08.2018

NATIONAL GEOGRAPHIC

THE SCIENCE OF SLEEP

"We are now living in a worldwide test of the negative consequences of sleep deprivation."

ROBERT STICKGOLD,
HARVARD MEDICAL SCHOOL

The 2018

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CONTENTS

On the Cover
Wile Wennman, seven, of Nacka, Sweden, likes to fall asleep with the light on, says his father, Magnus—a photographer who's traveled the world to capture how and where people sleep.
MAGNUS WENNMAN

PROOF

EMBARK

EXPLORE

FEATURES


THE GREATEST DANGER IN LIFE
IS NOT TO TAKE THE ADVENTURE.
– GEORGE LEIGH MALLORY
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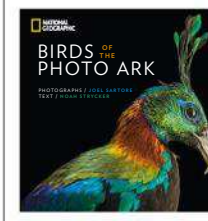
NAT GEO TV

Observe Wildlife in Real Time on *Yellowstone Live*

Within the 22.6 million acres of the Greater Yellowstone Ecosystem, there are lush forests, dramatic canyons, gushing geysers—and more than 300 animal species. For the four-night television event *Yellowstone Live,* world-renowned cinematographers will use cutting-edge technology to show some of Earth's most majestic wildlife in real time. Episodes will air August 5 to 8 at 9/8c on National Geographic.



BOOKS

Birds of the Photo Ark Take Flight

Of the many species that Joel Sartore has photographed, some of the most glorious are birds. Their images fill the 240 pages of *Birds of the Photo Ark,* available where books are sold and at *shopng.com/books.*

NAT GEO WILD

Learn Insiders' *Secrets of the Zoo*

Go behind the scenes at one of America's most popular zoos: the Columbus (Ohio) Zoo and Aquarium, where an array of habitats houses more than 10,000 animals. The new series *Secrets of the Zoo* airs Sundays at 9/8c starting July 29 on Nat Geo WILD.

NAT GEO WILD

Safari Live Is Back

The popular real-time program returns, broadcasting from parched South Africa and from Kenya's Masai Mara Game Reserve. *Safari Live: Migration* premieres July 27 at 11/10c on Nat Geo WILD.

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PHOTO: RONAN DONOVAN

Clarion Angelfish *(Holacanthus clarionensis)*
Size: Body length, males 17 - 22.5 cm (6.7 - 8.9 inches); females 11.2 - 17.3 cm (4.4 - 6.8 inches)
Weight: Unknown **Habitat:** Clear water rocky reefs **Surviving number:** Unknown

Photographed by Claudio Contreras

WILDLIFE AS CANON SEES IT

This reef isn't big enough for the both of us. That's the reaction of the male Clarion angelfish when he encounters other males invading his spawning territory. After aggressively chasing away interlopers, he welcomes a single female to his domain. This striking fish has always been in high demand for collections, but this demand is now largely being met with captive-bred fish. However, climate change and related El Niño-Southern Oscillation (ENSO) events remain a serious threat to its life on the reef.

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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ARIANNA HUFFINGTON

Short on Sleep

INTERVIEW BY **SUSAN GOLDBERG**

Arianna Huffington, 68, co-founded the news and blog website the *Huffington Post,* and is CEO and founder of the wellness company Thrive Global. She has authored 15 books, including *The Sleep Revolution: Transforming Your Life, One Night at a Time.*

'WHEN I GET EIGHT HOURS, I KNOW THE DIFFERENCE. I KNOW I'M MORE EFFECTIVE; I KNOW I'M THE BEST VERSION OF MYSELF.'

Thanks for sharing your expertise on sleep, the topic of our cover story. Thomas Edison called sleep "an absurdity" and "a bad habit." Is that idea ingrained in our culture?
I think it's deeply ingrained, but we're at a moment of transformation. What stops people from prioritizing sleep is the fear that somehow they're going to miss out. We have so many phrases that confirm that—"You snooze, you lose," "I'll sleep when I'm dead." But now there are role models, people who are prioritizing sleep and are supereffective.

You're known as hard-charging. Did you have a moment when you said, I've got to change what I'm doing?
Yes, in 2007 when I collapsed from sleep deprivation, exhaustion, and burnout. Being a divorced mother of two teenage daughters, I had bought into the delusion that this was the price of success and of managing all aspects of my life. It was after I collapsed that I started studying this epidemic of burnout. There had been a lot written about the importance of nutrition and exercise, but sleep was still underrated and dismissed. And so I wrote the book.

Will getting enough sleep ever be prioritized in our culture?
Its importance is becoming more recognized. Of course there are holdouts, people who still brag about how little sleep they get, but they're increasingly like dinosaurs. One of the metaphors I use is that sleep is like the laundry. You're not going to take out the laundry 10 minutes early to save time. You have to complete all the cycles in the washing machine. Our sleep cycles have to be completed too; otherwise we wake up and we feel like wet and dirty laundry.

PETER YANG
THIS INTERVIEW WAS EDITED FOR LENGTH AND CLARITY.

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PROOF

NATIONAL GEOGRAPHIC

PHOTOGRAPHS BY **TIM FLACH**

LOOKING AT THE EARTH FROM EVERY POSSIBLE ANGLE

SHOEBILL *(BALAENICEPS REX)*

EMBRACING THE ENDANGERED

If these photos make you care about protecting these birds…well, that's the point.

VOL. 234 NO. 2

PHILIPPINE EAGLE *(PITHECOPHAGA JEFFERYI)*

EGYPTIAN VULTURE *(NEOPHRON PERCNOPTERUS)*

This vulture's range includes southern Europe, Africa, India, and Nepal. The International Union for Conservation of Nature (IUCN) has assessed the bird as endangered, one of the nine categories it uses to describe a species' conservation status.

PHOTOGRAPHED AT INTERNATIONAL CENTRE FOR BIRDS OF PREY, NEWENT, ENGLAND

PREVIOUS PHOTOS

Left: The shoebill is found in East Africa from South Sudan to Zambia. The IUCN has assessed it as vulnerable.

ZOOTAMPA AT LOWRY PARK, TAMPA, FLORIDA

Right: The IUCN says this eagle is critically endangered in its range, which covers the Philippine islands of Leyte, Luzon, Mindanao, and Samar.

PHILIPPINE EAGLE FOUNDATION, DAVAO CITY, PHILIPPINES

MILITARY MACAW *(ARA MILITARIS)* The IUCN has assessed the military macaw as vulnerable. Its range extends from Mexico to Argentina. This captive bird was photographed at a private collection.

PASSENGER PIGEON *(ECTOPISTES MIGRATORIUS)* This North American bird was hunted to extinction; the last one died in 1914. This specimen is part of the collection of extinction expert Errol Fuller.

THE BACKSTORY

TO SAVE RARE SPECIES FROM EXTINCTION, WE NEED TO BUILD EMOTIONAL BONDS WITH THE NATURAL WORLD.

CONSIDER THE SHOEBILL, whose photo opens this article. It's a one-of-a-kind species on the verge of extinction—exactly the type targeted for protection by the Evolutionarily Distinct and Globally Endangered species program, aka EDGE of Existence. But when I started the EDGE initiative in 2007, the challenge was getting people who'd never heard of those animals to commit to protecting them.

Ideally I could have gone to the leading marketing agency for nature and asked what to do to get people to emotionally connect with these weird and wonderful creatures. But no such agency exists—and we've only begun to develop both the art and science of making this vital connection.

Tim Flach photographed the birds in this article; all are in his book *Endangered,* to which I contributed. Flach has a unique ability to capture an animal's essence and an affinity for unusual, obscure creatures. We saw the book as a great opportunity to explore which images of species and habitats would elicit an emotional response.

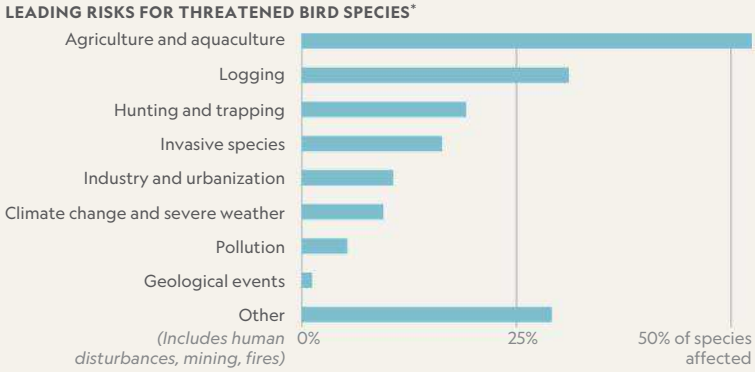
Were people connecting to species that were larger? More colorful? Or that had traits similar to human babies', such as big eyes? Was it more powerful if species were pictured in portrait style or in their native habitat? Did the viewer connect through seemingly shared emotions or behaviors, such as maternal gestures, fear, and vulnerability?

Flach's images have helped start the discussion. Now we at National Geographic, through our Making the Case for Nature grants program, are inviting experts to offer ideas about how to better connect humans with the natural world. It's a critical question; our future depends on it. —JONATHAN BAILLIE

At the National Geographic Society, **Jonathan Baillie** is chief scientist and executive vice president of science and exploration.

Human actions are driving the decline of threatened bird species

Most of the forces threatening bird populations are at least in part generated by humans. Currently, expanding agriculture and aquaculture pose the greatest risks; in the future the leading risk factor for many birds may be climate change.



*INCLUDES BIRDS LISTED AS CRITICALLY ENDANGERED, ENDANGERED, OR VULNERABLE ON THE IUCN RED LIST; STATUS AS OF 2017

DAISY CHUNG, NGM STAFF. SOURCE: BIRDLIFE INTERNATIONAL

THE DISCOVERIES OF TODAY THAT WILL DEFINE THE WORLD OF TOMORROW

NATIONAL GEOGRAPHIC | VOL. 234 NO. 2

Are We as Awful as We Act Online?

IT'S NOT BRUTISH HUMAN NATURE THAT PROMPTS NASTY POSTS AND TWEETS, THE AUTHOR SAYS. BUT HOW WE EVOLVED DOES PLAY A ROLE.

