

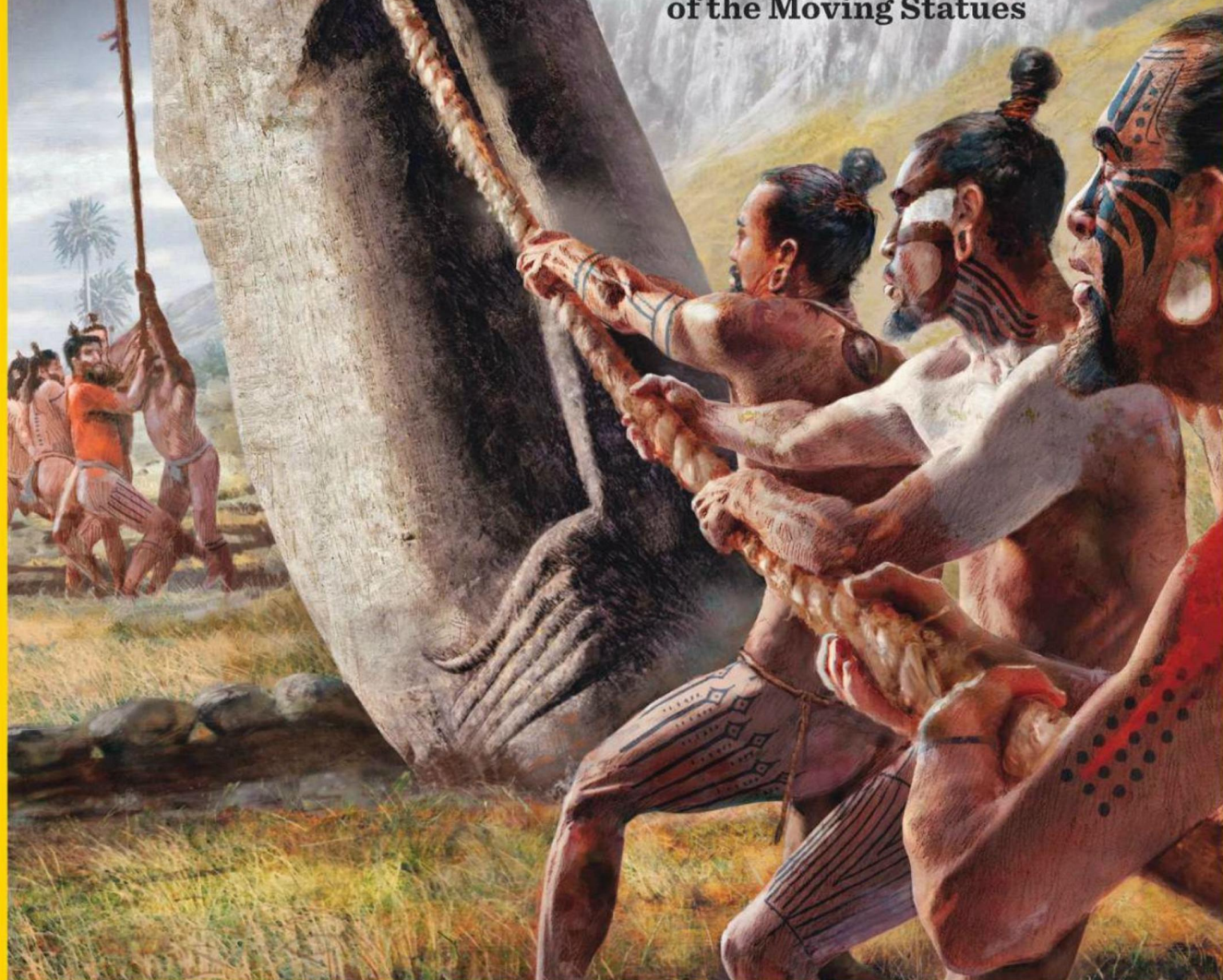
SAVING LOST LANGUAGES | ANTARCTICA'S ICE CAVES

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NATIONAL
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EASTER ISLAND

THE
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of the Moving Statues



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LYNN JOHNSON

No more than a thousand people speak the Seri language in Mexico. Marcela Díaz Félix is one of them. Here she uses a scarf for shade as she visits her father's grave.

July 2012

30 **The Riddle of Easter Island**

How did the statues move? That question puzzles archaeologists—and modern-day islanders.

By Hannah Bloch Photographs by Randy Olson

50 **Epic Storms**

Is that a spaceship? Or a mushroom cloud? Or a strange skyscape whipped up by wild weather?

By Jeremy Berlin Photographs by Mitch Dobrowner

60 **Vanishing Voices**

A language goes silent every 14 days. That could mean the end for words like *tradzy*, *azaac*, *khei-àt*.

By Russ Rymer Photographs by Lynn Johnson

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The breakfast of scientists freezes in the bowl. But weird microbes, possibly from Earth's bowels, thrive in the hot soil of an Antarctic volcano.

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In vacation cottages the women are in housedresses. The men, Speedos and rubber boots. They brood, plant, party, and restore their souls.

By Cathy Newman Photographs by Jonas Bendiksen



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Sabertooth Vegetarian ▶

A fossil unveils a bizarre creature whose huge teeth chewed leaves.

Stumble Stones

Bearing the names of Hitler's victims, they're installed on Europe's sidewalks.

Mental Mapping

The map in your head likely faces north.

Plastic Cash

Canada introduces polymer bills. They cost more to make but last a lot longer.

Cricket Chirps ▶

They're linked to the temperature.

Vertical Greenery

How do urban gardens grow? In many cities the answer is: up the wall.



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Fill 'er Up...in Space ▶

Mission: figure out a way to refuel and repair old satellites.

Handwriting on the Wall

Nowadays students rarely use cursive.

Forest Migration

Seedlings head north to see how global warming will affect the range of trees.



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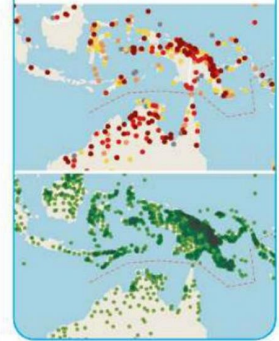


Easter Island Video

An animated statue tries different ways of "walking."

Vanishing Languages Interactive Map

Find out where native tongues are in danger.



TOP: HANS WEISE, NGM STAFF. MAP: VIRGINIA W. MASON, NGM STAFF



On the Cover

The illustration is based on a new theory about how ancient Easter Islanders used ropes to "walk" the statues. Art by Fernando G. Baptista, NGM Staff

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Blue Bird of Paradise (*Paradisaea rudolphi*)

Size: Head and body length, approx. 30 cm (12 inches) **Weight:** 124 - 189 g (4.4 - 6.7 oz) **Habitat:** Prefers lower montane forest; requires primary forest to display **Surviving number:** Estimated at 2,500 - 10,000



Photographed by Tim Laman

WILDLIFE AS CANON SEES IT

The ultimate show-off? Displays don't get much more spectacular than that of the blue bird of paradise. Hanging upside down, the male spreads his flank feathers into a triangular fan, raises and lowers his long tail plumes and catches the light in such a way that he shimmers in blue and violet. Accompanying vocalizations include cawing and a rhythmic buzzing sound. The female, nearly as colorful as her mate, is on her own when it comes

to incubating her eggs and caring for her young. The world those young inherit is on the verge of becoming paradise lost, threatened by habitat loss due to agriculture, logging and mining.

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.

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The Power of Voice

Lynn Johnson's voice is calm, thoughtful, and quiet—but not too quiet. She pulls you in. You want to catch every word. Her images also pull you in and compel you to catch every nuance. They are insightful, intelligent, and above all, profoundly human.

We knew we wanted Lynn to photograph this month's story "Vanishing Voices." We also knew it wouldn't be easy. How, after all, do you visualize a story about the spoken word? Native tongues are imperiled. Linguists estimate that nearly half the world's languages will disappear by the next century. Lynn's challenge was to show what is usually just heard.

She did not disappoint. Not only that, but she made it look effortless. How does she do it?

Photography, she says, is not unlike meditation. "It's a mind always at the ready. You go in knowing your story, then you are respectful of what and who is present."

The last sentence is the key to her success. The people she meets quickly sense her respect for them and trust her. The proof is in the photographs she makes. The intimacy she captures can come only from a relationship grounded in trust.

How do you get there?

"By being yourself," she says. "The more authentic you are, the more authentic you can be with others. It has to come from an intention not to manipulate."

Look closely at her images. They illuminate and glow with tenderness. Most of all, they magically give a voice to those in danger of losing theirs.

**Photography,
Lynn says,
is not unlike
meditation.**



Lynn Johnson has shot 21 feature stories for the *Geographic* since her first in 1989.



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The Apostles

Andrew Todhunter's article states: "Adhering to a faith that challenges the Hindu caste system can still be risky." This grossly distorts India's exemplary record as a diverse, secular society. For a nation that is 80 percent Hindu, India has had Muslim and Sikh presidents, a Sikh prime minister, and many Christians, Zoroastrians, and others in key positions. Its most influential political figure, Sonia Gandhi, was born in Italy and is a Roman Catholic. Churches, mosques, gurdwaras, and temples can be seen across India. To convey the truth, context is important, and I wish the article had provided it.

SUDHIR KRISHNA
Sunnyvale, California

I am a 62-year-old South Buffalo, New York, Irish Catholic. I was taught by Mercy nuns, Franciscan priests, and Jesuit professors. I thought I knew my faith until I read about Anil Kuldeep. This 19-year-old is pictured in a refugee camp in Odisha, India. Scars are visible from an eight-hour beating he received in 2008 at the hands of extremist Hindus for refusing to give up his Christian faith. I think this was the type of faith that all those nuns, priests, and

professors tried to pound into our heads all those years ago. Your picture of young Anil was worth 10,000 lectures. I hope his faith and your picture will lead to a better life for him. I am humble and a little bit jealous.

BRIAN M. STANTON
Orchard Park, New York

What leaps out of Todhunter's scholarly article is the fervent faith that so many have in a very amorphous system of beliefs. The Egyptians held their sun god

beliefs for thousands of years, and they were certainly an intelligent civilization. But they were wrong. The stories of a young holy man who impressed a small tribe of Jews with the power of love must be reexamined for his example to endure.

IVAN LADIZINSKY
Delray Beach, Florida

I hail from Cape Comorin (or Kanniyakumari) on the tip of India. We believe a slightly different history than what I read. We believe Thomas the Apostle built seven and a half churches. From Thiruvithancode he came to our town; there he built a small shrine, which is a better word to use than church. While he was building, the Brahmins drove him out, and he fled to Madras. He could not finish, and that is why we call it a half church.

HERMANAGILD JAYACHANDRA
Boulder, Colorado

The Bible is capable of speaking for itself, and we would all be the better if we let it do so.

JUDY MCFARLAND
Nashville, Tennessee

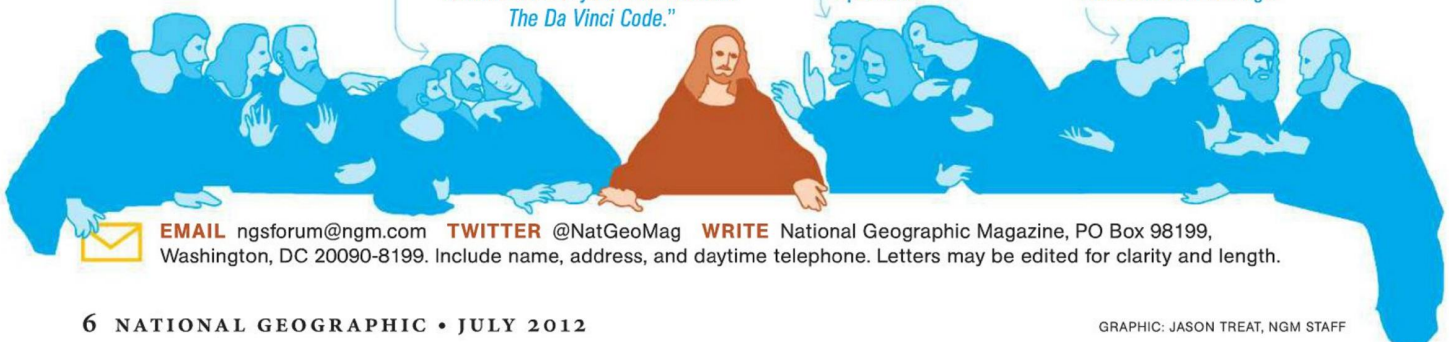
FEEDBACK Many readers' responses focused on individual Apostles.

"No Apostle was chastised more for his many doubts throughout the Gospels than Peter."

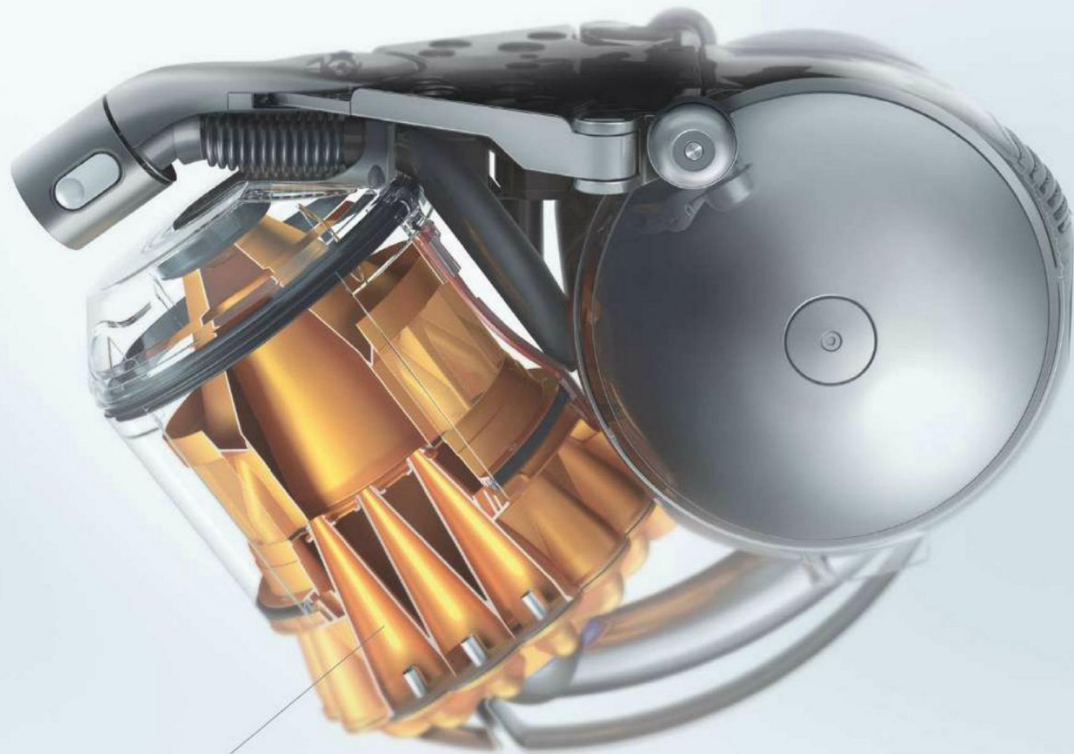
"Interesting that the cover avoids showing the person seated to Christ's right. The reason for this is obvious to anyone who has read *The Da Vinci Code*."

"Sounds to me like Thomas's doubt was shared by all the Apostles."

"Mark wrote first, and Matthew and Luke used most of his material as a basis for their writings."



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Erratics

I live at the bottom of ancient Glacial Lake Missoula, and until the recent issue arrived I thought I was the only one who loved erratics. I have painted about 30 portraits of these gentle giants resting in a mule pasture north of town. They take on a wonderful and mysterious presence in the first snow of winter. Our erratics were said to have arrived on ice rafts, then tumbled down to the bottom of the lake.

R. WADE NELSON
Thompson Falls, Montana

Interesting to read that glaciers formed during the most recent ice age started melting around 21,000 years ago. We must be naive to think we can stop them from melting.

JOE LANDINO
Columbia, North Carolina

When is the world going to play hardball with the butchers involved in the rhino horn trade?

Rhino Horn Trade

For anybody who has looked on the unmitigated failure of a legal trade in ivory to reduce elephant poaching, the prospect of permitting a similar trade in rhino horn can only inspire a sense of déjà vu. Rhinos teetered on the brink of extinction once in the past 30 years, but the current crisis has an added dimension—the involvement of organized

international criminal syndicates in countries that are neither range states nor major consumer markets, syndicates speculating on the demise of the rhino by stockpiling horn.

MARY RICE
Executive Director
Environmental Investigation Agency
London, England

Poaching is a disgusting and cruel practice, especially when what is being taken from the animals offers a hypothetical cure for hangover and fever.

MIRA PAUL
Pine, Colorado

When is the world going to play hardball with the butchers involved in the rhino horn trade? Solution number one: Put out a bulletin announcing that toxic rhino horns have been sold into the black market. Why would you buy a product that would make you violently ill? Solution number two: Develop a counterfeit rhino horn and saturate the market, making the stocks worthless.

BILL CODY
Camillus, New York

Marseille

As an ancient historian, I would like to make a correction about the city's past. Marseille was not founded by the Phoenicians but rather by their enemies the Greeks. The misinformation is due to the similar name of the Greek city-state of Phocaea that founded Marseille. In the sixth century B.C. the Phocaeans established the colony of Alalia in Corsica. Carthage, a

Phoenician city-state, felt threatened and considered this an intrusion. A combined fleet of Etruscans and Carthaginians attacked Alalia. A great sea battle ensued that ended in a draw. However, the Phocaeans suffered serious losses and withdrew to the south of France, where they founded Massilia (modern-day Marseille).

NICK ALEXANDER
Oak Park, Illinois

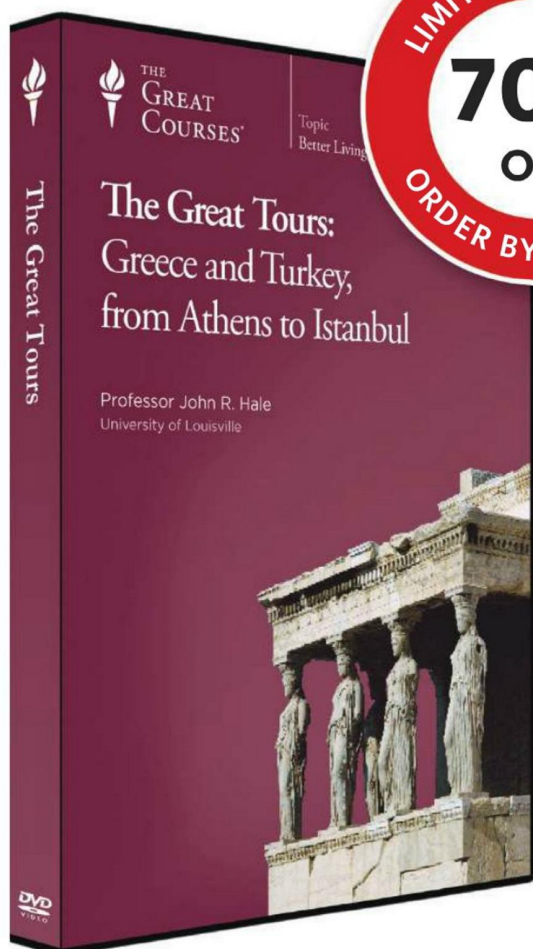
Many Marseillais, and others, believe the city was founded by Phoenicians, based on indications that they may have spent time in the area in the eighth and seventh centuries B.C. But we missed the opportunity to clarify that the current city was actually founded by Greek Phocaeans from Asia Minor in 600 B.C.

NEXT: Monument

Just who has the bigger obelisk, partner? You state the Washington Monument is the world's tallest freestanding stone structure. You shame Texas one-upmanship because, as any Lone Star type person knows, the San Jacinto Monument, located on the pristine Houston Ship Channel near the Bayou City, is faced with stone, has no external support, and is two good Texans taller (nearly 12 feet) than the Washington Monument.

ROBERT TAYLOR
Houston, Texas

While taller at roughly 570 feet, the San Jacinto Memorial Monument is not a freestanding stone structure: It has a poured concrete center faced in stone.



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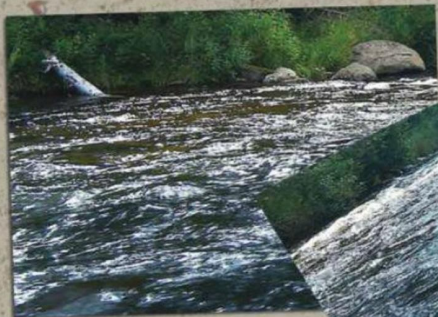
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Santa Fe, New Mexico-based photographer Ralph Lee Hopkins travels to the world's wild places with Lindblad Expeditions and National Geographic

RALPH LEE HOPKINS

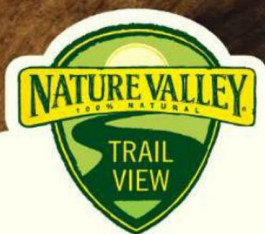
It was a family camping trip that first introduced me to our national parks, with the Grand Canyon having the biggest impact on me. Growing up on the East Coast I had never seen anything like it—a canyon so deep that I couldn't see the bottom. It was this childhood memory that inspired me to move west. A twist of fate landed me at Northern Arizona University, where I studied the rim rocks of the Grand Canyon for my master's degree.

Matkatamiba Canyon is one of the hidden gems and is particularly photogenic in the late afternoon when reflected light from the canyon walls illuminates the sinuous layers in the Muav Limestone. What I love most about photographing in our national parks, and the Grand Canyon in particular, is the sense of freedom and being in the moment that keeps bringing me back year after year.

MY VIEW Being in the Moment ^{IN} Grand Canyon National Park

This is Ralph Lee's view.
Find your own perfect national parks view at NatureValleyTrailView.com.

Photo: Ralph Lee Hopkins (main); Michael Melford (inset)



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VISIONS





United States

July means frolicking with goggles in a spray of firefighting foam in Lehi, Utah. The tradition, now in its fourth year, takes place this month to celebrate Pioneer Day, a state holiday honoring the 1847 arrival of Mormons in the Salt Lake Valley.

PHOTO: LANCE BOOTH, DAILY HERALD

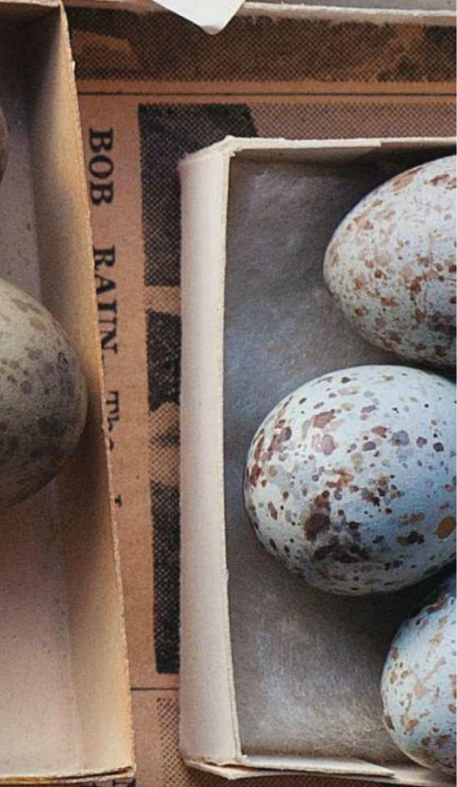
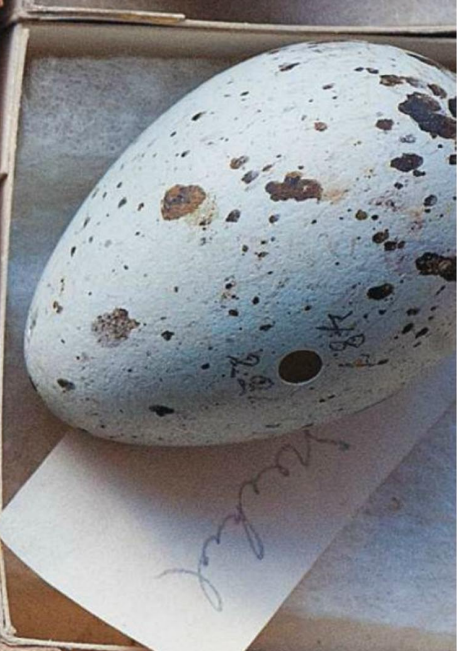


United States

Though more than a century old, these bird eggs retain a fresh palette at the University of Nebraska State Museum. The specimens, whose contents were emptied via shell holes, include a large one from a white-necked raven (far right) and five blue wood thrush eggs (far left).

PHOTO: JOEL SARTORE

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along the blocked off street pl
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BOB RAIN
NCY PORT
t of the 15





United Kingdom

On a snow-carpeted field in Essex County's Weald Country Park, a young fallow deer pauses to groom while foraging. Known as a pricket at this stage, he sports his first set of antlers—simple spikes of hard bone.

PHOTO: NICK ANSELL,
PRESS ASSOCIATION/AP IMAGES



EDITORS' CHOICE **Liz Andersen** Fredrikstad, Norway

As a child in the sixties, Andersen dreamed of being a fashion designer. "These Barbie dolls were my guinea pigs—I made clothes for them," she says. Today she's a post office manager, and her friends' kids enjoy playing with the dolls, dressed here in vintage clothing for a beach excursion.



READERS' CHOICE

Nathan Goshgarian
Boston, Massachusetts

While completing his master's degree in conservation biology in New Zealand, Goshgarian, 32, and a friend explored South Island in a camper van. At Milford Sound, "one of the most breathtaking places on Earth," he waited several hours for winds calm enough to shoot.



The Great Energy Challenge

GAME-CHANGING INNOVATION IN ENERGY

The future of energy is an issue that touches every person on the planet. What are the **break-throughs** and **new technologies** that will enter the energy mix? How will we drive change for **smarter mobility**? As we move to a population of nine billion by mid-century, how do we manage the **stress on the intersection of food, water, and energy**? Do rapidly **growing cities** offer a blueprint for energy efficiency?

To help address these questions and more, National Geographic, in partnership with Shell, launched **The Great Energy Challenge**. The site includes **news, quizzes, interactives, blogs, videos, photo galleries, and features about projects** supported by the Great Energy Challenge and its distinguished advisors. It's a one-stop resource where you can participate and be heard, and find authoritative briefings on game-changing innovations in energy worldwide. Get started now at **GreatEnergyChallenge.com**. ▶



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What is the Great Energy Challenge?
The Great Energy Challenge is a National Geographic initiative to help you understand our current energy situation. Explore the GEC to figure out and trim your carbon footprint.

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Quiz: What You Don't Know About Nature's Forces of Energy



Quiz: What You Don't Know About Carbon Capture



Quiz: What You Don't Know About Food and Energy

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Did You Know?

China's electricity generation in 2035 will be close to three times what it was in 2006. See where the world gets its power with this interactive map.

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- The 1 Percent's Electric Car: The \$980,000 Rimac Concept_One
- TUfast Eco: With Innovation to Victory
- Cherry-picking the Evidence in the Energy Jobs Debate
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TECHNOLOGY AND INNOVATION: REPORTING FROM AROUND THE WORLD

Written by experts and constantly updated, **Energy News** takes you around the world in pursuit of news about resources, renewables, and breakthrough practices. You'll read about global innovations—such as solar-powered irrigation that brings food, water, and light to African villages—that reflect the breadth of the current energy situation. **The Energy Blog** offers analysis, personal stories, and actionable information from scientists, think-tank leaders, and National Geographic editors and explorers.

SMARTER MOBILITY: PHOTO GALLERIES AND GLOBAL NEWS

As the economic situation improves for developing nations, so does the demand for cars—which accelerates the need for fuel. **Energy News** and **The Energy Blog** showcase super-computer simulations that will contribute to super-efficient combustion for car engines, reveal San Francisco's award-winning parking reform program, and even offer a sneak peek at the future: flying cars.

Photo Galleries provide a rich testimony to transportation innovation. From Bogota to Zurich, Fez to Tokyo, tour "Twelve Car-Free City Zones" that reduce carbon emissions and restore leisurely strolling. Check out "Nature Yields New Ideas for Energy and Efficiency," on how engineers draw inspiration from schools of fish, termite mounds, and the photosynthesis of leaves. Then ramp up on "The Road to 55 MPG," a look at the auto industry's efforts to improve fuel efficiency.



