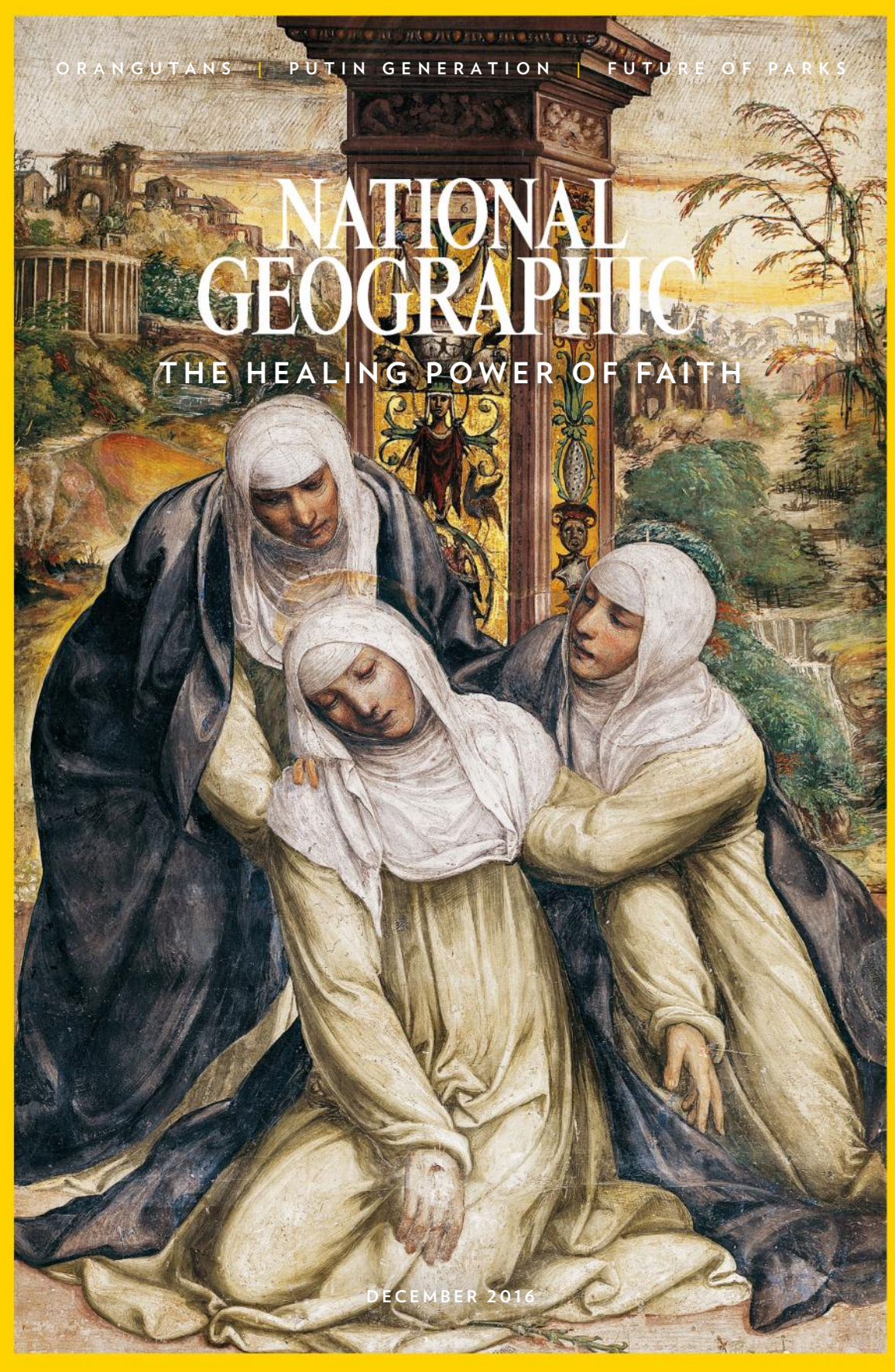
ORANGUTANS | PUTIN GENERATION | FUTURE OF PARKS

NATIONAL GEOGRAPHIC

THE HEALING POWER OF FAITH



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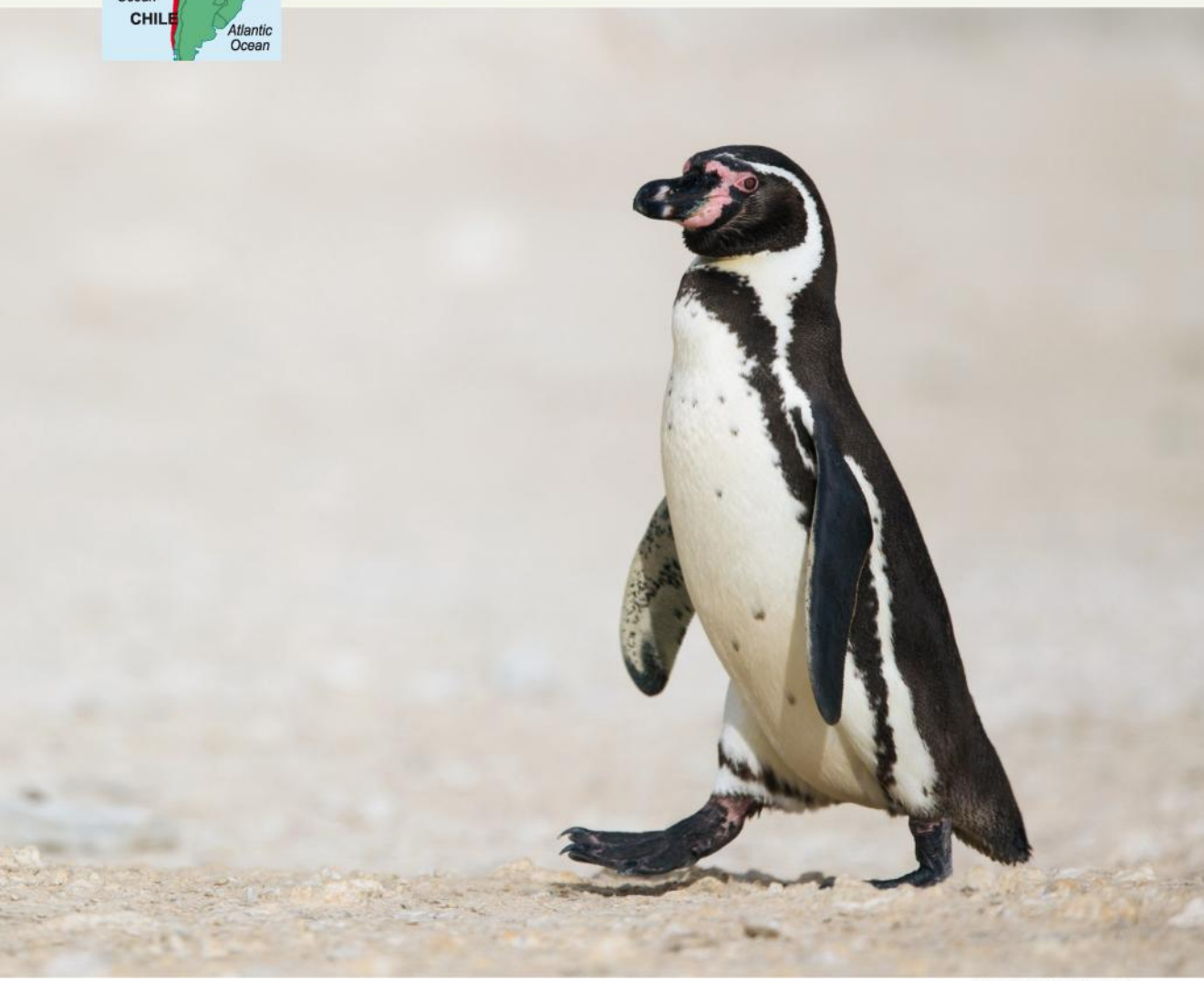
Humboldt Penguin *(Spheniscus humboldti)*
Size: Body length, 65 - 70 cm (25.6 - 27.6 inches) **Weight:** 4 - 4.7 kg (8.8 - 10.4 lb)
Habitat: Nests on rocky stretches of mainland and island coasts **Surviving number:** Estimated at 2,500 – 10,000 adults



Photographed by Cyril Ruoso

WILDLIFE AS CANON SEES IT

Water wings. The Humboldt penguin's graceful swimming has been likened to "flying" under water. When foraging for its partner or chicks, this penguin may spend as much as nine hours a day beneath the waves, diving in search of pelagic schooling fish and other prey. During breeding season it returns without fail to the same nesting site, but when people approach the vicinity its heart rate skyrockets under the stress. Human disturbance, along with fishing-related mortality, are the banes of the penguin's existence.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.

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DECEMBER 2016 • VOL. 230 • NO. 6 • OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

DEPARTMENTS

FEATURES

On the Cover St. Catherine swoons after receiving the stigmata in this 1526 fresco by Giovanni Antonio Bazzi at the Basilica Cateriniana San Domenico in Siena, Italy. Pilgrims visit her shrine in search of cures. *Leemage/Corbis via Getty Images*

Corrections and Clarifications
Go to *ngm.com/corrections*.

CONTENTS

ELSEWHERE

TELEVISION

JOIN THE DARING MISSION TO *MARS*

Actor JiHAE plays a pilot in the six-part series *MARS,* which blends documentary footage and scripted drama. The global event series airs at 9/8c on Mondays through December 19, on National Geographic.

TELEVISION

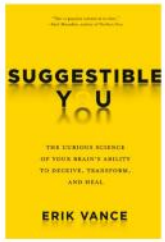
WHO SURVIVES IN THE *SAVAGE KINGDOM*?

The battles among warring clans play out like *Game of Thrones*—but the royal families are Africa's lions, leopards, hyenas, and more. The mini-series *Savage Kingdom* debuts November 25 at 9/8c on Nat Geo WILD.

PHOTOS: ROBERT VIGLASKY, NATIONAL GEOGRAPHIC CHANNELS (TOP); NATIONAL GEOGRAPHIC CHANNELS/NHF

NATIONAL GEOGRAPHIC BOOKS

JUST HOW *SUGGESTIBLE* IS THE HUMAN BRAIN?



Science writer Erik Vance examines the power of belief to influence us, in this issue's cover story—and in his new book, *Suggestible You: The Curious Science of Your Brain's Ability to Deceive, Transform, and Heal.* Available wherever books are sold and at *shop.nationalgeographic.com.*

VIRTUAL REALITY AND VIDEO

GLIMPSES OF LIFE AMONG THE ORANGUTANS OF BORNEO

See how orangutans contend with threats to their habitats and existence, in an exclusive virtual-reality experience. Then watch the compelling story of an orangutan mother raising her baby, in a National Geographic video. Both are online at *ngm.com/Dec2016.*

NATGEO.COM VIDEO

NEW HOPE FOR REFUGEES—AND THEIR PLACES OF REFUGE

When refugees fleeing conflict arrive in declining Italian villages, everyone benefits—as when a refugee named Assan met a local named Cosmano in the town of Camini. See the moving story of their friendship at *ngm.com/Dec2016.*

NATIONAL GEOGRAPHIC TRAVEL

THE ANNUAL 'BEST OF THE WORLD' ISSUE IS HERE

A Mediterranean island, an alpine Eden, a vibrant megacity—tour those destinations and 18 more that made *Traveler*'s annual "Best of the World" list. Find the magazine's special issue on newsstands, or read it online at *NatGeoTravel.com.*

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WE ARE ALLIES IN EARTH'S CARE

Planet Earth is amazing, it's diverse—and it needs all our help, now more than ever. That's why we at National Geographic are redoubling our commitment to exploring and helping to protect it. With an endowment that is now around one billion dollars, we can have more impact than ever.

About 128 years ago, the nonprofit National Geographic Society was founded with a commitment to "increase and diffuse geographic knowledge." For more than a century we've explored the world, making discoveries and inspiring people with our images and stories. That's still the core of what we do. But now our planet is at a crossroads. We must push further, and we can't do it alone.

We live in an exciting age of exploration with more opportunities to make discoveries—and make a difference—than ever before. It's time to be bold, to act urgently, in order to ensure a healthier and more sustainable existence for generations to come. Only by acting as a true global community can we halt the pollution of oceans, the trafficking of wildlife, the destruction of critical habitats, and other threats to life on Earth.

You play an important role. As a reader and supporter, you're part of a powerful community of curious and passionate people helping to create solutions and effect meaningful, long-lasting change.

Thanks to your support, we've had some real breakthroughs. Last year, backed by our new Special Investigations Unit, journalist Bryan Christy used a fake elephant tusk implanted with a tracking device to reveal how illegal ivory was traveling through Africa. Our Pristine Seas project, overseen by marine biologist Enric Sala, has helped protect more than one million square miles of ocean since its launch in 2008.

As a father I can think of nothing more important than helping to give our next generation a healthier future. It's a worthy goal that we can all share and work toward—now more than ever.

Gary E. Knell, *President and CEO*
National Geographic Society

PHOTO: MARK THIESSEN, NGM STAFF

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NATIONAL GEOGRAPHIC

PRIVATE EXPEDITIONS

Photo: Sabi Sabi Earth Lodge, **South** Africa

OUR CHANGING ROLE IN PARKS

What happens if there are no more glaciers in Glacier National Park?

In 2016 we have focused in the magazine and digital platforms on parks in the United States and worldwide. We did so to celebrate the 100th anniversary of the U.S. National Park Service—and because parks are a fascinating lens through which to explore changes and challenges in our planet's environment, wildlife, and climate.

Though "protected," parks clearly are not immune from the man-made and natural forces that are altering their landscapes and the habitats of the animals that live within their borders.

Take glaciers. In 1850 there were about 150 massive ones in what is now Glacier National Park (above), near the Canadian border in Montana. Today just 25 remain, and scientists believe even the largest of them will disappear by 2030.

In Sequoia National Park in California, home to towering trees that can live 3,000 years, climate change is boosting temperatures, but with uncertain results. "We don't know which scenario will play out," says Sequoia Superintendent Woody Smeck in this issue. Will it mean more or less rain? Will change be abrupt or gradual?

This is why, a century after the Park Service was founded, it's looking anew at its role in conserving land- and seascapes by managing parks not as static terrain but as places of transformation.

That has meant moving an iconic lighthouse inland at North Carolina's Cape Hatteras National Seashore. It may mean planting sequoia seedlings above the current range, in the cooler, higher parts of Sequoia National Park. And at Assateague Island National Seashore in Maryland, it means teaching students about sea rise the way chief of education Liz Davis does: by throwing a bucket of water on a sand model of the park.

When people ask her about the future of parks, Davis gives an answer that is hopeful—and that may prove true only if we all do our part.

"People ask, 'Will my kids and grandkids be able to enjoy it?' " Davis says. "Yes, they will. They might not enjoy it in the same way, and they might not get here the same way. But they will still be able to enjoy it."

Susan Goldberg, *Editor in Chief*

PHOTO: KEITH LADZINSKI

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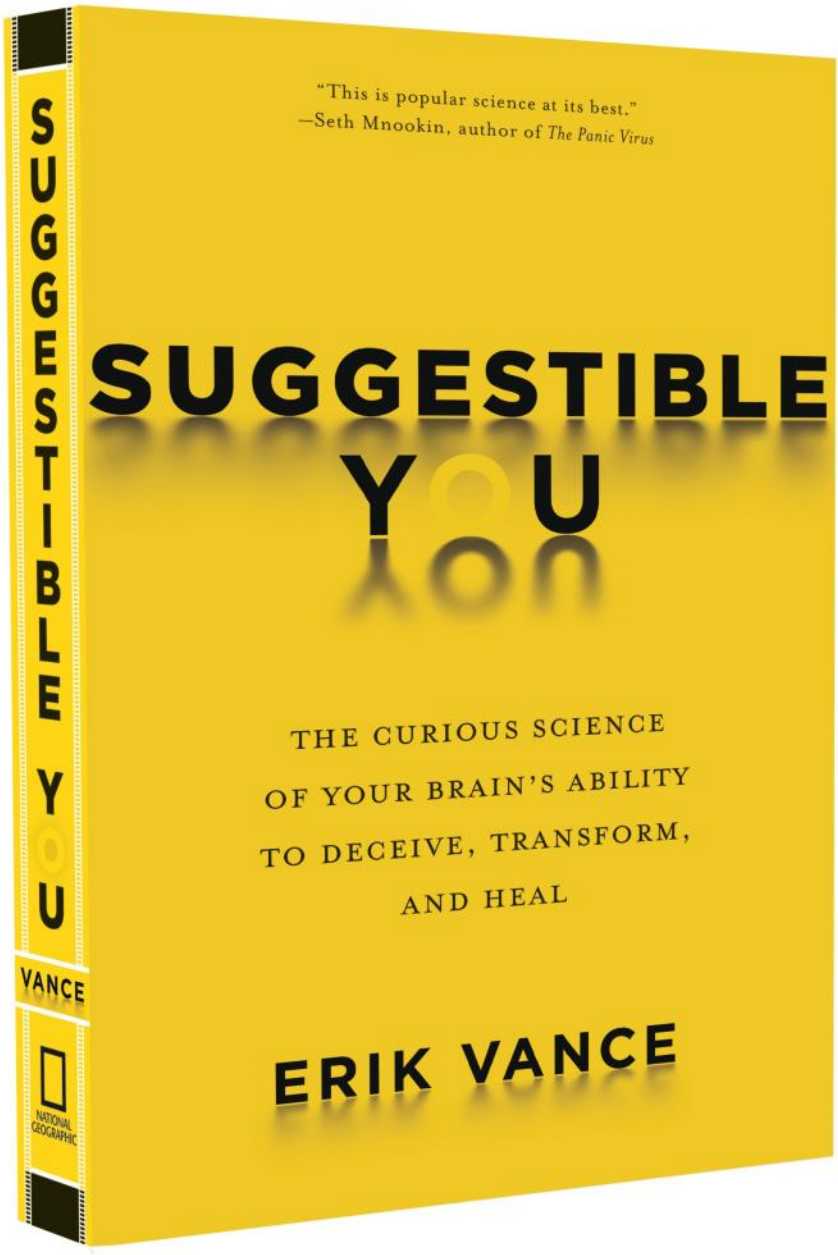
HOW **SUGGESTIBLE** ARE **YOU**?



COULD THE SECRETS TO PERSONAL HEALTH LIE WITHIN OUR OWN BRAINS?
Journalist Erik Vance explores the surprising ways our expectations and beliefs influence our bodily responses to pain, disease, and everyday events. This riveting narrative explores the world of placebos, hypnosis, false memories, and neurology to reveal the groundbreaking science of our suggestible minds.

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WHY I'M SENDING A TIME CAPSULE TO MARS

Emily Briere is planning a mission to Mars. The 23-year-old aerospace engineering student aims to get a time capsule – a small satellite loaded with messages from Earth – to the red planet. As mission director of Time Capsule to Mars, she's recruited students from colleges across the United States to meet a goal she describes as "ambitious, but just within reach."

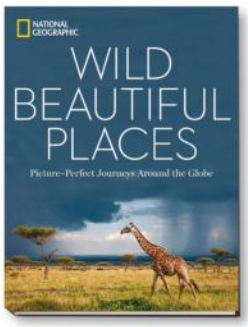
Voyager carried records designed to communicate with aliens. Whom are you trying to reach?
The time capsule is a challenge for humans to get out there and colonize Mars. One day, when we're there, it'll be the kind of thing that's put in the National Geographic Museum or the Smithsonian to document how far we've come.

How are you building the time capsule?
It'll be a low-cost mission using a CubeSat satellite the size of two cereal boxes. You have to be a student to do hands-on work on the project. We're building different subsystems at different universities. For example, a lab at MIT is doing ion electric-based propulsion, and a lab at Stanford is testing space environments. We would be the secondary payload of some big scientific mission. We're saying we'll launch in the next three to five years, but it's really a matter of funding. If everything were to go perfectly, we could launch sooner.

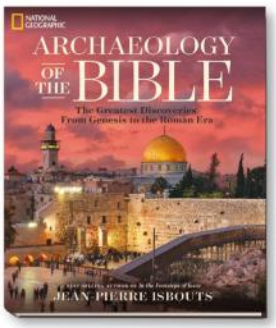
What will the time capsule contain?
Digital photos, videos, audio uploaded by people all around the world. We want the content of the capsule to provide a very broad and full snapshot of Earth as it is today. We're on this mission to Mars together as humanity, rather than as a country or as an individual company.

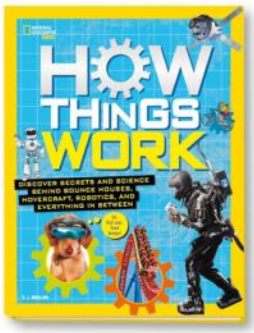
PHOTO: REBECCA HALE, NGM STAFF
THIS INTERVIEW WAS EDITED FOR LENGTH AND CLARITY.

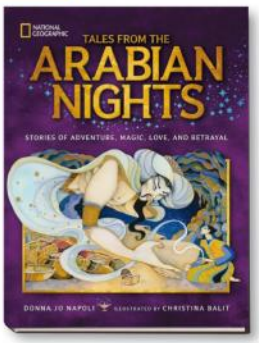
NATIONAL GEOGRAPHIC BOOKS, ALWAYS A GREAT GIFT

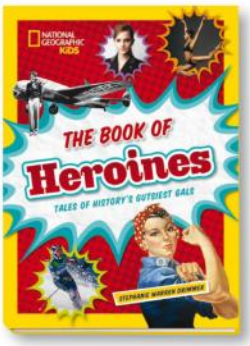


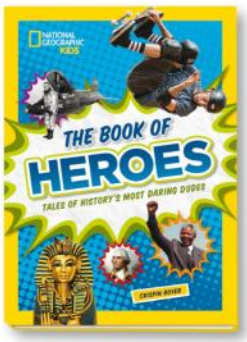
FOR KIDS!











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VISIONS

Slovenia
High above the village of Črni Vrh, fantastical ice formations – including spikes over a yard long – encase the trees and lookout tower atop Mount Javornik. The windswept ice, or hard rime, is the result of fog freezing after a week of snow and gales.