BY **AGUSTÍN FUENTES**

"**YOU NEED TO HAVE** your throat cut out and your decomposing, bug-infested body fed to wild pigs." An anonymous Facebook user wrote that—and more that's unprintable—to Kyle Edmund after the British pro tennis player lost in a 2017 tournament.

After University of Cambridge classics professor Mary Beard spoke about the history of male suppression of female voices, she received Twitter threats, including "I'm going to cut off your head and rape it."

On Martin Luther King Day this year, an anonymous Twitter user lionized the man who killed King some 50 years ago: "RIP James Earl Ray. A true fighter for the white race." The same month, U.S. President Donald Trump tweeted that his "Nuclear Button…is a much bigger & more powerful one" than Kim Jong Un's. This capped weeks of dueling statements in which Trump called the North Korean leader "Rocket Man" and "a madman" and Kim called Trump "a gangster" and a "mentally deranged U.S. dotard."

HOW WE EXPERIENCE THE WORLD IS INTENSELY SHAPED BY WHO AND WHAT SURROUND US ON A DAILY BASIS. TODAY THAT CAN INCLUDE MORE VIRTUAL, SOCIAL MEDIA FRIENDS THAN PHYSICAL ONES.

The internet is a particularly volatile place of late. Aggression on social media has reached such a pinnacle of acrimony that some U.S. House members proposed designating an annual "National Day of Civility." The proposal drew civil responses—but also tweets and posts of wrath, ridicule, and profanity.

Is this aggression on social media giving us a glimpse of human nature, one in which we are, at our core, nasty, belligerent beasts?

No.

It's true that hate crimes are on the rise, political divisions are at record heights, and the level of vitriol in the public sphere, especially online, is substantial. But that's not because social media has unleashed a brutish human nature.

In my work as an evolutionary anthropologist, I've spent years researching and writing about how, over the past two million years, our lineage transformed from groups of apelike beings armed with sticks and stones to the creators of cars, rockets, great artworks, nations, and global economic systems.

How did we do this? Our brains got bigger, and our capacities for cooperation exploded. We're wired to work together, to forge diverse social relationships, and to creatively problem-solve together. This is the inheritance that everyone in the 21st century carries.

I would argue that the increase in online aggression is due to an explosive combination of this human evolutionary social skill set, the social media boom, and the specific political and economic context in which we find ourselves—a combination that's opened up a space for more and more people to fan the flames of aggression and insult online.

LET ME EXPLAIN. We've all heard the diet-conscious axiom "You are what you eat." But when it comes to our behavior, a more apt variation is "You are whom you meet." How we perceive, experience, and act in the world is intensely shaped by who and what surround us on a daily basis—our families, communities, institutions, beliefs, and role models.

These sources of influence find their way even into our neurobiology. Our brains and bodies constantly undergo subtle changes so that how we perceive the world plays off of, and maps to, the patterns of those people and places we see as most connected to us.

This process has deep evolutionary roots and gives humans what we call a shared reality. The connection between minds and experiences enables us to share

Lobbing hostile language online

How—and why—are American adults abusing one another on the internet? In 2017 the Pew Research Center crunched the numbers. In a study of some 4,000 people, four out of 10 said they'd been subjected to harassing behavior. Politics was the issue most likely to trigger the harassment: About a third of those who'd been attacked—Democrats and Republicans equally—said it was due to their political beliefs. More than half those who'd been harassed said they didn't know the perpetrator's identity; nearly nine out of 10 said the anonymity online provides cover for vicious and harassing behavior. Among the adults polled, slightly less than a third said they responded or took some sort of action when witnessing someone being harassed online, and slightly more than a third said they made no response. —NINA STROCHLIC

HOW EASY IS IT to hurl anonymous insults on social media? As visualized by artist Javier Jaén, it's as easy as if a brawny catapult were flinging an egg—in this case, the blue egg that was Twitter's original default anonymous avatar. The aim was to express "hate in the internet era, especially on the social network of the blue bird," Jaén says. "I'm already waiting for the Twitter trolls to criticize the image."

space and work together effectively, more so than most other beings. It's in part how we've become such a successful species.

But the "who" that constitutes "whom we meet" in this system has been changing. Today the who can include more virtual, social media friends than physical ones; more information absorbed via Twitter, Facebook, and Instagram than in physical social experiences; and more pronouncements from ad-sponsored 24-hour news outlets than from conversations with other human beings.

We live in complicated societies structured around political and economic processes that generate massive inequality and disconnection between us. This division alone leads to a plethora of prejudices and blind spots that segregate people. The ways we socially interact, especially via social media, are multiplying exactly at a time when we are increasingly divided. What may be the consequences?

Historically, we have maintained harmony by displaying compassion and geniality, and by fostering connectedness when we get together. Anonymity and the lack of face-to-face interaction on social media platforms remove a crucial part of the equation of human sociality—and that opens the door to more frequent, and severe, displays of aggression. Being an antagonizer, especially to those you don't have to confront face-to-face, is easier now than it's ever been. If there are no repercussions for it, that encourages the growth of aggression, incivility, and just plain meanness on social media platforms.

SINCE WE'LL CONTINUE to be influenced by whom we meet virtually, the next question is: Whom do we *want* to meet? What kind of society do we want to shape and be shaped by? That is, how do we modify the whom by which our brains and bodies are being molded—and thereby reduce the aggression?

Humans are evolutionarily successful because our big brains have allowed us to bond together and cooperate in more complex and diverse manners than any other animal. The capacity to observe how the world operates, to imagine how it might improve, and to turn that vision into reality (or at least make the attempt) is the hallmark of humanity.

And therein lies the solution to the problem. We are equipped with the skill set both to quell aggression and to encourage cohesion.

For countless millennia people have acted collectively to punish and shame aggressive antisocial actions such as bullying or abuse. On social media, where the troll is remote and anonymous, even the best intentioned individual challenge may devolve into a shouting match. But confronting the bully with a group action—a reasoned, communal response rather than a knee-jerk, solo gesture—can be more effective at shutting down aggression.

IF THE ANTAGONIZERS ON SOCIAL MEDIA FACE NO REPERCUSSIONS, THAT ENCOURAGES THE GROWTH OF AGGRESSION, INCIVILITY, AND JUST PLAIN MEANNESS.

Consider the impact of the #MeToo movement, the Time's Up movement, and the Black Lives Matter movement. Look at the public pressure brought to bear on media corporations to monitor "fake news" and hate speech.

These are excellent examples of how humans can leverage social media to nurture what's positive and sanction what's negative.

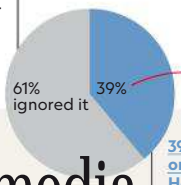
After the mass shooting at Marjory Stoneman Douglas High School in Parkland, Florida, activist students called out their Twitter trolls and shut them down. The neo-Nazi rallies have diminished, and some of the alt-right hate websites have been taken offline—all because thousands of people stood up to them and said, "No more."

Yes, it seems that the world is getting more aggressive, but that's not because we are aggressive at our core. It's because we haven't been stepping up, in unison, to do the difficult social work our contemporary world demands. That means standing up against bullying, abuse, and aggressive harassment, and fostering pro-social attitudes and actions. In person and on social media, we must do both.

Agustín Fuentes, who has been a National Geographic explorer and grantee, is the Edmund P. Joyce Professor of Anthropology at the University of Notre Dame. He has authored numerous books, including *Race, Monogamy, and Other Lies They Told You: Busting Myths About Human Nature* and *The Creative Spark: How Imagination Made Humans Exceptional.*

Antisocial media

When the Pew Research Center asked people how they handled their most recent exposure to online harassment, 61 percent said they ignored it. The rest said they made some sort of response; within that group, the top six responses, ranked by popularity at right, ranged from confronting the harasser online to deleting or changing the name on their own account online.



39% did not ignore online harassment. Here's what they did:

1. Confronted the person online
2. Unfriended/blocked the person
3. Reported the person responsible to website
4. Confronted the person face-to-face or via text/phone call
5. Discussed problem online
6. Changed username/deleted profile

SOURCE: PEW RESEARCH CENTER

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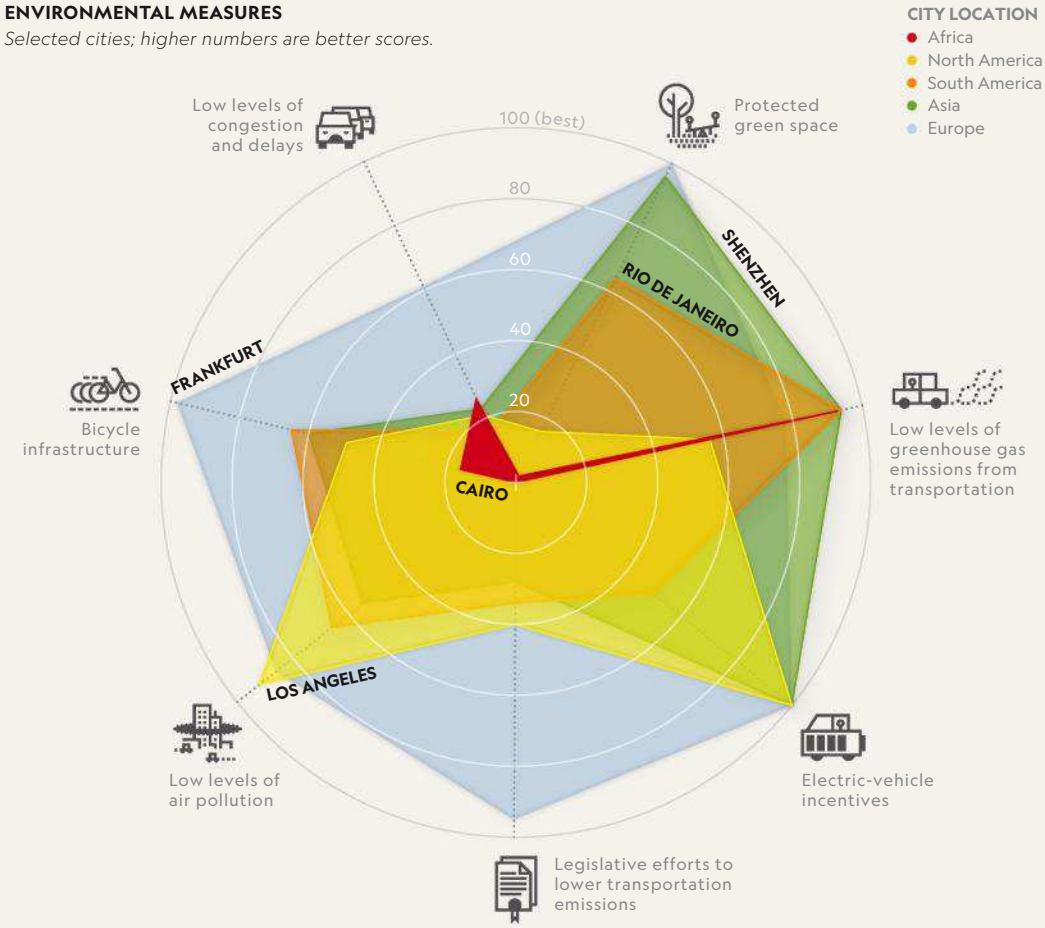
TOWARD GREENER CITIES