Go to **GREATENERGYCHALLENGE.COM**
to learn more about and contribute to the world's energy solutions.

TEST YOUR ENERGY KNOWLEDGE

Featuring amazing facts and energy-saving tips, **Energy Quizzes** cover subjects that affect us all, such as Food, Cars, Biofuels, and Cities. You find out which nation leads in ethanol production, how drivers can reduce fuel use, how cities like Seoul keep warm through urban planning, and the symbiotic relationship between energy and water.

Try your hand at this sample question from the **Food and Energy quiz** to get started.

Quiz: What You Don't Know About Food and Energy

Questions: 1 2 3 4 5 6 7 8 9 10



How much of world energy goes into producing and providing food?

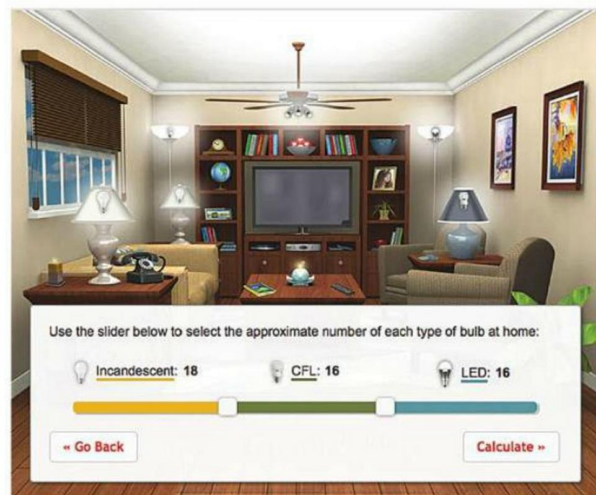
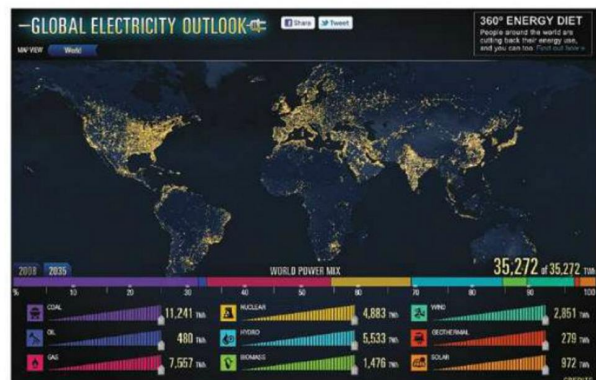
- A. 5 percent
- B. 15 percent
- C. 30 percent
- D. 40 percent

Submit Answer

ANSWER: C. According to the Food and Agriculture Organization of the United Nations, the food sector accounts for 30 percent of all global energy consumption and 22 percent of total greenhouse gas emissions.

CALCULATE YOUR ENERGY USE WITH INTERACTIVE FEATURES

The **Great Energy Challenge** provides consumers with an interactive way to measure and trim their carbon footprints with the **Personal Energy Meter**, and to see what fuels the world's electricity output with the **Global Electricity Mix**. The **Light Bulb Savings Calculator** brings it all home: simply input the number and type of bulbs you use in your home to see how you can save energy—and how you compare with the average U.S. household.



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THE GREAT ENERGY CHALLENGE
GRANTEE SPOTLIGHT
ECOLEÑA GUATEMALA



(from left to right clockwise)
Photo One: Teresa Imul Us—The future of EcoLeña.
Photo Two: EcoLeña producers learning about a bio-diesel powered molina/grinder.
Photo Three: Sacapulas EcoLeña producers preparing materials.
Photographs by Joyce Stanley.

The Legacy Project provides training, technology, and media services for biomass fuel briquette production, environmental conservation, and income generation throughout the world. With the support of the Great Energy Challenge, the group is combating deforestation in Guatemala by helping to substitute fuel wood and charcoal with hollow-core biomass briquettes (EcoLeña Guatemala). The project will establish a self-sustaining, income-generating network of briquette producers, trainers, and equipment suppliers in Guatemala.

Because of their technical simplicity and economic viability, fuel briquettes may outcompete the existing fuel wood supply, which directly or indirectly accounts for more than half of Guatemala's deforestation. The Legacy Foundation's important work will help ensure cleaner air within homes, improve the economic situation of participants, and protect forests in Guatemala and 45 other countries on our shared planet.

A MESSAGE FROM SHELL

Peter Voser, CEO, Royal Dutch Shell



"Energy is vital to our daily life. As the engine of our economy and growth, it powers our homes, factories, and cities and provides millions of people with jobs. As the global population rises, more people are moving out of poverty and gaining access to energy. All sources will be needed to meet growing needs in a sustainable way. Everyone has a part to play."



A NATIONAL GEOGRAPHIC INITIATIVE IN PARTNERSHIP WITH SHELL

A PANEL OF ADVISORS HELPS GUIDE THE GREAT ENERGY CHALLENGE by identifying and providing support for projects that focus on innovative energy solutions. The aim is to highlight local projects that have potential to expand to regional or global scale.

THOMAS E. LOVEJOY, Advisory Team Chair, is a conservation fellow at the National Geographic Society and chairman of the Energy Advisory Committee. He is known for his work on biodiversity, and his innovations include the concept of debt-for-nature swaps and the public television series *Nature*.

SALLY M. BENSON, a leading expert in low-carbon energy supply, directs the Global Climate and Energy Project at Stanford University. She is a research professor in the Department of Energy Resources Engineering in the School of Earth Sciences.

JOSÉ GOLDEMBERG, the former environment minister in Brazil, helped guide that country's effort to replace much of its oil consumption with sugarcane ethanol. He is a professor at the University of São Paulo.

DANIEL KAMMEN is the Class of 1935 Distinguished Professor of Energy and the founding director of the Renewable and Appropriate Energy Laboratory at the University of California, Berkeley. He is a Contributing Lead Author for the IPCC and in 2010-11 was the Inaugural Chief Technical Specialist for Renewable Energy and Energy Efficiency for the World Bank Group.

AMORY LOVINS cofounded and chairs Rocky Mountain Institute—an independent, entrepreneurial, nonprofit "think-and-do tank" that drives the efficient and restorative use of resources.

RAJENDRA K. PACHAURI chairs the Nobel Prize-winning Intergovernmental Panel on Climate Change. He is director-general of the Energy and Resources Institute (TERI), renowned for its work in energy, the environment, forestry, biotechnology, and conservation.

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SKYCAST

Overhead this month
in parts of the world

July 28-29



Delta Aquarid
meteor shower

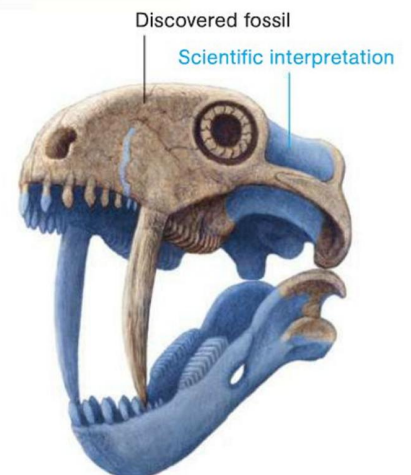
This short-snouted,
boar-size creature lived
roughly 265 million
years ago in what is
now Brazil.

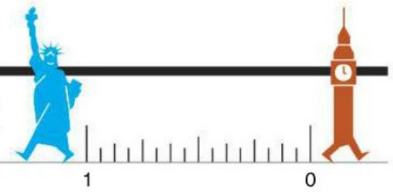


Sabertooth Vegetarian

My, what big teeth it had—the better to eat plants with. That's what Juan Carlos Cisneros of Brazil's Federal University of Piauí concluded last year after studying the partial skull and worn dentition of a fossil species “so bizarre it was like finding a unicorn.” Called *Tiarajudens eccentricus*, this therapsid—an extinct reptilian ancestor of mammals—efficiently chewed leaves and stems with interlocking horselike incisors and cowlike molars. Saber canines, like those of a modern musk deer, may have warded off predators and competitors.

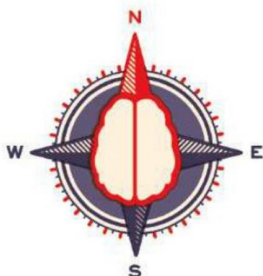
Jörg Fröbisch of Berlin's Natural History Museum says the mishmash mouth offers evolutionary insights into the late Paleozoic, when herbivores became ascendant. Cisneros is now analyzing the rest of the remains, to get more than a mouthful. —Jeremy Berlin





Stumble Stones Sidewalks in Germany and nine other European nations are getting a historical makeover. Some 34,000 brass-capped cobbles bearing the names and fates of Nazi victims have been installed outside buildings where they lived or worked. German artist Gunter Demnig devised the idea; individual donors pay for the mini-memorials. Most of the names are Jewish, but Demnig has dedicated stones to Jehovah’s Witnesses, political prisoners, and others. He calls them “stumble stones,” hoping pedestrians will “stumble with their head and heart.” Some municipalities stumble over the concept, arguing there are plenty of memorials and, besides, such reminders shouldn’t be underfoot. Supporters appear to outweigh critics; Demnig continues to install the stones. —Andrew Curry

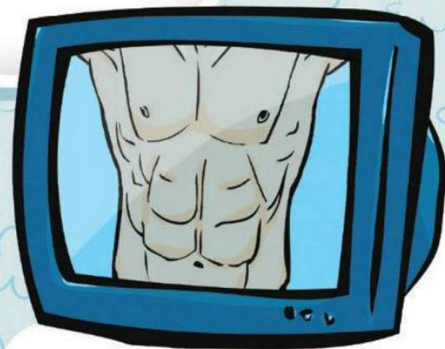
Hand-engraved cobbles, here in Berlin, bring the names of Nazi victims “back to the houses where they lived,” says the artist who installs them.



WHICH WAY TO...? It’s a common question. A visitor asks where such and such is, and the local pauses, thinks, points. Familiar sites may seem to be the reference base for giving a person directions, but a new study suggests orientation plays a key role.

In Tübingen, Germany, researchers used a virtual model of the town to test the spatial knowledge of its residents. When asked to locate a place outside their line of vision, participants fared best if facing north. Their “mental maps,” says psychologist Julia Frankenstein, seemed to mirror the layout of actual city maps and weren’t rooted entirely in navigational memory. Not yet tested is her theory that the brain has a map of emotional landmarks too—like the site of someone’s wedding. —Catherine Zuckerman

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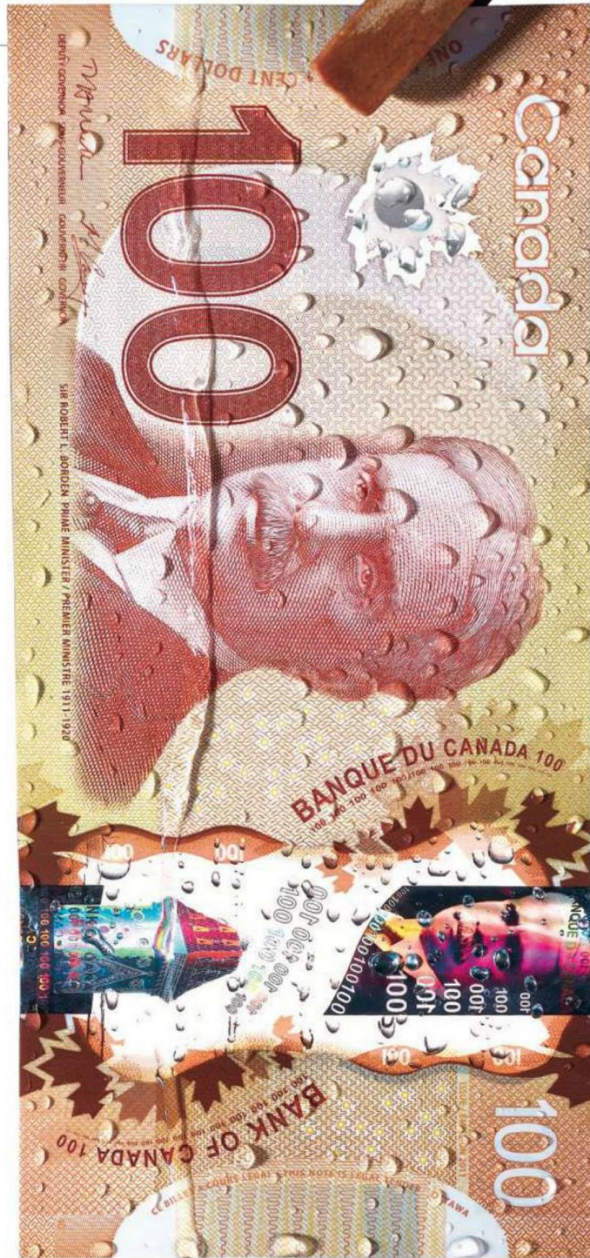
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Paying With Plastic

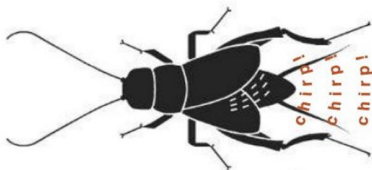
No longer is it cash or plastic in Canada. By late next year all freshly printed bills will be slick polymer notes packed with anticounterfeiting features. New \$100 and \$50 bills have already entered the currency stream, following a five-year design process and a bevy of wear-and-tear tests. Though more costly to produce, the plastic notes last at least 2.5 times as long as paper ones.

Security innovations include a wide see-through stripe with color-shifting holograms (right) and a maple leaf with numbers visible only under certain lighting. Security was the redesign's main driver, says Bank of Canada's currency chief, Gerry Gaetz. Counterfeiting cost Canadians nearly \$13 million at its peak, in 2004. The country joins a handful of others in converting fully to polymer banknotes, pioneered by Australia in 1988. —Luna Shyr



Is It Hot? Ask a Cricket.

In 1897 physicist Amos Dolbear posited a link between temperature and how often crickets chirp, which speeds up in heat because they're cold-blooded—Dolbear's law.



A simplified version of Dolbear's equation: Count the number of times a field cricket chirps in 15 seconds.

Dolbear likely studied snowy tree crickets, but most field crickets work for rough estimations.

Add 40 to the chirp total to arrive at the approximate temperature in degrees Fahrenheit.

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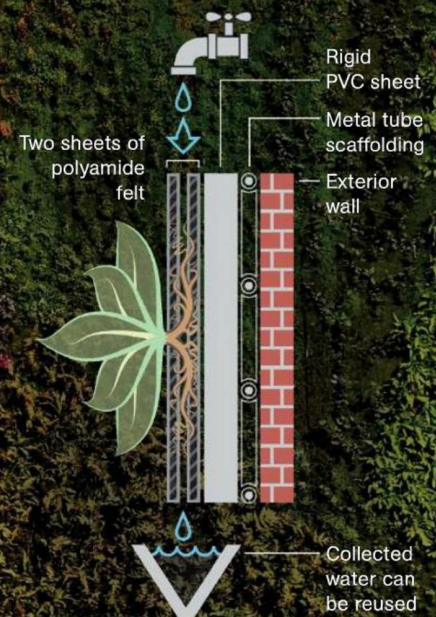
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Vertical Gardens

From Paris to Bangkok, Sydney to Seoul, green is growing up. Over the past decade, lush living walls—like this one next to a Madrid cultural center—have been planted wherever space is scant, beauty is absent, or air quality is poor.

French botanist Patrick Blanc's soil-free, auto-irrigated model (below) has been a blueprint for many public and private projects. But variety is in bloom. U.K. firm Biotecture builds modular systems with water-saving mineral wool, not felt. Walls by U.S.-based Green Living Technologies yield leafy greens and crops like carrots. And compost is at the root of many DIY setups.

Thousands of plants can grow vertically—making green walls a natural city solution in a crowded 21st century. —Jeremy Berlin



Inspire Future Generations



Grace Cleere included National Geographic in her estate plans.

A communications expert for the government, Grace Cleere recently named National Geographic as a beneficiary in her will. “I included a bequest intention to National Geographic because I believe in everything the organization represents,” says Cleere. “If we don’t understand our world, we are bound to mistreat it. And if we are not curious about all living things on our planet, we are bound to lose them through thoughtlessness and indifference. National Geographic shines a spotlight on the critical issues of the day and proposes innovative solutions that are grounded in science. I feel good about my legacy knowing that National Geographic will leverage my gift so it can have the greatest impact.”

It is easy to include National Geographic in your will. For more information about how to include National Geographic in your estate plans, or to let us know that you have already done so, please contact the Office of Estate Planning.

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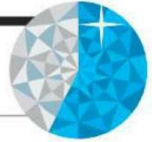
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Wonder Wasp

A small number of species, including humans, primates, and some wasps, have a special skill for learning faces.



About Face

We know that paper wasps can deliver many mighty stings. Now research shows that one type, *Polistes fuscatus*, can also distinguish among wasps' faces, indicating it has brains in addition to brawn.

When charged with choosing between pictures of two different wasps, the insects identified the image linked to a reward 74 percent of the time, says biologist Michael Sheehan. When pictures of caterpillars—their prey—were swapped in, the success rate plummeted to 53 percent.

Sheehan tweaked the wasp photos (such as bottom row, center) and retested. This time the bugs flopped. The upshot? If facial features are intact, these social creatures can spot a face in the crowd.

—Catherine Zuckerman



ANCIENT ANGLERS Deep-sea dinners have been on our menus since the Stone Age. That's what Sue O'Connor of the Australian National University learned when Timor-Leste's Jerimalai shelter—home to Pleistocene-epoch humans—yielded 42,000-year-old bones from tuna and other species. The site also surrendered the world's oldest fishhook (left). As many as 23,000 years ago, it was fashioned from a sharpened snail shell, likely strung with bait, and used to snare reef fish. O'Connor says the bones and hook show "that early modern humans had advanced maritime skills," helping them reach Australia some 50,000 years ago. —Jeremy Berlin

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Forget sleek and subtle, the Stauer Colossus Hybrid is one tough timepiece...now for less than \$50!

Never underestimate your competition. Just ask Demetrius, the unfortunate Greek general who set out to conquer Rhodes in 305 BC. He assumed that a massive force of 40,000 men, a fleet of Aegean pirates and an arsenal of wall-smashing war machines would be enough to crush the tiny Greek island. He was wrong. The Rhodians were tougher than he thought. And so is this watch. If you've always believed that the biggest, baddest watches had to cost big, bad money, the \$49 Stauer *Colossus Hybrid Chronograph* is here to change your mind.

A monument to toughness. The people of Rhodes were ready for Demetrius and repelled his attack. To celebrate, they built the Colossus of Rhodes, a 107-foot bronze and iron giant that towered over the harbor like a ten-story trophy. It warned future invaders that "Rhodes is tougher than you think." You give the same message when you wear the Stauer *Colossus*.

The timepiece that works twice as hard. In designing the *Colossus Hybrid Chronograph*, our instructions to the watchmaker were clear: build it as tough as a battleship and fill it full of surprises. Make it a hybrid, because it should work twice as hard as a regular watch. And make it look like a million bucks, because when you put it on, you should get excited about rolling up your sleeves. Mission accomplished.

A toolbox on your wrist. It will keep you on schedule, but the *Colossus Hybrid* is about much more than time. The imposing case features a rotating gunmetal bezel that frames the silver, black and yellow face. You'll find a battalion of digital displays on the dial arranged behind a pair of luminescent hands and a bold yellow second hand.

Powered by a precise quartz movement, the watch is doubly accurate in analog and digital mode. And it's packed with plenty of handy extras including a bright green EL back-light for enhanced nighttime visibility, a tachymeter along the outer dial and a full complement of alarms and split-second countdown timers. The *Colossus Hybrid* secures with a folded steel bracelet that highlights a row of striking dark center links. It's a rugged watch that's more than ready for your daily grind.

Your Satisfaction is Guaranteed. Wear the Stauer *Colossus Hybrid* for 30 days and if you are not 100% thrilled with your purchase, return it for a full refund of your purchase price. But once you get a taste of more watch for less money, it's likely you'll be back for more... and we'll be waiting.

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Coffin Coiffures In ancient Egypt styled tresses were complex expressions of identity. Male and female, young and old, noble and peasant chose among curls, waves, twists, braids, extensions, wigs, razor cuts, and dye jobs according to their position in society, religious canons, and personal preference. These indicators of style and status were equally important in the afterlife, and the hair of the dead was arranged with just as much care. A recent study of 18 mummies at the University of Manchester revealed that most had hair coated with a fatty substance—perhaps applied after mummification, like modern styling gel, to prepare a postmortem hairdo. Further testing promises to reveal the makeup of this mysterious product with permanent holding power. —A. R. Williams



The Diving Bell Spider

It looks like your average air bubble, but this glimmering globule (above) is held underwater by a silk web to sustain the life of the spider *Argyroneta aquatica*. New research from Berlin's Humboldt University shows the Eurasian species can live in resting mode for at least a day using oxygen that passes from the water into the bubble—similar to the way a gill works. Air connects with openings on the spider's body that take up vital oxygen. When the “diving bell” shrinks, the spider surfaces and replenishes it with fresh air. Babies even hatch underwater, inside the bell. So why live the life aquatic at all? The better to dine on small fish and other animals in slow-moving waters. —Luna Shyr



Lady Rai went to her grave with elaborate braids in the 16th century B.C. Half were unwrapped during research in 1909.

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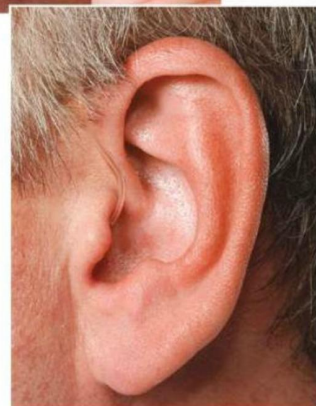
New Personal Sound Amplification Product is an affordable alternative

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™.

"Reading glasses for your ears"

Perfect Choice HD is NOT a hearing aid. Hearing aids can only be sold by an audiologist. In order to get a hearing aid, you had to go to the doctor's office for a battery of tests and numerous fitting appointments. Once they had you tested and fitted, you would have to pay as much as \$5000 for the product. Now, thanks to the

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Intelligent Setting Memory	YES	Few
Tests and Fittings Required	NO	Yes
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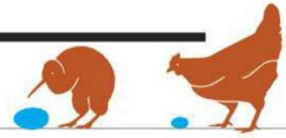
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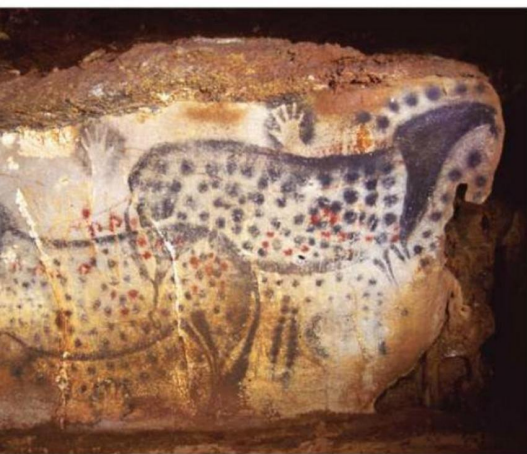
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A white rump marked by patches of pigment, known as leopard spotting, is a hallmark of the Appaloosa horse breed.



Ancient Appaloosas Cave artists aren't known for their precision—archaeologists have debated whether prehistoric paintings were mostly symbolic or accurate reflections of animals. The creatures that grace the walls of Pech Merle cave (left) in France date back to 23,000 B.C. Horses? Definitely; predomestic equines had been roaming Europe for millennia by then. But spotted horses? New research says yes. Though dappled coats were thought to exist only in a few modern breeds, the genotype showed up frequently in DNA analysis of horse bones from western Europe's Pleistocene epoch. This means early humans “made very correct observations of their environment,” says study co-author Arne Ludwig of Berlin's Leibniz Institute for Zoo and Wildlife Research. In other words, those prehistoric artists were spot-on. —Amanda Fiegl

ET CETERA

University of Chicago research shows that **RATS HAVE EMPATHY** and value freeing trapped fellow rats on par with eating chocolate. ▪ A South African excavation found a **77,000-YEAR-OLD LEAF MATTRESS**, likely used by multiple family members. ▪ New evidence from NASA's WISE telescope may exonerate **ASTEROID FAMILY BAPTISTINA**, charged with killing off the dinosaurs 65 million years ago. ▪ Biologists have identified **12 NEW FROG SPECIES**, plus rediscovered three not seen in 75 years, in western India.



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Experts warn that millions of rings may be "romantically defective" when compared to the spectacular 4-Carat DiamondAura® Avalon

She loves natural diamonds. She loves you even more. But when even the skimpiest solitaires sell for as much as \$1,200, it's time to reconsider your relationship...with diamonds. Have you recently overpaid only to be underwhelmed? Send it back. You can do bolder. You can do brighter. You can own the Stauer 4-Carat DiamondAura® Avalon Ring for under \$100.

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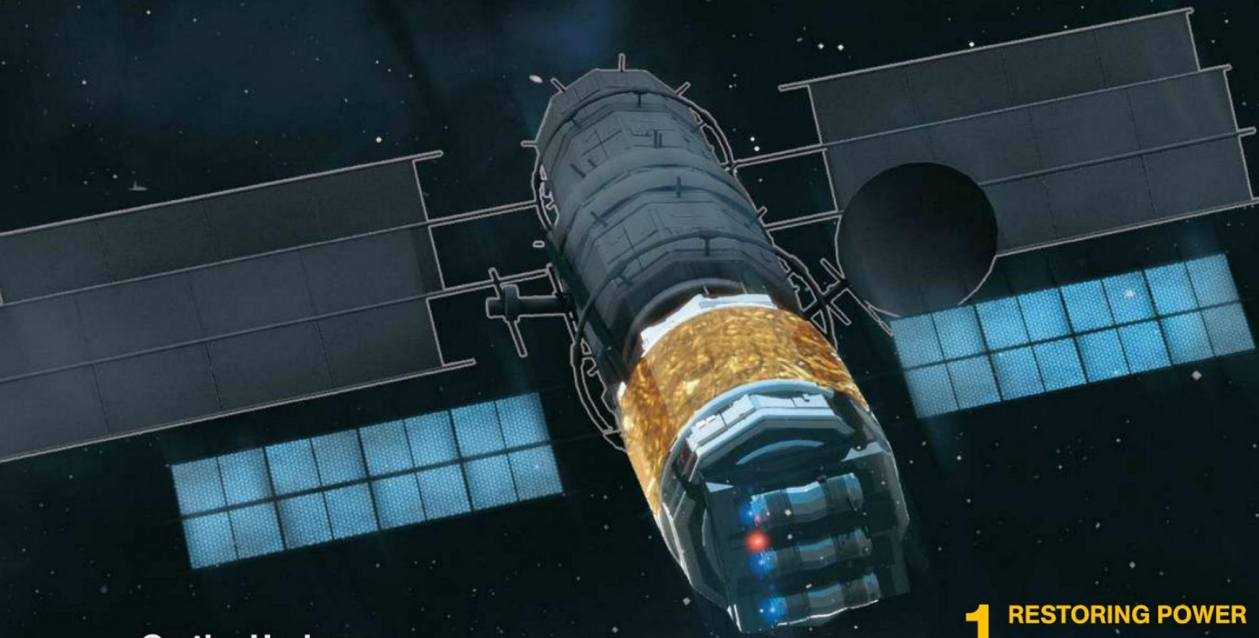
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NEXT

Giving old satellites new life tackles costs and space clutter.



On the Horizon

Here's a look at three of the most promising approaches to extending the utility of aging satellites.


1 RESTORING POWER

Like a portable engine, a "mission extension vehicle" attaches itself to an old satellite to provide a new source of propulsion. The fuel in such vehicles could propel a satellite for years.

RECYCLING SATELLITES | On board the International Space Station a robotic arm is demonstrating how aging satellites could become young again. In March "Dextre" began twisting and prodding mock equipment on NASA's Robotic Refueling Mission—an early step toward developing a vehicle with similar arms that could one day refuel and repair satellites in space.

