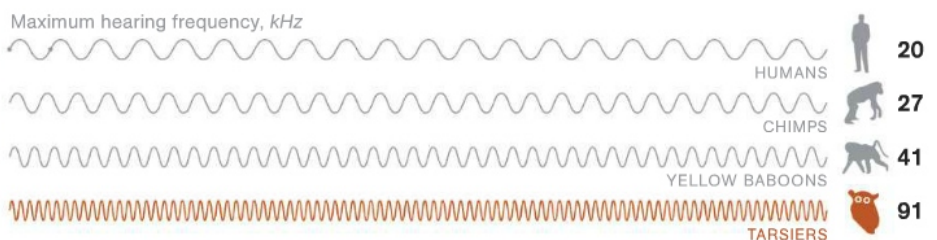
In a test tank a curtain of pumped bubbles—intended to encircle machinery—preserves ambient sound.

Surround Sound Blue whales have the loudest voices of any living thing. Pile drivers are louder. Acousticians at the University of Texas have a way to dim underwater industrial noise and conserve whale chatter: surround machinery with a curtain of bubbles that can cut 40 decibels off the din of bridge building or oil drilling, dampening the equivalent of a city street’s noise to a library’s.

The premise: Ramming into bubbles saps a sound wave’s energy. Early tests used traditional bubbles, but the final formula uses air encased in plastic connected to weighted wire ropes—like a ’70s bead curtain—so the bubbles won’t break up, float away on currents, or entangle animals. In tests the curtain restored the natural commotion of the ocean, letting sea creatures natter on. —Johnna Rizzo



GETTING AN EARFUL Palm-size Philippine tarsiers have huge eyes but rely on their ears to stay sharp. The most acoustically acute primate, *Tarsius syrichta* hears sounds of up to 91 kilohertz (kHz)—a level inaudible to nearly all terrestrial mammals. Tuning in to high frequencies may help them snare insects and evade less perceptive predators. —Lacey Gray



MONTANA *A deluge falls from the core of a thunderstorm near Glasgow in July 2010. "I felt like if you could stand in the middle and look up, you'd see straight into the heavens," says photographer Sean Heavey.*

PANORAMA COMPOSED OF FOUR IMAGES
SEAN R. HEAVEY, BARCROFT MEDIA/LANDOV

WEATHER GONE



WILD

Rains that are almost biblical, heat waves that don't end, tornadoes that strike in savage swarms—there's been a change in the weather lately. What's going on?

BY PETER MILLER





ARIZONA *The biggest dust storm in living memory rolls into Phoenix on July 5, 2011, reducing visibility to zero. Desert thunderstorms kicked up the mile-high wall of dust and sand.*

DANIEL BRYANT



TEXAS A flaming fence post marks the trail of a forest fire near Bastrop on September 5, 2011, during a record drought and heat wave. The fire, which destroyed 1,685 houses, may have been sparked by dead pine trees falling onto power lines.

LARRY W. SMITH, EUROPEAN PRESSPHOTO AGENCY/LANDOV

SWITZERLAND Frozen spray from Lake Geneva entombs cars, trees, and a promenade during a severe cold spell in February 2012. An unusual dip in the polar jet stream, which looped as far south as Africa, brought Arctic air and deep snows to Europe, killing several hundred people.

MARTIAL TREZZINI, EUROPEAN PRESSPHOTO AGENCY/LANDOV







THE WEEKEND FORECAST FOR NASHVILLE, TENNESSEE, CALLED FOR TWO TO FOUR INCHES OF RAIN.

But by the afternoon of Saturday, May 1, 2010, parts of the city had seen more than six inches, and the rain was still coming down in sheets.

Mayor Karl Dean was in the city's Emergency Communications Center monitoring the first reports of flash flooding when something on a TV screen caught his eye. It was a live shot of cars and trucks on Interstate 24 being swamped by a tributary of the Cumberland River southeast of the city. Floating past them in the slow lane was a 40-foot-long portable building from the Lighthouse Christian School.

"We've got a building running into cars," the TV anchorman was saying. Dean had been in the "war room" for hours. But when he saw the



TENNESSEE *Jamey Howell and Andrea Silvia had just heard that church was canceled when the flood submerged their Jeep near Nashville on May 2, 2010. The teenagers clung to the roof rack for more than an hour and then—as their parents watched helplessly—let go. A mile downstream they struggled onto a riverbank, alive.*

RICK MURRAY

building floating down the highway, he says, “it became very clear to me what an extreme situation we had on our hands.” Soon 911 calls were coming in from every part of the city. Police, fire, and rescue teams were dispatched in boats. One crew in a skiff headed out to I-24 to pluck the driver of an 18-wheeler from the chest-high water. Other teams pulled families off rooftops and workers from flooded warehouses. Still, 11 people died in the city that weekend.

This was a new kind of storm for Nashville. “It came down harder than I’ve ever seen it rain here,” says Brad Paisley, the country singer, who owns a farm outside town. “You know how when you’re in a mall and it’s coming down in sheets, and you think, I’ll give it five minutes, and when it lets up I’ll run to my car? Well, imagine that it didn’t let up until the next day.”

Over at NewsChannel 5, the local CBS station,

meteorologist Charlie Neese could see where the weather was coming from. The jet stream had gotten stuck over the city, and one thunderstorm after another was sucking up warm, humid air from the Gulf of Mexico, rumbling hundreds of miles northeast, and dumping the water on Nashville. While Neese and his colleagues were broadcasting from a second-floor studio, the first-floor newsroom was being swamped by backed-up sewers. “Water was shooting up through the toilets,” Neese says.

The Cumberland River, which winds through the heart of Nashville, started rising Saturday morning. At Ingram Barge Company, David Edgin, a former towboat captain, had more than seven boats and 70 barges out on the waterway. As the rain continued to pound down, he called the U.S. Army Corps of Engineers to get its forecast of how high the river would rise. “It’s blowing up our models,” the duty officer said. “We’ve never seen anything like this.” Edgin ordered all of Ingram’s boats to tie up at safe locations along the riverbank. It turned out to be a smart move.

By Saturday night the Cumberland had risen at least 15 feet, to 35 feet, and the corps was predicting it would crest at 42. But the rain didn’t stop Sunday, and the river didn’t crest until Monday—at 52 feet, 12 feet above flood stage. Spilling into downtown streets, the flood caused some two billion dollars in damage.

When the sun came out on Monday morning, parts of Nashville had seen more than 13 inches of rain—about twice the previous record of 6.6 inches set during Hurricane Frederic in 1979. Pete Fisher, manager of the Grand Ole Opry, needed a canoe to get into the famous theater, which is on the riverfront northeast of the city. He and audio engineer Tommy Hensley paddled across a parking lot and through a side door. “We basically just floated into the theater,” Fisher says. “It was pitch black, and we shined a light on the stage. If you’d been sitting in the front row, you’d have had seven feet of water over your head.”

In warehouses along the river, the flood had submerged millions of dollars’ worth of

equipment, including components for a 36-by-60-foot video screen that had been assembled for Brad Paisley's upcoming concert tour, which was set to begin in less than three weeks. "Every amp, every guitar I'm used to, was destroyed," Paisley says. "I felt powerless in a way I've never felt before with weather."

The experience changed him. "Here in Nashville our weather is manageable, normally," he says. "But since that flood, I've never once taken normalcy for granted."

THERE'S BEEN A CHANGE in the weather. Extreme events like the Nashville flood—described by officials as a once-in-a-millennium occurrence—are happening more frequently than they used to. A month before Nashville, torrential downpours dumped 11 inches of rain on Rio de Janeiro in 24 hours, triggering mud slides that buried hundreds. About three months after Nashville, record rains in Pakistan caused

more of damage each, far exceeding the previous record of nine such disasters in 2008.

What's going on? Are these extreme events signals of a dangerous, human-made shift in Earth's climate? Or are we just going through a natural stretch of bad luck?

The short answer is: probably both. The primary forces driving recent disasters have been natural climate cycles, especially El Niño and La Niña. Scientists have learned a lot during the past few decades about how that strange seesaw in the equatorial Pacific affects weather worldwide. During an El Niño a giant pool of warm water that normally sits in the central Pacific surges east all the way to South America; during a La Niña it shrinks and retreats into the western Pacific. Heat and water vapor coming off the warm pool generate thunderstorms so powerful and towering that their influence extends out of the tropics to the jet streams that blow across the middle latitudes. As the warm pool shifts back

ARE WE SEEING A DANGEROUS SHIFT IN CLIMATE? OR JUST A NATURAL STRETCH OF BAD LUCK?

flooding that affected more than 20 million people. In late 2011 floods in Thailand submerged hundreds of factories near Bangkok, creating a worldwide shortage of computer hard drives.

And it's not just heavy rains that are making headlines. During the past decade we've also seen severe droughts in places like Texas, Australia, and Russia, as well as in East Africa, where tens of thousands have taken refuge in camps. Deadly heat waves have hit Europe, and record numbers of tornadoes have ripped across the United States. Losses from such events helped push the cost of weather disasters in 2011 to an estimated \$150 billion worldwide, a roughly 25 percent jump from the previous year. In the U.S. last year a record 14 events caused a billion dollars or

and forth along the Equator, the wavy paths of the jet streams shift north and south—which changes the tracks that storms follow across the continents. An El Niño tends to push drenching storms over the southern U.S. and Peru while visiting drought and fire on Australia. In a La Niña the rains flood Australia and fail in the American Southwest and Texas—and in even more distant places like East Africa.

Those outcomes aren't mechanical and invariable; the atmosphere and ocean are chaotic fluids, and other oscillations influence the weather at a given time and place. The tropical Pacific is especially influential, though, because it pumps so much heat and water vapor into the atmosphere. Extreme El Niños or La Niñas thus set the stage for extreme events elsewhere.

But natural cycles can't by themselves explain the recent streak of record-breaking disasters.

Senior Editor Peter Miller wrote the January cover story on the scientific study of twins.

WHY SO WILD?

The atmosphere is getting warmer and wetter. Those two trends, which are clear in data averaged globally and annually, are increasing the chances of heat waves, heavy rains, and perhaps other extreme weather.

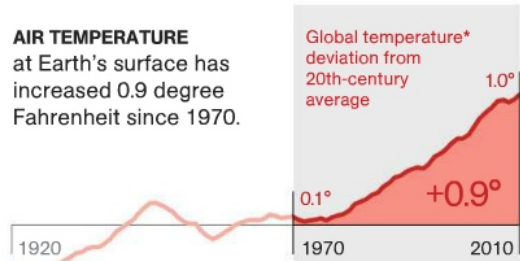
Something else is happening too: The Earth is steadily getting warmer, with significantly more moisture in the atmosphere. Decades of observations from the summit of Mauna Loa in Hawaii, as well as from thousands of other weather stations, satellites, ships, buoys, deep-ocean probes, and balloons, show that a long-term buildup of greenhouse gases in the atmosphere is trapping heat and warming up the land, oceans, and atmosphere. Although some places, notably the Arctic, are warming faster than others, the average surface temperature worldwide has risen nearly one degree Fahrenheit in the past four decades. In 2010 it reached 58.12°F, tying the record set in 2005.

As the oceans warm, they're giving off more water vapor. "Everybody knows that if you turn up the fire on your stove, you evaporate the water in a pot more rapidly," says Jay Gulledge, senior scientist at the Center for Climate and Energy Solutions (C2ES), a think tank in Arlington, Virginia. During the past 25 years satellites have measured a 4 percent average rise in water vapor in the air column. The more water vapor, the greater the potential for intense rainfalls.

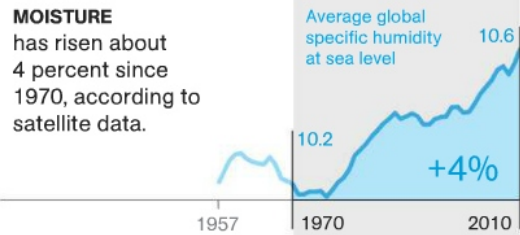
By the end of the century the average world temperature could rise anywhere from three to eight degrees Fahrenheit—depending in part on how much carbon we emit between now and then. Scientists expect the weather to change substantially. Basic circulation patterns will move toward the Poles, just as some plants and animals are doing as they flee (or take advantage of) the expanding heat. The tropical rain belt is already widening, climatologists report. The subtropical dry zones are being pushed poleward, into regions such as the American Southwest, southern Australia, and southern Europe, making these regions increasingly susceptible to prolonged and intense droughts. Beyond the subtropics, in the midlatitudes, including the lower 48 of the United States, storm tracks are moving poleward too—a long-term trend superimposed on the year-to-year fluctuations triggered by La Niña or El Niño.

One of the biggest wild cards in our weather future is the Arctic Ocean, which has lost 40

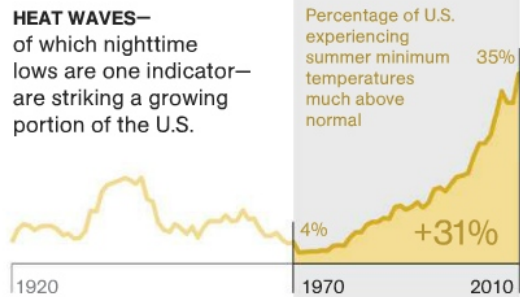
AIR TEMPERATURE
at Earth's surface has increased 0.9 degree Fahrenheit since 1970.



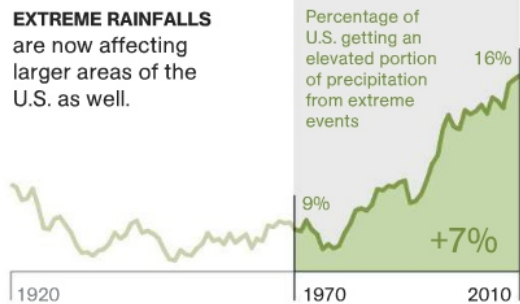
MOISTURE
has risen about 4 percent since 1970, according to satellite data.



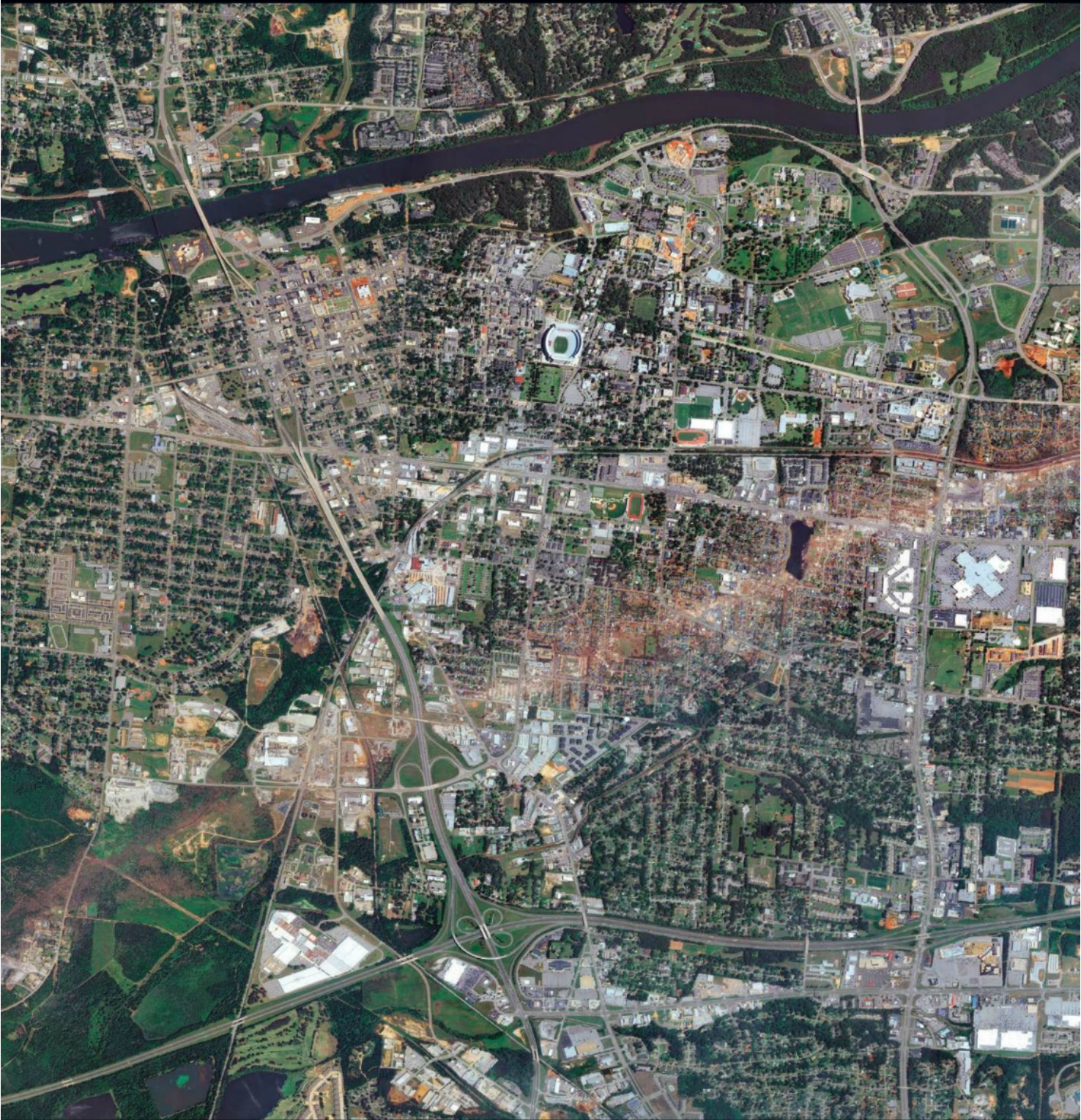
HEAT WAVES—
of which nighttime lows are one indicator—are striking a growing portion of the U.S.



EXTREME RAINFALLS
are now affecting larger areas of the U.S. as well.




GRAPHS ABOVE ARE SMOOTHED USING A TEN-YEAR MOVING AVERAGE.
*AVERAGE TEMPERATURE OVER LAND AND OCEAN
JOHN TOMANIO, NGM STAFF; ROBERT THOMASON
SOURCES: JEFF MASTERS, WEATHER UNDERGROUND; NATIONAL CLIMATIC DATA CENTER (TEMPERATURE, HEAT WAVES, AND RAINFALL); NOAA (HUMIDITY)





ALABAMA On April 27, 2011, the U.S. was hit by 199 tornadoes, a single-day record—but there's no clear evidence, scientists say, of a long-term rise in tornado frequency. The 190-mile-an-hour twister that carved a sharp path across Tuscaloosa missed the University of Alabama football stadium (upper left) by a mile, then threaded between a large mall (X-shaped building at center) and the main hospital, which was soon treating victims. The tornado killed 44, then roared northeast to the Birmingham area, where it killed 20 more.

DIGITALGLOBE



NEBRASKA

“It was really cranking.”

At 130 miles an hour, to be precise—but to photographer Mike Hollingshead, that was not a clue to run the other way. A dedicated storm chaser, Hollingshead caught this funnel on June 20, 2011, outside Bradshaw, near I-80, where it derailed several freight-train cars. A TV crew (far right) also raced in for a closer look.

MIKE HOLLINGSHEAD (ALL)



percent of its summer sea ice since the 1980s. Autumn temperatures over what is now open ocean have risen 3.6 to 9°F, as the dark water absorbs sunlight that the ice once bounced back into space. New evidence suggests that warming is altering the polar jet stream, adding lazy north-south meanders to its path around the planet—which might help to explain why North America was so warm last winter and Europe so cold. Meandering farther north than normal into Canada, the jet stream brought warm air with it; dipping far south over Europe, it delivered frigid winds and snow to that region. In the winter of 2010-11 it was eastern North America that got heavy snow. Because the meanders move around every year, the extreme weather may too.