CITIES AROUND THE WORLD are striving to improve air quality and provide better transit options to their citizens by embracing environmentally friendly practices such as creating bike lanes, using alternative fuels, and offering incentives for electric vehicles. A recent survey of a hundred international cities ranks how well municipal governments are doing at helping people get where they need to go while also making cities more livable and attractive—and sustainable.

BY **RYAN MORRIS** AND **KELSEY NOWAKOWSKI**

ENVIRONMENTAL MEASURES

Selected cities; higher numbers are better scores.



HOW THE CITIES RANK

1 FRANKFURT

German cities score high due to advanced bike infrastructure, plentiful green spaces, and low greenhouse gas emissions.

28 SHENZHEN

Despite its rapid growth from fishing village to megalopolis of over 10 million people, the Chinese city has developed sustainable transit.

52 RIO DE JANEIRO

To combat major pollution, the Brazilian city launched a 50-year strategy in 2015 to improve air quality and local ecosystems by using cleaner fuels.

67 LOS ANGELES

Electric-vehicle incentives and investments in public transit are improving mobility in the U.S. city, which is known for its epic traffic jams.

97 CAIRO

The densely populated Egyptian city struggles to meet demand for public transit. Offering a wider variety of transit options could help.

ART: ÁLVARO VALIÑO. SOURCE: SUSTAINABLE CITIES MOBILITY INDEX 2017, PLANET SUB-INDEX, ARCADIS

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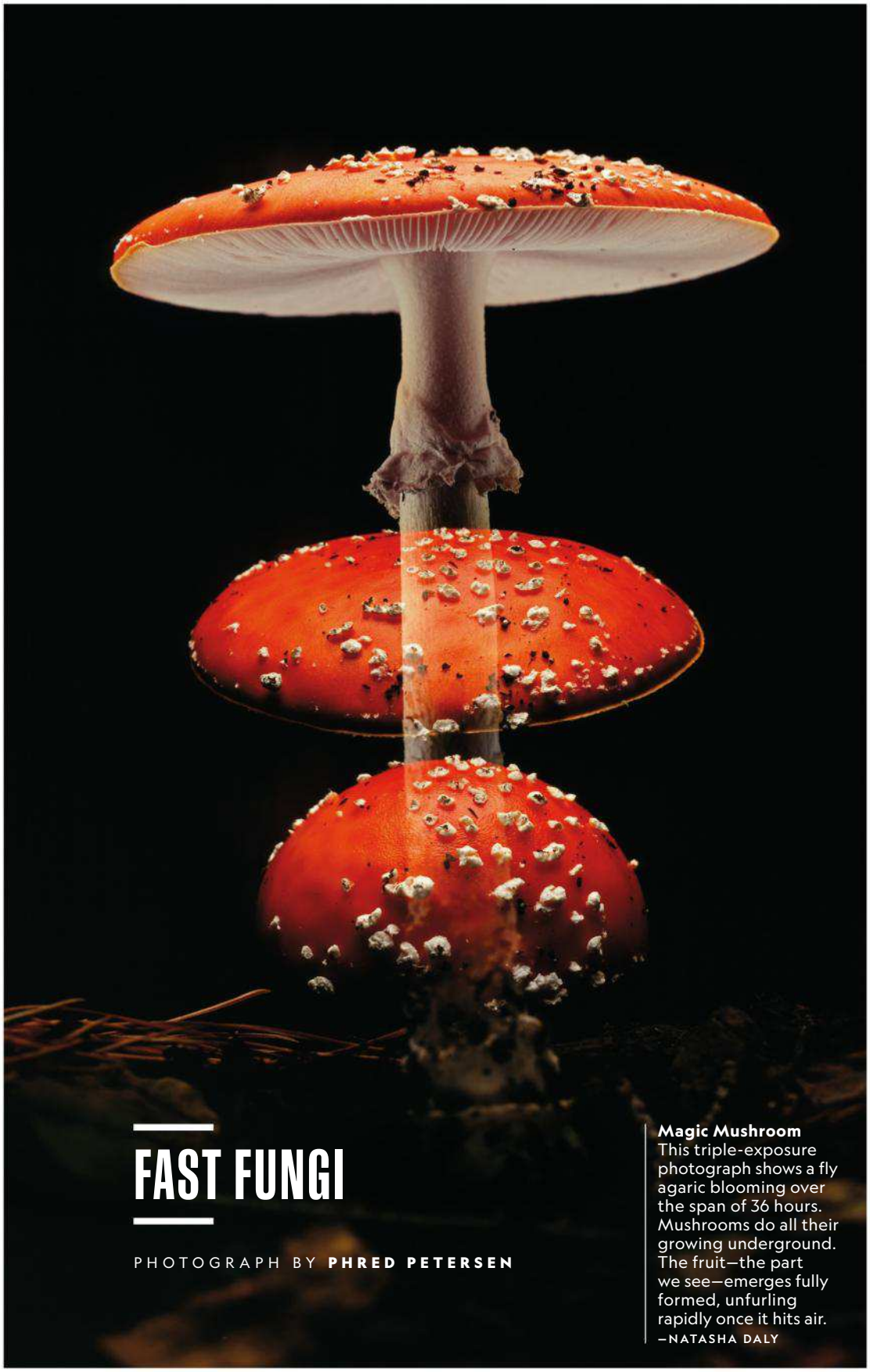
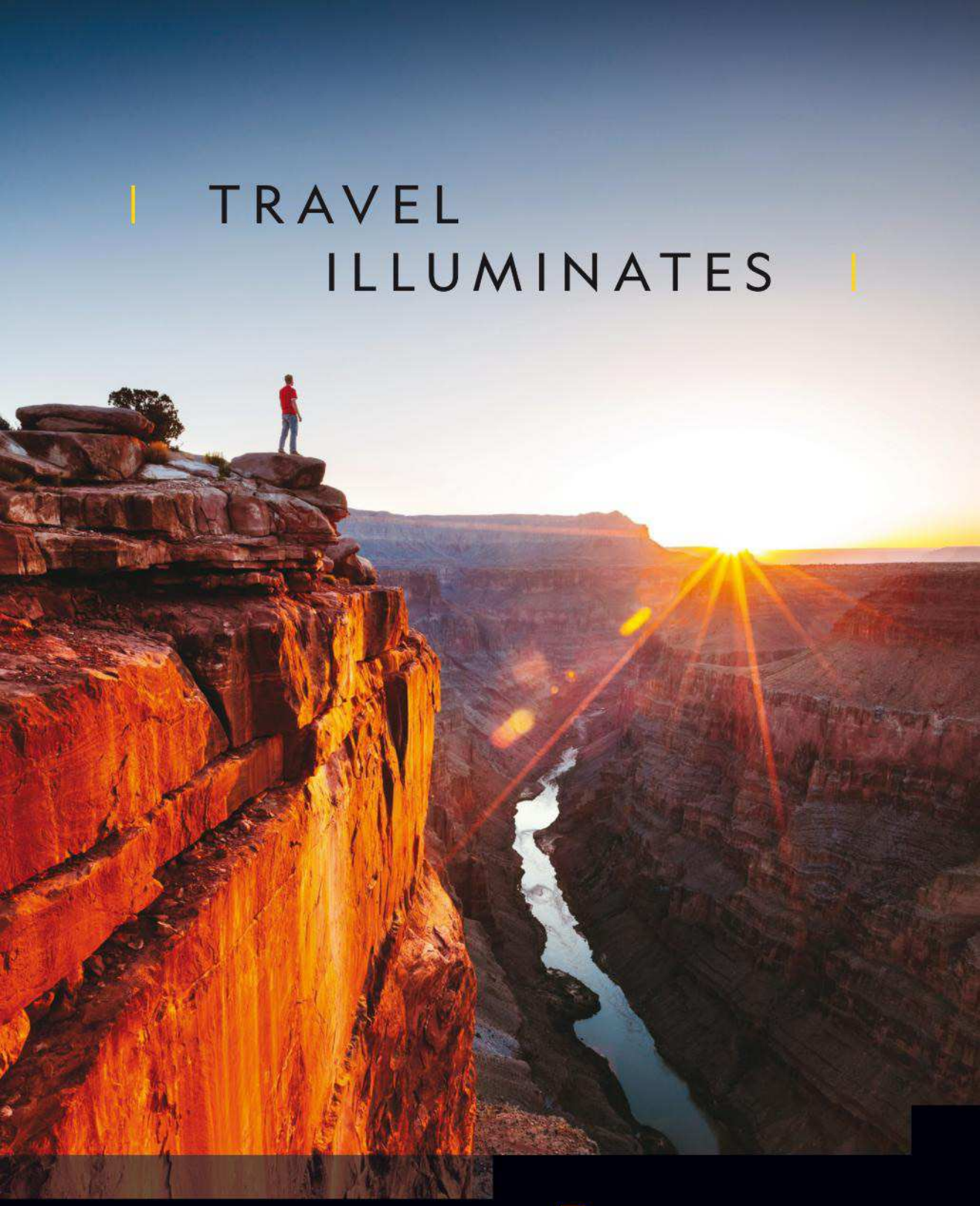