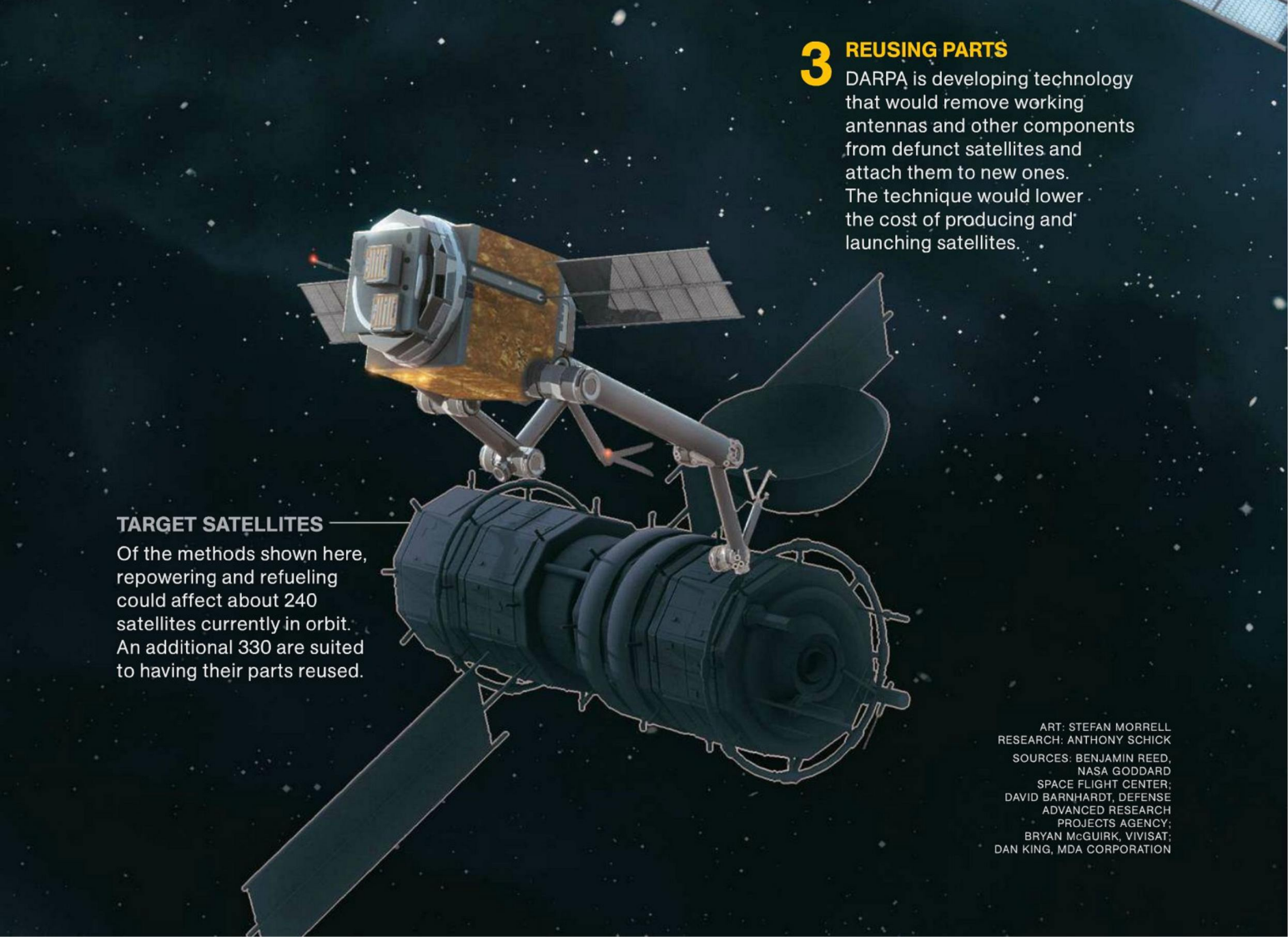
Hundreds of satellites sit in geosynchronous orbit today. When their fuel runs low, they'll boost themselves above the traffic and become space junk. NASA's Benjamin Reed, who notes there's no way to service satellites now, envisions

a vehicle that travels among working ones to provide fuel, basic repairs, or transport to another orbit. DARPA and private companies are working on vehicles of their own. Some would have to hack into fuel tanks and hardware that weren't meant to be accessed once launched. Such robotic repair technology could also aid in future manned space missions. Reed says the greatest challenge, though, is pulling up to and grasping a fast-moving satellite. "Every single satellite in space, when it runs out of fuel, is disposed of," he says. "We're trying to break that paradigm." —Elizabeth Preston



2 REFUELING

Many satellites go out of service simply because they run out of fuel and weren't designed to be refueled. A vehicle acting as a roving service station would cut into the satellite and remove safety caps to connect a fueling hose.



3 REUSING PARTS

DARPA is developing technology that would remove working antennas and other components from defunct satellites and attach them to new ones. The technique would lower the cost of producing and launching satellites.

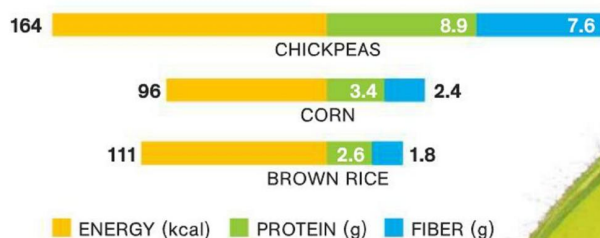
TARGET SATELLITES

Of the methods shown here, repowering and refueling could affect about 240 satellites currently in orbit. An additional 330 are suited to having their parts reused.

ART: STEFAN MORRELL
RESEARCH: ANTHONY SCHICK
SOURCES: BENJAMIN REED,
NASA GODDARD
SPACE FLIGHT CENTER;
DAVID BARNHARDT, DEFENSE
ADVANCED RESEARCH
PROJECTS AGENCY;
BRYAN MCGUIRK, VIVISAT;
DAN KING, MDA CORPORATION

Packing a Punch Protein-rich chickpeas are grown in more than 50 countries from the Mediterranean to South Asia, so improved varieties could make a big contribution to future food needs. The legumes also enrich soil with nitrogen, so farmers can use less fertilizer. New chickpea varieties developed to grow in harsher conditions and fight off blight have made it possible for farmers in Africa and Asia to double their yields. —Nancy Shute

Nutritional value, 100 grams (g), cooked



POWER PODS

Chickpeas provide more than two times as much protein as corn and more than four times as much fiber as brown rice.



BUG PROTEIN

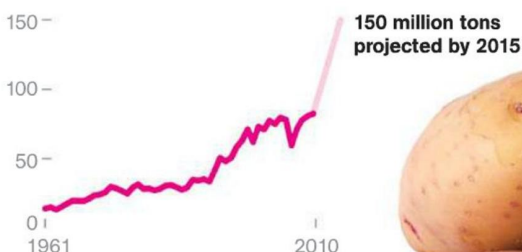
They're nutritious, plentiful, and often crunchy. Grasshoppers, rhino beetles, and termites are just some of the more than one thousand species of insects eaten around the world. Most are foraged. But as food prices rise, bug farming may become a growth industry.



THE HUMBLE SPUD

The world's top potato producer, China is pushing to develop disease-free seed potatoes and new varieties tailored to diverse climates as its population grows.

Potato production in China, millions of tons



PHOTOS: KIRIAKO IATRIDIS (TOP); DAVID LIITTSCHWAGER (LEFT); ERIC GREGORY POWELL. GRAPHICS: JASON TREAT, NGM STAFF SOURCES: USDA; FAOSTAT; INTERNATIONAL POTATO CENTER



Still thinking small.

Fifty years ago, when we first told the world to Think Small, it was about how a little car could have a huge impact. Since then, we've expanded that small thinking beyond the car to everything we do: from efficient-but-powerful* engines to the first LEED® Platinum-certified automotive plant. Because today, having a big impact means making a small one. It's called thinking blue and it means thinking beyond green. **That's the Power of German Engineering.**

Think Blue.®



Das Auto.



Cursive

Cursive

Cursive

Cursive

Disappearing Act

The quill, fragile and prone to splattering, had limitations. Cursive's continuous paper contact solved the problem for U.S. first graders until the 1900s, when block print supplanted it. So began a slow shift as cursive classes slid to the third grade. By the mid-2000s, 88 percent of elementary teachers felt undertrained to teach cursive, and a 2010 survey showed 85 percent of collegians printed when they wrote.

As of the start of 2012, 45 states had adopted the Common Core State Standards for education, which include instruction in typing and use of digital tools for writing but leave out cursive altogether—"the start of the end," according to handwriting historian Steve Graham. A lost art, then? Not just cursive but all writing may be at risk. Pen and quill are fairly equivalent in modern classrooms, says Graham: "19th-century tools in a 21st-century writing world." —*Johnna Rizzo*

Feel Like You're Defying Gravity

This is my story

I used to be more active. I used to run, play basketball, tennis; football... I



was more than a weekend warrior. I woke up every day filled with life! But now, in my late 30's, I spend most of my day in the office or sacked out in front of the TV. My energy has fizzled and I'm embarrassed to admit that I've grown a spare tire (I'm sure it's hurting my love life). Nowadays I rarely walk. For some reason it's just harder now. Gravity has done a job on me.

Wear them and you'll know

But that's when a friend told me about a new kind of shoe. A shoe biomechanically engineered to make standing and walking on hard surfaces like concrete, tile and linoleum easy. They defy the force of gravity by absorbing harmful impact and propel you forward maximizing energy return. The longer he talked, the more sense it made. He was even wearing a pair himself!

Excitement swept through my body

I received my package from GravityDefyer.com and rushed to tear it open like a kid at Christmas. Inside I found the most amazing shoes I had ever seen – different than most athletic shoes. Sturdy construction. Cool colors. Nice lines... I was holding a miracle of technology. This was the real thing.

GDefy Benefits

- Absorbs Harmful Shock
- Have Instant Comfort
- Improve Energy Return
- Appear Taller
- Cools Feet
- Reduces Foot Odor
- Customize Your Fit
Accommodate most orthotics

Energy—
without the can!

I put them on and all I could say was, "WOW!" In minutes I was out the door. I was invincible; tireless in my new Gravity

Customer Satisfaction Speaks for Itself!
4 out of 5 customers purchase a 2nd pair within 3 months.

Defyer shoes. Years of feeling exhaustion seemed to slip away. It was as if my legs had been replaced with super-powered bionics. At last, I was back in the game. Gravity has no power over me!

Nothing to lose: Start your 30 Day Trial Today!

So, my friend, get back on your feet like I did. Try Gravity Defyer for yourself and live better, one step at a time.



ABSORB SHOCK
For ultimate comfort.



REBOUND PROPELS YOU FORWARD
Maximize energy return.

Semi-Rigid Heel Stabilizing Cage

Removable Comfort-Fit™ Insole Accommodates most orthotics

VersoShock™ Trampoline Shock-Absorbing Membrane Heel

Smart Memory™ Master Spring Propels you forward

Twin Stabilizers

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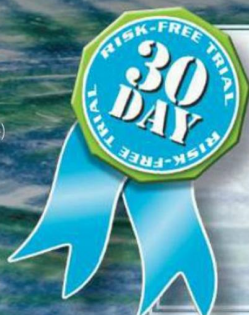
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The Beauty in the Beast

For almost a hundred years it lay dormant. Silently building strength. At 10,000 feet high, it was truly a sleeping giant, a vision of peaceful power. Until everything changed in one cataclysmic moment. On May 18, 1980, the once-slumbering beast awoke with violent force and revealed its greatest secret.

It was one of nature's most impressive displays of power. Mount St. Helens erupted, sending a column of ash and smoke 80,000 feet into the atmosphere. From that chaos, something beautiful emerged... our spectacular *Helenite Necklace*. Produced from the heated volcanic rock dust of Mount St. Helens, this brilliant green creation has captured the attention of jewelry designers worldwide. Today you can wear this 6½-carat stunner for the exclusive price of only \$129!

Your satisfaction is guaranteed. Our *Helenite Necklace* puts the gorgeous green stone center stage, with a faceted pear-cut set in gold-layered .925 sterling silver. The explosive origins of the stone are echoed in the flashes of light that radiate as the piece swings gracefully from its 18" gold-plated sterling silver chain. Today the volcano sits quiet, but this unique piece of natural history continues to erupt with gorgeous green fire.



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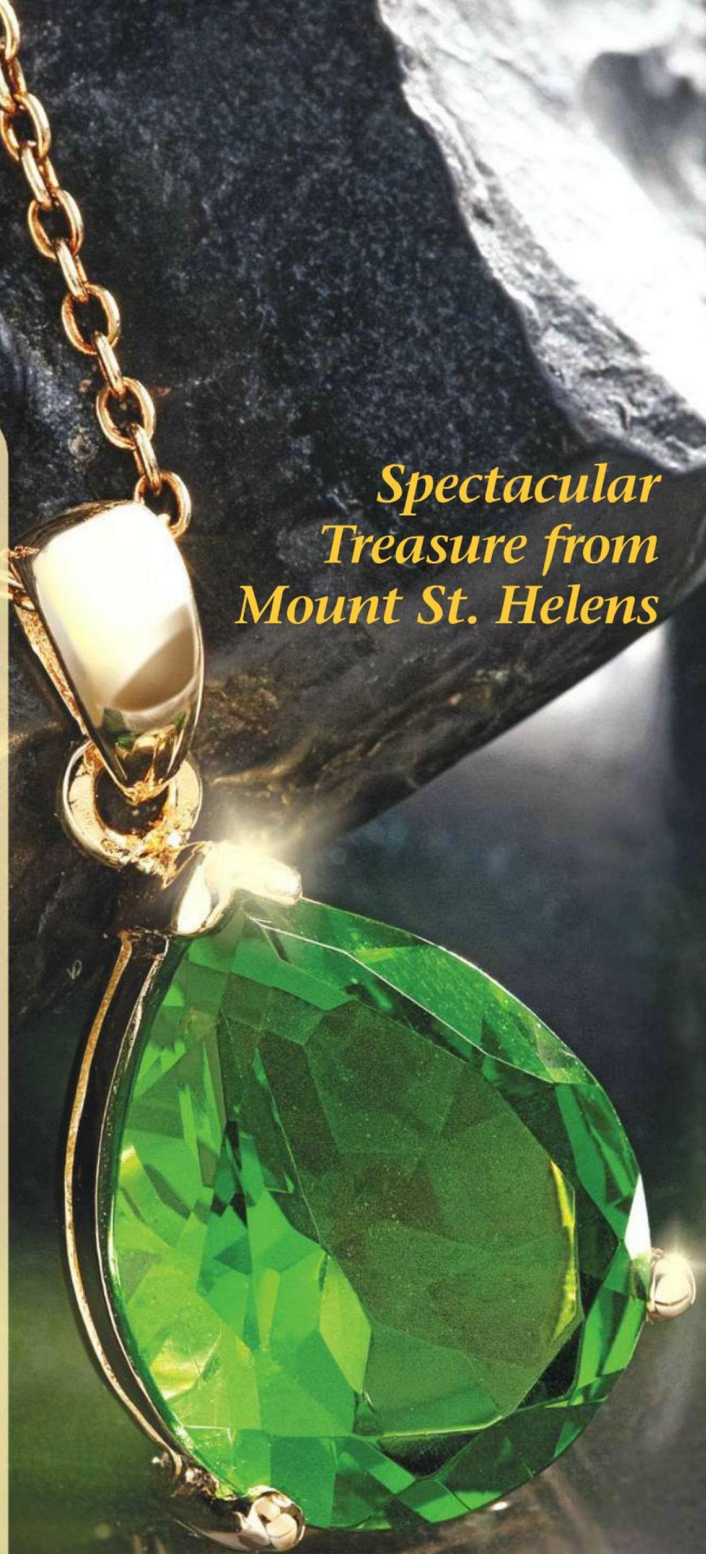
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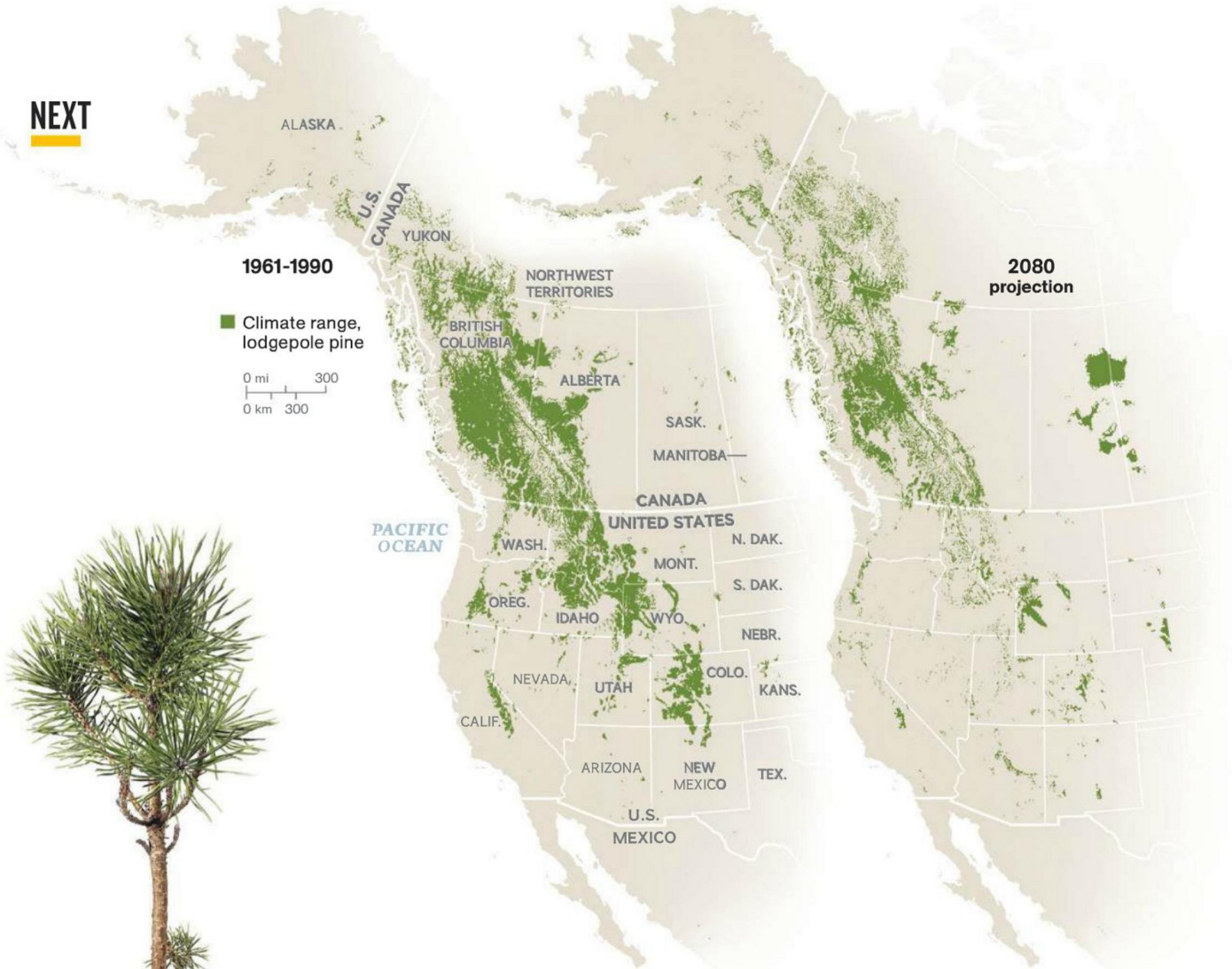
— James Fent
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Smart Luxuries—Surprising Prices



Maps showing historical and projected areas where climate suits certain trees help foresters pick species for assisted-migration planning. British Columbia is evaluating 15 kinds, including lodgepole pine (above).

Future Forests

If global temperatures rise, can forests still flourish in their current ranges? Some scientists think not, so British Columbia—with assistance from the U.S. Forest Service—is now testing the climate tolerance of 15 common and commercially valuable tree species in non-native habitats. The aim: to identify ones that can be moved into areas expected to be more hospitable in the future.

Called assisted migration, the controversial approach presumes “evolution can’t keep up with the rate of climate change, so it needs some help,” says project head Greg O’Neill. Detractors of the increasingly studied forestry practice cite the risks of altering ecosystems.

British Columbia has already extended the legal range in which timber companies can plant western larch seedlings. Other species, including Douglas fir and lodgepole pine, are being tested at sites spanning 1,700 miles, from Canada’s Yukon to California. These will be monitored for 30 years to evaluate their survival. “One day we could rely on Washington’s seed, Washington on Oregon’s, and so on,” says O’Neill. “It’s a problem that knows no geographic boundaries.” —Luna Shyr

ET CETERA

The Hubble Space Telescope revealed a **NEW TYPE OF PLANET** made largely of water, with a thick, steamy atmosphere.
 ■ A **SPIDERWEB’S ABILITY** to withstand high stress is due partly to a design that allows a single filament to break away and leave the rest intact, say MIT scientists.
 ■ A Russian team has reached the surface of a **MASSIVE SUBGLACIAL LAKE** in Antarctica after some three decades of drilling.
 ■ A NASA-led study found that the **EARTH SPUN FASTER** during two weeks in 2009 due to a slowing ocean current.



If They Could Only Talk

“The statues walked,” Easter Islanders say. Archaeologists are still trying to figure out how—and whether their story is a cautionary tale of environmental disaster or a celebration of human ingenuity.

BY HANNAH BLOCH

PHOTOGRAPHS BY RANDY OLSON



The ancient statues known as *moai* are everyday sights on Easter Island, or Rapa Nui—native dancers in body paint, less so. Some 2,000 Rapanui live on the island, which belongs to Chile. They numbered only 111 in 1877, after slave traders and disease had decimated the population.



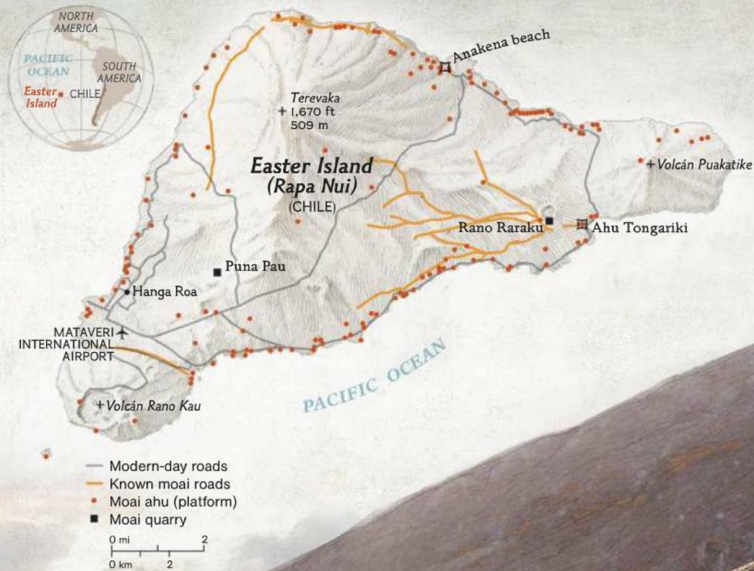




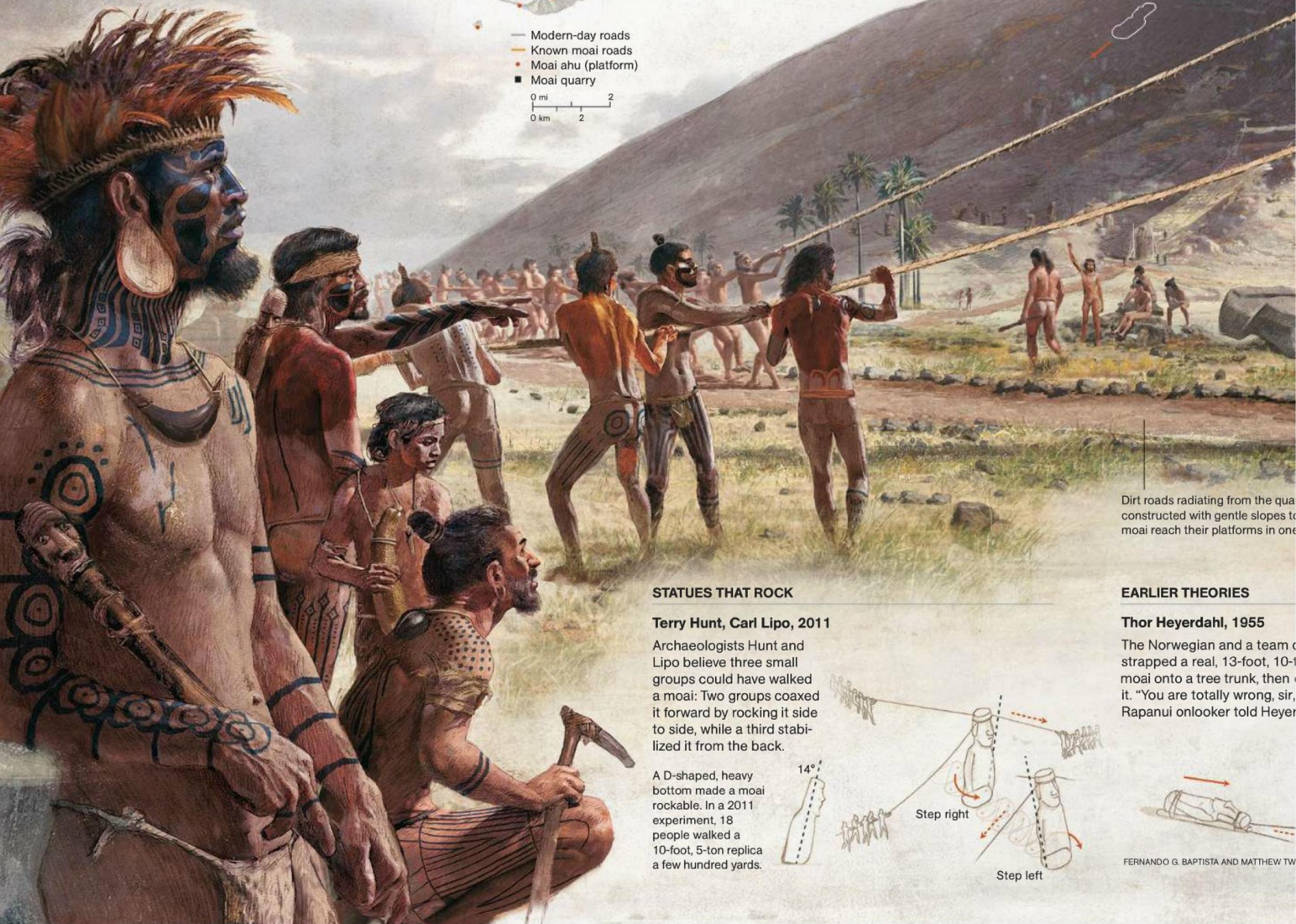
Their backs to the Pacific, 15 restored moai stand watch at Ahu Tongariki, the largest of Easter Island's ceremonial stone platforms. Rapanui artisans carved the moai centuries ago from volcanic rock at a quarry a mile away. By the 19th century all of Easter's moai had been toppled—by whom or what is unclear. In 1960 these moai were swept inland by a tsunami, which fractured some (left).

How Did They Move?

It's one of Easter Island's persistent mysteries: How were hundreds of giant statues transported across the island centuries ago, over distances as long as 11 miles, by people who lacked draft animals and wheels? The scene imagined here with a 21-foot-tall moai illustrates a new theory. It takes its cues from Rapanui oral tradition, which says the moai "walked."



At Rano Raraku, the main quarry, the moai was carved out of sloping rock until only a slender "keel" remained. The last step was to sever the keel and lower the moai downhill with a trench to await transport.



Dirt roads radiating from the quarry were constructed with gentle slopes to help the moai reach their platforms in one piece.

STATUES THAT ROCK

Terry Hunt, Carl Lipo, 2011

Archaeologists Hunt and Lipo believe three small groups could have walked a moai: Two groups coaxed it forward by rocking it side to side, while a third stabilized it from the back.

A D-shaped, heavy bottom made a moai rockable. In a 2011 experiment, 18 people walked a 10-foot, 5-ton replica a few hundred yards.



EARLIER THEORIES

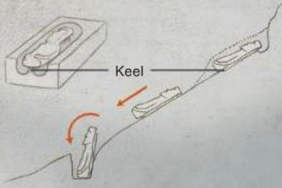
Thor Heyerdahl, 1955

The Norwegian and a team of men rolled a real, 13-foot, 10-ton moai onto a tree trunk, then rolled it down a hill. "You are totally wrong, sir," a Rapanui onlooker told Heyerdahl.