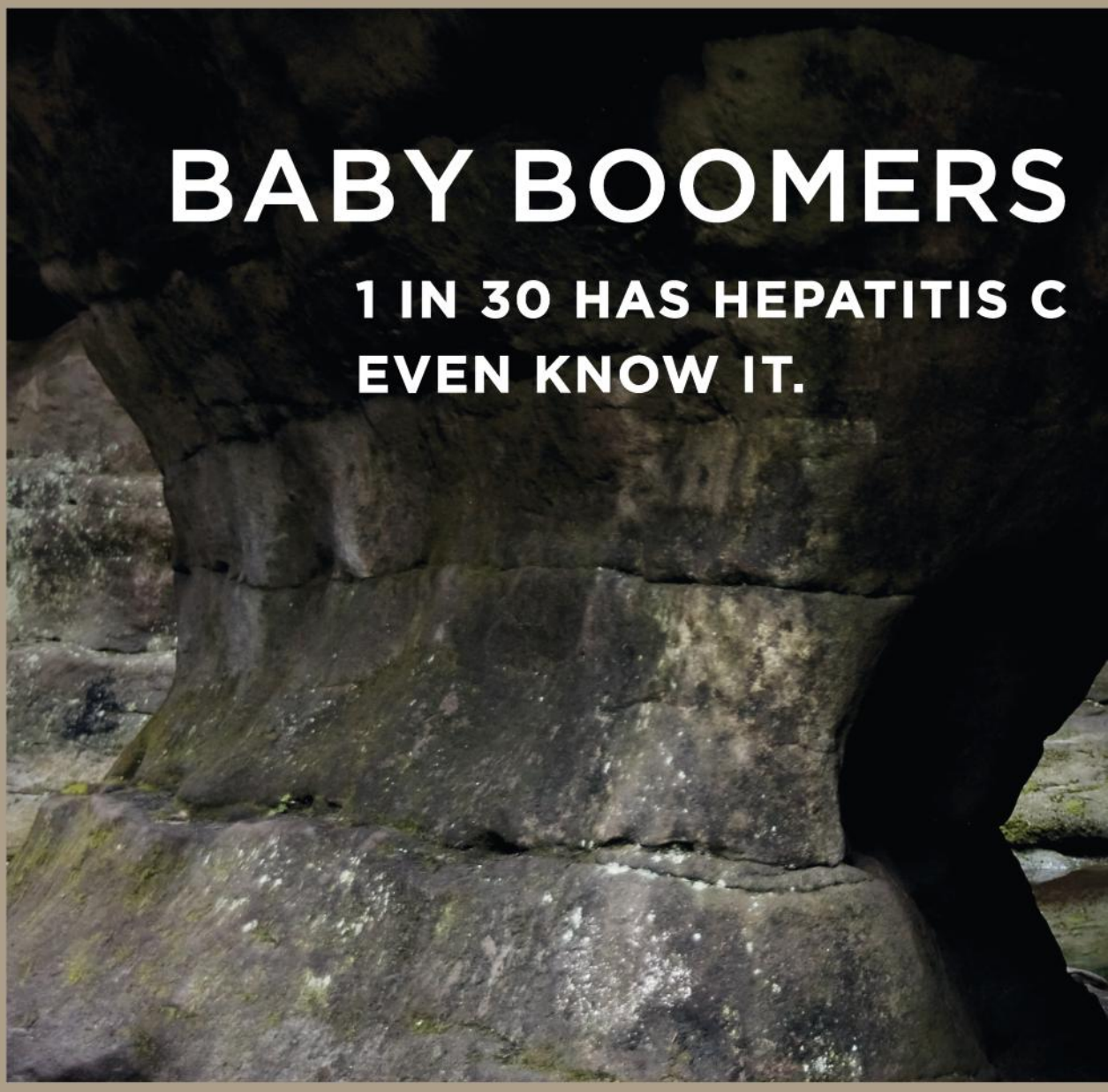
PHOTO: MARKO KOROŠEC

Tonga
Off the coast of the Vava'u islands, a newborn humpback whale – perhaps less than a week old – drifts near the placid surface. Already about 15 feet long, it could grow to 50 feet. These waters are a prime calving ground for the species.

PHOTO: KARIM ILIYA

Czech Republic
In the village of Deštné in the Orlické Mountains, an ice-encrusted house is a landmark for contestants in the Šediváčkův Long dogsled race. European mushers and up to 700 dogs compete in the annual four-day race, which covers 150-some miles.

PHOTO: PETR JOSEK, REUTERS



There's a virus out there that hasn't been talked about much, and you may not have heard about it. A virus that's serious, like HIV. **It's hepatitis C (Hep C).** It can hide in your body for years, even decades, without symptoms. And it isn't tested for in routine blood work. If left untreated, Hep C can cause liver damage and even lead to liver cancer.

The CDC (Centers for Disease Control) recommends **all Baby Boomers** get tested for Hep C. All it takes is a simple one-time blood test. The good news is: **if you have Hep C, it can be cured**. Ask your doctor at your next appointment to be tested for Hep C.

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CURIOUSER AND CURIOUSER

More than 59 million followers catch a glimpse of the world's wonders through the *@natgeo* Instagram account, where National Geographic photographers share moments both professional and personal. A new book, *@NatGeo,* showcases the best of these images. The four pictures below are from the section on curiosity.

Find the book @NatGeo *at* shopng.com/natgeobook *or wherever books are sold. And see the photography in person at the @NatGeo exhibit from November 11, 2016, to April 30, 2017, at the National Geographic Museum, Washington, D.C.*

On the landing of an 18th-century Parisian staircase, an umbrella awaits the next walk in the rain. **@TOMASVH**

Ready for a Mardi Gras parade, an empty float near the Mississippi River brightens the gloom. **@GEOSTEINMETZ**

A clownfish hides in a bleached sea anemone in the warming waters of Papua New Guinea. **@DAVIDDOUBILET**

Glowing embers dapple this shot of a campsite along an elk migration trail near Yellowstone National Park. **@JOERIIS**

CLOCKWISE FROM TOP LEFT: TOMAS VAN HOUTRYVE; GEORGE STEINMETZ; JOE RIIS; DAVID DOUBILET

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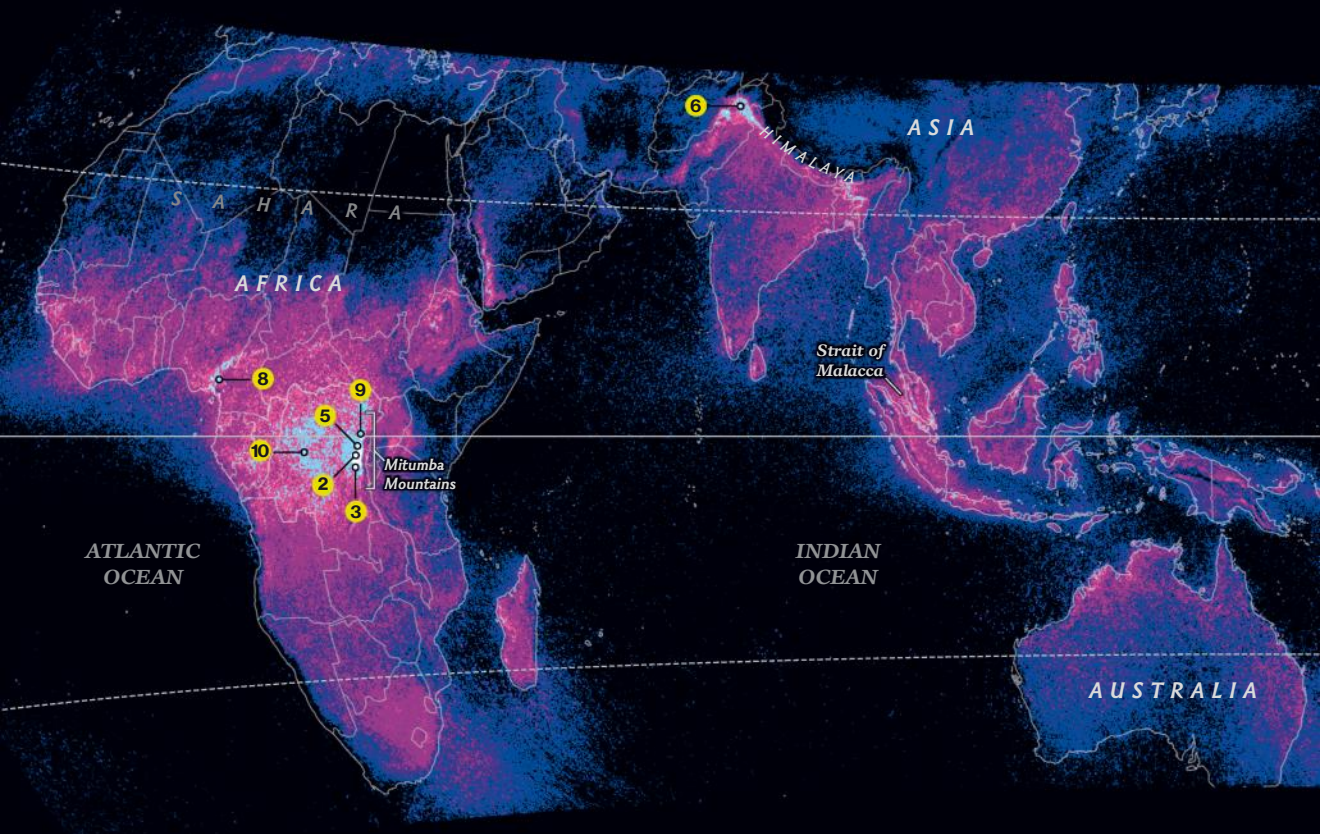


FLASH POINTS

By Catherine Zuckerman

Venezuela's Lake Maracaibo holds the distinction of being South America's largest lake by area, but the skies above it also are record setting. There, lightning flashes most nights of the year, new research shows—and perhaps no other place on Earth experiences more lightning annually.

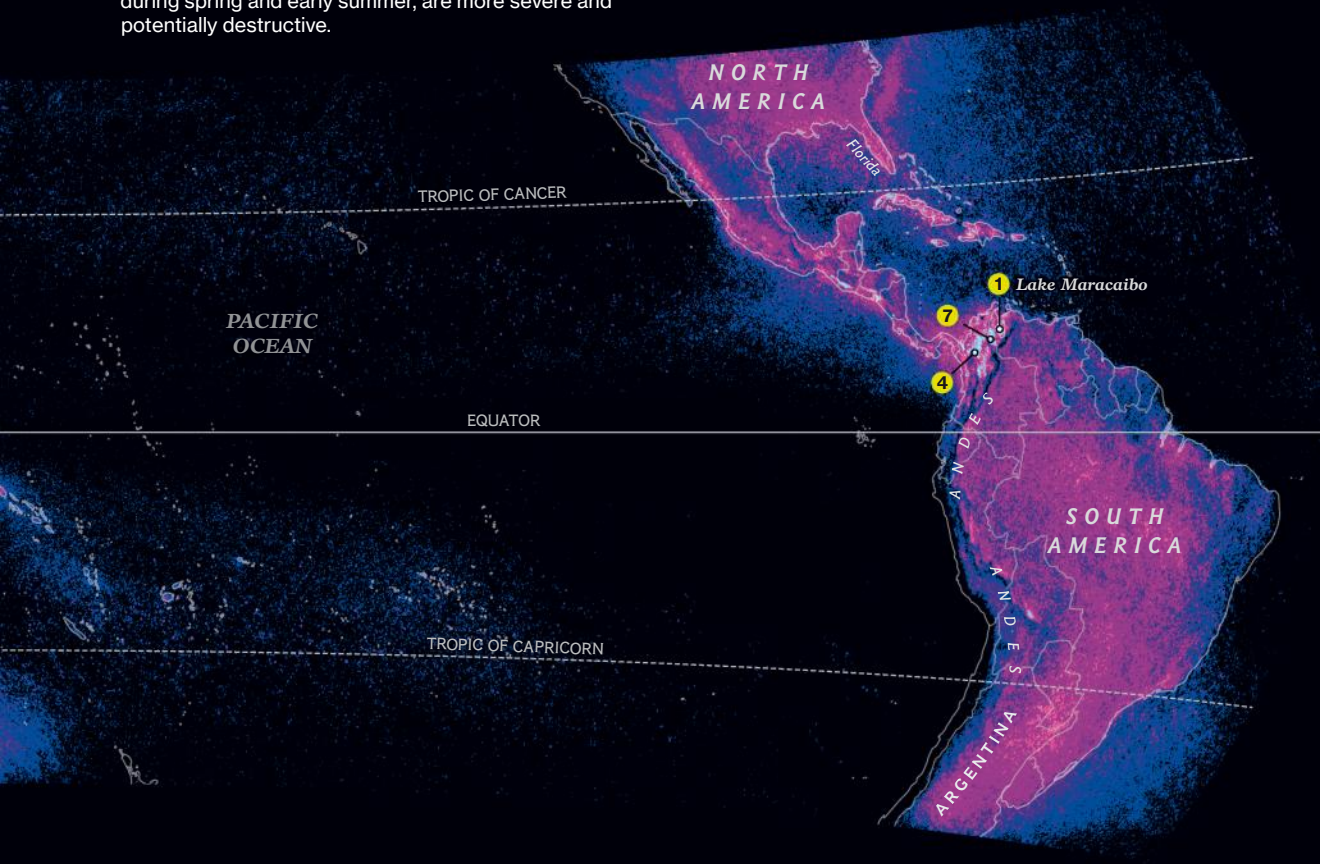
The phenomenon is tied to topography, says University of São Paulo meteorology professor Rachel Albrecht, who analyzed high-resolution satellite data to determine where lightning flashes most frequently. Lake Maracaibo sits in a valley at the northern end of the Andes and connects to the Gulf of Venezuela. All those mountain winds converging with warm sea breezes, plus high humidity, add up to near-constant nocturnal thunderstorms.

Of the 500 lightning "hot spots" that the data revealed, more than half are situated in Africa, and of the top 30 only six are not located near mountain ranges. Other revelations: Oceanic lightning tends to occur at night, while terrestrial lightning tends to happen in the afternoon.

LAUREN E. JAMES, NGM STAFF. SOURCE: "WHERE ARE THE LIGHTNING HOTSPOTS ON EARTH?" RACHEL I. ALBRECHT AND OTHERS, *BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY* (2016)

PERSISTENCE VERSUS POWER

Some areas in the southeastern United States – the Florida Everglades, for example – and parts of northern Argentina experience frequent lightning, but still far less than Lake Maracaibo. However, many of the thunderstorms that do occur in these regions, most during spring and early summer, are more severe and potentially destructive.



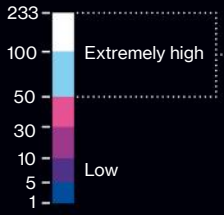
TOP LIGHTNING HOT SPOTS

Until this year scientists believed central Africa's Mitumba Mountains saw more lightning than anywhere else on Earth. But new high-resolution satellite data moves the number one spot to South America.

Rank	Location
1	Lake Maracaibo, Venezuela
2	Kahuzi-Biega National Park, Democratic Republic of the Congo
3	Shabunda, Dem. Rep. of the Congo
4	Cáceres, Colombia
5	Walikale, Dem. Rep. of the Congo
6	Daggar, Pakistan
7	El Tarra, Colombia
8	Nguti, Cameroon
9	Butembo, Dem. Rep. of the Congo
10	Boende, Dem. Rep. of the Congo

Lightning frequency

Average annual flash-rate density*



The top 500 hot spots have flash rates in this zone.

Although lightning occurs all around the world, the satellite that collected this data focused on just the tropics and near tropics.

*NUMBER OF FLASHES PER SQUARE KILOMETER, FROM NASA'S TROPICAL RAINFALL MEASURING MISSION'S LIGHTNING IMAGING SENSOR, 1998-2013

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A SLEIGHFUL OF SANTAS, SURVEYED

By Patricia Edmonds

Take "Santa Claus Is Coming to Town," multiply it by several hundred, and you've got what's billed as the World's Largest Santa Convention, held this past July in Branson, Missouri. At the five-day trade show, Kris Kringle impersonators attended workshops on makeup and marketing, beard care and Santa ethics. More than 550 Santas answered a survey about playing the jolly old elf. Here are some of the results.

Average age: 63.5 years, with a youngest Santa of 29 and a senior Santa of 94. **Average weight:** 252 pounds, ranging from lightest Santa (130) to heaviest (450). **Is that "bowl full of jelly" belly real?** 78% said yes. **Is that your real beard?** 93% said yes. **Who has pulled your beard to be sure it's real?** 67% said mostly children; 25% said mostly adults. **Do you dye, or don't you?** 49% claimed naturally white hair/beard; 40% said they bleach or lighten. **Has a child on your lap ever wet on you?** 31% said yes. **Do you use an agent to help get Santa bookings?** 24% said yes. **Are you a tech-savvy elf?** 50% have a Facebook page as Santa; 44% have a Santa business website; 24% said, "I am lucky if I can just use email." **Have you attended a Santa school?** 23% said no; the rest said they had attended at least one. **Favorite cookie:** chocolate chip, 44%; oatmeal raisin, 20%; sugar cookie, 9%. **Favorite beverage:** hot cocoa, 31%; milk, 25%; eggnog, 20% (alcohol content not specified). **Favorite Christmas song:** "Santa Claus Is Coming to Town," 21%; "Silent Night," 18%; "Rudolph the Red-Nosed Reindeer," 14%. **Least favorite Christmas song:** "The Twelve Days of Christmas" and "Grandma Got Run Over by a Reindeer" finished in a virtual tie, with each song getting less than one percent of the vote.

PHOTO: DINA LITOVSKY


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SERVING UP JACKFRUIT

By Stacie Stukin

Spiky, gigantic, and fibrous, jackfruit may not seem particularly inviting. But the tropical fruit in its unripened state is gaining popularity in the United States as a sustainable substitute for meat.

Twenty-five percent of U.S. consumers decreased their meat intake from 2014 to 2015, according to the *Nutrition Business Journal*. And sales of meat alternatives have nearly doubled—from $69 million in 2011 to $109 million in 2015.

That may explain why some chefs and food companies have begun promoting jackfruit. It has a texture (though not a protein content) like meat's. It's starchy and neutral tasting, so "you can do anything with it," says chef Kajsa Alger, who cooks with it at her L.A. restaurant.

It remains to be seen whether Americans will embrace this South Asian staple, which grows in abundance in its native India. For one thing, jackfruit—from the family that includes breadfruit, figs, and mulberries—oozes a sticky, white substance when cut, and breaking one down takes time. "Basically, they're big and uncooperative," says Alger.

But for those who would sample, there is a shortcut: The meaty fruit also comes prepackaged and in cans.

A jackfruit can weigh a hundred pounds; the whole one seen here weighs about 20 pounds.

PHOTO: PAULETTE TAVORMINA

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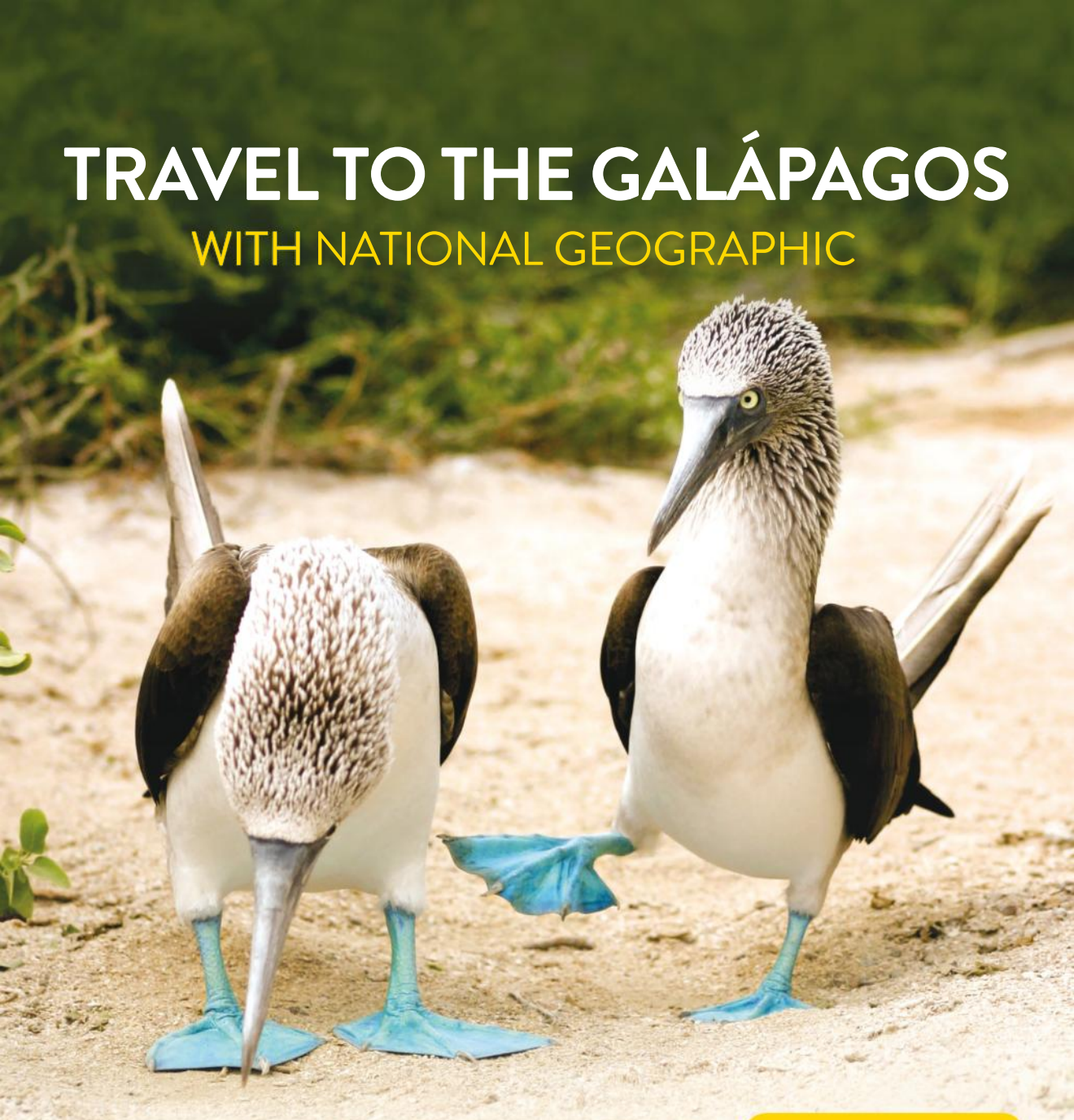

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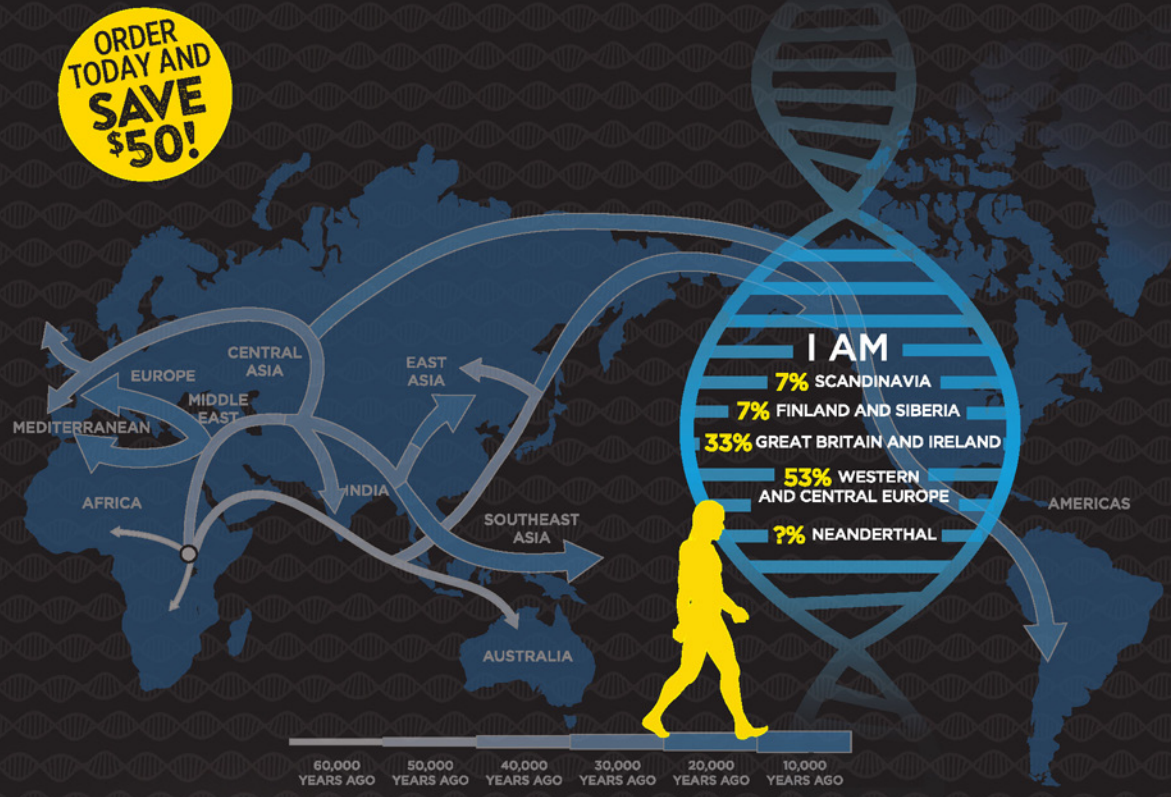

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NATIONAL GEOGRAPHIC

EXPLORATION WITH A PURPOSE

For 128 years National Geographic has supported pioneering men and women who use science, exploration, and storytelling to change the world. Since 1976 the Rolex Awards for Enterprise have pursued a parallel mission: identifying and supporting outstanding innovators who work to improve lives, protect the planet, and advance human knowledge. On the following pages, we celebrate 16 individuals who have been Rolex laureates or Geographic explorers—or both—for their vision and achievements.