FAST FUNGI

PHOTOGRAPH BY **PHRED PETERSEN**

Magic Mushroom
This triple-exposure photograph shows a fly agaric blooming over the span of 36 hours. Mushrooms do all their growing underground. The fruit—the part we see—emerges fully formed, unfurling rapidly once it hits air.
–NATASHA DALY



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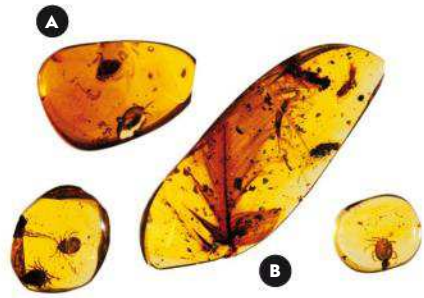
DISPATCHES FROM THE FRONT LINES OF SCIENCE AND INNOVATION

Bloodsuckers Even Then

Here's proof that ticks are truly prehistoric pests: When scientists found 99-million-year-old ticks entombed in Burmese amber, one (A) was engorged with blood. Judging by a feather entangled with another of the arachnids (B), ticks may have preyed on feathered dinosaurs in the Cretaceous period. –LORI CUTHBERT



BIOLOGY

Salamanders Might Hold Clues for Humans on Regrowing Body Parts

A creature that can repair and regenerate limbs and organs is helping scientists at the University of Minnesota understand why humans can't do the same. The critically endangered axolotl—also known as the Mexican salamander—shares a type of cell, called a glial cell, with humans. If an axolotl hurts its spinal cord, its glial cells go to work to repair the nerve damage and fix the injury. The same cells in humans work to form scar tissue, which prevents nerve pathways from regenerating. Researchers hope that grasping the underlying process of how axolotls can regrow their bits will one day help us regrow ours. –LORI CUTHBERT

SPACE

HOW TO CHILL OUT ON THE RED PLANET

ICE HOME MAY SHIELD MARS SETTLERS FROM RADIATION

Settling on Mars? That radiation is a killer. To block harmful cosmic rays while letting light in, the protective habitat depicted below would use ice.

The plan: A shipment of Mars Ice Home components would land and begin to deploy. A circular array of cells would inflate and fill with water drawn from Martian resources. That would freeze into the radiation shield. Homes could be linked to form an expandable base.

NASA chose the project to be part of its 2019 MISSE-11 mission, which will test how well the home's materials hold up by attaching them to the outside of the International Space Station. –LC

PHOTOS: ENRIQUE PEÑALVER MOLLÁ, INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA (AMBER); TIM FLACH, COMPOSITE OF TWO IMAGES (SALAMANDER); ARTIST'S RENDERING BY NASA/CLOUDS AO (MARS ICE HOME)

GENIUS

JASON DE LEÓN

BY **RACHEL HARTIGAN SHEA** PHOTOGRAPH BY **DAN WINTERS**

Jason De León directs the Undocumented Migration Project.

WHAT HE'S FOUND: LOVE LETTERS, A CD PLAYER, TEQUILA, A BIBLE CONTAINING TICKETS TO A SOCCER MATCH IN BOLIVIA

Archaeological skills helped him unearth the ancient. Now he uses those skills to explore modern migration.

Jason De León began his career as a traditional archaeologist. He excavated ancient sites in Mexico, uncovering artifacts that were centuries—if not millennia—old. But as he was finishing his dissertation on stone tools, he found himself increasingly drawn to the digs' laborers, who told him harrowing tales of crossing the border into the United States, only to be deported.

Although he grew up near the border in Texas and California, "I realized I didn't know anything" about immigration, De León says now. But he thought archaeology could be used to understand the contentious issue.

More than five million people have attempted to cross the Sonoran Desert since 2000. De León's research reveals how that migration has changed over time. For instance, in 2009 he began finding black plastic bottles. White jugs were too visible to Border Patrol agents; now migrants carried bottles decorated with pictures of the patron saints of migrants or maps of important landmarks—products of a new industry based on undocumented migration.

De León describes his fieldwork as "eclectic." Some days he walks the trails. On others he might interview migrants at a shelter, safe house, or courthouse—or launch a drone to search for dead bodies. Archaeology is about "trying to understand human behavior in the past through the study of what people leave behind," he says. "Nobody ever said the past had to be a thousand years ago."

EXPLORE

IN THIS SECTION
Hidden Afghanistan
Toxic Sulfur Mine
Starving Polar Bear

ILLUMINATING THE MYSTERIES—AND WONDERS—ALL AROUND US EVERY DAY
NATIONAL GEOGRAPHIC | VOL. 234 NO. 2

CORAL CRISIS

HALF OF THE GREAT BARRIER REEF has been bleached to death since 2016. Mass coral bleaching, a global problem triggered by climate change, occurs when unnaturally hot ocean water destroys a reef's colorful algae, leaving the coral to starve. The Great Barrier Reef illustrates how extensive the damage can be: Thirty percent of the coral perished in 2016, another 20 percent in 2017. The effect is akin to a forest after a devastating fire. Much of the marine ecosystem along the reef's north coast has become barren and skeletal with little hope of recovery.

Reef bleaching severity
Proportion of individual reef in 1998, 2002, or 2016 event*
- Extreme (more than 60%)
- Moderate (30–60%)
- Low (10–29%)

Worse than expected
Bleaching in 2016 occurred so rapidly that scientists had to retool their predictions for how much heat the reef could endure.

SCALE VARIES IN THIS PERSPECTIVE. DISTANCE FROM SAIBAI ISLAND TO CAPE YORK IS 90 MILES. *MOST SEVERE SCORE (SOME REEFS SURVEYED IN MORE THAN ONE BLEACHING). TERRAIN RENDERING: CHARLES PREPPERNAU. ART: MATTHEW TWOMBLY. SOURCES: ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES; NOAA CORAL

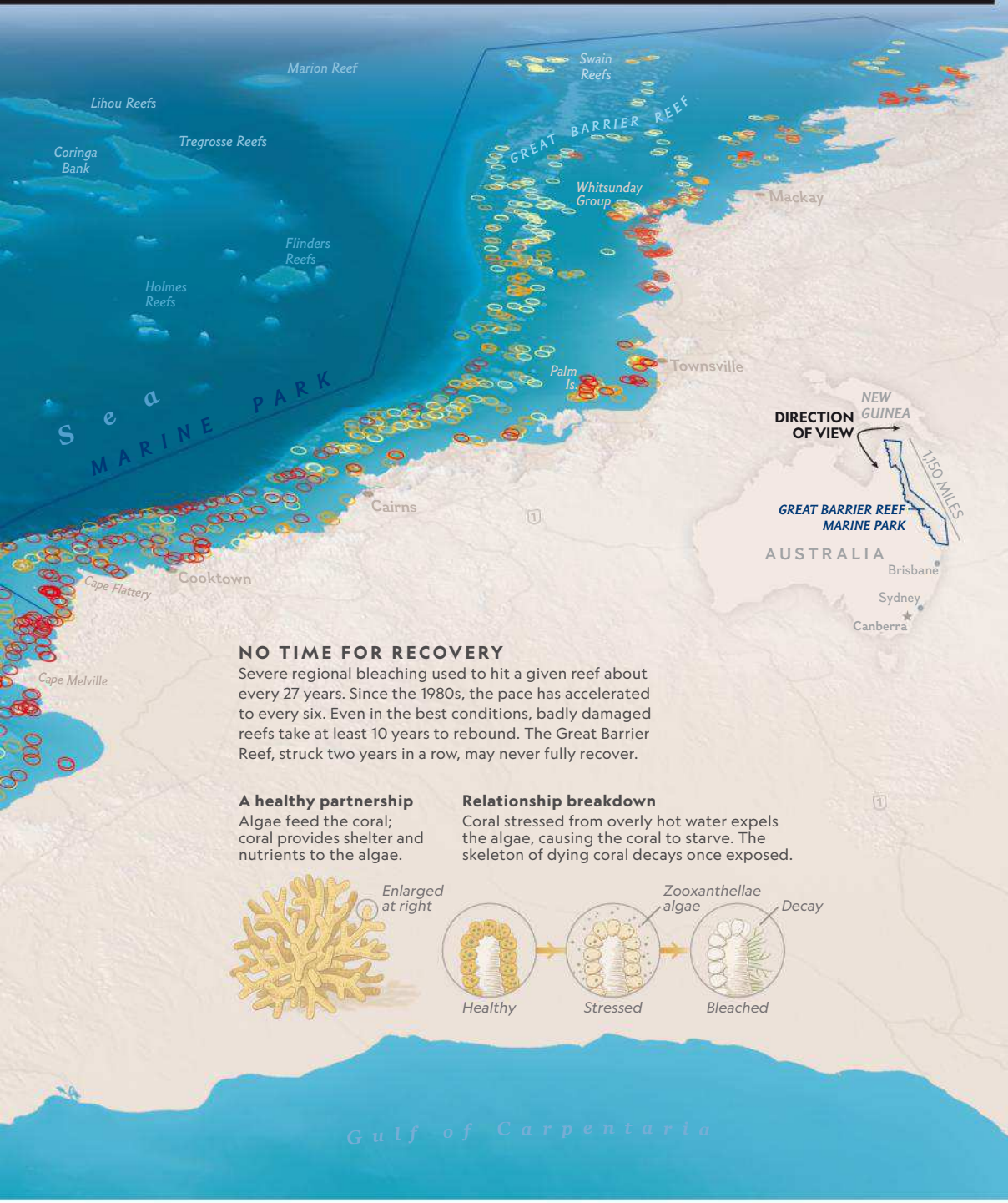
HEAT STRESS
Great Barrier Reef
Far Northern Management Area

Degree heating week (DHW) *combines intensity and duration of heat stress into a single number.*

HOW HOT FOR HOW LONG

As climate change warms Earth's oceans, underwater heat waves last longer. Coral species can't withstand extended hot periods. They start to die off, which diminishes reef diversity. After heat stress becomes severe, as it did along the northern Great Barrier Reef in 2016, few species remain, and final die-off is rapid.