When it comes to individual storms, scientists are even less certain what effect global warming might have. In theory extra water vapor in the atmosphere should pump heat into big

in U.S. history, with monster twisters roaring through Tuscaloosa, Alabama, and Joplin, Missouri. But scientists don't yet have the data or the theoretical understanding to say whether global warming was to blame.

In the case of some weather extremes, though, the connection is pretty clear. The warmer the atmosphere, the more potential for record-breaking heat waves. In the U.S. high-temperature records are being set these days twice as often as low-temperature ones; around the world 19 countries set national records in 2010.

As moisture in the atmosphere has increased, rainfall has intensified. The amount of rain falling in intense downpours—the heaviest one percent of rain events—has increased by nearly 20 percent during the past century in the U.S. “You're getting more rain from a given storm now than you would have 30 or 40 years ago,” says Gerald Meehl, a senior scientist at the National Center for Atmospheric Research in

THE AMOUNT OF RAIN FALLING IN THE HEAVIEST DOWNPOURS HAS INCREASED NEARLY 20 PERCENT.

storms such as hurricanes and typhoons, adding buoyancy that causes them to grow in size and power. Some models have predicted that global warming could increase the average strength of hurricanes and typhoons by 2 to 11 percent by 2100. But the jury's still out on whether any increase has occurred yet. And the same models that predict bigger hurricanes also say we could get fewer of them in the future.

The picture is murkiest with tornadoes. A hotter, wetter atmosphere should promote more severe thunderstorms, but it might also reduce the wind shear needed for those storms to spawn twisters. More tornadoes are being reported in the U.S., but there are more people looking for them with better instruments—and there's been no documented increase in the past half century in the number of severe tornadoes. The spring of 2011 was one of the worst tornado seasons

Boulder, Colorado. Global warming, he says, has changed the odds for extreme weather.

“Picture a baseball player on steroids,” Meehl goes on. “This baseball player steps up to the plate and hits a home run. It's impossible to say if he hit that home run because of the steroids, or whether he would have hit it anyway. The drugs just made it more likely.”

It's the same with the weather, Meehl says. Greenhouse gases are the steroids of the climate system. “By adding just a little bit more carbon dioxide to the climate, it makes things a little bit warmer and shifts the odds toward these more extreme events,” he says. “What was once a rare event will become less rare.”

NOBODY HAS LIVED THROUGH more weather on steroids lately than Texans. The 1,049 residents of Robert Lee, a West Texas town of ranchers,

oil workers, retirees, and small business owners, spent much of 2011 watching their water supply dry up. The E. V. Spence Reservoir, like many lakes in the region, lost more than 99 percent of its water.

“If we don’t get some additional runoff soon, there will be no more water coming out of the faucets,” Mayor John Jacobs said last winter. “As in nothing. It’s getting serious.” In January the town began construction of a 12-mile pipeline to Bronte, a community that has wells in addition to a reservoir. Completed in March, the pipeline was still being tested in early May. “We feel like we’re going to get it done in time,” Jacobs said. “But it’s going to be just under the wire. Living in West Texas is not for the weak at heart.”

Less rain fell on Texas from October 2010 to September 2011 than in any other 12-month period since record keeping began in 1895. The whole state suffered, but West Texas was already close to the edge. All across the region farmers, ranchers, and municipalities were feeling the damage. (See “The New Dust Bowl,” page 56.) In many places water levels dropped below well pumps, causing the motors to burn out. “A lot of wells are going dry,” said Clark Abel, a well driller in San Angelo. “Our phone’s been ringing off the hook. It’s overwhelming.”

The drought withered grazing lands too, forcing some ranches to ship their livestock to greener pastures up north. In a kind of modern cattle drive, ranch hands from the Four Sixes Ranch near Guthrie and from its Dixon Creek operation in the Texas Panhandle drove more than 4,000 head of Angus crossbreeds onto double-decker trucks to transport them to leased lands from Nebraska to northern Montana.

The last time the Four Sixes attempted such a thing, said general manager Joe Leathers, was more than a century ago, when the ranch moved herds to what was then the Indian Territory of Oklahoma. This drought was worse. By last July the ranch had run out of tank water—drinking water in dirt ponds for cattle. “The long and the short of it is that nobody has ever faced anything like this before,” Leathers said.

“This has been the most severe one-year

drought we’ve ever had,” said state climatologist John Nielsen-Gammon. (A drought in the 1950s took six years to get as bad.) On top of that, Texans sweated last year through the hottest summer in memory. Dallas residents saw the mercury climb to 100°F or higher on 71 days.

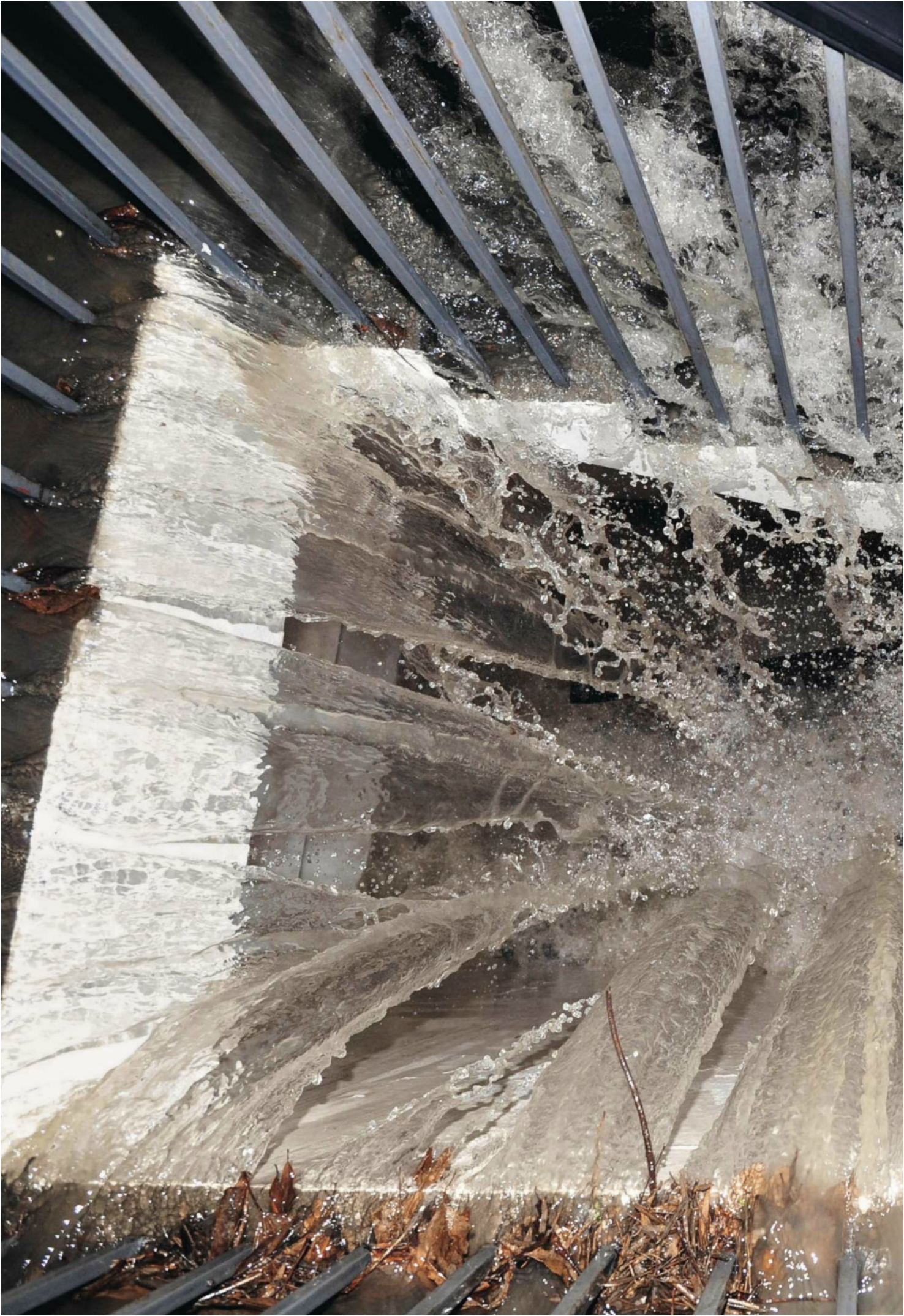
There’s no mystery about the main cause, Nielsen-Gammon said: It was La Niña, which pushed storm tracks farther north over the U.S., reducing rainfall throughout the South, from Arizona to the Carolinas. “We just happened to be right in the center of it,” he said.

But global warming aggravated the situation, making an already bad heat wave even worse. “Under normal conditions a lot of the sun’s energy gets used to evaporate water from the soil or from plants,” Nielsen-Gammon explained. “But when there’s no water to evaporate, all that energy goes into heating the ground and consequently heating the air. Given how little rain we had, we probably would have had record warmth in Texas in 2011 even without climate change. But climate change added an additional degree or so of heat to it.”

That extra degree of heat was like an extra shot of gasoline on the state’s forests: By increasing evaporation, it made them even drier. In a drought, said Nielsen-Gammon, “every little increase in severity makes a big difference.” Texas in 2011 experienced the worst wildfire season on record. Taken together, the fires blackened an area larger than Connecticut—nearly twice as much acreage as in the previous worst year.

One of the costliest fires started last September just outside Bastrop State Park, southeast of Austin, where the loblolly pines were as dry and brittle as kindling. Fanned by strong winds, the blaze raced south through suburban neighborhoods in what firefighters call long “streets” of fire. It consumed 1,685 houses but occasionally spared others nearby, leaving residents shaking their heads.

When Paige and Ray Shelton returned to inspect their property adjacent to the state forest, they found their bungalow still standing, but the sawmill that Ray operated with his brother, Bo, was reduced to ashes and Paige’s pottery studio





CHINA Rainwater cascades onto a Chengdu resident rushing up a flight of stairs from an underground garage. An unusually severe down-pour on July 3, 2011, flooded streets and knocked out electricity in the city, which is the capital of Sichuan Province in central China.

CHINA DAILY/REUTERS

was burned to the ground. As Paige picked through the wreckage, Ray made a beeline for the chicken coop, hoping to spare his wife the sorrow of cleaning up all the burned carcasses. Trees all around the coop were charred black.


“Well, guess what?” Ray said later. “As I came around the corner, the rooster stuck his head out and crowed. I couldn’t believe it. I almost fell over backwards.”

The fire had come within an inch of the coop, but for some reason the red cedar walls hadn’t ignited, and somehow the birds had avoided the intense heat and smoke—a small miracle in the midst of great loss. All five hens had survived too, along with 18 doves Paige was raising. “They were singing up a storm,” Ray said.

THE RISING COST and frequency of natural disasters can be blamed only partly on the weather. Disasters are also on the rise because more people are located in harm’s way. In states like Texas, Arizona, and California the buildup of neighborhoods in former woodlands has exposed more properties to wildfires, just as coastal development in states like Florida, North Carolina, and Maryland has exposed expensive beach houses and hotels to hurricanes and other storms. At the same time, the rapid growth of megacities in developing countries in Asia and Africa has made millions more vulnerable to heat waves and floods. Instead of defending themselves against climate change, many communities appear to be leading with their chin.

“Something has gone wrong,” says climatologist Michael Oppenheimer of Princeton University, who helped write a recent report on extreme weather for the Intergovernmental Panel on Climate Change. “To put it bluntly, we’re doing a lousy job keeping up with disasters.”

The economic significance of this hasn’t been lost on the insurance industry. Insured losses from natural disasters in the U.S. last year totaled nearly \$36 billion, 50 percent higher than the average during the previous decade. “Whether it’s the ‘new normal’ or not, the industry sees a pattern of losses that’s extraordinary,” says Frank Nutter of the Reinsurance Association



MISSISSIPPI Fortified by a levee, a house near Vicksburg survives a Yazoo River flood in May 2011. Snowmelt and intense rains—eight times as much rainfall as usual in parts of the Mississippi River watershed—triggered floods that caused three to four billion dollars in damages.

SCOTT OLSON, GETTY IMAGES

of America. “The past is not prologue to the type of weather we’re about to see.”

In Florida, where hurricanes, wildfires, and drought pose enormous risks to insurers, several national firms have stopped writing new policies altogether or pulled back in other ways. They’re afraid of another disaster like Hurricane Andrew in 1992, which cost the industry an estimated \$25 billion. To fill the gap, small companies have sprung up across the state, and in 2002 the state government created the Citizens Property Insurance Corporation, which has become Florida’s largest provider of homeowner’s insurance. Whether this new system has the resources to survive a big storm isn’t clear yet, Nutter says. “It’s an untested experiment. They haven’t had a major hurricane there since 2005.”

Meanwhile some governments have taken small but important steps to better prepare for



extreme weather. An exceptional heat wave in Europe in 2003 took at least 35,000 lives; a later analysis found that climate change had doubled the odds of such a disaster. Afterward French cities set up air-conditioned shelters and identified older people who would need transportation to the shelters. When another heat wave hit France in 2006, the death rate was two-thirds lower.

Similarly, after a tropical storm killed as many as 500,000 people in Bangladesh in 1970, the government there developed an early warning system and built basic concrete shelters for evacuated families. When cyclones hit today, the death count stays in the thousands.

Weather disasters are like heart attacks, says Jay Gullledge. “When your doctor advises you about how to avoid a heart attack, he doesn’t say, Well, you need to exercise, but it’s OK to keep smoking,” he says. The smart approach to

extreme weather is to attack all the risk factors, by designing crops that can survive drought, buildings that can resist floods and high winds, policies that discourage people from building in dangerous places—and of course, by cutting greenhouse gas emissions.

“We know that warming of the Earth’s surface is putting more moisture in the atmosphere. We’ve measured it. The satellites see it,” Gullledge says. So the chances for extreme weather are going nowhere but up.

We need to face that reality, Oppenheimer says, and do the things we know can save lives and money. “We don’t have to just stand there and take it.” □

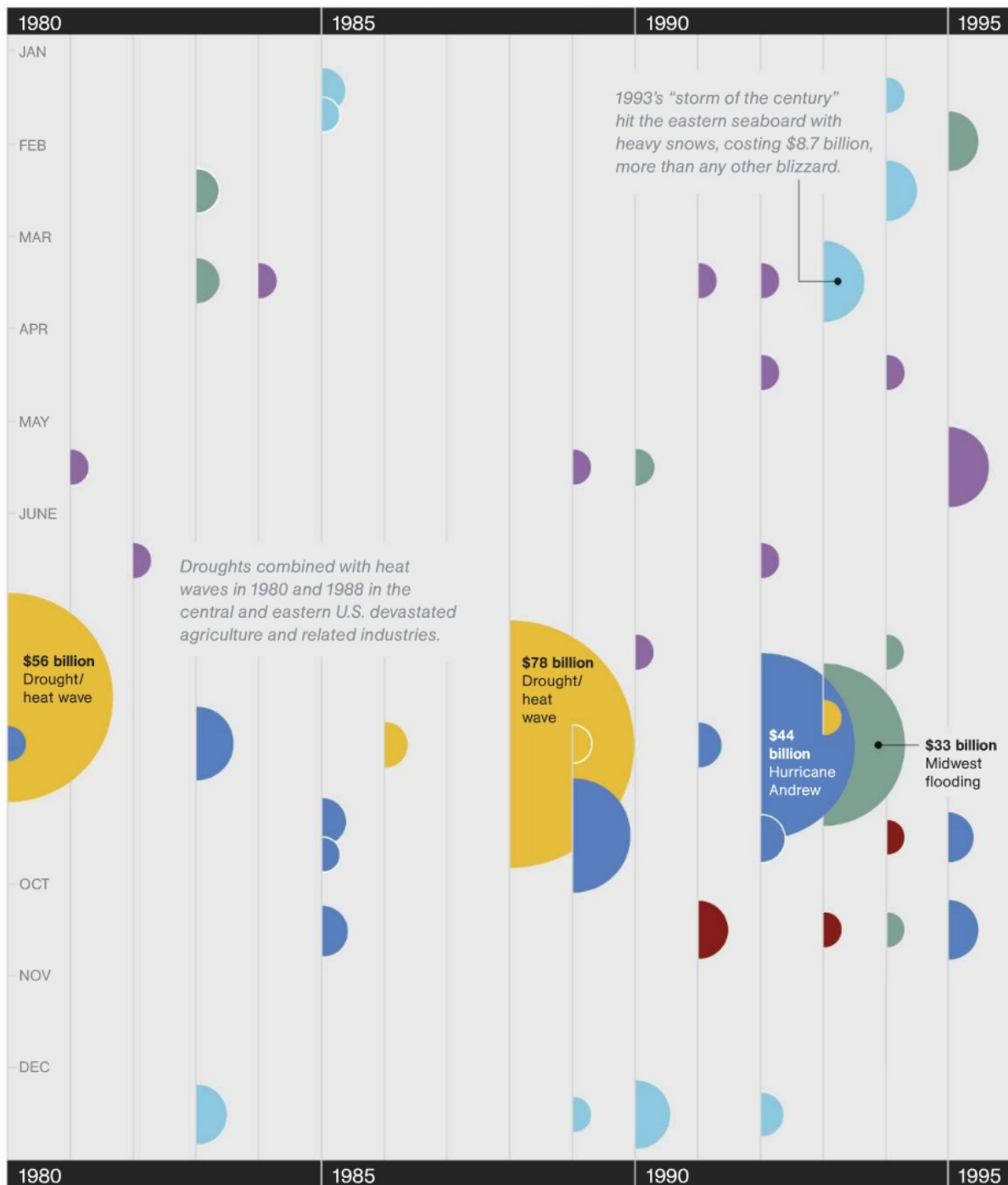
■ **Educational Note** National Geographic has free educational resources about weather for students, teachers, and families at natgeoed.org/weather.

BILLION-DOLLAR WEATHER

A chart of the most costly U.S. weather disasters shows nearly twice as many billion-dollar events since 1996 as in 1980-1995. The main reason: More people are living on higher-value properties in vulnerable places, such as coasts. But as the atmosphere warms, scientists expect destructive weather itself to become more common.