FERNANDO G. BAPTISTA AND MATTHEW TWOMEY

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White coral eyes with pupils of obsidian or red scoria were inserted after a moai reached its platform. They brought the stone face to life.



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William Mulloy, 1970

Using a desktop model, this U.S. archaeologist speculated that a moai might be swung forward in steps while hanging by the neck from an inverted wooden V.



OMBLBY, NGM STAFF; PATRICIA HEALY, DEBBIE GIBBONS, NG MAPS

Pavel Pavel, 1986

Czech engineer Pavel, Heyerdahl, and 17 helpers walked a 13-foot, 9-ton moai—another real one—with a twisting rather than a rocking motion. They damaged the base.



SOURCES: TERRY L. HUNT, UNIVERSITY OF HAWAII; CARL LIPO, CALIFORNIA STATE UNIVERSITY LONG BEACH; HELENE MARTINSSON-WALLIN, GOTLAND UNIVERSITY; FRANCISCO TORRES HOCHSTETTER, RAPA NUI MUSEUM

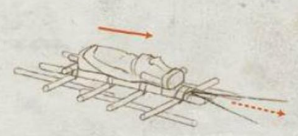
Charles Love, 1987

U.S. archaeologist Love and his team of 25 stood a 13-foot, 9-ton replica on a wood sledge and hauled it over rollers. In two minutes, they moved it 148 feet.



Jo Anne Van Tilburg, 1998

Laying a 13-foot, 10-ton replica on a wood sledge, 40 volunteers pulled it 230 feet on a wood "ladder"—a Polynesian way of moving giant canoes.



JO ANNE VAN TILBURG, EASTER ISLAND STATUE PROJECT

On a winter night last June,

José Antonio Tuki, a 30-year-old artist on Easter Island, did one of the things he loves best: He left his one-room home on the southwest coast and hiked north across the island to Anakena beach. Legend has it the earliest Polynesian settlers hauled their canoes ashore at Anakena a thousand years ago or so, after navigating more than a thousand miles of open Pacific. Under the same moon and stars Tuki sat on the sand and gazed directly before him at the colossal human statues—the *moai*. Carved centuries ago from volcanic tuff, they're believed to embody the deified spirits of ancestors.

Sleepless roosters crowded; stray dogs barked. A frigid wind gusted in from Antarctica, making Tuki shiver. He's a Rapanui, an indigenous Polynesian resident of Rapa Nui, as the locals call Easter Island; his own ancestors probably helped carve some of the hundreds of statues that stud the island's grassy hills and jagged coasts. At Anakena seven potbellied moai stand at attention on a 52-foot-long stone platform—backs to the Pacific, arms at their sides, heads capped with tall *pukao* of red scoria, another volcanic rock. They watch over this remote island from a remote age, but when Tuki stares at their faces, he feels a surge of connection. "It's something strange and energetic," he says. "This is something produced from my culture. It's Rapanui." He shakes his head. "How did they do it?"

Easter Island covers just 63 square miles. It lies 2,150 miles west of South America and 1,300 miles east of Pitcairn, its nearest inhabited neighbor. After it was settled, it remained isolated for

Hannah Bloch was a Pakistan correspondent for Time before joining the Geographic as an editor. Randy Olson has shot 27 features, including ones on war-torn Sudan and Congo's Mbuti Pygmies.



The one-room house that José Antonio Tuki built on Easter Island for himself and his Belgian girlfriend, Joyce Verbaenen, has electricity but no indoor plumbing. The ocean is only steps away.



centuries. All the energy and resources that went into the moai—which range in height from four to 33 feet and in weight to more than 80 tons—came from the island itself. Yet when Dutch explorers landed on Easter Sunday in 1722, they met a Stone Age culture. The moai were carved with stone tools, mostly in a single quarry, then transported without draft animals or wheels to massive stone platforms, or *ahu*, up to 11 miles away. Tuki's question—how did they do it?—has vexed legions of visitors in the past half century.

But lately the moai have been drawn into a larger debate, one that opposes two distinct visions of Easter Island's past—and of humanity

in general. The first, eloquently expounded by Pulitzer Prize winner Jared Diamond, presents the island as a cautionary parable: the most extreme case of a society wantonly destroying itself by wrecking its environment. Can the whole planet, Diamond asks, avoid the same fate? In the other view, the ancient Rapanui are uplifting emblems of human resilience and ingenuity—one example being their ability to walk giant statues upright across miles of uneven terrain.

WHEN THE POLYNESIAN SETTLERS arrived at Rapa Nui, they had been at sea for weeks in open canoes. There were probably only a few dozen



of them. Nowadays 12 flights arrive every week from Chile, Peru, and Tahiti, and in 2011 those planes delivered 50,000 tourists, ten times the island's population. Just three decades ago, cars, electricity, and phone service were scarce; now Hanga Roa, the only town, buzzes with Internet cafés, bars, and dance clubs, and cars and pickup trucks clog the streets on Saturday nights. Wealthy tourists drop a thousand dollars a night at the poshest of scores of hotels. A Birkenstock shop caters to footsore rambblers. "The island is not an island anymore," says Kara Pate, 40, a Rapanui sculptor. She's married to a German she met here 23 years ago.

Chile annexed Easter Island in 1888, but until 1953 it allowed a Scottish company to manage the island as a giant sheep ranch. The sheep ranged freely, while the Rapanui were penned into Hanga Roa. In 1964 they revolted, later obtaining Chilean citizenship and the right to elect their own mayor.

Ambivalence toward *el conti* (the continent) runs high. Easter Islanders depend on Chile for fuel and daily air shipments of food. They speak Spanish and go to the mainland for higher education. Meanwhile, Chilean migrants, lured in part by the island's income tax exemption, gladly take jobs that Rapanui spurn. "A Rapanui will



Three volcanoes, quiet now, formed Easter Island half a million years ago. It has three crater lakes but no streams; fresh water is scarce. Chile, the island's source of fuel and most food, is 2,150 miles away.

say, What, you think I'm going to wash dishes?" says Beno Atán, a 27-year-old tour guide and a native himself. Though many Rapanui have married mainlanders, some worry their culture is being diluted. The population is now around 5,000, nearly double what it was 20 years ago, and fewer than half the people are Rapanui.

Just about every job on Easter Island depends on tourism. "Without it," says Mahina Lucero Teao, head of the tourism chamber, "everyone would be starving on the island." The mayor, Luz Zasso Paoa, says, "Our patrimony is the base of our economy. You're not here for us, but for that patrimony." That is, for the moai.

THOR HEYERDAHL, the Norwegian ethnographer and adventurer whose Pacific expeditions helped ignite the world's curiosity about Easter Island, thought the statues had been created by pre-Inca from Peru, not by Polynesians. Erich von Däniken, the best-selling Swiss author of *Chariots of the Gods*, was sure the moai were built by stranded extraterrestrials. Modern science—linguistic, archaeological, and genetic evidence—has proved the moai builders were Polynesian but not how they moved their creations. Researchers have tended to assume the ancestors dragged the statues somehow, using a lot of ropes and wood. "The experts can say whatever they want," says Suri Tuki, 25, José Tuki's half brother. "But we know the truth. The statues walked." In the Rapanui oral tradition, the moai were animated by *mana*, a spiritual force transmitted by powerful ancestors.

There are no reports of moai building after Europeans arrived in the 18th century. By then Easter Island had only a few scrawny trees. In the 1970s and 1980s, though, biogeographer John Flenley of New Zealand's Massey University found evidence—pollen preserved in lake sediments—that the island had been covered in lush forests, including millions of giant palm trees, for thousands of years. Only after the Polynesians arrived around A.D. 800 had those forests given way to grasslands.

Jared Diamond drew heavily on Flenley's work for his assertion in *Collapse*, his influential 2005



Tourists diving on Easter Island's reef encounter a fake moai, made for a 1994 Hollywood movie and then sunk offshore. The reef is healthy, though it is overfished. Tuna and salmon are imported, primarily for tourists.



The loss of Easter Island's forests was an "ecological catastrophe"—but the islanders were not to blame, the new theory says. And the moai certainly weren't.

book, that ancient Easter Islanders committed unintentional ecocide. They had the bad luck, Diamond argues, to have settled an extremely fragile island—dry, cool, and remote, which means it's poorly fertilized by windblown dust or volcanic ash. (Its own volcanoes are quiescent.) When the islanders cleared the forests for firewood and farming, the forests didn't grow back. As wood became scarce and the islanders could no longer build seagoing canoes for fishing, they ate the birds. Soil erosion decreased their crop yields. Before Europeans showed up, the Rapanui had descended into civil war and cannibalism. The collapse of their isolated civilization, Diamond writes, is "the clearest example of a society that destroyed itself by overexploiting its own resources" and "a worst-case scenario for what may lie ahead of us in our own future."

The moai, he thinks, accelerated the self-destruction. Diamond interprets them as power displays by rival chieftains who, trapped on a remote little island, lacked other ways of strutting their stuff. They competed by building ever bigger statues. Diamond thinks they laid the moai on wooden sledges, hauled over log rails—a technique successfully tested by UCLA archaeologist Jo Anne Van Tilburg, director of the Easter Island Statue Project—but that required both a lot of wood and a lot of people. To feed the people, even more land had to be cleared. When the wood was gone and civil war began, the islanders began toppling the moai. By the 19th century none were standing. Easter Island's landscape acquired the aura of tragedy that, in the eyes of Diamond and many others, it retains today.

REARRANGE AND REINTERPRET the scattered shards of fact, though, and you get a more optimistic vision of the Rapa Nui past—that of

archaeologists Terry Hunt of the University of Hawaii and Carl Lipo of California State University Long Beach, who have studied the island for the past decade. It's a vision peopled by peaceful, ingenious moai builders and careful stewards of the land. Hunt and Lipo agree that Easter Island lost its lush forests and that it was an "ecological catastrophe"—but the islanders themselves weren't to blame. And the moai certainly weren't. There is indeed much to learn from Easter Island, Hunt says, "but the story is different."

His and Lipo's controversial new version, based on their research and others', begins with their own excavation at Anakena beach. It has convinced them that the Polynesians didn't arrive until A.D. 1200, about four centuries later than is commonly understood, which would leave them only five centuries to denude the landscape. Slashing and burning wouldn't have been enough, Hunt and Lipo think. Anyway, another tree killer was present. When archaeologists dig up nuts from the extinct Easter Island palm, the nuts are often marred by tiny grooves, made by the sharp teeth of Polynesian rats.

The rats arrived in the same canoes as the first settlers. Abundant bones in the Anakena dig suggest the islanders dined on them, but otherwise the rodents had no predators. In just a few years, Hunt and Lipo calculate, they would have overrun the island. Feasting on palm nuts, they would have prevented the reseedling of the slow-growing trees and thereby doomed Rapa Nui's forest, even if humans hadn't been slashing and burning. No doubt the rats ate birds' eggs too.

Of course, the settlers bear responsibility for bringing the rats; Hunt and Lipo suspect they did so intentionally. (They also brought chickens.) But like invasive species today, the Polynesian rats did more harm to the ecosystem than to the humans who transported them. Hunt and Lipo see no evidence that Rapanui civilization collapsed when the palm forest did; based on their own archaeological survey of the island, they think its population grew rapidly after settlement to around 3,000 and then remained more or less stable until the arrival of Europeans.

Cleared fields were more valuable to the



Rapanui than palm forests were. But they were wind-lashed, infertile fields watered by erratic rains. Easter Island was a tough place to make a living. It required heroic efforts. In farming, as in moai moving, the islanders shifted monumental amounts of rock—but into their fields, not out. They built thousands of circular stone windbreaks, called *manavai*, and gardened inside them. They mulched whole fields with broken volcanic rocks to keep the soil moist and fertilized it with nutrients that the volcanoes were no longer spreading. In short, Hunt, Lipo, and others contend, the prehistoric Rapanui were pioneers of sustainable farming, not inadvertent perpetrators of ecocide. “Rather than a case of abject failure, Rapa Nui is an unlikely story of success,” Hunt and Lipo argue in their recent book.

It’s called *The Statues That Walked*, and the Rapanui enjoy better spin in it than they do in *Collapse*. Hunt and Lipo don’t trust oral history accounts of violent conflict among the Rapanui; sharp obsidian flakes that other archaeologists see as weapons, they see as farm tools. The moai helped keep the peace, they argue, not only by signaling the power of their builders but also by limiting population growth: People raised statues rather than children. What’s more, moving the

Chilean newlyweds in festive paint and feathers (at right) celebrate marriage Rapanui style. Nearly two-thirds of the 50,000 visitors to the island in 2011 were from Chile.

moai required few people and no wood, because they were walked upright. On that issue, Hunt and Lipo say, evidence supports the folklore.

Sergio Rapu, 63, a Rapanui archaeologist and former Easter Island governor who did graduate work with Hunt, took his American colleagues to the ancient quarry on Rano Raraku, the island’s southeastern volcano. Looking at the many moai abandoned there in various stages of completion, Rapu explained how they were engineered to walk: Fat bellies tilted them forward, and a D-shaped base allowed handlers to roll and rock them side to side. Last year, in experiments funded by National Geographic’s Expeditions Council, Hunt and Lipo showed that as few as 18 people could, with three strong ropes and a bit of practice, easily maneuver a 10-foot, 5-ton moai

■ **Society Grant** Terry Hunt and Carl Lipo’s moai experiment was funded by your Society membership.

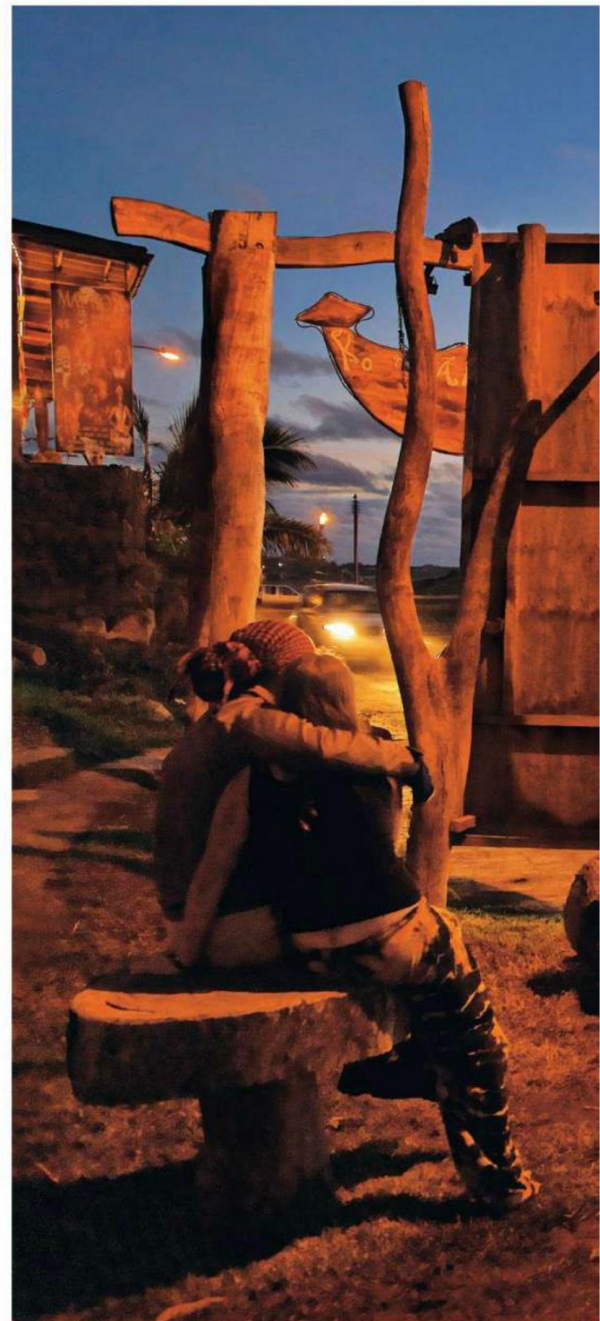
replica a few hundred yards. In real life, walking miles with much larger moai would have been a tense business. Dozens of fallen statues line the roads leading away from the quarry. But many more made it to their platforms intact.

No one knows for sure when the last statue was carved. The moai cannot be dated directly. Many were still standing when the Dutch arrived in 1722, and Rapanui civilization was peaceful and thriving then, Hunt and Lipo argue. But the explorers introduced deadly diseases to which islanders had no immunity, along with artifacts that replaced the moai as status symbols. Snatching Europeans' hats—Hunt and Lipo cite many reports of this—became more appealing than hoisting a multiton red pukao onto a moai. In the 19th century slave traders decimated the population, which shriveled to 111 people by 1877.

As Hunt and Lipo tell it, Easter Island's story is a parable of genocide and culturecide, not eco-cide. Their friend Sergio Rapu buys some but not all of it. "Don't tell me those obsidian tools were just for agriculture," he says, laughing. "I'd love to hear that my people never ate each other. But I'm afraid they did."

TODAY ISLANDERS confront a fresh challenge: exploiting their cultural legacy without wrecking it. A growing population and thousands of tourists are straining a limited water supply. The island lacks a sewer system and a place to put the swelling volume of trash; between 2009 and mid-2011 it shipped 230 tons to the mainland. "So what do we do?" asks Zasso Paoa, the mayor. "Limit migration? Limit tourism? That's where we are now." The island recently started asking tourists to take their trash home with them in their suitcases.

Tourists are forbidden to touch moai, but horses happily rub against them, wearing away the porous tuff. Though cars are now the preferred mode of transport, more than 6,000 horses and cattle—"more than people," grumbles tour guide Atán—still run free, trampling ground once trodden by Scottish-owned sheep and relieving themselves on once sacred platforms. But the islanders' own desire to develop



Isolated no more, seductive but not easy, Rapa Nui holds its people. José Tuki (at left, with girlfriend, Joyce) moved to Chile, but only for four years. "If you go away," he says, "the island will call you back."



their ancestral lands may be a greater threat to their densely packed heritage: more than 20,000 archaeological features in all, including walled gardens and stone chicken houses as well as moai and ahu. More than 40 percent of the island is a protected national park, which limits available land. “People have to learn that archaeology isn’t their enemy,” says Rapu.

Decades ago he himself helped get the moai at Anakena back upright. In the process he and his colleagues also discovered how the moai builders had breathed soul into their colossal statues after the long trek from the quarry: As a finishing touch, they placed eyes of white coral and pupils

of obsidian or red scoria into the empty sockets.

A grove of coconut palms, imported from Tahiti, overlooks Anakena beach today, reassuring sunbathers and Chilean newlyweds that they really are in Polynesia, even if the wind is shrieking and the grassy rolling hills behind them look like the Scottish Highlands. The moai are eyeless now and not confiding—to the tourists, José Tuki, or anyone else—how they got there or which story of Easter Island is true. Tuki, for one, can handle the ambiguity. “I want to know the truth,” he says. “But maybe the island doesn’t tell all its answers. And maybe knowing everything would take its power away.” □



EPIC STORMS

Photographs by Mitch Dobrowner



*Resembling a mushroom cloud, a monsoon thunderstorm drops a deluge on the desert.
The base of this cloud may hang some two miles above the ground.* LORDSBURG, NEW MEXICO



“SOME THINGS YOU LEARN BEST IN CALM,” wrote author Willa Cather, scribe of the Great Plains, “and some in storm.” She wasn’t referring to the local weather, but she might as well have been. Each year the American heartland offers a graduate course in natural tumult. From March to October these flatlands play host to thousands of visible, violent storms. Meteorology and topography conspire to paint blusterous murals and apocalyptic tableaux.

When dry air from the Rockies slides over



A dying tornado like this one is said to be in the “roping out” phase. REGAN, NORTH DAKOTA

moist air from the Gulf of Mexico, the stage is set for a storm. The burst may expel rain and hail, thunder and lightning, wind and funnel. It may kill people and animals, destroy crops and property, flood roads and towns. (The National Weather Service reports scores of storm-related deaths every year. In 2011, says the insurance industry, U.S. thunderstorms caused some \$26 billion in damage.) Yet a storm giveth too, delivering rain to

parched fields, wind to inert turbines, lightning-produced nitrogen to nutrient-starved soil.

To document these awe-inspiring tempests, Mitch Dobrowner, a landscape photographer inspired by Ansel Adams and Minor White, teamed with renowned storm chaser Roger Hill, a witness to more than 600 tornadoes. Over the past three years, aided by mobile satellite data, radar imaging, and more, the pair have stalked

It's not a hovering spaceship. It's a low-precipitation supercell—"one of the prettiest sights in the severe-weather world," says storm chaser Roger Hill. Photographer Mitch Dobrowner says they tracked this one 300 miles from the Texas Panhandle. NEAR CLAYTON, NEW MEXICO







Most storms move fast. This one crept over a farming community for more than an hour, bristling with electricity. "No two storms are the same," says James LaDue, a meteorologist at the National Weather Service. "No two skies are either." NEAR GUYMON, OKLAHOMA





More of Mitch Dobrowner's work can be seen at mitchdobrowner.com and in his two books, published by 21st Editions.

some 45 weather systems over 16 states and 40,000 miles, sometimes driving 900 miles in a day to capture a moment. "With storms," says Dobrowner, "it's like shooting a sporting event. Things happen so quickly, I really have to adapt."

Working in black and white—"Color seems too everyday," he says—he looks especially for supercells, rarest and mightiest of thunderstorms. A classic one, says Hill, "is the most violent, prolific tornado-producing machine there is." Its recipe requires four ingredients: moisture,



Born in a bruising supercell, a funnel cloud looms beyond a cornfield. NORTHFIELD, MINNESOTA

atmospheric instability, something to lift the air, and vertical wind shear to rotate the storm.

When those elements align, an erratic, uniquely structured storm appears. Powered by a strong, rotating updraft, a supercell can steer itself away from the prevailing wind, devour or destroy other squalls in its path, and dodge its own storm-extinguishing precipitation, staying alive for up to 12 hours.

Indeed, both Dobrowner and Hill see supercells as living things: born under the right conditions, gaining strength as they grow, changing shape and form, fighting for their life, eventually dying. Not that personifying them removes the danger. In the still wild West, says Hill, storms demand admiration and respect. “I feel honored to be shooting them,” says Dobrowner. “If I’m going to go, let me go like this.” —*Jeremy Berlin*

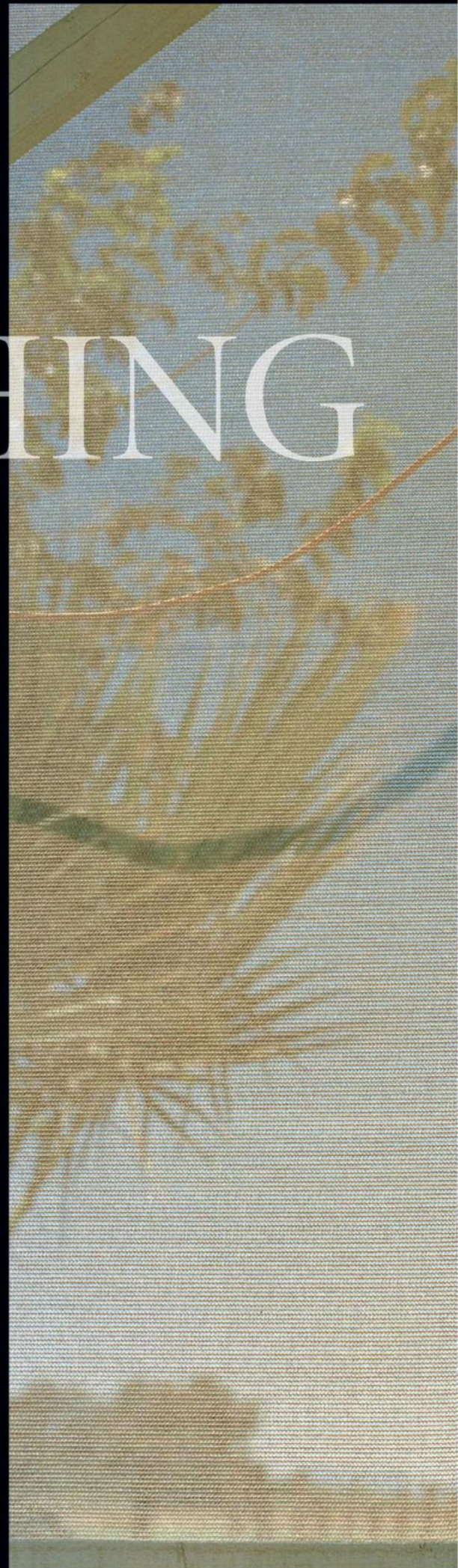
BY RUSS RYMER

PHOTOGRAPHS
BY LYNN JOHNSON

VANISHING

One language dies every 14 days. By the next century nearly half of the roughly 7,000 languages spoken on Earth will likely disappear, as communities abandon native tongues in favor of English, Mandarin, or Spanish. What is lost when a language goes silent?

Johnny Hill, Jr., of Parker, Arizona, is one of the last speakers of Chemehuevi, an endangered Native American language: "It's like a bird losing feathers. You see one float by, and there it goes—another word gone."



VOICES



TUVAN

THE COMPASSION OF KHOJ ÖZEERI

ONE MORNING in early fall Andrei Mongush and his parents began preparations for supper, selecting a black-faced, fat-tailed sheep from their flock and rolling it onto its back on a tarp outside their livestock paddock. The Mongush family's home is on the Siberian taiga, at the edge of the endless steppes, just over the horizon from Kyzyl, the capital of the Republic of Tuva, in the Russian Federation. They live near the geographic center of Asia, but linguistically and personally, the family inhabits a borderland, the frontier between progress and tradition. Tuvans are historically nomadic herders, moving their *aal*—an encampment of yurts—and their sheep and cows and reindeer from pasture to pasture as the seasons progress. The elder Mongushes, who have returned to their rural *aal* after working in the city, speak both Tuvan and Russian. Andrei and his wife also speak English, which they are teaching themselves with pieces of paper labeled in English pasted onto seemingly every object in their modern kitchen in Kyzyl. They work as musicians in the Tuvan National Orchestra, an ensemble that uses traditional Tuvan instruments and melodies in symphonic arrangements. Andrei is a master of the most characteristic Tuvan music form: throat singing, or *khöömei*.

When I ask university students in Kyzyl what Tuvan words are untranslatable into English or Russian, they suggest *khöömei*, because the singing is so connected with the Tuvan environment that only a native can understand it, and also *khøj özeeri*, the Tuvan method of killing a sheep. If slaughtering livestock can be seen as part of humans' closeness to animals, *khøj özeeri*

represents an unusually intimate version. Reaching through an incision in the sheep's hide, the slaughterer severs a vital artery with his fingers, allowing the animal to quickly slip away without alarm, so peacefully that one must check its eyes to see if it is dead. In the language of the Tuvan people, *khøj özeeri* means not only slaughter but also kindness, humaneness, a ceremony by which a family can kill, skin, and butcher a sheep, salting its hide and preparing its meat and making sausage with the saved blood and cleansed entrails so neatly that the whole thing can be accomplished in two hours (as the Mongushes did this morning) in one's good clothes without spilling a drop of blood. *Khøj özeeri* implies a relationship to animals that is also a measure of a people's character. As one of the students explained, "If a Tuvan killed an animal the way they do in other places"—by means of a gun or knife—"they'd be arrested for brutality."

Tuvan is one of the many small languages of the world. The Earth's population of seven billion people speaks roughly 7,000 languages, a statistic that would seem to offer each living language a healthy one million speakers, if things were equitable. In language, as in life, things aren't. Seventy-eight percent of the world's population

speaks the 85 largest languages, while the 3,500 smallest languages share a mere 8.25 million speakers. Thus, while English has 328 million first-language speakers, and Mandarin 845 million, Tuvan speakers in Russia number just 235,000. Within the next century, linguists think, nearly half of the world's current stock of languages may disappear. More

than a thousand are listed as critically or severely endangered—teetering on the edge of oblivion.

