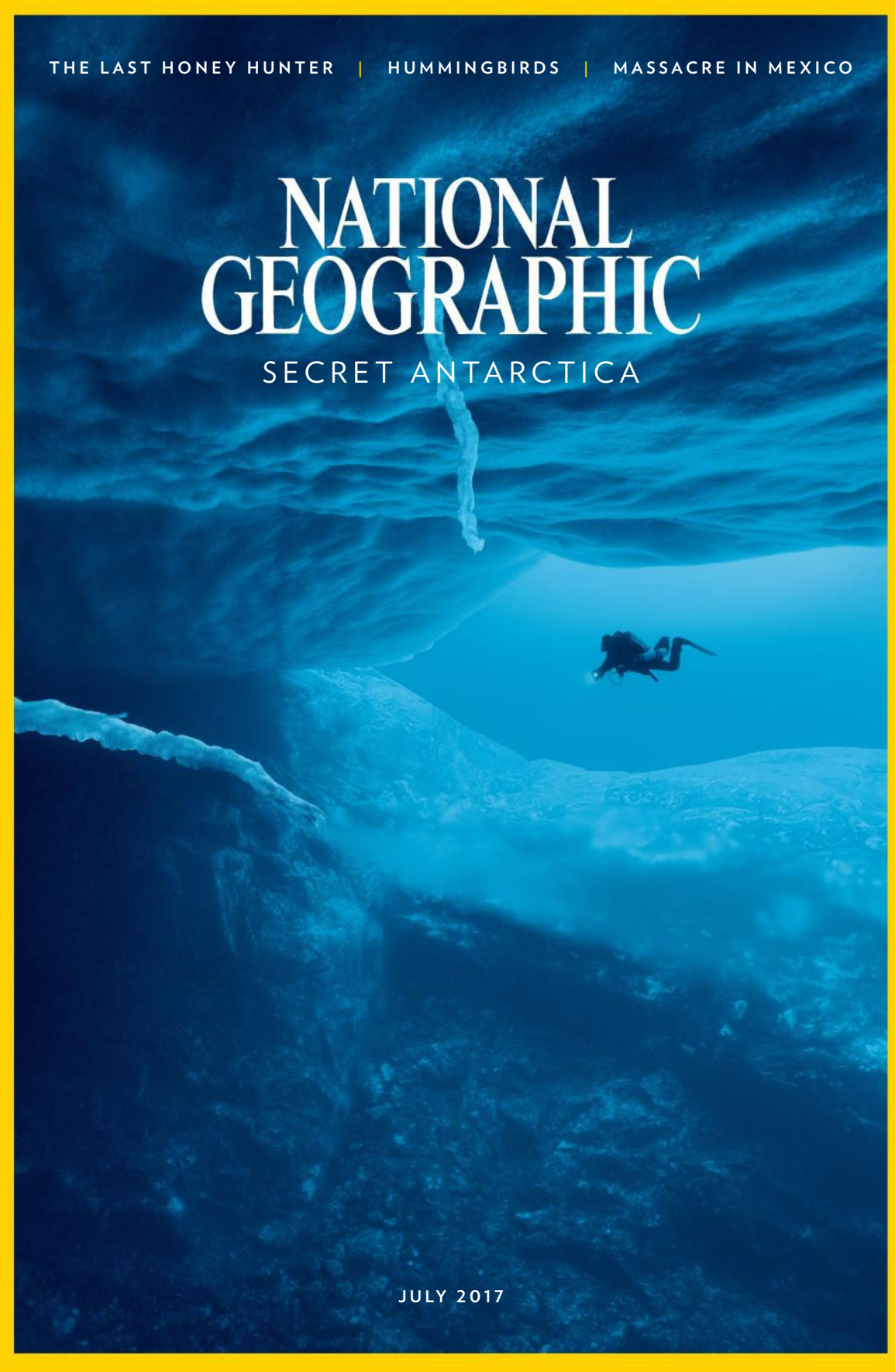
THE LAST HONEY HUNTER | HUMMINGBIRDS | MASSACRE IN MEXICO
NATIONAL GEOGRAPHIC
SECRET ANTARCTICA
JULY 2017


ESh
NXh

Ocean Sunfish *(Mola mola)*
Size: Body length, up to 2.7 m (8.9 feet) **Weight:** Up to 2,300 kg (5,070 lb) **Habitat:** Tropical and temperate oceans worldwide **Surviving number:** Unknown; populations declining

Photographed by Richard Herrmann

WILDLIFE AS CANON SEES IT

Bigger than big. The ocean sunfish is, in fact, the largest and heaviest bony fish in the world. Despite its size and bizarre body shape, which creates the appearance of a huge floating head, this sunfish is a fast and accomplished swimmer, rivaling sharks for speed and penguins for grace in gliding underwater. Its eyes are also very large, which comes in handy for scanning the area while foraging. Nevertheless, the ocean sunfish often runs afoul of commercial fishing; ending up as bycatch is the biggest threat it faces.

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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JULY 2017 • VOL. 232 • NO. 1 • OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

FRONT

FEATURES

On the Cover In spring, when the sea ice retreats to within a few miles of the Adélie Coast of East Antarctica, an expedition of divers and photographers set out to drill through the ice, dive beneath it, and explore – as deep as 230 feet down.
Photo by Laurent Ballesta (two images stitched together)

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

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ELSEWHERE

360-DEGREE VIDEO

HANGING OUT WITH THE HONEY HUNTER

The man using ropes to reach a honeycomb on the cliff is Mauli Dhan. The man hanging above him – seen here as dangling legs – is photographer Renan Ozturk, who captured Dhan's exploits for "The Last Honey Hunter" (page 80). Lightly clad Dhan pursues his prize despite swarms of bees; Ozturk gets stung right through his protective suit. See the story behind the story in a 360-degree video at *natgeo.com/honeyhunters360.*

NAT GEO WILD

THE INCREDIBLE DR. POL IS BACK

Veterinarian Jan Pol treats animals of all kinds in rural Michigan – and visits his homeland, the Netherlands – in another udder-ly awesome season of *The Incredible Dr. Pol.* Nat Geo WILD's No. 1 series airs Saturdays at 9/8c starting July 1.

TELEVISION

EARTH LIVE: WILDLIFE IN REAL TIME FROM SIX CONTINENTS

On July 9, top wildlife cinematographers will transmit images from more than 30 spots on the globe to one broadcast. Jane Lynch hosts the two-hour live event at 8 p.m. ET and 5 p.m. PT on National Geographic and Nat Geo WILD.

TELEVISION

COAL STORY: *FROM THE ASHES*

Residents of struggling coal industry towns wrestle with mining's legacy and worry about their future in *From the Ashes.* The documentary film airs June 25 at 9/8c on National Geographic.

TELEVISION

PHOTO ARK ON THE AIR

National Geographic photographer Joel Sartore's project to document thousands of animals is the subject of the three-part series *Rare—Creatures of the Photo Ark.* It airs July 18 and 25 and August 1 on PBS stations; check local listings for times.

BOOKS

LITERARY TRAVEL

Let *Novel Destinations* guide you from Kafka's Prague to Alcott's New England. Available where books are sold and at *shopng.com.*

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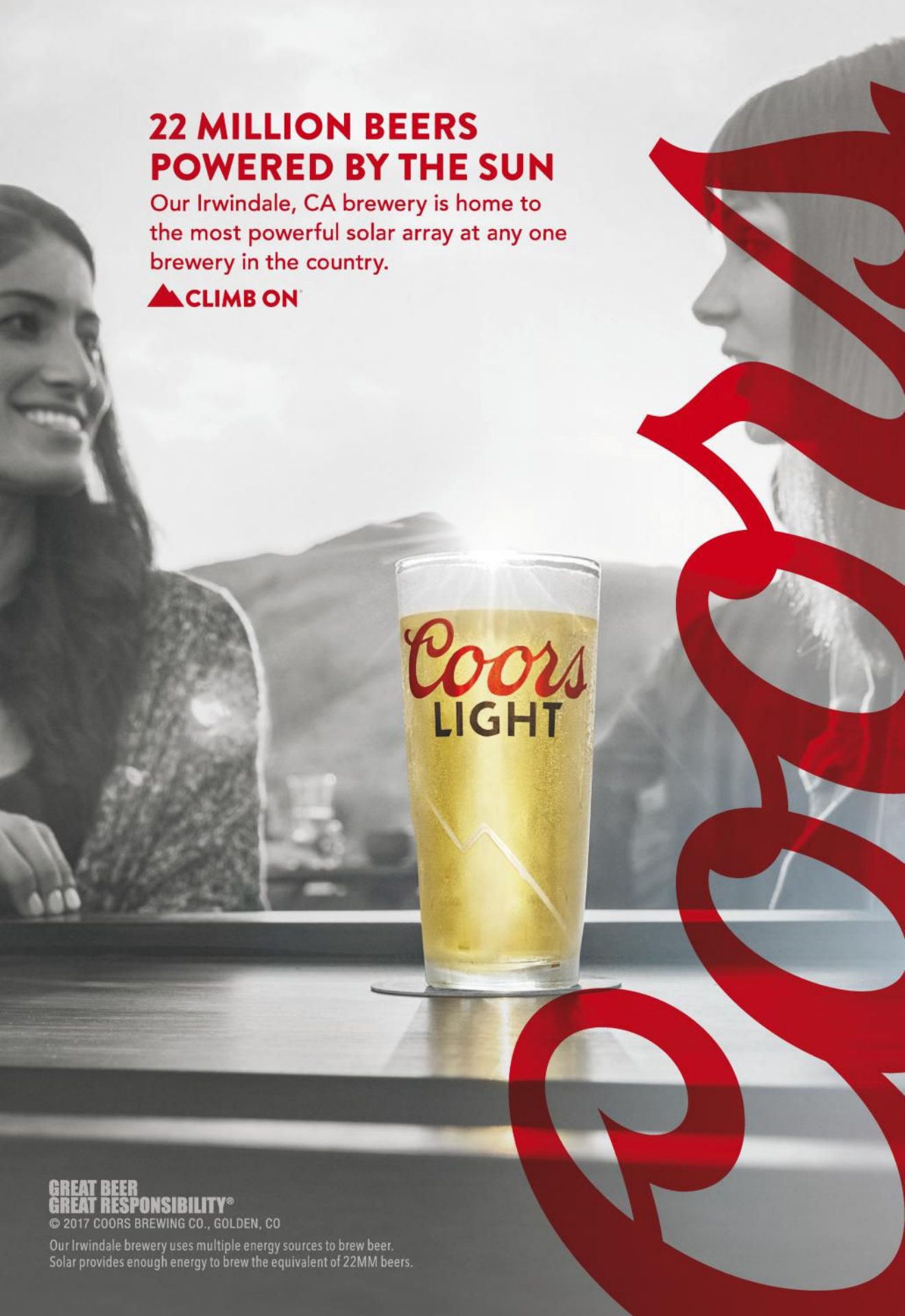
PHOTOS: RENAN OZTURK (TOP); MICHAEL STANKEVICH, NATIONAL GEOGRAPHIC CHANNELS (LEFT)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Anand Varma sets up to photograph an Anna's hummingbird in a virtual reality tunnel at the University of British Columbia in Vancouver, Canada.

ONLINE

If you think Varma's still images of hummingbirds are great, wait until you see his video – at *ngm.com/Jul2017.*

SEEING BEAUTY VIA TECHNOLOGY

When photographer Anand Varma first pitched us a story about hummingbirds in 2011, he says we told him: "That's boring. Every photo of a hummingbird that can be taken, has been taken."

I wish we'd been more polite than that because, as you'll see in this issue, such a response would make us not only rude but wrong. In fact, no one has seen photos quite like this before—and that's especially true of Varma's video of hummingbirds in action, on our website at *ngm.com/Jul2017.*

One of our principles of storytelling at *National Geographic* is, "Do what others can't." Others may not have our global reach, our crazy ambition, or the depth of our visual and reportorial journalism. In this case they don't have Anand Varma and his ability to photograph animal behavior and movement in a new way.

"At first I imagined myself as a conventional wildlife photographer who would document animals in their natural habitat," Varma says. "Then I learned that photographing creatures in a controlled environment allowed me to reveal details that wouldn't be visible any other way."

What kind of details? When it comes to hummingbirds, there are many extraordinary traits. Their wings can flap as fast as a hundred times a second. In horizontal flight they can go at least 35 miles an hour, and males' courtship dives can hit 60 miles an hour.

To capture these marvels, Varma worked in a lab equipped with still cameras that can record action within 1/13,500 of a second, video cameras that shoot 3,000 frames a second, and tools that he designed. To get just the right view of a hummingbird's tongue (see page 111), he had a glassblower make a tiny basin with a spout at one end. Varma filled it with nectar he concocted—and trained hummingbirds to drink from it.

Back in 2011 we were right about one thing: We've done a lot of hummingbird stories. This is the 10th in our 129-year history. But this one stands out for its use of technology to create unique images and advance knowledge.

As Varma says, "I take a very technical approach because I want to find new ways of visualizing familiar creatures. My hope is to capture people's imagination and inspire them to see the world with a renewed sense of wonder."

Thank you for reading *National Geographic.*

Susan Goldberg, *Editor in Chief*

PHOTO: NICOLAS LOCATELLI

National Geographic and Rolex have supported the history-making endeavors of some of the world's most distinguished explorers. Among them (from left): photographer David Doubilet, oceanographer Sylvia Earle, and filmmaker James Cameron.

ROLEX PARTNERS WITH NATIONAL GEOGRAPHIC ON A VITAL MISSION

A message from Gary E. Knell, President and CEO, National Geographic Society:

National Geographic is synonymous with exploration. It has been the core of our identity for 129 years—and no one else does it quite like we do.

For 63 of those years, we've had an incredible partner in this mission: Rolex, whose watches explorers have worn to Earth's deepest oceans and highest peaks. Rolex has long been driven by the spirit of exploration, and it continues to support pioneering ventures in discovery and conservation.

We and Rolex share a passion for exploring the unknown. We also share a deep sense of responsibility toward the planet and a recognition of the importance of protecting its wonders.

This month we're pleased to announce an enhanced partnership with Rolex—the first of its kind in National Geographic's history—that further unifies the efforts of our two organizations.

What are our shared goals in this new partnership? To advance human knowledge. To raise awareness of the planet's challenges as well as its marvels. And to inspire the next generation of explorers as they seek solutions that will ensure a healthy and sustainable future.

How will we pursue these goals? By focusing, during the next five years, on three critical attributes of our planet: the oceans, the poles, and the mountains. We'll enable and participate in expeditions that lead to scientific discovery, foster research and invention that will yield new exploration technologies, and convene summits and activities that generate public support for conservation.

To inform and inspire as many citizens of the world as possible, we'll report on the partnership's work via National Geographic's trademark journalism and photography. We envision a digital storytelling hub, videos and virtual reality experiences, social media channels, television programming, films, magazine articles, and more.

We're profoundly grateful to have Rolex with us on this journey to understand and protect our world, and to support outstanding explorers like those pictured above. With many years together behind us, it's a grand legacy on which to build.

We invite you to explore with us as we dive into this exciting future.

PHOTOS (FROM LEFT): JENNIFER HAYES, NATIONAL GEOGRAPHIC CREATIVE; MARCO GROB; MARK THIESSEN, NGM STAFF

AN UNLIKELY OPTIMIST

With his 2006 documentary, *An Inconvenient Truth,* former U.S. vice president **Al Gore** drew public attention to the threat of climate change. This July, *An Inconvenient Sequel* opens in theaters. Gore, 69, says the stakes are higher now but the solutions are clearer.

What do you think the public misunderstands about climate change?
I think the overwhelming majority of the public understands very well that climate change is an extremely important challenge, that human beings are responsible for it, and that we need to act quickly and decisively to solve it. The most persuasive arguments have come from Mother Nature. Climate-related extreme weather events are now so numerous and severe that it's hard to dismiss what's happening. But even those who don't want to use the words "global warming" or "climate crisis" are finding other ways to say, "Yes, we've got to move on solar, wind, batteries, electric cars, and so on." We have so much at risk.

Why have such sharp political divisions emerged over climate change?
There's an old saying in Tennessee: If you see a turtle on the top of a fence post, you can be pretty sure it didn't get there on its own. A determined minority—with active financial support from a few large carbon polluters—has held up progress for quite a while. They have used lobbying power and the threat of financing primary opponents, using the same techniques we saw in the past with Big Tobacco to falsely create doubt. All of us are vulnerable to what psychologists call denial: If something is uncomfortable, it's easier to push it away, to not engage. But the solution is to listen and approach people on the basis of where they are.

What gives you hope for the future?
There are so many people working around the world on this that I am extremely optimistic. It would certainly be helpful to have policies and laws that speed up our response. But market forces are working in our favor. Solar, wind, and other technologies are getting cheaper and better. More cities and companies are pledging to go 100 percent renewable. I believe the sustainability revolution is unstoppable.

PHOTO: CHRISTOPHER ANDERSON, MAGNUM PHOTOS
THIS INTERVIEW WAS EDITED FOR LENGTH AND CLARITY.

VISIONS

Order prints of select *National Geographic* photos online at **NationalGeographicArt.com.**

China
In the Garzê Tibetan Autonomous Prefecture, a red sea of dwellings for students and disciples surrounds Larung Gar, an academy and monastery said to be the world's largest center of Tibetan Buddhist learning. The view is from a mountain-top overlook at sunset.

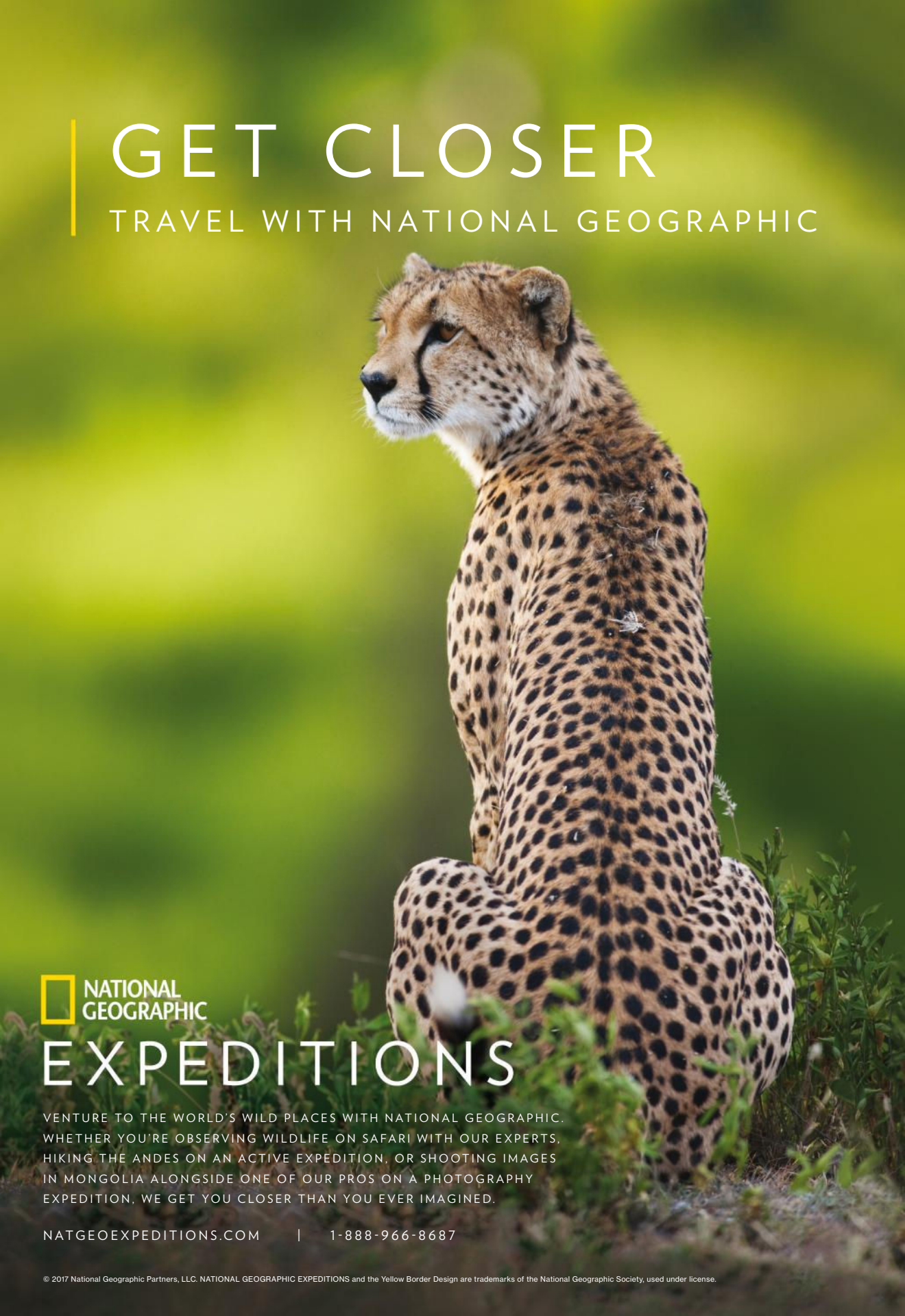
PHOTO: YAN GAO

#NGMADVENTURE

ASSIGNMENT We asked to see your daily adventures, whether epic or routine, through a lens that reveals the human spirit.

Anthony Leutenegger
Leysin, Switzerland

One day last fall Leutenegger heard that someone might try to walk a highline between Tour d'Aï and Tour de Mayen, Swiss peaks each more than 7,000 feet high. He arrived in time to frame a man against the clouds covering Lake Geneva as he started across the line – and saw him safely finish.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EXPLORE
ADVENTURE

A 65-foot schooner, the *WHY*, cuts through ice near Greenland. Beginning this summer its French crew will take the ship from Greenland to Antarctica.

Under the Pole is supported by Rolex, which partners with National Geographic on exploration, science, and storytelling.

A FAMILY ON THE HIGH SEAS

By Daniel Stone

It started with a husband, a wife, and their dog.

In 2010 divers Ghislain Bardout and Emmanuelle Périé-Bardout took their Siberian husky, Kayak, to the North Pole to explore the ecosystems beneath the ice. The pair assembled a team of eight to shoot photos and video and monitor the group's health. Kayak's role was to bark if he saw polar bears.

Under the Pole—as their expedition was first named—has since grown into a worldwide quest to explore the most inhospitable parts of Earth's oceans. In 2014 the full team swelled to 55 people for a trek to the west coast of Greenland, where they dived to world-record depths of 364 feet. "People said it wasn't possible, but we believed it was," says Périé-Bardout. Their trip resulted in films, a book, and plenty of academic research.

This summer they and their rotating team—now up to a hundred—are starting the third part of the project: a three-year excursion to nearly every latitude on Earth. From France they'll travel past Greenland, through the Arctic, around Alaska, down to French Polynesia, past the tip of South America, on to Antarctica, and then up north through the Atlantic back to Europe—a nearly 50,000-mile journey. Along the way they'll study life below a hundred feet, the dark and rarely seen depths known as the twilight zone. They'll also test the limits of dive physiology, attempting deeper dives (breaking their previous under-ice record) and diving for longer periods—including a bid for 72 continuous hours submerged.