At Alaska's Sukok Lake, astrobiologist Kevin Hand tests a rover designed to move beneath ice on Jupiter's moon Europa.

A program profiling Rolex laureates will air on National Geographic on November 18 at 7:30/6:30c.

***NATIONAL GEOGRAPHIC* PRODUCED THIS EXPANDED VERSION OF FIELD NOTES AS PART OF A PARTNERSHIP WITH THE ROLEX AWARDS FOR ENTERPRISE.**

PHOTO: MARK THIESSEN, NGM STAFF

Kakenya Ntaiya shares some candlelight learning time with students at the Kakenya Center for Excellence. Ntaiya started the rural Kenyan boarding school in 2009 to help improve girls' lives by extending their education. The first 26 will finish high school in 2017.

EDUCATION WHERE IT WASN'T BEFORE

Kakenya Ntaiya

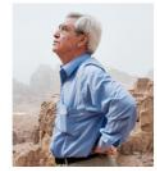
Kakenya Ntaiya's life was mapped out at an early age, as it is for many traditional Kenyan girls: a preordained engagement at age five, followed by genital mutilation at 14, which would mark the end of her formal education and lead to marriage. But she eventually persuaded her family and her village of Enoosaen to allow her to leave and get an education.

After earning a Ph.D. in education from the University of Pittsburgh, Ntaiya decided to pay it forward. Since May 2009, when she opened the Kakenya Center for Excellence, a girls boarding school in Enoosaen for fourth to eighth graders, nearly 280 girls have attended. They gain knowledge and are encouraged to break the cycle of cultural practices such as genital mutilation and early forced marriage. The first 26 will graduate from high school in 2017.

"Every year we have over 200 girls wanting to come to the school, and we can only take 40. That's what's most frustrating," says Ntaiya, a 2010 National Geographic emerging explorer. Ntaiya hopes to raise five million dollars to expand, and to boost enrollment to 600 girls by 2021.

THE PLAN TO PRESERVE AN ANCIENT CAPITAL

Talal Akasheh



Talal Akasheh has devoted half his life to protecting the 2,500-year-old Jordanian city of Petra from the ravages of nature and neglect. And at a time when many of his peers have long since retired, Akasheh, 69, remains dogged in his efforts to preserve the once thriving trade capital.

The 2008 Rolex laureate, who trained as a chemist, created a research database on Petra, mapping and analyzing nearly 3,000 archaeological features carved from red sandstone. Akasheh spent three years using photogrammetry to gauge the stability of rocks in the Siq, the main entrance to Petra. In 2015 he completed a conservation plan for the ancient city.

There's still time to conserve what's standing for scholars, tourists, and posterity. But if parts of structures crumble, Akasheh's database can provide references of how the originals looked.

LOOKING FOR LIFE ON A FARAWAY MOON

Kevin Hand

The quest to find life on other planets has intrigued scientists for eons. Astrobiologist Kevin Hand's extraterrestrial search could be complete in less than 15 years.

Hand (pictured on the previous page) is a 2014 Rolex Awards juror and 2011 National Geographic emerging explorer. As a deputy project scientist at NASA's Jet Propulsion Laboratory, he oversees the development of a concept for a lander that will explore Jupiter's moon Europa. His research has taken him from ocean floors to Antarctic glaciers, where he can study life in extreme environments, like

PHOTOS: PHILIP SCOTT ANDREWS (LEFT); MARC LATZEL, ROLEX AWARDS

those on Europa. With luck, Hand says, a launch could occur by 2024 and a robotic vehicle could touch down by 2030.

A NEW RODENT, WITH AN INSPIRED NAME

Erika Cuéllar

Conservation biologist Erika Cuéllar displayed such dedication to conservation in the Gran Chaco, a biodiverse region in South America, that her colleagues named a newly discovered type of rodent after her: Erika's tuco-tuco, aka *Ctenomys erikacuellarae*.

The gopher-like tuco-tuco is native to Bolivia. That's where Cuéllar, a 2012 Rolex laureate and 2013 emerging explorer, works to empower communities by helping locals acquire conservation skills and expertise.

THE SECRET SAUCE TO SAVE A CULTURE

Ilse Köhler-Rollefson

Got camel milk?

It's a central question to Ilse Köhler-Rollefson, a 2002 Rolex laureate dedicated to preserving the camel-herding lifestyles of India's Raika people.

The nomadic pastoralists have herded camels in the remote regions of Rajasthan for centuries, but their way of life is threatened by disappearing grazing lands, mechanized farming, and falling demand for camels. Köhler-Rollefson believes camel milk—which some think has medicinal benefits for people with diabetes and children with autism—is key to the survival of Raika culture.

A veterinary surgeon, Köhler-Rollefson helped start a small camel-milk dairy that now produces about 150 liters a week; she aims to boost that to 300 liters a day to support new product development. She hopes to help the pastoralists market more cheese, soap, wool—even artisanal paper made from camel dung.

Veteran explorer **Lonnie Dupre** is accustomed to long, solitary nights in severe Arctic conditions. But a successful January solo ascent of Denali in Alaska came only after surviving a harrowing storm at 11,200 feet.

ALONE ON A RUTHLESS MOUNTAIN

Lonnie Dupre

After three attempts failed because of severe weather, Lonnie Dupre in 2015 became the first mountaineer to complete a January solo summit of Alaska's Denali.

Dupre, a 2004 Rolex laureate, is now planning another challenge: the first ever January solo ascent of Alaska's Mount Hunter, considered among North America's most difficult climbs. With 30 years' experience, he has his training regimen down to a science. But winnowing 19 days of food and supplies to fit into a 60-pound backpack is still daunting. "Fuel is the number one priority," he says. You can go a little while without food, but only two to three days without water, and you need gas to melt snow." He takes high-fat, high-protein fare such as dried

PHOTOS (CLOCKWISE FROM TOP RIGHT): LONNIE DUPRE; MARC LATZEL, ROLEX AWARDS; DIPTI DESAI; THIERRY GROBET, ROLEX AWARDS

Rwanda's gray crowned crane population dwindled to fewer than 500 before veterinarian **Olivier Nsengimana** became a driving force to rescue and revitalize the endangered species, the target of poachers and traffickers.

meats—and a luxury item: "The one thing I allow myself is a good cup of coffee."

USING COMIC BOOKS TO HELP PROTECT BIRDS

Olivier Nsengimana

To save Rwanda's endangered gray crowned crane from extinction, veterinarian Olivier Nsengimana is using everything from comic books to high-tech drones.

The comic books help educate Rwanda's youth about conservation and biodiversity. Such awareness is vital in a country where scores of gray crowned cranes, chicks, and eggs have been poached from their marsh habitat and trafficked as symbols of wealth and longevity.

Their global population is down nearly 80 percent over the past five decades, and fewer than 500 remain in the wild in Rwanda. Nsengimana, a 2014 Rolex laureate, stepped in to stop the illegal trade, promote breeding, protect habitat, and return captive birds to the wild. So far, 216 captive cranes have been identified and registered; 98 have been reintroduced to Rwanda's Akagera National Park.

NUCLEAR ENERGY COMING TO THE 21ST CENTURY

Leslie Dewan

Nuclear power has been under a dark cloud in the United States since the partial meltdown at Three Mile Island in 1979. But Leslie Dewan, a nuclear engineer and 2015 National Geographic emerging explorer, believes a safe, next-generation nuclear reactor offers a brighter outlook.

Dewan's Boston area–based start-up, Transatomic Power, is developing a molten-salt reactor based on a 1960s design. In commercial use, the reactor would process and repurpose spent nuclear fuel—the U.S. stockpile is 82,700 tons—and produce enough energy to power the world for decades.

Her goal is to have a prototype by the early 2020s and a commercial reactor by the 2030s.

EAVESDROPPING ON OCEAN NOISE POLLUTION

Michel André

French bioacoustician and 2002 Rolex laureate Michel André spent more than a decade developing the first passive whale anticollision system to prevent the sea mammals from colliding with ships off the Canary Islands.

Over the next 10 years, he helped build Listening to the Deep Ocean Environment, a platform linking 22 major underwater observatories to create a global record of how human-caused ocean noise affects marine life's ability to hunt, feed, and dwell in ocean waters. "Noise is considered a form of pollution," André says. "But unlike other sources of contamination, it's easier to solve."

PHOTOS (CLOCKWISE FROM TOP LEFT): THIERRY GROBET, ROLEX AWARDS; LYNN JOHNSON, NATIONAL GEOGRAPHIC CREATIVE; ERIC VANDEVILLE, ROLEX AWARDS

DINOSAUR EDUCATION FOR ALL KIDS

Bolortsetseg Minjin

Bolortsetseg "Bolor" Minjin was one of Mongolia's first women to earn a Ph.D. in paleontology. Now the 2010 National Geographic emerging explorer is inspiring a new generation of fossil hunters.

Mongolia's Gobi desert is one of the world's most diverse fossil areas. That's because, in the past, it was a humid region with vast freshwater lakes and rivers, a paradise for plant life and dinosaurs. Even so, few Mongolian kids today have the fascination for dinosaurs that kids elsewhere do, Bolor notes. "Dinosaurs are more of a mythical creature to kids in my country because there have been no resources to learn about them."

In addition to a bus that now hosts a dinosaur exhibit, Bolor hopes to broaden educational outreach. She's currently raising money to break ground in 2018 on the first of several museums.

BRINGING NATURE TO PRISON INMATES

Nalini Nadkarni

It's a long way from Costa Rica's rain forests to a Washington State prison, but Nalini Nadkarni is comfortable in both. The field biologist has spent much of her career studying plant life dwelling in the forest canopy. Her penchant for scaling 200-foot-tall ceiba trees once spurred her to develop a Treetop Barbie doll. But after years of fieldwork, she turned to developing nature programs for prison inmates while teaching at Washington's Evergreen State College. Her Sustainability in Prisons Project has since spread to several states.

Marine biologist and oceanographer **Sylvia Earle** has logged more than 7,000 hours underwater. And at 81, the National Geographic explorer-in-residence shows no signs of slowing down. Earlier this year she spent time underwater studying deep coral reefs near Oahu, Hawaii.

Nadkarni, a National Geographic grantee and University of Utah biology professor, has also spread her gospel about nature to minority groups and faith congregations. "Rather than saying, 'You need to read my articles or attend my lectures to understand my science,'" she says that she prefers "appealing to people in their own venues."

THE LESSONS EARLY HUMANS STILL TEACH

David Lordkipanidze

Scientists found 1.8-million-year-old fossils in Dmanisi, Georgia, more than 25 years ago. Today evidence

PHOTOS (CLOCKWISE FROM TOP RIGHT): MARCO GROB; IRA KURMAEVA; LAWRENCE BOYE, UNIVERSITY OF UTAH/NATIONAL GEOGRAPHIC CREATIVE; MARK THIESSEN, NGM STAFF

Rolex was an early supporter of anthropologist **Johan Reinhard,** a longtime National Geographic explorer-in-residence. In 1999 Reinhard's team made a historic discovery: the 500-year-old frozen remains of a teenage girl sacrificed to Inca gods atop Argentina's Volcán Llullaillaco.

is still emerging of the earliest known human ancestors to venture outside Africa.

David Lordkipanidze, a paleoanthropologist and 2004 Rolex laureate, headed the 1991 excavation of the Dmanisi site, which led to the theory that all early *Homo* fossils belong to the same species.

As head of the Georgian State Museum in nearby Tbilisi, he still visits the site at least twice each week. "I couldn't imagine my life without this place,'' he says. Teams have excavated 5,980 square yards, just 10 percent of the explorable site.

SAFE PLACES FOR SHARKS AND FISH TO HANG OUT

Barbara Block

Using cutting-edge technology to monitor the movements of sharks, billfish, and bluefin tuna, marine biologist Barbara Block has developed a trove of information on the secret lives of ocean predators.

As co-chief scientist for the Census of Marine Life's Tagging of Pacific Predators project, Block helped identify several marine hot spots—hunting grounds where predators find abundant krill, sardines, squid, anchovies, and salmon. One of these hot spots, now California's Monterey Bay National Marine Sanctuary, is featured in Block's 2016 science documentary, *Blue Serengeti*.

Like land-based parks, Block says, these areas need conservation and protection so they can continue to foster the diversity of species. "What we've found is that, like clockwork, they come back to the same neighborhood," says the 2012 Rolex laureate, who is trying to raise funds to develop antipoaching tags for vulnerable marine species.

"The biggest problem is unregulated and illegal fishing," Block points out. "We're only just getting a handle on it through technology."

TRACKING BATS WITHOUT THEM KNOWING

Winifred Frick

After earning a degree in environmental studies, Winifred Frick was waiting to begin graduate school when she met her future husband, bat biologist Paul Heady. "I fell in love with him and bats at the same time," says Frick, a National Geographic grantee. In the years since, she has studied bat ecology and conservation with a focus on white-nose syndrome, a fungal disease of bats that has devastated hibernating colonies in North America.

This spring, Frick, senior director of conservation science for Texas-based Bat Conservation International, will begin a yearlong study of the migration patterns of the lesser long-nosed bat in Mexico's Baja Peninsula. She aims to collar 50 bats with GPS transmitters, which will yield detailed tracking data when the bats return to their caves in 2018.

PHOTOS (CLOCKWISE FROM TOP LEFT): JOHAN REINHARD; WINIFRED FRICK; BART MICHIELS, ROLEX AWARDS

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ROMANTIC ATTACHMENT

By Patricia Edmonds

Keeping your mate extraordinarily close—as in permanently fused to your body—has its advantages.

A mile or more down in the lightless ocean, deep-sea anglerfish search for partners. The 162 species of this Ceratioid suborder form odd couples: The males are dwarfed, the females many times larger (some three feet long). Yet they're uniquely equipped to find each other.

The male's outsize nostrils pick up the female's waterborne pheromones. His well-developed eyes search for a spot of light: the bioluminescent lure on a stalk adorning the female's brow. Ted Pietsch, a University of Washington ichthyologist, says the lures' different shapes, pigment patterns, and flash patterns tell a male when he's found a female of his species to hook up with.

"Hook up" is putting it mildly. Rather than risk separation from his mate in the vast dark, the male clamps his teeth onto some part of her and stays put. "Eventually the skin of male and female grows together," Pietsch says; vessels join "so her blood flows through his body." Fins and other disused body parts wither away until the male is only what the female needs him to be: a sperm factory.

This sexual parasitism bears fruit. When the female's eggs are ready, she signals the male. As he releases sperm, she releases a gelatinous egg mass that expands in water, absorbing the sperm.

The buoyant mass of fertilized eggs slowly rises to the ocean's upper reaches. There the larvae hatch and fatten on plankton. As they start to mature, Pietsch says, the anglerfish will make "the great vertical migration" back to the dark deep to find mates of their own.

CERATIOID ANGLERFISH

HABITAT/RANGE
Deep waters of every ocean

CONSERVATION STATUS
For most species, too little data to assess risk

OTHER FACTS
Like this *Haplophryne mollis* (above), some females have more than one male attached. The known record is eight.

PHOTO: PETER DAVID, GETTY IMAGES


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Geek in Space

Why did we dress author Andy Weir, the guy who wrote *The Martian*, in a space suit that actor Matt Damon wore in the movie? To celebrate a launch. This is the debut of a recurring Q&A with astrophysicist Neil deGrasse Tyson, drawn from interviews for his *StarTalk* podcast and television show. The first guest: self-described science geek Weir.

Neil deGrasse Tyson: So Andy, were you a geeky kid? I have to ask.
Andy Weir: Well, of course I was a geeky kid! Do I look like someone who wasn't?

NT: Does that mean you did well in your science and math classes? Were you abused for that?
AW: Yes, absolutely. Although I'm not sure if I was abused for being good at science or because I'm an inveterate smartass. Probably more the latter.

NT: So, college: What'd you major in?
AW: Computer science and engineering.

NT: Am I correct in supposing that your English teachers would've never said, "Oh, he'll be a great novelist one day"?
AW: Yeah, I think my English teachers would agree I'd make a great mathematician someday. I'd always wanted to be a writer, even when I was in high school. But I also liked eating regular meals, and so when the time came to choose a career, I went with software engineering.

NT: How did writing *The Martian* begin?
AW: In 1999, I was working for AOL, and I got laid off when they merged with Netscape. I had a bunch of money in stock options, so I took three years off. I wrote a book, it did not get published, and I just decided writing is going to be my hobby. So I set up a web page, wrote short stories and serials—and *The Martian* was one of those serials. It did really well, which led me to self-publish it to Amazon. It made it into the top sellers, that got the attention of Random House, and they offered me a book deal. It was like all my dreams coming true.

While I was writing the book, anytime I was tempted to take a shortcut and have unrealistic science or physics, I'd say, "What if Neil deGrasse Tyson reads this? He will notice, and he will point it out."

NT: I don't know if I'm happy or sad that that was your mental state at the time.

In *The Martian* all we care about is whether the main character survives on his scientific wit. I don't care about interpersonal relationships. I don't care if his parents are alive or dead, if he's married, has kids. I just care if the stuff he's figuring out is going to work. And he's tapping science, technology, engineering, and math: all the STEM fields. That may be without precedent.
AW: Well, see, no one would accuse *The Martian* of being literature, right? The main character, Mark Watney, is exactly the same at the end of the story as he is at the beginning. He doesn't undergo any change—no personality crisis, no nothing. And I don't feel bad about that. I'm completely unrepentant.

NT: So at no time are you developing the character?
AW: Never.
NT: Could you have invented a new genre here?
AW: I've heard people describe it as competence porn.

NT: What I liked about the film was that

Neil deGrasse Tyson is the host of *StarTalk*, airing Mondays at 11/10c on National Geographic. His new book *StarTalk: Everything You Ever Need to Know About Space Travel, Sci-Fi, the Human Race, the Universe, and Beyond* is available wherever books are sold and at *shopng.com/startalk*.

WILLIAM CALLAN, CONTOUR BY GETTY IMAGES

PHOTOS: DAN WINTERS
THIS INTERVIEW WAS EDITED FOR LENGTH AND CLARITY.

LEAVE A WISE LEGACY

"When it came to deciding where my money would go, I chose places that I felt would make an effort to continue doing what I have tried to do in my lifetime—educate people and illuminate issues."

—Barbara Flowers, who included the National Geographic Society in her estate plans.

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for the first time in my life experience, looking at storytelling in film, science was a character unto itself.
AW: That was part of the goal. I didn't set out to say, "People need to understand science more." I was just like, "This is really cool to me. I want other people to feel that feeling."

NT: The movie takes place in 2035. That's not a random time, presumably.
AW: No. I calculated all the orbital trajectories that the spacecraft Hermes has to take to get from Earth to Mars and back, based on an ion propulsion drive that can provide a constant two millimeters per second per second [mm/s²] acceleration—which, as I'm sure you know, is way more than we can do right now.

NT: These are real launch windows if we were actually to do this? So you have far more accurate information in this story than most people will ever know.
AW: Yes. And in fact, some orbital dynamicists actually double-checked my calculations, and I was only off by about 2 percent. That's pretty big when you're talking about interplanetary stuff…

NT: But for fiction purposes…
AW: It will do.

NT: Right. So now you're on Mars. Do you say, "I have to invent some nonrealistic stuff to tell my story. I did everything else right, now give me some latitude"? You know what scene I'm thinking of in particular.
AW: You're talking about the sandstorm.

NT: The dust storm. It's never a sandstorm, because the air is not thick enough to carry sand.
AW: Right.

NT: For those who might have not seen the film: You have a spaceship that wants to take off, and there's a dust storm—very common on Mars—whose pressure is so great that it's tipping the spaceship. But the Martian atmosphere is so thin, and the mass of dust that it carries is so low, that a dust storm can't tip over a spaceship.

Cans full of film reels surround Andy Weir in a storage vault at the 20th Century Fox Studios in Los Angeles.

AW: It cannot possibly. It could barely tip over a piece of paper.

NT: And I've defended you, by the way. I've said, "Look, he needs it to tell the story. At least he got the fact that Mars has dust storms."
AW: Before I had the dust storm, I had a different idea, but this is a man-versus-nature story, so I wanted nature to get the first punch in. That was the most fun part: coming up with stuff to throw at him and figuring out how he'd solve it.

NT: Did you feel at any point in the novel, "OK, this will actually kill him"?
AW: Oh sure. There were lots of places where I came up with a problem that was so severe there was no way for him to survive. In those cases, I would either give him some piece of technology that enables him to solve the problem or I'd just have that problem not occur.

NT: For me it didn't matter whether I knew he was going to die or not. I'm invested in, Can he solve this problem?
AW: That's because you're a geek, like me. It would've been a helluva shock if he had died at the end, right? It's like a James Bond movie: He's in constant life-threatening peril, but you don't actually think he's going to die. You're really just curious *how* he doesn't die.
NT: Exactly.

At the University of Florida, Parkinson's disease patient Russell Price undergoes surgery to implant a microelectrode that will deliver deep brain stimulation (DBS) to motion-controlling parts of his brain. Doctors don't know how much of a positive result would be due to the treatment and how much to the placebo effect. "The line between treatment and placebo is blurrier than ever," says neurologist Michael Okun.