In an increasingly globalized, connected, homogenized age, languages spoken in remote places are no longer protected by national borders or natural boundaries from the languages that dominate world communication and commerce. The reach of Mandarin and English and Russian and Hindi and Spanish (Continued on page 70)





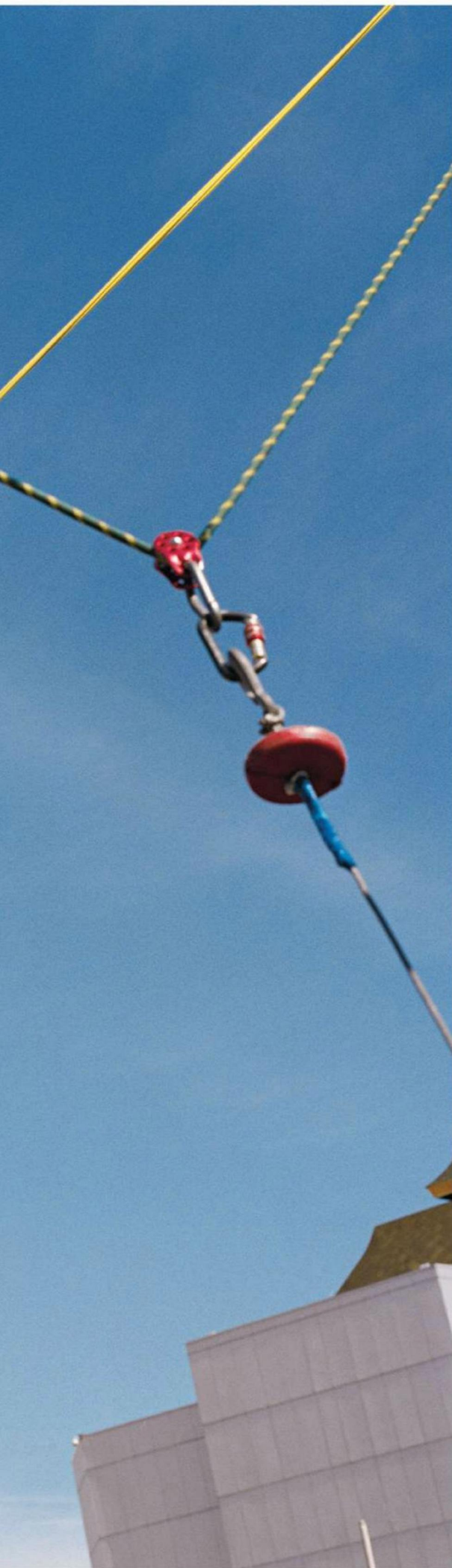
TUVAN

[artyštaar]

to burn juniper | to purify

A Tuvan shaman cleanses the house of a deceased relative's spirit using smoke from burning juniper to chase away darkness. The incense fills the room as the family ask the spirits of hearth and home to protect them.





TUVAN

LANGUAGE

Russia

Number of speakers

235,000

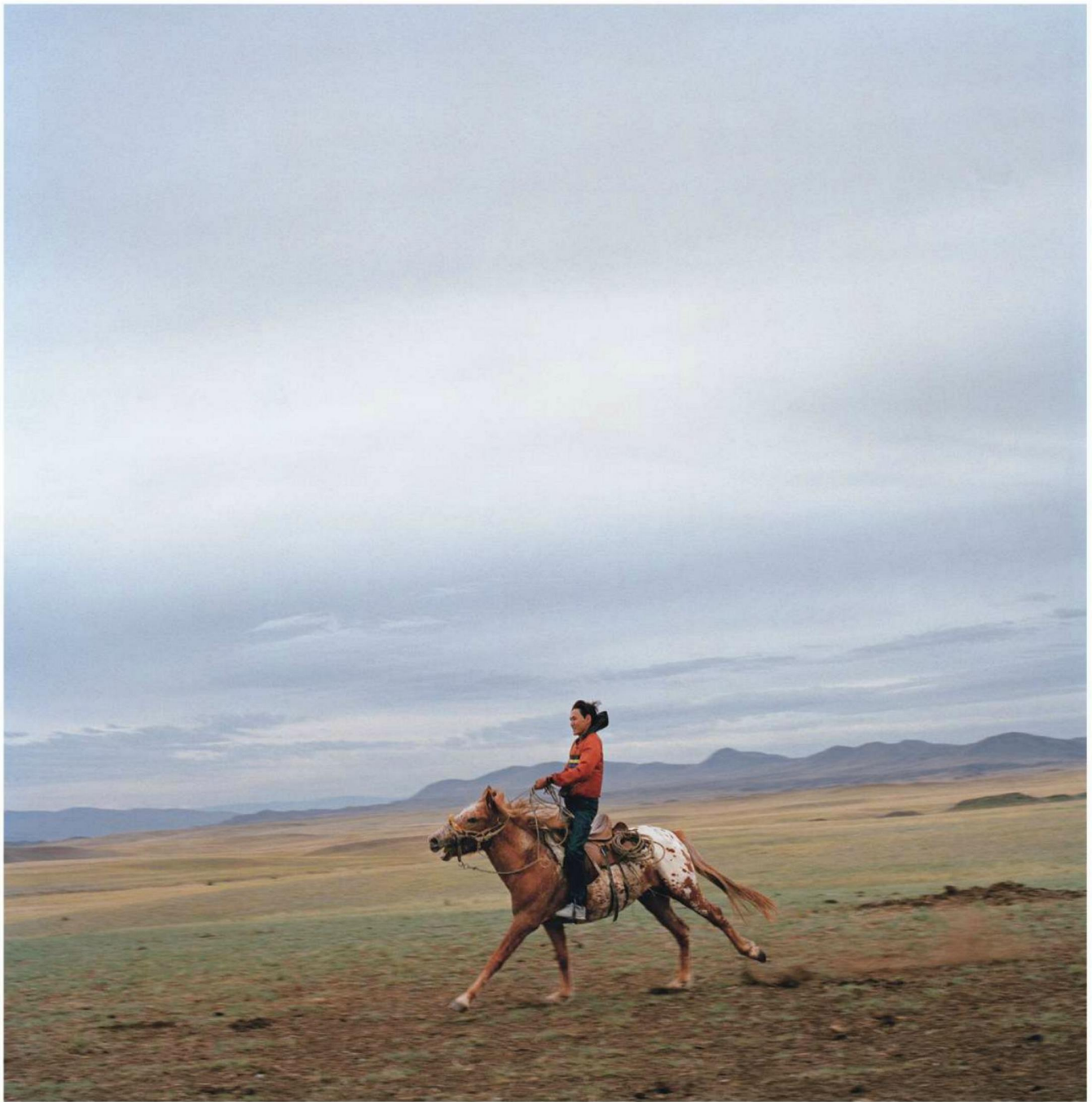
[songgaar]

go back | the future

[burungaar]

go forward | the past

Tuvans believe the past is ahead of them while the future lies behind. The children who flock to this bungee-cord ride outside the National Museum of Tuva look to the future, but it's behind them, not yet seen.



TUVAN

[eze nggileer]

to stirrup | to sing with the rhythms of riding a horse

The words used to describe styles of throat singing—an art among Tuvan herders—perfectly capture their distinctive sounds. Eze nggileer evokes the pulsing rhythms of galloping on a horse.



TUVAN

[khei-àt]

air horse | a spiritual place within

Ai-Xaan Oorzhak throat sings and plays the igil, or horse-head fiddle, with bow techniques like “make horse walk.” Singers use the term “air horse” to describe the spiritual depths they draw from to produce the harmonic sounds.



TUVAN

[anayim]

my little goat

Aidyng Kyrgys caresses his newborn baby girl, whom he refers to using this tender term of endearment. The arrival of an infant is cause for a celebration and feasting for the whole family at their tiny log house.



TUVAN

[ak byzaa]

white calf, less than one year

Raising sheep, yaks, and goats on the Siberian steppe is so central to Tuvan life that the vocabulary for livestock is embedded with detailed information about each animal's age, gender, fertility, coloration.

and Arabic extends seemingly to every hamlet, where they compete with Tuvan and Yanomami and Altaic in a house-to-house battle. Parents in tribal villages often encourage their children to move away from the insular language of their forebears and toward languages that will permit greater education and success.

Who can blame them? The arrival of television, with its glamorized global materialism, its luxury-consumption proselytizing, is even more irresistible. Prosperity, it seems, speaks English. One linguist, attempting to define what a language is, famously (and humorously) said that a language is a dialect with an army. He failed to note that some armies are better equipped than others. Today any language with a television station and a currency is in a position to obliterate those without, and so residents of Tuva must speak Russian and Chinese if they hope to engage with the surrounding world. The incursion of dominant Russian into Tuva is evident in the speaking competencies of the generation of Tuvans who grew up in the mid-20th century, when it was the fashion to speak, read, and write in Russian and not their native tongue.

Yet Tuvan is robust relative to its frailest counterparts, some of which are down to a thousand speakers, or a mere handful, or even one individual. Languages like Wintu, a native tongue in California, or Siletz Dee-ni, in Oregon, or Amurdak, an Aboriginal tongue in Australia's Northern Territory, retain only one or two fluent or semifluent speakers. A last speaker with no one to talk to exists in unspeakable solitude.

Increasingly, as linguists recognize the magnitude of the modern language die-off and rush to catalog and decipher the most vulnerable tongues, they are confronting underlying questions about languages' worth and utility. Does each language have boxed up within it some irreplaceable beneficial knowledge? Are there

aspects of cultures that won't survive if they are translated into a dominant language? What unexpected insights are being lost to the world with the collapse of its linguistic variety?

Fortunately, Tuvan is not among the world's endangered languages, but it could have been. Since the breakup of the Soviet Union, the language has stabilized. It now has a well-equipped army—not a television station, yet, or a currency, but a newspaper and a respectable 264,000 total speakers (including some in Mongolia and China). Yet Tofa, a neighboring Siberian language, is down to some 30 speakers. Tuvan's importance to our understanding of disappearing languages lies in another question linguists are struggling to answer: What makes one language succeed while another dwindles or dies?

AKA

THE RESPECT OF MUCROW

I WITNESSED the heartrending cost of broken languages among the Aka people in Palizi, a tiny, rustic hamlet perched on a mountainside in Arunachal Pradesh, India's rugged northeasternmost state. It is reachable by a five-hour drive through palm and hardwood jungles on single-track mountain roads. Its one main street is lined with unpainted board-faced houses set on stilts and roofed with thatch or metal. Villagers grow their own rice, yams, spinach, oranges, and ginger; slaughter their own hogs and goats; and build their own houses. The tribe's isolation has bred a radical self-sufficiency, evidenced in an apparent lack of an Aka word for job, in the sense of salaried labor.

The Aka measure personal wealth in mithan, a breed of Himalayan cattle. A respectable bride price in Palizi, for instance, is expressed as eight mithan. The most cherished Aka possession is the precious *tradzy* necklace—worth two mithan—made from yellow stones from the nearby river, which is passed down to their children.

*Russ Rymer is the author of *Genie: A Scientific Tragedy, the story of an abused child whose case helped scientists study the acquisition of language*. Photographer Lynn Johnson's last feature for the magazine was on the trail of the Apostles.*

no words for specific numbers but gets by using “few” or “many.”

The yellow stones for the tradzy necklaces can no longer be found in the river, and so the only way to have a precious necklace is to inherit one.

Speaking Aka—or any language—means immersing oneself in its character and concepts. “I’m seeing the world through the looking glass of this language,” said Father Vijay D’Souza, who was running the Jesuit school in Palizi at the time of my visit. The Society of Jesus established the school in part because it was concerned about the fragility of the Aka language and culture and wanted to support them (though classes are taught in English). D’Souza is from southern India, and his native language is Konkani. When he came to Palizi in 1999 and began speaking Aka, the language transformed him.

“It alters your thinking, your worldview,” he told me one day in his headmaster’s office, as children raced to classes through the corridor outside. One small example: *mucrow*. A similar word in D’Souza’s native language would be an insult, meaning “old man.” In Aka “mucrow” means something more. It is a term of respect, deference, endearment. The Aka might address a woman as *mucrow* to indicate her wisdom in civic affairs, and, says D’Souza, “an Aka wife will call her husband *mucrow*, even when he’s young,” and do so affectionately.

American linguists David Harrison and Greg Anderson have been coming to Arunachal Pradesh to study its languages since 2008. They are among the scores of linguists worldwide engaged in the study of vanishing languages. Some have academic and institutional affiliations (Harrison and Anderson are both connected with National Geographic’s Enduring Voices Project), while others may work for Bible societies that translate Scripture into new tongues. The authoritative index of world languages is *Ethnologue*, maintained by SIL International, a faith-based organization. The researchers’ intent may be hands-off, to record a grammar and lexicon before a language is lost or contaminated, or it may be interventionist, to develop a written

accompaniment for the oral language, compile a dictionary, and teach native speakers to write.

Linguists have identified a host of language hotspots (analogous to biodiversity hotspots) that have both a high level of linguistic diversity and a high number of threatened languages (see map, pages 92-3). Many of these are in the world’s least reachable, and often least hospitable, places—like Arunachal Pradesh. Aka and its neighboring languages have been protected because Arunachal Pradesh has long been sealed off to outsiders as a restricted border region. Even other Indians are not allowed to cross into the region without federal permission, and so its fragile microcultures have been spared the intrusion of immigrant labor, modernization—and linguists. It has been described as a black hole of linguistics because its incredible language variety remains so little explored.

Much of public life in Palizi is regulated through the repetition of mythological stories used as forceful fables to prescribe behavior. Thus a money dispute can draw a recitation about a spirit

whose daughters are eaten by a crocodile, one by one, as they cross the river to bring him dinner in the field. He kills the crocodile, and a priest promises to bring the last daughter back to life but overcharges so egregiously that the spirit seeks revenge by becoming a piece of ginger that gets stuck in the greedy priest’s throat.

Such stories were traditionally told by the elders in a highly formal version of Aka that the young did not yet understand and according to certain rules, among them this: Once an elder begins telling a story, he cannot stop until the story is finished. As with linguistic literacy, disruption is disaster. Yet Aka’s young people no longer follow their elders in learning the formal version of the language and the stories that have governed daily life. Even in this remote region, young people are seduced away from their mother tongue by Hindi on the television and English in the schools. Today Aka’s speakers number fewer than 2,000,







AKA

LANGUAGE

India

Number of speakers

1,000-2,000

[tradzy]

a necklace of yellow stone beads

The Aka have more than 26 words to describe beads. Beyond being objects of adornment, beads are status symbols and currency. This toddler will get this necklace at her wedding.



AKA

[shobotro vyew]

to calculate bride price using twigs

The price for an Aka marriage is negotiated with bamboo sticks. The groom's side lays down a number representing money and gifts, and the bride's family counteroffers. Families can haggle for months using the same sticks.



AKA

[chofe gidego]

is looking at liver

A marriage is not recognized until after the ritual slaughter of a mithan, a type of cattle, when its liver can be read. The verdict: A small spot might signal an accident in the couple's future but otherwise a happy life.



AKA

[nichleu-nuggo]

village counselor | wise, compassionate, tolerant

Govardhan Nimasow is a rich man who married eight wives, fathered 26 children, and owns one of the few concrete houses in his village. But his status as a nichleu-nuggo also means he possesses humility and wisdom.

few enough to put it on the endangered list.

One night in Palizi, Harrison, Anderson, an Indian linguist named Ganesh Murmu, and I sat cross-legged around the cooking fire at the home of Pario Nimasow, a 25-year-old teacher at the Jesuit school. A Palizi native, Nimasow loved his Aka culture even as he longed to join the outside world. In his sleeping room in an adjacent hut was a television waiting for the return of electricity, which had been out for many months thanks to a series of landslides and transformer malfunctions. After dinner Nimasow disappeared for a moment and came back with a soiled white cotton cloth, which he unfolded by the flickering light of the cooking fire. Inside was a small collection of ritual items: a tiger's jaw, a python's jaw, the sharp-toothed mandible of a river fish, a quartz crystal, and other objects of a shaman's satchet. This satchet had belonged to Nimasow's father until his death in 1991.

"My father was a priest," Nimasow said, "and his father was a priest." And now? I asked. Was he next in line? Nimasow stared at the talismans and shook his head. He had the kit, but he didn't know the chants; his father had died before passing them on. Without the words, there was no way to bring the artifacts' power to life.

LINGUISTICS HAS UNDERGONE two great revolutions in the past 60 years, on seemingly opposite ends of the discipline. In the late 1950s Noam Chomsky theorized that all languages were built on an underlying universal grammar embedded in human genes. A second shift in linguistics—an explosion of interest in small and threatened languages—has focused on the variety of linguistic experience. Field linguists like David Harrison are more interested in the idiosyncrasies that make each language unique and the ways that culture can influence a language's form. As Harrison points out, some 85 percent of languages have yet to be documented. Understanding them can only enrich our comprehension of what is universal to all languages.

Different languages highlight the varieties of human experience, revealing as mutable aspects of life that we tend to think of as settled and

universal, such as our experience of time, number, or color. In Tuva, for example, the past is always spoken of as ahead of one, and the future is behind one's back. "We could never say, I'm looking forward to doing something," a Tuvan told me. Indeed, he might say, "I'm looking forward to the day before yesterday." It makes total sense if you think of it in a Tuvan sort of way: If the future were ahead of you, wouldn't it be in plain view?

Smaller languages often retain remnants of number systems that may predate the adoption of the modern world's base-ten counting system. The Pirahã, an Amazonian tribe, appear to have no words for any specific numbers at all but instead get by with relative words such as "few" and "many." The Pirahã's lack of numerical terms suggests that assigning numbers may be an invention of culture rather than an innate part of human cognition. The interpretation of color is similarly varied from language to language. What we think of as the natural spectrum of the rainbow is actually divided up differently in different tongues, with many languages having more or fewer color categories than their neighbors.

Language shapes human experience—our very cognition—as it goes about classifying the world to make sense of the circumstances at hand. Those classifications may be broad—Aka divides the animal kingdom into animals that are eaten and those that are not—or exceedingly fine-tuned. The Todzhu reindeer herders of southern Siberia have an elaborate vocabulary for reindeer; an *iyi düktüg myiys*, for example, is a castrated former stud in its fourth year.

If Aka, or any language, is supplanted by a new one that's bigger and more universally useful, its death shakes the foundations of the tribe. "Aka is our identity," a villager told me one day as we walked from Palizi down the path that wound past the rice fields to the forests by the river. "Without it, we are the general public." But should the rest of the world mourn too? The question would not be an easy one to frame in Aka, which seems to lack a single term for world. Aka might suggest an answer, though, one embodied in the concept of mucrow—a regard for

tradition, for long-standing knowledge, for what has come before, a conviction that the venerable and frail have something to teach the callow and the strong that they would be lost without.

SERI

THE WISDOM OF THE HANT IIHA CÖHACOMXOJ

THE ONGOING collapse of the world's biodiversity is more than just an apt metaphor for the crisis of language extinction. The disappearance of a language deprives us of knowledge no less valuable than some future miracle drug that may be lost when a species goes extinct. Small languages, more than large ones, provide keys to unlock the secrets of nature, because their speakers tend to live in proximity to the animals and plants around them, and their talk reflects the distinctions they observe. When small communities abandon their languages and switch to English or Spanish, there is a massive disruption in the transfer of traditional knowledge across generations—about medicinal plants, food cultivation, irrigation techniques, navigation systems, seasonal calendars.

The Seri people of Mexico were traditionally seminomadic hunter-gatherers living in the western Sonoran Desert near the Gulf of California. Their survival was tied to the traits and behaviors of the species that live in the desert and the sea. An intimate relationship with the plant and animal worlds is a hallmark of the Seris' life and of their language, Cmiique Iitom.

Traditionally the Seris, who refer to themselves as the Comcaac, had no fixed settlements, so their locale of the moment depended on what part of the desert offered the most food, whether the cactus fruit was ripe on the mountainside or the eelgrass was ready to harvest in the bay. Today they reside in two settlements, Punta Chueca and El Desemboque, each a small covey of concrete-block homes set in the vast red, seemingly empty desert beside the gulf. The homes are surrounded

by rows of thorny ocotillo canes stuck into the sand, where they've taken root as living fences.

Each day, Armando Torres Cubillas sits in the corner of his open-air, beachside atelier in El Desemboque, his crippled legs curled under him on the sandy ground, carving sea turtles from dark desert ironwood. Occasionally, if he's in the mood, he gazes out over the gulf and eases the artisanship with a song that relates the operatic story of a conversation between the small beach clam *tajitiquiixaz* and the mole crab. The verse is typical of songs of the Seri tribe: a celebration of nature, tinged with loss.

The Seris see their language as a defining characteristic, a seed of their identity. One Seri told me of a "local expression" that says everyone has a flower inside, and inside the flower is a word. A Seri elder, Efraín Estrella Romero, told me, "If one child is raised speaking Cmiique Iitom and another speaking Spanish, they will be different people."

When American linguists Edward Moser and Mary Beck Moser came to live with the Seris in 1951 in El Desemboque, the group's fortunes were at a low ebb—outbreaks of measles and influenza had reduced their numbers to a couple hundred. It was a propitious time for the researchers, though, because the group's culture hadn't yet been co-opted by the majority culture surrounding it. Mary Moser served the tribe as nurse and midwife. After many births, per custom, the families gave her a dried piece of their infants' umbilical cords, which Mary kept protected in a "belly button pot." They also gave her their long, eight-plait braids, markers of Indian identity that the men felt compelled to chop off when they traveled to Mexican towns. The braids were like cultural umbilical cords, severed connections between what was old and what was new, evidence of the broken link.

The Mosers had a daughter, Cathy, who grew up among the Seris in El Desemboque and became a graphic artist and ethnographer. She and her husband, Steve Marlett, a linguist with SIL International and the University of North Dakota, have continued the Mosers' study of the Seri language. Today the community has

and inside the flower is a word. Language is a seed of Seri identity.

rebounded to somewhere between 650 and 1,000 speakers. They have managed to hang on to their language, thanks in part to their hostility to the majority culture of Mexico. Steve Marlett diplomatically refers to this in one academic paper as “the general lack of cultural empathy between the Seri population and the Spanish-speaking population.” In 1773 they killed a priest who tried to establish a mission. The Vatican did not send a follow-up, and the tribe was never Catholicized.

The Seris maintain to this day a proud suspicion of outsiders—and a disdain for unshared individual wealth. “When the Seris become rich, they will cease to exist” is a Seri saying. Having been nomadic, they tend to regard possessions as burdens. Traditionally, when a Seri died, he was buried with his few personal possessions. Nothing was passed down to relatives except stories, songs, legends, instructions.

What modern luxuries the Seris have adopted are imported without their Spanish names. Automobiles, for instance, have provoked a flurry of new words. A Seri car muffler is called *ihiisaxim an hant yaait*, or into which the breathing descends, and the Seri term for distributor cap associates it with an electric ray that swims in the Gulf of California and gives you a shock. Such words are like ocotillo canes stuck into the sand: The Cmiique Iitom lexicon is alive, and as it grows, it creates a living fence around the culture.

Sitting in the shade of an awning in front of his house, René Montaña told me stories of an ancient race of giants who could step over the sea from their home on Tiburon Island to the mainland in a single stride. He told me of *hant iiha cõhacomxoj*, those who have been told about Earth’s possessions, all ancient things. “To be told” entails an injunction: Pass it on. Thanks to that, we have all become inheritors of the knowledge enshrined within Cmiique Iitom. Folk sayings and often even single words encase centuries of close observation of species

that visiting scientists have only begun to study in recent decades.

Cmiique Iitom has terms for more than 300 desert plants, and its names for animals reveal behaviors that scientists once considered far-fetched. The Seri word for harvesting eelgrass clued scientists in to the sea grass’s nutritional merits. (Its protein content is about the same as wheat’s.) The Seris call one sea turtle *moosni hant cooit*, or green turtle that descends, for its habit of hibernating on the floor of the sea, where the traditional fishermen used to harpoon it. “We were skeptical when we first learned from the Seri Indians of Sonora, Mexico, that some *Chelonia* are partially buried on the sea floor during the colder months,” stated a 1976

paper in *Science* documenting the behavior. “However, the Seris have proved to be highly reliable informants.” The Seris enjoyed eating sea turtles but not leatherbacks, for a simple reason. Leatherbacks, they say, understand their language and are Seri themselves. In 2005 the Seri name for shark, *hacat*, be-

came the official name for a newly discovered species of smooth-hound shark, *Mustelus hacat*. Newly discovered by modern scientists, that is—the Seris had been aware of them for years.

The Seri language is what linguists call an isolate, though a better term might be “sole survivor.” “The Seris are a window into a lost world of gulf peoples,” Steve Marlett says, referring to the extensive family of potentially linguistically linked groups who once inhabited both coasts of the Gulf of California. “Many others are gone,” he says, and worse, gone before they could be documented. One remaining key to the nearly vanished cultures is Cmiique Iitom.

ONE WAY TO PRESERVE a language is to enshrine it in writing and compile a dictionary. Linguists both love and fear the prospect of inventing scripts for languages that are usually verbal only. Fear because the very idea of an alphabet changes the language the alphabet (Continued on page 86)



SERI

LANGUAGE

Mexico

Number of speakers

650-1,000

[*ziix quih haasax
haaptxö quih
áno cöcacaixaj*]

one who strongly greets
with joy/peace/harmony

There is no greeting among the Seris akin to a handshake or wave. But Josué Robles Barnett demonstrates a gesture that used to be performed when arriving in a strange community to convey you meant no harm.







SERI

[hant iiha cöhaicomxoj]

ones who have been told the ancient things

She's blind and nearly deaf, but Isabel Chavela Torres still passes on traditional knowledge. The Seri names for species in the Sonoran Desert and Gulf of California reveal behaviors scientists have only recently begun to discover.



SERI

[hepem cöicooit]

one who dances like the white-tailed deer

Chavela's grandson Jorge Luis Montaña Herrera shakes gourd rattles and assumes the identity of a deer. Just as his grandmother once sang him traditional melodies, he now wants to teach the deer dance to Seri children.

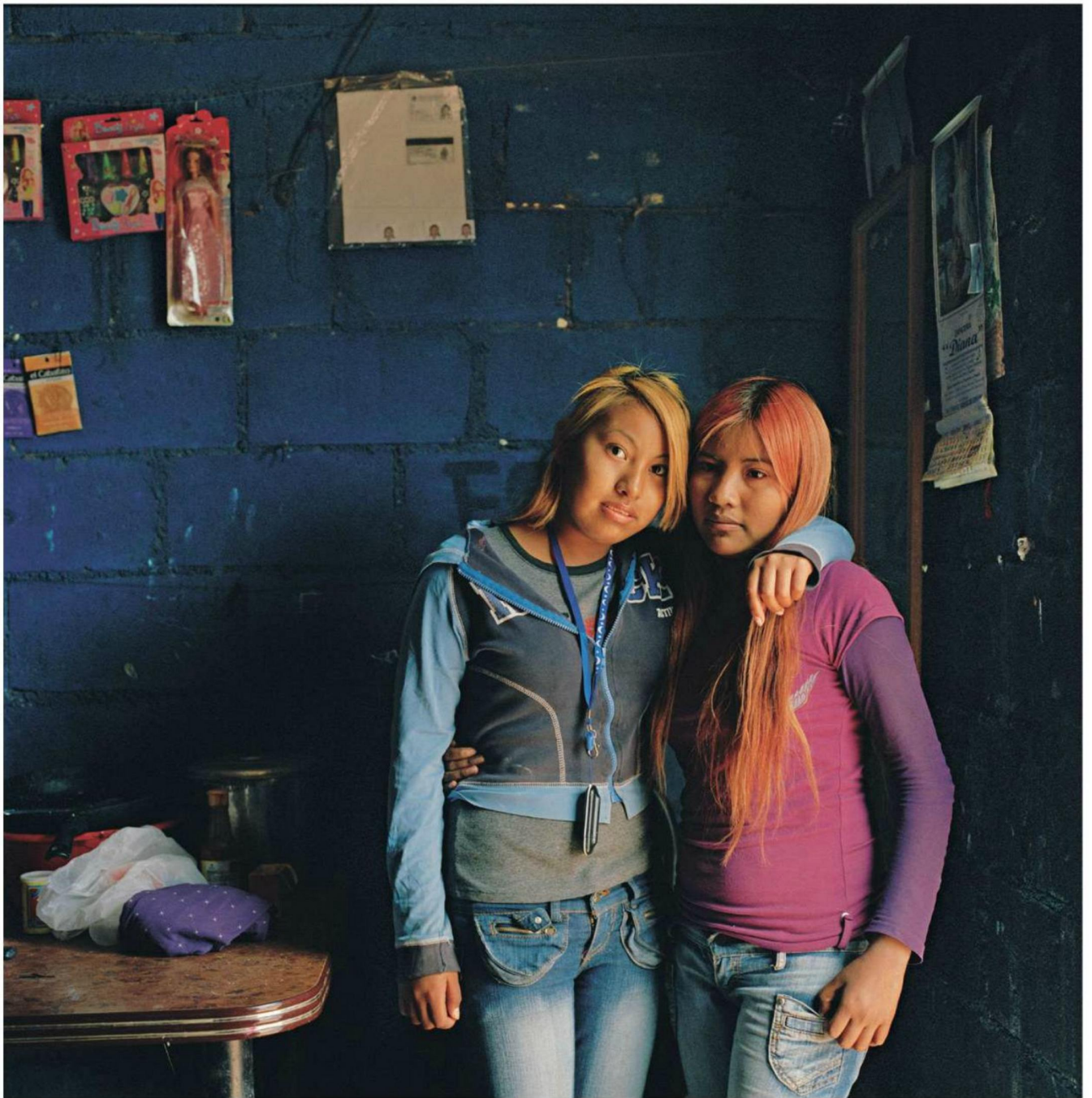


SERI

[*ziix hacx tiij catax*]

thing that moves on its own

As modern inventions like cars enter their world, the Seris tend to adapt their language rather than import Spanish words. Erica Barnett uses an abandoned car as a hothouse to grow mangroves to replenish an estuary.