Bardout and Périé-Bardout have also expanded their immediate crew. They now rely on their sons, Robin and Tom, ages five and one, for an important job. "They change the ambience on board," says Bardout. "If tensions get high, no one can explode when there's a kid playing with Legos."

LUCAS SANTUCCI, UNDER THE POLE/ZEPPELIN NETWORK

THE SPORT THAT SOARS—AND KILLS

By Nina Strochlic

In 1997 Patrick de Gayardon donned a webbed nylon suit and leaped, it's believed, from Norway's Kjerag mountain. The rush of air inflated the suit's three wings, allowing him to glide. This first modern wingsuit transformed BASE jumping: named for launch points building, antenna, span (bridge), and earth.

Previously, BASE jumpers descended vertically with parachutes. In wingsuits pilots can perform daring horizontal stunts such as flying through rings of fire and narrow rock formations.

But wingsuit pilots are much more likely to die. The first recorded fatality from a wingsuit BASE jump was in 2002; it has since become one of the world's most lethal sports. "You feel you have absolute control over what you're doing—that's what's become such a killer," says Jeb Corliss, who has been jumping for nearly 20 years. "We are not birds. We are not flying. We are falling toward the ground at incredible speed, and if you do something wrong, you can die."

Last year was the deadliest on record for BASE jumpers: Twenty-four of the estimated 37 killed were wearing wingsuits. Few jumpers are trained in the added dangers of wingsuits—for instance, how to judge the distance from a cliff face while hurtling toward it at 150 miles an hour. In 2017 a company called Next Level introduced the first curriculum for progressing from skydiving to BASE jumping to wingsuit flying. "We can't save the people who want to take maximum shortcuts and get maximum praise from their peers after sharing a video of themselves," says Matt Gerdes, the co-founder of Squirrel wingsuits. "But at least now they can't say that they didn't have a choice."

Sébastien Brugalla leaps from a cliff in Chamonix, France. The town temporarily banned wingsuit BASE jumping after the fifth death there last year.

PHOTO: DAMIEN DESCHAMPS

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The *Hokulea,* a modern replica of the kind of double-hulled vessel that brought people to eastern Polynesia, takes a test sail before a voyage from Hawaii to Tahiti.

VOYAGES OF OLD

By A. R. Williams

Settling the islands of the Pacific Ocean was one of the greatest maritime adventures in human history. Some 3,400 years ago people began to sail from Southeast Asia, crossing hundreds of miles of open water to find specks of land where they could build new lives. Archaeological evidence provides a time line of when the individual islands were colonized. But scientists are uncertain about the precise starting points of the voyages and how the early sailors managed to travel such long distances.

A new study has worked out likely scenarios by combining computer simulations of seafaring with climatic and oceanographic data. Some colonists probably set out from the Moluccas in northern Indonesia, arriving in Palau, about 500 miles away. Others may have left the Bismarck Archipelago near New Guinea and ended up as far east as Samoa and Tonga.

Once people reached western Polynesia, their explorations stalled for the next two millennia. The study suggests why. Sailors started off with the wind at their backs, but near Samoa the wind reverses and they were stranded. Eventually they learned to sail against the wind, which allowed them to continue eastward.

"Going farther, to remote Oceania, required a very different voyaging strategy from what was used before," says University of Oregon archaeologist Scott M. Fitzpatrick, who contributed to the research. "No islands were visible, so sailors had to use a celestial compass."

They also developed the double-hulled voyaging canoe, which would carry them to Hawaii, Easter Island, and New Zealand on trips lasting up to two months. "Sailing so far was ambitious and dangerous and a challenging test of endurance," says Fitzpatrick. "They were exceptional seafarers, no doubt about it."

EARLY ISLAND CULTURE

Artifacts from Palau that are 500 to 1,200 years old are similar to finds from other Pacific shores settled long ago.

Snail-shell fishhook

Bone needle

Shell scraper

Drilled bone ornament

Shell pendant

Shell adze

Shell adze

PHOTOS: CRISTINA MITTERMEIER, NATIONAL GEOGRAPHIC CREATIVE (SAILING CANOE); WILLEM SCHNITGER (ARTIFACTS)

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This climber in the Italian Dolomites is on a *via ferrata* equipped with fixed cables, ladders, and footholds that make the ascent safer and less arduous.

GETTING A GRIP ON ADVENTURE

By Patricia Edmonds

When a system of cables, steps, and ladders was built in the Dolomites to help World War I troops traverse the mountains, it was called a *via ferrata* (iron road). Today such assisted routes exist on six continents and let less seasoned adventurers visit "terrain once reserved for rock climbers and mountaineers," says veteran alpine guide Markus Beck.

Pediatric ER nurse Heidi Farrington, 53, took a West Virginia via ferrata three years ago, in part to shake a fear of heights. Tethered to lines anchored in rock, she could enjoy some of the challenges and scenic heights of rock climbing, "but in such a way that I felt pretty darn safe." Thrilled with the outing, Farrington began climbing more and later took a trip to the Dolomites.

Her mountain guide there, Alberto De Giuli, calls via ferrata "a perfect approach to the vertical world. It's not an adventure park–style journey—it's real adventure. You use the cable to help you climb, but your feet are on the rock."

PHOTO: MARTIN BRAITO, IMAGE BROKER/AURORA PHOTOS

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EXPLORER HONOR TO BRIAN SKERRY

By Patricia Edmonds

Photographer Brian Skerry, who has spent more than 10,000 hours underwater exploring the world's oceans with a camera, is the Rolex National Geographic Explorer of the Year for 2017.

The award honors individuals who make scientific discoveries and share them to benefit the world. It is presented by Rolex, which recently entered into a new partnership with National Geographic to support exploration.

Skerry, 55, is internationally known for his images of undersea wildlife and environments. A National Geographic photographer for two decades and a National Geographic photography fellow since 2014, he currently is at work on his 25th feature story for the magazine.

"Brian's images tell stories that celebrate the mystery and beauty of the ocean while bringing attention to the issues that threaten it," says National Geographic Society President and CEO Gary E. Knell. To capture those images, Knell says, "Brian has lived on the bottom of the sea, spent months aboard fishing boats, and traveled in everything from snowmobiles to the Goodyear blimp."

Skerry is a founding fellow of the International League of Conservation Photographers. He lectures widely on photography and conservation and has authored 10 books.

Rolex and National Geographic are longtime collaborators on the Explorer of the Year award, which is presented each June during the Society's Explorers Festival in Washington, D.C.

"We want our families, for generations to come, to be able to rely on and enjoy our oceans. This is what drives Brian," Knell says. "It's about giving a voice to the sea and its creatures, many of which are endangered."

SKERRY'S AIM IS TO CREATE 'IMAGES THAT CELEBRATE THE SEA YET HIGHLIGHT ENVIRONMENTAL PROBLEMS.'

Top: In New Zealand's Auckland Islands, Skerry captured his assistant Mauricio Handler's close encounter with a southern right whale.

PHOTOS: BRIAN SKERRY (TOP); MAURICIO HANDLER (ABOVE); NATIONAL GEOGRAPHIC CREATIVE (BOTH)

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TRUE DISCOVERY

By Kenny Broad

Explorers lie, at least to themselves—myself included. We rationalize our monomaniacal passions and risktaking under the guise of discovering new forms of life, identifying remedies from nature, measuring climate change, or testing physiological limits.

The truth is that some genetic defect drives us to do things that make most people uncomfortable. During the colonial era, ego-based ventures were fueled by the search for "gold and glory." But explorers today are increasingly motivated by a wider set of goals, including conservation and education.

In December I was involved in a National Geographic Society expedition supported by the Bahamian government and local organizations. Our goal was to map one of the world's unique ecosystems: underwater caves, aka "blue holes." Their biogeochemistry creates hot spots for extremophile life-forms.

They also contain fossils from previous inhabitants, and their geologic features allow us to reconstruct the climate from hundreds of thousands of years ago. What's more, they hold our most precious resource: freshwater. Call it one-stop shopping for exploration science.

Underground, we collected imagery for virtual reality models of cave features and surveyed using cutting-edge equipment. While the divers were underwater, schoolkids tracked them with radiolocators, crawled through a constructed cave, "explored" underwater with VR headsets, held fossils and living creatures, and sampled medicinal plants.

On most expeditions the goal is to go farthest or deepest. But working with these kids—and sharing the adventure of the environment that will be theirs to manage—was the most memorable exploration achievement for many of us. By applying new technologies and empowering locals, we can discover more about our world, and ourselves.

University of Miami environmental anthropologist Kenny Broad explores a cave in the Bahamas.

PHOTO: JILL HEINERTH

REVIVING A RUINED CITY

By A. R. Williams

When British archaeologist Max Mallowan investigated the neo-Assyrian site of Nimrud in northern Iraq, he got help from someone who loved detective work—his wife, Agatha Christie. Despite her busy career, the mystery writer made time every winter from 1949 to 1957 to register and photograph the artifacts that her husband's excavations brought to light.

She probably also took the picture of the stone relief shown above left. That art, which once adorned a palace wall, depicts a priest performing a ceremony before a motif called a tree of life. But the photo reveals something curious—a cut around the priest's head. Looters in the 19th century are possible culprits, but so are invading soldiers in antiquity.

The city of Nimrud, known as Calah in the Bible, became the capital of the neo-Assyrian Empire in 883 B.C., under King Ashurnasirpal II. At the end of the seventh century B.C., the empire collapsed and a coalition of enemies sacked the city. The relief of the priest may have been damaged deliberately in that attack. "We know many things were desecrated as part of the sacking," says Mark Altaweel, a Mesopotamia expert at University College London.

History repeated itself when Islamic State militants overran Nimrud in 2014 after taking the nearby city of Mosul. Using bulldozers, sledgehammers, and bombs, they shattered the buildings that modern Iraqis had restored. But some things survived, such as this section of a relief, above right. As with the one Christie photographed, the scene had been repaired before. Could it be pieced together again? "Most of the site was probably fractured from the shock waves of the explosions," says Altaweel. "That means it's potentially fixable."

Agatha Christie photographs one of the several thousand finely carved ivories found at Nimrud. Many of the pieces originally adorned furniture and arrived in the capital as booty or tribute from cities near the Mediterranean coast.

PHOTOS: COURTESY JOHN MALLOWAN (LEFT); JEROME SESSINI, MAGNUM PHOTOS (RIGHT); BETTMANN ARCHIVE/GETTY IMAGES (BOTTOM)

CRUSTACEAN ASSIGNATION

By Patricia Edmonds

To a lobster couple, this is normal sex:

For days the female squirts urine into the den of her desired mate. Beguiled by the scent, he lets her move in. Foreplay—stroking each other with antennae and with feet covered in taste receptors—lasts several days.

Once she's convinced that he'll protect her, the female disrobes, slowly shedding both her hard shell and the pouch where she had banked sperm from a prior mate. Molting leaves her in a perilously soft new shell, so he stands guard for the half hour it takes to harden. Then, supported by his claw legs, he suspends himself above her and lifts her to face him, cradling her in his legs. Her new shell has a new sperm pouch; he thrusts a packet of sperm into it using appendages called gonopods. The deed is done.

As soon as one mate leaves, the male will welcome another. The female, meanwhile, will use the sperm packet to fertilize thousands of eggs, which she'll carry under her tail for about a year until the larvae hatch.

But climate change is threatening this babymaking process, says Diane Cowan, founder of the Lobster Conservancy.

When water is warm, lobsters put their energy into growing; when it's cold—winter water temperatures in the 30s Fahrenheit—they put that energy into making eggs and sperm, Cowan says. If climate change shortens that cold period, "they'll produce fewer gametes. And if it's steadily too warm, they just won't produce. No eggs. No sperm. No lobsters."

HOMARUS AMERICANUS

HABITAT/RANGE
Atlantic Ocean waters from northern Canada to southeastern U.S.

CONSERVATION STATUS
Currently assessed as least concern by IUCN

OTHER FACTS
American lobsters sold for food average about 1¼ pounds; the largest ever recorded weighed more than 44 pounds.

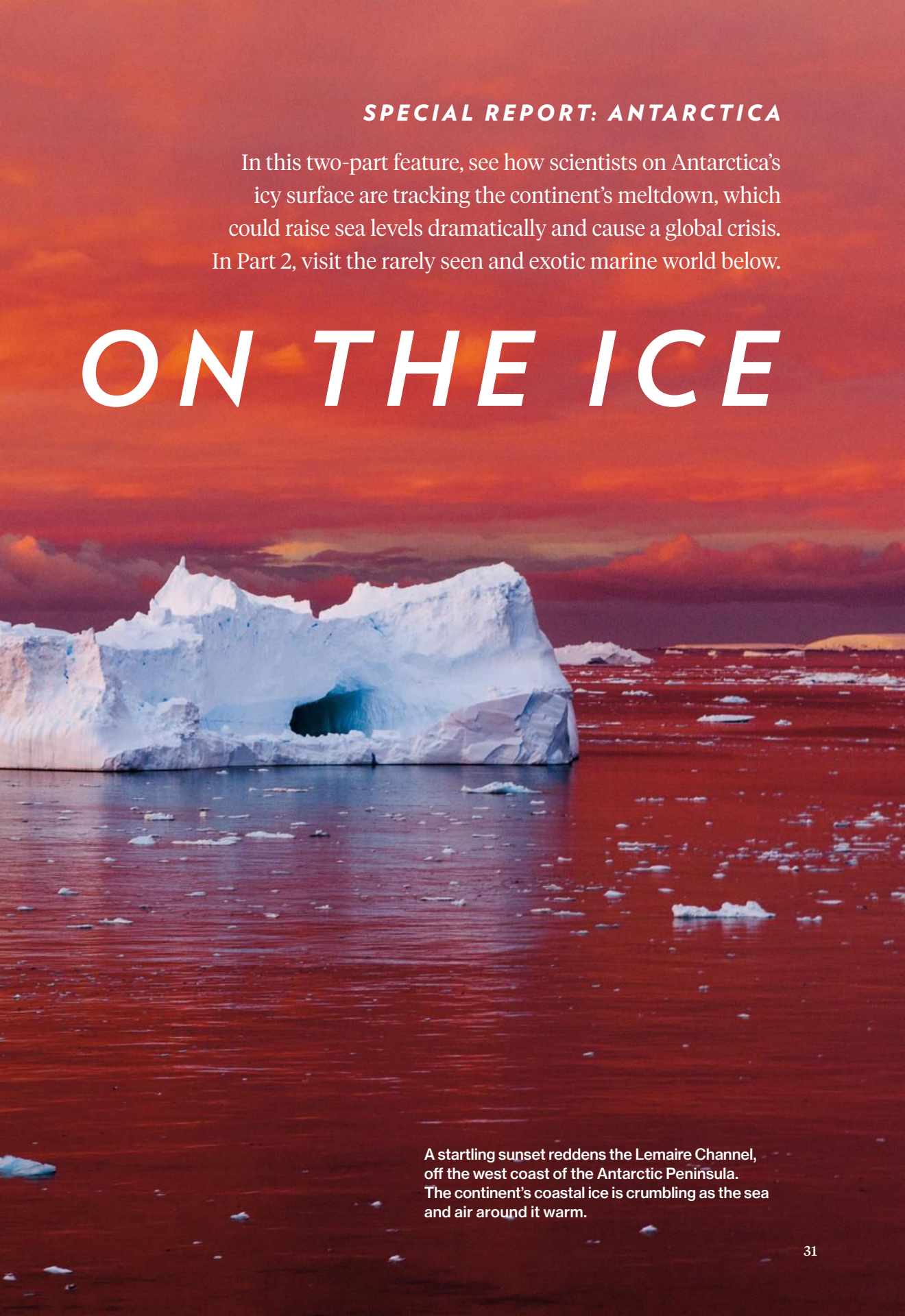
PHOTO: JERRY MONKMAN, MYN/NATURE PICTURE LIBRARY


THE CRISIS

SPECIAL REPORT: ANTARCTICA

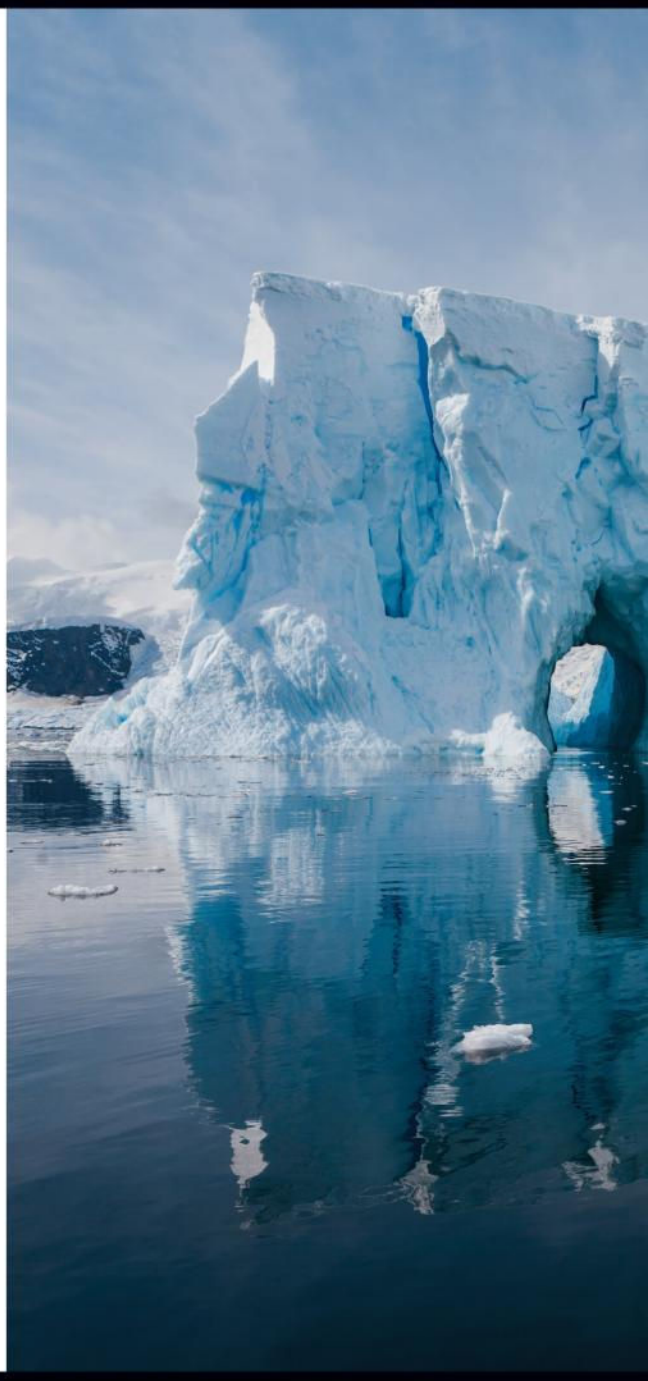
In this two-part feature, see how scientists on Antarctica's icy surface are tracking the continent's meltdown, which could raise sea levels dramatically and cause a global crisis. In Part 2, visit the rarely seen and exotic marine world below.

ON THE ICE



A startling sunset reddens the Lemaire Channel, off the west coast of the Antarctic Peninsula. The continent's coastal ice is crumbling as the sea and air around it warm.

BY **DOUGLAS FOX**
PHOTOGRAPHS BY **CAMILLE SEAMAN**



Seen from above, the Pine Island Ice Shelf is a slow-motion train wreck. Its buckled surface is scarred by thousands of large crevasses. Its edges are shredded by rifts a quarter mile across. In 2015 and 2016 a 225-square-mile chunk of it broke off the end and drifted away on the Amundsen Sea. The water there has warmed by more than a degree Fahrenheit over the past few decades, and the rate at which ice is melting and calving has quadrupled.

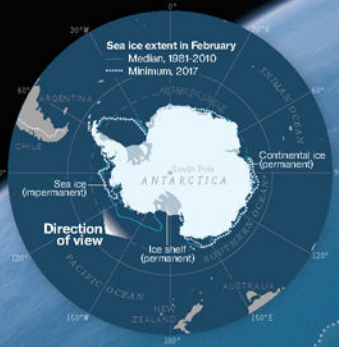
The ice shelf is the floating terminus of the Pine Island Glacier, one of several large glaciers that empty into the Amundsen Sea. Together they drain a much larger dome of ice called the West Antarctic Ice Sheet, which is up to two and a half miles thick and covers an area twice the size of Texas. The ice sheet is draped over a series of islands, but most of it rests on the floor of a basin that dips more than 5,000 feet below sea level. That makes it especially vulnerable to the warming ocean. If all that vulnerable ice were to become unmoored, break into pieces, and float away, as researchers increasingly believe it might, it would raise sea level by roughly 10 feet, drowning coasts around the world.

The ice sheet is held back only by its fringing ice shelves—and those floating dams, braced against isolated mountains and ridges of rock around the edges of the basin, are starting

The west side of the Antarctic Peninsula is warming several times faster than the rest of the planet. Ninety percent of its 674 glaciers are now in retreat and are calving more icebergs into the sea, like this one in Andvord Bay.

THE MELTING OF ANTARCTICA

Snow falling on Antarctica through the ages has piled up in domes of ice more than two miles thick. Most of that is likely safe for many centuries. But as the climate warms, the edges of the frozen continent are crumbling. The natural flow of ice, down through coastal glaciers and floating ice shelves to the sea, is speeding up. By 2100 the ice loss may contribute several feet to global sea-level rise.



Erratic sea ice

The sea surface freezes annually. The ice extent set a record high in 2014 – and a record low this year.

Fast-Melting West

West Antarctica, separated from the east by the Transantarctic Mountains, is losing 30 cubic miles of ice a year. That could speed up sharply: Most of the ice sits on the floor of a marine basin, vulnerable to a warming ocean.

Sea ice extent, February 2017 (impermanent ice)

Ice flow velocity
Ice is constantly on the move in Antarctica, moving faster at ice shelves and glaciers.