PHOTOGRAPHED AT McKNIGHT BRAIN INSTITUTE, UNIVERSITY OF FLORIDA

You're not just what you eat, or do, or think. You are what you believe.

Mind Over Matter

In Merced, California, Hmong shaman Va Meng Lee performs a home-based curing ceremony for a man who fell ill during a funeral. To keep his soul from being drawn into the underworld with the deceased, the soul of a sacrificed pig is offered in exchange. Recognizing the healing power of belief, Dignity Health's hospital in Merced allows shamans to work with patients in its medical facility.

By Erik Vance
Photographs by Erika Larsen

The pilgrim wasn't sure he'd make it to the Chapel of Grace. It was agony to walk at all, let alone endure the 70 miles that thousands of believers trek each year to behold an enshrined wood statue: the Black Madonna of Altötting.

Richard Mödl had recently broken his heel, but in 2003 he was determined to complete his first pilgrimage from Regensburg to Altötting, Germany. He figured if the pain got too bad he could always hitch a ride. But he had a deep faith in the Virgin Mary's ability to deliver him. So he walked. And walked. "When you are on your way to Altötting, you almost don't feel the pain," he says.

Today, at 74, Mödl has a warm smile and a wiry frame that looks as if it could survive a charging rhinoceros. Since the healing of his foot, he's made the pilgrimage 12 more times, and he's a passionate believer in its transformative power.

Mödl is not alone in his belief. Whether it takes the form of a touch of the Holy Spirit at a Florida revival meeting or a dip in the water of the Ganges, the healing power of belief is all around us. Studies suggest that regular religious services may improve the immune system, decrease blood pressure, add years to our lives.

Religious faith is hardly the only kind of belief that has the ability to make us feel inexplicably better. Six thousand miles from Altötting, another man experienced what seemed to be a medical miracle.

Mike Pauletich first noticed he had a problem in 2004. His aim with a baseball was off, and his arm hurt. His hand shook a little, and, strangest of all, his wife noticed he never smiled anymore.

Figuring he had carpal tunnel syndrome, he went to the doctor. But his bad aim wasn't because of his arm, and the reason he wasn't smiling wasn't because his arm hurt. At 42 years old, Pauletich had early onset Parkinson's disease. His doctor told him that within a decade he wouldn't be able to walk, stand, or feed himself.

Pauletich didn't deteriorate as much as his doctor predicted, but for years he struggled with the disease and with depression, as talking and writing became ever harder. Then, in 2011, he turned to Ceregene, a company that was testing

Maximillian Klement (left) and Benedikt Braun, 18 and 21, carry a statue of the Virgin Mary during an annual pilgrimage in Germany to the Shrine of Our Lady of Altötting, where healing rituals have taken place since medieval times. In Siena, Italy, at the Basilica Cateriniana San Domenico, the shrine of St. Catherine, which includes her mummified head (opposite), beckons to Roman Catholic pilgrims seeking cures. "If you have doubt," says local guide Chiara Biccellari, "you will receive nothing."

Ex-votos, or offerings, in the form of snapshots fill a prayer room at the back of the Santuario Madonna dell'Ambro, in Montefortino, Italy. They were left in hope of or gratitude for healing. Studies have shown that attending regular religious services can measurably improve health.

Tiny cues as we walk into a hospital—many of which are experienced unconsciously—trigger responses in our bodies.

a new gene therapy. Parkinson's is the result of a chronic loss of the neurotransmitter dopamine. It had been shown in monkeys that injections of a protein called neurturin could halt the progress of the disease by protecting and possibly repairing damaged dopamine-secreting neurons. Ceregene's experimental treatment was to cut two holes, one in each hemisphere of the brain, through a patient's skull and inject the drug directly into the target regions.

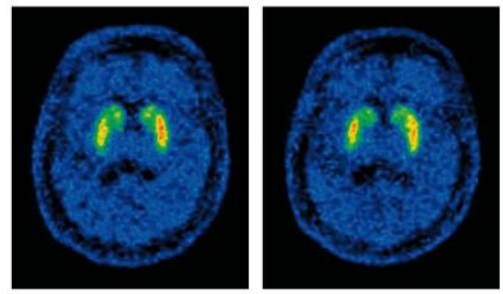
Pauletich's improvement after the surgery was impressive. Before the trial he had struggled to move around. He had to constantly explain to clients of his technology development company that his slurred speech wasn't caused by drinking. After the procedure his shaking disappeared, his mobility improved, and his speech became markedly clearer. (Today you can hardly tell he has the disease at all.) His doctor on the study, Kathleen Poston, was astonished. Strictly speaking, Parkinson's had never been reversed in humans; the best one could hope for was a slowdown in the progression of the disease, and even that was extremely rare.

In April 2013, Ceregene announced the results of the trial: Neurturin had failed. Patients who had been treated with the drug did not improve any more significantly than those in a control group who had received a placebo treatment—a sham surgery in which a doctor drilled "divots" into the patient's skull so that it would feel as if there had been an operation. Ceregene was bought by another company in 2013, and its work on neurturin for Parkinson's has not been continued.

Poston was crushed. But then she looked at the data and noticed something that stopped her cold. Mike Pauletich hadn't gotten the real surgery. He had gotten the placebo.

IN A SENSE both Pauletich and Mödl participated in a performance, one that we humans have been engaging in for thousands of years, every time we go to healers with the hope that they can make us feel better. And just as a good performance in a theater can draw us in until we feel we're watching something real, the theater of healing is designed to draw us in by creating powerful expectations in our brains. These expectations drive the so-called placebo effect, which can affect what happens in our bodies as well. Scientists have known about the placebo effect for decades and have used it as a control in drug trials. Now they are seeing placebos as a window into the neurochemical mechanisms that connect the mind with the body, belief with experience.

How does a belief become so potent it can heal? Back to the theater: A crucial part of an inspiring performance is sets and costumes. When Pauletich experienced improvement in his symptoms, it wasn't just because of the divots he could feel in his head or what the doctors told him about surgery. It was the whole scene he'd experienced: the doctors in their white coats, stethoscopes



PET scans show nearly equal amounts of dopamine released in the brain of a Parkinson's patient when the drug L-dopa was administered (left) and when the same patient took an inert pill, or placebo, after being told there was a 75 percent chance the pill would be L-dopa. Expectations triggered by placebos are especially effective with nervous system disorders.

SARAH LIDSTONE, UNIVERSITY OF BRITISH COLUMBIA

Mike Pauletich, during a trial at Stanford University, believed he had surgery to alleviate Parkinson's symptoms. In fact he'd received a sham surgery – but he did feel significant relief. "Whether it was placebo or some effect of a drug," he says, "it doesn't matter to me."

around their necks; the nurses, checkups, tests, maybe even the bad music in the hospital waiting room. Physicians sometimes call these trappings around hospitals the theater of medicine.

This stagecraft extends to many aspects of treatment and can operate on a subconscious level. Expensive placebos work better than cheap ones. Placebos in brand-name containers work better than those labeled generics. Placebo suppositories work better in France, while the English prefer to swallow their placebos. Often fake injections work better than fake pills. But fake surgeries seem to be the most powerful of all.

Most astonishingly, placebos can work even when the person taking them knows they are placebos. This was reported in a now classic 2010 paper published by Ted Kaptchuk, a researcher at Harvard Medical School, and his team. After 21 days of taking a placebo, people with irritable bowel syndrome felt markedly better when compared with people who received nothing, even though those who reported feeling relief were told beforehand (and reminded afterward) that they were receiving placebos.

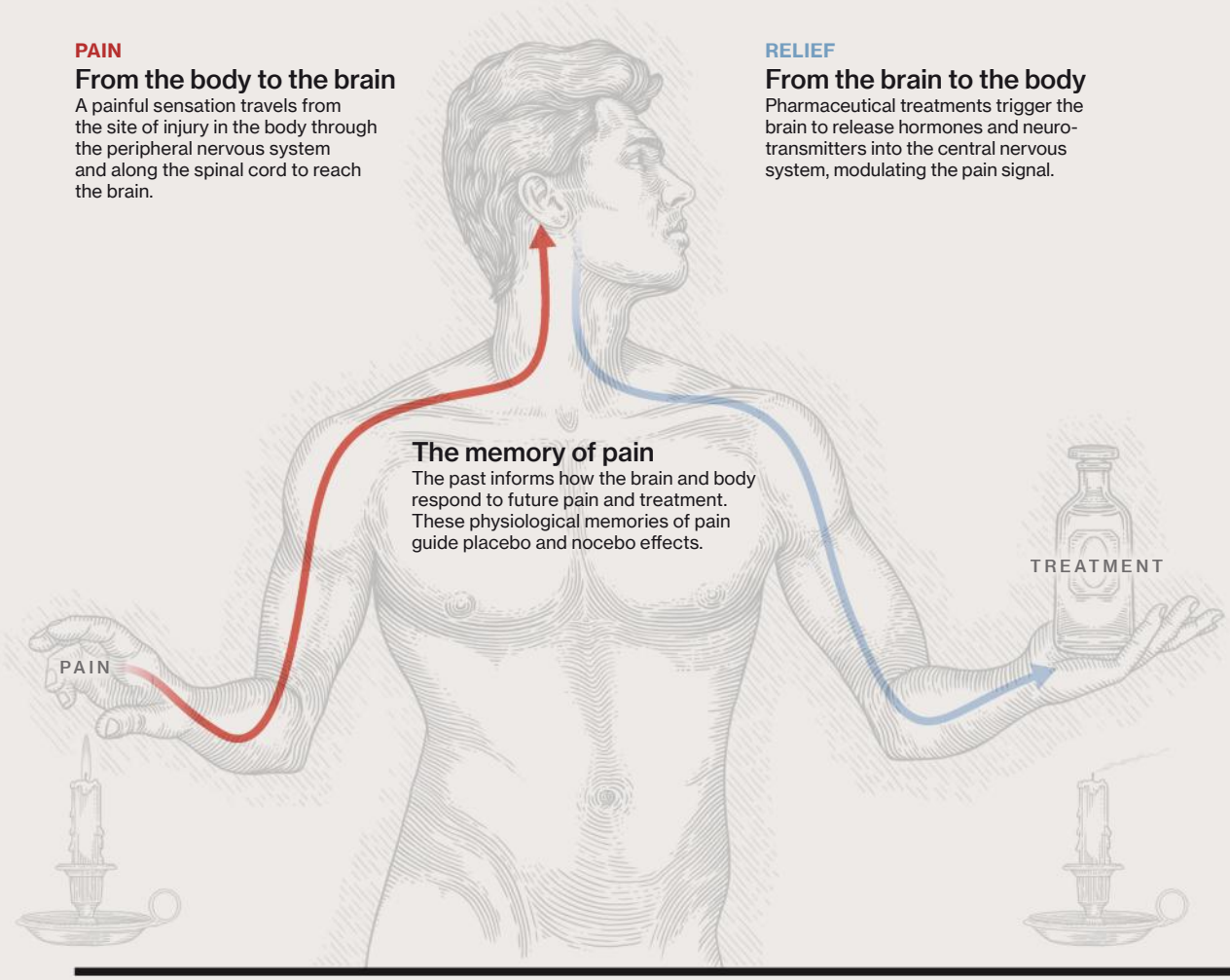
The experiment showed that a supportive patient-practitioner relationship was key in creating belief in a successful outcome. Patients were educated about the power of placebos and positive attitude. They were told that the placebo pills had been shown, in rigorous clinical testing, to induce meaningful self-healing processes. They were instructed to *(Continued on page 48)*

While Russell Price remains awake, doctors insert a microelectrode in his skull (visible in CT scan, right) that will deliver DBS to the brain regions where Parkinson's creates such debilitating symptoms as tremors, rigidity, loss of balance, and slowed movement. Price's wife says his speech is better. His tremors have lessened, and he feels like a different person.

LEFT: PHOTOGRAPHED AT McKNIGHT BRAIN INSTITUTE.
RIGHT: PHOTOGRAPHED BY MAX AGUILERA-HELLWEG FROM A CT IMAGE PROVIDED BY KELLY FOOTE, UNIVERSITY OF FLORIDA

Pathways of Pain and Placebo

Expectations and conditioning from past experiences continue to shape how we feel pain. For some, a strong belief that a treatment will heal an ailment can prompt the brain to tap into its own pharmacy, flooding the nervous system with medicating neurotransmitters and hormones. This is the placebo effect. Its inverse, the nocebo effect, can be activated if a patient anticipates a negative experience; this expectation can cause pain to increase.



The brain's apothecary

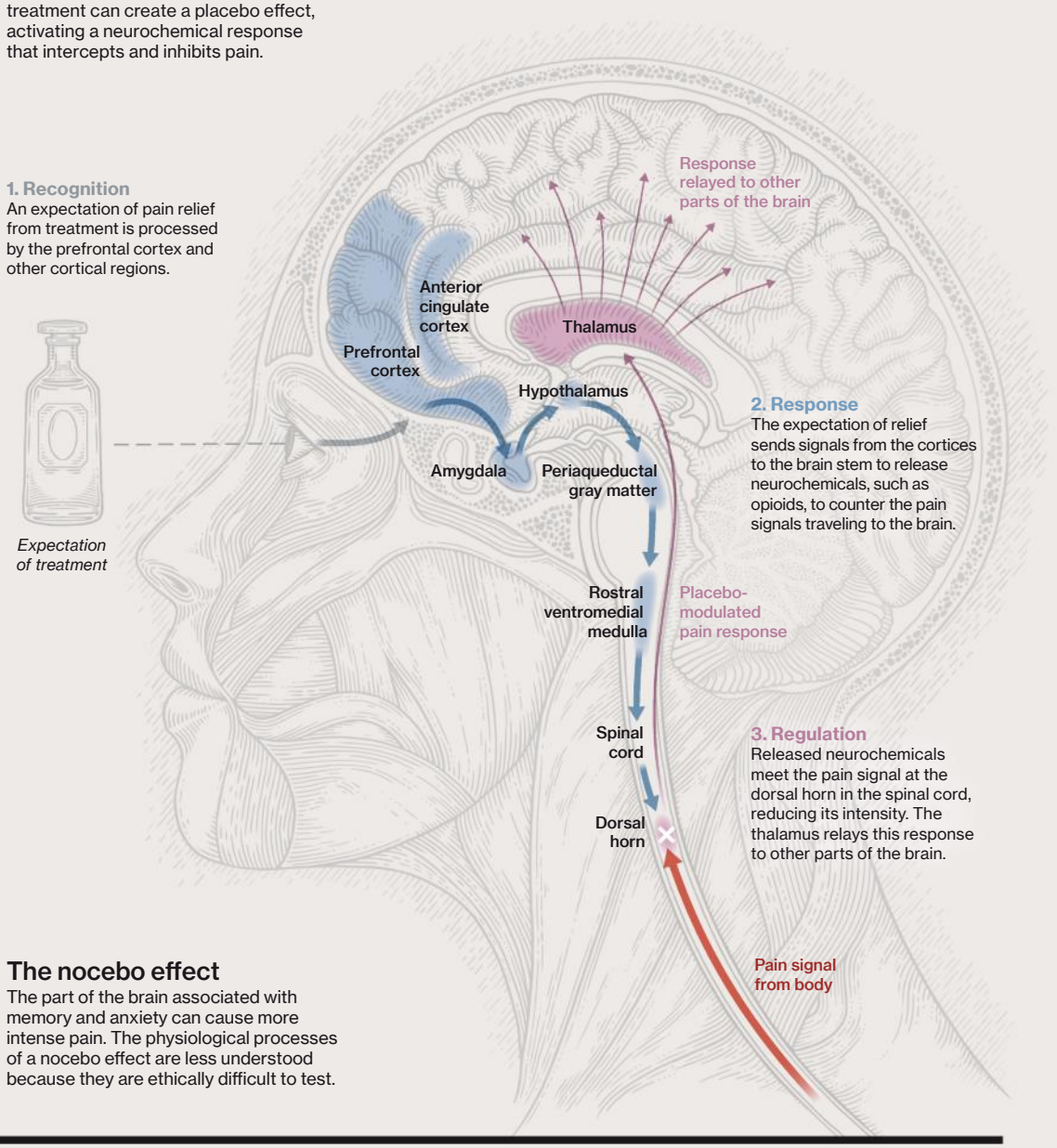
Neurotransmitters and hormones regulate many body functions. They also play roles in placebo and nocebo responses by blocking, amplifying, or diminishing signals that instruct our minds how to react to outside stimuli.

Opioids
Endorphins, the body's natural opioids, attach to the same receptors as synthetic painkillers, modulating sensations like pain, hunger, and thirst.

Endocannabinoids
The endocannabinoid system connects the body with the part of the brain that controls mood, appetite, and pain. Some internal cannabinoids are similar to THC in marijuana.

The placebo effect

The expectation of pain relief with treatment can create a placebo effect, activating a neurochemical response that intercepts and inhibits pain.



The nocebo effect

The part of the brain associated with memory and anxiety can cause more intense pain. The physiological processes of a nocebo effect are less understood because they are ethically difficult to test.

Dopamine
Placebos can cause the release of dopamine in the brain; it regulates desire, pleasure, and reward. When a nocebo effect kicks in, dopamine is deactivated.

Prostaglandins
In high-altitude headaches, prostaglandins dilate blood vessels in the brain to induce pain. This response falls during a placebo effect and rises with nocebo.

CCK
Released by anxiety, cholecystokinin can work against the ameliorating effect of opioids – a nocebo effect that increases pain.

JASON TREAT, NGM STAFF; KELSEY NOWAKOWSKI
ART: STUDIO MUTI. SOURCES: IRENE TRACEY, UNIVERSITY OF OXFORD; FABRIZIO BENEDETTI, UNIVERSITY OF TURIN

The Ashaninka people of Peru use vapor from boiled herbs in their healing rituals. This ceremony is performed by Mircyla Prado Pintallo; at 11 years old she's learning the art of the *vaporadora.* Once the patient inhales the vapor, Mircyla will read the leaves to determine whether the healing has succeeded and possibly prescribe other herbs to help the patient regain good health.

The patterns on the robe of Peruvian healer Enrique Flores Agustín represent songs he sings during curing ceremonies. Researchers at Stanford University (opposite) experiment with transcranial magnetic stimulation to reduce pain. Ancient or modern, the theater of healing works by creating strong expectations in the brain.

A separate network of brain activity kicks in when conventional placebos are enhanced by peer pressure.

(Continued from page 39) take the pills faithfully, missing no doses.

"Dealing with expectation is very tricky," says Kaptchuk, who has spent his life studying placebo effects. "We're dealing with very imprecise measuring of a very imprecise phenomenon. And a lot of it's nonconscious."

Karin Jensen, one of Kaptchuk's former colleagues who now runs her own lab at the Karolinska Institute in Stockholm, Sweden, designed an experiment to determine whether it was possible to use subliminal cues to condition subjects to experience a placebo effect.

During the conditioning phase of the experiment, subjects viewed alternating faces on a screen. Jensen used faces in her experiment because our brains are particularly adept at quickly recognizing them. Half the subjects received subliminal cues: The faces appeared for just a fraction of a second—not long enough to consciously tell them apart. For the other subjects, the facial cues appeared long enough for them to be consciously recognized.

During this first phase, varying heat stimuli were delivered to the subjects' arms along with the facial cues: more heat with the first face, less heat with the second. In the testing phase that followed, the subjects, including those who saw only the quick-flash subliminal cues, reported feeling more pain when they saw the first face, although the heat stimuli remained moderate and identical for both faces. The subjects had thus developed an unconscious link between greater pain and the first face.

Reporting for this story was supported by a grant from the Pulitzer Center.

The experiment showed that a placebo response can be conditioned subliminally. Jensen points out that tiny cues as you walk into a hospital—many of which are experienced unconsciously—trigger responses in our bodies in a similar way. "Part of healing is nonconscious—something that happens instinctually," she says.

HOSPITALS ARE JUST one common venue for the theater of belief. There are hundreds of alternative medical treatments that harness our expectations—homeopathy, acupuncture, traditional Chinese medicines, urine therapy, cow dung tablets, human blood facials, vitamin infusions, sound healing, to name a few—all with varying levels of proven efficacy.

"Belief is natural. It comes partly from the way our minds are hardwired," says Tanya Luhrmann, an anthropologist at Stanford University who has dedicated much of her professional life to understanding people's interactions with God.

She says that belief-based healing requires not only a good story but also the effort of an active listener—one with the ability to make what is imagined feel real. When story and imagination sync, the results can be astounding. "Humans have the capacity to change their experience," she says. "These are skills, and we can learn them."

I'd heard of the belief-based healing of the *brujos,* or witch doctors, of Catemaco, in the state of Veracruz on the eastern coast of Mexico. They are particularly theatrical healers, blending shamanistic traditions with Roman Catholicism much as Christians did a thousand years ago. I'd heard stories of massive, pentagram-shaped bonfires and dancing madmen who spit all over you as a blessing. Certainly worth a visit.

But when I arrived in Catemaco and made my way to a modern brujo's office, I found no fires or whooping shamans. Far from the dark, bat-infested cave I'd expected, the waiting area turned out to be a tidy little living room that smelled of disinfectant. Plastic amulets and glass crystals lined the shelves. About 10 people

sat in chairs, reading magazines or watching soccer on TV. As witch doctors go, the brujo who greeted me looked more doctor than witch. Dressed all in white, he sported a neat mustache and short, heavily gelled hair. Half his office was taken up by an altar packed with crucifixes, statues of saints, flowers, and hundreds of blinking, colored lights.

I'd come for a simple *limpia*—a cleansing of my spirit. The brujo grabbed an egg, a few sprigs of basil, and a couple of plastic squirt bottles filled with what he said were envy blockers, bad-energy protection, and a liquid that makes wealth. Everything was orderly and sanitized. After a short interview, he got down to the business of my spirit, squirting me liberally with pungent oils and rubbing an egg over my body before cracking it open into a glass of water and examining the contents.

I was familiar with this routine—it's common among brujos in Mexico. What surprised me was the lack of pomp or mumbo jumbo. It was more clinical than ceremonial. The brujo asked about my knees and lower back (both fine) and informed me that the egg indicated I might be in for some pain in the future. Like a radiologist explaining features on an x-ray, he noted several bubbles around the egg white in the glass: a sign that someone close to me was jealous and wished me ill. Then he offered, for an extra fee, to protect me from future harm. I declined; we shook hands. I left feeling a sense of anticlimax, as if I had somehow missed something. Where was the theater?

It was only when I was back on the street that I began to understand. Twenty years ago you could still find "authentic" dancing, spitting witch doctors in Catemaco (and they still show up for tourists and festivals). But expectation is a moving target. Over the past generation, conventional medicine has become the norm in Catemaco. Spitting and waving chicken feathers inspired confidence before, but most brujos today have adapted to the times, mixing white lab coats and antiseptic spray with their mysticism to tap into their modern patients' expectations: the theater of medicine. My brujo made eye contact and smiled warmly, like a skillful, caring medical doctor.