46 DISASTERS

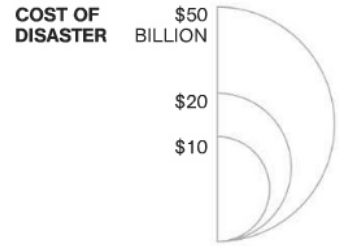
Causing at least \$1 billion in damages, 1980-1995



Total losses: \$339 billion

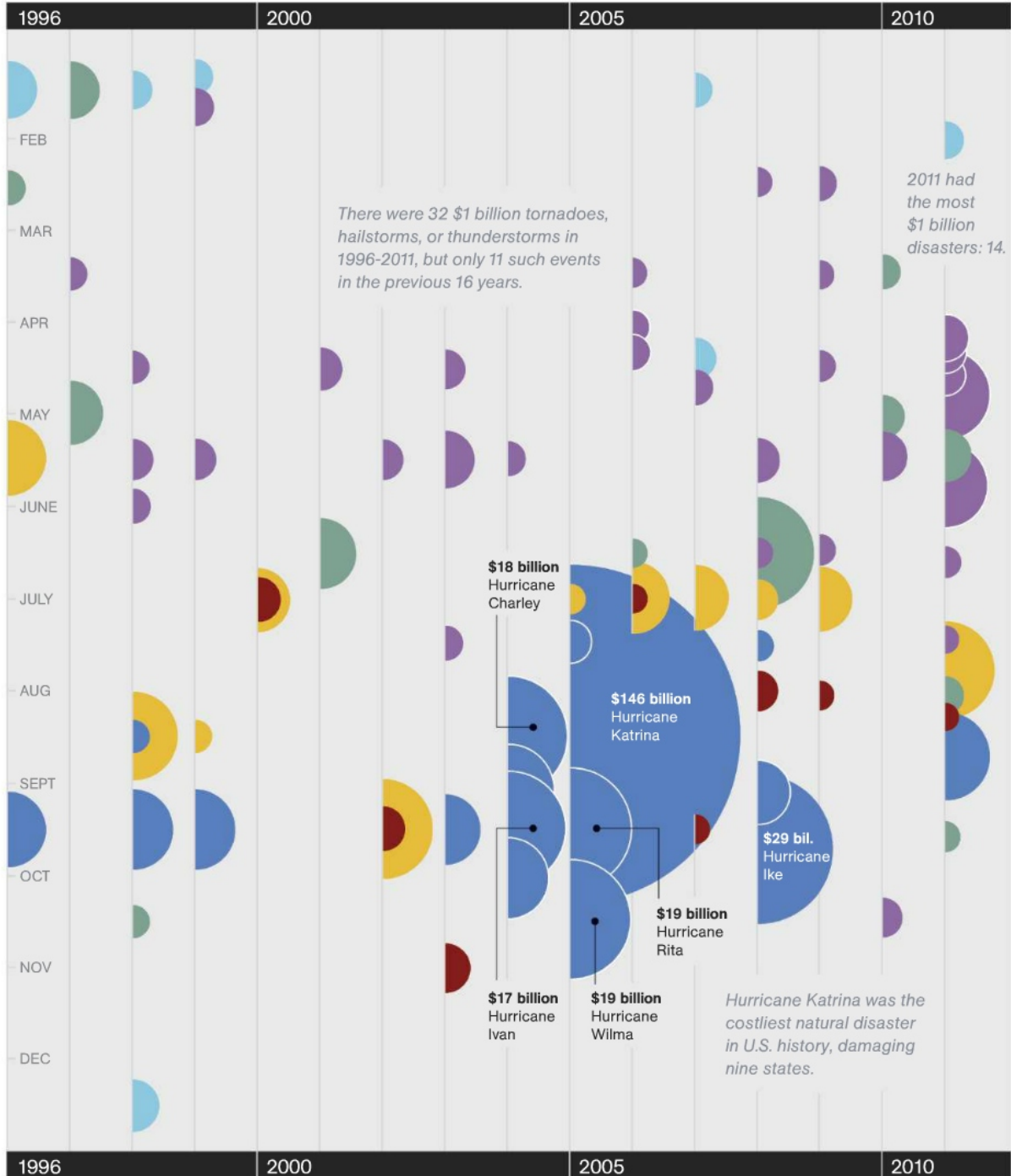
*ALL DOLLAR AMOUNTS ADJUSTED TO MARCH 2012 DOLLARS
 JOHN TOMANIO, NGM STAFF. SOURCES: ADAM SMITH, NATIONAL CLIMATIC DATA CENTER;
 JEFF MASTERS, WEATHER UNDERGROUND; NATIONAL CLIMATIC DATA CENTER

ALL U.S. WEATHER DISASTERS from 1980 to 2011 that caused at least one billion dollars* in damages are plotted by month and year; the size of each half circle represents the cost of the disaster. The ten most costly events are labeled.



87 DISASTERS

Causing at least \$1 billion in damages, 1996-2011



Total losses: \$541 billion



PEP *Gusting winds fling dirt from barren cotton fields onto Farm to Market Road 303, near a small community called Pep. Parts of West Texas saw next to no rainfall in 2011.*



THE NEW DUST BOWL

Texans have endured dry days before. They've seen lakes vanish and rangeland wither. But the drought of 2011 was gut-kicking even by Texas standards.

HE'S SEEN IT ALL BEFORE. BACK IN THE DUST BOWL DAYS HE WATCHED IN AWE AS DARK CLOUDS OF TOPSOIL SWALLOWED UP THE FAMILY RANCH.

That was in the mid-1930s, when Bill Tullos was just a boy. He still lives on the ranch outside San Angelo, Texas, and that memory is still vivid. “Day turned to night,” he recalls.

It was even worse in the 1950s. The rains didn’t come. Grazing lands withered. Water holes dried up. “We said, Well, it will rain tomorrow,” Tullos says. “We waited seven years before it finally broke.”

Last year he saw the signs once more. “Normally May and June are our rainy months, and we just weren’t getting any rain,” he says. So he started selling his animals at the local auction house. First the cattle, then the sheep and goats. “The 1950s nearly broke me. This time I was determined it wasn’t going to happen to me.”

By the end of 2011 Tullos was down to 300 goats on his 8,000-acre spread. The man who had seen it all—taking over the family business at 16 after his father died—was calling it quits. “It was nearly heartbreaking, it sure was,” he says.

All across West Texas, men and women accustomed to toughing it out were nearing their breaking point. Those who managed to hang on were spending a fortune on feed and hay for livestock or on water to irrigate dusty fields. The air was so hot and dry, much of the water sprayed on the soil evaporated before it could soak in. “They just couldn’t keep up,” Buzz Cooper says of the cotton farmers near Lubbock who normally bring their crops to his gin. In May two-thirds of the nearby fields were bare ground.

By September Texas had suffered the driest 12 months in its history. Farmers across the state lost more than eight billion dollars. In West Texas, where people are used to hardship, the drought caused some to question whether their way of life was even possible anymore. Although the winter at last brought some nourishing rain, they still faced a long road back to good times. —*Peter Miller*





SAN ANGELO *"If you're proud of your country, you try to take care of it," says Bill Tullos. Last year, rather than watch his animals graze drought-stricken pastures to bare dirt, he sold most of them to protect the land.*



TEXAS HILL COUNTRY *In better days the San Saba River between Llano and Brady is a 50-foot-wide stream filled with largemouth and Guadalupe bass. Last year it dried up completely. These trees aren't autumnal; they're dying.*





VERIBEST *In this very small town, the Friday night game at Veribest High is a major event. “Football’s huge,” says Falcons head coach Grant Richmond (at far right). Despite the drought and record-breaking heat, the school managed to water its field enough to keep most of the grass green. Practices were brutal, though, Richmond says. “I tried not to look at a thermometer.”*



MASON *As the drought dried up grazing lands, ranchers converged on the Mason Feed Store. “They bought a lot of hay and feed to save at least their younger cows,” says Kenneth Durst, who’s worked here for 48 years. Later, after ranchers reduced their herds, sales dropped off. But demand for wildlife feed remained steady, as landowners and hunters tried to sustain deer, quail, and turkeys.*



SAN ANGELO *Well drillers Clark Abel (top) and his son, Justin, install the head of a windmill that will pump water from a new and deeper well. Drought is good for their business—but in the long run could drive people away from West Texas.*



An underwater photograph showing a submersible on the right side, illuminated by a bright light. The background is a vast, dark blue ocean floor with a prominent, rugged seamount or underwater mountain range extending from the center towards the left. The lighting is dramatic, highlighting the textures of the seamount and the submersible's light.

Mountains in the Sea

Hundreds of thousands of seamounts rise from Earth's ocean floor. Life has been explored on barely 300.



The submersible DeepSee, some 600 feet below the surface of the Pacific, descends into a volcanic vent of the seamount Las Gemelas.

A harbor seal peers from a kelp forest on Cortes Bank, a series of undersea peaks and plateaus off the coast of San Diego. This shallow, light-filled summit supports a wide variety of animals and plants.





BY GREGORY S. STONE
PHOTOGRAPHS BY BRIAN SKERRY

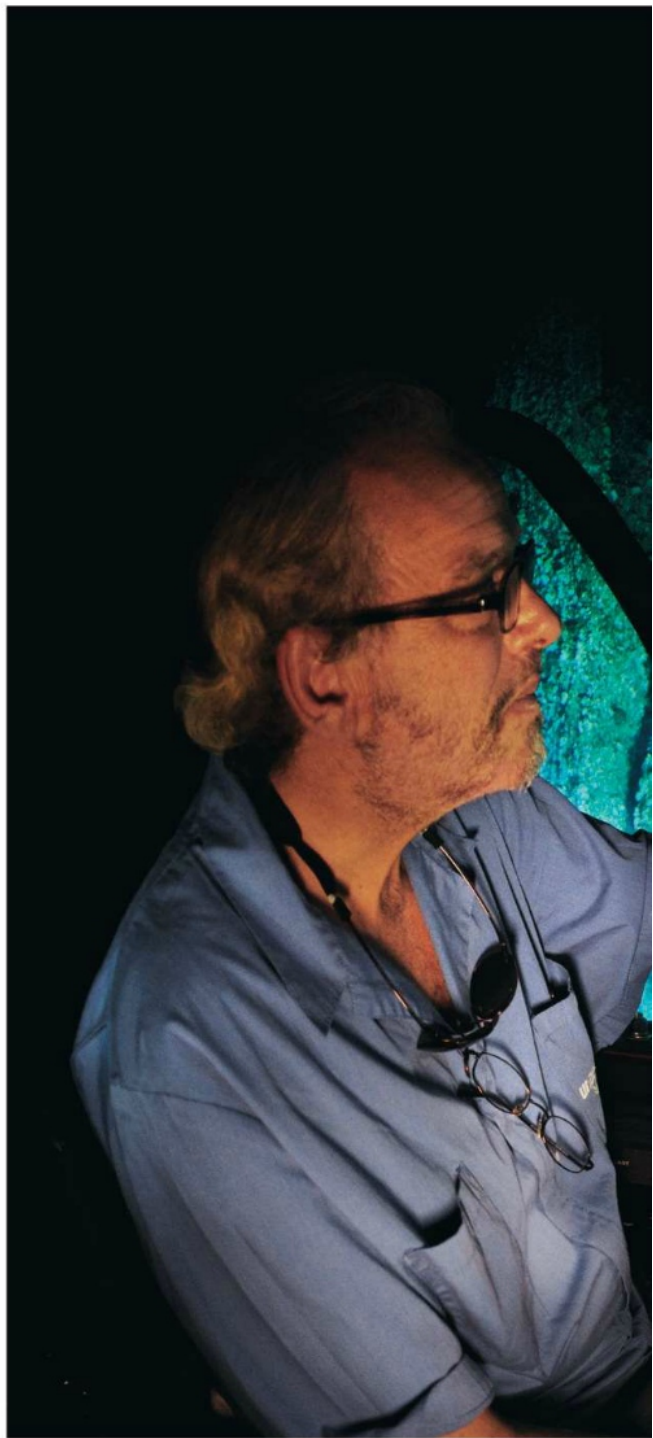
Sealed in our submersible, DeepSee, we wait, watching the crew on *Argo*'s deck shout orders to each other—a movie without a sound track.

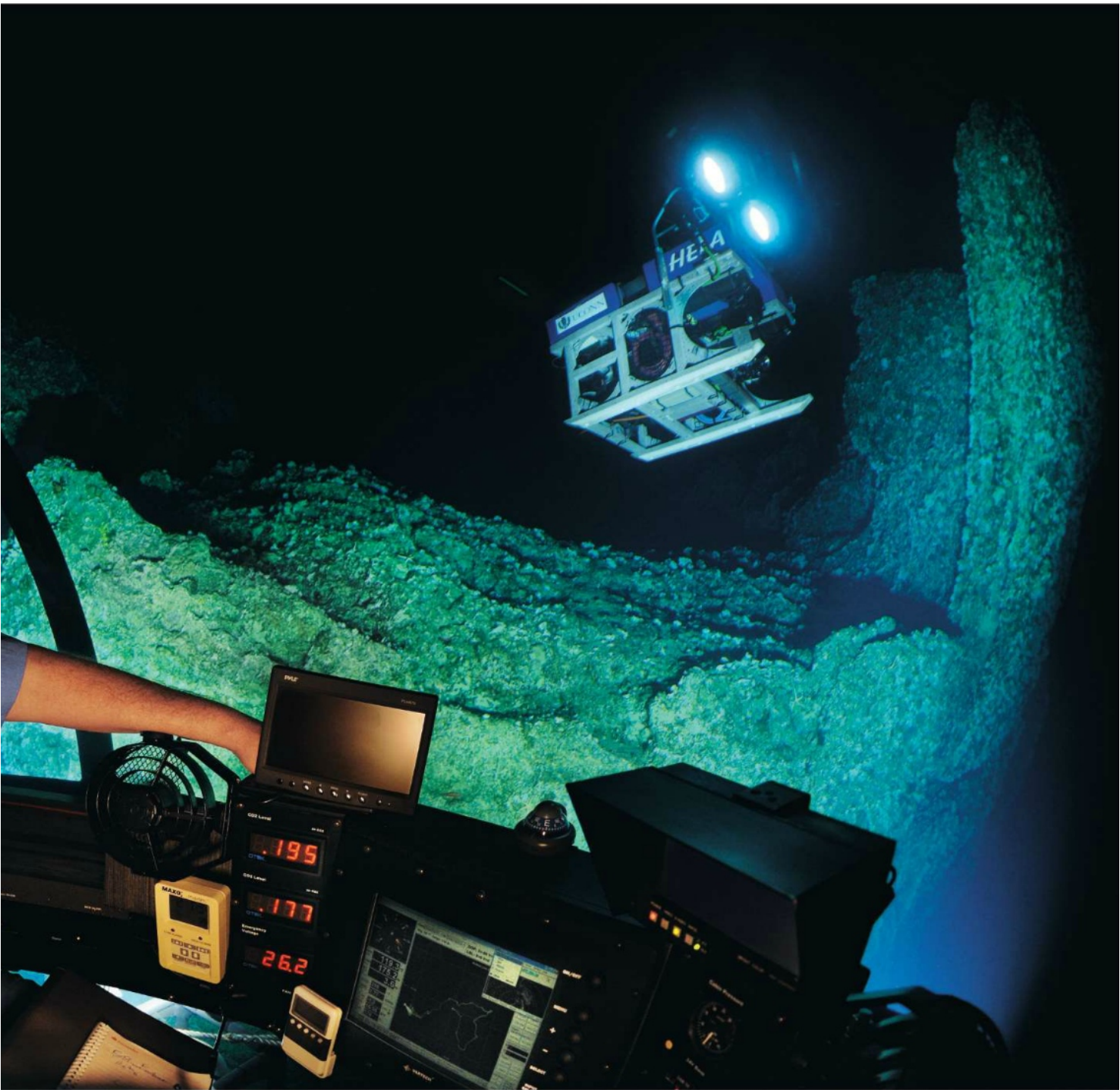
Then we are untied, drifting, a tiny dot on the immense Pacific Ocean. Pilot Avi Klapfer floods the ballast tanks, and we sink, surrounded by bubbles. It's like falling into a glass of champagne, and we feel appropriately giddy. A diver pokes through the bubbles to make a final adjustment to the camera housing mounted on the outside of the sub. Out there with the camera are hydraulics, thrusters, and hundreds of other essential parts that will keep us safe.

Three of us—Klapfer, photographer Brian Skerry, and I—are crammed inside *DeepSee*'s five-foot sphere, surrounded by communication equipment, pressure valves, controls, snacks, cameras, special bags to urinate in: everything we need for our quest to reach a seamount named Las Gemelas. Its cluster of peaks, rarely seen up close before, rises from the bottom of the Pacific near Cocos Island, 300 miles southwest of Cabo Blanco in Costa Rica. The highest peak here is more than 7,500 feet tall.

Seamounts generally form when volcanic mountains rise up from the seafloor but fail to reach the surface (those that break the surface become islands). Scientists estimate that there

Gregory S. Stone is a senior vice president and chief ocean scientist at Conservation International. Brian Skerry's book Ocean Soul was published in 2011.






Author Greg Stone, aboard the submersible DeepSee, watches a remotely operated vehicle maneuver around Las Gemelas. Braving strong currents, rough terrain, and technical glitches, a ten-person team spent seven days studying the seamount in early 2012.

Tour of a Seamount

Undersea mountains, mainly volcanic in origin, rise in the hundreds of thousands from the ocean floor. One of Earth's most prominent physical features, they compare in size with terrestrial mountains but are likely more numerous.



Undersea mountains take many forms—from this flat-topped guyot to smaller pinnacles to vast rolling hills with bases spanning 50 miles or more. Surfaces may be sculpted with craters, crevices, and ridges.

UPWARD FLOW

Currents collide with the base and accelerate upward, carrying cold, nutrient-rich water toward areas near the surface and providing food for animals living in the vicinity.

OCEAN
CURRENTS

The Chrysler Building, 1,046 feet high, is shown to scale against this depiction of Cross Seamount, which is over 14,000 feet tall.



-1,115 ft
depth

AT THE SUMMIT

Currents above a seamount can form an eddy, trapping organisms that normally migrate up and down. Once trapped, these species are fodder for predators near the summit.

DOWNWARD FLOW

Currents that travel up one side of a seamount can form rolls and eddies as they move down the opposite side.




Many types of corals populate the slopes of seamounts at various depths.




Global Distribution

Around half the world's seamounts are thought to be in the Pacific Basin; most of the rest are in the Atlantic and Indian Oceans.

WILLIAM E. McNULTY, NGM STAFF; THEODORE A. SICKLEY, ART; STEFAN FICHTEL, PHOTO; NOAA/MBARI
SOURCES: 2010 CENSUS OF MARINE LIFE; KAREN STOCKS, SCRIPPS; CHRISTOPHER KELLEY, HURL; UNIVERSITY OF HAWAII, SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY



GASTROPOD MOLLUSK (*FUSITRITON MAGELLANICUS*)




DECAPOD (*EICONAXIUS* SP.)



SEA URCHIN (*DERMECHINUS HORRIDUS*)



BRITTLE STAR




CORAL (*IRIDOGORGIA* SP.)




FEATHERY BLACK CORAL (*ANTIPATHARIA*)

Life on a Mount


Oases of abundance, sea-mounts attract, harbor, and sustain diverse communities of animals. These images represent a minuscule sampling of the sponges, corals, crustaceans, gastropods, vertebrates, and other creatures that live on or around undersea peaks, rich with waterborne nutrients. Scientists still have much classifying and cataloging to do: New species are discovered on almost every expedition.



BUBBLEGUM CORAL (*PARAGORGIIDAE*)



SPONGE (*FARREA* SP.)




SEA CUCUMBER (*BENTHODYTES* SP.)




VENUS FLYTRAP ANEMONE



BOTTLEBRUSH CORAL (*THOUARELLA* SP.)




DEEPWATER BIGEYE SHRIMP (*PANDALOPSIS AMPLA*)



BATFISH (*OGCOCEPHALIDAE*)



SEA PEN



SQUAT LOBSTER (*MUNIDA* SP.)



SEA STAR



GASTROPOD MOLLUSK (CALLIOSTOMATIDAE)



PENCIL URCHIN (CIDARIDAE) WITH HYDROIDS



CORAL (ENALLOPSAMMIA SP.)



HYDROID



SEA SQUIRT (TUNICATA)



BUBBLEGUM CORAL (PARAGORGIA SP.)



CORAL (IRIDOGORGIA SP.)