SERI

[atcz | azaac]

daughter of a parent's younger sibling | daughter of a parent's older sibling

The Seris have more than 50 terms for kinship relationships, such as between these two cousins, many specific to the gender and birth order of the relative. A woman uses a different word for father than a man does.

is meant to preserve and converts the linguist from observer to activist. David Harrison and Greg Anderson compiled the first Tuvan-English dictionary and are proud of the excitement the volume elicited from native speakers. Steve and Cathy Marlett worked until 2005 finishing a Cmiique Iitom dictionary begun by her parents in 1951. Steve remembers the day René Montaña asked, “Can I show you how I write?” and demonstrated a way of dividing words that had not occurred to the linguist before. The revelation meant revising years of work. But Marlett was delighted, because the project was enlisting native Seri speakers into diagnosing and defining their own language.

The cataloging of vocabulary and pronunciation and syntax that field linguists do in remote outposts helps keep a language alive. But saving a language is not something linguists can accomplish, because salvation must come from within. The answer may lie in something Harrison and Anderson witnessed in Palizi one day, when a villager in his early 20s came with a friend to perform a song for them. Palizi is far removed from pervasive U.S. culture, so it was something of a surprise to the two linguists when the teenagers launched into a full-bore, L.A.-style rap song complete with gang hand gestures and head bobbing and attitude, a pitch-perfect rendition of an American street art, with one refinement: They were rapping in Aka.

Were the linguists dismayed? I asked. To the contrary, Harrison said. “These kids were fluent in Hindi and English, but they chose to rap in a language they share with only a couple thousand people.” Linguistic co-optation and absorption can work both ways, with the small language sometimes acting as the imperialist. “The one thing that’s necessary for the revival of a language,” Father D’Souza told me one day, “is pride.”

Against the erosion of language stands an ineffable quality that can’t be instilled from without: someone’s insistence on rapping in Aka, on singing in Tuvan, on writing in the recently

orthographized Cmiique Iitom. The Mosers’ and Marletts’ dictionary initiative has given birth to a new profession in Seriland: scribe. Several booklets have been authored by Seris. The Marletts hope the number of volumes will reach 40, one threshold, it is believed, for enticing people to maintain literacy in a language (though some put the number much higher).

The interest is already there. The Marletts had a regular visitor when they were living in El Desemboque, a young boy who would come each day to pore over a Cmiique Iitom booklet. One day he arrived, and the Marletts explained they’d lent it to someone else. “He just burst into uncontrollable tears,” Steve remembers.

The spread of global culture is unstoppable. Kyzyl, a capital city that never had a railroad connect it to the rest of Russia, will get one in the next few years. In El Desemboque power lines have been run through the desert to drive an electric pump for a municipal well. And in Arunachal Pradesh a new hydroelectric dam has been completed, ensuring the village of Palizi better access to electricity, refrigeration, and television.

To be involved in the plight of vanishing languages, even just as a journalist, is to contemplate the fragility of tribal life. Since my visits over the past two years to Palizi and Kyzyl and Seriland, Efraín Estrella died of pancreatitis, and young Pario Nimasow, who unwrapped his father’s shaman’s kit for me and wondered what its contents might mean, was killed in a landslide. A week after I wrote the paragraph describing Armando Torres’s daily singing, I received an email from Cathy Marlett. “Sad news,” its subject line read. Torres had died of a heart attack at 67, in his place by the beach in El Desemboque.

Their mortality is a reminder of the mortality of their cultures, an intimation that with each speaker’s death another vital artery has been severed. Against that—against the possibility that their language could slip away without alarm or notice—stands a proud perseverance, a reverence for the old, an awareness that in important ways a key to our future lies behind us. That, and an insistence that the tongues least spoken still have much to say. □

■ **The Enduring Voices Project** is funded in part by your National Geographic Society membership.



SERI

[Miixöni quih zó hant ano tiij?]

Where is your placenta buried?

*This is how the Seris ask, Where are you from?
Those who were born before hospital births
know the exact spot where their afterbirth was
placed in the ground, covered in sand
and ash, and topped with rocks.*

LAST SPEAKERS

EUCHEE

LANGUAGE

Oklahoma

K'asa Henry Washburn, 86, is one of only four fluent speakers of Euchee left. Every day he drives ten miles from his home in West Tulsa to the Euchee

Language House, where children are learning their native tongue. As a result, Euchee students sometimes get in trouble again for speaking their ancestral language in school. Richard Grounds, director of the project that is recording Washburn's memories, calls him a "living dictionary."



iPad Exclusive: Listen to the voices of last speakers of endangered languages in a special portrait gallery.



LAST SPEAKERS

WINTU

LANGUAGE

California

Caleen Sisk is the spiritual leader and tribal chief of the Winnemem Wintu tribe—and a last speaker of the language that sustains her people's identity. For more than a hundred years tribal members have been fighting with the U.S. government over their territory along the McCloud River, abutting Mount Shasta, which they consider their birthplace. Loss of land and loss of language are connected, says Sisk.

"This land is our church."





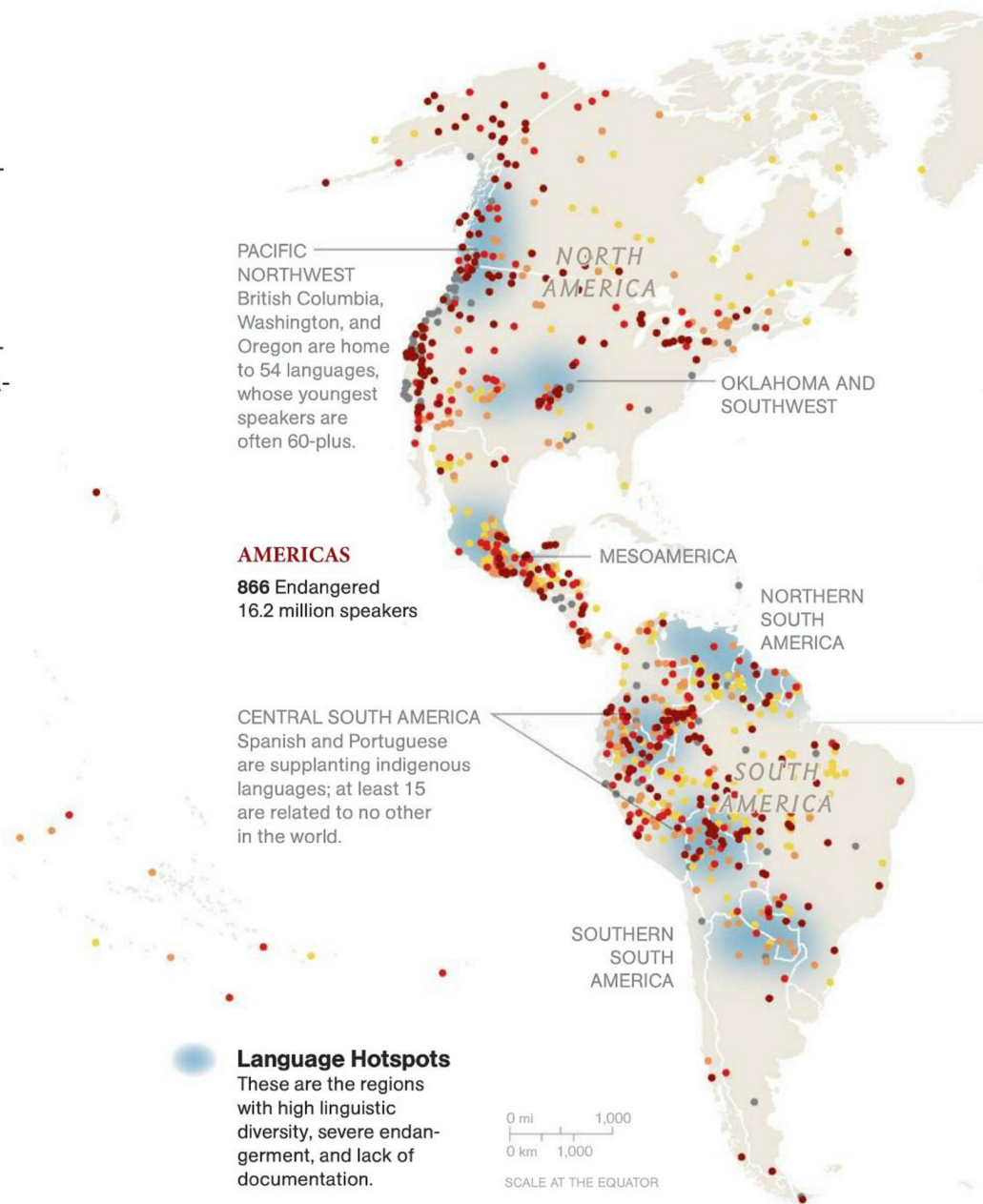
LANGUAGES AT RISK

Language follows power. In an increasingly globalized and homogenized era, languages that dominate world communication and commerce jump geopolitical borders and geographical boundaries, pushing smaller languages toward extinction. Linguists have identified hotspots where revitalization efforts could be targeted, before many native tongues fade away forever.

Threat Level

UNESCO ranks the world's languages by degree of intergenerational usage: 2,724 are endangered or extinct.

- **Critical: 607**
Spoken rarely and only by older generations
- **Severe: 554**
Spoken only by older generations
- **Definite: 681**
Replaced as mother tongue by new language
- **Vulnerable: 628**
Spoken by children but rarely outside the home
- **Extinct: 254 languages**
No speakers since 1950



AMERICAS

866 Endangered
16.2 million speakers

CENTRAL SOUTH AMERICA
Spanish and Portuguese are supplanting indigenous languages; at least 15 are related to no other in the world.

Language Hotspots

These are the regions with high linguistic diversity, severe endangerment, and lack of documentation.

Dominant Languages

Nearly half of the world speaks a top-ten language. The smallest 3,524 languages, spoken by fewer than 10,000 people each, are used by just 0.1 percent of the world's population.

First-Language Speakers (in millions)



VIRGINIA W. MASON, NGM STAFF; MARTY SCHNURE
SOURCES: LIVING TONGUES INSTITUTE FOR ENDANGERED LANGUAGES; UNESCO; SIL INTERNATIONAL

*INCLUDES ALL FORMS OF THE LANGUAGE

EUROPE

177 Endangered
66.4 million speakers

CAUCASUS

Mountainous terrain and a vibrant sense of cultural identity help preserve local languages in this Russian-dominated region.

ASIA

933 Endangered
48 million speakers

EASTERN SIBERIA
Education policy has discouraged use of some 20 indigenous languages in favor of Russian and Sakha, a dominant regional tongue.

AFRICA

284 Endangered
5.4 million speakers

SOUTHERN AFRICA
The unique consonant sounds of click languages, once numerous in southern Africa, are fast disappearing.

AUSTRALIA AND OCEANIA

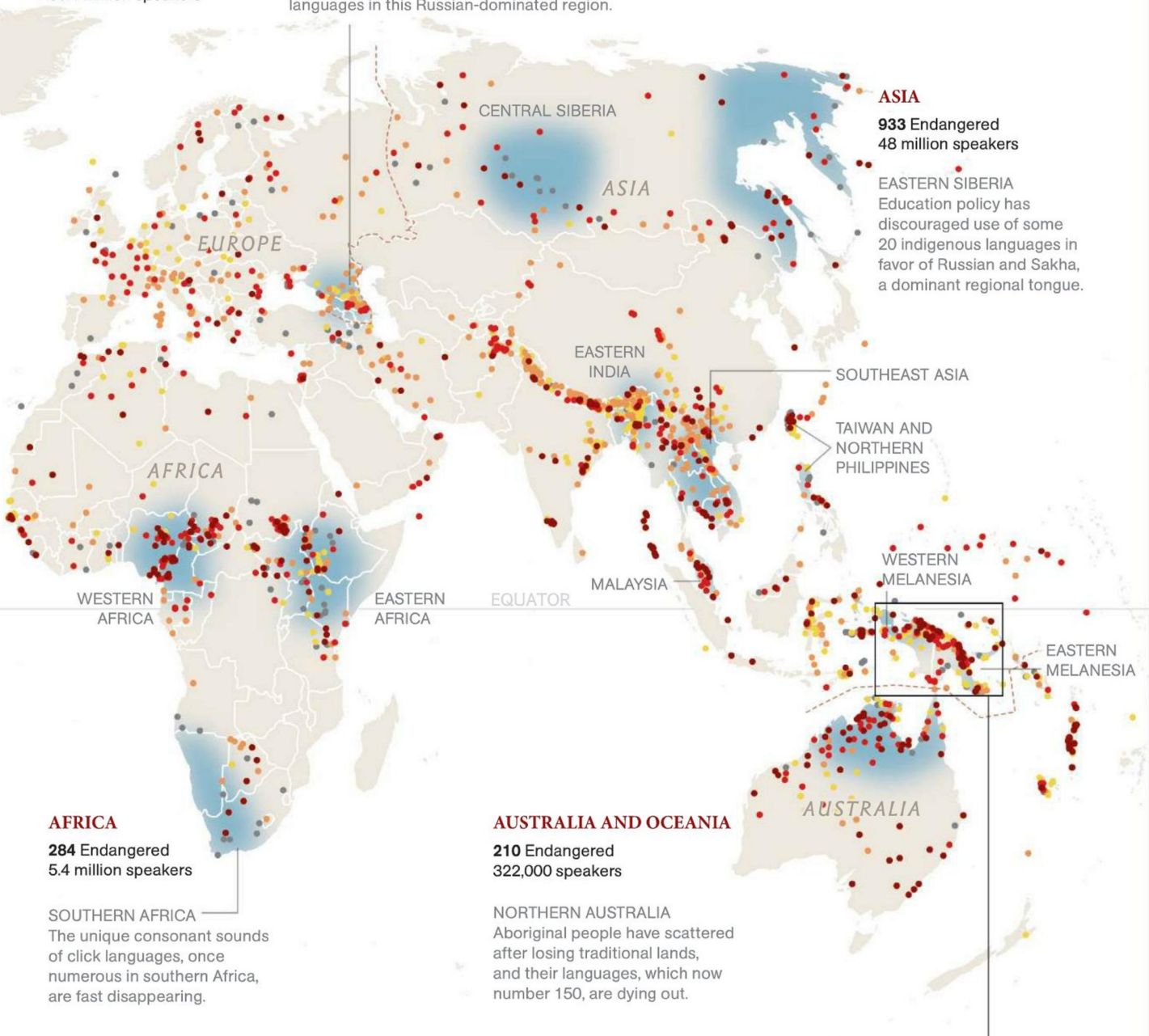
210 Endangered
322,000 speakers

NORTHERN AUSTRALIA
Aboriginal people have scattered after losing traditional lands, and their languages, which now number 150, are dying out.

Highest Diversity

Split between Indonesia and Papua New Guinea, this island is home to nearly a thousand languages, about one-seventh of the world's total. Most are spoken by small populations in isolated pockets.

● Nonendangered, unique spoken language





Sunlight filters through the dome of an ice cave on Erebus, the most southerly active volcano in the world.

We've come to one of the coldest spots on Earth to search for beings that thrive in blistering heat. In a place with full daylight for four months, we're seeking life that dwells in utter darkness. Welcome to the topsy-turvy world of Antarctica's

Mt. Erebus



A study in contrasts: ice and snow in the foreground, the lava lake of Mount Erebus below. Erebus is one of just a handful of volcanoes to boast a permanent lava lake. At the moment this picture was taken, the volcano was quiet, but it frequently erupts, hurling lava bombs high in the air.







A mix of ropes and ladders eases access to Warren Cave, a labyrinth of passages melted from the ice by the volcano's heat. Small currents of air probably cause the scalloping around the cave's entrance.



On a clear evening the main crater of the volcano is quiet, exuding just a few puffs of steam. Abutting it is another crater, now extinct. Beyond, a dreamscape of sea ice and ocean stretches to the mountains and dry valleys of the Antarctic mainland.



By Olivia Judson

Photographs by Carsten Peter



The scene: a tent on Mount Erebus, an active volcano on Ross Island, Antarctica. The tent is a four-cornered tepee modeled after those that Captain Robert Falcon Scott brought with him on his Antarctic expeditions more than a century ago. It is high enough at the center for someone five feet five inches tall to stand erect and has two vents at the peak that serve as chimneys. This particular tent is occupied by two people; both are in sleeping bags. Between the sleeping bags are a large box, a Primus stove, a couple of thermoses, and two pairs of heavy boots. It is too cold to read; even with gloves on, it is too cold to hold a book. Thus the inmates—of whom I am one—are passing the time by talking.

“What are your favorite microbes?” I say, dusting ice off my sleeping bag.

“It’s got to be those funky archaea,” says my companion, Craig Herbold, a large, thirty-something American with a taste for Japanese

electronic music and an interest in astrobiology, the study of what life elsewhere in the universe might be like. He’s a postdoctoral researcher at the University of Waikato in New Zealand and the junior member of a team of three who have come here to look for life in the volcano’s hot soils. That’s right. He’s come to one of the coldest places on Earth to look for beings that thrive in heat.

Mount Erebus is the most southerly active volcano on the planet. It began to form about 1.3 million years ago and now stands 12,448 feet above sea level. Its slopes are covered with snow and ice, glaciers, crevasses, and the occasional lava flow, but steam usually rises from its summit, betraying the heat within. If Erebus were a desert, it would be a reverse baked Alaska—frozen on the outside, hot in the middle.

It was discovered in 1841 during an expedition led by Sir James Clark Ross, who named it after one of his ships, the H.M.S. *Erebus*, which had in turn been named after the Greek god of primeval darkness. (Ross’s other ship, the H.M.S. *Terror*, gave its name to a smaller, extinct volcano that stands next to Erebus.) But no one reached the summit until 1908, when the mountain was climbed by members of Sir Ernest Shackleton’s Nimrod expedition—the expedition on which Shackleton led a team to within a hundred nautical miles of the South Pole but turned back so as to get everyone home alive.

Shackleton’s party hiked up Erebus. It took them five and a half days to get to the top, an undertaking that included a blizzard that kept them in their sleeping bags for more than 24 hours with nothing to drink, exposed them to temperatures of minus 30°F, caused one man to collapse with exhaustion, and gave another such an extreme case of frostbite that he ultimately lost a big toe.

Our journey was less arduous: We went by helicopter.

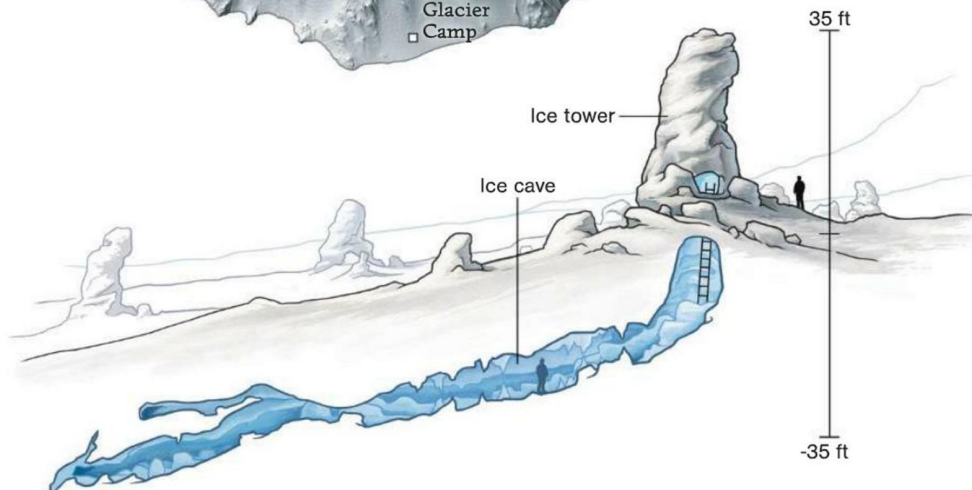
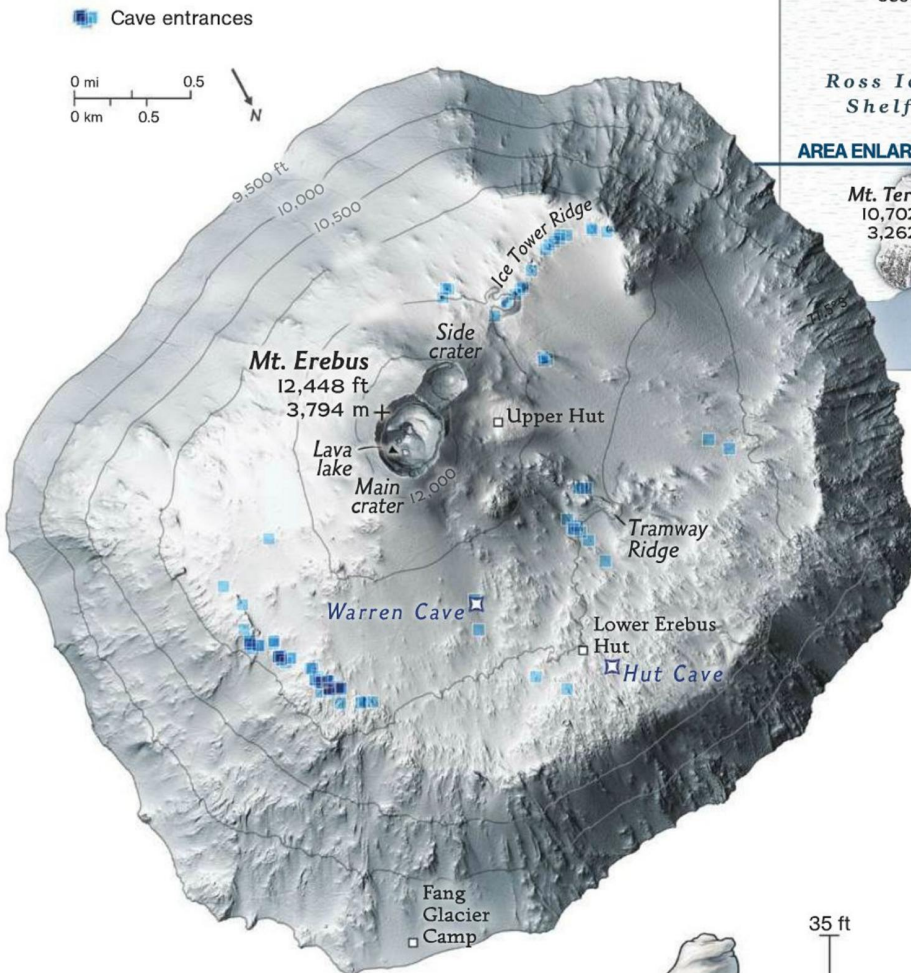
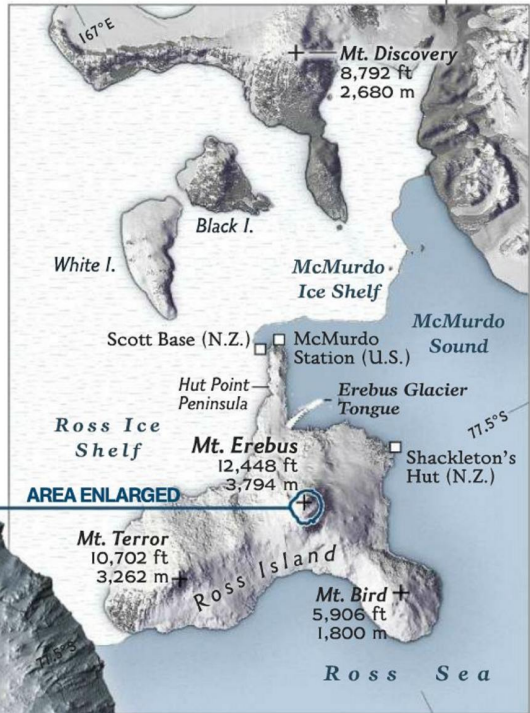
WE WERE EIGHT. There were the aforementioned Herbold and the two senior members of his research team: Craig Cary, a flamboyant American, and Ian McDonald, an understated

Olivia Judson is the author of Dr. Tatiana’s Sex Advice to All Creation. This is her first story for National Geographic. Carsten Peter’s last story was on Australian slot canyons, in October 2011.



Icy Inferno

Just a short helicopter ride from New Zealand's Scott Base and the U.S.'s McMurdo Station, the 12,448-foot Mount Erebus volcano dominates the skyline of Ross Island, Antarctica. The upper slopes, where temperatures can drop to minus 40°F in summer, are adorned with more than a hundred ice caves and towers.



Sculpted towers, melted caverns

The ice towers form over fumaroles, or vents, where hot, moist gases leak from within the volcano, instantly freezing in the cold air. Sculpted into strange shapes by wind, towers can reach more than 35 feet. Below the surface, frosty caverns are melted out of the ice by vent gases and the raw heat of the volcano.

MARTIN GAMACHE AND MATTHEW TWOMBLY, NGM STAFF
 SOURCES: BRITISH ANTARCTIC SURVEY; BEA CSATHO, UNIVERSITY AT BUFFALO; AARON CURTIS, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY; NASA; NATIONAL SCIENCE FOUNDATION U.S. ANTARCTIC PROGRAM

Englishman, both biologists at the University of Waikato, both veterans of Antarctic research. Cary also has an appointment at the University of Delaware, and before he began working in Antarctica, he traveled regularly to the bottom of the sea to study organisms that live on deep-sea vents. Stu Arnold and Al Moore, two wind-burned New Zealanders with broad shoulders and broader accents, had the job of keeping us from, in Arnold's words, "getting carnaged by the mountain." Then there were Carsten Peter, the photographer, and his assistant, Daniel Jehle, both from the mountains of southern Germany. And then there was me: in Jehle's words, "a girl."

Despite its remote location and savage climate—the temperature averages minus 4°F in the summer and minus 58°F in winter—Erebus

**If you don't eat
your food within
a few minutes,
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is a much studied volcano. Since 1972 a team of volcanologists, long led by Philip Kyle, a professor of geochemistry at the New Mexico Institute of Mining and Technology, has spent part of each austral summer on the mountain investigating matters such as the nature and frequency of its eruptions, the types of gases it gives off, and the age of its rocks.

The biology of the place has been less well documented. This is in part because up on Erebus most life-forms are microscopic. (The main exceptions are a few mosses and cyanobacteria—bacteria that, like plants, turn sunlight into energy and that can grow into colonies large enough for us to see.) Until recently the study of unknown microbes has been problematic: If you

couldn't grow it in the laboratory, you couldn't describe it, let alone study it. And most microbes don't take to laboratory life.

But it's no longer necessary to grow a microbe to know something about it. In the past decade or so, genetic techniques have been developed that allow whole communities of microbes to be characterized by their DNA alone, giving us a far more complete picture of what lives where. So although life had been found in the hot soils of Erebus in the early 1960s, it's only now that we're able to do much in the way of studying it.

The hot soils of Erebus are dotted around its summit, most famously at a site called Tramway Ridge. Heat from the volcano melts the ice, creating small patches of hot, moist soil that become home to communities of mosses and microbes.