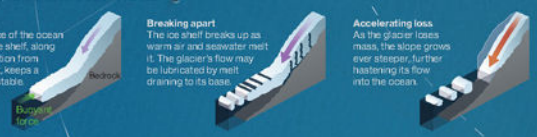
Surface speed of ice (feet per year)
Slower — *Faster*
0 ft | 3,250 | 6,500 | 9,750 | 13,000

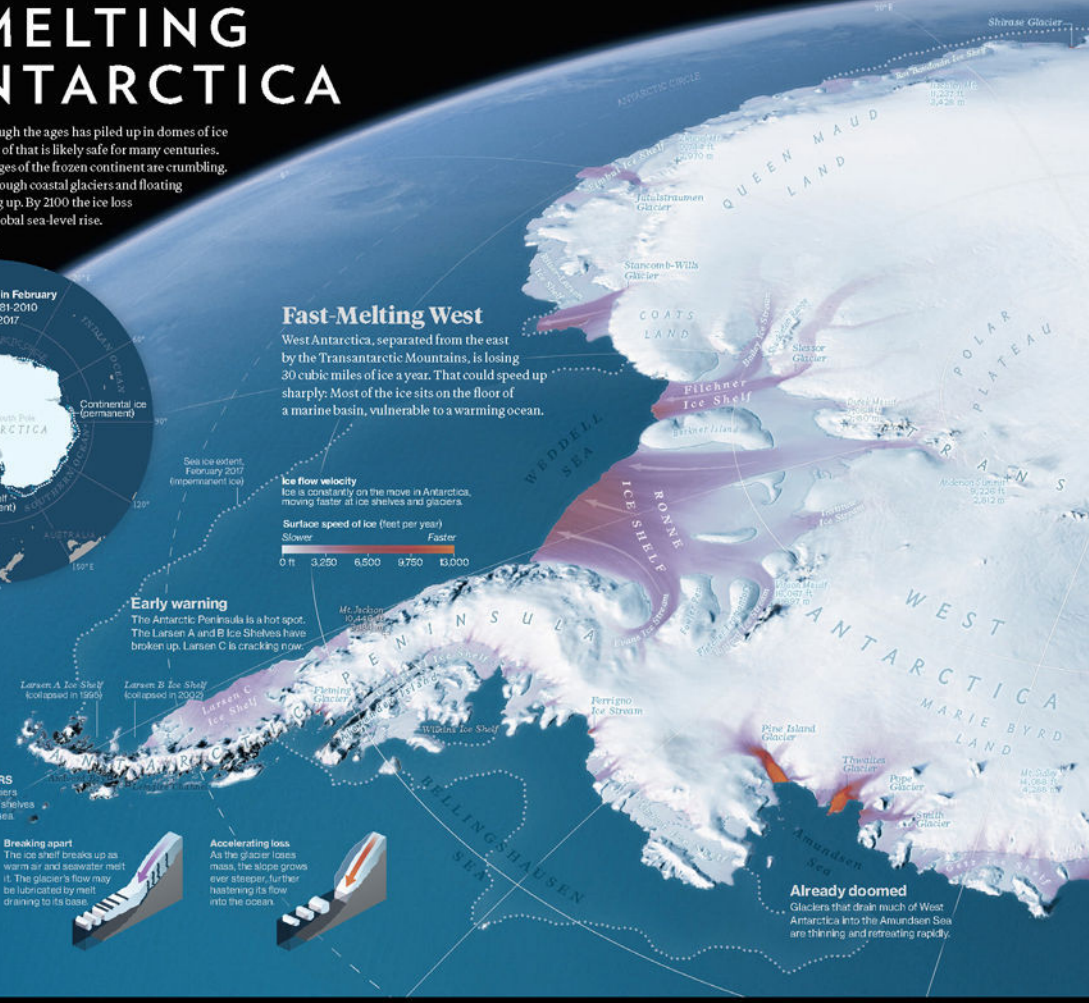
Early warning

The Antarctic Peninsula is a hot spot. The Larsen A and B Ice Shelves have broken up. Larsen C is cracking now.

HOW WARMING SPEEDS GLACIERS

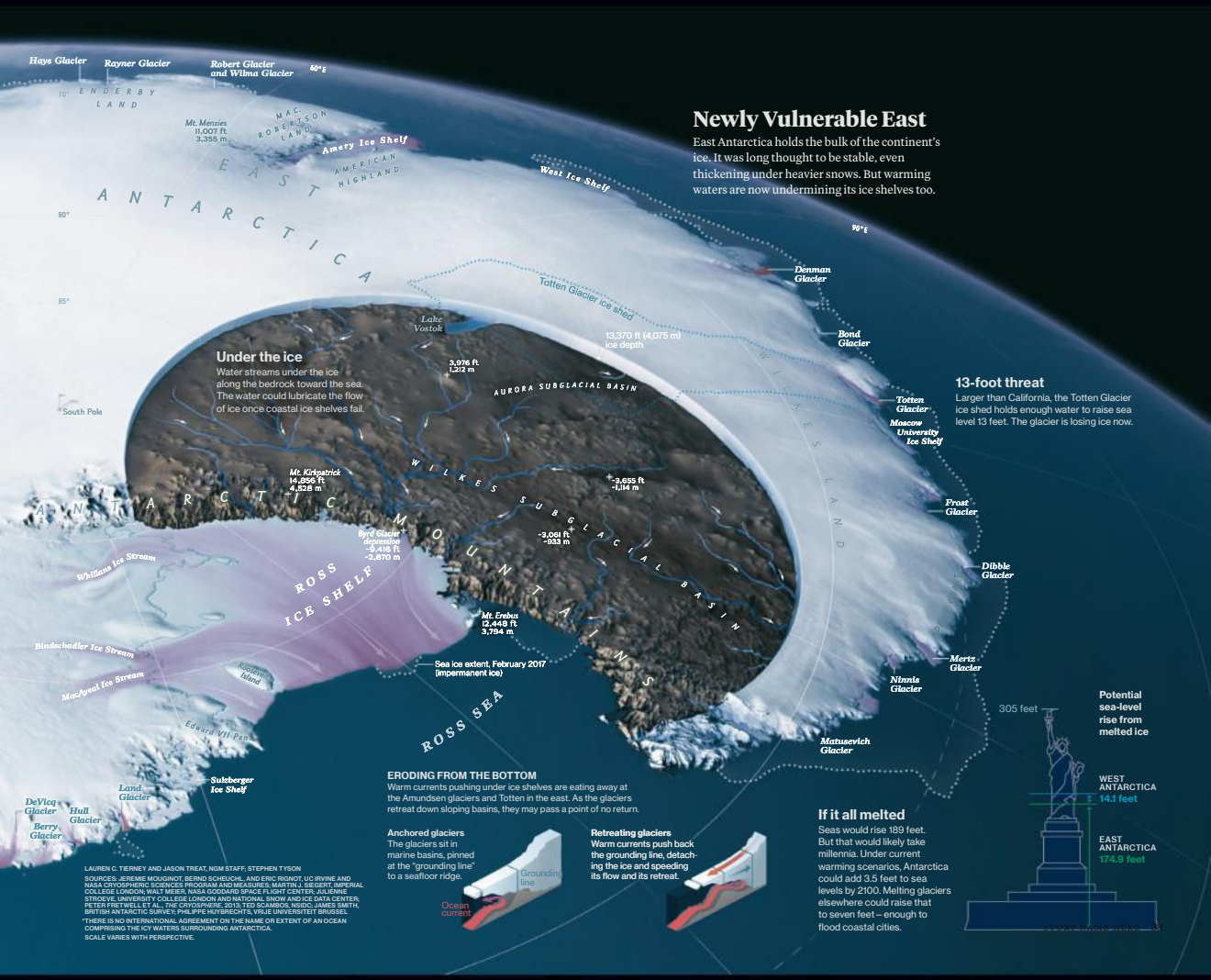
Floating ice shelves buttress coastal glaciers and the inland ice behind them. When ice shelves break up, the land ice flows faster to the sea.





Already doomed

Glaciers that drain much of West Antarctica into the Amundsen Sea are thinning and retreating rapidly.



LAUREN C. TIERNEY AND JASON TREAT, NGM STAFF; STEPHEN TYSON

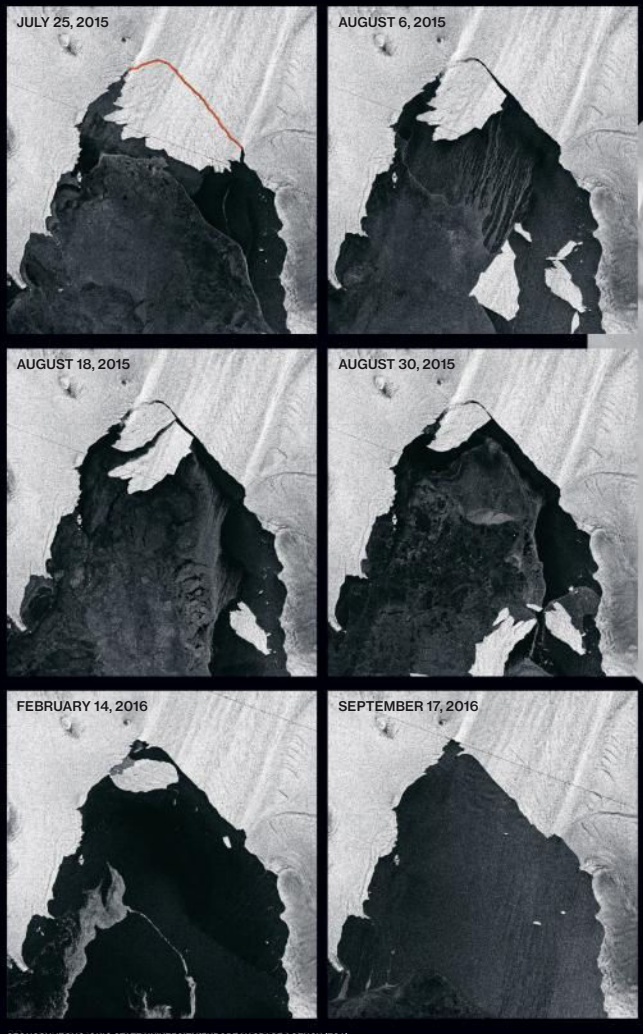
SOURCES: JEREMIE MOUGINOT, BERND SCHEUCHL, AND ERIC RIGNOT, UC IRVINE AND NASA CRYOSPHERIC SCIENCES PROGRAM AND MEASURES; MARTIN J. SIEGERT, IMPERIAL COLLEGE LONDON; WALT MEIER, NASA GODDARD SPACE FLIGHT CENTER; JULIENNE STROEVE, UNIVERSITY COLLEGE LONDON AND NATIONAL SNOW AND ICE DATA CENTER; PETER FRETWELL ET AL., *THE CRYOSPHERE*, 2013; TED SCAMBOS, NSIDC; JAMES SMITH, BRITISH ANTARCTIC SURVEY; PHILIPPE HUYBRECHTS, VRIJE UNIVERSITEIT BRUSSEL

*THERE IS NO INTERNATIONAL AGREEMENT ON THE NAME OR EXTENT OF AN OCEAN COMPRISING THE ICY WATERS SURROUNDING ANTARCTICA.

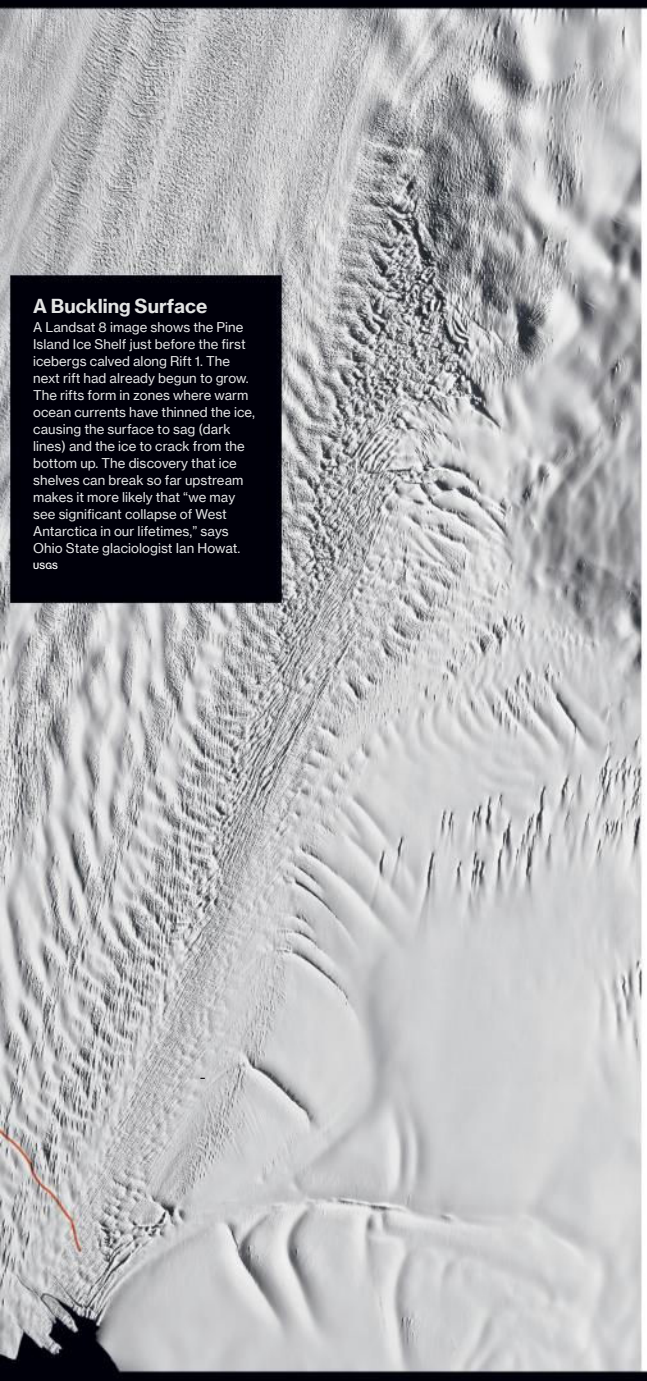
SCALE VARIES WITH PERSPECTIVE.

A FAILING BUTTRESS

RIFT 1 The floating Pine Island Ice Shelf, which supports a massive glacier, is failing. Warm ocean water is weakening it from below, reaching farther under the shelf than ever. Satellite pictures (below) captured the growth of a rift—Rift 1 on the large image at right—some 10 miles in from the sea. It sliced across the width of the shelf, releasing 225 square miles of ice.



SEONGSU JEONG, OHIO STATE UNIVERSITY/EUROPEAN SPACE AGENCY (ESA)



A Buckling Surface
A Landsat 8 image shows the Pine Island Ice Shelf just before the first icebergs calved along Rift 1. The next rift had already begun to grow. The rifts form in zones where warm ocean currents have thinned the ice, causing the surface to sag (dark lines) and the ice to crack from the bottom up. The discovery that ice shelves can break so far upstream makes it more likely that "we may see significant collapse of West Antarctica in our lifetimes," says Ohio State glaciologist Ian Howat.
USGS

RIFT 2 The upstream rift in the Landsat image at left was still growing when this close-up was made from a NASA aircraft in November 2016. Rift 2 is more than a hundred yards wide, and its freshly fractured ice cliffs tower eight stories above the water.

to fail. All around the Amundsen Sea, on the Pacific coast of West Antarctica, the ice shelves are weakening and the glaciers behind them are retreating as the ice flows faster into the sea. The Pine Island Ice Shelf, about 1,300 feet thick over most of its area, is a dramatic case: It thinned by an average of 150 feet from 1994 to 2012. But even more worrisome is the neighboring Thwaites Glacier, which could destabilize most of the West Antarctic Ice Sheet if it collapsed.

"These are the fastest retreating glaciers on the face of the Earth," says Eric Rignot, a glaciologist at the NASA Jet Propulsion Laboratory in Pasadena, California. Rignot has studied the region for more than two decades, using radar from aircraft and satellites, and he believes the collapse of the West Antarctic Ice Sheet is only a matter of time. The question is whether it will take 500 years or fewer than a hundred—and whether humanity will have time to prepare.

"We have to get these numbers right," Rignot says. "But we have to be careful not to waste too much time doing that."

Getting the predictions right requires measurements that can be made only by going to the ice. In December 2012 a red-and-white Twin Otter plane skimmed low over the Pine Island Ice Shelf. The pilot dragged the plane's skis through the snow, then lifted off and circled back to make sure he hadn't uncovered any crevasses. After the plane landed, a single person disembarked. Tethered to the plane by a rope and harness, he probed the snow with an eight-foot rod.

Finally the scout was satisfied: There were no buried crevasses that might swallow a landing party. More scientists got out of the plane. The team, led by glaciologist Martin Truffer of the University of Alaska, proceeded to set up camp. Their plan was to spend two months on the ice shelf; they would be the first humans to spend even a single night. The ice had

NATHAN KURTZ, NASA

The melt rates were 'just crazy,' researcher Adrian Jenkins says. 'It was beyond our concept that a glacier would melt that fast.'

long been considered too dangerous to visit. But Truffer's team wanted to bore holes all the way through the ice shelf, so they could measure the heat eating at it from the seawater below.

As the researchers lay in their tents at night, in the middle of a 4,000-mile arc of coastline that lacked a single permanent outpost, they heard loud pops and bangs coming from the ice. Each morning they saw new cracks, an inch wide and seemingly bottomless, cutting across its surface. During their five weeks of studying it, the ice under their boots thinned by another seven feet.

IT TOOK SCIENTISTS A LONG TIME to realize just how quickly West Antarctica's ice could melt. In part that's because the most vulnerable glaciers are so well guarded. In front of the Pine Island Ice Shelf—the floating end of the glacier—the sea surface itself freezes each winter. In summer this fractured sea ice joins icebergs calved from the ice shelves to form a shifting palisade that historically kept ships at least a hundred miles from the ice shelf.

In March 1994 the U.S. icebreaker *Nathaniel B. Palmer* became perhaps only the second vessel ever to reach it. For a few days powerful winds parted the ice floes, creating a narrow, ephemeral passage for the *Palmer* to thread. With no accurate maps to guide them, the crew on the ship's bridge eyed the sonar monitor nervously. It showed a chaotic seafloor of canyons and sharp ridges, including one that rose within 20 feet of the ship's keel.

The *Palmer* would spend just 12 hours at the front of the ice shelf before encroaching sea ice forced it to retreat north. But that gave the crew enough time to lower scientific instruments through the water column. They made a disturbing discovery. Near the surface, a current was streaming out from under the ice shelf that was slightly less salty than the sea around it, because it was freshened by melted ice. (The ice is fresh because it originated as snow falling on West Antarctica.) And at depths of 2,000 to 3,000 feet, along a seafloor canyon that ran straight under the ice, warmer seawater was streaming in.

Stan Jacobs, an oceanographer from the Lamont-Doherty Earth Observatory in New York, quickly understood what was going on. The warm water was coming from the South Pacific, more than 200 miles north. It was so heavy with salt that it was following the floor of a submarine canyon, which sloped down toward the glacier. The glacier itself had carved that canyon, thousands of years ago during the Ice Age, when it and the other glaciers in West Antarctica advanced hundreds of miles out from their present-day positions.

Now that same canyon was channeling warm ocean water under the Pine Island Ice Shelf. Somewhere tens of miles inland, the warm water was finding the "grounding line": the place where the glacier lifts off the seafloor and becomes a floating ice shelf. Hitting that wall of ice, the warm water was eroding it, producing a steady stream of melt-laden seawater. Because it was cooler and fresher, it was less dense, and so it was rising above the warmer, incoming water and flowing back out to sea just under the shelf.

By measuring the amount of this freshwater, the researchers could estimate how much ice was being lost. The melt rates "were just crazy," says Adrian Jenkins, a glaciologist from the British Antarctic Survey in Cambridge. According to his calculations, the ice shelf was losing 13 cubic miles of ice per year from its underside; back near the grounding line, the ice was probably thinning up to 300 feet per year.

"It was just beyond our concept that a glacier would melt that fast," Jenkins says.

Over the next 13 years he and Jacobs tried

three times to return to Pine Island. Sea ice blocked them each time. When they finally got back there on the *Palmer* in January 2009, they found that the melt rate had increased by about 50 percent. This time they came equipped with a new tool: a yellow robotic submarine called *Autosub3*. Shaped like a torpedo and as long as a delivery truck, it could navigate autonomously under the ice shelf, out of contact with the ship, for up to 30 hours at a time.

On its first three dives, *Autosub3* discovered that the ice shelf had thinned enough to lift off a submarine ridge that, running across its width, had once supported and stabilized the ice shelf. That had opened a gap that was allowing warm water to flow in and melt the underside of the ice even faster. On its fourth dive the yellow robot nearly died. When the crew winched it out of the water, they found its nose cone smashed and some of its delicate internal equipment damaged.

Technicians reconstructed what had happened from the sub's navigation data. Thirty miles back, under the ice shelf, *Autosub3* had strayed into a chasm on the underside of the ice. Searching for a way forward, it had smashed and scraped against the walls of the chasm—ultimately rising 500 feet up into the labyrinthine bowels of the ice shelf. Finally it had dropped back out and escaped into open water.

The sub's sonar data, meanwhile, revealed the breathtaking landscape it had navigated. The bottom of the ice shelf was corrugated with not just one but many channels, which cut as far as 600 feet up into it. The walls of these inverted ice canyons were sculpted into terraces, ledges, and sharp corners, and along the ceiling of each ran a gaping crack that penetrated even farther into the ice.

"What the hell is going on?" Jenkins recalls thinking when he first saw the sonar maps.

What he and Jacobs came to realize was that the upside-down canyons had been carved, like rock canyons on land, by flowing water. Apparently the meltwater rising off the grounding line was still warm enough to melt more ice. And as it flowed for tens of miles along the underside of the ice shelf, back out to the open sea, it was melting a lot of it.

LARGE SWATHS OF WEST ANTARCTICA are hemorrhaging ice these days. The warming has been the most dramatic on the Antarctic Peninsula, a spine of ice-cloaked mountains that reaches 700 miles up toward the tip of South America. Catching the powerful winds and ocean currents that swirl endlessly around Antarctica, the peninsula gets slammed with warm air and water from farther north. Average annual temperatures on its west side have risen nearly 5 degrees Fahrenheit since 1950—several times faster than the rest of the planet—and the winters have warmed an astonishing 9 degrees. Sea ice now forms only four months a year instead of seven.

Since 1988, four ice shelves on the east side of the peninsula have disintegrated into armadas of icebergs. (A large and rapidly growing crack on another shelf, called Larsen C, suggests it might do the same.) Warmer air helped trigger these collapses by forming meltwater ponds on the surface of ice shelves; the ponds drained into crevasses, wedging them deeper into the ice. As the shelves have vanished, the glaciers they once stabilized have stampeded into the ocean, accelerating to two, five, even nine times their original speed. They're relatively small glaciers and won't raise sea level much—but their acceleration has reinforced concerns that the same thing might happen to the much larger glaciers along the Amundsen Sea.

The Amundsen Sea is farther south than the peninsula, and the air there is not as warm. The biggest threat to its glaciers is the mechanism Jacobs and Jenkins helped uncover: deep submarine canyons that channel warm water from the north under the ice shelves, and deep inverted canyons that focus the warmth on the underside of the ice.

A satellite survey last year of many Antarctic ice shelves—led by glaciologists Ted Scambos of the National Snow and Ice Data Center in Boulder, Colorado, and Helen Fricker of the Scripps Institution of Oceanography in San Diego—revealed that such melt canyons are common.

An iceberg's graceful curves bear witness to the rapid melt it has experienced since being dumped by a glacier into the Lemaire Channel. Winters on the west side of the Antarctic Peninsula have warmed by 9 degrees Fahrenheit since 1950.

Research indicates that the collapse of major glaciers that flow into the Amundsen Sea is now unstoppable.

They tend to fan out and steer warm water toward the edges of the shelves. The ice there is crucial: It rubs against the stationary banks and slows the flow of the shelf and the glacier behind it. But that edge ice is also thinner than the rest. This "is something that bears watching," Scambos said in early 2016.