CRAB (LITHODIDAE)



PICASSO SPONGE



GASTROPOD MOLLUSK (NUDIBRANCHIA)



SEA FAN



GAPER (CHAUNACIDAE)



OCTOPUS



SEA URCHIN (POLYCHINUS AGULHENSIS)



SEA FAN

LEFT TO RIGHT FROM TOP: ROW 1: DAVID SHALE, NATURE PICTURE LIBRARY [ALL]. ROW 2: DAVID SHALE, NATURE PICTURE LIBRARY [1]; TIM SHANK, WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI)/DEEP ATLANTIC STEPPING STONES (DASS)/NOAA-OFFICE OF OCEAN EXPLORATION AND RESEARCH (OER)/INSTITUTE FOR EXPLORATION/UNIVERSITY OF RHODE ISLAND (IFE/URI) [2-5]. ROW 3: TIM SHANK, WHOI/DASS/NOAA-OER/IFE/URI [1-3]; NOAA-OER [4]. DAVID SHALE, NATURE PICTURE LIBRARY [5]. ROW 4: NOAA/MONTEREY BAY AQUARIUM RESEARCH INSTITUTE (MBARI) [ALL]. ROW 5: NOAA/MBARI [1]; NOAA [2]; DASS/IFE/URI INSTITUTE FOR ARCHAEOLOGICAL OCEANOGRAPHY/NOAA [3]. WAITT INSTITUTE [4]; ROB STEWART, NATIONAL INSTITUTE OF WATER & ATMOSPHERIC RESEARCH, NEW ZEALAND [5]. ROW 6: DAVID SHALE, NATURE PICTURE LIBRARY [ALL]



are some 100,000 seamounts at least one kilometer (3,281 feet) high. But if you include others that range from small hills to rolling mountains, there may be as many as a million of them.

We've seen little of these oases of life in the deep. Of all Earth's seamounts, marine biologists have studied only a few hundred. More finely detailed maps of the surface of Mars may exist than of the remotest parts of the ocean floor.

Scientists don't often explore their slopes firsthand—or even their shallower summits: living mazes of hard coral, sponges, and sea fans circled by schools of fish, some of them orange roughly that have lived to be more than a hundred years old. Among the teeming life, might there be new species that could produce new

chemical compounds that can cure diseases, possibly even cancer?

Las Gemelas was designated a Seamounts Marine Management Area in 2011 by Laura Chinchilla, president of Costa Rica. Her goal: to “help set clear parameters to defend one of the greatest zones of marine wealth on the planet.” But for seamounts worldwide, this wealth is threatened. More and more, deep-sea fishing trawlers drag nets weighted with heavy chains across seamounts to catch schools of fish that congregate around them. In the process the nets destroy long-lived and slow-growing corals, sponges, and other invertebrates. Once these underwater communities are disrupted, it can take hundreds, even thousands, of years for them to reestablish themselves.

We turn a ghostly greenish blue in the light, kept dim so we can see outside. Clear, pulsing

■ **Society Grant** Gregory Stone's seamount research was funded in part by your Society membership.



A diver explores a shallow, coral-encrusted seamount slope near Raja Ampat, Indonesia (left); the remotely operated vehicle can descend to survey deeper reaches. An abandoned trawl net blankets part of the El Bajo Seamount in Mexico's Gulf of California, destroying corals. Overfishing has depleted the once vibrant ecosystem here and at seamounts worldwide.

jellies glide gently in the dark, bouncing off the sub in every direction. A black-and-white manta ray flexes its wings and soars past for a look. We are still in the photic zone, where sunlight penetrates and provides energy for countless microscopic, photosynthetic ocean plants that create much of the Earth's oxygen. Then we descend farther. The ocean is pitch-black.

At about 700 feet the sub's dazzling lights bring the bottom into view. Klapfer maneuvers deftly, but the current is strong, and we may not be able to stay down for too long. Suddenly something just beyond the lights rises from the otherwise featureless seafloor. We joke that maybe we've found a new wreck, but instead it is a volcanic remnant, perhaps millions of years old. Within minutes a muffled whir tells us that Klapfer has reversed the thrusters and is bringing the sub into position to hover inches from

the bottom, inside an ancient, circular vent of the now extinct volcano that forms Las Gemelas. Its sculptured walls look like the facade of a deep-sea cathedral.

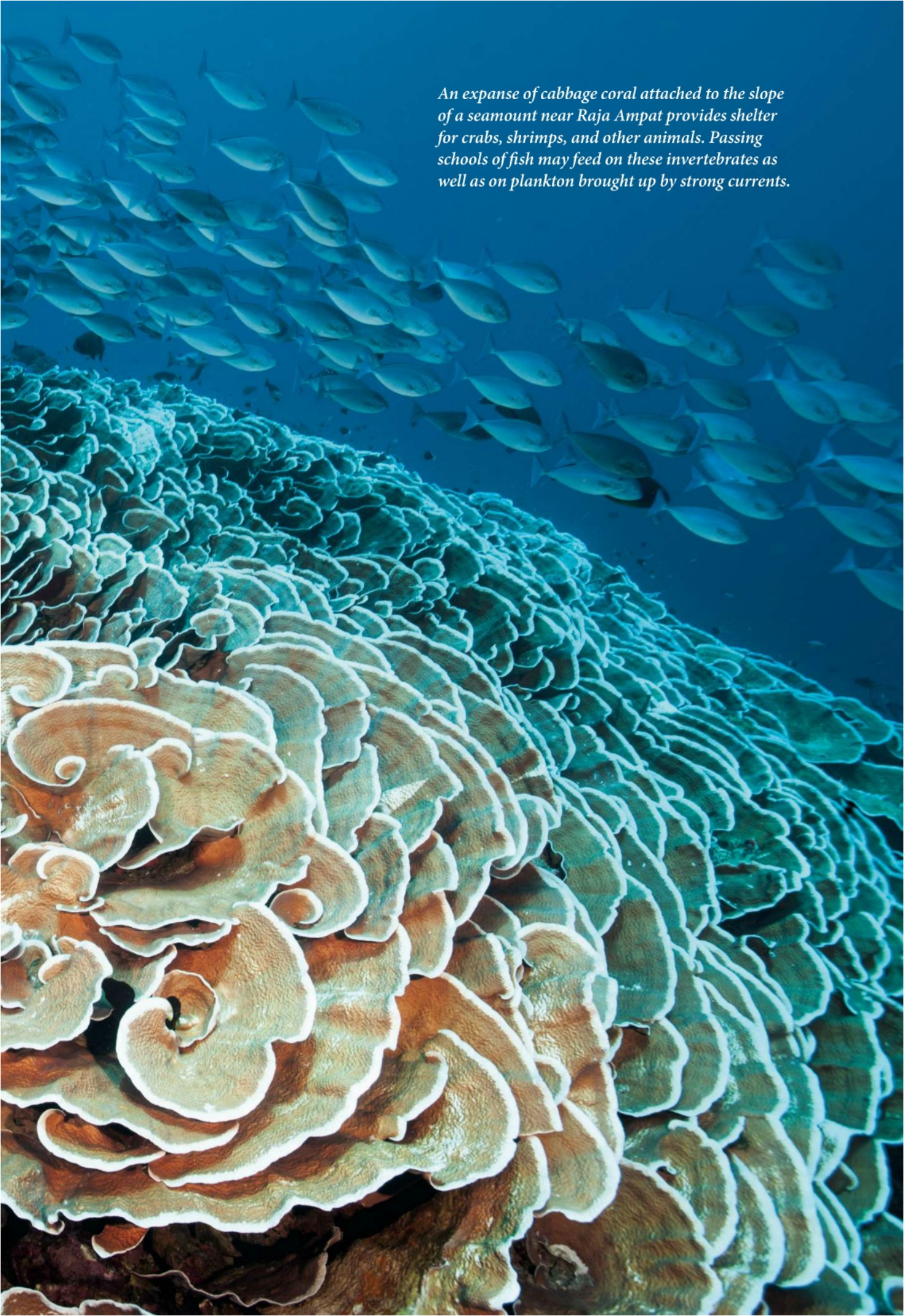
This is the last of our five dives in *DeepSee*, after a week of calling Las Gemelas home. During our time here, we have observed the animals that live on the summit of this seamount and the pelagic, or marine, invertebrates that occupy the water column around it.

Our sub surfaces after five hours—all too soon. We stow our gear aboard *Argo* and begin the long haul back to our landlocked lives, where we will analyze our data and add one more piece to the puzzle of our global ocean. □



Take a voyage of discovery of our ocean planet with scientist Robert Ballard in *Alien Deep*, a five-part series airing in September on **National Geographic Channel**.



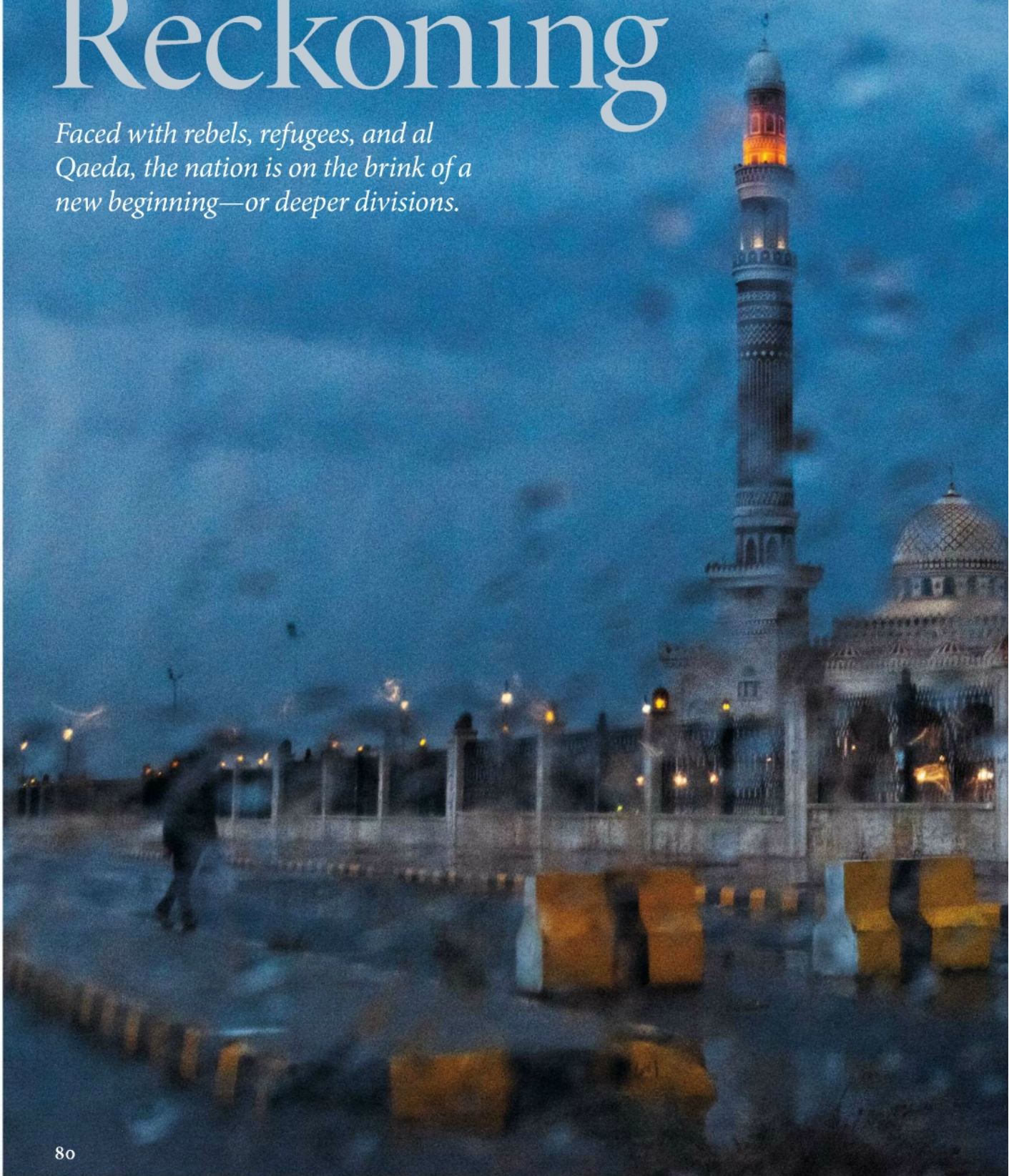
A large school of fish, possibly snappers, is swimming in a clear blue ocean. Below them, a vast expanse of cabbage coral covers a seamount slope. The coral consists of numerous overlapping, rounded, and slightly wavy plates, creating a textured, layered appearance. The color of the coral transitions from a light tan or beige in the foreground to a deeper teal or greenish-blue as it extends into the distance. The fish are densely packed and appear to be moving in a coordinated pattern, likely following a current or searching for food. The overall scene is a vibrant and dynamic underwater ecosystem.

An expanse of cabbage coral attached to the slope of a seamount near Raja Ampat provides shelter for crabs, shrimps, and other animals. Passing schools of fish may feed on these invertebrates as well as on plankton brought up by strong currents.

YEMEN

Days of Reckoning

Faced with rebels, refugees, and al Qaeda, the nation is on the brink of a new beginning—or deeper divisions.





Lights atop the 300-foot minarets at four-year-old al Saleh Mosque glow during a storm in Sanaa. The \$60 million house of worship is Yemen's largest and most extravagant, named for Ali Abdullah Saleh, who stepped down in February after 33 years as president. It opened with claims of promoting moderate Islam. But militant groups have only gained strength.



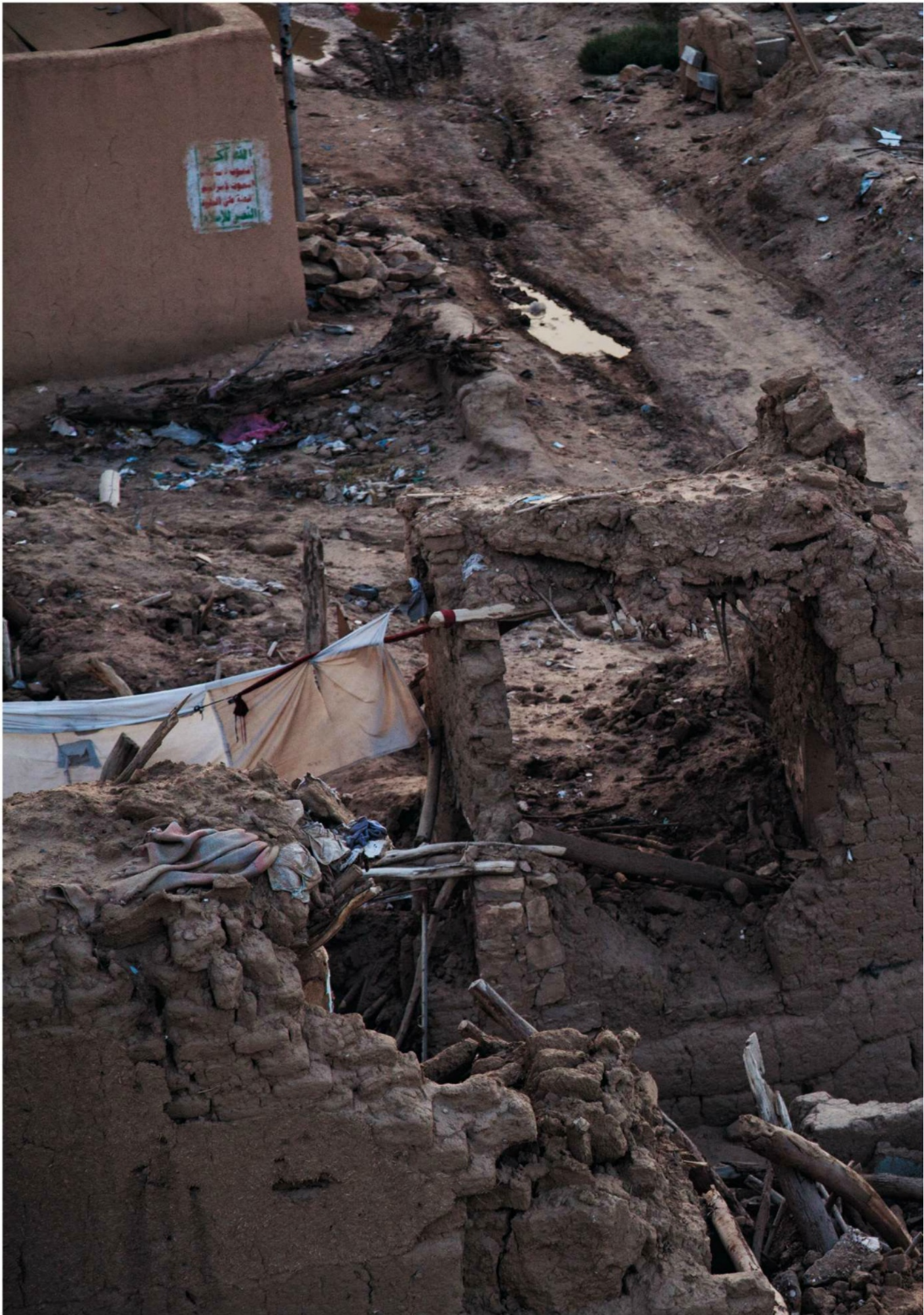
A shattered family mourns 15-year-old Nadaa Showqi Abdullallah Hussein, her body swathed in cloth. She was killed by a sniper in the southern port city of Aden during a March clash between gunmen and government forces. "What happened to her makes all people cry," says her father, Showqi Abdullallah Hussein (at right, in head scarf). "She had no enemies."





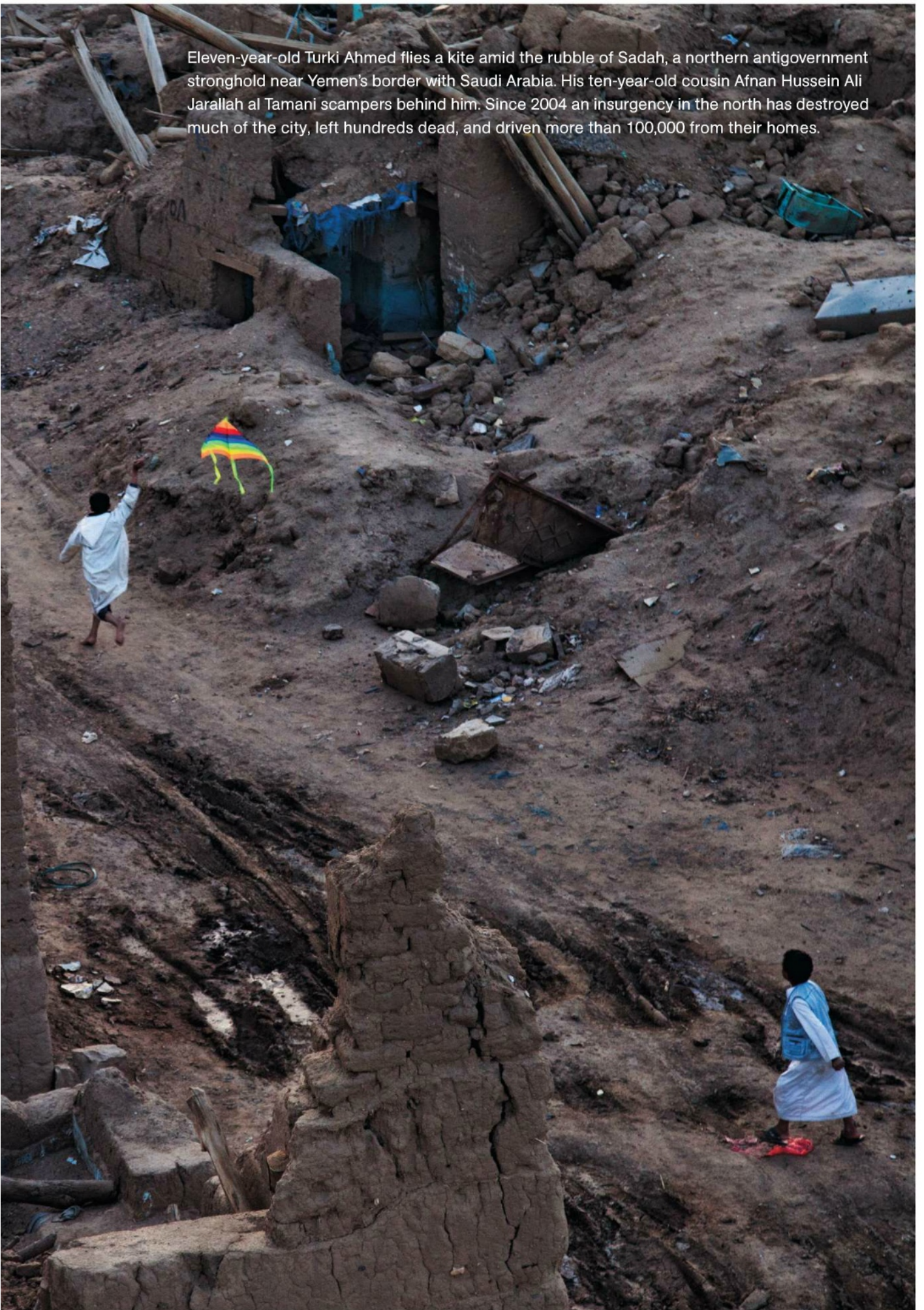
A lieutenant patrols the pink barracks of Yemen's female counterterrorism unit at a Sanaa base. "The color on the walls was our idea," says one officer. "We fought for the color." Some 1,500 women serve in police and counterterror units. They're crucial in an ultraconservative culture where men cannot check female suspects—or those disguised as women.