ATLAS | BY **LAUREN E. JAMES**



NO TIME FOR RECOVERY

Severe regional bleaching used to hit a given reef about every 27 years. Since the 1980s, the pace has accelerated to every six. Even in the best conditions, badly damaged reefs take at least 10 years to rebound. The Great Barrier Reef, struck two years in a row, may never fully recover.

A healthy partnership
Algae feed the coral; coral provides shelter and nutrients to the algae.

Relationship breakdown
Coral stressed from overly hot water expels the algae, causing the coral to starve. The skeleton of dying coral decays once exposed.

REEF WATCH; ROBIN BEAMAN, JAMES COOK UNIVERSITY; AUSTRALIAN HYDROGRAPHIC OFFICE; GEOSCIENCE AUSTRALIA; AUSTRALIAN INSTITUTE OF MARINE SCIENCE; RAY BERKELMANS AND OTHERS, *CORAL REEFS* 23, 2004;

A RUGGED REALM SHIELDED FROM WAR

BY **PAUL SALOPEK**
PHOTOGRAPH BY **MATTHIEU PALEY**

AFGHANISTAN is a place, not a war.

Taliban suicide bombings may dominate the news, but the sprawling Central Asian country—bigger than France—embraces a cosmos. One of its least visited corners, the rugged Wakhan corridor, is an Afghanistan as few outsiders imagine it: shielded from violence by the Hindu Kush mountain range, locked in a more idyllic time, and shining with alpine light.

Last summer I hiked through this utterly remote wilderness hemmed by the mountain walls of Tajikistan, Pakistan, and western China. For weeks photographer Matthieu Paley joined me, and we trekked up valleys where peaceful Ismaili farmers threshed wheat in the biblical way, under the hooves of oxen. Waterwheels spun in icy creeks, grinding out flour. Villagers tending apricot orchards at the foot of glaciers were barely aware of the bloodshed in the distant capital, Kabul.

We traversed the largely roadless landscape in the same way early Silk Road travelers had: with pack donkeys. *"Zabardast!"* we cried, urging them up a nearly 14,000-foot pass. It's a local command that translates roughly as "superb" or "fantastic" or "powerful"—words that describe the Wakhan itself. Look for the story of our traverse in September's *National Geographic*.

THE OUT OF EDEN WALK

In 2013 Paul Salopek began what he calls "an experiment in slow journalism": a walking journey of 21,000 miles along the pathways of the humans who first explored Earth in the Stone Age. As he travels, he's covering the major stories of our time, from climate change to cultural survival, by giving voice to the people who inhabit them every day. You'll find periodic updates in the magazine and can follow the entire journey online at *outofedenwalk.org*.

NGM MAPS

FIND EVENTS NEAR YOU AT
natgeoevents.com

NATIONAL GEOGRAPHIC LIVE!

BY THE NUMBERS

7,100
ELEVATION OF SULFUR MINE, IN FEET

1112°F
TEMPERATURE OF SULFURIC GASES RELEASED FROM THE CRACKS

1999
MOUNT IJEN'S LAST KNOWN ERUPTION

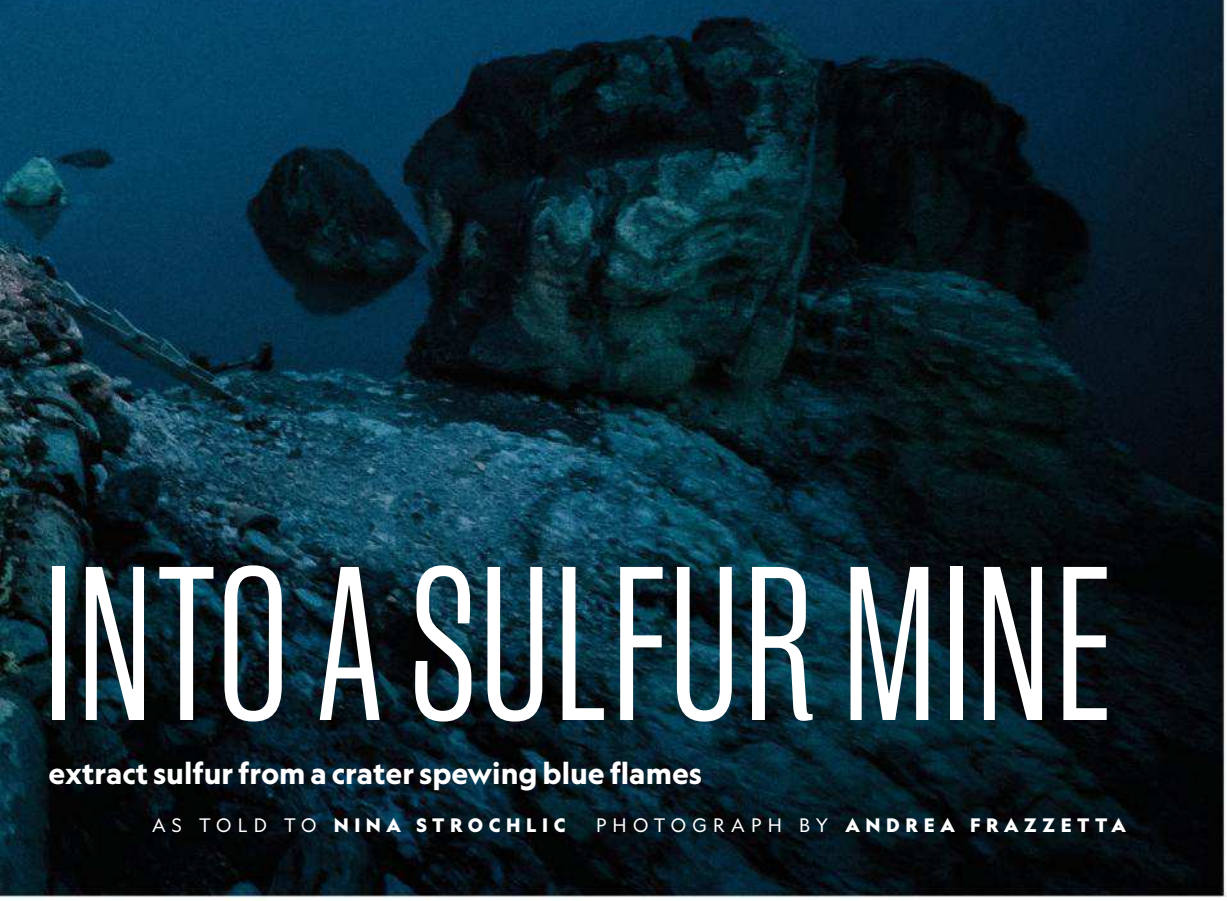
Indonesia has 127 active volcanoes. Only the U.S. (168) and Russia (144) have more.

DESCENT

A 2 a.m. hike into an active volcano where miners

‘WHEN YOU’RE IN THE MINE, THE SKY IS COVERED BY GASES. DAY AND NIGHT ARE CONFUSED. YOU FEEL SUSPENDED IN TIME.’

—Andrea Frazzetta



INTO A SULFUR MINE

extract sulfur from a crater spewing blue flames

AS TOLD TO **NINA STROCHLIC** PHOTOGRAPH BY **ANDREA FRAZZETTA**

T MINUS SIX MONTHS

A VOLCANIC DREAM

I’ve been wanting to document how people live and work in extreme environments, because that may teach us how to adapt to a changing planet. Mount Ijen in East Java, Indonesia, is an active volcano that contains an acidic lake and a sulfur mine. Deep in the crater, in air heavy with toxic gases, miners extract chunks of sulfur. They carry 150- to 200-pound loads to the rim and then down the mountain to sell to factories, which use sulfur in the manufacture of things like cosmetics and sugar.

T MINUS THREE DAYS

ESSENTIAL PACKING LIST

We landed in Java and drove for three days to reach Mount Ijen. While preparing for the trip, I learned that the sulfurous gas is unpredictable. Sometimes it’s so thick you can’t see or breathe. If that happens, I was advised, don’t panic—just wait for the wind to move it along.

- Goggles
- Water and energy bars
- Heavy jacket for nighttime temperatures
- Headlamp

T MINUS ONE HOUR

READY FOR LAUNCH

At the foot of the volcano, I rented a gas mask. From there we climbed to the mountain edge, where tourists flock after dark to see blue flames from the combustion of gases. But if you just take a beautiful picture of the flames, you miss the human story. The miners choose nighttime to descend into the crater and do their backbreaking labor because it’s cooler. I wanted to go into the mine. At 2 a.m. I followed them into the crater to spend the night.

‘Nothing Prepared Me for What I Saw’

BY **CRISTINA MITTERMEIER**

A GUT-WRENCHING PHOTO. A COMPLICATED THREAT. A GLOBAL OUTCRY. BUT NATIONAL GEOGRAPHIC SHOULD NOT HAVE DEFINITIVELY BLAMED CLIMATE CHANGE FOR THIS BEAR’S DEATH.

CLIMATE CHANGE KILLS slowly and by proxy: through fire, drought, cold, and starvation. The connection between an individual animal’s death and climate change is rarely clear—even when an animal is as emaciated as this polar bear.

Photographer Paul Nicklen and I are on a mission to capture images that communicate the urgency of climate change. Documenting its effects on wildlife hasn’t been easy. With this image, we thought we had found a way to help people imagine what the future of climate change might look like. We were, perhaps, naive. The picture went viral—and people took it literally.