Ian Howat, of the Byrd Polar and Climate Research Center in Columbus, Ohio, is another glaciologist who's watching Pine Island closely. Last November he reported two ominous new rifts spreading across the ice shelf that threaten to prune it to its shortest length in recorded history. As Howat looked back through monthly satellite photos, he realized that the rifts had been triggered by a singular event that had happened, unnoticed, three years before. The strip of torn-up ice anchoring the ice shelf to its northern bank had suddenly fallen apart, suggesting it had been undermined by melting from below. It blew out "just in a matter of days," Howat says, "like a zipper, unzipping the side of the glacier."

It's unclear when the entire ice shelf might disintegrate. The "warm" water flowing underneath it from offshore is only 4 to 6 degrees Fahrenheit above freezing. But roughly 3,000 cubic miles of it arrives every year, which means the ice shelf is receiving an amount of heat that exceeds the output of a hundred nuclear power plants, operating 24/7.

When Truffer and his team camped on the shelf in December 2012, they could sense how it had already weakened. As the meltwater cuts deep into the ice from below, the unsupported ice sags, causing the entire shelf to bend and warp. Crevasses erupt along the lines of stress, on both the top and the bottom of the ice. The pops and bangs the researchers heard and the daily opening of new cracks bore witness to the ice's gradual failure as it thinned and broke down beneath them.

As the Pine Island Ice Shelf has weakened and the glacier behind it has accelerated, the ice has stretched and thinned for 150 miles inland from the coast. The destabilizing effects spread farther into West Antarctica every year. "A little nudge can get you to several decades of retreating behavior that's hard to reverse," Truffer says.

In fact, research by Rignot and others over the past few years indicates that the collapse of several major glaciers flowing into the Amundsen Sea is now unstoppable. Between 2002 and 2009 alone, the ice shelf in front of the Smith Glacier thinned by 1,500 feet in some places, the one in front of the Pope Glacier by up to 800 feet. The grounding lines of the Amundsen glaciers have retreated so far—tens of miles in some cases—that they now rest on seafloor that slopes down toward the center of the ice sheet. Each increment of retreat exposes a greater ice surface to warm ocean water. It's a runaway process—and scientists are urgently trying to figure out how fast it will run.

The ice shelves, Fricker says, "are the canary in the coal mine." Because they're already floating, they don't raise sea level themselves when they melt—but they signal that a rise is imminent, as the glaciers behind them accelerate. Fricker and her team have found that from 1994 to 2012, the amount of ice disappearing from all Antarctic ice shelves, not just the ones in the Amundsen Sea, increased 12-fold, from six cubic miles to 74 cubic miles per year. "I think it's time for us scientists to stop being so cautious" about communicating the risks, she says.

The retreat and hemorrhage of these glaciers "will accelerate over time," agrees Rignot. "Maybe you don't care much about that for the next 30 to 40 years, but from 2050 to 2100 things could get really bad, and at that point listening to

In East Antarctica, Australian researchers probe for crevasses on Totten Glacier – another one that has begun to look vulnerable – before deploying instruments to measure how fast it's moving and thinning.

scientists is irrelevant." Yet after things get really bad, they could still get worse.

MOST OF THE HEAT trapped by our fossil fuel emissions since the industrial revolution began in the 19th century has gone into the ocean. Most of the heat now hitting the Antarctic ice shelves, however, comes from another effect of climate change: Intensified circumpolar winds and currents have driven warmer water from offshore onto the continental shelf and under the floating ice. Much more ocean warming is yet to come, even if we begin to cut emissions. A lot more heat is on the way to Antarctica.

Scientists are especially concerned about the Thwaites Glacier, which by itself could raise global sea level four feet; last fall the British and American science foundations announced a coordinated $20 million to $25 million field campaign that will deploy ships, planes, satellites, and underwater robots to assess the glacier's status starting in 2018. For now, the best estimates suggest that Antarctica will sweat off enough ice to raise global sea levels by 1.5 to 3.5 feet by 2100, depending on how quickly humans continue to pump out greenhouse gases. Throw in Greenland and other rapidly melting glaciers around the world, and sea level could plausibly rise three to seven feet by 2100.

But that's not the worst case: Sea level won't stop rising in 2100. Earth's past offers worrisome clues to what the more distant future might bring. Geologists studying ancient shorelines have concluded that 125,000 years ago, when the Earth was only slightly warmer than today, sea levels were 20 to 30 feet higher. Some three million years ago, the last time atmospheric carbon dioxide was as high as it is today, and the temperature was about what it's expected to be in 2050, sea levels were up to 70 feet higher than today. Yet a collapse of the Greenland and West Antarctic Ice Sheets would raise sea level only about 35 feet.

To consider the worst case, then, scientists must turn their eyes toward East Antarctica, home to more than three-fourths of all the ice on Earth.

HAYDEN ANDERSON, AUSTRALIAN ANTARCTIC DIVISION

If Totten Glacier were to collapse, sea level could rise 13 feet—threatening many of the world's largest cities.

This past January a twin-propeller DC-3 made a series of flights from Australia's Casey Station along the East Antarctic coast. Built in 1944, the plane was packed with modern scientific equipment. As it flew over the Totten Glacier, a radar recorded the thickness of the ice. Another instrument recorded tiny changes in Earth's gravitational field—clues to the topography of the seafloor under the glacier's floating ice shelf. Now and then a crew member opened the plane's rear door, knelt in the windy opening, and tossed out a torpedo-shaped object. As the device splashed into the water, it split in two: One part floated, sending radio signals back to the plane, while the other part reeled down 2,600 feet of wire, measuring the water temperature all the way down.

Until recently the East Antarctic Ice Sheet was considered secure; unlike West Antarctica, it sits on high ground. But mapping with ice-penetrating radar has revealed a low-lying region cut by glacially carved channels that drop as far as 8,500 feet below sea level—perfect for guiding warm ocean water deep into the heart of the ice sheet. The Totten Glacier is the largest coastal outlet in this region. If it collapsed, global sea level could rise 13 feet—"roughly as much as all of West Antarctica," Rignot points out. "One glacier alone."

In January 2015, the Australian icebreaker *Aurora Australis* became the first ship to reach the front of Totten. Like the *Palmer* at Pine Island in 1994, it found deep, warm water flowing under the ice shelf, at a rate of 4.5 cubic miles a day. The glacier is already losing a couple of cubic miles of ice per year—small potatoes, in Antarctic terms. But Donald Blankenship, a University of Texas glaciologist who oversees the aerial survey, fears it could blow up.

In 2016 his team reported evidence from the bedrock that Totten repeatedly has retreated 100 to 200 miles inland from its current position—meaning it might help explain why sea level was

Iceberg A56, photographed through clouds from the International Space Station, is several times the size of Manhattan. It has drifted over 1,000 miles since breaking off the Filchner-Ronne Ice Shelf around 2000.

so much higher three million years ago. Blankenship's surveys have also identified two seafloor grooves deep enough to let warm water under Totten's ice shelf. Last January the team was refining those seafloor maps.

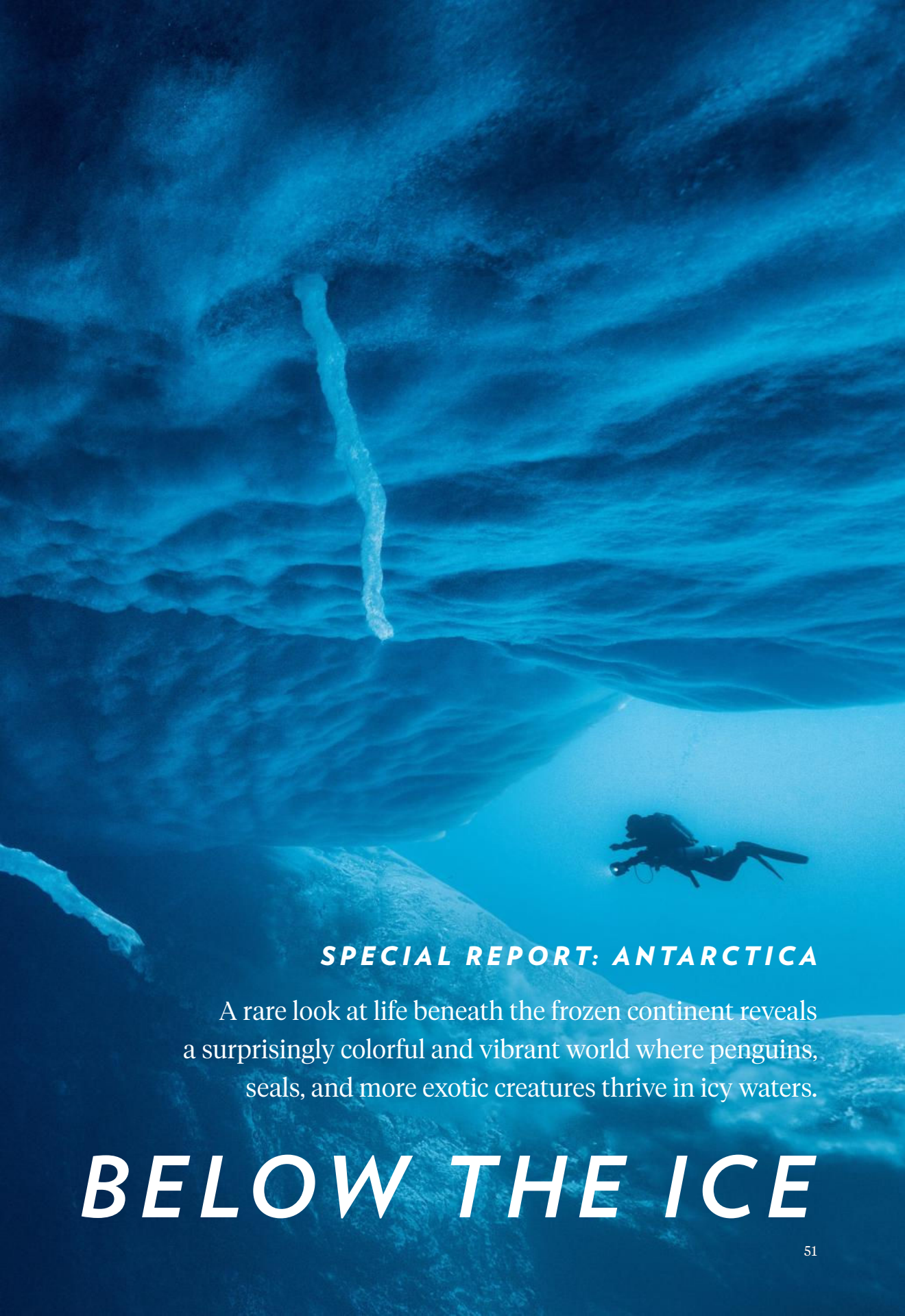
Totten will lose its ice more slowly than West Antarctica. The worst case coming out of Antarctica still seems to be centuries away. But it would mean abandoning many of the world's largest cities, including New York, Los Angeles, Copenhagen, Shanghai, and dozens of others—and it's looking less crazy all the time. "The fuse is lit," says Blankenship. "We're just running around mapping where all the bombs are." ☐

Writer **Douglas Fox** has traveled to Antarctica five times and has spent months on the ice there. This is his first feature for *National Geographic* magazine.

TIM PEAKE, ESA/NASA

Tendrils of ice-covered brine, or brinicles, leak from sea ice near East Antarctica's Dumont d'Urville Station. Ephemeral and seldom seen, they form when trapped, supercooled brine escapes from the ice and freezes less salty seawater.

THE BEAUTY



SPECIAL REPORT: ANTARCTICA

A rare look at life beneath the frozen continent reveals a surprisingly colorful and vibrant world where penguins, seals, and more exotic creatures thrive in icy waters.

BELOW THE ICE

A hundred feet below the ice, a feather star waves its frondlike arms, groping for food particles. It's an animal, not a plant – a cousin of sea stars – and it can swim. Photographer Laurent Ballesta dived as deep as 230 feet to get these shots.

PROMACHOCRINUS KERGUELENSIS

Emperor penguins head for the open ocean in search of food. The brownish patches above them are microalgae that cling to the sea ice and start to photosynthesize in spring. The photographer's day camp was on one of these floes.

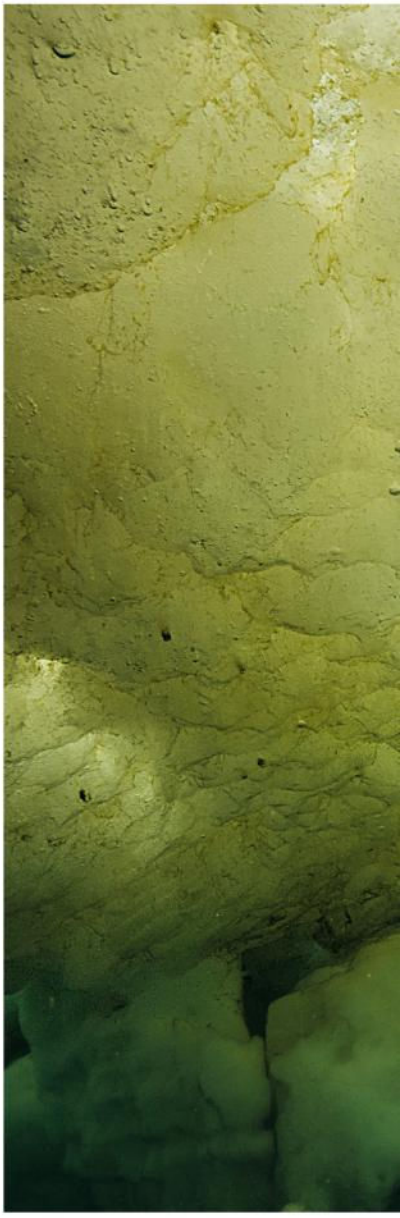
APTENODYTES FORSTERI (PENGUINS)

A bioluminescent crown jellyfish, some 14 inches wide, floats by at 130 feet deep, glowing and trailing a dozen stinging tentacles. These bell-shaped plankton-eaters avoid direct light, which can kill them.

PERIPHYLLA PERIPHYLLA

STORY AND PHOTOGRAPHS
BY ***LAURENT BALLESTA***

In the morning, when we arrive on foot from Dumont d'Urville, the French scientific base on the Adélie Coast of East Antarctica, we have to break up a thin layer of ice that has formed over the hole we drilled the day before. The hole goes right through the 10-foot-thick ice floe. It's just wide enough for a man, and below it lies the sea. We've never tried to dive through such a small opening. I go first.



Pushing and pulling with hands, knees, heels, and the tips of my swim fins, I shimmy through the hole. As I plunge at last into the icy water, I look back—to a sickening sight. The hole has already begun to close behind me.

The bottom surface of the sea ice is a thick slurry of floating ice crystals, and my descent has set them in motion. They're converging on the hole as if it were an upside-down drain. By the time I thrust one arm into the icy mush, it's three feet thick. Grabbing the safety rope, I pull myself up inch by inch, but my shoulders get stuck. Suddenly I'm stunned by a sharp blow to the head: Cédric Gentil, one of my dive buddies, is trying to dig me out, and his shovel has struck my skull. Finally a hand grabs mine and hauls me into the air. Today's dive is over—but it's only one of 32.

I've come here with another photographer, Vincent Munier, at the invitation of filmmaker Luc Jacquet, who's working on a sequel to his 2005 triumph, *March of the Penguins*. While Jacquet films emperor penguins and Munier photographs them, my team will document life under the sea ice. In the winter the ice reaches 60 miles out to sea here, but we've come in October 2015, at the beginning of spring. For 36 days, as the ice breaks

A curious young Weddell seal, weeks old, comes in for a close-up. It may have been the pup's first swim, says marine biologist Pierre Chevaldonné, who has worked at Dumont d'Urville. Weddell seals are the most southerly breeding mammal in the world.

Tethered to the seafloor more than 200 feet down, siphoning in water to collect food, orange sea squirts “look very simple, like sponges,” says Chevaldonné. “Yet they’re quite evolved” – they’re invertebrates, but the larvae have spinal cords.

SYNOICUM ADAREANUM

Extreme conditions beget extreme animals. Clockwise from upper left: Three inches long, this icebound Antarctic scallop is probably decades old – growth is slow in the extreme cold. An isopod looks like a pill bug – and rolls up when threatened – but is nearly five inches long. Sea spiders are another example of mysterious "polar gigantism": They're tiny in other places, but this one in Antarctica has legs that span seven inches. And the sea star nestled up to a worm-ridden, treelike sponge? It's more than a foot across.

CLOCKWISE FROM UPPER LEFT: *ADAMUSSIUM COLBECKI; GLYPTONOTUS ANTARCTICUS; COLOSSENDEIS MEGALONYX; MACROPTYCHASTER* SP. (SEA STAR), *PARBORLASIA CORRUGATUS* AND *FLABELLIGERA* SP. (WORMS), *HOMAXINELLA BALFOURENSIS* (SPONGE)

A wary icefish takes cover in a kelp grove. These bottom dwellers have antifreeze proteins in their blood that help them withstand temperatures below 29°F. There are at least 50 species of icefish in the frigid waters of Antarctica.

FAMILY NOTOTHENIIDAE (ICEFISH); *HIMANTOTHALLUS GRANDIFOLIUS* (KELP)

up and retreats to within a few miles of the coast, we'll dive through it, down as deep as 230 feet.

I've worked for decades as a deep-diving photographer, at first in the Mediterranean Sea, where I learned to dive 30 years ago. Later, a craving for new mysteries took me elsewhere. I've dived to 400 feet off South Africa to photograph rare coelacanths, and for 24 straight hours off Fakarava, in French Polynesia, to witness the mating of 17,000 groupers. But this expedition to Antarctica is unlike any other. Here we'll be diving deeper than anyone has dived before under Antarctic ice—and the conditions will be beyond harsh.

Getting into our suits takes an hour. When at last we topple into the freezing water, we're carrying 200 pounds each.

AT HOME IN FRANCE we spent two years preparing. On a map of the Adélie Coast pinned to my wall, I chose dive sites that had a range of bottom depths and were within six miles or so of Dumont d'Urville. We worked with manufacturers to identify the weak points of classic diving suits. The water was going to be colder than 29 degrees Fahrenheit. (Salt water remains liquid below freshwater's freezing point of 32 degrees.) Without dry suits we'd die in as little as 10 minutes. With our improved equipment we could last up to five hours.

The preparations for each day's dive take about as long. Where we can't slide into holes left by Weddell seals and their busy teeth, we dig our own with an ice-drilling machine. Seals, when they need air, somehow find their way back to their hole; our greatest dread is getting lost and trapped under the ice. So we drop a luminescent yellow rope into the hole and pull it along with us during the dive. At the end we follow it back up.

NGM MAPS

A Weddell seal accompanies her pup on a swim beneath the ice. When the juvenile is full-grown, it will be its mom's size: about 10 feet long and weighing half a ton. These placid seals stay close to the coast, breathing air through holes in the ice.

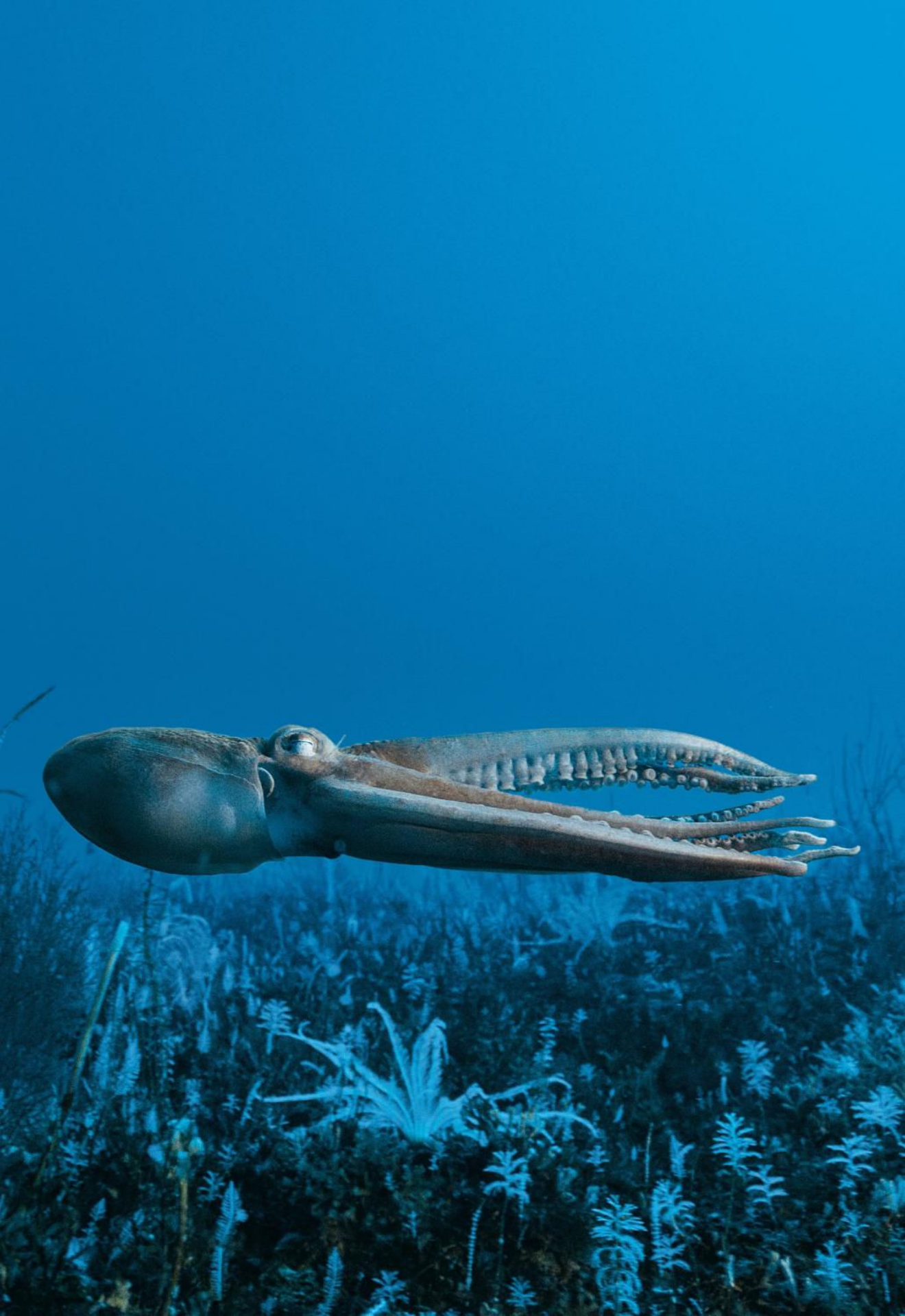
LEPTONYCHOTES WEDDELLII

Body stowed inside the ice floe, an anemone lets its tentacles dangle in the dark water. Marine biologist Marymegan Daly says it's the only anemone species known to live in ice. Scientists can't say how it penetrates the ice – or survives there.

EDWARDSIELLA ANDRILLAE

An octopus jets above a seabed packed with life. Antarctica has at least 16 species of octopuses. All have a specialized pigment in their blood called hemocyanin, which turns the blood blue and helps them survive subfreezing temperatures.

PARELEDONE SP.