And I have to say, I did feel a little better.

SO HOW DOES THE THEATER of medicine actually work? How does a belief literally heal?

One part of the puzzle involves conditioning, as Jensen has shown. Recall Pavlov's dog, which drooled every time it heard a bell. That happened because Pavlov conditioned the animal to connect food with the sound. Scientists have been able to train the immune systems of rats by pairing sweet liquids with cyclosporine A, a drug that blocks the function of immune cells to keep patients from rejecting transplanted organs. Every time the rat has a sweet drink, it also gets the drug. But after enough trials, the drug is unnecessary: The sweet drink alone is enough to shut down the rat's immune response.

The placebo effect's conditioned response in reaction to pain is to release brain chemicals—endorphins, or opium-like painkillers—synthesized in the body. In the 1970s two San Francisco neuroscientists interested in how those internal opioids control pain made a discovery during an experiment with patients who had just had their wisdom teeth pulled.

The researchers first compared the response of a placebo group to the response of another group that received naloxone, a drug that cancels out the ameliorating effect of opioids. None of the subjects received or expected to receive morphine—and all of them felt miserable. Then the scientists redesigned the experiment, telling the patients that some of them would receive morphine, some a placebo, and some naloxone. No one, including the researchers, knew who would receive what. This time, some of the patients felt better, even though they didn't receive morphine. Their expectation of potential relief triggered the release of endorphins in their bodies, and those endorphins reduced the pain. But as soon as they got naloxone, they were in pain again. The drug wiped out the action of the endorphins that the placebo response had released.

"Without the expectation of pain relief, you can't have a placebo effect," says Howard Fields,

Placebo expert Luana Colloca at the University of Maryland, Baltimore and others have uncovered another trigger of the mysterious effect: how we think *others* experience pain. In this experiment, subjects were conditioned to perceive a heat stimulus as stronger when it was paired with an image of a face showing distress, even when the stimulus was moderate. An fMRI machine captures how the brain responds to the coupled stimuli.

Jones Benally, a healer on the Navajo Reservation in Arizona for more than 75 years, treats the body and the mind of his patient to relieve her pain and stress. He works in a hogan (here) – and also in hospitals and elder-care centers. His daughter and his sons are learning his skills in order to carry on the tradition.

We don't imagine we're not in pain. We self-medicate, literally, by expecting the relief we've been conditioned to receive.

an emeritus professor at the University of California, San Francisco and one of the authors of the study.

Since that experiment, conditioning has been used to study the effects of belief on the release of other drugs produced by the body, including serotonin, dopamine, and some cannabinoids, which can work in a way similar to the psychoactive ingredient in marijuana. But it wasn't until the early 2000s that scientists could watch how these effects play out in the brain. Tor Wager, then a Ph.D. student at the University of Michigan, put subjects in a brain scanner. He applied cream to both of each subject's wrists, then strapped on electrodes that could deliver painful shocks or heat. He told the subjects that one of the creams could ameliorate pain, but the creams, in fact, were the same, and neither had any inherent pain-reducing qualities. After several rounds of conditioning, the subjects learned to feel less pain on the wrist coated with the "pain relieving" cream; on the last run, strong shocks felt no worse than a light pinch. A typical conditioned placebo response.

The most interesting part was what the brain scans showed. Normal pain sensations begin at an injury and travel in a split second up through the spine to a network of brain areas that recognize the sensation as pain. A placebo response travels in the opposite direction, beginning in the brain. An expectation of healing in the prefrontal cortex sends signals to parts of the brain stem, which creates opioids and releases them down to the spinal cord. We don't imagine we're not in pain. We self-medicate, literally, by expecting the relief we've been conditioned to receive.

"The right belief and the right experience work together," says Wager, now a professor at the University of Colorado Boulder and director of a neuroscience lab there. "And that's the recipe."

The recipe of belief and experience is finding its way out of the lab and into clinical practice as well. Christopher Spevak is a pain and addiction doctor at the Walter Reed National Military Medical Center in Bethesda, Maryland. Every day he sees active service members and veterans with severe injuries, sometimes just days or weeks after they have left the battlefield. This offers him an opportunity to use expectation and conditioning to tap into internal opioids to stave off, or at least mitigate, long-term pain.

When Spevak first meets patients, he doesn't ask about their injuries or their medical histories—he has all that on file. Instead he asks them about themselves. He might learn that in childhood a person had a favorite eucalyptus tree outside his house or loved peppermint candies. Eventually, if Spevak prescribes opioid painkillers, every time the patient takes one, he also has eucalyptus oil to smell or a peppermint to eat—whatever stimulus Spevak knows will resonate. Over time, just as with Jensen's quick-flash faces or Wager's skin cream (or for that matter, Pavlov's bell), patients start linking the sensory experience to the drugs. After a while, Spevak cuts down on the drug and just provides the sounds or smells. The patient's brain can go to an internal pharmacy for the needed drugs.

"We have triple amputees, quadruple amputees, who are on no opioids," Spevak says of his Iraq and Afghanistan veteran patients. "Yet we have older Vietnam vets who've been on high doses of morphine for low back pain for the past 30 years."

TWO YEARS AGO Leonie Koban, a member of Tor Wager's lab, spearheaded a novel placebo study. The scientists were well aware of the roles of conditioning and theater in channeling expectations. They wanted to test the effect of a third element influencing experiences of pain: other believers.

As in many previous tests of the placebo effect, the researchers delivered a burning

sensation to their subjects' arms and asked the subjects to rate how strong it was. But this time they introduced an extra variable. The volunteers looked at a screen and saw a series of hash marks representing how previous participants had rated their pain. For the same stimulus, the subjects reported feeling higher or lower levels of pain based on what they were told previous participants had felt.

The result was not surprising. In the 1950s, a series of tests called the Asch experiments showed that subjects can give answers they know to be wrong in order to conform with the group. What shocked Koban and Wager was the sheer strength of the social influence: The effect was larger than might be expected after conditioning. Tests of the subjects' skin conductance responses—involuntary changes in how the body is conducting electricity, often used in lie detection—showed that they were not just reporting what they thought the researchers wanted to hear; they were actually responding less to pain. Studies with fMRI machines implicated a separate, complementary network of brain activity that kicks in when conventional placebos are enhanced by peer pressure. Koban goes so far as to say that social information might be more powerful in altering the experience of pain than both conditioning and subconscious cues.

"Information we take from our social relationships has really profound influences, [not only] on emotional experiences but also on health-related outcomes such as pain and healing," Koban says. "And we are only beginning to understand these influences and how we can harness them."

The impact of the social group could help explain why religion might in a very literal sense be what Karl Marx defined as "the opium of the people": It can tap into the ability to access our own store of beliefs and expectations, especially when we're surrounded by other believers who are doing the same.

NOWHERE IS the power of group belief more evident than in religious pilgrimages—whether it's the annual Catholic trek to Lourdes, in France, the annual hajj pilgrimage of Muslims to Mecca, in Saudi Arabia, or, largest of all, the Maha Kumbh Mela, occurring every 12 years. The latest Kumbh Mela, in February 2013, drew an estimated 70 million Hindus to the Indian city of Allahabad.

Or the pilgrimage to Altötting where I met Richard Mödl. The first documented healing in Altötting was in 1489, when a drowned boy was said to have been miraculously brought back to life. Today the Black Madonna there attracts about a million visitors a year.

The pilgrims I joined on a cold Bavarian morning in 2016 had already been walking since 3 a.m. After pausing for breakfast, everyone was chatting happily, waiting for the signal to begin walking again, in the rain. I had been nervous about the trip because of ankle surgery I'd had three months before. But in that merry throng of believers, my pain faded away.

"Everyone is here for their own reasons, but they are all here for each other just as much," said Marcus Brunner, a cheery priest and 27-year veteran of the walk. "The group carries you, and you carry the group all together."

When we arrived in the Chapel of Grace, we found it covered inside and out with ex-votos—pictures representing miracles spanning hundreds of years and showing every imaginable ailment. Propped against the walls were crutches and canes left behind through the ages by parishioners and pilgrims whose suffering was relieved by the Black Madonna. The expectation of healing continues unabated.

"There is a different way of thinking here," said Thomas Zauner, a psychotherapist and deacon who had moved to Altötting in order to seek a supportive community for his developmentally disabled child. "Prayer seems to actually work." □

MARK THIESSEN, NGM STAFF

Photographer **Erika Larsen** contributed to this year's special issue on Yellowstone. Some material in this story appears in a different form in **Erik Vance**'s *Suggestible You,* published by National Geographic Books.

Out on a Limb

Scientists are gaining vital insights into the private lives of orangutans, but the elusive red apes face a precarious future.

A male Sumatran orangutan challenges a rival by baring his teeth and shaking branches. Now recognized as a distinct species, Sumatran orangutans number around 14,000 in the wild.

Commanding high prices as pets on the black market, baby orangutans can be captured only by killing their protective mothers. These orphans are being raised at International Animal Rescue.

Tempted by the fruit of a strangler fig, a Bornean orangutan climbs 100 feet into the canopy. With males weighing as much as 200 pounds, orangutans are the world's largest tree-dwelling animals.

By Mel White
Photographs by Tim Laman

‘Sometimes I feel like I’ve chosen the most difficult thing in the world to study,’

Cheryl Knott tells me as we sit beneath the rain forest canopy at her orangutan research station in western Borneo. The high-pitched, dental-drill sound of cicadas fills the air, at times forcing us to pause our conversation. As we talk, Knott’s associates are at work in the surrounding forest of Indonesia’s Gunung Palung National Park with GPS units and iPads, following orangutans in their daily wanderings, recording what they’re doing, what they’re eating, and how they’re interacting with others of their species.

Unlike gorillas and chimpanzees—fellow great apes that live in groups and can be followed and observed relatively easily—orangutans live mostly solitary lives. They spend nearly all their time in the treetops, they wander widely, and for the most part they inhabit rugged forest or swampy lowland that’s hard for humans to traverse. As a result, orangutans long remained among the least known of Earth’s large land animals. Only during the past 20 years or so has scientific evidence begun to outweigh speculation as a new generation of researchers has tracked the elusive apes across the islands of Borneo and Sumatra, the only places orangutans live.

For more than two decades Knott has supervised the research at Gunung Palung, looking at many aspects of orangutan life history but focusing especially on the way the availability of food affects female hormones and reproduction. “At the time we started here, no one had really worked on hormones in wild apes,” she says. “People said I was crazy.”

Knott’s studies have special significance because female orangutans give birth only every six to nine years. No other mammal has a longer interval between births. And there’s no telling what her research might mean for our knowledge of human fertility; we and orangutans are so similar that Knott can use standard drugstore test kits on urine from female orangutans to determine whether they’re pregnant.

Typical of many forests in southeastern Asia, the trees at Gunung Palung produce little or no fruit in most seasons. Then, every four years or so, trees of various species simultaneously bring forth massive amounts of fruit in a process called masting. The phenomenon led Knott to wonder about the connection between food abundance and orangutan reproduction.

Knott discovered that researchers could collect and preserve urine from female orangutans on filter paper so that the samples could be tested for hormones later. Her work has shown that reproductive hormones in female orangutans peak when fruit is most abundant in the forest—an adaptation to the boom-and-bust environment.

An 11-month-old baby copies mom at mealtime. The juvenile will stay with its mother for up to 10 years as she passes on essential survival skills. Among them: how to find the most nutritious rain forest fruits.

The expressive, heart-melting faces of baby orangutans make them highly valuable in the black-market pet trade.

"It makes a lot of sense," Knott says. "They're putting on weight during these high-fruit periods, and then they live off that during the low-fruit periods. During these high-fruit periods, females are more likely to conceive."

IT'S AN EXCITING TIME for Knott and other orangutan researchers, as advances in technology (including the possibility of using drones to find and follow orangutans in rugged terrain) mean that the pace of discovery, already far more rapid than it was just two decades ago, will almost certainly increase. This assumes, of course, that there will still be orangutans left to study in the forests of Borneo and Sumatra.

In the 1980s and '90s, some conservationists predicted that orangutans would go extinct in the wild within 20 or 30 years. Fortunately that didn't happen. Many thousands more orangutans are now known to exist than were recognized at the turn of the millennium.

This doesn't mean that all is well in the orangutans' world. The higher figures come thanks to improved survey methods and the discovery of previously unknown populations, not because the actual numbers have increased. In fact, the overall population of orangutans has fallen by at least 80 percent in the past 75 years. It's indicative of the difficulty of orangutan research that scientist Erik Meijaard, who has long studied the species' population trends, is willing to say only that between 40,000 and 100,000 live on Borneo. Conservationists on Sumatra estimate that only 14,000 survive there. Much of this loss has been driven by habitat destruction from logging and the rapid spread of vast plantations of oil palm, the fruit of which is sold to make oil used in cooking and in many food products.

There's another factor at work as well. A 2013 report by several top researchers said that as many as 65,000 of the apes may have been killed on Borneo alone in recent decades. Some were killed for bush meat by people struggling to survive. Others were shot because they were raiding crops—or protecting their young. The expressive, heart-melting faces of baby orangutans make them highly valuable in the black-market pet trade, within Indonesia as well as smuggled out of Borneo or Sumatra to foreign destinations. The ferocious protectiveness of female orangutans means that the easiest way to obtain a baby is to kill the mother—a compounded tragedy that not only removes two animals from the wild but also

Society Grant Your membership helped support the fieldwork and research behind this story.

Rows of oil palms replace rain forest near Borneo's Gunung Palung National Park. Vast expanses of orangutan habitat have been lost to palm oil, used for cooking, food products, and cosmetics.

COMPOSITE OF THREE IMAGES

eliminates the additional offspring the female would produce during her lifetime.

At rehabilitation centers such as International Animal Rescue near Gunung Palung, the steady influx of orphaned orangutans shows that this killing remains a serious problem. More than a thousand orangutans now live at rehab sites, and though the goal is to release as many as possible back into the forest, attempting to teach survival skills to young orangutans is challenging and unproven.

Threats to orangutans come as the recent boom in research is revealing a surprising range in their genetic makeup, physical structure, and behavior—including the beginnings of cultural development that could help us understand how we transitioned from ape to human.

For centuries, scientists considered all orangutans to belong to one species, but in the past two decades new insights have led researchers to see Bornean and Sumatran orangutans as distinct species, both of which are critically endangered. Surprisingly, researchers have found that a recently discovered population at a site called Batang Toru in western Sumatra is actually closer genetically to Bornean orangutans than to other Sumatran populations—possibly the result of differing waves of migration to the islands from mainland Asia.

The Batang Toru orangutans are believed by some researchers to diverge from others enough to constitute a third species. Numbering as few

Among the Orangutans

Orangutans learn most of the behaviors illustrated here from their mothers before reaching adolescence around age 12. Some of the behaviors are ubiquitous. Others occur only in certain areas, suggesting there could be regional cultures.

Male with facial flange

LEAF WIPING 1 4 5 6 8

Orangutans have been observed wiping their chins, eyes, and bodies with leaves. Sometimes this is to remove sticky residue left by food, but often the purpose is unclear.

THIRST QUENCHING

Orangutans sometimes drink by dipping a hand into water and then dripping it into their mouths, but they get most hydration from food.

Variation 1 6
Some squeeze wet leaves like a sponge.

Variation 3 7
Some bite the bottom of a pitcher plant and suck out rainwater.

Variation 2 6
Some use leafy twigs to get water from very deep tree holes.

Water

Unflanged male

TERMITE FEEDING

Orangutans eat termites, from nests on the ground or in the forest canopy, by tapping the insects into their hands or sucking them out.

SNAG CRASHING
Male orangutans push tree snags over to make noise as part of a display of dominant behavior.

Variation 5 6 7
Some ride the snag as it falls, grabbing onto vegetation before the snag hits the ground.

NESTBUILDING
Each day the apes make fresh nests for sleep or day rest by breaking and weaving together branches to build a sturdy structure.

Variation 1 —all sites
Some use leaves as pillows, linings, covers, and possibly even mosquito repellent.

UMBRELLA MAKING
Orangutans make umbrellas to shelter from the rain, holding leaves over their heads and sometimes their backs.

"KISS SQUEAKING"
Orangutans make a sound known as a kiss squeak to threaten other orangutans and humans.

Variation 1 4 6 7 8
Some kiss-squeak into a handful of leaves, then toss them on the ground.

***NEESIA* FEEDING** 4 5 9
In the rain forests where *Neesia* is found, orangutans use their hands and teeth to break open these fruits and eat their fat-rich seeds.

Variation 2 3
Some use sticks to extract the seeds and avoid the fiberglass-like hairs.

FERNANDO G. BAPTISTA, MATTHEW W. CHWASTYK, AND RYAN WILLIAMS, NGM STAFF; MANYUN ZOU

SOURCES: TIM LAMAN; CHERYL D. KNOTT, BOSTON UNIVERSITY; CAREL P. VAN SCHAIK, UNIVERSITY OF ZURICH; SERGE WICH, LIVERPOOL JOHN MOORES UNIVERSITY; MEREDITH BASTIAN, SMITHSONIAN NATIONAL ZOO

A male Bornean orangutan uses a leafy branch as a makeshift umbrella. This learned behavior is an example of orangutan “culture” passed down from one generation to the next.

Preserving old-growth rain forest is crucial, but the human-altered landscape is also vital to orangutan survival.

as 400 individuals, they're threatened by a proposed hydropower project that would fragment their habitat and open the area to more human intrusion, including illegal hunting.

What's more, several populations on Borneo are now deemed to be separate subspecies, based on factors such as differing body types, vocalizations, and adaptations to the environment. The diversity of orangutans extends even further—into differences whose origins continue to resist scientific understanding.

FROM HIS PERCH high in the rain forest canopy of Sumatra, a big male orangutan known as Sitogos jumps to the trunk of a dead tree and, using all his 200 pounds, rocks it back and forth until it snaps at the base. At the last moment Sitogos leaps to a nearby limb, while the tree falls toward me with an enormous crash.

Orangutans do this a lot when they're mad, and they're very good at it. The tree couldn't have been aimed any more accurately if it had been laser guided.

Sitogos means "the strong one" in the Batak language of northwestern Sumatra. True to his name, the big male stares down at me, shakes the branch he's holding, and gives a guttural, bubbling call. There may be Sumatran tigers and sun bears roaming the forest floor, he seems to say, but up here in the treetops, I'm the king.

Stretching his arms to their full span of seven feet, Sitogos moves through the canopy by using his long-fingered hands and dexterous feet to clamber from branch to branch. A young female, Tiur ("optimistic"), follows his every move, approaching closely whenever he pauses. Much smaller and more delicately built, she persists in her pursuit even though he seems indifferent. They sprawl on a branch together, eating flowers and breaking off cuplike fern fronds to drink the water inside. When he leans forward against a limb, Tiur grooms his back.

Sometime in the recent past, Sitogos had undergone an astounding transformation. He'd spent years hardly larger than Tiur. Then, with testosterone flooding his body, he'd grown powerful muscles, longer hair, fleshy pads called flanges on the sides of his face, and a massive throat sac to amplify his calls.

The sybaritic scene in the forest canopy—the devoted attention of Tiur and access to her and other females for mating—is Sitogos's reward, but his physical change has a price too. From somewhere in the distance comes the call of another male orangutan. Sitogos stands up, transfixed, and begins moving toward his challenger.

The males of many species of animals undergo major physical changes as they mature, but for orangutans the process is especially intriguing. Not all males develop the massive bodies, facial flanges, and throat sacs shown by Sitogos. Many retain smaller bodies long after they reach sexual maturity, transforming years later than other individuals. Some remain undeveloped their entire lives. The mechanism behind this divergence, called bimaturism, ranks among the greatest mysteries of zoology.

In the forests of northern Sumatra, only one dominant flanged male maintains control over a local group of females. Many males in the area retain smaller bodies and don't develop flanges, thereby avoiding the confrontations that inevitably occur when several males try to assert dominance (until they themselves can try to move into the dominant role). For the smaller males, the only chance to pass on their genes is to watch from the sidelines, out of reach of the boss, sneaking in for mating whenever possible.

In Borneo, by contrast, nearly all males develop flanges. They wander across large areas, with no one male maintaining an associated group of females. A male's best chance at mating is to grow strong and join the competition, leading to more confrontations and injuries.

On a trail not far from Knott's research station, I see evidence of these conflicts. A male orangutan named Prabu sits high in the branches of a strangler fig, occasionally peering down to reveal a fresh puncture wound on his forehead and a lower lip missing a chunk of flesh. Obviously Prabu had been in a fight, but was he the winner or the loser?

As I watch, he rises up and gives the loud series of sounds known as a long call: a complicated and thrilling medley of deep rumblings and bubbling hoots that can carry a mile through the forest. Usually males' long calls last less than a minute, but Prabu's continues for more than five minutes. Bloody but defiant, Prabu still proclaims his power to rival males and potential female mates alike.

SOME SCIENTISTS BELIEVE the dichotomy between male orangutans arose in part because of the differing geologic histories of Sumatra and Borneo. Sumatra is more fertile than Borneo, where ancient, weathered soil lacks plant nutrients, and many forests see the boom-and-bust cycles of masting fruit trees, leading to periods of low food availability. Orangutans on Sumatra don't have to travel far to find enough food, and female density is higher. This gives males the ability to remain in a single place and develop associations. The relatively poorer environment of Borneo has created a free-for-all in which individuals roam over large areas, finding food and mating opportunities where they can.

This may explain why the development of dominant male characteristics differs between the islands. But it brings up a far more difficult question.

"How does a Sumatran male know that if he grows flanges and he's not the boss, he's not going to be successful at mating?" Carel van Schaik asks as we talk in his office in Switzerland, at the University of Zurich, where he and his colleagues have published dozens of scientific papers on orangutan research from both Sumatra and Borneo.

The answer to van Schaik's question, of course, is that the male doesn't "know," in the human sense. "It's not something they can learn," van Schaik says. "There has to be a switch, the sensitivity of the switch has to be different for different populations, and it has to be somehow genetic."

This question of how male development is triggered remains unanswered, in part because of the same challenge that faces orangutan researchers on so many fronts: Their subjects are just so difficult to study.

In addition to their physiological diversity, orangutans exhibit differences in behavior that are passed from individual to individual and generation to generation in ways that can legitimately be called cultural.

"At one of our sites we've heard a call used by mothers when they reassure their kid," Maria van Noordwijk, a member of the Zurich team who studies primate maternal care, told me. "We call it the throat scrape. We had a female that we knew pretty well before she gave birth for the first time. The day after giving birth she already gave that call. It had never been heard before from her. It's clearly something she learned from her mom."

"Primates aren't supposed to do vocal learning," says Carel van Schaik. "And yet, unless you believe this is genetic, which we think we can reject, then it's very likely that it's cultural. What orangutans do isn't like the human voice, but the comprehension and learning and imitating of sounds is there."

RESEARCHERS SEE MORE than just animals' behavior when they watch orangutans. After all, these scientists (and you and I) took only a slightly divergent route on the great-ape evolutionary highway than did their arboreal subjects. Behind the field notes and data points is the question of what orangutans can tell us about humans.