الله أكبر
الحمد لله رب العالمين
والصلاة والسلام على
سيدنا محمد وآله الطيبين
الطاهرين

Eleven-year-old Turki Ahmed flies a kite amid the rubble of Sadah, a northern antigovernment stronghold near Yemen's border with Saudi Arabia. His ten-year-old cousin Afnan Hussein Ali Jarallah al Tamani scampers behind him. Since 2004 an insurgency in the north has destroyed much of the city, left hundreds dead, and driven more than 100,000 from their homes.



BY JOSHUA HAMMER

PHOTOGRAPHS BY STEPHANIE SINCLAIR

T

he man was crucified, Um Mohammed said, her black eyes peering out through the slit in her black *niqab*. She was a widow in her 30s with two small children. Fleeing danger and chaos, she found herself this morning in the faculty room of an elementary school in the Crater neighborhood of Aden, a port city in south Yemen. Her children—Ibrahim, ten, and Fatima, seven—both sat cross-legged on wooden chairs beside their mother and shyly watched me.

The school had been converted into a center for displaced people—some 530 men, women, and children on three floors overlooking a litter-filled dirt courtyard. Undeterred by the squalor and fetid heat, young boys kicked soccer balls in the corridors. Dozens of new arrivals waited to be registered by a volunteer tapping their names into a dusty laptop.

Um Mohammed was too frightened to divulge her real name but not too frightened to speak her mind. She showed me a cell phone video she had made three weeks earlier, this past January, during a trip home to Zinjibar to retrieve some belongings. It showed a bearded man hanging from a lamppost, his hands nailed to a wooden crossbeam. Speaking in a shrill voice muffled by the black cloth in front of her face, she said that the man, an al Qaeda operative, had been accused of spying for the Yemeni government. “He hung there for three days. It was a warning to the people: Every traitor should be killed like this.”

Other countries in the Middle East suffered more violence than Yemen during the Arab Spring—Muammar Qaddafi’s Libya, Bashar al Assad’s Syria—but this country of 24 million has emerged from its popular revolution in a deeply precarious condition. In the far north, al Houthis, a Shiite-based political movement,

waged a six-year insurrection against the Yemeni government and now controls a large swath of territory—though its leaders have signaled a desire to participate in a national dialogue. In the far south, Aden and its surrounding districts are under siege by al Hirak, a separatist movement that wants independence for the region.

And east of Aden, al Qaeda in the Arabian Peninsula (AQAP) is mounting a campaign of insurgency and terror. It was formed in 2009 through a merger of Yemeni and Saudi branches of al Qaeda and gained force during the popular uprising that convulsed Yemen between January and November 2011.

After mass protests calling for President Ali Abdullah Saleh to resign, the United States and Persian Gulf nations pressed the weakened leader to step down. With the government in tatters and the army divided and demoralized, al Qaeda began recruiting new followers with promises of glory fighting the U.S.-backed army. In May 2011 al Qaeda militants drove government forces out of Zinjibar, the capital of Abyan Province, a 150-mile-long sliver of mountain redoubts and strategic coastline along the Arabian Sea.

More than 130,000 refugees from Abyan have poured into Aden during the past year. AQAP extremists now control parts of three provinces



Wearing his ceremonial dagger, Yemen's top tribal leader, Sheikh Sadiq al Ahmar, and his tribesmen stand by his Sanaa residence, with its portrait of al Ahmar's politician father. The sheikh's followers fired on government troops in May 2011; they retaliated, attacking his home.

and have carried out terrorist attacks in other regions, including the oil-rich eastern province of Hadramawt and the capital, Sanaa. Islamist gunmen patrol the region in trucks draped in black banners that proclaim, "There is no other God but Allah."

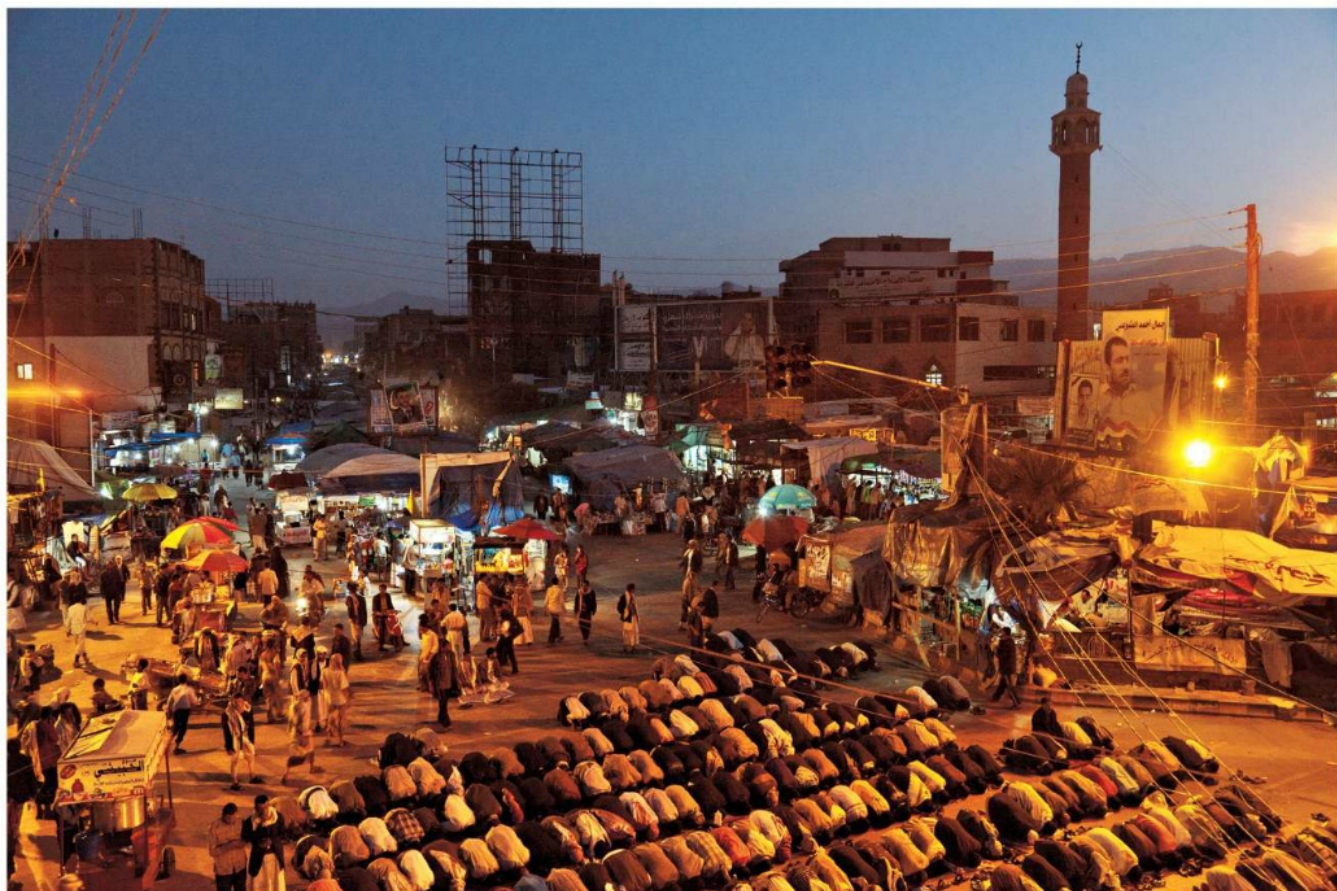
So far the U.S. has spent hundreds of millions of dollars arming and training Yemen's Central Security Forces to fight al Qaeda as well as carrying out air strikes against militant leaders. In September 2011 a drone attack killed Sheikh Anwar al Awlaki, the U.S.-born militant who galvanized Nidal Malik Hasan, the Fort Hood shooter, and Umar Farouk Abdulmutallab, the "underwear bomber." This past May the CIA used a Saudi double agent to foil an AQAP plot to blow up a U.S. airliner. Al Qaeda struck back soon after, when a suicide bomber blew himself up in Sanaa, killing more than 90 soldiers.

Besides al Qaeda and the separatist factions, Abed Rabbo Mansour Hadi—the former vice president who was elected president in February 2012 for a two-year transition period—faces dire

domestic problems. With a per capita income of \$1,140, Yemen is one of the poorest countries in the Arab world. Over half a million desperate Somali immigrants are burdening the already overstrained economy. Yemen's water is running out, and its oil supplies are expected to be exhausted by 2022. Its population is both young and growing; unemployed youths are a threat to stability. Hadi has moved boldly to solidify control over the military, sideline Saleh-family politicians, and begin a national dialogue on civil society, but his hold on power remains tenuous.

In the face of these grave challenges, what kind of society will take root in Yemen? Will it become a modern nation, grounded in the rule of law? Or an even more anarchic state, torn by tribal, ethnic, and religious conflict and a threat to Western security?

YEMEN HAS NOT always been so blighted. The Greek-Roman geographer Ptolemy called the region Eudaimon Arabia—Happy Arabia—and marveled at its stability and prosperity.



People still assemble and pray near Sanaa University's southern gate, dubbed Change Square in early 2011, when it became a gathering place for thousands of Arab Spring protesters opposing the Saleh regime. Saleh stepped down, but Yemen's woes remain.



Pre-Islamic Sabaean rulers expanded their empire through the Horn of Africa and in the second century A.D. built architectural wonders such as the skyscraper palace of Ghumdan, celebrated by a medieval Arab poet as “twenty floors wound with a turban of white cloud and girdled in alabaster.”

After Islam spread to the region in the 630s, Happy Arabia fluctuated between periods of unity and deep division. In the 19th century the Ottomans in the north and later the British in the south tried to impose their authority, only to be confounded by Yemen's defiant tribes and its geography—narrow valleys, dizzying mountain ranges, and the Empty Quarter, one of the world's most inhospitable deserts, along its border with Saudi Arabia.

Saleh—a barely educated, wily army officer—

Veteran foreign correspondent Joshua Hammer specializes in Africa and the Middle East. Stephanie Sinclair's June 2011 coverage of child brides won first place in the 2012 World Press Photo contest.

was the latest leader to try to tame Yemen. When he rose to power in 1978, he ruled North Yemen; 12 years later he oversaw the unification of the north and the south. He forged ties with tribal sheikhs and Islamic leaders, buying loyalty with bribes and patronage. He cozied up to Saddam Hussein (Yemenis dubbed him “Little Saddam”), and after 9/11 he made overtures to the U.S. He also packed the military and intelligence services with family members and allowed corruption to infuse every facet of Yemeni life. In February 2012 Saleh stepped down, signing a deal that divided the government between his party and a coalition of five opposition groups. Saleh, his kin, and his security forces were guaranteed immunity from prosecution. Now in Sanaa, he continues to stir up trouble—inciting loyalists, even denouncing the new government as “thugs” on the TV stations owned by his party.

“QAT IS BETTER THAN HONEY,” exclaimed Abdullah al Kholani, 60, with a grin. “We would



Yemen's tribes have been a defining force, often outweighing the power of the state. Tribes are strongest in the north, a bastion of Shiite Islam in a country that is otherwise Sunni. The population, half under age 18, swells yearly with refugees from Ethiopia and Somalia.

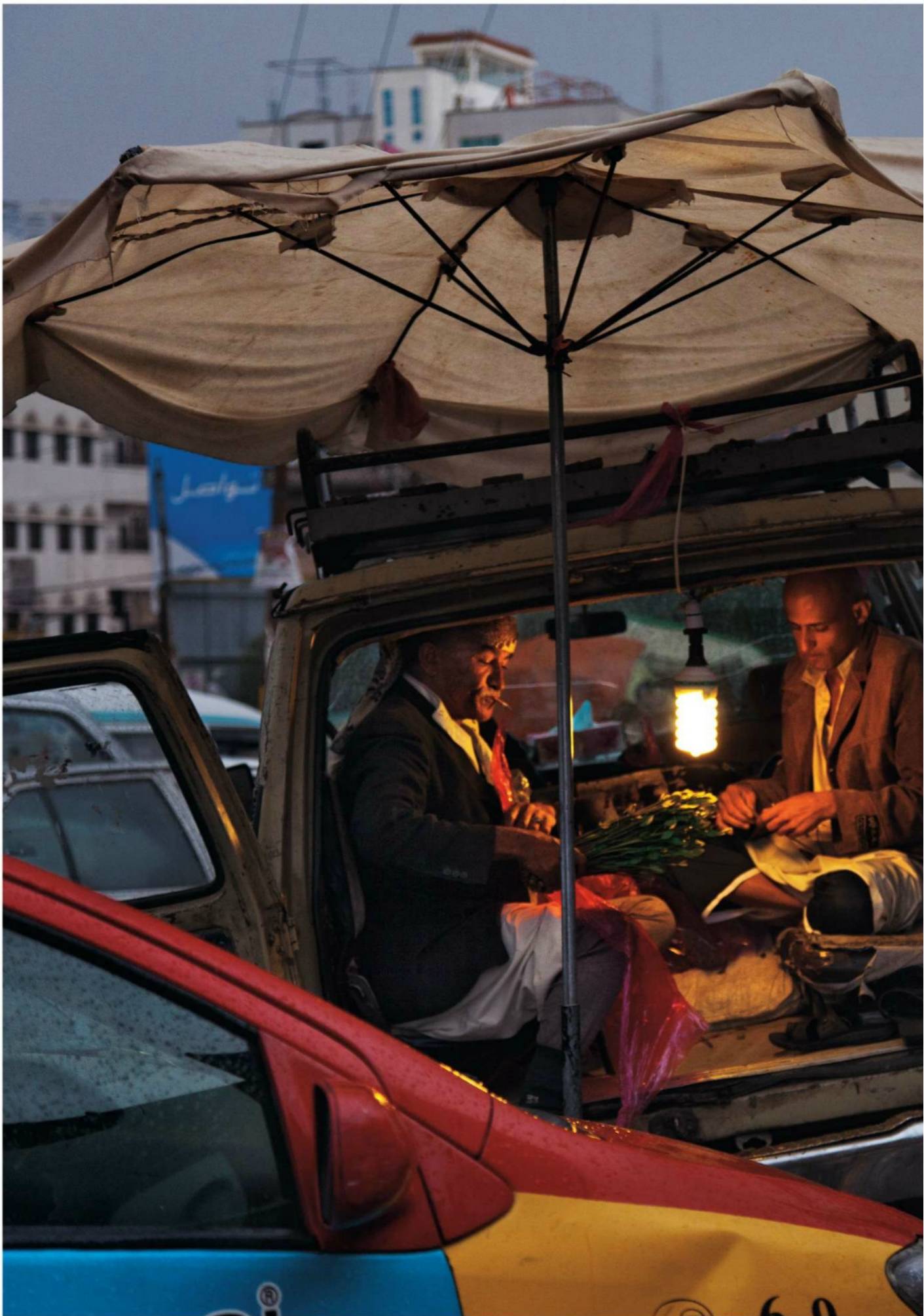
stop eating before we would stop chewing.” Al Kholani was a squat man with a red-and-white kaffiyeh bundled at a jaunty angle atop his head. He had deep-set eyes, a hawk nose, and a snaggletooth that extended over his lower lip. His hands were rough and stained green from plucking qat leaves. His beige vest and off-white abaya were in need of a wash. He was “a man of the soil,” al Kholani told me, “and proud of it.” He spoke Arabic in guttural, high-pitched bursts that my interpreter found barely coherent. That’s because the farmer’s mouth was stuffed with qat.

Al Kholani led me from the stone house where he and his wife had raised their six children along a bone-dry irrigation ditch to a clearing amid a jungle of slender, light brown trees. We paused to admire one that rose to about 40 feet, with a trunk as big as that of a medium-size oak, its extended branches thick with small, oval leaves. “It’s about 200 years old,” al Kholani said.

We were in Wadi Dhahr, a canyon northwest of Sanaa lined with vertiginous sandstone walls. Dar al Hajr, the summer retreat of the last ruling

imam of Yemen, a marvel of stained-glass windows and cool stone passageways, rose on an outcropping behind us. Al Kholani, whose family has farmed qat here for generations, boasted that his leaf was the strongest. “You chew that, and you will be awake for three days,” he said, laughing, as he offered me a clump of leaves from the ancient tree. They were bitter and brought on an intense thirst, which I quenched with a long swig of mineral water.

Al Kholani cultivates several acres of qat in two plots. He sells two harvests a year to a wholesaler who distributes the leaves to markets across Sanaa. The crop brings about \$4,000 a year—nearly four times the average per capita income. And there’s a side benefit: Al Kholani gets to chew as much qat as he wants, starting early in the morning and continuing late into the night. “Qat is much better than whiskey, much better than hashish, because it keeps you working,” he said, shoving another fistful of leaves into his mouth. “It gives you energy. I chew qat when I don’t have any rials in my pocket, and it keeps





AK-47 in hand, a man passes by as Muhammad Ali Jobebi (left) and his son prepare bundles of qat, a popular stimulant leaf, at a Sanaa bazaar. Once best known for its coffee, Yemen now devotes 40 percent of its scarce water to irrigating qat. Worth \$1.2 billion a year, the qat trade can earn sellers a thousand dollars a day. Meanwhile most of the country's food is imported.





Preparing to leave for school, 13-year-old Alhanouf al Tamani peeks out from her *niqab*. For the past three years she has lived with her parents and six siblings in a single room in Sadah—all that was left of the family home after fighting between government forces and insurgents virtually destroyed it. They're the lucky ones. Others, displaced by violence, make do in tents.

me happy. If I don't have something to eat, no problem." Al Kholani told me that he ignored the turmoil in Sanaa last year. "I care only about my farm," he said. But because of the protests and gun battles, "people were not chewing as much as usual, and business was bad. Inshallah, it will get better."

At least ten million Yemenis—40 percent of the population—chew qat four or more hours a day, according to surveys. The activity is a drain on income and, despite al Kholani's insistence that it keeps you working, productivity. Qat contains an alkaloid that breaks down to form a chemical closely related to adrenaline. It imparts an urge to talk and a general sense of well-being, but if consumed in excess, as I learned, it can

“Qat is much better than whiskey, much better than hashish, because it keeps you working,” al Kholani said, shoving another fistful of leaves into his mouth.

make you fidgety, restless, sick to your stomach, and unable to sleep.

The strongest argument in qat's favor is that it can play a mediating role. A Western diplomat in Sanaa told me that rivals often chewed together during the uprising against Saleh. "You'd go to a qat chew, and somebody from the faction of Ali Mohsin, somebody from Saleh's Republican Guard, who maybe was his cousin, would be there." (Ali Mohsin al Ahmar is a powerful general who defected to the opposition.)