Our suits have four layers: thermal underwear on the inside, followed by an electrically heated bodysuit, a thick fleece, and a half-inch-thick layer of waterproof neoprene. There's a hood as well as an underhood, waterproof gloves and heated liners, fins, and 35 pounds of weights. There are two batteries for the heated bodysuit, a rebreather to remove carbon dioxide from our exhalations (allowing us to dive longer), backup gas cylinders, and finally, my photography equipment. We look like astronauts minus the bubble helmets. Just getting into our suits takes an hour and the help of Emmanuel Blanche, our emergency doctor.

When at last we're ready to topple into the freezing water, we're wearing and carrying 200 pounds each. It feels like we're learning to dive all over again. Moving is a struggle, swimming almost impossible. The cold quickly anesthetizes the few square inches of exposed skin on our cheeks, and as the dive wears on, it intrudes into our suits and gloves, biting harder and harder. It's unbearable, but we must bear it. Toward the end, as we're pausing on our ascent to decompress, we search for anything to distract us from the pain.

The cold anesthetizes our exposed skin and intrudes into our suits and gloves. It will take seven months for my damaged nerves to recover.

When we finally crawl or haul ourselves out of the freezing ocean, I lie prostrate on the ice, my brain too dulled to think about removing my gear, my skin hard and wrinkled, my lips, hands, and feet swollen and numb—then, as my body warms and the blood starts to flow again, the pain is at its worst. It's so intense I find myself wishing my extremities were still frozen. After four weeks, I can't feel my toes anymore, even in the warmth. It will take seven months after our return to Europe for my damaged nerves to recover.

WHAT COULD POSSIBLY make this worthwhile? The light, first of all—it's a sight to elate any photographer. At the very beginning of spring, after the long polar night, microscopic plankton have not yet begun to bloom and cloud the water. Under the floe it's exceptionally clear, because there are so few particles to scatter the light. What little light there is wells down through the cracks or seal holes as if from streetlamps, casting a subtle glow over the underwater landscape.

And what a landscape! Only a few species of seals, penguins, and other birds live in East Antarctica, and no land mammals at all. You might think the seafloor too would be a desert. In fact, it's a luxuriant garden, with roots in deep time.

Antarctic marine life has been largely isolated from the rest of the planet for tens of millions of years, ever since the continent separated from the other continents and froze over. Since then the powerful Antarctic Circumpolar Current has swirled from west to east around Antarctica, creating a sharp temperature gradient that inhibits the spread of marine animals. The long isolation has allowed a tremendous diversity of species, unique to the region, to evolve on the seafloor.

At depths of 30 to 50 feet, forests of kelp, with blades more than 10 feet long, create a sober, imposing scene. Farther down, we meet giant sea stars: At 15 inches in diameter, they're much bigger than those in warmer seas. Then come the giant sea spiders. They're arthropods, like insects and spiders on land, and they're found in all the world's oceans, but in warmer waters they're rare and tiny, nearly invisible to the naked eye. Here, as in the Arctic, the sea spiders can span a foot or more. Yet their bodies are so small that their internal organs extend into their legs.

Below 165 feet, the light dims and we see no kelp or other plants. Instead, the seafloor is covered with thick carpets of feather hydroids (colonial animals related to corals) and with thousands of scallops. The scallops are four inches across but

may be 40 years old or more—things grow slowly in the Antarctic. At these depths we also notice feather star crinoids, close relatives of sea stars, which snag particles of drifting food with up to 20 undulating arms. Crawling and swimming among them are giant isopods that resemble beetles.

At 230 feet, the limit of our dives, the diversity is greatest. We see gorgonian sea fans, shellfish, soft corals, sponges, small fishes—the colors and exuberance are reminiscent of tropical coral reefs. The fixed invertebrates in particular are enormous. Well adapted to a stable environment, these plantlike animals grow slowly but, it appears, without limit—unless something disturbs them. How, we can't help wondering, will they respond as climate change warms their world?

As we ascend to the surface, the biodiversity diminishes. The shallower waters are a less stable environment: Drifting icebergs and sea ice scour the seafloor, and the seasonal freezing and melting of the sea surface, which removes freshwater from the ocean and then returns it, causes dramatic swings in salinity. But there is still plenty to occupy the eye. Microalgae cling to the ceiling of ice, turning it into a flamboyant rainbow of orange, yellow, and green. The ceiling is really more like a chaotic labyrinth, with layers of ice at different levels, and we pass through them slowly, cautiously. One day as I'm nearing the hole, I see a mother and baby seal plunge through it. I watch them for a long, envious moment as they move effortlessly through this fairy landscape.

On another day, while I'm desperate for distraction from the cold, Gentil calls my attention to a field of tiny, translucent anemones hanging from the floe. They're rooted a few inches deep in the stonelike ice, and their tentacles, pierced by the sun and waving in the current, are sharp and shiny. In all my research I'd never heard or read of such animals. They're mesmerizing.

The scientists back at the French base, looking at our pictures, say they'd never seen our ice anemones either. At first we're very excited; we think we've discovered a new species. Later we learn that scientists working in the American sector had described the animals two years earlier, based on photographs and samples taken with a remotely operated vehicle. We're disappointed but still proud, because we've seen these amazingly delicate creatures live, with our own eyes.

THE WATERS UNDER ANTARCTIC ICE are like Mount Everest: magical, but so hostile that you have to be sure of your desire before you go. You cannot go half-heartedly; you cannot feign your passion. The demands are too great. But that's what makes the images you see here unprecedented, and the experience of having taken them and of having seen this place so unforgettable.

After 36 days we felt we'd only begun to plumb it. The trip was so intense—the work so hard and exhausting, the sleep each night so deep—that in memory it seems to fuse into a single, 36-day-long dive. Our feet and hands froze, but our emotions were on a perpetual boil.

One dive toward the end stands out in my heart, not for the animals we saw but for the location. At home in France, looking at the Dumont d'Urville map, I had dreamed about it. Where, in this century on this Earth, can you be truly alone? Where can you see something no one has seen before? On the map I marked the Norsel reef, a tiny island more than seven miles offshore from Dumont d'Urville. In winter it's icebound.

By the time our helicopter flew over it, Norsel was in the open sea, a spire of rock just piercing the surface of water more than 600 feet deep. It was topped with a little ice cap. When the chopper dropped us, we were surrounded by ocean and giant icebergs—and well aware of the privilege of being where nobody had ever dived.

Summer was coming, and it was a mild, almost balmy day, around freezing. But the water was still below 29°F. Blanche, the doctor, activated the chronometer: He gave us three hours and 40 minutes. Then we were off, for another soak in another world. □

French biologist and photographer **Laurent Ballesta** covered coelacanths for the March 2011 issue. His next expedition will take him back to French Polynesia to swim at night with gray reef sharks on the hunt.

Go With Nat Geo: Explore Antarctica on a National Geographic Expedition *(natgeoexpeditions.com).*

After more than two weeks without medication for kidney disease, Oseas Ríos was so weak he could hardly walk. Here mediums who are adherents of the religious cult of María Lionza channel Viking spirits in a healing ceremony for him at the base of Sorte Mountain, near Chivacoa.

Desperate for a Cure

Venezuelans are turning to spiritual healers as the nation's health care crisis deepens.

STORY AND PHOTOGRAPHS
BY MERIDITH KOHUT

Bare shelves tell a grim story in Silvia Limardo's pharmacy, which was previously considered one of the best stocked in Caracas. Now it's hard or impossible to find more than 85 percent of such essential medicines as antibiotics and drugs for pain, allergies, epilepsy, and hypertension.

Yasmary Díaz piled her three children into the back of a pickup truck one day and made the short but bone-jarring trip from her home in Guarenas up a rutted track to a tiny mountain shack in Zamora made of dried mud and tree branches. She was desperate to cure the cancer growing in her breast, and with no other option available, she had come to be treated by a shaman, a traditional healer who would channel the powerful spirit of an elderly man named Emeregildo, who had died decades before.

According to custom, she lay down on the bare dirt, surrounded by flickering candles and intricate patterns drawn in white chalk, and closed her eyes. Standing over her in a cloud of cigar smoke, Edward Guidice, bare chested with strands of colorful beads and wild boars' teeth draped around his neck, began to pray aloud—invoking a pantheon of saints and spirits of the religious cult of María Lionza to send a spirit to take over his body and heal Díaz.

Then he knelt down, grazed her breast with a razor blade, and covered it with red hibiscus flowers. Leaning in to within inches of her chest, he puffed on his cigar, alternately blowing smoke on the skin above the tumor and dripping red candle wax on it. Tobacco smoke is believed to absorb sickness, and when the ash changes color from black to white, healing is said to be taking place.

Díaz, 28, is one of likely thousands of Venezuelans now flocking to spiritual healers because their health care system is in crisis—part of the broader economic collapse in the wake of the late president Hugo Chávez's profligate socialist revolution. The Venezuelan Pharmaceutical Federation reports that more than 85 percent of basic medicines are impossible or difficult to find. Pharmacy shelves are bare, and public hospitals turn patients away for lack of supplies. The government won't disclose health care statistics, but in a survey of 92 state-run hospitals published in March 2017 by the Venezuelan nonprofit Physicians for Health, 78 percent reported having no medicines or severe shortages of them. The same survey also found that 89 percent of hospitals can't regularly perform x-rays and that 97 percent of medical labs aren't functioning at full capacity.

Díaz had spent a year waiting for care. Doctors at her hospital repeatedly turned her away: The

NGM MAPS

mammography machine was still broken, there were no medicines in stock, no chemicals for her blood work, no way to develop her x-rays. Uninsured and living on meager wages earned cleaning homes and baking cakes, she couldn't afford treatment at an expensive private clinic.

In November 2016 Díaz buried her grandmother, who had died from untreated cancer. This January, after a woman in Díaz's extended family died from untreated cancer, child protective services took her year-old baby away. Díaz was stricken by the fear that the same thing would happen to her children if cancer ended her life too.

"I never believed in this before," she says of spirit-medium healing. "But that day I stood up and said, 'I'm afraid, but I'm going to go, to see what happens.'"

"Patients arrive with different kinds of sicknesses: heart problems, spine problems, cancer, problems with their leg, knees, and eyes," Guidice says. "There are many poor people suffering."

Weeks after seeing him, Díaz said the pain in her breast had subsided. She felt more energetic. Guidice told her that because it had taken so long for the cigar ash to whiten up, she would need at least two more sessions. No longer a doubter, she's committed to the process. "Knocking on this door, there can be help that one cannot see. It's like the wind—you can't see it, but you can feel it." □

Above: In the mountains outside Guatire, healer Edward Guidice channels the spirit of a venerable chieftain named Mara and uses tobacco smoke and a mixture of herbs to treat the knees of Rómulo Fuentes. Below: In Petare, on a street lined with spiritual-healing clinics known as the Alley of the Witches, Glenda Abaché symbolically snaps scissors to alleviate Marcos Cabrales's back pain. Up to 80 people a day come to her clinic.

Above: After invoking the spirit of José Gregorio Hernández, a doctor revered for treating the poor for free, Henry Ruíz extracts a tumor from the uterus of Belkis Amalia Ramírez. “What happened was a miracle,” she says. Below: Guidice ministers to Yasmary Díaz, whose local hospital could operate on her breast cancer only if she provided her own medicines and paid for breast scans at a private clinic – which she couldn’t afford to do.

The Last Honey Hunter

One man from Nepal's Kulung culture harvests black market honey that is guarded by capricious spirits and the world's largest honeybees.

Mauli Dhan climbs a hundred feet up a bamboo rope ladder to his prize: a hive filled with neurotoxic honey. Smoke from smoldering grass disorients the bees, possibly reducing the number of stings Mauli will suffer. Before he grabs the support rope beside him, a misstep could be fatal.

Asdhan Kulung (right) has attached ropes to a hive and holds it steady as Mauli saws it away from the rock. Once pieces of the hive are severed, they will be lowered to the ground with ropes. The process can take hours.

An eight-mile trek through jungle brought Mauli's team to this location. In a cloud of smoke and bees – while dangling above the Hongu River on a rope ladder secured at the top of the cliff – he chops at a hive with his bamboo pole to break it from the rock.

By Mark Synnott
Photographs by Renan Ozturk

WATCH 360-DEGREE VIDEO

Join photographer Renan Ozturk as he dangles from a cliff to see Mauli Dhan harvest rare honey in this video at *natgeo.com/honeyhunters360*.

Three hundred feet in the air, Mauli Dhan dangles on a bamboo rope ladder, surveying the section of granite he must climb to reach his goal: a pulsing mass of thousands of Himalayan giant honeybees. They carpet a crescent-shaped hive stretching almost six feet below a granite overhang. The bees are guarding gallons of a sticky, reddish fluid known as mad honey, which, thanks to its hallucinogenic properties, sells on Asian black markets for $60 to $80 a pound—roughly six times the price of regular Nepali honey.

Himalayan honeybees make several types of honey depending on the season and the elevation of the flowers that produce the nectar they eat. The psychotropic effects of the spring honey result from toxins found in the flowers of massive rhododendron trees, whose bright pink, red, and white blossoms bloom each March and April on north-facing hillsides throughout the Hongu Valley. The Kulung people of eastern Nepal have used the honey for centuries as a cough syrup and an antiseptic, and the beeswax has found its way into workshops in the alleys of Kathmandu, where it is used to cast bronze statues of gods and goddesses.

BEN KNIGHT

Face stung and body spent after a hunt, Mauli rests. He doesn't see his work as remarkable; he does it because he was chosen to carry out the harvest – the Kulung believe – by a spirit that came in a dream. "I'm nothing," he says, "just a statue made of clay."

For Mauli, honey hunting is the only way to earn the cash he needs to buy the few staples he can't produce himself, including salt and cooking oil. But no matter how important the money is to him and to others in his village far below, Mauli believes it is time to stop doing this. At 57 he is too old to be attempting this dangerous, seasonal honey harvest. His arms grow tired as the ladder swings in space. Bees buzz around him, stinging him on his face, neck, hands, bare feet, and through his clothes.

But he pushes aside such thoughts and focuses on the problem at hand. He swings his leg over to the rock face and steps onto a small ledge, barely the width of a brick. Letting go of the rope ladder, he shuffles sideways to make room for Asdhan Kulung, his assistant, to join him. Now both men share the narrow ledge. Far below, Mauli can see the river, swollen with monsoonal runoff, cascading down a V-shaped valley.

With each move toward the hive, the holds get smaller and farther apart. He moves slowly but with confidence until only 10 feet separate him from his quarry. This final section of loose, wet rock offers hand- and footholds no bigger than Mauli's fingertips, and since he is not attached to a safety rope, it would be certain death should he lose his grip. Adding to his challenge, he carries a 25-foot bamboo pole hooked over one shoulder, and he pinches a bundle of smoldering grass between the thumb and forefinger of his right hand. A wispy trail of smoke drifts upward from his hand toward the agitated bees. If air currents cooperate, the smoke may engulf the bees and confuse them slightly as he approaches.

The hive pulses like a subwoofer, each beat sending waves of angry bees into the air. They continue to swarm Mauli, but he doesn't flinch. Instead he murmurs a Kulung mantra meant to appease the bees and the spirits that inhabit this cliff: "You are Rangkemi. You are of the bee spirits. We are not thieves. We are not bandits. We are with our ancestors. Please fly. Please leave."

Rangkemi, the guardian spirit of bees and of difficult, dangerous places, has always looked after Mauli, and there is no reason to believe he will abandon him now. With this knowledge in his heart, Mauli shows no fear as he commits to the most difficult part of the climb.

FOR CENTURIES THE KULUNG PEOPLE have remained separate from the outside world thanks to the dense jungle surrounding their home in a deep gorge carved by the Hongu River. Although Mount Everest is just one valley to the north of these Himalayan foothills, the area remains isolated and remote. Much of it is still a mystery, even to wide-ranging Kulung hunters such as Mauli.

But every year the outside world gets closer.

A dirt road has been cut to within a couple days' march of his village, Saddi, and work has begun on a tourist trekking route that will penetrate into the upper reaches of the valley, connecting Saddi and its sister villages to a popular trekking area just over a pass from the well-known circuits of the Khumbu region. A politician has promised to build a small airport in the area.

Kulung elders like Mauli still refer to Kathmandu as "Nepal," a place apart from where they live. In their minds the capital is a foreign country, a distant neighbor of their own tiny realm. But the world around them is changing so fast that the boundaries—and the magic—that have long defined this ancient community are beginning to fade away.

MAULI SITS BESIDE THE FIRE PIT in his ramshackle, one-room home. The mud walls, riddled with cracks from the 7.8 magnitude earthquake of April 2015, look as if they could cave in at any moment. Most homes visible from his doorway have bright blue metal roofs, but his is made of thatched grass, a sign of his poverty. He may be the only one of the small band of hunters allowed to actually rip hives from the rock walls with his own two hands—but clearly the honor does not convey a great deal of cash.

It's been 42 years since Mauli had the dream that put him on this path. It came when he was 15, the night after he assisted his father with a honey harvest for the first time.

"I saw two beautiful women," he recalls. "Suddenly I found myself trapped in a spiderweb on the side of a cliff. I was struggling to get free when I saw a large white monkey above me. It dropped its tail down, and the women helped me grab it. Then the monkey lifted me up, and I escaped."

The elders, one of them his father, told him that the monkey was Rangkemi, the guardian spirit of bees and monkeys—a sometimes wrathful energy that inhabits dangerous places where few humans dare to go. They assured him that he would be guaranteed safe passage onto the cliffs, that the spirit would not retaliate against him and his family when he took the precious honey. On that day Mauli shouldered the rare and difficult burden of a honey hunter. In the decades since, he has risked his life every spring and fall to harvest the sweet, mind-bending substance from the same cliffs his father harvested a generation ago.

Mauli was born under the light of a bamboo torch across the valley in the village of Chheskam. It had no formal school, and his classroom was the steep hillside terraces where he spent his youth cutting grass and farming. Poverty and isolation mean early death for many Kulung. Mauli had four brothers, but two of them died; he has been married and widowed three times, leaving him alone to care for his four daughters, two sons, five grandchildren, and the few other relatives who scurry in and out of his hut at all hours.

As we sit beside the fire pit, Mauli reaches into the hip pocket of his rough wool jacket, grabs a pinch of homegrown tobacco, and deftly rolls it into a scrap of dried corn husk. He shoves the stubby cigarette into the coals and brings it to his lips. As he exhales, his cloudy, bloodshot eyes reveal the soul of a man who is worn out. "I'm tired, and I don't want to do it anymore," he says. "The

Society Grant Your National Geographic Society membership helped fund this project.

MAP: RILEY D. CHAMPINE, NGM STAFF
SOURCES: HUMANITARIAN DATA EXCHANGE; USGS; NASA

only reason I still do is because I'm poor, and no one else will do it."

One of Mauli's nephews sits on the only furniture in the dark room, a wooden trunk wedged in a corner. His hair is spiked at wild angles, accenting his tight jeans and black T-shirt. A large fake-gold medallion hangs around his neck. He has no interest in following his uncle up the cliff faces.

As for his sons, Mauli won't let them harvest the honey. "People who climb cliffs are idiots," he says. "My kids go to school so they won't have to do it."

The obvious person to take over as the head honey hunter is his assistant Asdhan, who is wiry and strong, in his early 40s, and a community leader. He and Mauli have worked together on the cliffs for some 15 years, but in all that time Asdhan has never had the dream and, adhering to Kulung tradition, has never led the harvest or touched the precious honeycomb before it is separated from the cliff.

"Yeah, I'd like to have the dream," Asdhan says, "but I haven't, and I don't know why. Of course I could harvest the honey. But other people have tried without the dream, and bad things have happened to them. Their fathers have died, their children have died, their houses have fallen in, and their crops have failed. And I'm afraid of that."

AT DAWN, AS IS THE CUSTOM during the harvest, we follow a shaman deep into the jungle to a tiny clearing from where we can see the honey cliffs. There are 10 of us, including Mauli and his band. The shaman walks around the clearing, driving bamboo stakes into the ground and wrapping a long piece of twine around them to form an enclosure. He hangs bits of meat and other food from the twine and burns incense made of cotton soaked in butter. Its pungent smoke wafts through the air. Once the ceremony begins, says the shaman, we must remain in this sacred enclosure for our own safety.

In one corner the shaman carefully builds a pair of altars from banana leaves. One is for Rangkemi; the other is for his companion, the forest spirit Baneskandi. The altars are provisioned with dried beans, corn, and rice.

HONEYMAKERS
The Himalayan giant honeybee – the world's largest honeymaker – is a subspecies of *Apis dorsata* (top). Only four of the seven species of honeybees are kept commercially. Dwarf and giant honeybees practice open-air nesting, making it difficult to keep them in man-made hives.

*WORKER BEES. ALBERTO LUCAS LÓPEZ, NGM STAFF; KELSEY NOWAKOWSKI
SOURCES: NOAH WILSON-RICH, THE BEST BEES COMPANY; MICHAEL S. ENGEL, UNIVERSITY OF KANSAS

Although only Mauli removes honey from the rock, team members haul equipment through the jungle to hive locations. Sancha Kulung is a rope carrier; here he hefts Mauli's 120-pound ladder across a bamboo bridge built hastily to replace one swept away by a river swollen with monsoon rains.

The key to confronting agitated bees, Mauli says, is to show no fear. Still he winces with pain from the 20 to 40 stings he sustains on each hunt – and at the way his support rope digs at his underarms as he inches his way up. Chunks of the hive he has cut from the rock travel to the ground in a bucket.

After a hunt, team members relax with their spoils: eight hives of honey. They'll process most of it into wax to be sold in Kathmandu. The harvest is a team effort – to a point. Only Mauli can cut the hives off the cliffs. Because he's the last honey hunter who's had "the dream," this ancient tradition may not survive.

The honey's psychotropic effects result from toxins in the flowers of the massive rhododendron trees on the north-facing hillsides.

Rangkemi's also includes a bottle of Johnnie Walker Red Label whisky.

The ceremony begins. The tiny circle is crowded with us, the altars, and two bamboo baskets, each containing a cackling chicken. Mauli kneels before the altars, head bowed, his hands on his thighs. The shaman has donned a vest made of stinging nettles and has wound a colorful sash around his waist. He dances among us, chanting in a tongue known only to him and the forest spirits that he beckons to our enclosure. In one hand he holds a bamboo wand, in the other a gourd filled with water. He continuously dips the wand into the gourd and flings the water onto our heads.

The shaman grabs a chicken and in one smooth motion slices off its head with a knife. Everyone is splattered with blood. He carefully places the lifeless head at Rangkemi's altar and rubs some of the blood onto Mauli's forehead. The headless chicken thrashes at our feet. "DO NOT leave the enclosure," commands the shaman.

As if on cue, several honeybees land on the altar. Inexplicably the camera our documentary team is using to film the ceremony shuts off and won't restart. One of our team members looks at his altimeter watch, which shows the barometric pressure spiking, indicating clear weather. But instead it starts to rain.

The shaman snatches something invisible out of the air in front of him, brings his hand to his mouth, and chants into his closed fist. He opens his hand, flinging the invisible object back into the thick jungle that surrounds us.

The ceremony ends, and as soon as we leave the enclosure, the camera starts working again. The barometric pressure drops, signaling bad weather, but instead a ray of sun breaks through the clouds. The shaman plops down on a rock next to Mauli and opens the bottle of Johnnie Walker. The others begin to pluck the dead chicken.