Unlocking all the secrets contained in the brains and bodies of these great-ape relatives means preserving the entire spectrum of adaptations. "If every group is unique, it's not good enough to say we'll protect them at just a few spots," Knott says. The loss of any single population brings an end to any chance to learn from its unique environmental and cultural adaptations.

I spent time in the field with Marc Ancrenaz,

Wearing masks to shield their charges from human pathogens, rescue workers conduct daily “forest school,” teaching orphan orangutans to practice skills and natural behaviors for surviving on their own.


INTERNATIONAL
ANIMAL RESCUE

Fires set to clear forest for oil palm and other crops burned more than six million acres in Indonesia in 2015. Unequipped to survive in the wild after years as a pet, this male orangutan will spend his life at a rescue center.

who since 1996 has directed an orangutan research and conservation project on the Kinabatangan River, in the Sabah region of northeastern Borneo. Here several hundred orangutans live in a narrow corridor of degraded habitat along the river, among villages that themselves are surrounded by a sea of oil palm. The patchy woodland is nothing like the "virgin rain forest" usually associated with orangutans.

"Of course we would prefer primary forest, but this is what we have," Ancrenaz says, as we take shelter from a storm in a hut at his study site. Outside, the muddy ground is dotted with the circular footprints of Borneo pygmy elephants. "Twenty years ago science thought orangutans couldn't survive outside primary forest. We were very surprised here. How come orangutans are in a place where they are not supposed to be?"

Ancrenaz is among several researchers who see the human-altered landscape as vital to orangutans' survival. "I think this is the future of biodiversity," he says.

In western Borneo, Knott has set up an organization to work with local communities to develop sustainable alternative livelihoods, reduce illegal logging and poaching, and provide conservation education in areas surrounding Gunung Palung National Park. In the same spirit, Ancrenaz has established conservation education programs in Sabah schools and communities, trying to find ways that people and nature can coexist. He partners with people living along the Kinabatangan, helping them make money from orangutans and other wildlife through ecotourism and related enterprises. His hope is that residents will become invested in the survival of animals. "Remote villages are the front line for wildlife conservation," he says. "If we don't incorporate local

people into our plans, I think we're going to fail."

For orangutans to survive in their present diversity, governments and conservationists must make smart choices about where to establish preserves, how to manage them, and how to use limited resources. They must find ways for the species to coexist with humans on two islands where habitat is constantly shrinking.

"I see a lot of people trying to do conservation with their heart, with their feelings, which is fine," Ancrenaz says. "But conservation has to be backed up with strong science. The goal of people doing research is to produce better knowledge, better understanding of orangutan ecology and genetics. The rest is actually using this knowledge to impact land use and communities. This is where conservation takes place."

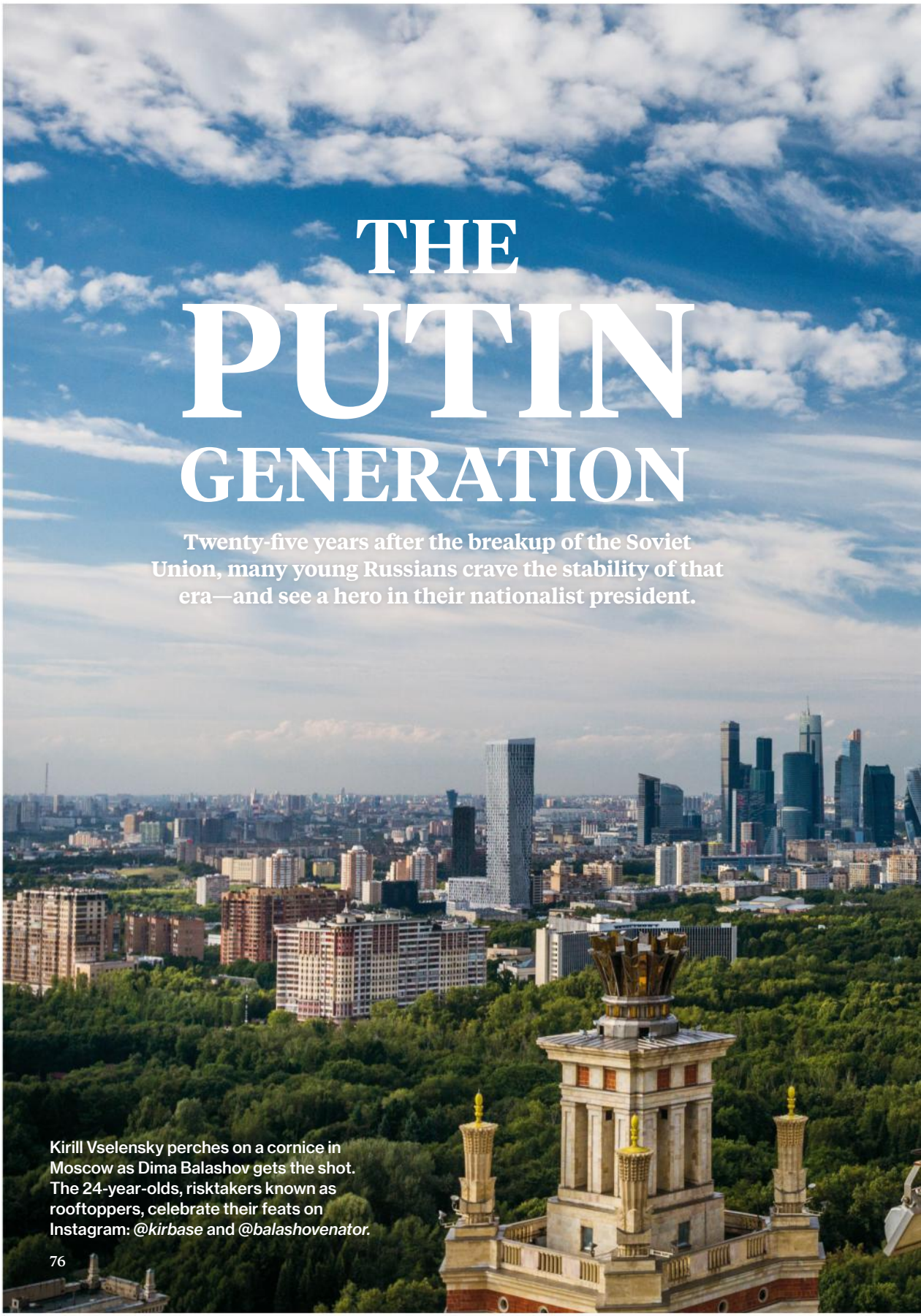
In the forests of Borneo and Sumatra, orangutan behavior determined by millions of years of evolution endures: Males challenge each other with their calls, young males wait for their chances to assert dominance, and females teach their young how to survive in the treetops. Some of the mysteries of their lives have been revealed. What else we learn will depend on the success of this teaming of science and conservation, seeking answers about the links between humans and these apes that seem so like us when we look into their eyes.

"As a scientist you're supposed to be objective," Knott says, as we talk at her camp deep in the Borneo rain forest. "But you're also human, and that connection is why I'm here." □

Photographer **Tim Laman** and anthropologist **Cheryl Knott,** a husband-and-wife team, have been documenting the private lives of orangutans since 1992. "Every year brings new surprises," says Knott.

THE PUTIN GENERATION

Twenty-five years after the breakup of the Soviet Union, many young Russians crave the stability of that era—and see a hero in their nationalist president.



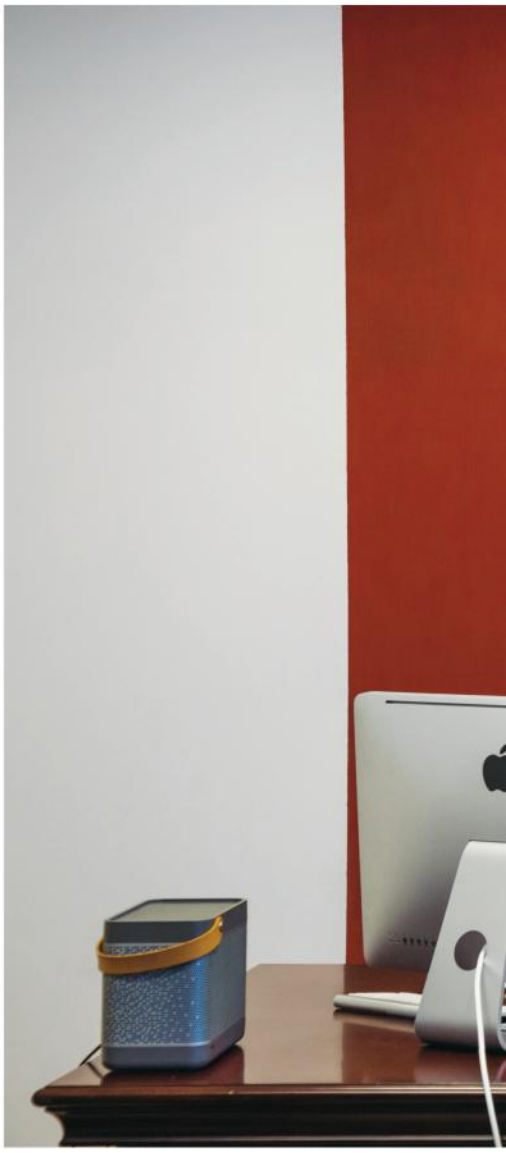
Kirill Vselensky perches on a cornice in Moscow as Dima Balashov gets the shot. The 24-year-olds, risktakers known as rooftoppers, celebrate their feats on Instagram: *@kirbase* and *@balashovenator.*

Alexander and Victoria Khlynin escape the everyday through cosplay (costume play) in their suburban Moscow flat. The 28-year-old banker and 25-year-old interior designer own several animal outfits. Many young Russians, shaped by the chaos of the 1990s and conformity of the Vladimir Putin years, seek stable jobs and families.


HOBBIT
STING

The Wild Mint festival, a multiday extravaganza held about a hundred miles outside Moscow, draws more than 36,000 fans who camp out in a tent city to hear bands play until 3 a.m. Among this year's highlights were the Accident, a popular Russian band that sings about old-fashioned values, and the Wanton Bishops, from Beirut.

By Julia Ioffe
Photographs by Gerd Ludwig



He doesn't know where to take me when I meet him at the hotel by the train station, so we just start to walk down the dusty summer streets of Nizhniy Tagil, a sputtering industrial city on the eastern slope of the Ural Mountains. His name is Sasha Makarevich, a 24-year-old cement worker, a blond ponytail falling down his back, a Confederate flag stitched onto his cutoff denim vest. "I thought it just meant independence," he explains when I ask about it.

We walk past a small, one-story cube of a building covered with images of red Soviet stars and the orange-and-black St. George's ribbon that holds imperial, Soviet, and Russian military medals. "We could go in here," Sasha shrugs. "But it's full of people who survived the Nineties."

Sasha survived the Nineties too. In December 1991, just months before he was born, the Soviet flag came down over the Kremlin and the Russian tricolor went up, ushering in the decade that hangs like a bad omen in the contemporary Russian psyche. The expectation that Russians would start living like their prosperous Western counterparts gave way to a painful reality: It would be a hard slog to turn a command economy into a market one, to make a democracy out of a society that had lived under absolute monarchy and totalitarianism for centuries.

I never got to see those Nineties. My family left Moscow in April 1990. When I first returned, in 2002, the era of President Vladimir Putin, the antidote to the turbulent Nineties, was in full swing. Since then I've been back to Russia many times and lived there for several years as a reporter.

Most of the Russians I know have, to some extent, been shaped by the 74-year Soviet experiment. We know in a deep, personal way our families' small histories and tragedies within the larger tragedy of that history. But this generation coming up knows only a Russia traumatized by the Nineties and then tightly ruled by Putin. This year—25 years after the Soviet Union's collapse—I went back again, to meet these young people like Sasha. Who are they? What do they want from their lives? What do they want for Russia?

INSIDE THE WINDOWLESS BAR, all linoleum and fake-wood paneling, Sasha and I get some thin beer in thin plastic cups and find a seat

An energetic 27-year-old entrepreneur, Radik Minnakhmetov straightens Putin's official portrait, prominently displayed in his office next to one of the president of Tatarstan, a Russian republic about 450 miles east of Moscow. At 24, Minnakhmetov became the head of a new futuristic stadium in Kazan, Tatarstan's capital.

among the heavily tattooed, red-faced men in tracksuits and sandals, blasting reedy Russian pop from their phones.

Nizhniy Tagil, Sasha says, "is all factories and prison camps." Once famous for manufacturing the Soviet Union's train cars and tanks, it's now famous for its idled factories, unemployment, and Vladimir Putin. When Putin announced, in 2011, his intention to return for a third presidential term, protests broke out in Moscow and other large cities. The protesters were largely from the young, educated, urban middle class, and that winter a factory worker from Nizhniy Tagil told Putin on national TV that he and "the boys" were ready to come to Moscow to beat up the protesters. Putin demurred, but the city has come to be seen as the very heart of Putinland.

Now Nizhniy Tagil has a new mayor, whom Putin sent in to beautify the city, and a local magnate has built a fancy health care clinic, but life is still tough here. Sasha went to school for welding and worked in a factory making good money until crashing oil prices and Western sanctions for the invasion of Ukraine sank the economy. Sasha

stopped getting paid. He spent a year looking for work before he landed a job in a Boeing factory two hours away. Now he makes 30,000 rubles, or $450, a month—about the local average.

I meet Sasha after a long workday, and he is tired, his hands dirty. He doesn't feel totally comfortable—or safe—in this bar with the survivors of the Nineties. The city he describes is a violently conformist place. "People here are very aggressive toward anyone who doesn't look like them," he says. It's a local, working-class uniform: tracksuit, buzz cut with a hint of bangs. His peers, Sasha says, are often children of ex-cons. "They don't respect the law," Sasha says. "'A real man is either in the army or in jail.' My sixth-grade teacher told us that." So Sasha learned to fight, with fists, with knives. Once he walked home after a fight covered in someone else's blood, and he is strangely, beatifically cheerful as he tells me all this.

What Sasha really wants to do is escape to cosmopolitan St. Petersburg and open a bar. He's been there a couple times; it's where he feels most at home. But his girlfriend won't move unless he buys an apartment there. Between his salary and hers, his dream will likely remain just that.

It is a common refrain in Nizhniy Tagil: young people with young-people dreams, locked out of them by the reality of Putin's Russia. They want to travel, but their salaries are in rubles, the value of which has been halved by the economic crisis. Some want to open their own businesses but don't know how to scale the dangerous slopes of local corruption. So they train their sights lower. They want a house or apartment, a car, and a family. The things they crave are also the things that many of them didn't have precisely because their families survived the Nineties.

"The Nineties were very hard for us financially," Alexander Kuznetsov, a 20-year-old from Nizhniy Tagil, tells me. "In 1998 my dad left the family." Alexander was three. "My mom's entire salary went to feed me. I didn't have many toys," he says. "I'm alone in the family." That left its mark. "For me the most important thing is family," Alexander tells me as we sip coffee in a café off the main square. "I don't want to strive for high professional posts and have an empty home."

His father fought in the first Chechen war, in 1994. "Don't join the army, son," he advised Alexander. That was the sum total of his father's recollections of the Nineties. But Alexander isn't bothering to find a way out of the universal draft. "I always wanted to join," he explains. "Everyone in my family was in the military. My great-grandfather fought in World War II." Plus, military service opens up some of the more lucrative job prospects for a young man in Russia: work in the police or the Federal Security Service, or FSB, the successor to the KGB. The army would give him a shot at being a cop like his father. "I really want to have a stable income," Alexander says.

As Alexander and I talk, his friend Stepan, a strapping, smiling young man with a blond buzz cut, bounces in to join us. "So," he says, flashing me a mischievous grin, "you're writing about what it was like in the Soviet Union? People lived a lot better then."

"What!" exclaims Alexander. "Lived better?! No, we didn't!"

They argue about what it was like to live in Soviet times, until Stepan, who was born in 1992, realizes he has a question for me: "You Americans are pressuring us, slapping us with sanctions," he says. "What are you preparing for us? A war?" He explains why it was right for Russia to annex Crimea and for Putin to stand up to the West.

Stepan is reluctant to tell me his last name because I'm an American journalist, but when it's time for me to go, he offers me a ride. "Really, though," he says to no one in particular as we wheel through the city, "I want to get out of here."

Out of where? I ask. Nizhniy Tagil?

"No," he says. "Russia."

After his patriotic bluster, this was unexpected. Why? I ask him.

"There's nothing to do here," he says without any bitterness. "No opportunities, no way to grow and develop and make something of yourself."

What's your backup plan? I ask.

"What's my backup plan?" he repeats, smiling broadly. "Join the FSB."

"THOSE WHO WERE BORN in the U.S.S.R. and those born after its collapse do not share a common

experience," wrote Svetlana Alexievich, who won the Nobel Prize in literature in 2015. "It's like they're from different planets."

The Soviet Union drowned in a surge of optimism. Many believed Russia would quickly become a flourishing, Western-style democracy. But the optimism of 1991 dissipated in a decade of often depressing contradictions. With the end of the planned economy came untold riches or entry into a new middle class for some; for others it was a sudden plunge into poverty. Previously unavailable goods flooded store shelves, while the money to buy them periodically lost its value. Crime, especially in commerce, skyrocketed. Politics came out into the open, but many Russians came to see it as a dirty business.

Russians struggled to adjust to this foreign reality. It was a time of unprecedented freedom, but many found it deeply disorienting. "When these [Western] values encountered reality and people saw that changes came too slowly, these values receded into the background," says Natalia Zorkaya, a sociologist with the Levada Center, an independent polling organization in Moscow. Instead, she says, the younger generations are adopting "the pillars of Soviet society."

The Putin generation wants intact families and reliable, if unsatisfying, jobs. It associates the Soviet Union with longed-for stability.

Sasha, Alexander, Stepan, and their cohort do live on a planet different from the one their parents and grandparents live on, yet they are in some ways becoming even more Soviet. It's a strange thing: These young men and women know little of the privations, habits, and cruelty of Soviet life. The Putin generation doesn't carry this wound. Their desire for staid normalcy—intact families, reliable, if unsatisfying, jobs—is their response to what they lacked in the Nineties and found in the Putin era.

Yet they are profoundly insecure. Sixty-five percent of Russians between ages 18 and 24—that is, the first generation born after the Soviet breakup—plan their lives no more than a year or two ahead, according to the Levada Center. "It's a very egotistical generation," Zorkaya says, but adds, "It's a very fragile generation." They are also politically inert: Most don't know about news events the state doesn't want them to know about, and 83 percent say they have not participated in any kind of political or civil society activity.

LIZA MEETS ME IN THE GLITTERING white lobby of one of the many glass towers—some blue spirals, some coppery shards—that make up Moscow City, a financial center that looks like a cross between London and Shanghai. I follow her through tunnels linking the towers underground with cafés, shops, and an exhibit with paintings of Putin and Russian Foreign Minister Sergey Lavrov. We order lunch, and Liza, a stylish young woman with long, curled blond hair, dimples, and an expensive watch, tells me her story as she slurps her borscht. She asks me not to use her last name because she doesn't want to upset her parents.

She was born in Blagoveshchensk, in the Russian Far East, in 1992. A year before, her father, a history teacher, had been out in the streets of Moscow, cheering the arrival of democracy. But on returning home after the Soviet Union's demise, he was forced to find other ways to support the family. He began crossing the border into China and carrying back anything from clothes to appliances for resale in Russia. "I remember him coming home with money sewn into his shirt so that he wouldn't get robbed," Liza tells me.

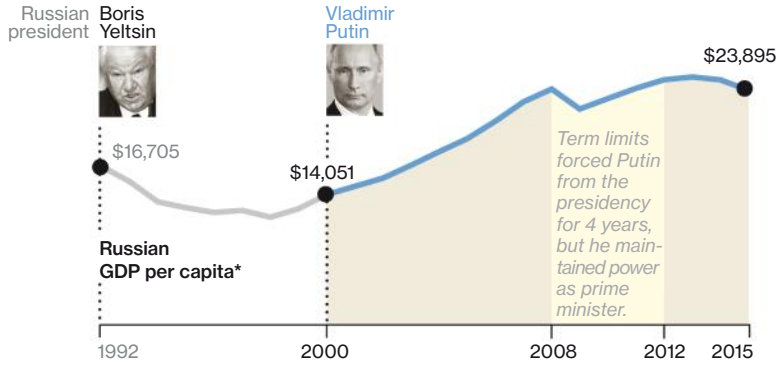
She's a corporate lawyer at a large Western firm. It's fine, but it's not what she wanted to do.

Popularity, Putin Style

Vladimir Putin is widely viewed at home as the man who tamed a tumultuous post-Soviet Russia and the first leader in decades willing to stand up to the West. His strong personality, combined with near-total control over the Russian media, has helped him keep his standing, especially among the young. If reelected in 2018, he'll be Russia's second longest serving leader, trailing only Joseph Stalin's 30-year reign.

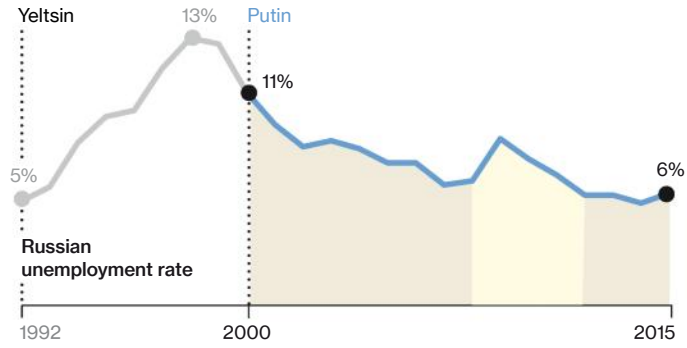
Standard of Living Makes Gains

Putin benefited from tough economic reforms adopted by Boris Yeltsin and his predecessor, Mikhail Gorbachev, as well as from increased oil revenue as prices rose beginning in 2003. Gross domestic product (GDP) per person has grown 70 percent under Putin, compared with 17 percent in the European Union.



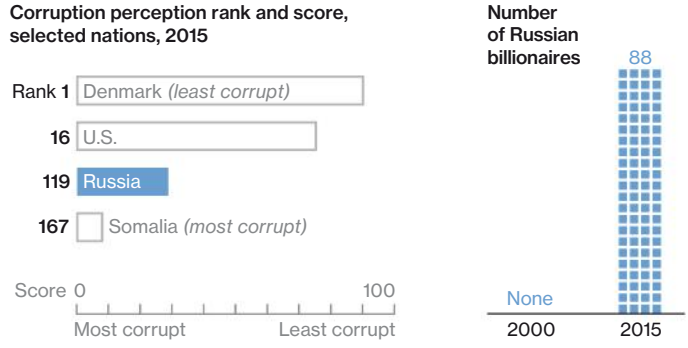
Stability Returns to the Job Market

Soviet leaders claimed that they had "liquidated" unemployment in the 1930s. So Russians were shocked by the rampant joblessness under Yeltsin, then relieved by the return to prosperity and jobs under Putin.