Some of al Kholani's qat goes to the Cairo Street market in northwest Sanaa, a raucous bazaar covered by a corrugated metal roof. In the early afternoon the souk is jammed with people from all walks of life: soldiers, traders, professionals, civil servants, students. Walid al Rami, my government minder, a qat addict with a bleary-eyed look, searched for small, soft leaves and reddish stems—"signs of sweetness and potency," he said. He bought a bundle for the

equivalent of \$25, enough for the night's chew.

About 40 percent of Yemen's dwindling water resources go to qat irrigation. Ever since the river that ran through al Kholani's farm suddenly dried up, he has had to draw more than 10,000 gallons a month from a deep well to irrigate his qat. In some parts of Sanaa water pipes are dry, and supplies have to be trucked in daily.

Adel al Shujaa runs the Yemeni Anti-Qat Organization in Sanaa. "Those who are against qat nowadays are very few," he said, before rattling off a list of the leaf's negative effects: appetite suppression, malnutrition, a weakened immune system. Al Shujaa has been lobbying the parliament to draft anti-qat legislation, but after a decade of lonely work his only success has been

to persuade a single qat farmer to grow coffee and other substitute crops. "I am optimistic that we will succeed at the end of the day," he said. "Christ Jesus, peace be upon him, had very few followers at the beginning, but now his followers are more than two billion."

IN SANAA'S OLD CITY a camel groaned in the semidarkness of a grottolike shop near Bab al Yemen, the only remaining stone archway of the seven that once sealed this 2,500-year-old city from the outside world. With a rope harness tied around its head and hump, the camel was plodding around a cast-iron mill, grinding mustard seeds into oil. It was 8:30 a.m., hours before the start of business in the ancient quarter of the capital, and many residents were still sleeping off the night's qat chew.

The Old City has diminished in size over the past century, and electrification and sewage projects have brought it into the modern world. But in many respects, it remains unchanged, with residential towers of fired brick and alabaster clustered around markets for gold, jewelry, textiles, fresh produce, spices. In a passageway two women wearing traditional Sanaani clothing—body-draping abayas printed with white, black, and red geometric designs—parted to let me pass. An elderly man with coal-blackened eyelids and a wispy white beard slid by, a curved dagger,

or *jambiya*, thrust into his brocaded belt. Not long ago jambiyas showed men's status as tribesmen, judges, and direct descendants of the Prophet Muhammad; each group wore jambiyas with markings that indicated its caste. But Saleh elevated the social status of shopkeepers and tradesmen, a politically astute move that broadened his base of support.

"We still love Saleh," Abdullah, the owner of the mustard-seed mill, told me, proudly pointing to framed photographs of the former president that cover the grimy walls of his shop. Along with Saleh and almost everyone else in the Old City, Abdullah is a Zaidi, an adherent of a moderate sect of Shiite Islam found mainly in Yemen. But commonality of religion only partly explains the allegiance to Saleh.

Traditionally in Yemen, tightly knit tribal groupings have served as states within the state, with arsenals of weapons and a parallel court system ruling on everything from property disputes to murder. Saleh derived support from his alliance with Sheikh Abdullah al Ahmar, the "sheikh of sheikhs," who led the powerful Hashid tribal confederation, one of Yemen's two major tribal groupings, along with the Bakil.

In recent decades education, urbanization, and exposure to the outside world have weakened tribal influences. Many tribesmen no longer unquestionably accept the supreme sheikh's authority, and demands for basic rights and freedoms are growing. In March 2011 after the senior al Ahmar died, his sons rose up against Saleh following a massacre of protesters. The Republican Guard and tribal militias engaged in heavy gun battles in Sanaa, signaling the beginning of Saleh's collapse.

IF ONLY THE CALM AND RESTRAINT of the Old City were the face of Yemen. Today the country's zeitgeist is more accurately embodied in lawless, unstable Aden, the city where al Qaeda suicide bombers struck the U.S.S. *Cole* in 2000. To avoid being kidnapped on roads stalked by mercenary tribesmen and al Qaeda insurgents, I traveled there by plane.

The stench of decay and burning trash filled

the torpid air of the once cosmopolitan port city, set on a peninsula of volcanic hills overlooking the Gulf of Aden. Sanitation workers had been on strike for two weeks, and mountains of refuse, picked at by donkeys and goats, lined the roadsides. Graffiti covered the walls—INDEPENDENCE NOW; TELL THE SANAA REGIME TO STOP KILLING THE SOUTH PEOPLE—and flags from the long-defunct People's Republic of South Yemen flew at almost every intersection. Youths with AK-47s manned roadblocks of bricks and concrete in the Maalla neighborhood, a separatist stronghold.

Nasser Saleh Attawil, 62, is the secretary general of a moderate wing of al Hiraq, southern Yemen's separatist movement. It was too dangerous to meet at his apartment in Maalla (a teenage separatist had been shot by a sniper in the area the previous day, igniting violent protests), so we talked in the shade of an umbrella at the deserted Elephant Bay Beach Resort. Attawil, a former South Yemen Air Force officer educated in Ukraine when it was part of the Soviet Union, complained that Saleh had given away southern land to northern allies and siphoned oil wealth from southern Hadramawt. Since unification in 1990 and the civil war that followed, Attawil said, "our state, wealth, and identity have all been lost." Like many southerners, he regards north Yemenis with condescension. "We don't carry jambiyas here," he said with a mocking laugh.

Attawil founded his group five years ago as a peaceful movement dedicated to achieving more self-governance for the south, such as the ability to levy taxes and control revenues. But a faction of radical separatists, emboldened by the collapse of central authority, is demanding full independence and, reportedly financed by Iran, has mounted frequent protests and carried out attacks against Yemeni security forces. There have been reports about collaboration between the separatists and al Qaeda, though these seem to be government propaganda aimed at delegitimizing al Hiraq's grievances.

While waiting out a sandstorm at the airport in Aden, I fell into conversation with Hussein Othman, a burly 38-year-old sheikh from the al Arwal tribe in eastern Abyan. "I am from the

place where al Qaeda in the Arabian Peninsula began,” he told me. He divides his time between Abyan and Sanaa, where he works as a human resources manager for a journalists’ cooperative. He enrolled his 16-year-old son in a school in Sanaa to educate the teenager away from al Qaeda’s influence.

Othman is trying to mediate between the government and the Islamic militants, many of whom he grew up with or are the children of members of his clan. But the talks aren’t going anywhere. Al Qaeda, he said, has demanded that the government enforce sharia and withdraw all remaining troops from the province.

As we talked, Othman toyed with his .32 pistol, which he carries for protection whenever

Strict social codes relegate women to second-class status. Yemen ranks dead last in the World Economic Forum’s Global Gender Gap Report.

he returns to Abyan. Some insurgents believe he’s allied with the government, but Othman insisted that he’s neutral. “Tribesmen and Bedouin are always affected by religion. And there is poverty,” he said, explaining the militants’ appeal. Abyan is one of Yemen’s poorest, least developed provinces. “Al Qaeda breeds in this environment,” Othman said. As in Afghanistan and Pakistan, drone attacks on suspected militants have sometimes killed civilians, inflaming sentiment against the U.S. and persuading men to join al Qaeda. “The militants are chased by drones. The people see them as heroes,” he said.

JUST OVER A HUNDRED MILES northwest of Aden is Taizz, the city that, as the heart of the revolution, stirred hopes for a very different kind of Yemen. Taizz had emerged alongside trade routes to the Red Sea coast to become a center of commerce, industry, and education. Yet this least tribal, most liberal of Yemen’s cities was

marginalized by Saleh, and it languished. The first protests took place here in February 2011. A year later protest marches were still held every Friday following afternoon prayers. One Friday I watched thousands of men, women, and children waving flags in support of the Syrian opposition and flashing V-for-victory signs.

In Garden City—a pleasant compound of cafés, playgrounds, and an amusement park in the shadow of the Qalat al Qahira, a multiwinged Ottoman citadel perched on a precipice—I met one of the leaders of Taizz’s pro-democracy movement, which is now struggling to remain relevant. Belkhis al Abdeli is 31, though at first glance she could pass for a teenager. She’s tiny, with chipmunk cheeks and dark eyes framed

by a green *hijab*, the head scarf that, unlike the niqab, leaves the face exposed. Nudge al Abdeli onto the subject of politics—or women’s rights—and the warm smile disappears. Her eyes flash, and her hand stabs the air as she speaks. “I hate the niqab,” she said, adding that she has never accepted the strict social codes that relegate Yemeni women to second-class status. Women,

she said, should have the choice to cover their faces or leave them exposed—“but most women in Yemen are not given the choice.” Al Abdeli is unmarried and unapologetic. “My relatives say, ‘You have no chance of getting married anymore.’ It doesn’t bother me.” She often travels on her own, shrugging off disapproving looks.

By almost all indicators—health, education, and economic opportunity—women fare poorly in Yemen. It has one of the highest rates of child marriage in the world, and 60 percent of Yemeni women are illiterate. Infant mortality rates are also among the world’s worst, attributed to the lack of prenatal and postnatal health care. Unlike men, women cannot easily get divorced, and they have limited property and inheritance rights. The country ranks dead last among 135 countries in the World Economic Forum’s Global Gender Gap Report.

Al Abdeli is an assistant professor of accounting at a university in Taizz, and she enjoys more

freedoms than most of her peers. She credits this to growing up in Taizz and having an open-minded father who “did not go to university but is knowledgeable about the world.” She is also a poet who for years openly expressed her loathing for Ali Abdullah Saleh’s regime. “I put some of my dreams in my poetry and implanted them in the minds of my students,” she said. When Hosni Mubarak fell in Egypt, al Abdeli had new hope. “I felt definitely we will have a revolution here too. From the first day I wanted to join the protests, but my father advised me not to. He said, ‘The regime is bloody.’ So I went a few days later.”

In a tent camp called Freedom Square, al Abdeli was elected to the leadership council. In April 2011 she started her own movement, the Forum for Change, which grew to include hundreds of members. She organized seminars and led demonstrators through Taizz’s streets after Friday prayers. A fiery orator, she spoke passionately of the need to eliminate corruption and patronage and guarantee equal rights for women.

The mood turned ugly on the night of May 29, when unidentified attackers (who many believe were Saleh’s security forces) burned down hundreds of tents in Freedom Square and killed 50 protesters. After the massacre the area’s most powerful sheikh, Hamoud al Mikhlafi, announced that he would serve as the protesters’ protector, and hundreds of militiamen came to Taizz from rural areas to defend them.

Republican Guards and other pro-Saleh forces attempted to crush the revolt. During that time al Abdeli huddled with her parents and siblings in the basement of the family home while mortar rounds and artillery shells crashed around them.

Now the city that has long been considered Yemen’s least tribal finds itself beholden to al Mikhlafi and his brethren. His militias control many streets, and his membership in al Islah, the country’s main Islamic party, which includes everyone from Muslim Brotherhood moderates to ultraconservative Salafists, has given the Islamists new prominence: At the Friday afternoon rally I attended, the only speakers were Islamic party members. Secular democrats like al Abdeli are out of the power structure, but she still goes

to Freedom Square several times a week. “We wanted a real revolution,” she said animatedly.

LEAVING GARDEN CITY, I drove at dusk to al Mikhlafi’s hilltop villa, pocked by bullet holes from last year’s fighting. A dozen of his guards were patrolling the street in front with AK-47s. Al Mikhlafi was chewing qat in a smoke-filled reception room on the ground floor, crammed with about a hundred qat-chewing tribesmen sitting in two rows facing one another, with their backs to the white walls of the narrow chamber. Weapons were propped up against the walls, and the blue-and-russet carpet was strewn with qat leaves and stems and overflowing ashtrays. Al Mikhlafi led me into a private room across a courtyard to talk.

He had been a security officer in Saleh’s government, responsible for gathering intelligence on the regime’s foes. “I gave him advice—to consult more with the people, to institute real democracy—but he ignored it,” said the sheikh, a handsome man with a patchy black beard, soft eyes, and a helmet of curly gray hair that accentuated the squareness of his head. Al Mikhlafi called himself “a defender of democracy.” (He is a cousin of Tawakkol Karman, the Nobel Peace Prize winner.) But the secular democrats of Taizz say that his allegiance to the Islamic party and his pattern of resolving conflicts through displays of force suggest that building a civil society is not foremost on his agenda.

When I was in Taizz, it was a city very much on edge. Men wearing camouflage jackets had recently ambushed and killed a 29-year-old American teacher as he drove to his job at a Swedish-run English-language school and women’s education center. Al Qaeda claimed responsibility for the murder, alleging—falsely—that he was a Christian missionary. It was the first time AQAP had carried out a terrorist act in Taizz—and it served as a sign of heightened danger throughout Yemen. Al Abdeli and her pro-democracy movement hope to build a new society based on transparency and the rule of law. But al Mikhlafi and those like him are in charge now. Yemen still belongs to the men with guns. □



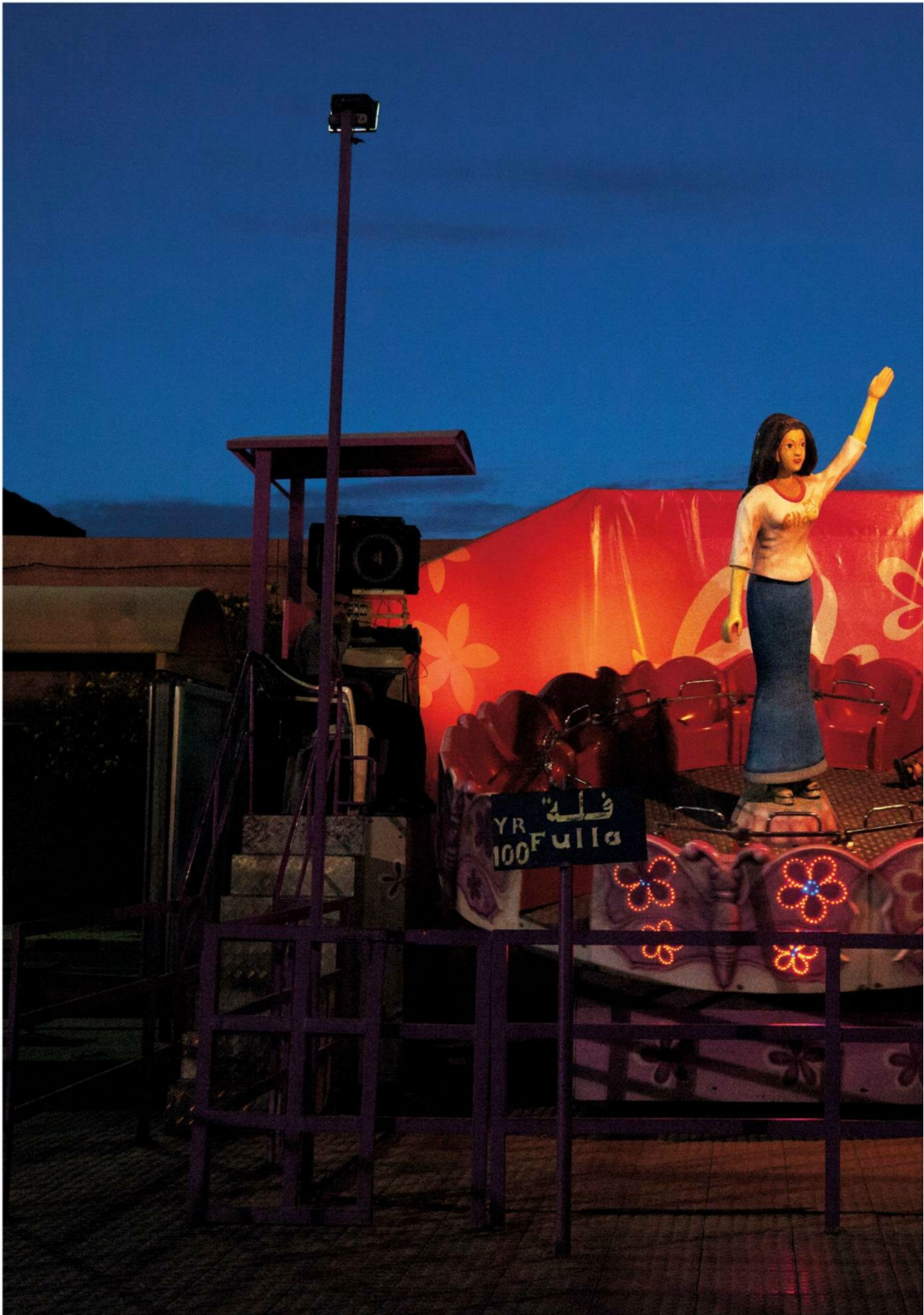


Cradled by his mother, Saleem al Harazi lost both eyes to a sniper. The 12-year-old was shot when he joined antigovernment protesters in Sanaa in March 2011. "I loved them and wanted to stand with them," he recalls. "I wanted them to end poverty." They were the last people he ever saw, and he has no regrets: "I am still happy I was able to witness the protests firsthand."





Generators keep lights blazing as relatives and neighbors fete bridegroom Ameen Ararah (in floral head scarf, at center rear), 21, at his wedding in Sanaa's Old City. In a country where nearly half the population lives on \$1.45 a day, wedding expenses—which can exceed \$5,000—are prohibitive. Many couples now pool resources and marry in groups.





As dusk falls over Sanaa's Fun City amusement park, a mother watches her children spin on a ride featuring an unveiled version of Fulla, a Barbie doll alternative popular among Middle Eastern girls. Moments like this offer relief from troubles, but the "emergence of a new dawn" heralded by Yemen's 2011 peace Nobel, Tawakkol Karman, eludes much of the country.



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ROMAN

ROME'S BORDER WALLS WERE THE BEGINNING OF ITS END



FRONTIERS

TIMGAD, ALGERIA *This triumphal arch awed visitors to the city of Thamugadi, founded by the emperor Trajan around A.D. 100 as a civilian settlement near the fort of Lambaesis. The grooves left by wagon and chariot wheels can still be seen in the stone road.*





HADRIAN'S WALL, ENGLAND *Barbarians would have stared up at this section, which runs along a cliff near the northern town of Once Brewed. In its heyday, the wall was 14 feet high and stretched 73 miles, from coast to coast. A deep ditch reinforced parts of it. Today a walking trail runs alongside it.*

Bouncing along a dusty Bavarian logging road, archaeologist Claus-Michael Hüssen keeps his eyes on the tree line to the left, searching for some familiar landmark in the thick forest. Suddenly he pulls the van over and gets out, pausing to pack tobacco into his pipe and consult a 1:50,000-scale survey map.

Head down, pipe in hand, Hüssen—a researcher with the German Archaeological Institute—crosses the road and wades through the thick underbrush. Fifty yards from the road, he nearly misses a low dirt mound about three feet high and six feet across. Littered with flat white stones, it runs in an unnaturally straight line along the forest floor.

Nearly 2,000 years ago this was the line that divided the Roman Empire from the rest of the world. Here in Germany the low mound is all that's left of a wall that once stood some ten feet tall, running hundreds of miles under the wary eyes of Roman soldiers in watchtowers.

It would have been a shocking sight in the desolate wilderness, 630 miles north of Rome itself. “The wall here was plastered and painted,” Hüssen says. “Everything was square and precise. The Romans had a definite idea of how things should be.” Engineering students measuring another stretch of wall found one 31-mile section that curved just 36 inches.

Hüssen faces north, the Roman Empire at his back. Two hundred yards away, just past a narrow meadow torn up by wild boars and a rushing stream, the next hill rises like a green wall. “Here's the border,” he says, “and on the other side is a wonderful view of nothing.”

A stunning network of walls, rivers, desert forts, and mountain watchtowers marks Rome's limits. At its peak in the second century A.D., the empire sent soldiers to patrol a front that

stretched from the Irish Sea to the Black Sea as well as across North Africa.