BACK IN SADDI, Jangi Kulung beckons me into his home to show off the new, 300-foot rope ladder that he and the rest of Mauli's helpers have spent the past two weeks weaving from hundreds of long, thin strips of bamboo. Jangi is the keeper of the tools and, for the past 18 years, the brains behind the honey harvest. With his massive potbelly and sausage-like fingers, he stands out from the other honey hunters, who are all wiry and thin.

Jangi is a born dealmaker, possessing the ruthless savvy necessary to get permission for the harvests from the local forest committees, and the contacts to sell the honey and beeswax in distant markets in Kathmandu and beyond. He trades other goods as well, sending his team of mules loaded with heavy bags of sweet-scented black cardamom to the new dirt road—a rugged two-day trek away—to meet other traders and bring back batteries, instant noodles, cooking oil, and beer. Jangi can read, unlike many in the village, and does his own accounting. He rations the pay for the eight other members of the honey-hunting team—all his cousins—according to their duties and experience. Mauli makes the most, about a hundred dollars for three days of death-defying work, twice a year. No one in Saddi knows how much Jangi earns from the harvest, and he won't tell me, but he is the only person in the village who owns a house in Kathmandu.

For many years the trade in mad honey centered on a single trader in Kathmandu who had a buyer in South Korea, where some people believed it improved sexual performance. "For a long time we could basically name our price," Jangi says. "Then someone in Korea ate too much and died." The death is rumored and not proven, but the incident killed the Korean market and drastically reduced the price of the honey. One has to be careful not to eat too much of

the honey, says Jangi. Two to three teaspoons is usually the correct dose. After about an hour you are overcome with an urgent need to defecate, urinate, and vomit. "After the purge you alternate between light and dark. You can see, and then you can't see," says Jangi. "A sound—*jam jam jam*—pulses in your head, like the beehive. You can't move, but you're still completely lucid. The paralysis lasts for a day or so."

"I will give you some honey," he says, "and you can try it for yourself."

THE HONEY HUNTERS are sitting on benches around a long wooden table while hailstones pummel the tin roof above them. The sound is deafening but not loud enough to drown out their animated voices as they argue about whether they will leave for the honey harvest in the morning or cancel. A battered jug of *raksi,* a clear, millet-based alcohol that tastes like Japanese sake, makes the rounds.

The next morning it's still raining. The deluge overnight has started a landslide across the river. Through breaks in the fog, we watch refrigerator-size boulders crash down the hills to the river. The honey hunters gather to talk. The approach to the honey cliff—a steep and exposed climb up a grassy slope and moss-covered rock—would be suicidal in these conditions. Perhaps Rangkemi has spoken. The honey hunters find a jug of raksi and pick up where they left off the night before. It's 7 a.m.

A few hours later Mauli, reeking of raksi, is making his impossible climb in the rain as large, angry honeybees swarm and sting his face.

By whatever force—his skill or perhaps Rangkemi's benevolence—Mauli, now obscured on the cliff face in a dense cloud of bees, makes it across to the hive. He carefully places his bundle of smoldering grass on a tiny ledge and wipes the bees off the hive with his bare hands. The swarm falls, almost as if it is a single being, and becomes a stinging, writhing fog.

Mauli pokes two wooden pegs through the comb and fixes them to a thin bamboo rope that has been lowered from above by helpers. He pulls the long bamboo pole off his shoulder and presses its sharpened end against the comb and begins sawing it from the rock.

After a few minutes the hive breaks free and swings on the rope, just missing Mauli. He cries out, the first loud noise he has made since he left the village hours before. The two men tending the fire at the foot of the cliff cover their heads as a gooey dark rain and a black hail of dead bees fall upon them.

MAULI'S SON SITS alongside a small river at the base of the cliff, waiting to help carry loads of honey, wax, and tools back to the village. The honey hunters appear in the mist—wet, exhausted, swollen. As Asdhan carefully pulls a few remaining stingers out of Mauli's face, his son pulls out a phone and takes photo after photo. He has a Facebook page; later he may post a shot.

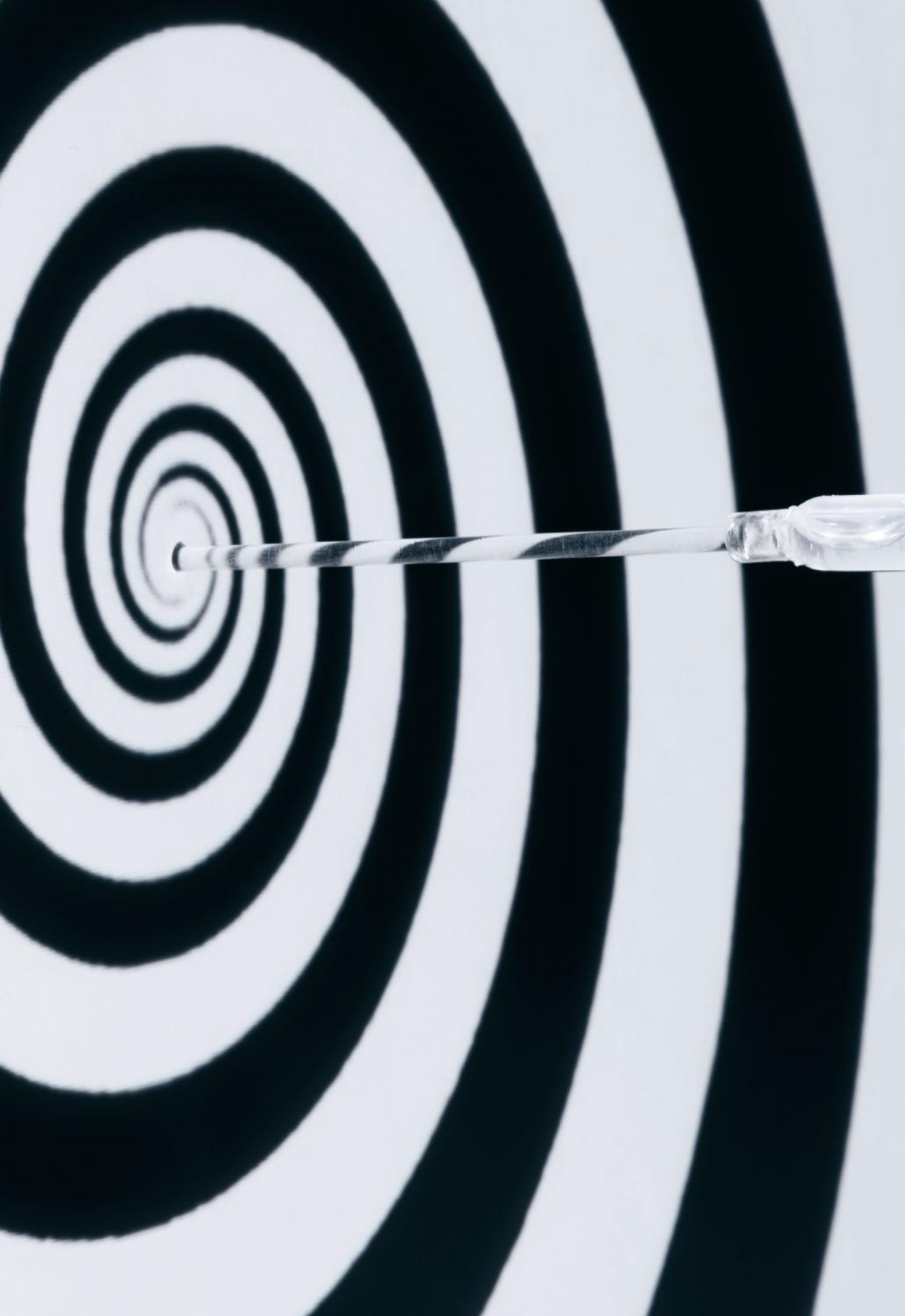
As with much of rural Nepal, there is cell reception. All the teenagers in Saddi know when to gather on the appropriate rock so that they can catch a weak 3G signal with their inexpensive Chinese smartphones. These portals to a separate reality, which exists far from the fields in which their parents toil, have instilled in them a desire to see the world and to earn wages.

"Children these days don't value the culture," Mauli says. "If this continues, our culture is going to disappear." The elders know it's the reason no one has had the dream—or if they have, why they won't admit it.

As the loads of honey and wax are distributed, the never-ending bottle of raksi again makes the rounds. No one mentions what we're all thinking: that we've likely witnessed Mauli's last honey hunt, the end of an era.

Mauli puts the jug to his lips and drinks deeply. He takes one last look at the cliff, shoulders his bamboo pole, and moves silently up the trail toward home. One by one the other honey hunters, like worker bees following their queen, fall in behind. □

Mark Synnott wrote about Uzbekistan's Dark Star cave system in March 2017. **Renan Ozturk** was part of an expedition in Myanmar in "Point of No Return," published in our September 2015 issue.



A captive Anna's hummingbird feeds while hovering before an optical illusion in a reenactment of an experiment that illustrates just how heavily hummingbird flight depends on the bird's visual perceptions. When this spiral rotates to create the illusion that the bird is moving forward, the bird shifts into "reverse gear" – and its beak slips out of the feeder.

SOURCES: BENNY GOLLER AND DOUG ALTSHULER, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

Flight School

They move so fast that human eyes see only a hovering spot of color, a blur of wings. But when frozen in time by high-speed cameras, hummingbirds yield their secrets.

Sight for flight

By tracking the trajectory and speed of this Anna's hummingbird when it flies in front of different background patterns and colors projected in this tunnel, researchers at the University of British Columbia, Vancouver, hope to learn more about how hummingbirds process the world whizzing by. It's thought that birds in general may monitor the height of objects looming in their visual field, such as these horizontal bars, to avoid midair collisions.

SOURCES: ROSLYN DAKIN AND DOUG ALTSHULER

By Brendan Borrell
Photographs by Anand Varma

In pursuit of the world's smallest bird, we've come to the backyard of a flamingo pink house in Palpite, Cuba. Ornithologist Christopher Clark has a car full of gear to unload: cameras, sound equipment, a sheer cube-shaped cage. Within minutes of arriving this May morning, Clark is spinning around in circles. He's trying to follow the path of a bullet with wings as it whizzes from one clump of orange fire bush blossoms to the next. When the hummingbird pauses to draw sugary fuel from the flowers, his wings continue to beat a grayish blur too fast for the human eye to resolve.

Even by the Lilliputian standards of hummingbirds, Cuba's bee hummingbird *(Mellisuga helenae)* is a midget—literally the smallest bird in the world. Its iridescent green body weighs a bit more than the average almond. Locally it's known as *zunzuncito*—the little buzz-buzz, after the sound it makes—and is even smaller than its cousin the *zunzun,* or emerald hummingbird.

What this bird lacks in size, he makes up for in enthusiasm when he spots a visitor in his territory. She's a comely female, contained by the sheer cage that Clark brought and has placed on a corrugated metal roof. If the male notices this female's enclosure, it doesn't dampen his ardor. He helicopters up from his perch on a branch, hovers in the air, and lets out a trill in her direction.

He climbs higher, until he's a pinprick against the cloudy sky. Then, like a roller coaster that's reached its apex, he pitches forward and whooshes toward the ground. In an instant the daredevil is doing it all over again: climb, dive, and swoop. These plunges last a mere second. Then he vanishes, and the only trace of his passage is the leaves trembling in his wake.

Though I stared intently at the courtship show, I did not see it.

Neither did Clark, but he did something better. He recorded the display with a high-speed camera

For a study of male Cuba's bee hummingbirds' mating displays, scientists captured the birds to get body weight and wing measurements (above). This one stayed still on the scale because hummingbirds are temporarily disoriented when flipped on their backs – but within moments of being restored to their feet, they're again zipping around. No birds were harmed in making these images.

SOURCE: CHRISTOPHER CLARK, UC RIVERSIDE

VIDEO

See video of these hummingbirds in motion at *ngm.com/Jul2017.*

that slices each second of it into 500 frames. After Clark downloads video of the dive—the first ever recorded of this species at that high camera speed—he shows the footage to me on his laptop, clicking through every hard-won frame. Only then do we see the breathtaking maneuvers that the hummingbird's speed had concealed.

For the past eight years, Clark has traveled from the Arizona desert to the Ecuadorian rain forest to rural Cuba, recording hummingbird courtship displays. Back in his lab at the University of California, Riverside, the professor examines the videos for what they reveal about hummingbird flight. His findings could contribute to our understanding of animal flight in general and hummingbird mating systems in particular.

With their rocketing movements and jewel-like plumage, hummingbirds seem like a hybrid of flesh, feather, and fireworks. The wings of some species flap up to a hundred times per second. Their heart rate can exceed a thousand beats per minute, and they gulp nectar with a near-invisible flick of the tongue. In gardens or at backyard feeders, they're the definition of fleeting beauty. So who could resist the temptation to slow their motion, to dissect their movements—to inhabit, even briefly, the hummingbird's world?

HUMMINGBIRDS LIVE EXCLUSIVELY in the Americas. From southern Alaska to Tierra del

A flip of the wing

Most birds produce substantial upward force – aka lift force – only with the downward flap of their wings. The secret to the hummingbird's hovering ability lies in the near symmetry of its wing motion, which allows it to produce lift during the upstroke as well as the downstroke. By filling the air with a fine mist using an ultrasonic fogger, researchers can observe the tornado-like vortices that this Anna's hummingbird sheds at the end of each half-stroke – when its wings flip more than 90 degrees and reverse course.

SOURCES: VICTOR ORTEGA-JIMENEZ AND ROBERT DUDLEY, UC BERKELEY; DOUG ALTSHULER, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

Full speed ahead

Letting hummingbirds loose in wind tunnels allows researchers to probe the mechanics of flight at airspeeds of up to 35 miles an hour. This black-chinned hummingbird at the University of California, Riverside is part of an experiment testing whether aerial mating displays are a good representation of a bird's physical abilities. In other words: Do the male birds that perform the most acrobatic dives to impress females also possess the ability to fly the fastest? For this photograph a fog of water vapor was added to make the wind movement visible.

SOURCES: SEAN WILCOX AND CHRISTOPHER CLARK

Fuego, there are about 340 recognized species. Of these, 27—including the seemingly ubiquitous ruby-throated hummingbird—have been sighted in the United States. The center of hummingbird diversity is in the northern Andes, where 290 species reside in lowland rain forests, mountaintop cloud forests, and every ecosystem in between. The smallest can weigh less than two grams. The largest, the giant hummingbird found in Peru and Chile, tips the scales at around 20 grams. You could send something that weight in the U.S. mail with a single first-class stamp.

World's smallest birds is just one of several distinctions that hummingbird species claim. They're the only birds that can hover in still air for 30 seconds or more. They're the only birds with a "reverse gear"—that is, they can truly fly backward. And they're the record holders for the fastest metabolic rate of any vertebrate on the planet: A 2013 University of Toronto study concluded that if hummingbirds were the size of an average human, they'd need to drink more than one 12-ounce can of soda for every minute they're hovering, because they burn sugar so fast. Small wonder that these birds will wage aerial dogfights to control a prime patch of nectar-laden flowers.

The tongue that sips from those flowers is a specialized organ, nearly transparent, and made up of two tubes rolled up like sheets of cellophane. As the bird drinks, its tongue flicks about rapidly, and as English naturalist William Charles Linnaeus Martin noted in 1852, the liquid "disappears very fast, perhaps by capillary attraction."

When Alejandro Rico-Guevara, a postdoctoral researcher at the University of California, Berkeley, made high-speed films of hummingbirds drinking from feeders and flowers, he found that their forked tongues are more like a catcher's mitt than like rigid drinking straws. Each tube of the tongue unfurls to snatch the nectar in a hundredth of a second. Then the birds pump the liquid into their gullets by squeezing their beaks. What a 19th-century scientist could only guess at, a 21st-century camera showed in minute detail.

■ **Society Grant** Your National Geographic Society membership helped fund this photographic coverage.

Tongue twister

The forked tongue of this Anna's hummingbird can be seen through the glass vessel from which it's drinking artificial nectar. To fuel their energetic flight, hummingbirds may consume more than the equivalent of their body weight in nectar each day, via a tongue that makes a sipping motion up to 15 times a second. To keep the birds healthy in captivity, the artificial nectar they're fed contains protein powder and other nutrients, seen here as white specks.

THE FIRST ATTEMPT to analyze hummingbird flight is believed to have occurred in Nazi Germany in the late 1930s. With support from the Reich Office for Educational Film, two German ornithologists secured a camera capable of recording 1,500 frames a second from a military research institute. With it, they filmed two South American hummingbird species at Zoo Berlin. "The regime was developing the first helicopters," says Karl Schuchmann, former curator of birds at the Alexander Koenig Zoological Research Museum in Bonn. "They wanted to know how birds could hover on the spot."

The images showed hummingbirds to be more like bees or flies than like other birds, in that they generate lift on both the downstroke and the upstroke of their wings. When the ornithologists published their paper in 1939, they compared hummingbirds to the German Focke-Wulf helicopter.

In the United States, Crawford Greenewalt had served science on the opposite side of the war effort: He was an engineer with the Manhattan Project, the U.S.-led program that produced the first nuclear weapons. A dozen years after the German ornithologists published, Greenewalt picked up the thread of their investigation. His wife, Margaretta, had become interested in bird-watching at their home in Delaware, and from her Greenewalt caught what he called "hummingbird fever." His hummingbird photographs were first published in the November 1960 issue of *National Geographic*.

Dissatisfied with the high-speed motion picture cameras then available, Greenewalt built

SOURCE: ALEJANDRO RICO-GUEVARA, UC BERKELEY

his own. He filmed the flight of hummingbirds inside a homemade wind tunnel, capturing them at speeds up to 27 miles an hour. As the birds accelerated from a hovering position, Greenewalt documented the plane of their wings tilting from horizontal to vertical, redirecting their thrust.

The new images were groundbreaking, but they didn't solve the mystery of how hummingbirds can flap their wings as quickly as they do. Typically, the faster a muscle contracts, the less force it generates. So how do hummingbirds produce enough force to stay aloft?

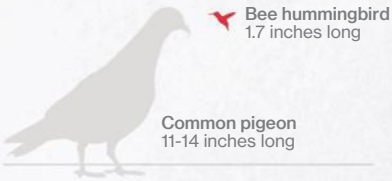
In 2011 Tyson Hedrick and his colleagues jury-rigged a way to answer that question. A University of North Carolina at Chapel Hill researcher who specializes in animal biomechanics, Hedrick knew that hummingbird wings are different from those of their closest relatives, the swifts. Hummingbird arm bones are relatively smaller, and most of the wing is made up of the equivalent of hand bones. To get a penetrating view of the wing moving at top speed, Hedrick coupled a camera that shoots a thousand frames per second with an x-ray imaging system.

When Hedrick viewed the frames in sequence, infinitesimal movements of the wing bones merged into patterns, then continuous motion, and the wing's operation could be seen. Rather than flapping with an up-and-down motion of the shoulder, Hedrick discovered, hummingbirds flap with a twist. This modification gives them what amounts to a "high gear," so that a millimeter-length muscle movement is enough to drive their wings across a wide arc.

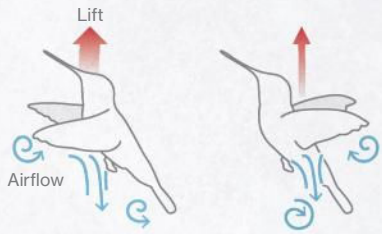
Once, high-speed cameras were ungainly contraptions, difficult to operate and lug into the field. Now they can fit in a large pocket and are as essential to hummingbird biologists as binoculars are. The sheer magnitude of information captured by these cameras can be hard to fathom. To put Clark's 500-frames-per-second videos in perspective, consider this: At the typical frames-per-second rate of a theatrical movie—let's say, the 1939 classic *Gone With the Wind*—500 frames is roughly what it took for Scarlett O'Hara to run down the staircase, tearfully plead, "Rhett, Rhett! If you go, where shall I go? What shall I do?" and

Majesty in Miniature

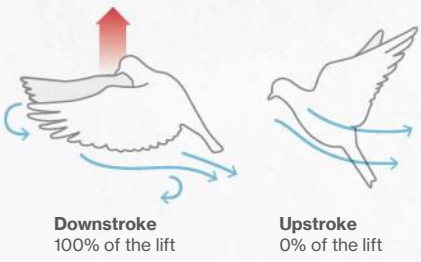
Unlike other birds, such as pigeons, a hummingbird can fly in multiple directions, including backward and sideways. Its wings can beat up to a hundred times per second. Its brain, at 4.2 percent of body weight, is proportionally one of the largest in the animal kingdom.



Hovering hummingbirds
Hummingbirds produce lift with both upward and downward wing strokes, creating vortices that help with hovering and maneuverability.



Forward-flying pigeons
Larger birds such as pigeons use wing downstrokes to push air jets down and behind them, propelling them forward.



Motion detection
The motion-sensing lentiformis mesencephali (LM), larger than in other species, is believed to help with stabilization while hovering.

Sharp memory
Thanks to a large hippocampus, a hummingbird remembers the location of flowers in its territory and knows when they'll refill with nectar.

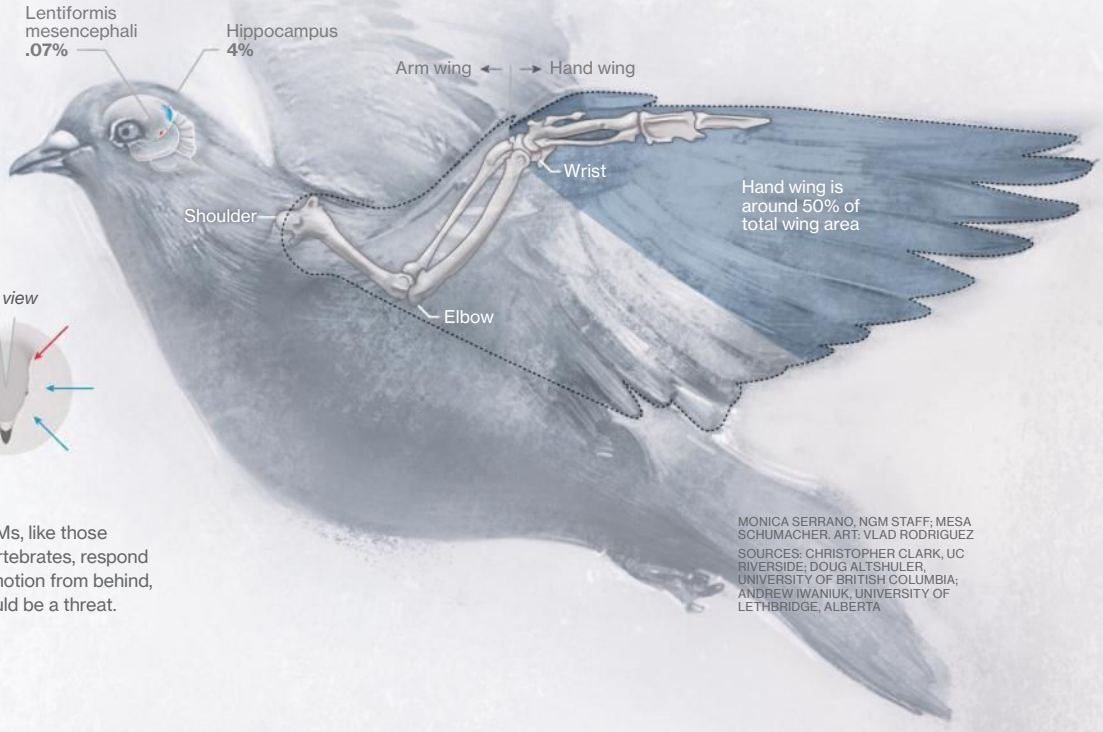
Powerful wrists
A hummingbird's small arm wing allows wrist motion to control a larger area of the wing, leading to a more powerful upstroke.

top view

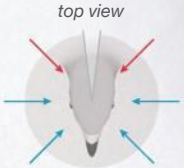
Their larger LM allows hummingbirds to respond with more sensitivity to motion from all directions.