Corruption Persists and Wealth Rises

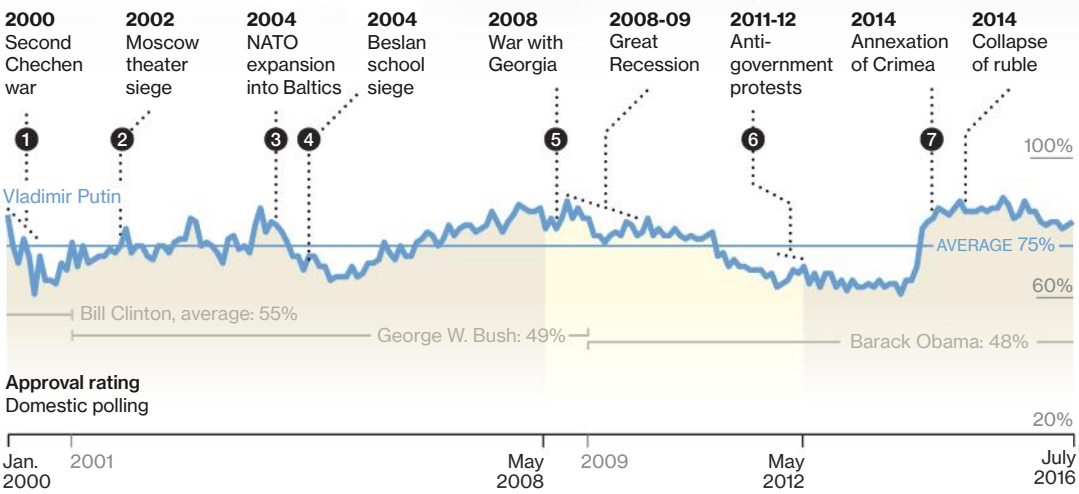
Despite widespread support for Putin, many Russians view their government as highly corrupt, seeing the sudden dramatic rise in the number of billionaires as evidence. More billionaires live in Moscow than in any other city in the world besides New York and Hong Kong.



*CONSTANT 2011 INTERNATIONAL DOLLARS AT PURCHASING-POWER-PARITY RATES

Heralded at Home

With no powerful opposition, Putin has remained popular despite challenges, including the admission of three former Soviet republics into NATO, terrorist attacks, and a collapsing ruble.



An Active Everyman

Putin has publicly participated in a wide variety of traditionally masculine endeavors, in contrast to the aging and infirm Yeltsin, whom he succeeded on December 31, 1999.

Fishing

Hunting

Judo

Hockey

Skiing

MATTHEW W. CHWASTYK AND JOHN TOMANIO, NGM STAFF; FARHANA HOSSAIN. SOURCES: ANDERS ÅSLUND, ATLANTIC COUNCIL; WORLD BANK; TRANSPARENCY INTERNATIONAL; FORBES.COM; LEVADA CENTER; GALLUP.COM. PHOTOS (LEFT TO RIGHT): ALEXANDER NATRUSKIN, REUTERS; RUSSIAN PRESIDENTIAL PRESS AND INFORMATION OFFICE; ALEXEY DRUZHININ, AFP/GETTY IMAGES; DMITRY ASTAKHOV, GETTY IMAGES; AFP/GETTY IMAGES; ALEXEY DRUZHININ, RUSSIAN PRESIDENTIAL PRESS AND INFORMATION OFFICE; DMITRY ASTAKHOV, GETTY IMAGES

Supporters of the Other Russia, an opposition party, rally in Moscow, displaying flags and armbands with their symbol, a grenade. The Other Russia was formed by members of a banned ultra-nationalist political party in 2010, but it is not recognized by Putin's government.

At a sports and military camp, paratroopers teach children as young as 10 how to handle weapons. Putin has restored Russian pride in the country's military might by defeating rebels in Chechnya, seizing Crimea, invading Ukraine, and intervening in Syria. Young people in particular say they want Russia to be seen as a global power.

With some seven million Instagram followers, 29-year-old TV actress Nastasya Samburskaya *(@samburskaya)* is one of Russia's biggest social media stars. Nevertheless, like many Muscovites, she lives in a small apartment. No different from youth in many countries, young Russians rarely part with their smartphones.

"I always wanted to be a journalist; I was always writing," she says, noting that her grandmother kept all her short stories. "But my parents told me journalism isn't serious. It's a venal profession"—a relic of the 1990s, when journalism here was bought and sold like any commodity—"You won't make a lot of money. You're the oldest and the smartest; you need to go into a solid profession so you can feed yourself and take care of your sister." Along the way her parents separated. Her father's business eventually took off, and Liza was able to spend a year of high school in Oregon and also study abroad in London.

A modern Westernized woman, she tells her mother about her boyfriends and the drug-fueled parties she attends. But in some ways she is very, very Russian. "Putin irritates me," she begins, sounding like many in the oppositional, educated milieu of Moscow. "But just let a foreigner try to criticize him! I will always defend Russia." When she was in London, she says, people constantly made fun of Russia and Russian women, mocking them as mail-order brides. "It was offensive to the point of tears, to sit there and hear outsiders making fun of us," she says.

This is as political as she gets these days. Back in 2011 Liza became interested in liberal politics, which was all the rage in Moscow. She joined Amnesty International and the liberal Yabloko party as an observer for the December parliamentary elections. She was assigned to the polling station at her little sister's school and was shocked to see teachers stuffing ballot boxes. When Liza tried to say something, they screamed at her and made her sit in a corner while the principal blocked her view. This was happening all over the country. Many election observers caught it on their phones and put the proof online, which sparked a mass protest movement in Moscow and major cities unlike any Russia had seen in 20 years.

Liza, however, lost her nerve. "I was hysterical," she tells me. "I spent two hours crying." After that she decided, "No more politics. Ever. This doesn't concern me, and I'm not strong enough to fight." It's a promise that she hasn't broken, even as the ruble has crashed, cutting into her ability to do

Students take a break at Muhammadiya madrassa in Kazan, a city on the Volga River that is about half ethnic Russian and half Tatar. Most Tatars are Muslim; Islam, Russia's second largest religion, is followed by about 7 percent of the population. The school teaches religion, humanities, linguistics, and Tatar history and culture.

the other thing she loves most: travel. "Yes, it's terrible; there are fewer opportunities," she says, but she refuses to seek an answer in politics. "It's a psychological block."

Kseniya Obidina, Liza's law school friend, sees things similarly. Also the child of divorce, she says family and stability are of primary importance to her. She wants a secure, well-paying job. She wants to be able to afford travel and to support her mother and sister. This dream has become more remote, though, with the political and economic crisis: Kseniya wants to work at foreign law firms, but they are increasingly packing up and leaving the country. Like Liza, she refuses to think about politics. "I don't see the point of talking about something you can't influence. Talk for talk's sake isn't interesting," she says as we sit in a Moscow Starbucks. As we leave, she adds, "It's better to know and be quiet. It's better not to speak up. Why spoil your mood?"

HOW DID THEY COME to be this way? Vladimir Putin is a big part of the answer. He came to power in 2000 as an anti-Nineties candidate just as this generation was becoming aware of the world around them. He promised to bring prosperity and security. Coasting on historically high oil prices and economic reforms implemented in the Nineties, Putin was able to fulfill much of that promise but at the expense of democratic freedoms.

Stability and economic well-being became the ideology of the day, peppered with a heavy dose of nostalgia for the U.S.S.R. and a whitewashing of its sins. Putin called the disintegration of the Soviet Union "the greatest geopolitical catastrophe" of the 20th century. Whoever didn't feel that, he said, "doesn't have a heart." Joseph Stalin became, in the business-friendly lingo of the day, an "effective manager" who went a bit too far. Textbooks and television came to reflect this new, state-sanctioned nostalgia. Today 58 percent of Russians would still like to see a return of the Soviet order, and some 40 percent see Stalin favorably.

Much of post-Soviet life has been a hapless search for a uniting idea. At first it was democracy; then consumerism became a stand-in for

At a classy high school prom at St. Petersburg's elegant Grand Hotel Emerald, students help themselves to a pyramid of cocktails. The end of communism brought both poverty and wealth to Russia and created a small middle class. For the young who lived through the volatile 1990s, economic security remains a top desire.

Westernization. "Modernization came through consumption, but that's not enough," says sociologist Zorkaya. Ikea, which came to Russia in 2000, became wildly popular among the new middle class as a way to affordably live in a stylish European—that is, non-Soviet—way. "It became a symbol of how you could civilize your life without a lot of money," she says, "but the fact that behind this decor is a totally different concept of human beings and values, somehow it doesn't connect for Russians."

Since the beginning of his third presidential term, in 2012, Putin has promoted an even more aggressive neo-Soviet ideology, both at home and abroad. He fought to keep former Soviet republics, like Ukraine and Kazakhstan, in Moscow's sphere of influence and flexed Russia's military power in distant Syria. A series of laws promoted traditional social values and made dissent even more dangerous. One result is a generation whose dreams are the embodiment of everything Putin desires them to be: conformist, materialist, and highly risk averse.

Much is made of Putin's stratospheric popularity—at the time I reported this article, Putin had the approval of 80 percent of Russians polled. But Russians between the ages of 18 and 24 approve of him at a higher rate than any other age group: 88 percent. More than any other generation, they are proud of their country and its stature in the world, associate its military prowess with greatness, and believe in its future.

IN A DARK, NARROW COURTYARD in Novosibirsk, between two 19th-century brick buildings, I find the local bohemians drinking beer and listening to electronic music. It's here that Filipp Krikunov, born in 1995, opened an art gallery. Ducking away from the gathering, he shows me around. One room is lit with a fluorescent pink light, the wall arrayed with shelves holding mini-busts of Lenin, painted in silly patterns. In the next room young artists have cobbled together mind-bending ways to take selfies: Stick your head into this cardboard box full of shattered mirrors. Stick your head in another to find the remains of a Burger King meal.

Seminary students at Moscow Theological Academy in Sergiyev Posad study the New Testament, liturgical music, icon painting, and other subjects. Brutally repressed by the communists, the Russian Orthodox Church has seen a resurgence under Putin, who sees it as an ally in his bid to restore the nation to greatness.

One of Filipp's friends and partners in the gallery bounds up and shakes my hand. "We just found out that they didn't bury anyone under this space," he gushes. After Filipp rented the rooms, he and his friends realized that the building next door houses the FSB. In the 1930s it was called the NKVD, and it killed as many as 1.2 million people. Often the NKVD's victims were shot and buried on-site. But Filipp's gallery, Space of Modern Art, lucked out. No bones in the basement here. Just hipsters in the mild Siberian summer night.

I had met Filipp earlier that day at a chic Novosibirsk café, surrounded by impossibly fashionable young women with very obvious lip jobs. Novosibirsk is Russia's third largest city, a center of industry and scientific innovation. There's a lot of money here. Filipp, though, didn't see much of it. He grew up without a father. Like many young Russians, he was raised by his mother and grandmother. His great-grandfather fought in World War II and was later purged by Stalin. His grandmother became a renowned chemist, and his mother also worked in science. But the women's passion was politics. "All the main hashtags at home are politics," Filipp says.

Filipp was 16 when the pro-democracy protests broke out in Moscow and spread to cities like Novosibirsk. Tens of thousands poured into the streets to demand free and fair elections, yet the protests felt more like block parties than demonstrations. Filipp too was fed up with Putin. "Messages were being sent to him, messages of discontent, and yet there was no dialogue with those people," Filipp says. He didn't recognize the Russia that Kremlin-controlled television showed. "That was a different country," he says. "I didn't know a single person like that."

"I went to the protests. I tried to be politically active," Filipp tells me. "It was boiling inside me. I wasn't thinking about anything else. The whole country is rising in protest, and I'm part of it." But he was soon disappointed. "I looked around, and the people at the rallies weren't my people. I wasn't totally comfortable," he says. "And it didn't lead to anything."

A chic restaurant in an affluent suburb of Kazan attracts the young, fashionable set. Voda|Sneg (Water|Snow), on the shore of the Volga River, offers a range of entertainment options that change with the seasons. In summer there's outdoor dining, a dock for boats, and swimming; in winter, skiing, snow biking, and dogsledding.

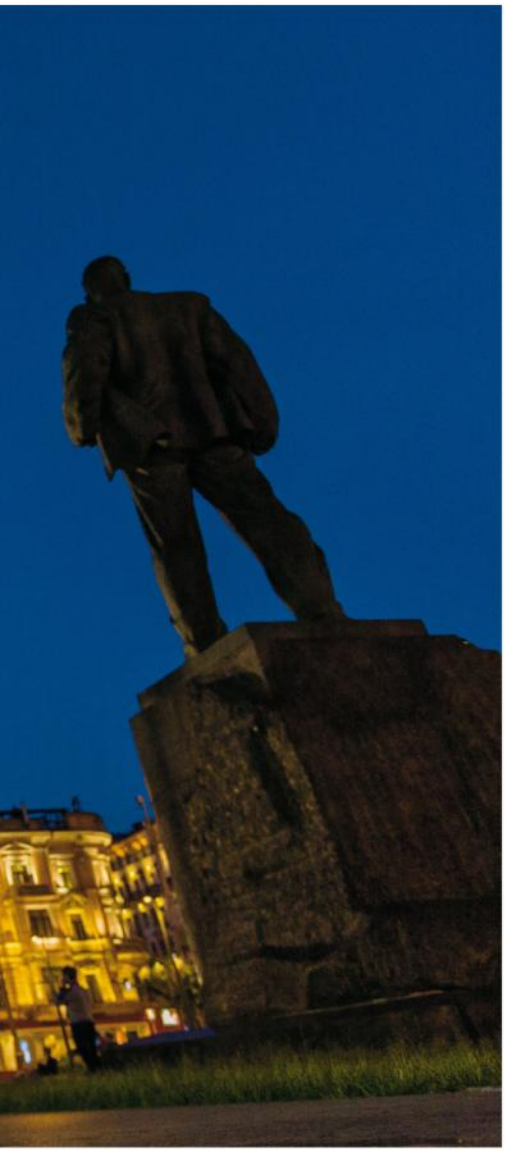
Before the “Day of the Village” celebrations in Nikolskoye, 175 miles northeast of Moscow, young people do what young people do everywhere entertainment is sparse: hang out and flirt. Until the recent downturn, the country’s oil-fueled economy expanded rapidly, and Russia’s young flocked to its cities to seek higher paying jobs.

Mikhail Vasilev, a 29-year-old billiard-equipment salesman, practices his skateboard moves in Moscow's Triumfalnaya Square near a statue of Vladimir Mayakovsky, a poet who extolled the 1917 revolution. Russia's young people have more freedoms than their parents and grandparents could ever have imagined.

That's not quite true. The protests did change things, just not for the better. In May 2012 the Kremlin cracked down. Since then dozens of people who attended protests have been rounded up, tried, and jailed. The political situation in the country only worsened as Putin—feeling betrayed by the middle class he felt he had created with his policies—pursued an increasingly authoritarian line. He publicly labeled liberals who advocated for freedom and democracy "national traitors" and "a fifth column."

The harsh response left a deep impression on the Putin generation: It taught them to stay out of politics. "I decided that either I fight this system," Filipp says, "or I live in a different system"—the world of art. "There's more good in it," he says. "Politics are nerve-racking. You're constantly unhappy; you're not enjoying your life."

Putin is up for reelection in 2018. There is little doubt that he will run again and even less that he will win another six-year term. That would mean he would be in power until 2024, if not longer. By then Filipp, who was five when Putin first became president, would be 29. Is he comfortable living



with Putin until then? He shrugs. "I've lived my whole life with my right hand, and it's fine."

IN AKADEMGORODOK, a small academic town built around Novosibirsk State University and its many labs, I meet Alexandra Mikhaylova. She's 20, with cutoff denim shorts and the dyed red hair of a punk rocker. Alexandra came from a family of scientists—her mom is a geologist and her father a physicist—who gravitated to this little town, which was founded in 1957 as an incubator for science and the engine of the Soviet Union's technological race with the West. Since the Soviet collapse, underfunded Russian scientists have fallen behind their Western colleagues. Both of Alexandra's parents have gone into business.

Now, as a third-year journalism student, she is working on a documentary about the town and its lively intellectual history, specifically the underground of the 1960s. "They had their own system of government until 1966," Alexandra tells me as we stand in the gleaming hallway of the university's new building. Her eyes light up as she tells me about her research into this little corner of freedom and intellectual ferment in a sea of totalitarianism. In 1966 some of these free-spirited young scientists wrote a letter to Moscow, complaining about things they didn't like. The response, Alexandra says, was swift. Many were fired, and strict political control was put in place. But Alexandra's documentary picks up again in the 1980s, with the Soviet punk rock underground that spread all over the country.

These days, Alexandra says, "it's stagnant. Something's missing. People aren't politically engaged. When it comes to the government, young people are either neutral or positively disposed. No one stands up for their opinion, and there's a thin line between indifference and agreement."

The government is again in the censorship business. A classic rocker from the 1990s had his concert canceled here because he spoke out against the invasion of Ukraine. "Year after year they close another media outlet, the ones that show things more objectively," Alexandra says. More than anything, though, she is saddened that the Akademgorodok she lives in lacks the creative fervor of the Sixties and Eighties. The society around her, unlike the one her parents experienced, is cautious and stale. She longs for a change, a shake-up. But she knows it won't be her generation that brings it.

"It'll be the kids who are 13, 15 now," Alexandra says wistfully. When they are the age she is now, her generation will have other priorities. "We'll try to help, but if you're 30, you're not going to lead a revolution with a baby in your arms." □

MAX AVDEEV

Julia Ioffe is a contributing writer for *Politico Magazine* and the *Huffington Post*'s *Highline.* Born in Moscow, she lived there while writing for *Foreign Policy* and the *New Yorker.* This is her first article for *National Geographic.*

GLACIER NATIONAL PARK, MONTANA

Glacial retreat

Sunrise lights up the Garden Wall, a spine of rock shaped by Ice Age glaciers. Grinnell Glacier once filled the basin below the wall, but like most glaciers in a warming world, it's shrinking: Since 1850 it has lost more than 75 percent of its surface area.

THE PARKS OF TOMORROW

America's special places will always be beautiful—but a warming climate forces us to accept that they can't be frozen in time.

OLYMPIC NATIONAL PARK, WASHINGTON

Warming ocean

Surrounded by giant green anemones, a lone ocher sea star feeds on mussels and barnacles. Since 2013 sea stars along the Pacific coast have been dying in unprecedented numbers. Scientists suspect that warmer seas are weakening the species' resistance to disease.

SEQUOIA NATIONAL PARK, CALIFORNIA

Heat, drought

High in the Sierra Nevada, floodlit giant sequoias tower into the night sky. They can live 3,000 years, but California's historic drought has tested them. "We're treating this drought as a preview of the future," says ecologist Nate Stephenson.

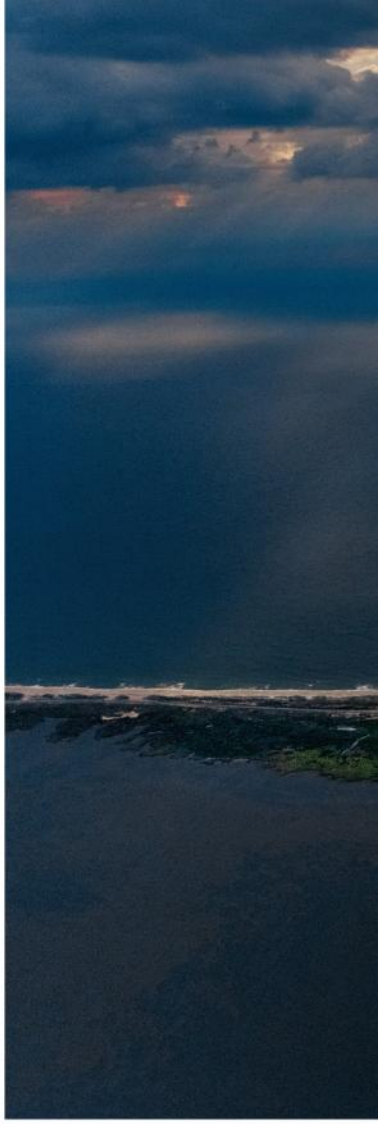
ASSATEAGUE ISLAND National Seashore, which sits on a 37-mile-long sliver of land just off the coast of Maryland and Virginia, is gradually shuffling west. Over centuries, as hurricanes and nor'easters drive sand from its Atlantic beaches across the island and into its bayside marshes, the entire island is scooting closer to the coast.

"It's neat, isn't it?" says Ishmael Ennis, hunching against a stiff spring wind. "Evolution!" He grins at the beach before him. It's littered with tree stumps, gnarled branches, and chunks of peat the size of seat cushions—the remains of a marsh that once formed the western shore of the island. Later buried by storm-shifted sand, it's now resurfacing to the east, as the island shuffles on.

Ennis, who recently retired after 34 years as maintenance chief at Assateague, has seen his share of storms here. This national seashore, in fact, owes its existence to a nor'easter: In March 1962, when the legendary Ash Wednesday storm plowed into Assateague, it obliterated the nascent resort of Ocean Beach, destroying its road, its first 30 buildings, and its developers' dreams. (Street signs erected for nonexistent streets were left standing in a foot of seawater.) Taking advantage of that setback, conservationists persuaded Congress in 1965 to protect most of the island as part of the National Park System. Today it's the longest undeveloped stretch of barrier island on the mid-Atlantic coast, beloved for its shaggy feral ponies, its unobstructed stargazing, and its quiet ocean vistas—which have always been punctuated, as they are on other barrier islands, by impressive storms.

Scientists expect that as the climate changes, the storms will likely strengthen, sea levels will keep rising, and Assateague's slow westward migration may accelerate. Ennis knows the island well enough to suspect that these changes are under way. Assateague's maintenance crew is already confronting the consequences. On the south end of the island, storms destroyed the parking lots six times in 10 years. The visitors center was damaged three times. Repair was expensive, and after fist-size chunks of asphalt from old parking lots began to litter the beach, it began to seem worse than futile to Ennis.

A tinkerer by nature—he grew up on a small farm on Maryland's Eastern Shore—he realized the situation called for mechanical creativity. Working with the park's architect, Ennis and his co-workers adapted the toilets, showers, and beach shelters so that they could be moved quickly, ahead of an approaching storm. They experimented with different parking lot surfaces, finally arriving at a porous surface of loose clamshells—the kind often used on local driveways—that could be repaired easily and, when necessary, bulldozed to a new location. "It was a lot of what we called 'Eastern Shore engineering,'" Ennis says, laughing. "We weren't thinking about climate change. We did it because we had to." He lowers his voice, mock-conspiratorially. "It was *all by accident*."



By Michelle Nijhuis
Photographs by Keith Ladzinski

This is the last article in a yearlong series commemorating the 100th anniversary of the National Park Service. For more stories, photos, and videos on the power of parks and the threats to them, go to *nationalgeographic.com/power-of-parks.*

CAPE HATTERAS NATIONAL SEASHORE, NORTH CAROLINA

Sea-level rise

Just off the coast, Hatteras Island forms a slender barrier between the mainland and the open ocean, as Assateague Island does off Maryland and Virginia. Rising seas and intensifying storms are narrowing Hatteras, damaging habitats and historic structures and threatening to expose the mainland to the storms' full fury.