Paul spotted the polar bear a year ago on a scouting trip to an isolated cove on Somerset Island in the Canadian Arctic. He immediately asked me to assemble our SeaLegacy SeaSwat team. SeaLegacy, the organization we founded in 2014, uses photography to spread the message of ocean conservation; the SeaSwat team is a deployable unit of storytellers who cover urgent issues. The day after his call our team flew to an Inuit village on Resolute Bay. There was no certainty that we would find the bear again or that it would still be alive.

When we arrived at the cove on a donated vessel, I scanned the shore with my binoculars. All I saw were a few dilapidated buildings, some empty fuel drums, and a very desolate landscape in what seemed like an abandoned fishing camp. We couldn’t locate the bear. Only when it lifted its head were we able to spot it lying on the ground, like an abandoned rug, nearly lifeless. From the shape of its body, it seemed to be a large male.

We needed to get closer; we boarded a Zodiac boat and motored to land. Strong winds covered our

PHOTO: CRISTINA MITTERMEIER (ON A SEALEGACY EXPEDITION)

PERHAPS WE MADE A MISTAKE NOT TELLING THE FULL STORY—THAT WE WERE LOOKING FOR A PICTURE THAT FORETOLD THE FUTURE.

noise and smell. From the shelter of one of the empty buildings, we watched the bear. He didn't move for almost an hour. When he finally stood up, I had to catch my breath. Paul had warned me about the polar bear's condition, but nothing could have prepared me for what I saw. The bear's once white coat was molted and dirty. His once robust frame was skin and bones. Every step that he took was pained and slow. We could tell he was sick or injured and that he was starving. We could see that he was probably in his last days.

I took photographs, and Paul recorded video. As the bear approached the empty fuel drums looking for food, I could hear my colleagues sobbing.

When Paul posted the video on Instagram, he wrote, "This is what starvation looks like." He pointed out that scientists suspect polar bears will be driven to extinction in the next century. He wondered whether the global population of 25,000 polar bears would die the way this bear was dying. He urged people to do everything they could to reduce their carbon footprint and prevent this from happening. But he did not say that this particular bear was killed by climate change.

National Geographic picked up the video and added subtitles. It became the most viewed video on National Geographic's website—ever. News organizations around the world ran stories about it; social media exploded with opinions about it. We estimate that an astonishing 2.5 billion people were reached by our footage. The mission was a success, but there was a problem: We had lost control of the narrative. The first line of the National Geographic video said, "This is what climate change looks like"—with "climate change" highlighted in the brand's distinctive yellow. In retrospect, National Geographic went too far with the caption. Other news outlets ran dramatic headlines like this one from the *Washington Post:* "'We stood there crying': Emaciated polar bear seen in 'gut-wrenching' video and photos."

We had sent a "gut-wrenching" image out into the world. We probably shouldn't have been surprised that people didn't pick up on the nuances we tried to send with it. Yet we were shocked by the response. Many people expressed gratitude that we'd shined a light on climate change, but others angrily asked why we had not fed the bear or covered him with blankets or taken him to a vet—none of which would have saved him. Those responses revealed how disconnected people are from wildlife, ecology, and even geography. And then there were those who are still bent on maintaining the dangerous status quo by denying the existence of climate change. We became to them yet another example of environmentalist exaggeration. But they offered us a glimpse of the daunting number of people we still need to reach.

Perhaps we made a mistake in not telling the full story—that we were looking for a picture that foretold the future and that we didn't know what had happened to this particular polar bear.

I can't say that this bear was starving because of climate change, but I do know that polar bears rely on a platform of sea ice from which to hunt. A fast-warming Arctic means that sea ice is disappearing for increasingly longer periods of time each year. That means many more bears will get stranded on land, where they can't pursue the seals, walruses, and whales that are their prey and where they will slowly starve to death.

After finding nothing of value in the fuel drums, the polar bear waddled into the water and swam away. Paul worried that he would waste energy and die, but the bear seemed to have an easier time in the water. He disappeared around a bend in the shoreline. We never saw him again, but we hope that our images of this dying bear moved the conversation about climate change to the forefront, where it must remain until we solve this planetary problem.

Until then, when we come across a scene like this one, we will again share it with the world—and take pains to be sure that our intentions are clear and the narrative remains our own. □

Cristina Mittermeier is a contributing photographer, speaker, and explorer for National Geographic. She is the co-founder, executive director, and vision lead of SeaLegacy, a nonprofit organization working to protect the oceans.

Editor's note

National Geographic went too far in drawing a definitive connection between climate change and a particular starving polar bear in the opening caption of our video about the animal. We said, "This is what climate change looks like." While science has established that there is a strong connection between melting sea ice and polar bears dying off, there is no way to know for certain why this bear was on the verge of death. To see an updated version of the video, go to *natgeo.com/starvingpolarbear.*

FEATURES

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'IT'S HARD TO PIN DOWN THE EXACT SIZE OF THE GLOBAL BLACK MARKET FOR BUTTERFLIES TODAY, BUT ESTIMATES RANGE UP TO HUNDREDS OF MILLIONS OF DOLLARS A YEAR.'

PHOTO: EVGENIA ARBUGAEVA

Want to Fall Asleep? Read This Story.

No, seriously. Put down your phone. We'll show you what a healthy night's sleep looks like. And how those blue lights keep us from getting enough.

BY **MICHAEL FINKEL**

PHOTOGRAPHS BY **MAGNUS WENNMAN**

Americans sleep less than seven hours a night, about two hours less than a century ago. In our restless floodlit society, we often think of sleep as an adversary.

Sleep is seen as interrupting life, but the real scourge is chronic sleeplessness. In Japan about 40 percent of the population sleeps less than six hours a night. Public dozing, as at this all-night diner in Tokyo, is socially accepted.

PREVIOUS PHOTO

Wile, the seven-year-old son of photographer Magnus Wennman, watches cartoons on his iPad—a modern bedtime ritual for some. The stimulation may drive off sleep, but so does the backlit screen: Light at night inhibits the production of melatonin, the hormone that helps regulate our daily biological rhythms.

Nearly every night of our lives, we undergo a startling metamorphosis.

Our brain profoundly alters its behavior and purpose, dimming our consciousness. For a while, we become almost entirely paralyzed. We can't even shiver. Our eyes, however, periodically dart about behind closed lids as if seeing, and the tiny muscles in our middle ear, even in silence, move as though hearing. We are sexually stimulated, men and women both, repeatedly. We sometimes believe we can fly. We approach the frontiers of death. We sleep.

Around 350 B.C., Aristotle wrote an essay, "On Sleep and Sleeplessness," wondering just what we were doing and why. For the next 2,300 years no one had a good answer. In 1924 German psychiatrist Hans Berger invented the electroencephalograph, which records electrical activity

Swathed in tubes and electrodes, 10-year-old Francis Ajua awaits "lights out" for his overnight sleep study at Children's National Health System in Washington, D.C. He was being tested for sleep apnea, in which breathing repeatedly pauses.

PREVIOUS PHOTO

At the Philharmonie de Paris, composer Max Richter leads a performance of *Sleep*, a minimalist, scientifically informed piece that aims to guide listeners through a rejuvenating rest. It lasts eight hours.

in the brain, and the study of sleep shifted from philosophy to science. It's only in the past few decades, though, as imaging machines have allowed ever deeper glimpses of the brain's inner workings, that we've approached a convincing answer to Aristotle.

Everything we've learned about sleep has emphasized its importance to our mental and physical health. Our sleep-wake pattern is a central feature of human biology—an adaptation to life on a spinning planet, with its endless wheel of day and night. The 2017 Nobel Prize in medicine was awarded to three scientists who, in the 1980s and 1990s, identified the molecular clock inside our cells that aims to keep us in sync with the sun. When this circadian rhythm breaks down, recent research has shown, we are at increased risk for illnesses such as diabetes, heart disease, and dementia.

Yet an imbalance between lifestyle and sun cycle has become epidemic. "It seems as if we are now living in a worldwide test of the negative consequences of sleep deprivation," says Robert Stickgold, director of the Center for Sleep and Cognition at Harvard Medical School. The average American today sleeps less than seven hours a night, about two hours less than a century ago. This is chiefly due to the proliferation of electric lights, followed by televisions, computers, and smartphones. In our restless, floodlit society, we often think of sleep as an adversary, a state depriving us of

The waking brain is optimized for collecting information, the sleeping brain for consolidating. At night we switch from recording to editing.

At the Children's sleep clinic in Washington, Michael Bosak, eight, sleeps through his exam in a position that helps prevent the repeated narrowing of the upper airway—the cause of his snoring. (This photo was taken in the dark with an infrared camera so as not to disturb him.) Sleep is crucial for childhood health and development; it's when most growth hormone and infection-fighting proteins are released. Poor sleep in kids has been linked to diabetes, obesity, and learning disabilities.

productivity and play. Thomas Edison, who gave us light bulbs, said that "sleep is an absurdity, a bad habit." He believed we'd eventually dispense with it entirely.

A full night's sleep now feels as rare and old-fashioned as a handwritten letter. We all seem to cut corners, fighting insomnia through sleeping pills, guzzling coffee to slap away yawns, ignoring the intricate journey we're designed to take each evening. On a good night, we cycle four or five times through several stages of sleep, each with distinct qualities and purpose—a serpentine, surreal descent into an alternative world.