A hovering hummingbird rotates its wings between the upstrokes and downstrokes, making a **figure eight** motion.

Actual size



top view



Pigeons' LMs, like those of most vertebrates, respond mainly to motion from behind, since it could be a threat.

MONICA SERRANO, NGM STAFF; MESA SCHUMACHER. ART: VLAD RODRIGUEZ

SOURCES: CHRISTOPHER CLARK, UC RIVERSIDE; DOUG ALTSHULER, UNIVERSITY OF BRITISH COLUMBIA; ANDREW IWANIUK, UNIVERSITY OF LETHBRIDGE, ALBERTA

Shaking off the rain

Hummingbirds often brave downpours to gather the nectar needed to avoid starvation. This Anna's hummingbird shakes off rain as a wet dog does, with an oscillation of its head and body. According to researchers at UC Berkeley, each twist lasts four-hundredths of a second and subjects the bird's head to 34 times the force of gravity. Even more remarkable: Hummingbirds can do this in flight as well as when perched.

SOURCES: VICTOR ORTEGA-JIMENEZ AND ROBERT DUDLEY

Aerial obstacle course

In dense vegetation, hummingbirds must dodge and weave around branches and vines. Marc Badger of UC Berkeley elicits such acrobatics in the lab by having birds fly through small apertures, a situation the photographer re-created here. To slip through an oval-shaped hole, this Anna's hummingbird performs a sideways shimmy, altering its wing strokes to avoid contact with the divider. To capture the action in a single frame, a strobe light flashed three times during a 0.4-second exposure.

SOURCE: ROBERT DUDLEY

for Rhett Butler to answer, "Frankly, my dear, I don't give a damn," walk out the door, and disappear into the fog.

BY SLOWING DOWN TIME, scientists learn more about what happens when biology brushes up against the laws of physics. "There's stuff that you absolutely do not see with the naked eye," Clark says. "Put a high-speed camera on it, and you're like, 'Holy cow! That's what the bird's doing?'"

When some species spread their tails during 60-mile-an-hour dives, he says, there's a chirping sound—not from their vocal cords but from the fluttering of tail feathers as air rushes through. In courtship displays some hummingbird species almost double their wingbeat frequency; others flap with a single wing. And when the Anna's hummingbird pulls up after a stunt, it is subjected to roughly nine times the force of gravity—enough that a human fighter pilot, even one wearing a specialized G suit, could pass out.

"Hummingbirds can do extraordinary things using the same building blocks found in ordinary birds," says Doug Altshuler, a comparative physiologist at the University of British Columbia in Vancouver. So studying their lives can tell us a great deal about general principles of biology.

On a summer morning a red glow emerges from a doorway of a room that Altshuler has taken to calling Hell. His postdoctoral research colleague, Roslyn Dakin, greets us with a sheen of sweat on her forehead. The sauna-like atmosphere is generated by six LCD projectors beaming vertical stripes onto the walls of a tunnel that runs the length of the room. Inside that tunnel sits a male Anna's hummingbird, watched from above by a panopticon of eight cameras.

Dakin is trying to figure out how the birds control their flight. Previous researchers theorized that flying animals have a cruise control circuit in their brains to balance movement across their field of vision. Bees do this. We do it too. When you're driving along a wide, open highway, it feels natural to be going 70 miles an hour, but if you're on a country road lined with trees, you'll probably tap on the brakes.

Hummingbirds apparently operate under a different set of rules. In one of Dakin's experiments, she has them flying through what's essentially a visual treadmill. Surprisingly, they fly just as fast when vertical stripes are moving with their direction of motion as against it.

At the moment we're watching a green dot jiggle around on the screen, an indicator that the hummingbird is sitting in the dark, doing practically nothing. Periodically, he lurches halfway down the tunnel but then boomerangs back to his perch. "It's really annoying when they don't do exactly what you want them to do," she says—"which is most of the time."

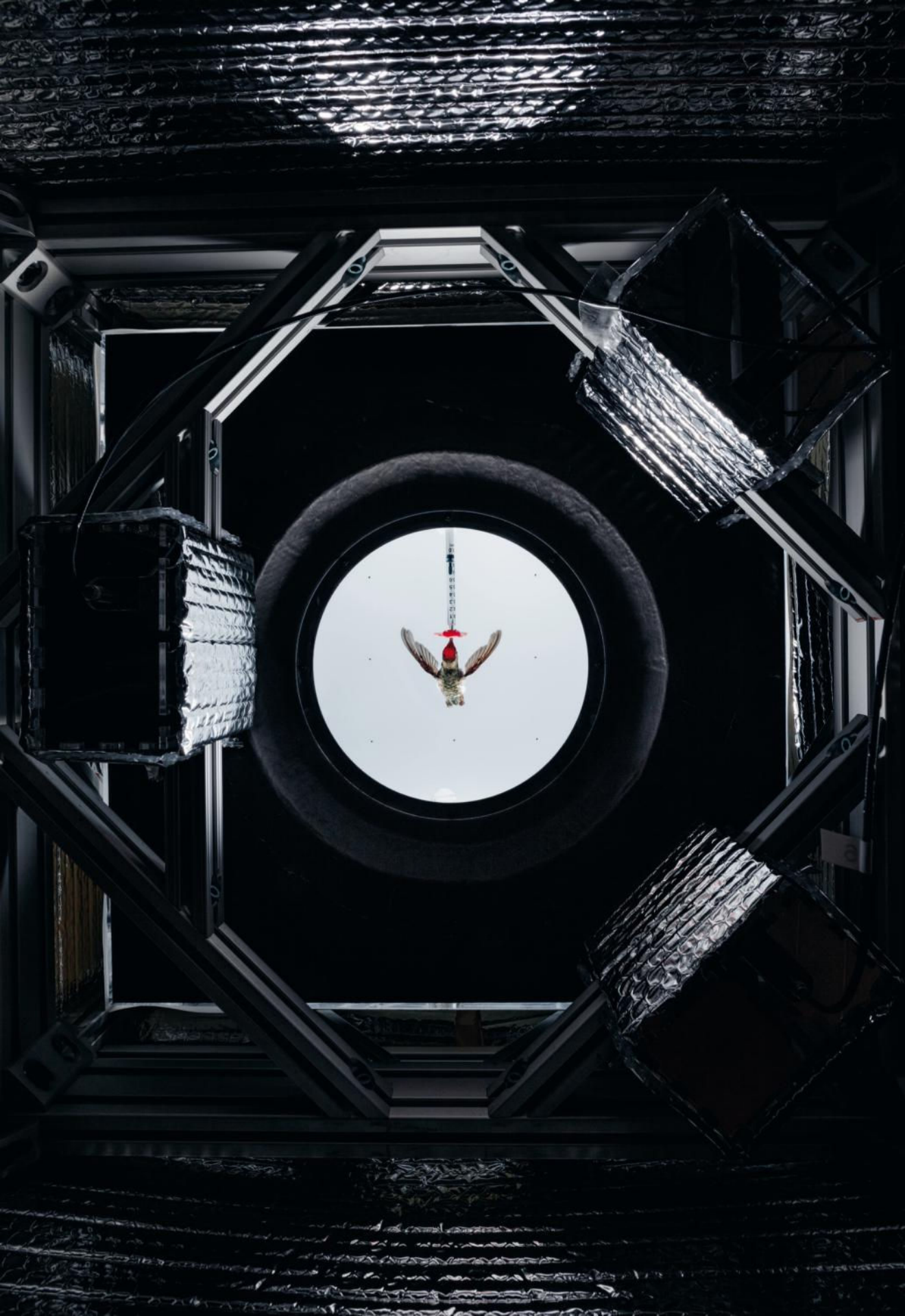
Dakin is convinced that hummingbirds have an instinctual wariness of larger shapes that helps them avoid collisions. Today she's playing around with projecting more complicated patterns—including what looks, to my eyes, like Elvis Presley's hair but is actually supposed to be a flower. To test this, she needs the bird to fly the length of the tunnel, which he is stubbornly refusing to do.

Suddenly he lets out a chirp, and I watch the green dot flit down the tunnel, pause at the feeder, and return. Dakin perks up; the day might not be a bust after all. She types a code for this data entry into her computer's command prompt and hits enter. On the screen thousands of coordinates coalesce into a rainbow-colored piece of tinsel—a three-dimensional summary of 15 long seconds in the fast life of a hummingbird. □

The force of flapping

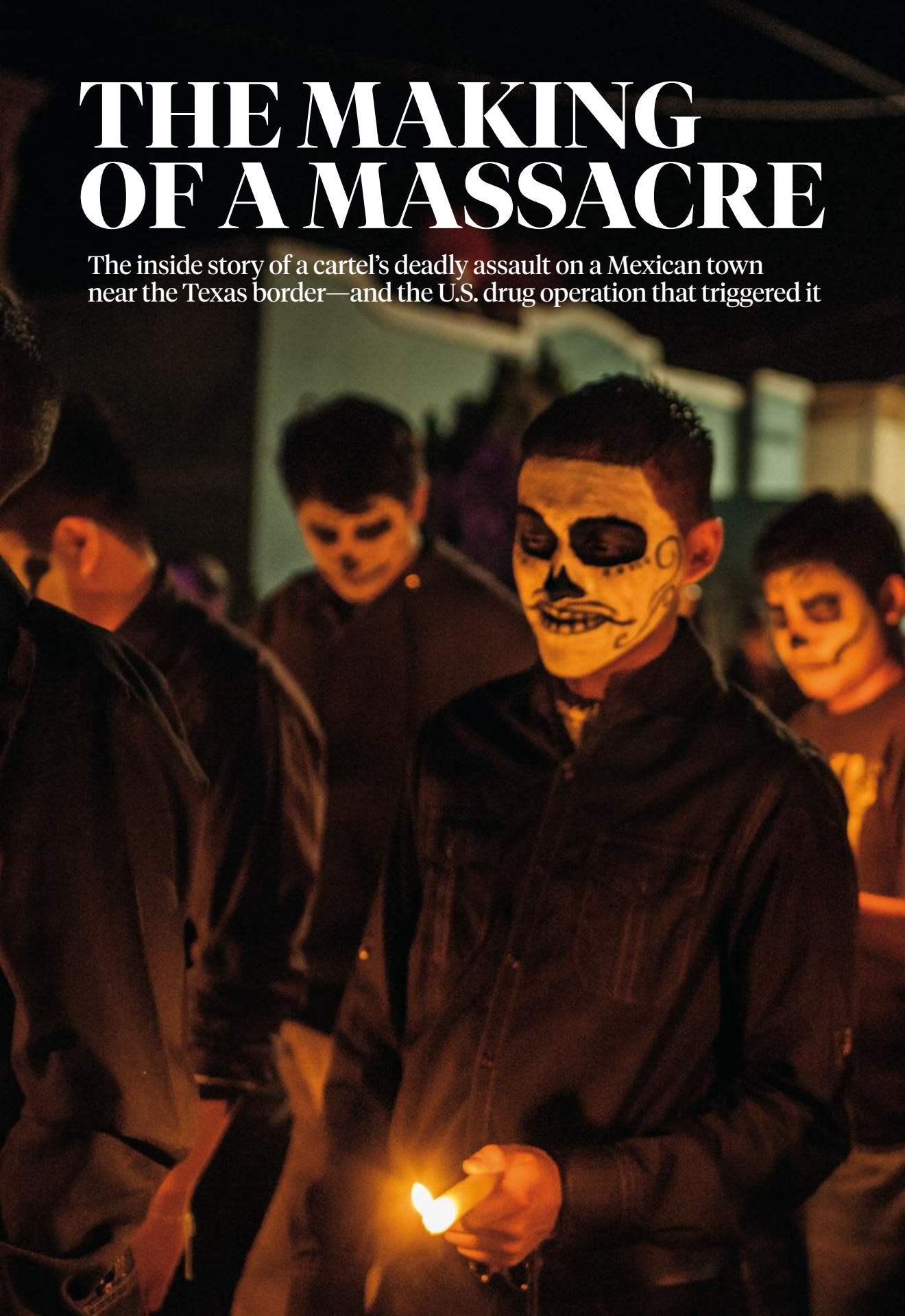
An Anna's hummingbird hovers inside a special chamber at Stanford University that can instantaneously record the tiny wave of pressure generated with every wingbeat. Before Rivers Ingersoll and David Lentink designed this device, researchers had to use theories of aerodynamics to estimate the forces produced by freely flying animals.

Once a nascent field biologist, **Brendan Borrell** is a freelance writer and a correspondent for *Outside Magazine.* **Anand Varma** is an award-winning photographer and a National Geographic Emerging Explorer.



THE MAKING OF A MASSACRE

The inside story of a cartel's deadly assault on a Mexican town near the Texas border—and the U.S. drug operation that triggered it



In 2011 the Zetas cartel, seeking revenge against members believed to be informants, rampaged through Allende and neighboring towns, killing at least 60 people. For this stricken community, the Day of the Dead holiday, when Mexicans honor their ancestors, has taken on extra poignancy.

In their murderous assault, the Zetas rounded up men, women, and children who had nothing to do with the betrayal that sparked the cartel's wrath. Among the dead was Edgar Ávila, who had gone out to watch a soccer game with a friend. He is pictured with his wife, María Eugenia Vela, and their daughter.

By Ginger Thompson
Photographs by Kirsten Luce

There's no missing the signs that something unspeakable happened in Allende. Entire blocks lie in ruins. Once garish mansions are now crumbling shells, with gaping holes in the walls, charred ceilings, cracked marble countertops, and toppled columns. Strewn among the rubble are tattered, mud-covered remnants of lives torn apart: shoes, wedding invitations, medications, television sets, toys.

In March 2011 the quiet ranching town of about 23,000, just a 40-minute drive from the Texas border, was attacked. Gunmen from the Zetas cartel, one of the most violent drug-trafficking organizations in the world, swept through Allende and nearby towns like a flash flood, demolishing homes and businesses and kidnapping and killing dozens, possibly hundreds, of men, women, and children.

But unlike most places in Mexico that have been ravaged by the drug war, what happened in Allende didn't begin in Mexico. It began in the United States, when the Drug Enforcement Administration scored an unexpected coup. An agent persuaded a high-level Zetas operative to hand over the trackable cell phone identification numbers for two of the cartel's most wanted kingpins, Miguel Ángel Treviño and his brother Omar.

Then the DEA took a gamble. It shared the intelligence with a Mexican police unit that has long had a problem with leaks. Almost immediately, the Treviños learned they'd been betrayed. The brothers set out to exact vengeance against the presumed snitches, their families, and anyone remotely connected to them.

Their savagery in Allende was particularly surprising because the Treviños not only based some operations nearby—moving tens of millions of dollars in drugs and guns through the area each month—they'd also made it their home.

For years after the massacre, Mexican authorities made only desultory efforts to investigate. They erected a monument in Allende to honor

ABOUT THIS STORY

ProPublica, an independent, nonprofit, investigative newsroom, and ***National Geographic*** teamed up on this story. **Ginger Thompson,** a ProPublica senior reporter, spent months researching the massacre, interviewing sources on all sides, and writing the article. **Kirsten Luce** photographed it for *National Geographic.* Additional reporting was done by **Alejandra Xanic,** a freelance journalist in Mexico.

Within view of passersby and not far from the police station, the fire department, and a military outpost, the Zetas demolished houses and businesses in Allende. The man who was mayor during the massacre still lives across the street from this house. He initially reported that he hadn't seen any evidence of violence.

the victims without fully determining their fates. American authorities eventually helped Mexico capture the Treviños but never acknowledged the devastating cost. In Allende, people suffered mostly in silence, too afraid to talk publicly.

A year ago ProPublica and *National Geographic* set out to piece together what happened in this town in the state of Coahuila—to let those who bore the brunt of the attack, and those who played roles in triggering it, tell the story in their own words, often at great personal risk. Voices like these have rarely been heard during the drug war: Local officials who abandoned their posts; families preyed upon by the cartel and their own neighbors; cartel operatives who cooperated with the DEA and saw their friends and families slaughtered; the U.S. prosecutor who oversaw the case; and the DEA agent who led the investigation and who, like most people in this story, has family ties on both sides of the border.

When pressed about his role, the agent, Richard Martinez, slumped in his chair, his eyes welling with tears. "How did I feel about the information being compromised? I'd rather not say, to be honest with you. I'd kind of like to leave it at that. I'd rather not say."

As the massacre unfolded, local police stood by. Years afterward, with top Zetas leaders in prison, officials in Piedras Negras, a town near Allende that was also attacked, fired nearly all the officers on its force, hired new ones, and asked the military to conduct joint patrols to restore public confidence.

THE MASSACRE

As sundown approached on Friday, March 18, 2011, gunmen from the Zetas cartel began pouring into Allende.

Guadalupe García, retired government worker: We were eating at Los Compadres, and two guys came in. We could tell they weren't from here. They looked different. They were kids—18 to 20 years old. They ordered 50 hamburgers to go. That's when we figured something was going on, and we decided we'd better get home.

Martín Márquez, hot dog vendor: Things began happening in the evening. Armed men began arriving. They were going house to house, looking for the people who had done them wrong. At 11 at night there was no traffic on the streets. There was no movement of any kind.

Etelvina Rodríguez, middle school teacher and wife of victim Everardo Elizondo: My husband, Everardo, usually came home between 7 and 7:30 at night. I was waiting for him. Time passed—7, 7:30, 8, 9. I began calling him. The phone was not in service. I thought maybe he was at his mother's house and his battery had died. I called his mother. She told me that she hadn't seen him and that maybe he was out with friends. But that didn't make sense to me. He would have called. So I went out looking for him.

The atmosphere felt tense. It was nine at night, which was not very late, not on a Friday. The town was completely deserted.

Lawlessness was not unfamiliar to people in Allende. Because of its proximity to the U.S. border—residents do their weekend shopping at the mall in Eagle Pass, Texas—there had long been families engaged in smuggling who lived quietly in their communities. But by 2007 the Zetas had moved in, and the region became a haven for all kinds of criminality. Using money and threats, the group took control of entire agencies—local police departments, mayors' offices, even the customs office close to the border.

They embedded themselves in society, marrying into local families or going into business with them. Some locals joined the cartel's ranks, including several members of a prominent clan of ranchers and coal miners, the Garzas.

Now those connections were proving deadly. Among those the Zetas suspected of being a snitch—wrongly, it turns out—was José Luis Garza, Jr., a relatively low-level cartel operative. When the truckloads of gunmen descended on Allende, one of their first destinations was a ranch owned by Garza's father, Luis, a few miles outside of town on a poorly lit two-lane highway. After nightfall, flames began rising from one of the ranch's large cinder-block storage sheds, where the cartel burned bodies of the dead.

Sarah Angelita Lira, pharmacist and wife of victim Rodolfo Garza, Jr.: My husband, Rodolfo, arrived. He told me, "My head is killing me. I'm going to take a shower." He was completely covered in soot because he was opening a new coal mine. After a while his phone started ringing. I thought he had gone to lie down, but he came out of the bedroom, fully dressed, and he looked me in the eye in a way I had never seen before. "Don't leave the house," he told me. "There's something going on. I don't know what it is. But don't leave the house. I'll be back."

After a while, Rodolfo called me. "Get out of the house," he said. He told me to ask my cousin to take our daughter, Sofía, and me to my mother's house.

His uncle Luis's ranch was on fire. And there were a lot of armed men standing outside the gate. His sister wasn't answering her phone. His father wasn't answering either. He sent one of his workers, Pilo, to the gate to see what was going on. Pilo had been in the military. The gunmen opened the gate. Pilo went in. But he never came out.

Rodolfo was inconsolable. He couldn't find his parents. He couldn't find his sister. And now his best worker was gone. He told me he was going to try to sneak onto the ranch through the back.

A few minutes later, he called again. He told me to get out of Allende. "Tell your cousin to take you to Eagle Pass. Don't pack. Just go."

THE ORAL HISTORIES HAVE BEEN EDITED FOR LENGTH AND CLARITY.

A Merciless Assault

In March 2011 the Zetas cartel conducted a brazen campaign of violence from Allende to Piedras Negras that killed dozens—possibly hundreds—of people and destroyed scores of homes and businesses. Cartel leaders ordered the massacre as revenge against operatives they suspected were collaborating with the U.S. Drug Enforcement Administration.

GUTTED MANSION
This mansion, ruined by bulldozers, sits across the street from the former mayor's house and just blocks from the main square.

THE BIRDHOUSE
A member of the Zetas raised exotic animals here. Residents refer to this place as *la casa de los pájaros*, the birdhouse.

ZETAS HOME
This house, built by a Zetas cartel member for a woman he hoped to marry, had barely been completed when it was destroyed.

MEXICO'S DEADLIEST STATES

Homicides linked to the cartels are concentrated in the major drug-trafficking zones in the north and on the west coast.

Average number of organized crime-style homicides a year, per 100,000 people (2007-2015)

- More than 50
- 11-50
- 5-10
- Fewer than 5

DAMIEN SAUNDER, NGM STAFF

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Many victims were brought to a ranch outside Allende, owned by the Garza family. The cartel allegedly turned this storage shed, which held equipment and animal feed, into an incinerator for the bodies. Ashes, a rosary, and what appear to be belt buckles lie on the charred concrete floor.

Evaristo Treviño (no relation to Zetas leaders), former fire chief: Officers under my command responded to reports of a fire at one of the Garza ranches. We're talking about less than three kilometers away from Allende. It appeared that the Garza family was having some kind of gathering. Among the first responders was a group of firefighters with a backup engine. They noticed there were certain people connected to criminal organizations, who told them, in vulgar terms and at gunpoint, to withdraw. They said there were going to be numerous incidents. We were going to get numerous emergency calls about gunshots, fires, and things like that. They told us we were not authorized to respond.

In my capacity as fire chief, what I did was to advise my boss, who in this case was the mayor. I told him that we were facing an impossible situation and that the only thing we could do was to stand down, out of fear of the threats we faced. There were too many armed men. We were afraid for our lives. We couldn't fight bullets with water.

From Allende the gunmen moved north along the dry, flat landscape, rounding up people as they covered the 35 miles to the city of Piedras Negras, a grimy sprawl of assembly factories on the Rio Grande. The attackers drove many of their victims to one of the Garza ranches, including Gerardo Heath, 15, and Edgar Ávila, 36. Neither had anything to do with the cartel or with those the cartel believed were working with the DEA.