Accidental or not, these modest adaptations were the beginning of something broader. The seashore is now one of the first national parks in the country to explicitly address—and accept—the effects of climate change. Under its draft general management plan, the park will not try to fight the inevitable: It will continue to move as the island moves, shifting its structures with the sands. If rising seas and worsening storm surges make it impractical to maintain the state-owned bridge that connects Assateague to the mainland, the plan says, park visitors will just have to take a ferry.

WHEN CONGRESS PASSED THE ACT CREATING the National Park Service in the summer of 1916, it instructed the agency to leave park scenery and wildlife "unimpaired for the enjoyment of future generations." The law did not define "unimpaired." To Stephen Mather, the charismatic borax magnate who served as the first director of the Park Service, it meant simply "undeveloped." Early park managers followed his lead, striving both to protect and to promote sublime vistas.

But the arguments began almost as soon as the agency was born. In September 1916 the prominent California zoologist Joseph

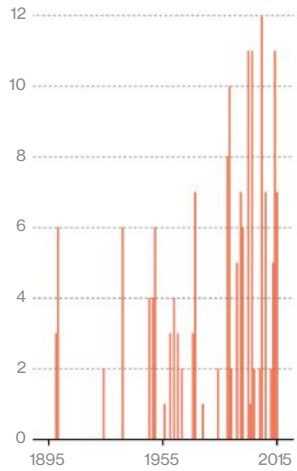
DROUGHT

Joshua Tree National Park

Joshua tree seedlings need rain to endure summer heat, but droughts have become more frequent and longer lasting. Scientists predict that by 2100 only isolated pockets of these now widespread trees will be found within park boundaries.

Months of severe drought

Palmer Drought Severity Index



MONICA SERRANO, NGM STAFF

SOURCES: CAMERON BARROWS, UC RIVERSIDE; NOAA

Grinnell, writing in the journal *Science,* suggested that the Park Service should protect not just scenery but also the "original balance in plant and animal life." Over the next few decades, wildlife biologists inside and outside the agency echoed Grinnell, calling for the parks to remain "unimpaired," in ecological terms. But the public came to the parks for spectacles—volcanoes, waterfalls, trees you can drive a car through—and preserving them remained the agency's primary concern.

In the early 1960s, Secretary of the Interior Stewart Udall—who would oversee the addition of nearly 50 sites to the National Park System, including Assateague—became concerned about the agency's management of wildlife in the parks. He recruited University of California wildlife biologist Starker Leopold, the son of famed conservationist Aldo Leopold, to chair an independent study.

The Leopold Report proved hugely influential. Like Grinnell, it called on the Park Service to maintain the original "biotic associations" that existed at the time of European settlement. In the decades that followed, the Park Service got more scientific. Park managers began setting controlled fires in forests where natural wildfires had long been suppressed; they reintroduced species that had vanished, such as wolves and bighorn sheep. The focus, though, was less on restoring ecological processes than on re-creating static scenes—on making each park, as the Leopold Report recommended, into a "vignette of primitive America." In time that vision took on what Yellowstone historian Paul Schullery describes as an "almost scriptural aura."

And yet, as Leopold himself later acknowledged, it was misleading. The notion of presettlement America as primitive ignored the long impact Native Americans had had on park landscapes, through hunting and setting fires of their own. It ignored the fact that nature itself, left to its own devices, does not tend toward a steady state—landscapes and ecosystems are always being changed by storms or droughts or fires or floods, or even by the interactions of living things. The ecological scenes the Park Service strove to maintain, from a largely imagined past, were in a way just a new version of the spectacles it had always felt bound to deliver to visitors.

"The Park Service has had a tacit agreement with the American public that it's going to keep things looking as they've always looked," says Nate Stephenson, an ecologist who studies forests at Sequoia, Kings Canyon, and Yosemite National Parks. "But time does not stop here."

FROM THE 1980S ON, SCIENTISTS gradually came to accept that a new sort of change was under way. The glaciers in Glacier National Park were shrinking, wildfires in Sequoia were getting larger, and coastal parks were losing ground to rising seas. Shortly after the turn of the century, researchers in Glacier announced that by 2030 even the park's largest glaciers would likely disappear.

In 2003 a group of researchers at the University of California,

Berkeley began to retrace the footsteps of Joseph Grinnell. In Yosemite and other California parks, the zoologist had conducted fanatically detailed wildlife surveys, predicting their value would not "be realized until the lapse of many years, possibly a century." When the Berkeley researchers compared their own Yosemite surveys and other data with Grinnell's 90-year-old snapshot, they noticed that the ranges of several small mammals had shifted significantly uphill, toward the ridgeline of the Sierra Nevada. Two other once common mammals, a chipmunk and a wood rat, were almost extinct in the park. The pattern was clear: Climate change had arrived in Yosemite too, and animals were migrating to escape the heat.

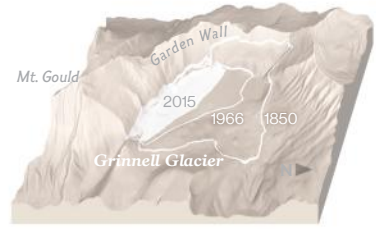
For a while the Park Service avoided talking about the subject. To acknowledge the reality of human-caused climate change was a political act, and the Park Service doesn't discuss politics with its visitors. At Glacier the interpretive signs made only a passing reference to rising temperatures. Rangers avoided talk of causes. "We were very constrained," remembers William Tweed, former chief of interpretation at Sequoia and Kings Canyon. "The message we got from above was basically, 'Don't go into it if you can help it.'"

The problem, though, ran deeper than transient politics. People had long come to national parks to experience the eternal—to get a glimpse, however deceptive, of nature in its stable, "unimpaired" state. The inconvenient truth of climate change made it more and more difficult for the Park Service to offer that illusion. But no one knew what the national parks should offer instead.

GLACIAL RETREAT

Glacier National Park

In 1850 there were about 150 glaciers in what is now the park. Today only 25 remain. Grinnell Glacier has decreased in area by more than 75 percent.



Scale varies in this perspective.

MATTHEW W. CHWASTYK, NGM STAFF
SOURCES: NATIONAL PARK SERVICE (NPS); DAN FAGRE AND MARK FAHEY, USGS

WHEN NATE STEPHENSON was six years old, his parents fitted him with boots and a hand-built wooden pack frame and took him backpacking in Kings Canyon National Park. For most of the 53 years since, Stephenson has been hiking the ancient forests of the Sierra Nevada. "They're the center of my universe," he says. Soon after he graduated from UC Irvine, he packed up his Dodge Dart and fled Southern California for a summer job at Sequoia National Park. Now he's a research ecologist there, studying how the park's forests are changing.

While park managers are often consumed by immediate crises, researchers like Stephenson have the flexibility—and the responsibility—to contemplate the more distant future. In the 1990s this long view became deeply disturbing to him. He had always assumed that the sequoia and foxtail pine stands surrounding him would last far longer than he would, but when he considered the possible effects of rising temperatures and extended drought, he wasn't so sure—he could see the "vignette of primitive America" dissolving into an inaccessible past. The realization threw him into a funk that lasted years.

"I was a firm believer in the mission of the Park Service," Stephenson remembers, "and suddenly I saw that the mission we had was not going to be the same as the mission of the future. We could no longer use the past as a target for restoration—we were entering an era where

GLACIER NATIONAL PARK, MONTANA

Fires

Cloaked in smoke from wildfires as far away as Washington State, the serrated peaks of the northern Rockies glow in the morning light. Fires in the West are growing larger and more destructive as temperatures rise and drought deepens.

EVERGLADES NATIONAL PARK, FLORIDA

Salinization

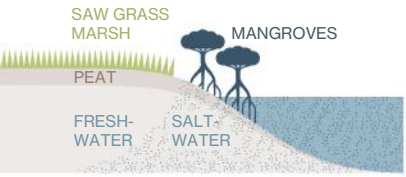
At the bottom of a cypress swamp in the northern Everglades, an American alligator waits for prey. As rising seas force salt water into the Everglades, alligators may be edged out by crocodiles, which can excrete excess salt through their tongues.

SEA-LEVEL RISE

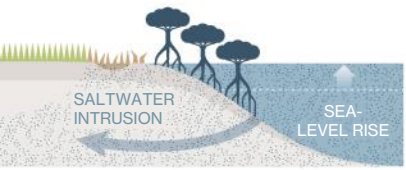
Everglades National Park

With 84 percent of the park already at an altitude of less than one meter (3.3 feet), sea-level rise is increasing the likelihood and extent of saltwater intrusion during storms and high tides. The park's freshwater inland marshes are giving way to brackish and marine habitats.

Typical conditions
Saw grass marshes flourish in fresh groundwater, while mangroves thrive in saline and brackish environments.



Sea-level rise
As encroaching salt water degrades peat, marshes recede and collapse, and mangroves advance inland.



SOURCES: NPS; EVERGLADES FOUNDATION; FLORIDA INTERNATIONAL UNIVERSITY; SOUTH FLORIDA WATER MANAGEMENT DISTRICT

that was not only impossible, but might even be undesirable."

Stephenson began what he calls a "road show," giving presentations to Park Service colleagues about the need for a new mission. Somewhat mischievously, he proposed a thought experiment: What if Sequoia National Park became too hot and dry for its eponymous trees? Should park managers, who are supposed to leave wild nature alone, irrigate sequoias to save them? Should they start planting sequoia seedlings in cooler, wetter climes, even outside park boundaries? Should they do both—or neither?

His audiences squirmed. Leopold had left them no answers.

On a late September day in Sequoia National Park, the sky is clear, blue, and thanks to a brisk wind, free of smoke from the wildfire burning just over the crest of the Sierra Nevada. Stephenson and his field crew are finishing a season of forest surveys, adding to a decades-long record of forest health. In their lowest-elevation study sites, below the sequoia zone, 16 percent of the trees have died this year, approximately 10-fold the usual rate. "It's about what you'd see after a low-grade wildfire," says Stephenson. Weakened by years of drought, many of the low-elevation trees are dying from insect attacks. At higher elevations, in the sequoia stands, several old giants have dropped some of their needles to combat drought stress; a few that were already damaged by fire have died. "It's not 'The sequoias are dying,'" Stephenson emphasizes. "The sequoias are doing relatively well. It's the pines, the firs, the incense cedars—the whole forest is affected."

The current drought may be a preview of the future, but the trouble with climate change—at Sequoia and elsewhere—is that many of its effects are hard to predict. Average temperatures at Sequoia will rise, and snow will give way to rain, but it's not clear whether total precipitation will increase or decrease, or whether the changes will be gradual or abrupt. "We don't know which scenario is going to play out," says Sequoia and Kings Canyon Superintendent Woody Smeck. The Park Service can no longer re-create the past, and it can't count on the future. Instead, it must prepare for multiple, wildly different futures.

IN 2009 PARK SERVICE DIRECTOR Jonathan Jarvis assembled a committee of outside experts to reexamine the Leopold Report. The resulting document, "Revisiting Leopold," proposed a new set of goals for the agency. Instead of primitive vignettes, the Park Service would manage for "continuous change that is not yet fully understood." Instead of "ecologic scenes," it would strive to preserve "ecological integrity and cultural and historical authenticity." Instead of static vistas, visitors would get "transformative experiences." Perhaps most important, parks would "form the core of a national conservation land- and seascape." They'd be managed not as islands but as part of a network of protected lands.

The report is not yet official policy. But it's the agency's clearest acknowledgment yet of the changes afoot and the need to manage

for them. Exactly what that management looks like isn't certain, and much of it will be worked out park by park, determined by science, politics, and money. Some parks have already gone to great lengths to resist change: Cape Hatteras National Seashore, for instance, spent almost $12 million to move a famous lighthouse a half mile inland. But such dramatic measures are rare and likely to remain so; the Park Service budget today is about what it was in 2008.

Instead, many parks are looking to boost their tolerance for change, adapting their own infrastructure and helping their flora and fauna do the same. At Indiana Dunes National Lakeshore, scientists are searching the oak savannas for cooler microclimates into which the Park Service might transport the endangered Karner blue butterfly, which has been all but driven from the park. In Glacier, biologists have already captured bull trout and carried them in backpacks to a higher, cooler lake outside their historic range. The idea is to give the fish a refuge both from climate change and from invasive lake trout.

At Sequoia, Stephenson wants park managers to consider planting sequoia seedlings in a higher, cooler part of the park—to see how the seedlings fare, and also how the public would respond to experimenting with the icons. "We have to start trying things," he says.

At Assateague, while Ennis's successors prepare the parking lots and toilets for change, Liz Davis, the chief of education, is preparing the park's younger visitors. In 25 years at Assateague she has introduced countless school groups to the seashore. When elementary students visit, she takes them to the beach, shapes a model of the island out of sand, and throws a bucket of seawater across it to show how the island shifts. Then she turns the model over to the kids: Where would they put the parking lots and campgrounds? How about the visitors center? "They get really into it," she says, laughing. "They'll say, No, no, don't put the new ranger station there, it'll get washed away!"

Like the Park Service, visitors must learn to accept that their favorite park might change. "People ask, 'Will I still be able to enjoy it? Will my kids and grandkids be able to enjoy it?' " Davis says. "The answer is yes, they will. They might not enjoy it in the same way, and they might not get here the same way. But they will still be able to enjoy it." □

DARCY HUNTER (TOP); ANDY MANN

Michelle Nijhuis has covered climate change and conservation for 15 years, beginning as a reporter for *High Country News* in Colorado. For *National Geographic* she has written about the prospects for "clean" coal, the California drought, and in the May 2015 issue, dams on the Mekong River.

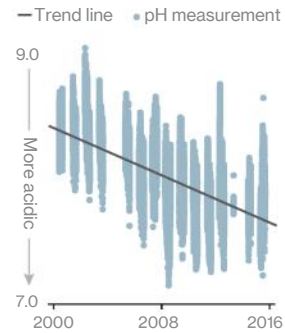
Keith Ladzinski grew up playing in the Colorado Rockies and has worked on all seven continents as an outdoor and adventure photographer. For *National Geographic* he has shot films on extreme climbing expeditions in China and Antarctica; this is his first photographic assignment.

OCEAN ACIDIFICATION

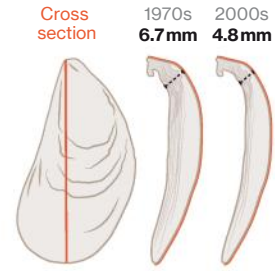
Olympic National Park

As the ocean absorbs at least a quarter of the carbon dioxide emitted by humans, its pH is falling: The water is getting more acidic. That can harm marine life – making it harder, for example, for species such as mussels to form shells.

Ocean pH



Mussel-shell thickness



California mussel
(Mytilus californianus)

SOURCES: TIM WOOTTON AND CATHY PFISTER, UNIVERSITY OF CHICAGO

CAPE HATTERAS NATIONAL SEASHORE, NORTH CAROLINA

Extreme weather

This photograph was taken underwater—filaments of algae are growing in what is normally a dry field at the Cape Point Campground on Hatteras Island. During four days this past spring, the remnants of tropical storm Bonnie dumped almost 14 inches of rain on the island, about a quarter of the annual average.

JOSHUA TREE NATIONAL PARK, CALIFORNIA

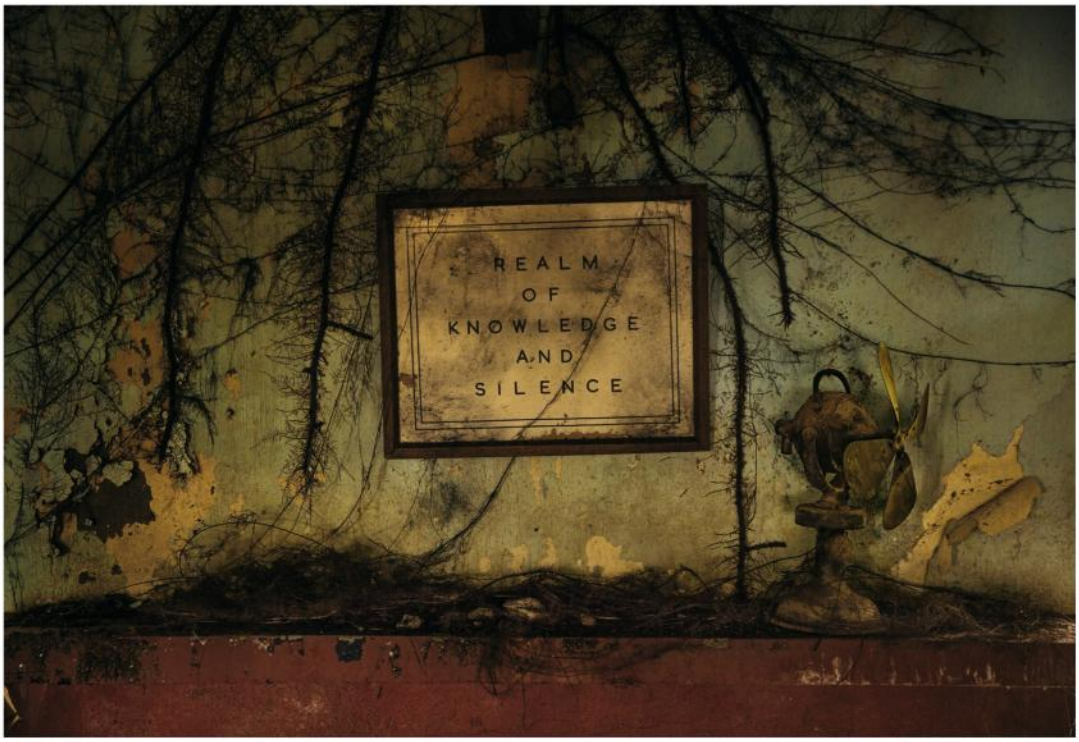
Heat, drought

A Joshua tree seems to bend a sheltering arm over a Mojave yucca. By 2100 most of the park may be too dry and hot for the trees, but park biologist Neil Frakes isn't giving up on them. "Joshua trees are incredibly resilient," he says. "I'm optimistic that the future isn't as grim as predicted."

Traces of the Future

A research station in Tanzania embodies the promise of the past—and a dream that never quite came true.

John Mganga, 67, is a former assistant at Tanzania's Amani Hill Research Station. From 1970 to 1977 he worked with British entomologist John Raybould, using insect nets to snare specimens.



By Jeremy Berlin
Photographs by Evgenia Arbugaeva

On a hilltop in northeastern Tanzania, high up in the Usambara Mountains, memories are tangible things. Modernist buildings litter the lush jungle. European trees and medicinal plants, affixed with Latin labels, mingle with local species. Scientific instruments and a fully stocked library are poised for use.

This is what's left of the Amani Hill Research Station—a past vision of the future, suspended in time. It's also what brought Siberian photographer Evgenia Arbugaeva to East Africa two years ago. Her aim? To document the nostalgia that lingers here and create images that "bring back the atmosphere of this dark, magical place."

Arbugaeva worked closely with Wenzel Geissler, an anthropologist at the University of Oslo. For the past several years, he and his team—an international consortium of scientists, historians, and artists—have been studying old research stations in the tropics. Their project examines the memories, perceptions, and expectations of those who used to live and work at these postcolonial scientific sites.

Yet Amani is not a ruin. A staff of 34—elderly watchmen and maintenance workers, a librarian, a few lab attendants—still lives there in the shells of houses, many without water or electricity. Some say they're waiting for the site to be revived.

"Amani stands for the dreams of science and progress bequeathed upon colonial populations," says Geissler. "When funding dried up here in the early 1980s, dreams did too. But hypothetically it's all there to be switched on again. In these buildings—in these people's memories and dreams—the idea of a potential future lives on."

Amani was founded in the late 19th century as a German botanical garden and coffee plantation.

At Amani past and present are intertwined. Near the seldom used but dutifully maintained library, an instructive sign still adorns a wall (below left). In one of the station's four laboratories, a white mouse under a bell jar belongs to a colony started years ago. An attendant still breeds the rodents in case they're needed for future research.

After World War II it became a British malaria research institute. Since 1979 it's been operated by Tanzania's National Institute for Medical Research, which pays the current staff to maintain the site for future use.

To "channel the spirit, motion, and beauty of the place" as it stands today, Arbugaeva spent a lot of time in the past—"in the library, amid all the dusty old books on natural history and diseases, reading by candlelight." She also shadowed John Mganga, a retired lab assistant.

"He loved to tell me stories," she says. "And to dream—to imagine what the people who used to work there are doing. He loves the idea of being part of something bigger, part of science. He's still connected to Amani. And he still misses it."

Geissler says collaborating with Arbugaeva was invaluable because she was able to turn workers' memories of old routines and rituals into images. "That helps us read the traces of a once ordered past—this idea of progress in a landscape that seems like it's only ruins and loss," he says. Her photos capture a sense of "shared nostalgia for…a modernity we never quite reached."

Arbugaeva agrees. "I want people to see what I saw: a hidden world that existed before and that still exists in memories. Somebody's still dreaming about it. I want to bring people there."

NGM MAPS

Mganga puts a lab shelf in order. “Local people used to think the scientists here were making potions in these bottles,” says photographer Evgenia Arbugaeva. Other science was also deemed supernatural. Researchers were called *mumianis* – Swahili for “vampires” – because they took blood samples to study malaria.

Arbugaeva says Mganga loved showing her his memories of Amani – “hidden waterfalls and his favorite spots, the houses where British staff used to live,” and this collection of insects, which he and Raybould spent years gathering and studying.

Unlike some assistants at Amani, the now retired Mganga – here resting in a lab – "really lost something when the whole place folded," says University of Oslo anthropologist Wenzel Geissler. "He had truly believed in science and the country's future. He lived that dream. And he suffered from losing it."


ATTENDANCE REGISTER
No. 17

CROWNING GLORY

By Eve Conant

The star of this 1919 photo – the ideal image to cap our coverage of the National Park Service's centennial year – is Old Faithful. The geyser in Yellowstone National Park mesmerizes us today as it did these women (inset) nearly a century ago. While the pair appear to be viewing one of America's best known landmarks at a precariously close range, they did remember to shield themselves from the sun – or perhaps a scalding mineral spray – with their elegant parasols.

PHOTO: SUMNER W. MATTESON, NATIONAL GEOGRAPHIC CREATIVE

From the Editors

Bill Bonner has brought a gift for unearthing just the right photo to In the Loupe and to countless other projects. During more than 33 years as the archivist of National Geographic's vintage collection, Bonner—wearing his trademark white cotton gloves—lovingly tended a collection containing some eight million photographs.

This year he began his well-earned retirement. So after this issue we're retiring In the Loupe as well.

Bonner always kept a loupe on hand to hunt for details hidden from the naked eye, says senior photo editor Jessie Wender: "There are few people who look at the past with such care."

In a 2014 documentary video about his distinguished career, Bonner describes photographs as "shadows of history that you can actually see ... of people like us, just doing our thing, just living our life." As he moves on to do exactly that, we wish him well.

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