Hadrian's Wall, in England, probably the best known segment, was named a UNESCO World Heritage site in 1987. In 2005 UNESCO established a combined site with the 342-mile German frontier. Preservation experts hope to add sites in 16 other countries. The international effort may help answer a surprisingly tricky question: Why did the Romans build the walls? To protect a regime besieged by barbarians, or simply to establish the physical edge of the empire?

The question isn't just academic. Defining and defending borders is a modern obsession too. As politicians have debated building a wall between the United States and Mexico and troops face off across the land-mine-strewn strip of ground between the two Koreas, the realities the Roman emperors faced are still with us. Understanding why the Romans were obsessed with their borders—and the role their obsession played in the decline of the empire—might help us better understand ourselves.

FROM AROUND 500 B.C., Rome expanded continually for six centuries, transforming itself from a small Italian city-state in a rough neighborhood into the largest empire Europe would ever know.

The emperor Trajan was an eager heir to this tradition of aggression. Between 101 and 117, he fought wars of conquest in present-day Romania, Armenia, Iran, and Iraq, and he brutally suppressed Jewish revolts. Roman coins commemorated his triumphs and conquests.

When he died in 117, his territory stretched from the Persian Gulf to Scotland. He bequeathed

Andrew Curry, a Berlin-based journalist, frequently writes about history. Robert Clark covered the Staffordshire gold hoard in the November 2011 issue.



An iron mask, sheathed in bronze and silver and discovered in the Netherlands, was attached to a cavalry soldier's helmet by a hinge and worn on parade—and perhaps into battle.

CONSTRUCTED BARRIERS

Wall (limes)

Of the thousands of miles of frontier, only a fraction were walls, sealing gaps between natural barriers.

Fortress

Tower or fort

Troops were concentrated in these frontier structures, ultimately making the interior more vulnerable.

NATURAL BARRIERS



GROUPS AND REGIONS

Roman Empire, mid-second century A.D.

Barbarian nation (Approximate location) **Daci**

Political region **GAUL**



TYPES OF FORTIFICATIONS

Walls, military outposts, and frontier cities were all part of Rome's efforts to mark and defend its vast empire.

Antonine Wall

Built of stone, turf, and wood in 142, it pushed the northern frontier beyond Hadrian's Wall for some 20 years.



DEFINING AN EMPIRE

By the middle of the second century, as depicted on this map, the Roman Empire's centuries of relentless expansion had slowed and then stopped. Rome relied on its network of forts, walls, and natural barriers to separate the empire from barbarians, the term for everyone outside its borders. A mixture of diplomacy, trade, and violence was used to keep the frontiers intact. Eventually, barbarian incursions led to the fall of the western part of the empire in the fifth century.



LIMES TRANSALUTANUS
(Walls in Romania)
60 miles

Region of Roman occupation at greatest extent ca A.D. 114 to 117

Lambaesis
Rome established this military fort in approximately 81. It later served as army headquarters in North Africa.

Dura-Europos
The Romans seized this city, on a cliff above the Euphrates River, from the Parthians in the second century A.D.

PRESENT-DAY POLITICAL BOUNDARIES AND NAMES ARE SHOWN. PRESENT-DAY CITY NAMES ARE IN PARENTHESES.

VIRGINIA W. MASON, MATTHEW TWOMBLY, AND AMANDA HOBBS, NGM STAFF
SOURCES: DAVID J. BREEZE, INTERNATIONAL CONGRESS OF ROMAN FRONTIER STUDIES; SIMON JAMES, UNIVERSITY OF LEICESTER, U.K.; MICHEL JANON AND JEAN-MARIE GASSEND, *LAMBESE. CAPITALE MILITAIRE DE L'AFRIQUE ROMAINE*



the empire to his adopted son—a 41-year-old Spanish senator, self-styled poet, and amateur architect named Publius Aelius Hadrianus. Faced with more territory than Rome could afford to control and under pressure from politicians and generals to follow in the footsteps of his adoptive father, the newly minted emperor—better known as Hadrian—blinked. “The first decision he made was to abandon the new provinces and cut his losses,” says biographer Anthony Birley. “Hadrian was wise to realize his predecessor had bitten off more than he could chew.”

The new emperor’s policies ran up against an army accustomed to attacking and fighting on open ground. Worse, they cut at the core of Rome’s self-image. How could an empire destined to rule the world accept that some territory was out of reach?

Hadrian may simply have recognized that Rome’s insatiable appetite was yielding diminishing returns. The most valuable provinces, like Gaul or Hadrian’s native Spain, were full of cities and farms. But some fights just weren’t worth it. “Possessing the best part of the earth and sea,” the Greek author Appian observed, the Romans have “aimed to preserve their empire by the exercise of prudence, rather than to extend their sway indefinitely over poverty-stricken and profitless tribes of barbarians.”

The army’s respect for Hadrian helped. The former soldier adopted a military-style beard, even in official portraits, a first for a Roman emperor. He spent more than half of his 21-year reign in the provinces and visiting troops on three continents. Huge stretches of territory were evacuated, and the army dug in along new, reduced frontiers. Wherever Hadrian went, walls sprang up. “He was giving a message to expansion-minded members of the empire that there were going to be no more wars of conquest,” Birley says.

By the time the restless emperor died in 138, a network of forts and roads originally intended to supply legions on the march had become a frontier stretching thousands of miles. “An encamped army, like a rampart, encloses the civilized world in a ring, from the settled areas of Aethiopia to the Phasis, and from the Euphrates in the interior

to the great outermost island toward the west,” Greek orator Aelius Aristides noted proudly, not long after Hadrian’s death.

That “outermost island” was where Hadrian built the monument that bears his name, a rampart of stone and turf that cut Britain in half. Today Hadrian’s Wall is one of the best preserved, well-documented sections of Rome’s frontier. Remnants of the 73-mile barrier run through salt marshes, across green sheep pastures, and for one bleak stretch not far from downtown Newcastle, alongside a four-lane highway. Miles of it are preserved aboveground, lining crags that rise high above the rain-swept countryside.

More than a century of study has given archaeologists an unparalleled understanding of Hadrian’s Wall. The wall, perhaps designed by Hadrian himself on a visit to Britain in 122, was the ultimate expression of his attempt to define the empire’s limits.

In most places the stone wall was an intimidating 14 feet tall and 10 feet wide. Traces of a 9-foot-deep ditch running the length of the wall are still visible today. In the past few decades excavations have uncovered pits filled with stakes between ditch and wall, one more obstacle for intruders. A dedicated road helped soldiers respond to threats. Regularly spaced gates were supported by watchtowers every third of a mile.

A couple miles behind the wall, a string of forts was evenly spaced half a day’s march apart. Each fort could house between 500 and 1,000 men, capable of responding quickly to any attacks. In 1973 workers digging a drainage ditch at Vindolanda, a typical frontline fort, uncovered piles of Roman trash under a thick layer of clay. The wet layer held everything from 1,900-year-old building timbers to cloth, wooden combs, leather shoes, and dog droppings, all preserved by the oxygen-free conditions.

Digging deeper, excavators came across hundreds of fragile, wafer-thin wooden tablets covered in writing. They provide day-to-day details of life along Hadrian’s Wall: work assignments, duty rosters, supply requests, personal letters. There is even a birthday party invitation from one officer’s wife to another, the earliest surviving

REASON FOR THE WALLS

example of women's handwriting in Latin.

The tablets suggest that watching over the “wretched little Britons,” as one Vindolanda writer describes the locals, was no picnic, but the fort wasn't exactly a hardship post. Some soldiers lived with their families—dozens of children's shoes, including baby booties, are among the footwear recovered. And the wall's patrollers ate well: Bacon, ham, venison, chicken, oysters, apples, eggs, honey, Celtic beer, and wine were on the menu. There was even *garum*, a fermented fish concoction that was the Roman version of Worcestershire sauce. Homesick soldiers received care packages too. “I have sent you...socks...two pairs of sandals and two pairs of underpants,” writes one concerned correspondent.

Scholars today ask a key question that must have crossed the minds of Roman soldiers shivering through long watches in the English rain: What were they doing there in the first place?

The scale of the wall and its system of ditches, ramparts, and roads suggest that the enemy could be deadly.

Yet reports from Vindolanda hardly portray a garrison under pressure. Aside from a few scattered clues—like the tombstone of luckless centurion Titus Annius, who was “killed in the war”—there are no direct references to fighting anywhere on the British frontier. The big building project to the north isn't even mentioned. “You get a sense something's up. Colossal amounts of supplies are being ordered,” says Andrew Birley, director of excavations at Vindolanda and Hadrian biographer Anthony Birley's nephew. “But they don't refer to the wall itself.”

If the walls weren't under constant threat, what were they for? By bringing the sheer scope of the Roman frontier into focus, the effort to create a multinational UNESCO heritage site may help answer the question. Ever since British



BECHELN, GERMANY Only a few stone foundations remain from the more than 800 watchtowers built by Roman soldiers along 342 miles of the frontier linking the Rhine and Danube Rivers.



A TRAVELING EMPEROR

Hadrian spent more than half of his 21-year reign on the road, overseeing the construction of new cities and frontier fortifications. Here he is shown on horseback with outstretched arm, riding in front of his Praetorian Guard to inspect the Saalburg fort while touring the German frontier around 121.



antiquarians organized the first scientific excavations along Hadrian's Wall in the 1890s, historians and archaeologists have assumed Rome's walls were military fortifications, designed to fend off barbarian armies and hostile invaders.

For decades arguments focused on tactical details: Did soldiers stand along the wall to rain spears and arrows down on invaders or sally forth to engage the enemy in the field? The trenches of WWI—and the deadly back-and-forth battling of WWII—did little to change the prevailing view of the ancient frontier as a fixed barrier separating Rome from hordes of hostile barbarians.

Archaeologists studying the frontiers in the 1970s and '80s later found that the Iron Curtain



dividing Europe had shadowed their view of the distant past. “We had in Germany this massive border, which seemed impenetrable,” says C. Sebastian Sommer, chief archaeologist at the Bavarian State Preservation Office. “The idea was here and there, friend and foe.”

Today a new generation of archaeologists is taking another look. The dramatic, unbroken line of Hadrian’s Wall may be a red herring, a 73-mile exception that proves an entirely different rule. In Europe the Romans took advantage of the natural barriers created by the Rhine and Danube Rivers, patrolling their waters with a strong river navy. In North Africa and the eastern provinces of Syria, Judaea, and Arabia,

the desert itself created a natural frontier.

Military bases were often ad hoc installations set up to watch rivers and other key supply routes. The Latin word for frontier, *limes* (LEE-mess), originally meant a patrolled road or path. We still use the term: Our “limits” comes from *limites*, the plural of *limes*.

Outposts on rivers like the Rhine and Danube or in the deserts on Rome’s eastern and southern flanks often resemble police or border patrol stations. They would have been useless against an invading army but highly effective for soldiers nabbing smugglers, chasing small groups of bandits, or perhaps collecting customs fees. The thinly manned walls in England and Germany





TIMGAD, ALGERIA *Rome imposed its sense of order all across the empire. The town of Thamugadi was laid out on a grid-style plan and included a market (at center), ceremonial gates, more than a dozen bath complexes, a library, and a theater that could seat 3,500.*





Roman soldiers went into battle with a shield, a spear to throw at close range, and a short sword for stabbing or slashing, as shown on this pedestal found in Mainz, Germany. The dragon's head would have been carried into battle on a pole, with a fabric body attached. Otherwise, the dragon would be kept in the central building of a frontier fort.

REVENGE WAS A FAVORITE TACTIC

were similar. “The lines were there for practical purposes,” says Benjamin Isaac, a historian at Tel Aviv University. “They were the equivalent of modern barbed wire—to keep individuals or small groups out.”

Isaac argues that the frontiers resembled certain modern installations more than thick-walled medieval fortresses: “Look at what Israel’s building to wall off the West Bank. It’s not meant to keep out the Iranian army, it’s made to stop people from exploding themselves on buses in Tel Aviv.” Warding off terrorists may not have motivated the Romans, but there were plenty of other factors—as there are today. “What the United States is planning between itself and Mexico is substantial,” says Isaac, “and that’s just to keep out people who want to sweep the streets in New York.”

More archaeologists are endorsing that view. “Isaac’s analysis has come to dominate the field,” says David Breeze, author of the recent *Frontiers of Imperial Rome*. “Built frontiers aren’t necessarily about stopping armies but about controlling the movement of people.” The Roman frontier, in other words, is better seen not as an impervious barrier sealing Fortress Rome off from the world but as one tool the Romans used to extend influence deep into *barbaricum*, their term for everything outside the empire, through trade and occasional raids.

FOR CENTURIES emperors used a mix of threats, deterrence, and outright bribery to secure peace. Rome negotiated constantly with tribes and kingdoms outside its frontier. Diplomacy created a buffer zone of client kings and loyal chieftains to insulate the border from hostile tribes farther afield. Favored tribes earned the right to cross the frontier at will; others could bring their goods to Roman markets only under armed guard.

Loyal allies were also rewarded with gifts, weapons, and military assistance and training. Friendly barbarians sometimes served in the Roman army; after 25 years, they retired as Roman citizens, free to settle anywhere in the empire. Vindolanda alone was home to units recruited from what are now northern Spain, France, Belgium, and the Netherlands. Iraqi bargemen

once sailed England’s rivers under the banner of Rome, and Syrian archers watched over the bleak countryside.

Trade was also a foreign policy tool: The Roman-Germanic Commission in Frankfurt, part of the German Archaeological Institute, has a database of more than 10,000 Roman artifacts found beyond the limes. Weapons, coins, and goods like glass and pottery show up as far away as Norway and modern-day Russia.

Roman foreign policy wasn’t all carrots. Revenge was also a favorite tactic, and the legions were eager to take the fight beyond the frontier.

They spent seven years avenging one disastrous defeat suffered in A.D. 9 in Germany. The historian Tacitus explains that when victorious on the battlefield, General Germanicus “took his helmet off his head and begged his men to follow up the slaughter, as they wanted not prisoners, and the utter destruction of the nation would be the only conclusion of the war.”

Hadrian lashed out at troublesome populations too. In 132 he suppressed a Jewish revolt in a ruthless, protracted campaign. One Roman historian claimed the fighting left half a million Jews dead and added, “As for the numbers who perished from starvation, disease, or fire, that was impossible to establish.” Survivors were enslaved or expelled. The name of the province was changed from Judaea to Syria-Palaestina to wipe away all traces of the rebellion.

Word of such brutality surely made Rome’s enemies think twice before crossing the line. To the Romans, slaughter and genocide were an important part of keeping the empire secure. “The Pax Romana isn’t simply won after a series of battles,” says Newcastle University archaeologist Ian Haynes. “Rather, it’s asserted over and over in brutal ways.”

JUST AS HADRIAN’S WALL shows the Roman frontier at its strongest, an abandoned fortress on the Euphrates River vividly captures the moment the borders began to collapse. Dura-Europos was a fortified city on the frontier between Rome and Persia, its greatest rival. Today Dura sits about 25 miles from the Syrian border with Iraq,

an eight-hour bus ride through the desert from Damascus. It first came to light in 1920, when British troops fighting Arab insurgents accidentally uncovered the painted wall of a Roman temple. A team from Yale University and the French Academy put hundreds of Bedouin tribesmen to work with shovels and picks, moving tens of thousands of tons of sand with the help of railcars and mine carts. “At times it was like the Well of Souls scene from *Indiana Jones*,” says University of Leicester archaeologist Simon James.

Ten years of frenzied digging uncovered a third-century Roman city frozen in time. Fragments of plaster still cling to mud-brick and stone walls, and the rooms of palaces and temples—including the world’s oldest known Christian church—are tall enough to walk through and imagine what they looked like when they had roofs.

Founded by Greeks around 300 B.C., Dura was

conquered by the Romans nearly 500 years later. Its tall, thick walls and perch above the Euphrates made it a perfect frontier outpost. The northern end was walled off and turned into a Roman-era “green zone” with barracks, an imposing headquarters for the garrison commander, a redbrick bathhouse big enough to wash the dust off a thousand soldiers, the empire’s easternmost known amphitheater, and a 60-room palace suitable for dignitaries “roughing it” in the hinterlands.

Duty rosters show at least seven outposts reported to Dura. One of the outposts was staffed by just three soldiers; another lay nearly a hundred miles downstream. “This was not a city under constant threat,” James told me when I visited, before the political situation in Syria deteriorated and made excavation impossible. We sat amid the ruins and watched orange gas flares from Iraqi oil wells flicker on the horizon. “Soldiers here were probably busier policing the



This fragment of a hand-painted glass vessel was found near Hadrian’s Wall, broken in two pieces. The glass has been attributed to workshops in Germany, evidence of widespread trade.





QASR BSHIR, JORDAN *Built around A.D. 300, this cavalry outpost on the edge of the desert is one of the world's best preserved Roman forts. With between 70 and 160 horsemen, the fort kept Arab nomads from attacking caravans carrying frankincense and myrrh.*

locals than defending against raids and attacks.”

The quiet didn't last. Persia emerged as a major threat along the empire's eastern border a half century after the Romans seized Dura. Beginning in 230, war between the rivals raged across Mesopotamia. It was soon clear the frontier strategy that had served Rome for more than a century was no match for a determined, sizable foe.

Dura's turn came in 256. Working with a Franco-Syrian team of archaeologists interested in the site's pre-Roman history, James has spent ten years unraveling the walled city's final moments. He says the Romans must have known an attack was imminent. They had time to reinforce the massive western wall, burying part of the city—including the church and a magnificently decorated synagogue—to form a sloping rampart.

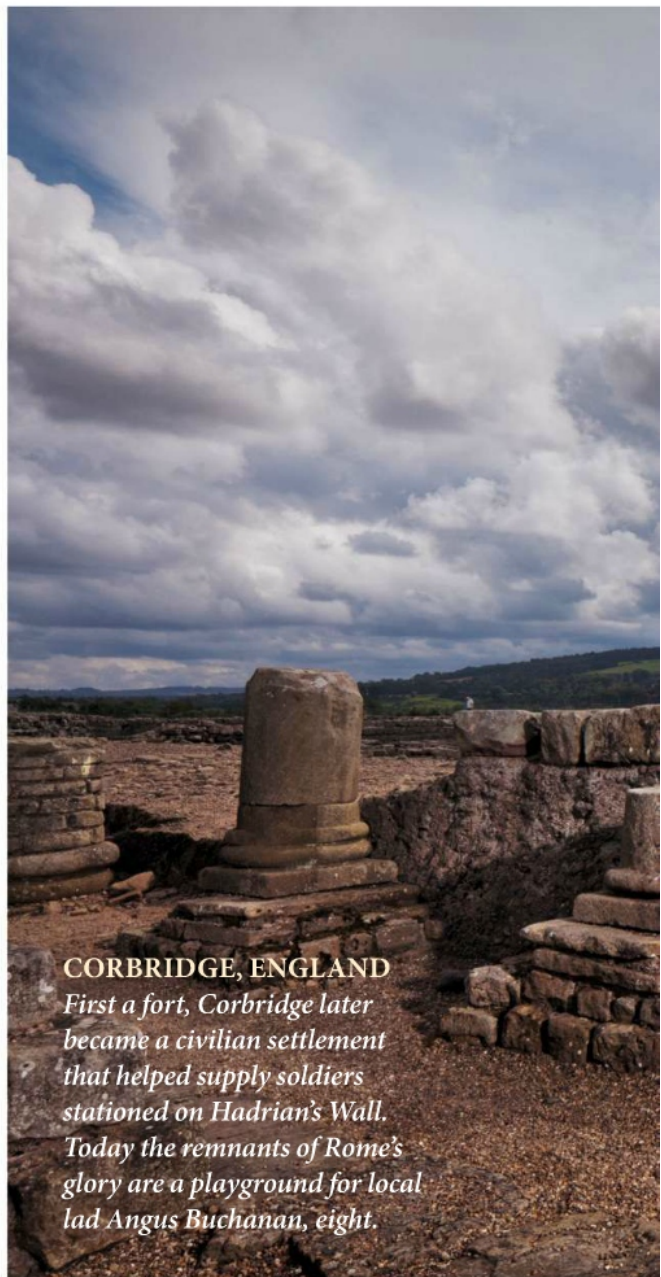
The Persian army set up camp in the city cemetery, a few hundred yards from Dura's main gate. As catapults lobbed stones at the Romans, the Persians built an assault ramp and dug beneath the city, hoping to collapse its defenses. Dura's garrison struck back with tunnels of their own.