Claudia Sánchez, cultural affairs director and mother of victim Gerardo Heath: At around 10 that night, my husband called Gerardo's cell phone to see what time he'd be coming home. Gerardo didn't answer. My husband called again. No answer. A while later someone knocked on our door. It was a couple of friends of Gerardo's from school. They looked terrified. I asked them, "What's the matter? Where's Gerardo?"

The boys said, "They took him."

I asked, "What are you talking about? Who took him?"

The boys said they saw Gerardo and our neighbors in front of the neighbors' house. A truck came, carrying a lot of men with guns. The men forced the neighbors and Gerardo into the truck and drove away. The boys told me they didn't recognize the men. And since they had weapons, the boys didn't dare say anything.

Within minutes, we called the mayor of Piedras Negras. He was at a wedding. He said that he felt terrible about what had happened to us, but there wasn't anything he could do. Not a single police car came.

María Eugenia Vela, lawyer and wife of victim Edgar Ávila: I was at work, waiting for the judge

Claudia Sánchez's 15-year-old son, Gerardo Heath, was kidnapped and killed in the attack, although he had nothing to do with the drug trade. Authorities never recovered his remains. Instead they provided Sánchez with an urn filled with dirt and ashes from Luis Garza's ranch. She placed it inside this crypt.

to sign off on two sentencing reports I had written, when Edgar called to say his friend Toño had invited him over to watch a soccer match. I was pregnant, and by the time I got home, I was supertired. Edgar had fed our daughter and given her a bath.

It wasn't until I woke up at two in the morning that I noticed Edgar wasn't home. None of my calls went through. I said to myself, How strange that he hasn't called. Edgar always called.

I sat in an armchair the rest of the night and waited for him until about 6:30 a.m. Then I called my sister. I told her he hadn't come home. So she came over, and wearing my pajamas, I went with her and my brother-in-law to Toño's house. There was no one there, but there were signs of a struggle. Everything had been thrown around.

The next morning, Saturday, March 19, the gunmen summoned several heavy-equipment operators and ordered them to tear down dozens of houses and businesses across the region. Many of the properties were ransacked in broad daylight, in busy, well-to-do neighborhoods within sight or earshot not only of passersby but also of government offices, police stations, and military outposts.

A drum and bugle corps practices at a state prison in Piedras Negras, one of many institutions the Zetas had successfully co-opted around the time of the massacre. Inmates told authorities that the cartel had nearly unfettered access and had used it for years as a hideout and an extermination site.

'It was as if they had kidnapped me too. They killed the future we had, the plans, the dreams, the illusions, the peace, everything.'

María Eugenia Vela, lawyer and wife of victim Edgar Ávila

The gunmen invited townspeople to take whatever they wanted, triggering a frenzy of looting.

Rodríguez, victim's wife: Saturday is when everything began. Houses began exploding. People began breaking in and looting, and all I could think about was where Everardo might be. All day Saturday I spent searching and calling people to ask, "What have you heard?"

One person told me, "I saw armed men." Another told me, "The warehouses are still on fire. The smoke is really black, as if someone's burning tires. It's black, scary smoke."

I got a call from a man who worked with my husband. My husband raised fighting cocks. In this region cockfighting is very popular. He worked for José Luis Garza, but not full time. In the mornings and in the afternoons, he would go to the ranch to feed the animals.

The man told me, "There's something bad going on at the ranch. We don't know what's happened to all the people." I asked, "What do you mean? What people?"

He said that several of the men who worked with my husband had not arrived home the previous night. One was a tractor driver. Another watered the fields. None had arrived home.

I asked him, "OK, what do we do? Let's go look for them." He said, "Don't go anywhere near there, or else they'll take you too."

The image of one thing that happened is still with me: people breaking into supply stores and carrying away sacks of animal feed, parrots, and cages. They were taking lamps and dining room sets.

The image that sticks with me most is of a tiny motorcycle with a woman riding on the back. She had turned a bedsheet into a sack. She had stuffed it full of things and was carrying it like Santa Claus, with one hand. And with the other she was holding a lamp. The motorcycle looked like it was going to tip over, but they looked happy with all the stuff they had taken.

Online ProPublica and *National Geographic* are each publishing an expanded version of this story online. To read it, go to *ngm.com/Jul2017.*

Márquez, hot dog vendor: I had two friends who collected and sold junk. They heard that the ranch was burning and that the owners had left, so they went—a father and son—to see if there was anything worth taking. They said they saw a freezer off the highway, a big one. And they wanted to take it. But it was really heavy. So the father told the son, "Let's dump what's inside." They opened it and saw two bodies. They ran away.

Evaristo Rodríguez, a veterinarian, and Allende's deputy mayor at the time: All the members of the town council met, not in formal session, but we all gathered—the council members, the public security director. There were a lot of questions. The main one was, "What's happening?" But what everyone really wanted to know was why. We already knew there had been gunfire and that there were cases of disappearances and deaths.

There were a lot of questions about what we should do, but no one wanted to take charge. One of the council members even said, "Let's just get out of here, before something happens to us."

I didn't want to be a hero, but I thought at the very least we should stay in our offices so that people would see that we had not abandoned them. But all the staff wanted to leave. Everyone was focused on their own families.

With all that we were going through, we distrusted everyone. We realized that there was a two-sided government, the official one and the criminal one that was in charge. We knew that the police were controlled by criminals.

The director of public security told us, "These are their affairs." He didn't say any more. He didn't need to. I understood: "Don't investigate or intervene, or else."

Lira, victim's wife: The last phone call with Rodolfo was at a quarter to noon. He sounded exhausted. He still hadn't heard anything from his parents. I told him he had done everything he could for them, and now it was time to think about Sofía and me. I begged him to come meet us in Eagle Pass. He said, "OK, I'm on my way."

I never heard from him again.

Sánchez, victim's mother: There's no playbook to tell you what to do when someone steals your child. There is no first step. You go crazy. You want to run, but you don't know where. You want to scream, but you don't know whether anyone is listening. One of my cousins suggested I put it on Facebook. So I wrote, "Give me back my son. If anyone knows where he is, bring him back to me."

Vela, victim's wife: How can I explain how I felt? It was as if they had kidnapped me that day too. In some ways I died. They killed the future we had, the plans, the dreams, the illusions, the peace, everything. At that time I had lived longer with Edgar than I had lived without him. Just think about that. On top of that I was pregnant, so I couldn't even think of taking any kind of sedative. I had to try to stay composed, very calm, but I'd come home and feel like the house was caving in on me. I couldn't find a place to sit down without feeling like the walls were falling. I couldn't make sense of this. Despite being a lawyer, I couldn't make sense of what had happened.

THE OPERATION

Several months earlier, in the Dallas suburbs, the DEA had launched Operation Too Legit to Quit after some surprising busts. In one, police had found $802,000, vacuum-packed and hidden in the gas tank of a pickup. The driver said he worked for a guy he knew only as "El Diablo," the Devil.

After more arrests, DEA Agent Richard Martinez and Assistant U.S. Attorney Ernest Gonzalez determined that El Diablo was 30-year-old José Vasquez, Jr., a Dallas native who'd started selling drugs in high school and was now the leading Zetas cocaine distributor in east Texas, moving truckloads of drugs, guns, and money each month.

As they prepared to arrest him, Vasquez slipped across the border to Allende, where he sought protection from members of the cartel's inner circle.

But Martinez and Gonzalez saw an opportunity in his escape. If they could persuade Vasquez to cooperate, it would give them rare access to the senior ranks of the notoriously impenetrable cartel and a chance to capture its leaders, particularly the Treviños, known as Z-40 and Z-42, who had killed their way to the top of the DEA's target list.

What Martinez wanted were the trackable PINs, or personal identification numbers, of the Treviños' BlackBerry phones. Vasquez had left the agent plenty of leverage. His wife and mother were still living in Texas.

José Vasquez, Jr., convicted Zetas operative: My wife calls me at like six o'clock in the morning. She tells me, "Hey, the house is surrounded."

I said, "What do you mean, it's surrounded?"

She said, "Yeah, there's a lot of cops outside."

I said, "Well, listen, they're probably going to arrest you. Let me call [my lawyer]. Just make sure you don't tell them nothing. Just try to relax. We'll get you out on bond."

Then Richard [Martinez] called me from there. He put me on speakerphone, so my wife could hear.

He told me he was going to arrest her. I thought he was bluffing, so I said, "Do what you got to do."

Ernest Gonzalez, assistant U.S. attorney: At the beginning all we wanted was for José to turn himself in and cooperate, so that he could tell us the structure of the Zetas organization. I think that would have appeased us at that point because we really didn't know how close—how near—he was to Miguel and Omar. We didn't know—until he started saying who he was talking to, who he was seeing—what they were doing. That's when our perspective of what we could do, and how, began to change. We started to try to come up with ideas about how to capture them.

When José didn't turn himself in, and we saw that he was willing to sacrifice his wife, we knew we needed to turn the screws even harder, or put more leverage on him.

Richard tells him, "Your mom's going to be charged."

Vasquez, convicted Zetas operative: I told him, "Man, listen, man, I'll go to the border right now, walk over and turn myself in. I won't fight you for nothing. I'll sign all your seizure papers. Give me

a life sentence. Throw away the key. I don't care. But leave my wife alone. Leave my mother alone."

He's like, "Listen, the only way your wife doesn't do no jail time or your mom doesn't do no jail time is if you cooperate with us."

I said, "Richard, I don't want to cooperate, man. There's going to be a lot of murders that come behind this."

He was like, "All I have to tell you is if you don't cooperate, they're going to do time with you."

I asked Richard, "What do you want?"

Richard Martinez, DEA agent: I wanted the numbers. Our hope was to get the Zetas leadership. I figured that those numbers gave us the best chance to get them.

When it comes down to it, a lot of these guys flee the United States. But if you grew up here, it's still America, the best country in the world. You still want to eventually come back to America. If your family is here, you still want to be around them. I thought that once José realized that the jig was up, he was going to do whatever he had to do to help us. I was going to push him to do that while I had the opportunity.

Vasquez, convicted Zetas operative: I got all the numbers—for 40, and 42, and all of them. I didn't know what they were going to do with them. I thought they were going to try to wiretap them or something like that. I never thought they were going to send the numbers back to Mexico. I told them not to do that, because it was going to get a lot of people killed. Not only that, I was still there. I was still hanging around those people. They said they wouldn't. Richard told me I had to trust him.

About three weeks after Vasquez provided the PIN numbers to the DEA, the cartel's leaders got word that one of their own had betrayed them. Law enforcement sources close to the case said a DEA supervisor in Mexico City shared information about the numbers with a Mexican federal police squad known as the Sensitive Investigative Unit, which had been trained and vetted by the DEA but still had a poor record of keeping information out of the hands of criminals. An official with the unit, the sources said, was responsible for the leak. The unit's leaders at the time didn't respond to multiple requests for interviews.

It wasn't hard for the Zetas to narrow the list of suspected leakers, because very few people had access to their PIN numbers. Among them were Mario Alfonso "Poncho" Cuéllar, the Treviños' top lieutenant in Coahuila; and Héctor Moreno, who was Cuéllar's right-hand man.

Without telling Cuéllar, Moreno had given the PIN numbers to Vasquez. He was returning a favor. It was Moreno's brother, Gilberto, who had

The Zetas' hold on the state of Coahuila has been weakened, and nightlife has returned to Allende. Hundreds of people gathered last fall for the *cabalgata,* a festive cowboy parade that goes on for two to three days, stops at several ranches across the area, and ends with an evening rodeo.

been caught driving the truck with $802,000 in the gas tank. Facing 20 years in prison, Gilberto had confessed that he was working for the Zetas and that the money belonged to the Treviños. Vasquez had arranged for his lawyer to represent Gilberto and promised not to let anyone else in the cartel know about Gilberto's incriminating statements.

Mario Alfonso "Poncho" Cuéllar, convicted Zetas operative: How did I know there was trouble? Because I was holding 596 kilos of cocaine for the cartel, and 40 sent a guy to take it back from me. That's something I had seen them do many times before. Every time 40 planned to kill someone in the organization, he would first make sure he had taken back their merchandise.

He sent me a photo of himself, with drawings of frogs all over it. At the bottom of the photo he wrote, "Look, the damned frogs had me shot." Frogs is their word for snitches.

I called 40 and asked him, "Hey, what's this about?" He didn't answer. All he said was, "I need to see you. Where are you going to be later?"

I told him I was going to be at the horse track. But I didn't go. I called a couple of my guys, and I told them to go see what was going on. After

they got there, they called me and said, "You're screwed." One of 40's guys was there, cursing my name because I hadn't shown up. That's when I knew I had to leave.

I began calling my friends, warning them to get out too. Unfortunately, none of them listened to me. When 40 couldn't find me, he went after them.

Vasquez, convicted Zetas operative: Héctor [Moreno] called me and told me that all hell was breaking loose. He asked me what I had done with the numbers. I told him that I had turned them in to the DEA.

I called Richard [Martinez] and said, "What'd you do with the numbers?" He said, "Man, they went to Mexico."

I said, "Man, how did you let that happen? I told you what would happen if those numbers came to Mexico."

Richard said, "Man, it wasn't me. It wasn't my call. It was above me. The boss did it. They sent the numbers to Mexico, thinking they had a friend over there they could trust."

Vasquez, Moreno, and Cuéllar fled to the United States when the massacre began and agreed to cooperate with U.S. law enforcement in exchange for leniency. Their horrifying accounts of what was going on in Allende made American authorities aware of the wrath that the leak had unleashed.

Cuéllar, convicted Zetas operative: I remember my first meeting with the DEA. I was telling them what was happening in Coahuila, about all the violence. I remember Ernest [Gonzalez] getting up from the table, going outside, and confronting one of the DEA bosses. He started shouting at him. He said something like, "Did you hear what's going on? All this because you sent those numbers to Mexico."

Gonzalez, assistant U.S. attorney: I told him this was bullshit. Things should have never happened this way. We had information that could have helped us capture these guys, but because of the way it was handled, the whole thing had unraveled. And now it was a goddamned mess.

THE AFTERMATH

For years state and federal authorities in Mexico didn't appear to make a real effort to investigate the attack. Estimates of the number of dead and missing vary wildly between the official count, 28, and the one from victims associations, about 300. ProPublica and National Geographic *have identified about 60.*

Relatives were left on their own to piece together what had happened and to rebuild their lives.

No family lost more members than the Garzas. Nearly 20 are believed dead, including 81-year-old Olivia Martínez de la Torre and her seven-month-old great-grandson, Mauricio Espinoza. The baby's siblings, Andrea and Arturo Espinoza, five and three at the time, turned up at a Piedras Negras orphanage after their parents had been killed.

Elvira Espinoza, hotel housekeeper and grandmother of the Espinoza children: Andrea says they drove to a place where the houses didn't have roofs. She said the men took her mother, her grandmother, and her great-grandmother out of the car. They told the children, "Stay here. We're just going to talk."

The men kept them there and told them to stay quiet. No crying. Andrea said she changed the baby's diapers and made his bottles.

She doesn't remember how many days they were there before the men took her, Arturo, and Mauricio to Piedras Negras. Andrea said the men dropped her and Arturo in a park, but they took Mauricio with them.

Andrea blames herself for what happened to him. She says, "If I had been stronger, Mauricio would still be with us."

Sánchez, victim's mother: When they [Coahuila state authorities] gave me the news, my body went limp. They told me Gerardo had been taken to a ranch and killed. Something inside told me that it was true. But I asked, "Are you sure it was him?"

They told me that the witnesses had said there was a family with three boys, and that one of the boys was my son. They said he had started to cry. It was stressing them out, so they killed

'The potential for someone to get killed is always there. But to actually be involved in something like that is devastating.'

Ernest Gonzalez, assistant U.S. attorney

him. That's when I lost it. How could anyone kill a 15-year-old boy who's afraid, and crying?

The officials asked me what I wanted. I told them I wanted remains. They said that would be difficult, since my son was incinerated along with a lot of other people. Instead they brought me ashes and dirt from the place where he died. I asked them if I could go there. They told me it wasn't safe. I told them I wanted to go anyway. So they escorted us in a caravan.

I was struck by how close it was. I thought to myself, Gerardo was so strong that if only he could have gotten away and made it to the highway, he would have easily managed to make it home.

Vela, victim's wife: They gave me a death certificate dated the 19th of March 2011—the day after he disappeared. The only thing I asked them was whether they were certain they were right. They told me that the forensic specialists had not been able to test the fragments that had been recovered, so they couldn't be 100 percent sure. But they told me they were confident that Edgar was there at the time of the massacre. I think it's because they had witness statements.

I still don't know what to believe. I hadn't heard anything from them in five years; then, out of nowhere, they ask me to believe the case is solved.

I bet that if you were able to get a look at my husband's case file, you'd see it's empty.

The Treviño brothers were eventually captured in 2013 and 2015, in operations led by Mexican marines. Since then, the cartel's hold on Coahuila has weakened, and nightlife has returned to Allende, though many residents remain emotionally scarred. They fixate on reports of drug-related violence, worrying that the Treviño brothers are exerting control over the drug trade from jail.

The DEA takes credit for the captures but won't say whether it has investigated how the information about the PIN numbers wound up in the hands of the Zetas. Terrance Cole, Martinez's supervisor in Dallas, and Paul Knierim, then a DEA supervisor in Mexico City who served as a liaison with the DEA-trained Mexican federal police unit, declined to be interviewed.

But Martinez agreed to speak. Named agent of the year in 2011, he is now battling colon cancer, and so far aggressive treatment has failed. Russ Baer, a DEA spokesman, twice flew from Washington, D.C., to Texas to monitor interviews with Martinez and another agent there. As Martinez spoke, Baer interrupted to stress that the top Zetas were in prison and the agency's investigation was ultimately a success.

Gonzalez, assistant U.S. attorney: Obviously I'm devastated by it. You know that in this line of work, there are going to be consequences. The potential for someone to get killed is always there. But to actually be involved in something like that and not being able to do anything is devastating.

The goal was an honorable goal: to try to get these guys arrested and put in jail so that they would stop killing people. But at that point in the investigation, it had the opposite effect.

Martinez, DEA agent: I gave it a shot. That's the way I felt. I did the best I could do that day. I had the opportunity to get the intelligence and pass it on. I got it. I can't very well go into Mexico and try to handle it myself.

Russ Baer, DEA spokesman: As far as what happened in Mexico and the aftermath of the compromise, the DEA's official position is: That's squarely on Omar and Miguel Treviño. They were killing people before that happened, and they killed people after the numbers were passed. DEA did our job to target them and to try to focus and dedicate our resources to put them out of business. We were eventually successful in that regard.

Our hearts go out to those families. They're victims, unfortunately, of the violence perpetrated by the Treviño brothers and the Zetas. But this is not a story where the DEA has blood on its hands. □

Ginger Thompson, a Pulitzer Prize-winning reporter, has covered Mexico for years. She was previously Mexico City bureau chief for the *New York Times* and the *Baltimore Sun.* **Kirsten Luce** has documented life along the U.S.-Mexico border for 10 years.

A River at Risk

Rapid development is fueli
the cost has been damage t
of the country's most vital r

STORY AND PHOTOGRAPHS BY IA

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N TEH

Officials in Qinghai Province say rising levels in Ngoring Lake, in the Yellow River Basin, prove that environmental efforts are working. But scientists say the effects of climate change – thawing permafrost, more rain and snow – are more likely responsible.

In a nature reserve in Dongying, near the mouth of the Yellow River, an aviary sits silent and empty. The ecology of this region – a critical refueling stop for migratory birds along the East Asia-Australasia flyway – has been damaged by development, including a nearby oil field.

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and the effect it's had on the country. S
second part: following the Yellow River
ing the roles that economic, political, a
this ever evolving story.

A sizable portion of China's population
percent of its farmland—are on the North
than 10 percent of the country's water. T

dscape, we tend to think of it as a always changing. This is especially hina Plain. From imperial times to the recent reform phase, humans the environment. The landscape a register of the past.

ct looked at China's coal industry ince 2011 I've been working on the across northern China, document- nd environmental policies play in

n and heavy industry—and about 40 n China Plain. Yet the region has less The control of water is a key part of

governance; policy has a real impact on Chinese land and lives, but due to the country's size, what happens here will have consequences globally as well.

China has plenty of environmental regulations, but they're seldom prioritized or enforced. Officials are rewarded for economically advancing the areas they represent, so they have plenty of incentives to put short-term economic gains ahead of longer term environmental goals.

To depict this landscape panoramically—in the spirit of classical Chinese landscape paintings—I use a large-format lens and medium-format film. I want to convey the river's vital place in culture and history and, in a dream-like way, show why it's a base of economic power. It's been a source of life for thousands of years, and today it sustains some 200 million people on the North China Plain. But its degradation exposes the dark side of China's rise.

By focusing on the dissonance in this fragile landscape, I hope to show that the price of our material desires comes at a great environmental cost. □

AS TOLD TO JEREMY BERLIN

In Linfen, a city on a tributary of the Yellow River, a residential development (top) – built to serve a robust mining industry – rises near farmland. In the 1970s this city was known for its clean water; by 2006 one study deemed it among the 10 most polluted cities in the world. Many miles upstream in Baiyin (left), a temple is visible above a limestone quarry. The previously rural area is now home to coal-fired power stations and plants that process nonferrous metals and chemicals.

In Shandong Province, on the lower reaches of the Yellow River, pumping jacks and a fish farm (top) sit perilously close together. Heavy industry can kill vegetation, pollute soil and water, and release contaminants. But that's not the only story here. Nearby (left), locals walk past the shadow of a wind turbine on the shore of Bohai Bay. China is the top producer of wind and photovoltaic power, as well as smart-grid technology. It generates more alternative energy than France and Germany combined.

FURTHER

A GLIMPSE OF WHAT'S NEW AND NEXT

COLORING SPACE

By Nina Strochlic

In 2015 NASA released a trove of black-and-white photos documenting the American-Soviet space race. The images show command-center crews at tense moments, engineers posing with the Apollo mission software code—and the late John Glenn as a young astronaut suited up for flight (below). Among those sifting through the thousands of images online was Matt Loughrey, a photographer based in the Irish village of Murrisk.

Loughrey's father used to tell him stories of the space race, but it seemed monochromatic and distant. He sympathized when his own son, at age seven, posed the question: Back then was the world in black-and-white? "I realized that he'd stumbled upon a poignant observation," says Loughrey. He told his son that the world has always been colorful, but the tools to capture it have changed.

Having recently colorized a picture of his grandmother as an experiment, Loughrey imagined how color versions of the NASA photographs could excite a new generation of scientists. Some 300 hours later, using software that predicts the real-life colors in a picture's gray scale, Loughrey had transformed a dozen images into windows to the vibrant past.

HIGH HONORS

Astrophysicist Neil deGrasse Tyson is the 2017 recipient of the prestigious Hubbard Medal, the National Geographic Society's award given to leading scientists and explorers.

See FURTHER into space as August's *National Geographic* looks at specks of stardust, a radio telescope's cosmic light show, and the future of space travel.

PHOTO: NASA; COLORIZATION BY MATT LOUGHREY, MY COLORFUL PAST

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