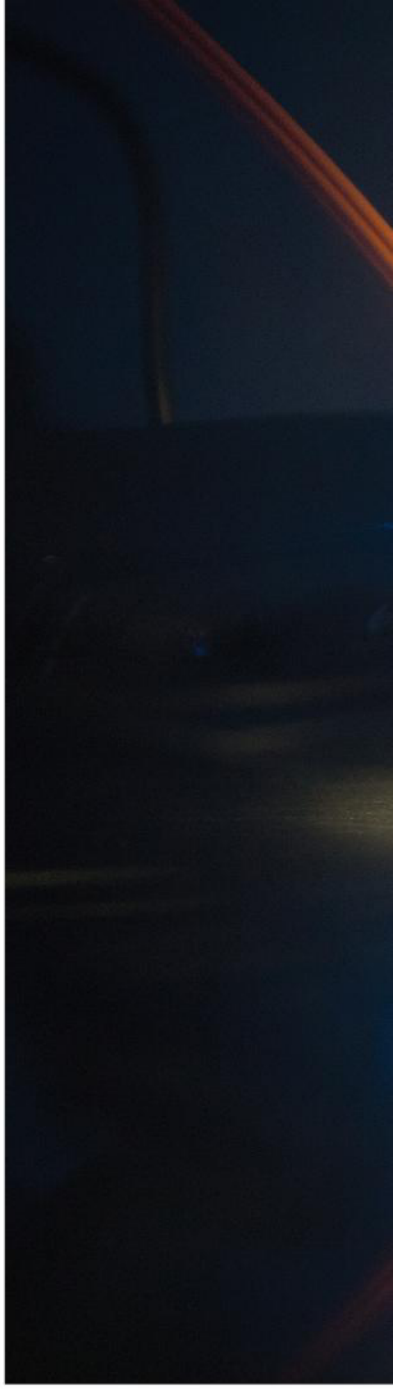
STAGES 1-2

AS WE FALL INTO SLEEP, OUR BRAIN STAYS ACTIVE AND FIRES INTO ITS EDITING PROCESS—DECIDING WHICH MEMORIES TO KEEP AND WHICH ONES TO TOSS.

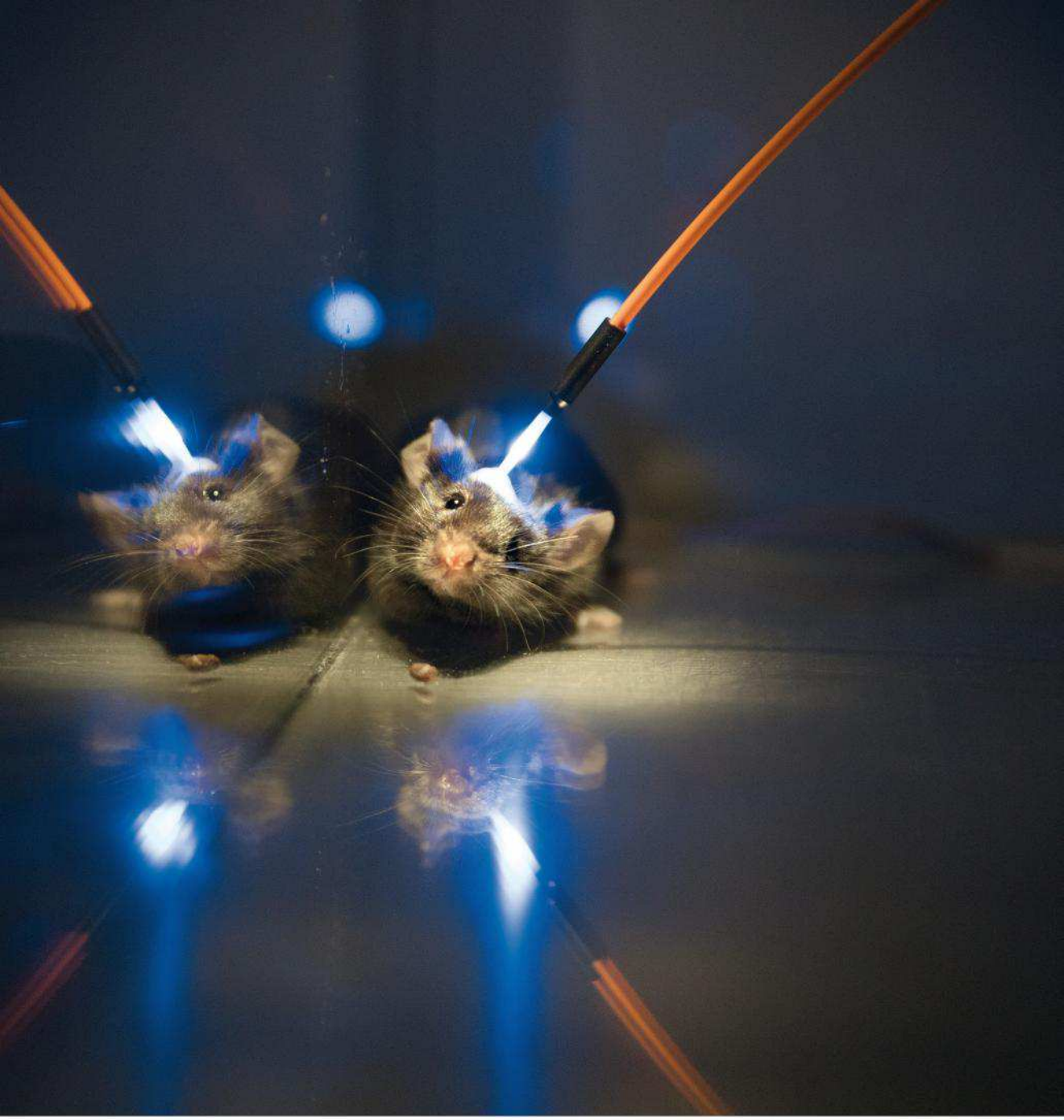
The initial transformation happens quickly. The human body does not like to stall between states, lingering in doorways. We prefer to be in one realm or another, awake or asleep. So we turn off the lights and lie in bed and shut our eyes. If our circadian rhythm is pegged to the flow of daylight and dark, and if the pineal gland at the base of our brain is pumping melatonin, signaling it's nighttime, and if an array of other systems align, our neurons swiftly fall into step.

Neurons, some 86 billion of them, are the cells that form the World Wide Web of the brain, communicating with each other via electrical and chemical signals. When we're fully awake, neurons form a jostling crowd, a cellular lightning storm. When they fire evenly and rhythmically, expressed on an electroencephalogram, or EEG, by neat rippled lines, it indicates that the brain has turned inward, away from the chaos of waking life. At the same time, our sensory receptors are muffled, and soon we're asleep.

Scientists call this stage 1, the shallow end of sleep. It lasts maybe five minutes. Then, ascending from deep in the brain, comes a series of electric sparks that zap our cerebral cortex, the pleated gray matter covering the outer layer of the brain, home of language and consciousness. These half-second bursts, called spindles, indicate that we've entered stage 2.



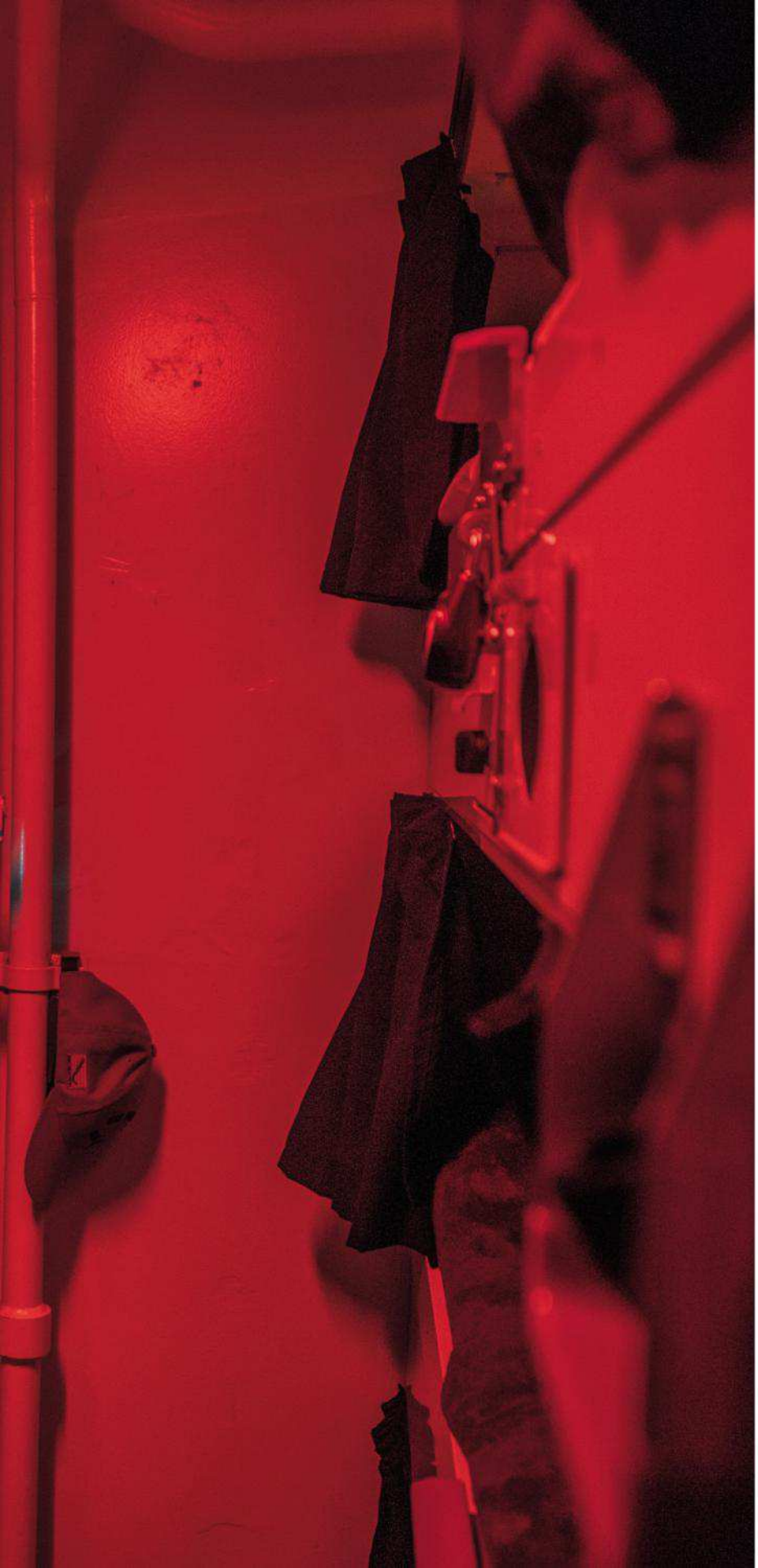
New memories are consolidated during sleep. What happens in the brain? At the University of Tsukuba, near Tokyo, Takeshi Sakurai studies the question with optogenetics—in which a laser turns individual brain cells on or off in mice that are genetically engineered to be sensitive to it.