As fighting raged on the surface, James says, a squad of 19 Romans broke through into a Persian tunnel. A cloud of poison gas, pumped into the underground chamber, suffocated them almost instantly. Their remains are some of the oldest archaeological evidence of chemical warfare. James believes the bodies, found 1,700 years later, stacked in a tight tunnel, were used to block the tunnel while the Persians set it on fire.

The Persians failed to topple Dura's wall but eventually succeeded in taking the city, which was later abandoned to the desert. Surviving defenders were slain or enslaved. Persian armies pushed deep into what had been Rome's eastern provinces, sacked dozens of cities, and overpowered two emperors before capturing a third, the hapless Valerian, in 260. The Persian king, Shapur, reportedly used Valerian as a footstool for a while, then had him flayed and nailed his skin to a wall.

The crisis was a turning point. Around the time Dura fell, the careful balance of offense, defense, and sheer intimidation along the frontier fell apart.

For nearly 150 years the border had helped



CORBRIDGE, ENGLAND

First a fort, Corbridge later became a civilian settlement that helped supply soldiers stationed on Hadrian's Wall. Today the remnants of Rome's glory are a playground for local lad Angus Buchanan, eight.

Rome ignore a painful reality: The world beyond the walls was catching up, in part thanks to the Romans themselves. Barbarians who served in the Roman army brought back Roman knowledge, weapons, and military strategy, says Michael Meyer, an archaeologist at Berlin's Free University.

While Rome looked the other way, barbarian tribes grew bigger and more aggressive and coordinated. When troops were pulled from across the empire to beat back the Persians, weak points in Germany and Romania came under attack almost immediately.

Hadrian's legacy was doomed. "The tragic point of their strategy is that the Romans



concentrated military force at the frontier,” Meyer says. “When the Germans attacked the frontier and got in behind the Roman troops, the whole Roman territory was open.” Think of the empire as a cell, and barbarian armies as viruses: Once the empire’s thin outer membrane was breached, invaders had free rein to pillage the interior.

The inscription on a five-foot-tall altar uncovered in Augsburg by German workers in 1992 is a sort of epitaph for Hadrian’s grand idea, noting that on April 24 and 25, A.D. 260, Roman soldiers clashed with barbarians from beyond the German frontier. The Romans prevailed—barely.

Their commander set up an altar to Victory.

Reading between the lines reveals a different picture: The barbarians had been raiding deep into Italy for months and were heading home with thousands of Roman captives. “It shows the border is already collapsing,” says the German Archaeological Institute’s Hüssen.

The empire would never be safe inside its shell again. Pressures on the frontiers finally became too great. Cities across the empire began building their own walls; the emperors scrambled to fight off regular invasions. The costs and chaos were crippling. Within two centuries an empire that once dominated an expanse larger than today’s European Union was gone. □



Home of the *Roma*

In a Romanian farm town, once itinerant traders have struck it rich, replacing caravans with mansions.

Str. ȘTEFAN CEL MARE

Kings



A fantasia of styles, from villa to temple to castle, lines the main street of Buzescu, population 5,000. Men are often away on business; women, wealthy or not, stay to cook, clean, and raise the kids.





Six-year-old twins Gelu and Edi Petrache wait for the parties to start on Easter Sunday. They live in one of the more than a hundred extravagant houses that have gone up since communist rule ended in 1989. The Roma's wealth in Buzescu, on the banks of the Danube, comes mostly from trade in silver and other metals.



On Easter Sunday Roma feast on the street, spending big on food, drink, and song. Here a band member accepts money—often it's hundreds of dollars—for calling out the donor's name and playing a request. Local families belong mostly to the Kalderash group, known for making copper stills.





Buzescu's well-to-do have a thing for flamboyant decor. Vandana Ispilante sits with her 13-year-old daughter, Edera, in a bedroom that looks like a honeymoon suite—except for a picture of the Virgin Mary on the headboard. Odds are Edera's closet will never hold head scarves and long flowered skirts, the traditional Romani dress.



By Tom O'Neill

Photographs by Karla Gachet
and Ivan Kashinsky

Hands folded over his prosperous belly, a straw fedora tight on his head like a crown, an old gent named Paraschiv sat back on a bench and surveyed his neighborhood realm. It was quite a sight for rural Romania. Up and down the main road and spilling into dirt side lanes reared improbable mansions. Facades undulated with balconies and pillars. Rooftops looked like party hats, all turrets and towers and domes. Sleek Beemers and Benzes patrolled the streets. Just then, a truck driver with a load of pigs ground down on his brakes to gawk. Paraschiv smiled. This was his hometown; this was Buzescu, showplace for that rarest of Europe's demographics, the wealthy Roma.

Paraschiv doesn't use the word "Roma," the correct, respectful name for his ethnic group, meaning "men" in the Romani language. Instead he and most of his neighbors unselfconsciously refer to themselves as Tsigani, or Gypsies, the old, pejorative name they grew up with, a label





Appearances matter inside the big houses. Casi, 13, wants to look good for husband-to-be Sami, 14, pictured on a closet door. Arranged marriages between children are common among Buzescu's wealthy families. Already Casi lives with Sami's family; they'll officially wed when both reach 17. Parents seem intent on giving children everything they themselves





lacked, from fast cars to the heaps of toys and stuffed animals that keep teenager Madalina Ion company (bottom left). Many grand spaces are used only on holidays and for weddings and funerals. To prepare for Easter, Simona Iancu shines an entrance hall. Doru and Valeria Constantin (below) seldom entertain in their glittery, marble-floored dining room.





In a backyard in the wealthy quarter, traditional village habits maintain a hold. On the day of a baptism, men send off a gift pig to the godparents. Some affluent Roma, especially older ones who grew up traveling in horse-drawn caravans, are uneasy in the mansions and still use outhouses and outdoor kitchens.





Zaharia Bureata greets Easter morning in a tie spun from solid gold thread, its front spelling out his name and the brand of his car, a Hummer. Others in town have copied his style. "People think all Roma are poor and filthy," declared one mansion dweller. "They should see us."

still wielded by many non-Roma in his country, synonymous with beggar, thief, parasite, and other ugly words. In common use since the early 1600s, "Gypsy" derives from "Egyptian," from the supposed origin of the Roma. Linguistic evidence indicates that the Roma came from India.

"I built one of the first mansions, in 1996," Paraschiv said, nodding toward his villa-style home, a fanciful hulk encased in gray and white marble and cornered with balconies. The names of his children, Luigi and Petu, are stenciled atop a tin-sheeted tower. "My sons want to tear down the house and build a different shape; they say it's out of fashion." Paraschiv shrugged. "If my sons want to, then OK."

At two stories, Paraschiv's mansion is modest. Giant five-story palaces ribbed with columns have been multiplying on the southern end of town, the Romani district. Call it the monument style. There's also the corporate HQ look, with curved,

mirrored-glass walls; the nobleman's castle, with sherbet-colored battlements and balconies arrayed like opera boxes; and the Swiss chalet, with high peaked roof and gnomes on the porch. It's gaudy, uninhibited architecture, the taste blatantly nouveau riche. In all, about a hundred Romani mansions have sprung up in an otherwise dour farm town of 5,000 people some 50 miles southwest of the capital, Bucharest. About a third of the citizenry is Roma, not all of them rich but enough to make the town a strange, compelling statement of ethnic pride.

"Wealthy Roma" looks like a misprint, a snide joke. For many of the estimated two million Roma in Romania, or about 10 percent of the population, life is poor and nasty, their communities stuck in squalid city slums or in cardboard shanties on the edges of towns. They share this fate with Roma throughout Eastern Europe, where these formerly seminomadic people are a despised underclass, conspicuous for their poverty, lack of education, and stubborn insularity.

To many *gadje*, the Romani term for outsiders, the palatial homes of Buzescu's Roma are a thumb in the eye, a flaunting of undeserved

Tom O'Neill is a staff writer. Karla Gachet and Ivan Kashinsky are a married couple based in Quito, Ecuador. Kashinsky photographed Bolivian female wrestlers for our September 2008 issue.

wealth. The Romani elite, however, seem to care less about impressing outsiders. Townspeople make it clear they don't want strangers stopping to ask questions and take pictures. *Pleaca, pleaca*, go away, go away, children would yell at me. Adults glowered or turned their backs when I approached. "These places are not for you," Roma sociologist Gelu Duminica told me, meaning anyone not Roma. The mansions are built for local eyes only, Duminica said, a way to strut wealth and status inside the Roma community.

So where does the wealth come from? The local Roma simply say, "Metal trading." The Buzescu Roma are mostly Kalderash—"coppersmith" in Romani—a group traditionally associated with metalworking. As recently as the early 1990s, Buzescu families still traveled the countryside in horse-drawn caravans, stopping in towns to sell *cazane*, copper stills for making fruit brandy. It was a lucrative business for the best craftsmen, like Paraschiv, with a *cazane* selling for hundreds of dollars. Communist authorities, however, kept a tight watch on Romani activities, and the richest families kept a low profile.

When Romania's communist regime fell in 1989, the entrepreneurial instinct of the Kalderash was unleashed. *Cazane* makers and their sons spread across Romania and the rest of Eastern Europe, stripping derelict factories, sometimes illegally, of silver, copper, aluminum, steel, and other valuable scrap. By playing the commodity market, some Buzescu Roma reaped hefty profits. Marin Nicolae, a former *cazane* maker, says: "After the revolution, even a stupid person could build five villas buying and selling metal."

For a week I walked up and down the streets of Buzescu, trying to talk my way into mansions. Photographers Karla Gachet and Ivan Kashinsky had paved the way, living two months on and off in the Romani quarter, gaining access to a number of homes only after strenuous persistence. Holding up photos Karla and Ivan had taken of people inside the big houses, I stood at front gates, appealing to the owners' curiosity and vanity. Sometimes it worked.

Front doors would open to gleaming expanses of marble, ceilings hung with chandeliers, and,

like the main prop of a stage set, a grand *Gone With the Wind* staircase leading to bedrooms heaped with toys. Yet most rooms looked totally un-lived in. In mansions with a dozen rooms or more, often the only occupants were grandparents and a few young children, and they mostly stayed in back rooms and ate in the kitchen. The parents and older sons were off doing business, usually returning for holidays, baptisms, and funerals. The mansions had been built largely as showrooms to be filled with pride and awe.

Another surprise was that behind the showy facades, time-encrusted customs remained in force. At Victor Filisan's house, where he offered me the local drink of Jack Daniel's and Red Bull, I asked to use the toilet. He showed me not to the Jacuzzi-equipped bathroom inside but to an outhouse at the back of the lot, the same one he and his wife use. For reasons of ritual purity, many Roma, especially older ones, do not cook and use the toilet under the same roof. In other houses, I saw teenage wives serving meals to teenage husbands. Arranged matches of children as young as 13 remain common among the town's wealthy families.

The community's itinerant past never seemed that far away either. It was a restless town. Families were constantly leaving, heading off to Spain, France, Bucharest. Old men on corners reminisced about their traveling days, nostalgic for the variety and adventure. They also gossiped about shifting fortunes, blaming a roulette wheel operated by *gadje* for bankrupting households. On every street people were building new houses or tearing down old ones to erect bigger, bolder mansions, like what Paraschiv's sons had in mind. Nothing seemed permanent except family ties.

"We are the most civilized Gypsies in Romania," a man named Florin bragged to me. "If we see something beautiful, we want something even more beautiful." When I repeated this to an elderly widow, Rada, who had once lived in a mansion but is now ending her days in a small musty house with chickens running in and out the kitchen door, she looked at me, foolish *gadjo*, and said, "No matter how high you build up, everyone ends up in the grave." □

Beyond Buzescu's mansion district, a kitchen belonging to a hard-pressed Romani family serves as a dance hall for Iasmina Iancu, six, twirling for her grandfather Ion, who raises her. Iasmina's mother works in Spain. Many households contain only old and young, the rest scattered across Europe to earn money.





NATIONAL GEOGRAPHIC ON TV



Alien Deep

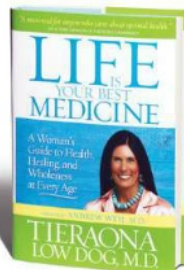
Robert Ballard, the man who discovered the *Titanic*, knows a thing or two about the world's oceans. Join him and a team of scientists this month on the National Geographic Channel as they get to the bottom of some deep-sea mysteries. Among their goals: Find out why some marine organisms (collected near Panama by bioengineer Kakani Katija, left) may beat the wind when it comes to ocean-churning power.

MAP

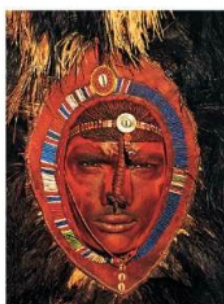
SOUTHEAST ASIA Take a closer look at Southeast Asia with National Geographic's new wall map. This detailed map shows current political boundaries, cultural sites, and more. Get it at shopng.com (\$12.99).

BOOK

WOMEN'S HEALTH From the proper dose of omega-3 fatty acids to the value of humor, Tieraona Low Dog takes a holistic approach to wellness. Her new guide combines personal stories, traditional practices, and medical science. Available in stores September 4 (\$26).



LECTURE



AFRICAN CEREMONIES Photographers Carol Beckwith and Angela Fisher have been traveling to Africa for 30 years. Their new book, *Painted Bodies*, features body adornment from across the continent, including this Maasai warrior's ochered face. For speaking dates in Los Angeles, Chicago, and Arizona go to nglive.org.

EXHIBIT

1001 INVENTIONS This exhibit highlights the scientific innovations of Muslim civilization from the 7th to 17th centuries. At the National Geographic Museum until February 3. Visit ngmuseum.org/1001.

Free Download of the Month



Depedro Complete Depedro

The music of Depedro—the solo project of Spanish singer and songwriter Jairo Zavala—is rooted in the sounds of Spain and Latin America. Comprising B sides, live tracks, and remixes, Zavala's new EP, *Complete Depedro*, seduces from the moment you hit play. Download a free song at natgeomusic.net/free.

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Brothers, Now and Then Luck and a storekeeper's camera phone were in play when Robb Kendrick made a new picture of two Mennonite brothers he had photographed 29 years earlier. Looking to capture the toll of last year's severe drought in his home state of Texas, he remembered Seminole, an agricultural community he had visited as a junior in college. "I like photographing people with hard jobs," Kendrick says. Gerhard and Peter Neustaeter, both cotton farmers, lost their entire crop in 2011. Reunited, the trio caught up on life. —Luna Shyr



BEHIND THE LENS

How did the brothers cope with the 2011 Texas drought?

RK: Gerhard [at left in both photos] and Peter are like many farmers—they have a lot of faith that next year's going to be better. If you're a farmer, you have to constantly be optimistic. Last year was rough, but crop insurance helped, plus that farmers' ability to put so much hard work into something they're not in control of. Also Mennonites are very pragmatic people. They don't cry over spilled milk.

How did you find them again nearly 30 years later?

It was a real shot in the dark, but I went into a Mennonite farm-supply store with the original photo I took of them. The store owner took a picture of the picture with his

phone and emailed it to the community. Within 15 minutes one of the brothers showed up.

And you went back to their town because...

For this assignment I wanted to visit places I had a

connection to. In college I passed through Seminole on my way home to visit my folks. Gerhard and Peter were 13 and 12 years old back then. We had a good time catching up—Peter said we should do it again in another 29 years.

A Class Action Settlement About Chinese Drywall May Affect You

A Settlement has been reached in a class action lawsuit involving drywall imported to the U.S. from China. The lawsuit claims that this Chinese Drywall caused property damage and personal injuries.

The companies being sued are distributors, suppliers, builders, developers, and installers who were associated with Chinese Drywall. Some of these companies (“Participating Defendants”) and some of their insurance companies (“Participating Insurers”) have agreed to a Settlement. The Participating Defendants and the Participating Insurers deny they did anything wrong.

Who’s Included?

You are likely included in the Class if you have any claim for property damage or personal injuries related to Chinese Drywall installed anywhere in the U.S., except for in Virginia. For the specific legal definition of the Class, please visit the website or call the phone number below.

What Can You Get?

Under the Settlement, Participating Defendants and Participating Insurers will contribute \$80 million into a Settlement Fund. At a later date, after other Chinese Drywall Settlements are resolved, the Court will approve a plan to distribute the Settlement Fund to Class Members. At that time, Class Members may receive payments for their damages. You can register at the website below to be updated if a claims process is available.

Your Other Rights

If you do nothing, you remain in the Class and you may be eligible to receive Settlement benefits. You will be bound by all the Court’s decisions. If you do not want to be legally bound by the Settlement, you must exclude yourself from the Settlement. The deadline to exclude yourself is **September 28, 2012**. If you do not exclude yourself you will not be able to sue the Participating Defendants or the Participating Insurers for any claim relating to the lawsuit. If you stay in the Settlement, you may object to all or part of it by **September 28, 2012**. The Court will hold a hearing on **November 13, 2012** to consider whether to approve the Settlement. The Court has appointed attorneys to represent the Class. If you wish, you or your own attorney may ask to appear and speak at the hearing at your own cost.

This notice is only a summary. Use the information below to get detailed information, and to register to receive future notifications about this Settlement and related Chinese Drywall Settlements.

Call: 1-877-418-8087
or Visit www.ChineseDrywallClass.com



Insides Out

Sitting in a Nome, Alaska, photo studio in the early 1900s, an Eskimo man models a parka fashioned of walrus intestine. Impermeable when wet and easy to come by for the sea-focused people, the material was prepared by air curing, then sliced and sewn with a waterproof stitch—the same as used for watercraft, including the umiak (canoe) he's holding. The jacket's extra material at the hem functioned as a spray skirt when he was at sea.

Other innards also had uses: Bladders became water bags, guts got sewn together as sod-house windows, and stomachs could be stretched for tambourine drums. —*Johnna Rizzo*

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

PHOTO: BEVERLY B. DOBBS, NATIONAL GEOGRAPHIC STOCK

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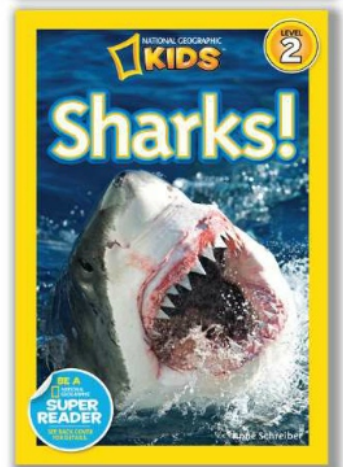
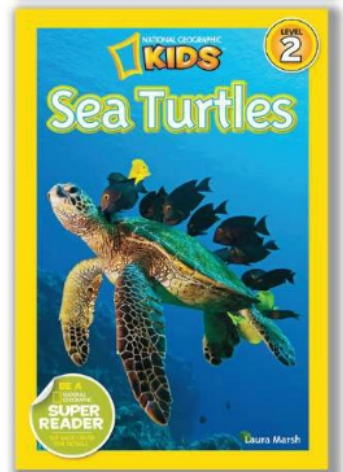


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