But here's the thing. These patches are tiny islands of warmth in a sea of coldness. Although the soils themselves are hot—they can reach temperatures of 149°F—the air just above is not. Moreover, move a couple of feet away from the hot spot, and the soil temperature drops sharply. The acidity changes too. At the hot spot the soil is relatively neutral; a short distance away it's harshly acidic. And lifeless: Cold, dry, and acid is unfriendly to life.

The presence of these islands raises intriguing questions. Which microbes live there, and where did they come from? Microbes can travel hundreds of miles on the wind. Did these blow in from the hot soils of volcanoes farther north? Or are the microbes on Erebus unique, and—this would be tremendously exciting—are they beings that have come up from deep within the Earth? The deep subsurface biosphere, where these organisms live in rocks far below the surface of the Earth, is one of the planet's least known ecosystems. But it may be one of the largest—some estimates suggest that one-third of all bacteria on the planet might live there—and weirdest. Such microbes don't make their living by drawing energy from the sun. Instead, they get energy from other sources, such as iron or hydrogen. This deep, dark ecosystem might also be among the Earth's most primeval and

could be home to life-forms that have long been charting a separate evolutionary course.

With such matters in mind, we set off.

OUR TRIP BEGAN in the offices of Antarctica New Zealand, in Christchurch, where a jolly man called Chris issued us clothes: long underwear, two pairs of fleece trousers (thick and thin), two fleece jackets (ditto), a pair of wind-proof overalls, a light jacket of synthetic down, a windbreaker, a heavy jacket of real down, two pairs of boots, two pairs of thick socks, down tent slippers, nine pairs of gloves and mittens, a hat, a balaclava, a neck gaiter (a scarf shaped like a tube), snow goggles, and sunglasses. Because Antarctica is a desert, albeit a chilly one, Chris also gave each of us a widemouthed water bottle emblazoned with the command HYDRATE OR DIE! along with a list of the more common signs of dehydration.

Thus outfitted, we flew on a U.S. military transport plane—along with a few other passengers and some huge crates labeled “Do

not freeze”—to Ross Island. We landed on an expanse of sea ice and stepped out into a landscape of white, blue, and gold. White: ice, snow, clouds. Blue: sky, certain kinds of ice, and where you can see it, open ocean. Gold: reflections of the sun off ice or clouds. But we didn’t have long to take it in, because we were met by a man wearing a gigantic bobbed hat and driven the short distance to Scott Base, New Zealand’s research station in Antarctica, for training.

Even in these modern times, when if something goes wrong there’s a reasonable chance of rescue, the practicalities of Antarctic travel are detailed and complex. “Make no assumptions,”

The microbiology team gets ready to sample the volcano’s hot soils. To protect the resident life-forms from invasive ones, the researchers spray their boots with ethanol to remove any contaminants and wear sterile suits over their cold-weather gear—giving them the look of monstrous snowmen.





It's midnight, but with the light so bright, it's hard to stop exploring the ice towers. This is one of the biggest on Erebus, but the flux of heat and moisture from below has collapsed its side. In the distance, beyond another ice tower, the Hut Point Peninsula extends like a finger toward Mount Discovery.





Inside the ice caves the volcano's warm, wet air freezes into frost crystals that grow into different shapes, depending on how the air currents flow. Here, a team member investigates the passages of Hut Cave. At left, light filters greenly through a vent encrusted with frost crystals in Warren Cave.



Explore the crystal interior of Hut Cave in the iPad edition.



said Arnold on the first day of our training. “Check all your equipment.”

McDonald leaned over to me and said, “Be sure to check that your thermos works—that it keeps water hot overnight and doesn’t leak.”

“Do you still have the water bottle we bought in New Zealand?” said Cary. I nodded. “Take it with you. It’s easier to drink from when you’re lying in the sleeping bag. If you drink from the one you were issued, you could pour water all over yourself—and oh boy, then you’re in trouble.”

Trouble, because wet means cold. At best, wet clothes and sleeping bags wick warmth away from your skin. At worst, they freeze into a suit of ice. One of the early explorers described how he left his tent in clothes merely damp from sweat and the humidity of his own breathing: “Once outside, I raised my head to look round and found I could not move it back. My clothing had frozen hard as I stood—perhaps fifteen seconds.” Yikes.

And so we tested thermoses and water bottles. We went on excursions to try out the clothes—different combinations suit different people—and went shopping at nearby McMurdo Station, the American base, for snowmobile masks. Also at McMurdo, a tattooed motorbike enthusiast called Toby taught us to “he-man” snowmobiles and explained how to change the spark plugs. Back at Scott Base we assembled sleeping kits. On the bottom a foam mat. Next an inflatable air mattress. On top of this a sheepskin rug. “Because we’re Kiwis and we like sheep,” said Arnold. Finally two down sleeping bags, one inside the other plus a polar fleece liner, inserted into a protective covering. All this done, we weighed everything, including ourselves, because helicopters are easy to overload.

Then we waited. The evening we were due to fly up the mountain, a big cloud was sitting on top of it. It wasn’t until late the next afternoon that the weather cleared enough for us to go.

FIRST STOP, Fang Glacier Camp, a site on the side of the volcano about 9,850 feet above sea level, where we were to spend several days letting our bodies get used to the altitude. Fang



sits on a snowfield at the top of a glacier with a view of the mountains of the Antarctic continent on one side and of the snow-clad summit of Mount Terror on the other. The dark fang of rock for which the camp is named juts into the sky in front; it’s the remnant of a caldera that collapsed hundreds of thousands of years ago. When the wind drops, the silence is total. No engines, birds, insects; no rustling leaves. Also, at this time of year the sun doesn’t set, and the light is bright—ski-slope bright—all the time. The only difference between noon and midnight is that at midnight the shadows are longer and the air is colder.

But Fang Camp is just that, a camp. Whereas our eventual base of operations, Lower Erebus



Hut, has two small buildings (the eponymous hut and a shed) with electricity, heat, chairs, tables, and a stove with an oven, Fang consists of nothing but a row of tents pitched on snow.

Camping in this environment presents certain difficulties. For example, if you don't eat your food within a few minutes of its being cooked, it will freeze. One morning I didn't eat my cereal fast enough—and had to chip it out of the bowl. The only way to keep something warm is to heat it with your own body heat. This means you must keep it with you in your sleeping bag. Which is how I came to share my sleeping bag with lip balm, moisturizer, toothpaste, baby wipes, a camera, a watch, several pens, one pair of tent slippers, two pairs of gloves, two water

Stu Arnold of the research support agency Antarctica New Zealand steadies a drill bit, while microbiologist Craig Cary drives it into an ice-tower wall. Moments later, cries of delight: They have a perfect ice core. They hope it will contain microbes lofted from deep within the volcano and frozen in the tower ice.

bottles, three batteries, and three pee bottles.

Pee bottles? To acclimate to altitude you must drink one and a half to two gallons of liquid a day, all of which, incidentally, has to be made by melting snow. Drinking so much has obvious consequences. So at Fang there is a toilet tent. However, to go to the toilet tent you must

get completely dressed; when it's 40 below outside, you don't sally forth in pajamas. For convenience, therefore, you stay in your tent and pee into bottles. When these are full, you go to the toilet tent and empty them. If they freeze—you're stuck.

Meanwhile, there's nothing to do at Fang but talk to your tentmate and melt snow. And so it was that Herbold and I came to be discussing the funky archaea.

"They're so strange," Herbold says. "I just can't figure them out."

Archaea are one of the three main branches, or domains, of the tree of life. (The others are bacteria, and eukaryotes—organisms with nuclei in their cells, like plants, fungi, and animals.) And although archaea can and do live in

Are the microbes on Erebus unique, and did they come up from deep within the Earth?

mundane places such as the open ocean, they are also celebrated for being extremophiles—life-forms that thrive in the most extreme environments this planet has to offer. Such as boiling acid—that sort of thing. So it's not surprising that they should be lurking in the hot soils of Mount Erebus.

But these archaea are particularly mysterious. Found in soils that the group collected on previous trips to Erebus, so far they're known only from their DNA sequences, which bear little resemblance to those of archaea that have been discovered elsewhere. This suggests, perhaps, that they have indeed long been charting their own evolutionary course. Are they from the deep subsurface? It's too soon to tell.

"We found them on Tramway, right underneath the cyanobacterial mats," Herbold says. "But we don't know anything about their lifestyle." He pauses, then adds, "The cyanobacterial mats are creepy. They look like matted hair that's been splattered on the ground and partially digested."

As we talk, the wind begins to pick up. Soon it's too loud to hear each other. For the next 15 hours the wind hurls ice crystals at the tent and makes the walls rattle and flap. The only thing to do is lie huddled in the sleeping bag, listening.

It's a relief when two days later we are deemed acclimated, the skies are clear, and a helicopter thuds into view.

THE FLIGHT FROM FANG to Lower Erebus Hut is brief. But you arrive in a different landscape. Above, the crater of Erebus, steaming gently. Two buildings, the hut and the shed. An array of solar panels. And a row of fantastically shaped ice towers. The largest looks like an astronaut, and the others look as if they're following in procession. I'm not alone in seeing figures in the ice towers. Shackleton's men took a photograph of themselves with one that they thought resembled a lion. And as they surmised, the ice towers mark the sites of fumaroles—vents where the volcano releases hot, moist gases. When the moisture hits the cold air, it freezes, building structures that can be more than 35 feet tall.

Lower Erebus Hut is simple—one room plus an antechamber for frozen food—but compared with Fang, it's a luxury hotel. Here's a typical evening. Above the heater, a row of gloves drying. Herbold is in one corner, sterilizing equipment to take into the field the next day. McDonald is bringing in a vat of snow to make more water. Cary is talking about how Erebus is part of a larger study of volcanic hot soils: They already have soils from other Antarctic volcanoes, they went to Yellowstone last summer, and they plan to go to Costa Rica soon. Jehle is cooking. Peter is worrying about his cameras. Arnold is making a radio call to Scott Base. Moore is outside fixing one of the snowmobiles. And I'm washing up and thinking about the immensity of the landscape.

THE ACTUAL DOING of scientific fieldwork is often humdrum. But on Erebus the humdrum takes you to astounding places. Let me paint three scenes.

One, we're wearing harnesses and hard hats and descending on ropes and ladders into an ice cave known as Warren Cave, which has been hollowed out by steam from the volcano. We unclip the harnesses about 40 feet below the surface of the mountain. The floor is moist, soft soil and rocks; the walls are ice. We are here to retrieve a temperature probe—one of 23 the group left on the mountain a year ago in the hopes of determining how much the soil temperatures change and thus whether these environments are relatively stable. As we move away from the entrance, the light fades, and we have to use flashlights. Any microbes living here do not depend on the sun. Now we have entered a cavern that glitters with clusters of delicate, feathery ice crystals. We stop to stare in wonder. Then Moore disappears down a corridor and after a few moments gives a shout. He's found the probe.

Two, we're standing on the rim of Mount Erebus. To get here we've driven as far as we could on snowmobiles, then hiked up a steep, slippery slope of scree—a mix of a glassy pumice and "Erebus crystals," large oblong pieces of feldspar from lava bombs that have been tossed out by the volcano. It's a gorgeous day: The temperature is around minus 13°F, the wind is light, the sky cloudless, the views huge. And the volcano is quiet. Whereas the crater is often full of swirling steam, today we can look down to the bottom, more than 750 feet below, and see the lava lake glowing redly. It's an eerie sight, like looking at a conduit to the center of the Earth.

Up here the air is thin and walking is slow. I'm wearing a thermal shirt, thermal leggings, wool leg warmers, fleece trousers, heavy overalls, a down vest, a fleece jacket, two down jackets, two pairs of socks, heavy boots, three pairs of gloves, a balaclava, a hat, a snowmobile mask, a neck gaiter, ski goggles, and two hoods. Dressed like this, I am bulky and clumsy but warm. Just. As long as we keep moving.

But we've stopped. Herbold is on his hands and knees digging, looking for another of the temperature probes. I hope he finds it soon; I want to start moving again. I have a sudden sense of vulnerability, of being in a landscape that is not benign.

Three, Lower Erebus Hut. Outside, a swirling storm. The door crashes open. Arnold and Moore stride in, their jackets icy, their faces grave. Arnold tosses an ice ax onto the table. It's broken; part of the top has sheared off because of the cold. There will be no ice climbing this afternoon. But we can enter the biggest of the nearby ice towers—the one that looks like an astronaut—and drill an ice core from inside.

Inside, the air is moist and warm. The floor is rocky, with a dusting of ice. Sky is visible through an opening high above. The drill bit looks like a boy-teen fantasy. It's enormous—three feet long—and bright yellow, with a thread of lurid orange. It takes two men to operate, one to cradle it in position, the other to push it into the side of the tower. The interior of the bit is hollow, and pushed like this, it fills with a core of ice, much as an apple corer fills with apple.

Success! Arnold and Cary remove the ice core from the drill bit and stow it in a bag. The hope is that such cores will contain microbes that have been lofted from inside the volcano and then frozen into the ice, giving a window into the microbial life in the vent below.

TWO WEEKS AFTER GOING up the mountain we come down. A few days after that McDonald and Cary and I fly back to New Zealand, along with boxes of samples destined for the laboratory—"where the real work gets done," says Cary. Shortly before the end of the flight a man comes over to McDonald and me and asks if we'd like to come to the cockpit for the landing. Yes please!

We are landing at sunset. Strange how refreshing the impending darkness is—how starved for darkness we have been. Strange too the lush, saturated colors of the New Zealand spring. It's like coming back into a Technicolor world.

It's like coming back to Earth. □



Russian Summer

Summer, the short, sweet release from the interminable cocoon of Russian winter, is a time for swimming and riding, and sometimes both in the cottage community of Vyalki.



*At the dacha, the soul of Russia—
and its cultural divide—is on display.*





The dacha is where Russians connect with nature and each other. On weekends (from left) 11-year-old German Shingel; his great-aunt Vera Zhelkina; his mother, Milana; and his grandmother Lyubov Saleyeva gather at their summer home in Valday.

By Cathy Newman

Photographs by Jonas Bendiksen

Everyone in Russia has a dacha story. It may be a trace of childhood memory like playing ball late into evening by grace of a sun that won't set, gathering pinecones to perfume the samovar fire, or swimming in an icy pond rimmed by the green spires of spruce.

It may be quietly romantic—a first love that fades with the season or blossoms into marriage. Or a narrative that is poignant, even redemptive. An older woman tells of coming home from work to find her husband in bed with her best friend. She kicked him out and, with retirement looming and no husband, wondered, What will I do now? The answer was the dacha she bought for 500 rubles, with a forest nearby for mushroom hunting, a lake, and a garden. “The dacha saved my life,” she says.

The story may be wreathed in sorrow, refracted through the lens of Russia's tragic history. After Natalia Ivanova's grandmother, a young widow with two children, remarried, her new husband bought a dacha outside Moscow. When he disappeared in a Stalinist labor camp, she stayed at the dacha for the rest of her life. “She never sowed anything, even flowers—only grass, which became thicker and thicker,” remembers Natalia, a Moscow writer and editor. “A childhood photograph shows it reaching well above my head.”

Sweet or bitter, lighthearted or dark, the story always takes place in summer. A dacha, after all, is a summer cottage.

Boris Veshnyakov has dacha stories too. They are muscular, with overtones of swagger. Once he confronted a group of teenagers who were drinking and blasting boomboxes in his dacha community near Valday, a town in

northwest Russia. “I picked a couple of them up and dunked them in the lake. Physical force is the only language they understand.” Another time, a beefy lout, flouting dacha decorum, let his dog swim in the lake. “I called over my son-in-law, the wrestler. End of problem.”

When Boris isn't at the dacha, he's driving a cab. One day while speeding down a road, he pointed out a pit where *dachniks* from big cities open their car doors and fling their garbage. “That's how it is in Russia today,” he groused. But Boris had a plan. He was going to set a camera trap to catch offenders.

Until then, Boris, a 63-year-old man with ice-blue eyes, a belly with the contours of an ingested basketball, and an array of short-sleeve shirts with tropical prints more typical of Maui than Moscow, was just Boris the cabdriver to me. Then I discovered his other identity. He was also Chairman Boris, the put-upon leader of Nertsy, a community of a thousand-odd dachas in Valday.

BORIS'S KINGDOM, the realm of the dacha, is a Russian phenomenon. One out of three Russians owns a dacha. In the Moscow region, where there are some one million dachas, Friday night marks the onset of dacha rush hour, in which the laws of inertia decree that a car at rest in dacha traffic stays at rest for a very long time.

The dacha has threaded its way through Russian



Six-year-old Polina Merkulova hides in the bushes outside her family's dacha near Sergiyev Posad, about 50 miles northeast of Moscow. An hour's drive brings the family from city to country.

culture ever since Peter the Great handed out land on the outskirts of St. Petersburg to courtiers. (“Dacha” is derived from the Russian verb “to give.”) The dacha is the stage upon which the drama (or comedy) of Russian summer unfolds. Summer in Russia is precious and brief; winter, interminable. The growing season in the taiga around St. Petersburg is a short four months. In western Europe it stretches eight months or more. A fifth of Russia is above the Arctic Circle. More than half is underlain by permafrost. The advent of spring, then summer, is a fairy tale of sorts. The soil thaws, as does the soul.

A dacha community is Russia abridged, with its stories of love, loss, and suffering; frictions; conflicting narratives in which everyone seems to have the True Story but no one really does; free-flowing vodka; and opportunities for corruption. (Municipalities grab property illegally and sell it to developers for dacha subdivisions.) It's a place to brood, ponder life, party, cherish the company of family and friends, and more recently it's become a badge of conspicuous, over-the-top consumption for Russia's new money. The dacha

is a litmus test for changing Russian values and a celebration of those that stay the same.

Boris's dacha, like most in Valday, is a garden plot with a cabin. Such plots, originally six *sotkas* (.15 acre), date back to Soviet-era land distribution programs that allowed Russians to endure postwar food shortages made worse by the disaster of centrally planned agriculture. With privatization in 1990, owners could buy land and expand beyond six *sotkas*, but the landscape remains a mishmash of shoulder-to-shoulder dwellings. Decor tends to out-of-date calendars, mismatched crockery, paintings of bears in the forest, and lace curtains hanging in doorways to defend against mosquitoes.

On the other end of the spectrum are *kottedzhy* (cottages), the name for the wannabe castles built by New Russians, postcommunism's superspenders. Many communities of steroidal cottages—there are 500 around Moscow—have

Editor at Large Cathy Newman last wrote about Crimea. Jonas Bendiksen is the author of Satellites, a photo chronicle of the former Soviet Union.





At his Valday dacha Sergey Yudin, deputy director of a pipeline-repair firm, plants, burns weeds, and indulges the “inner peasant” who lives within many Russians. In pinched Soviet times such gardens grew some 90 percent of Russia’s vegetables.

Boris insists that when Putin visits, scuba divers patrol the lake in front of the compound, which has a Turkish bath, a Russian banya, a Chinese teahouse, and a Finnish sauna.

elbowed aside traditional dachas and sometimes become primary residences. “Oligarchs go to the Loire, see castles, and say: I need one of those,” Konstantin Kovalyov-Sluchevskiy, a local historian, says dryly. Interiors tend to early Las Vegas: marble columns that hold up nothing, gilt thick as a call girl’s mascara. On the outside are high stone or brick walls, sometimes with slits, as if to allow archers to shoot burning arrows at any peasant foolish enough to attempt a breach. “Their owners have not developed a soul,” Konstantin observes sadly.

Valday doesn’t have many over-the-top *kot-tedzhy*, but it does have a dacha used by Russia’s President Vladimir Putin, who drops in from time to time by helicopter. Boris insists that when Putin visits, scuba divers patrol the lake in front of the compound, which has a Turkish bath, a Russian *banya*, a Chinese teahouse, and a Finnish sauna. It might be true; then again, it might not. It isn’t easy to know when to take Boris—who believes in angels but has a tattoo of a devil playing guitar on his left shoulder—seriously.

The pride of Valday (population 16,000) is its 390,000-acre national park. The terrain, a slow roll of birch-covered hills dotted by 200 lakes, overlies a watershed that sources two great rivers: the Dnieper and the Volga. Cool, green, quiet, it is an idyllic refuge from the heat of the city. In summer the population doubles, according to an informal census based on bread sales.

Though it is only about 225 miles from Moscow to the south and 180 miles from St. Petersburg to the north, the two cities might as well be on the moon as far as Valday is concerned. Big-city *dachniks* are regarded as an alien species best avoided, in the way that one tries not to brush against stinging nettles in the forest.

Though I suspect he is mistaken, Boris insists that only city folk trash their surroundings; locals would never be so remiss.

It’s a cultural divide, says Maxim Semyonov, editor of Valday’s weekly. “Our village past is still present. Our first multistory building went up only 40 years ago.” City folk, Maxim explains, consider the dacha a place to relax. “In Valday a dacha is about hard work and serious gardening.” Nadezhda Yakovleva, a soft-spoken woman with delicate features who runs the local museum, provides more evidence. She points to an 1839 photograph of Muscovites picnicking in Valday. “With French wine and sandwiches,” she says in pitying tones. The habits and attitudes of modern-day Muscovites are no better, she implies. “They don’t eat healthy. They lie in hammocks and don’t worry about bad weather like us. In their kitchen garden, called a supermarket, there will always be crops.”

In Boris’s community of Nertsy about 30 percent of the thousand dachas are owned by people from St. Petersburg or Moscow. “They have generators and pumps,” says Raisa Stepanov, a retired bookkeeper, with a tinge of envy. She has neither. A dacha with no running water or electricity is the rule. Raisa’s small wood dacha, painted three different shades of yellow, stands next to a birch tree. Rather it leans on the tree as if for support. There’s an outdoor privy in back.

A word about the dacha dress code in Valday: Women favor two-piece bathing suits with a faded ’50s look or cotton housedresses. For men: Speedos, sometimes paired with rubber boots. (Why do Russian men wear Speedos? “I don’t know, but it is truly Russian,” says Melissa Caldwell, a social anthropologist at the University of California, Santa Cruz. “I once almost had to burn my eyes after walking through a park in St. Petersburg and encountering what seemed like thousands of middle-aged men sunbathing in their Speedos.”)

Nina Marmashevya, Raisa’s best summer friend, joins us for green *schi*, a summer soup made with sorrel. Nina, a sturdy woman with hair the color of paprika, does not so much hug as crush me against her bosom. Small glasses



A Summer Space

The dacha follows a historical arc from aristocratic privilege (in the 18th century Peter the Great granted nobles parcels of land on the outskirts of St. Petersburg for summer palaces) to today's modest cottage communities. The map locates communities and places featured in the text.

appear on the table. Raisa fills them with homemade brandy. Soon the women are pleasantly tipsy, and Nina wanders over to Raisa's garden and starts picking potato beetles off leaves.

It is hard to say if Raisa's garden represents a labor of love or love of labor. Raisa, who is 68, makes fertilizer from compost, waters plants by hand with buckets from a well, and lugs her harvest home in shopping bags on the bus. At the end of summer she has more than 200 jars of preserves to see her through winter. "Each year I say that's it, I am not planting. But then in spring I do."

"So why not taper off?" I suggest. "It doesn't seem terribly relaxing."

"It's relaxing to me," Raisa says.

But a dacha means different things to different generations. Recently her daughter, who has two kids, bought a house in the city. "She is struggling," Raisa says. "I offered to sell my dacha to help her out."

"No, you can't sell it," her daughter said firmly. "At least I can still come here with the kids and go swimming."

VALDAY IS WHERE JOSEPH STALIN had a secret dacha he probably never used. One story says the paranoid dictator took one look at the dacha—known as Object No. 201—at the end of a solitary road at the end of a peninsula and said something like: I'm never staying in that mousetrap. But Valdai historian Galina Zimina suggests that Stalin, who had 20 other dachas around the Soviet Union, just never got around to it. "We'll know when they release more of Stalin's archives," she says.

In 1935 Stalin ordered the creation of a dacha colony for writers in Peredelkino, outside of Moscow. In Soviet times political and cultural elites were rewarded with country homes. Artists, party bosses, even cosmonauts, had their own summer compounds. The dacha was the carrot to the stick of the gulag. "Peredelkino was Stalin's way of keeping writers under control," says Konstantin, the historian. "He could keep an eye on them in one place."

In his study on the second floor of his dacha, in the green shade of Peredelkino, Boris





To stand under the springs at Gremyachiy Klyuch, nine miles from Sergiyev Posad, where a saint once stopped to pray, is to be showered with blessings. Tourists from all over Russia come to collect the holy water—reputed to cure illness—in buckets.

“A dacha has no address,” Konstantin says. “In detective movies the criminal always hid out in a dacha where he could not be found. A dacha was freedom.”

Pasternak wrote *Doctor Zhivago*, the novel that won him the Nobel Prize in 1958. He accepted. “Proud, astonished, abashed,” he wrote the Swedish Academy. The Soviet state thought otherwise. A vicious campaign against him, the possibility of exile, the threat to family (secret police surrounded his dacha) forced him to retract. One can only imagine his pain. At Pere-delkino he would tend his garden, bent over, covered with dirt. “The natural world revived him,” says the dacha’s curator, Irina Samokhina. His tweed cap, plaid scarf, and black overcoat still hang on the wall, as if he had just returned from a walk. Pasternak loved striding across the fields near his dacha, especially the one that led to the church where he prayed. Today the field is covered in newly constructed kottedzhy.

“NERTSY IS NOT A COLLECTION of dachas,” Chairman Boris tells me as I sit on the deck of his dacha admiring the lake view. His sister-in-law, who has been drying garlic, brings us a plate of fried fish, sliced cucumbers, and potatoes sprinkled with dill from the garden. There is no such thing as an unfed guest in a Russian dacha.

“It’s family,” he says. “When my neighbor grieves, I grieve. When I am joyful, so is he.” He repeats a common refrain: “There is no conflict. Everyone gets along.” True enough, though small irritations that abrade goodwill between neighbors seep out like water from a slowly dripping faucet. Nertsy, unlike the fortress dachas of Moscow suburbs, is a no- or low-fence community, but property lines still matter. Woe to the dachnik whose cucumber vines stray an inch onto public space or an adjacent holding.

A slight chill descends when discussion turns to Katya, a neighbor of Raisa Stepanov’s. Katya

lives near the path leading to Lake Nertsy. “Her garden keeps edging closer to the lake,” Raisa complains. “If her plants get trampled, she has only herself to blame.” Scratch a disagreement, and you’ll find a boundary issue. When arbitration is required, Boris appears with a survey pole to map the parameters of the dispute.

The penalty for infractions?

“A fine,” says Boris. “But just try and find the person to pay the fine.” His face darkens. Boris would like someone else to take over the unpaid post of chairman. But no one wants the job.

THE SOIL IS SACRED, almost mystical to Russians, a legacy of pagan beliefs and peasant tradition. “The religion of the soil,” philosopher Nikolay Berdyayev called it. A dacha provides the opportunity to dig in that soil and be close to nature. “By the end of the day I am tired and stressed,” a Valday woman tells me. “I go to the garden, touch the ground, and bad things go away.”

In July the soil yields cucumbers and feathery dill, also squash, peas, and green onions. July is for berries: black, red, and white currants; blueberries; blackberries; raspberries; gooseberries; and delicately perfumed wild strawberries, which, even more than the resinous astringency of pine, is the smell of summer. August brings mushrooms (a light rain is known as a “mushroom rain”): the prized *biali*, or white mushroom, and boletes that grow near birch trees and can be dried. Also potatoes—always potatoes. A Valday garden is unthinkable without them, although they cost less to buy than grow.

Galina Yertseva, an economist for the town, grows potatoes along with her two sons’ families and her in-laws. “Why? It’s in the blood,” she says. Perhaps, I suggest, it’s a genetic memory associated with times of famine, like after World War II, when people picked over fields for rotten potatoes to mix with weeds to make flour. Galina agrees. Her six-year-old granddaughter is playing in the garden. I ask if she has any aptitude for growing potatoes. “Hardly,” Galina answers.

The work of growing food may be an instinct passed on from generations that knew hardship, but a younger generation with no such memory



At the lavish end of the dacha spectrum are faux châteaux like these at Zelenyy Mys. Roughly half are permanent residences. A helicopter landing pad and yacht club are among the amenities for well-heeled owners.

or interest is stepping into place. “Given a good enough economy, I think in the future the dacha will be purely for investment and entertainment and not a source of food,” says researcher Tatyana Nefedova of the Institute of Geography in Moscow. As the dacha shifts from the Soviet-era ideal place for dutiful toil to a retreat for the sheer fun of it, the decorative replaces the practical: flowers instead of potatoes, plaster gnomes instead of onions.

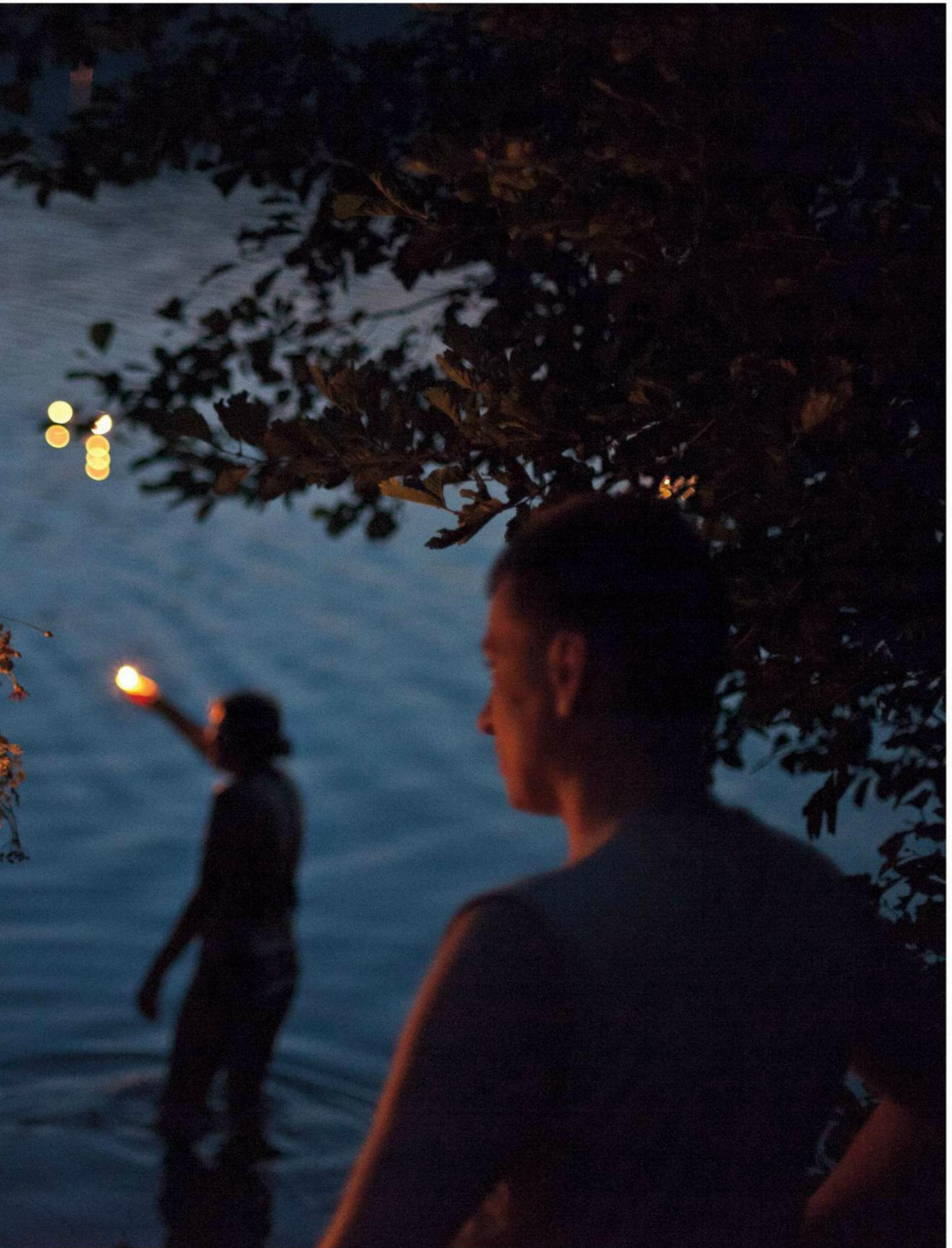
In Soviet times the dacha also was a respite from the communal apartment. In a world where the word “private” was missing from the dictionary and a drape served as a wall, the dacha provided room to breathe and escape from watchful eyes. “A dacha has no address,” Konstantin says. “In detective movies the criminal always hid out in a dacha where he could not be found. A dacha was freedom.”

Now that the Iron Curtain has been lifted and Russians can come and go as they please, there is a wider world beyond the dacha. In 2011 three times as many Russians traveled abroad for summer vacation as in 1997. “When our daughter

was little she came to the dacha,” says Tatyana. “Now she prefers Croatia.” “Visiting is good, but home is better,” a Russian proverb avers. Sometimes we need distance to appreciate what is near at hand. Will a more affluent and worldly generation of young Russians buy into that thought and cherish the homely dachas of their parents? Naturally, Boris, from his summit view at Nertsy, has a story about that too.

One day his 30-year-old daughter, Vladislava, came home to visit after a trip abroad. “She travels everywhere,” Boris says. “Egypt, Italy, Turkey.” This time, Vladislava, who works in advertising and lives in St. Petersburg, had gone to comfortable, orderly Switzerland. But Vladislava had had her fill of Swiss perfection. Now she longed for the familiar warmth of cobbled-together, unruly Nertsy. She sat on the deck of the family dacha and gazed at the calm, green oval of Lake Nertsy. Sunbathers stretched out on half-sunken docks splintered by winter ice. Water lilies floated like tiny yellow coronets. “Lake Geneva,” she said airily. “It’s just a pond.” □





Midsummer Night, known as the festival of Ivan Kupala (St. John the Baptist), is marked by candles and flower garlands in Vladimirskeye. Celebrants walk three times around Svetloyar Lake, which legend says makes wishes come true.



Barrel-bellied bathers (above), picnicking near the Dubna River, are as much a part of the summer scenery as grilled meat and beer. German Shingel fills a tub for watering the garden under the watchful eye of his father, Yevgeniy (below). To outwit Russia's short growing season, many dacha owners set flats of seedlings on their urban windowsills in March.





Shoes and inhibitions are shed (above) during a party at a dacha belonging to a Muscovite in the film industry. Like many, Anna Merkulova (below) is a weekend dachnik. She returns to Moscow on Mondays for her job as a dog groomer, leaving her children, Polina and Yegor, behind in the hands of their grandmother.



Deepwater Horizon Oil Spill

Economic and Property Damages Settlement

Providing Money to Individuals and Businesses

If you have economic loss or property damage because of the Deepwater Horizon oil spill, you could get money from a class action settlement with BP Exploration & Production Inc. and BP America Production Company ("BP"). Go to DeepwaterHorizonSettlements.com for more information, including information on how to file a claim.

WHO IS INCLUDED IN THE ECONOMIC & PROPERTY DAMAGES SETTLEMENT?

The Economic and Property Damages ("E&PD") Settlement Class includes people, businesses, and other entities in the states of Louisiana, Alabama and Mississippi, and certain counties in Texas and Florida, that were harmed by the oil spill. The website DeepwaterHorizonSettlements.com has detailed descriptions and maps to help you determine whether a geographic location may be included in the E&PD Settlement. Additionally, you can call 1-866-992-6174 or e-mail questions@DeepwaterHorizonEconomicSettlement.com to find out if a geographic location is included.

WHAT DOES THE ECONOMIC & PROPERTY DAMAGES SETTLEMENT PROVIDE?

The E&PD Settlement makes payments for the following types of claims: (1) Seafood Compensation, (2) Economic Damage, (3) Loss of Subsistence, (4) Vessel Physical Damage, (5) Vessels of Opportunity Charter Payment, (6) Coastal Real Property Damage, (7) Wetlands Real Property Damage, and (8) Real Property Sales Damage. There is no limit on the total dollar amount of the E&PD Settlement; all qualified claims will be paid.

HOW TO GET BENEFITS FROM THE ECONOMIC & PROPERTY DAMAGES SETTLEMENT

You need to submit a Claim Form to request a payment. You can get a copy of the various Claim Forms by visiting the website or by calling 1-866-992-6174. Claims can be submitted online or by mail. If you have questions about how to file your claim, you should call the

toll-free number for assistance.

The deadline to submit most E&PD claims will be April 22, 2014 or six months after the E&PD Settlement becomes effective (that is, after the Court grants "final approval" and any appeals are resolved), whichever is later. There will be an earlier deadline to submit E&PD Seafood Compensation claims. The earlier deadline to submit Seafood Compensation claims will be 30 days after final approval of the Settlement by the United States District Court for the Eastern District of Louisiana (regardless of appeals). Actual claim filing deadlines will be posted on the website as they become available. Valid claims will be paid as they are approved, beginning shortly after the Court-Supervised Settlement Program commences. It is highly recommended that E&PD Settlement Class Members complete and submit their claim forms promptly. Please read the Medical Benefits Settlement notice because you may also be eligible for benefits from that settlement.

YOUR OTHER OPTIONS

If you do not want to be legally bound by the E&PD Settlement, you must Opt Out or exclude yourself by **October 1, 2012** or you won't be able to sue BP over certain economic and property damage claims. If you stay in the E&PD Settlement, you may object to it by **August 31, 2012**. The Detailed Notice explains how to exclude yourself or object.

The Court will hold a hearing on **November 8, 2012** to consider whether to approve the E&PD Settlement. You or your own lawyer may ask to appear and speak at the hearing at your own cost. The Court will also consider Class Counsel fees, costs, and expenses including an interim payment of \$75 million and additional awards equal to 6% of class claims and benefits paid. Class Counsel fees, costs and expenses under the Economic and Property Damages Settlement Agreement and the Medical Benefits Settlement Agreement jointly cannot exceed \$600 million. Class members' payments will not be reduced if the Court approves the payment of Class Counsel fees, costs, and expenses because BP will separately pay these attorney fees, costs, and expenses.

Deepwater Horizon Oil Spill

Medical Benefits Settlement

Providing Benefits to Clean-Up Workers and Certain Gulf Coast Residents

If you have a medical claim related to the Deepwater Horizon oil spill, you could get benefits from a class action settlement with BP Exploration & Production Inc. and BP America Production Company ("BP"). Go to DeepwaterHorizonSettlements.com for more information, including information on how to file a claim.

WHO IS INCLUDED IN THE MEDICAL BENEFITS SETTLEMENT?

The Medical Class includes (1) clean-up workers and (2) certain people who resided in specific geographic areas in coastal and wetlands areas along the Gulf Coast during specific periods in 2010. The website DeepwaterHorizonSettlements.com has detailed descriptions and maps to help you determine whether a geographic location may be included in one of these zones. Additionally, you can call 1-866-992-6174 or e-mail info@DeepwaterHorizonMedicalSettlement.com to find out if a geographic location is included.

WHAT DOES THE MEDICAL BENEFITS SETTLEMENT PROVIDE?

The benefits of the Medical Benefits Settlement include: (1) payments to qualifying people for certain acute (short-term) and chronic (ongoing) medical conditions occurring after exposure to oil or chemical dispersants; (2) provision of periodic medical examinations to qualifying people; and (3) creation of a Gulf Region Health Outreach Program, consisting of projects to strengthen the healthcare system. Benefits (1) and (2) will be provided only after the Court grants final approval and any appeals are resolved.

HOW TO GET BENEFITS FROM THE MEDICAL BENEFITS SETTLEMENT

You need to submit a Claim Form to request benefits. You can get a copy of the Claim Form by visiting the website or by calling

1-866-992-6174. Claims can be submitted by mail. If you have questions about how to file your claim, you should call the toll-free number for assistance.

The deadline for filing a Claim Form is one year after the Medical Benefits Settlement becomes effective (that is, after the Court grants "final approval" and any appeals are resolved). The exact date of the claim filing deadline will be posted on the website. It is highly recommended that Medical Class Members complete and submit their claim forms promptly. Please read the Economic and Property Damages Settlement notice because you may also be eligible for a payment from that settlement.

YOUR OTHER OPTIONS

If you do not want to be legally bound by the Medical Benefits Settlement, you must Opt Out or exclude yourself by **October 1, 2012** or you won't be able to sue BP over certain medical claims. If you stay in the Medical Benefits Settlement, you may object to it by **August 31, 2012**. The Detailed Notice explains how to exclude yourself or object.

The Court will hold a hearing on **November 8, 2012** to consider whether to approve the Medical Benefits Settlement. You or your own lawyer may ask to appear and speak at the hearing at your own cost. Class Counsel will ask the Court to consider an award of fees, costs, and expenses of 6% of the value of the benefits actually provided under the Medical Benefits Settlement Agreement. Class Counsel fees, costs, and expenses under the Medical Benefits Settlement Agreement and the Economic and Property Damages Settlement Agreement jointly cannot exceed \$600 million. Class members' payments will not be reduced if the Court approves the payment of Class Counsel fees, costs, and expenses because BP will separately pay these attorney fees, costs, and expenses.

NATIONAL GEOGRAPHIC ON TV



The Hutterites

Like most families, they bicker now and then. Yet this group from rural Montana is hardly typical. Meet the Hutterites of King Colony (left). Their conservative way of life revolves around worship and work, but modern technology and higher education are tempting some to break away. It's all about reconciling the past with the present, this month on the National Geographic Channel.

WORKSHOP

CLASS IS IN SESSION Learn from the best photographers around at one of National Geographic's workshops. Choose from destinations such as New Orleans, New York City, Paris, and Rome. For more locations and photographer info see ngexpeditions.com/photo.

EXHIBIT



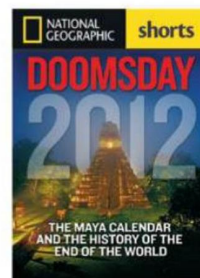
REAL PIRATES Let the high seas adventure unfold as you explore a pirate ship that sank off the coast of Cape Cod in 1717. Learn about the people aboard, and view more than 200 objects recovered—including treasure, weaponry, and the ship's bell (left)—at the Science Museum of Minnesota through September 3. Visit simm.org.

APP

NATIONAL PARKS See America's national parks in a whole new way with our latest app. Browse locations, check out comprehensive guides, discover park secrets, and collect park stamps. On the App Store now.

E-BOOK

APOCALYPSE NOW? In this e-book National Geographic sorts through the 2012 phenomenon and more. Delve into the Maya's cryptic calendar, and read up on the fascinating history of doomsday prophecies. Find it starting July 3 wherever e-books are sold.



Free Download of the Month



Bibi Tanga and the Selenites *40° of Sunshine*
 Afro-Parisian groove theorists Bibi Tanga and the Selenites return this year with a new album, *40° of Sunshine*. This fearlessly creative group melds retro-futurist visions and poetic couplings with slippery funk grooves and a sinewy Afro-beat. Download a free song from the album at natgeomusic.net/free.

Protecting Ecosystems



Feeding the Planet



Growing Cities

living in THE NEW NORMAL



JOIN explorers, business leaders, scientists, journalists, and policy makers when the world's premier environmental forum examines how adapting to urban living, climate change, and population growth affect transportation, energy, food security, water resources, and more—and offers cutting-edge solutions.

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Environmental Defense Fund

EDWARD O. WILSON
Harvard University



A Mystical Coat and Hat

Lynn Johnson faced a daunting task: make photos that embody the cultures of little-known or vanishing languages. In some cases she began with a certain word or phrase; other times she relied on instinct to find a captivating image.

In the Republic of Tuva, in Russia, Johnson visited a center where shamans counsel suffering souls. "People unburden their hearts and minds of things they feel are sabotaging their lives," she says. She saw this shaman in her ceremonial headdress and coat (right), adorned with objects believed to ward off evil: a copper disk, braided ribbons, wild boar tusks. The scene evokes the Tuvan word *eeren*, meaning protector spirit. —Luna Shyr



BEHIND THE LENS

How do the coat and headdress tie in with the spiritual beliefs of the Tuvans?

LJ: Every object on the shaman coat is local or symbolizes something local, and the shamans wear their coat and headdress when they perform ceremonies. The Tuvan people are very tied to the land and the wind—to all things that are natural. They believe that mountains, rivers, the world are imbued with spirits, so you have to live in concert with these spirits, and the Tuvan language reflects that. You can call it superstition, but it's really their worldview.

Why do the people of Tuva go to shaman centers?

If you had a broken heart, you would ask for [one] person. If you had financial problems, you would ask for another. What seemed most interesting to me was how everyday the visits were, like going to the

dentist or doctor.

The shamans had offices, and if they weren't performing a ceremony, they'd usually be at their desk, maybe on the phone, doing everyday stuff. On the walls they'd hang their coats and other sacred objects.

Their coats aren't just a source of

power, inspiration, and identity. They're also protection, because of the individual totems sewn into them. Because the shamans were around people who were sick or needed help all the time, they'd wear the coats and a copper or gold disk to protect themselves.

Give An Inspiring Gift



Pat Minnick included National Geographic in her financial plans.

In 2007 Pat Minnick, a professional artist, decided to establish a charitable gift annuity to support National Geographic.

“I feel good knowing that National Geographic is doing so much to protect endangered wildlife,” says Pat. “The environmental problems we face are vast, but by joining with National Geographic and their history of remarkable accomplishments, I know we can pass on a more beautiful world.”

Pat now receives a guaranteed life income and is a direct part of the Society’s efforts to inspire people to care about the planet.

For more information about a charitable gift annuity or other ways to include National Geographic in your estate plans, please see below.

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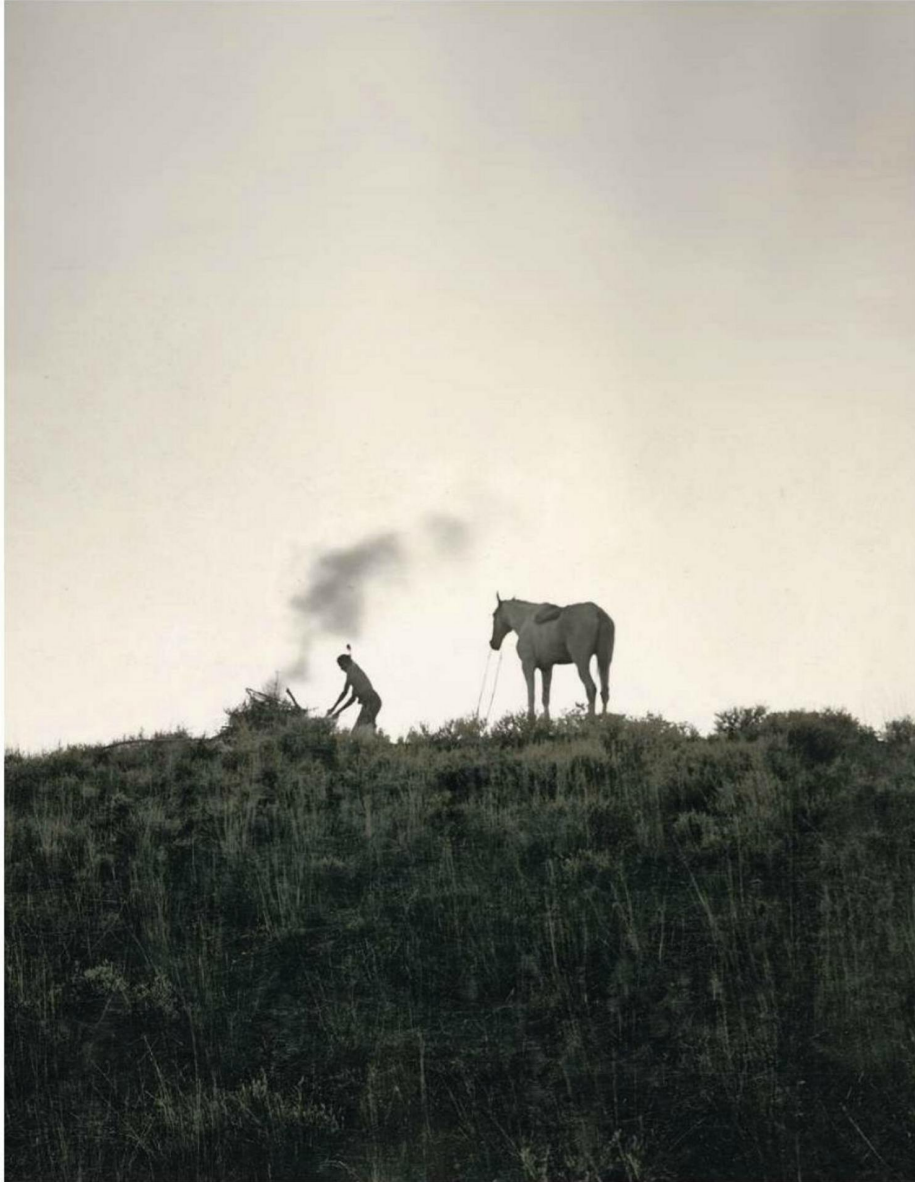
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Washington, D.C. 20036-4688



Sent Messages

These smoke signals were staged on a hilltop in Montana in 1909 for the book *The Vanishing Race*. The tribe of the messenger is unknown, but nearly all Plains Indians used this speedy form of sending news.

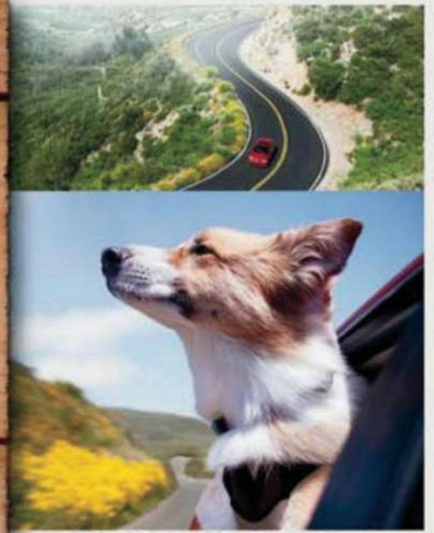
The book's author, Joseph K. Dixon—an ethnographer sent by President William Howard Taft to document the disappearing traditions of Native Americans—became more than an objective observer. According to his book's acknowledgments, while on a later expedition that spanned 26,000 miles and 189 tribes, Dixon was adopted by the Wolf clan of the Mohawk Nation and given the name of Ka-ra-Kon-tie, or Flying Sun. —*Johnna Rizzo*

➤ **Flashback Archive** Find all the photos at [ngm.com](https://www.ngm.com).

PHOTO: JOSEPH K. DIXON, NATIONAL GEOGRAPHIC STOCK

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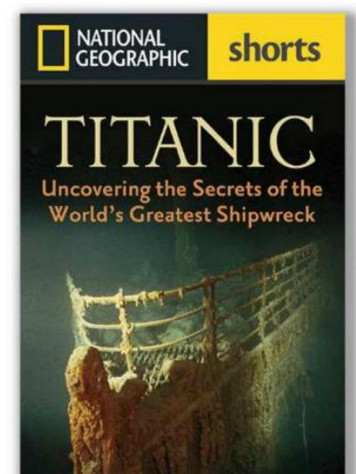
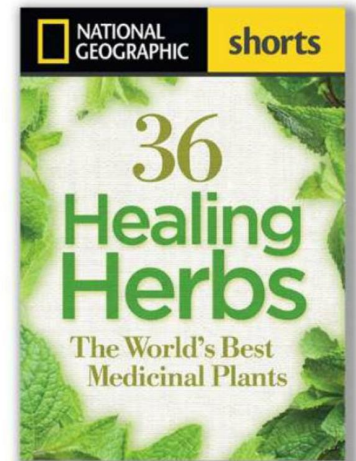
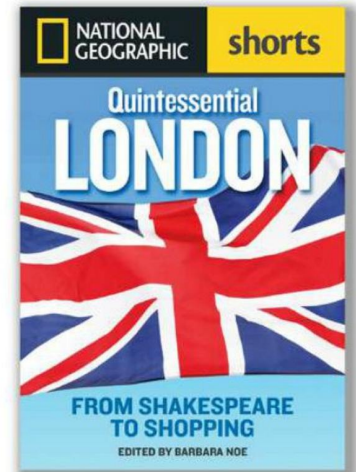
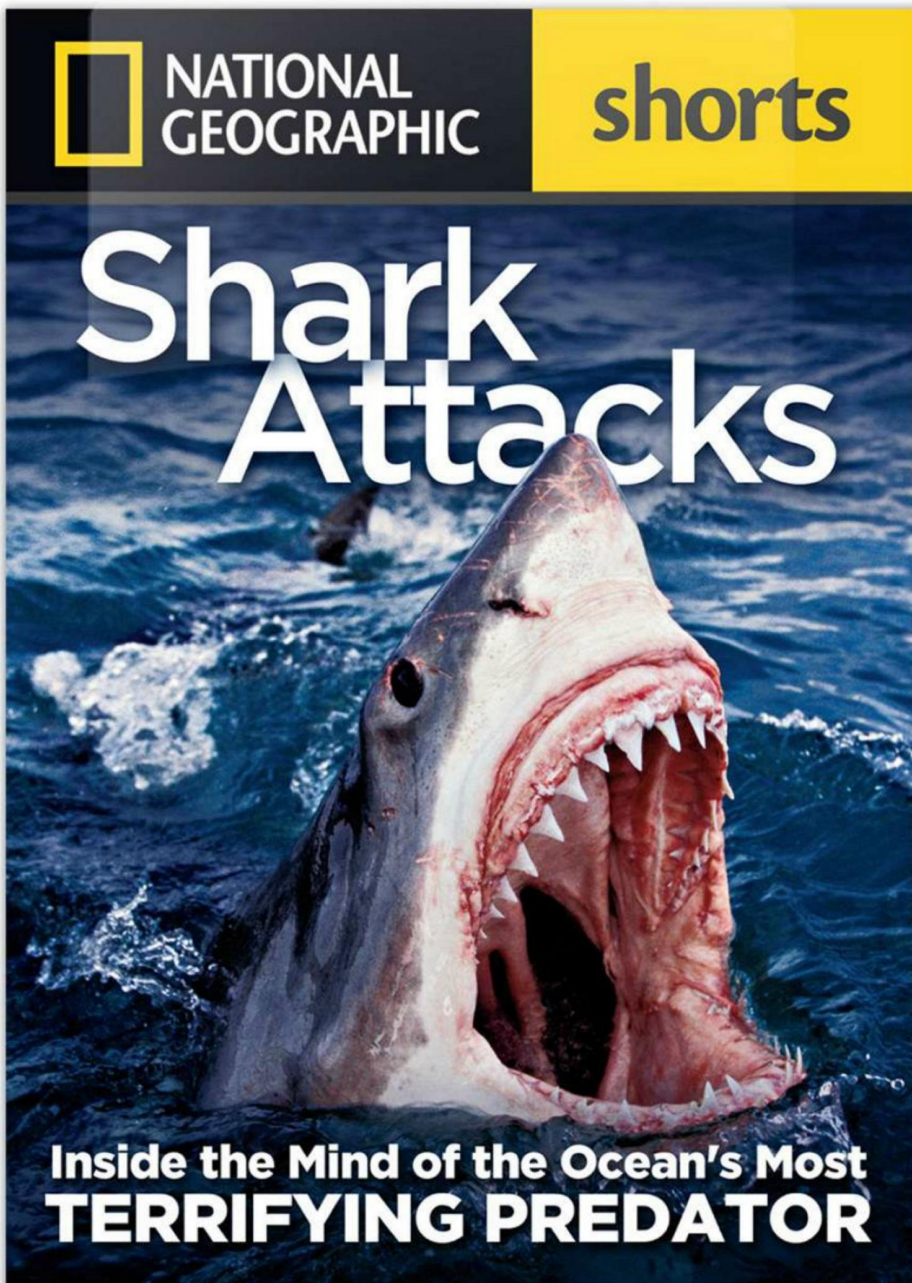


toyota.com/camry

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Prototype shown with optional equipment. Production model may vary. 1. Based on preliminary combined 41 mpg estimates determined by Toyota and 15.3 gallons of gas. EPA estimates not available at time of printing. Actual topography and road conditions are not taken into account. Actual mileage will vary. 2. 2012 Toyota Camry Hybrid LE preliminary 43 city/39 highway mpg estimates determined by Toyota. EPA estimates not available at time of printing. Actual mileage will vary. ©2011 Toyota Motor Sales, U.S.A., Inc.

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