Our brains aren't less active when we sleep, as was long thought, just differently active. Spindles, it's theorized, stimulate the cortex in such a way as to preserve recently acquired information—and perhaps also to link it to established knowledge in long-term memory. In sleep labs, when people have been introduced to certain new tasks, mental or physical, their spindle frequency increases that night. The more spindles they have, it seems, the better they perform the task the next day.

The strength of one's nightly spindles, some experts have suggested, might even be a predictor of general intelligence. Sleep literally makes connections you might never have consciously formed, an idea we've all intuitively realized. No one says, "I'm going to eat on a problem." We always sleep on it.

The waking brain is optimized for collecting external stimuli, the sleeping brain for consolidating the information that's been collected. At night, that is, we switch from recording to

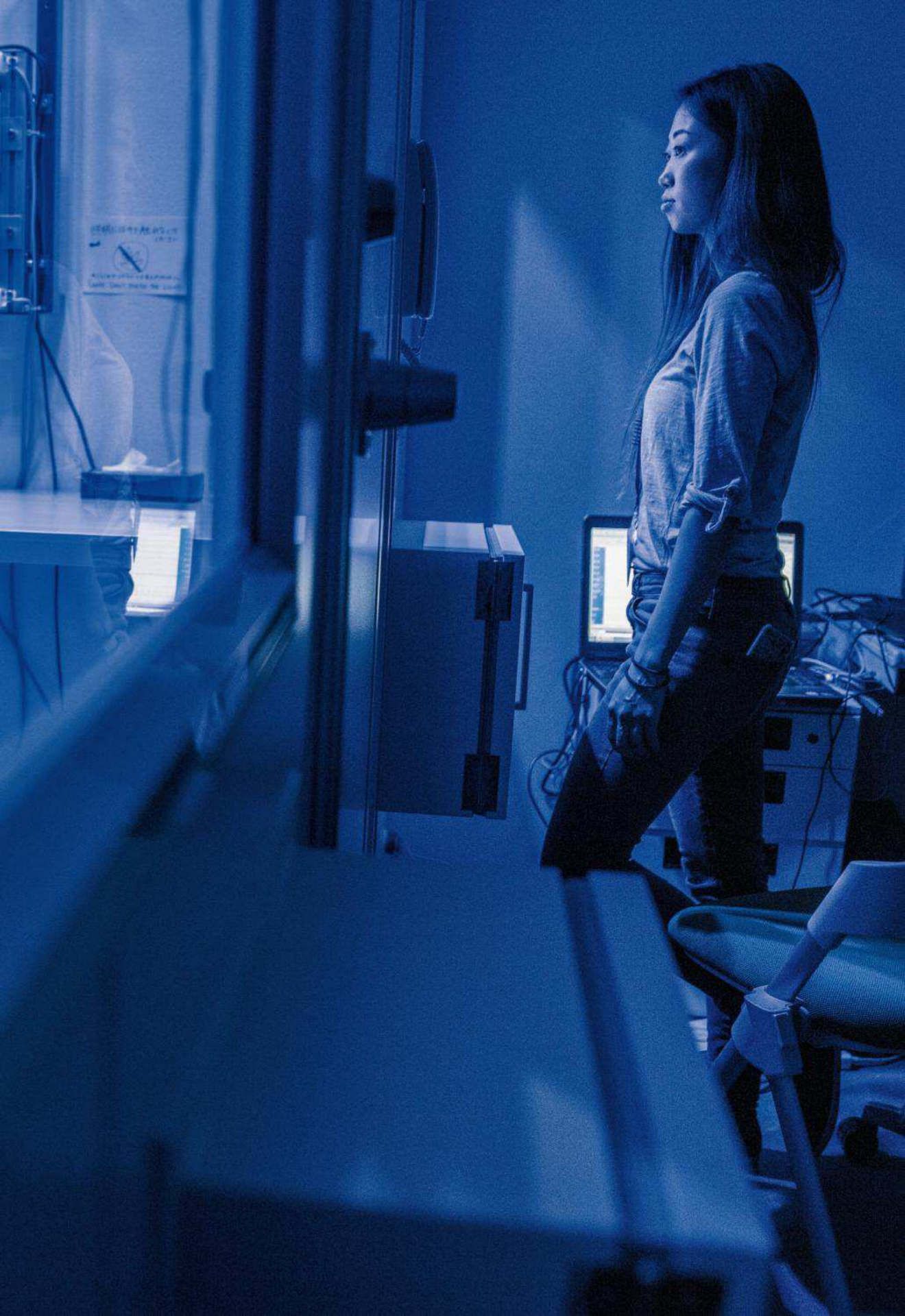


Sleep reinforces memory so powerfully that it might be best if exhausted soldiers returning from harrowing missions did not go directly to bed.

Resting in his bunk on the U.S.S. *Paul Hamilton,* a sailor wears light-emitting goggles for a short time after waking. Nita Shattuck of the Naval Postgraduate School in Monterey, California, is testing the devices to see if they can reset sailors' internal clocks, synchronizing them with work shifts rather than the sun cycle.

NEXT PHOTO

What makes us sleepy? This airtight chamber at the Tsukuba sleep institute allows researchers to precisely track a sleeper's oxygen consumption and thus his metabolic rate—and to measure how it's influenced, for example, by the brightness and color of ambient light. Finding the conditions that best trigger sleep could be the first step in curing insomnia.



editing, a change that can be measured on the molecular scale. We're not just rotely filing our thoughts—the sleeping brain actively curates which memories to keep and which to toss.

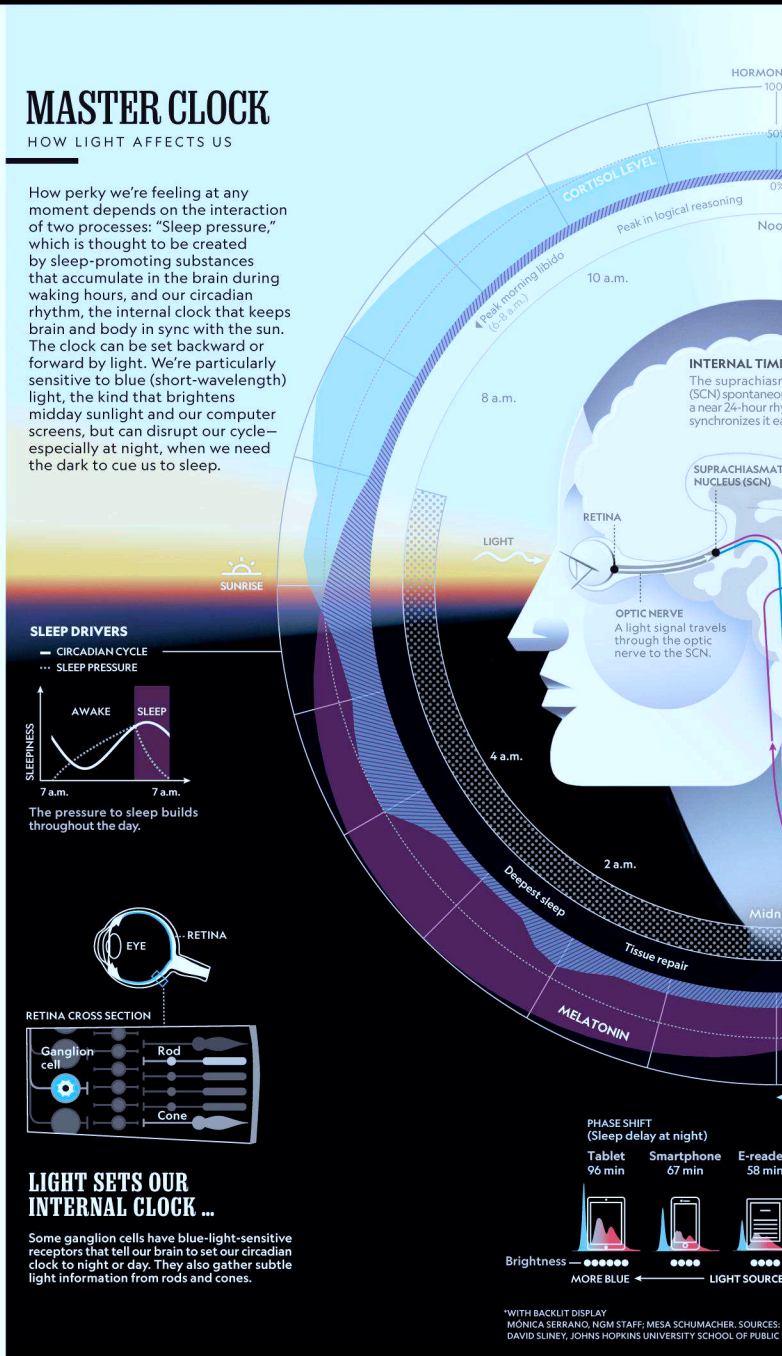
It doesn't necessarily choose wisely. Sleep reinforces our memory so powerfully—not just in stage 2, where we spend about half our sleeping time, but throughout the looping voyage of the night—that it might be best, for example, if exhausted soldiers returning from harrowing missions did not go directly to bed. To forestall post-traumatic stress disorder, the soldiers should remain awake for six to eight hours, according to neuroscientist Gina Poe at the University of California, Los Angeles. Research by her and others suggests that sleeping soon after a major event, before some of the ordeal is mentally resolved, is more likely to turn the experience into long-term memories.

Stage 2 can last up to 50 minutes during the night's first 90-minute sleep cycle. (It typically occupies a smaller portion of subsequent cycles.) Spindles can arrive every few seconds for a while, but when these eruptions taper off, our heart rate slows. Our core temperature drops. Any remaining awareness of the external environment disappears. We commence the long dive into stages 3 and 4, the deep parts of sleep.

STAGES 3-4

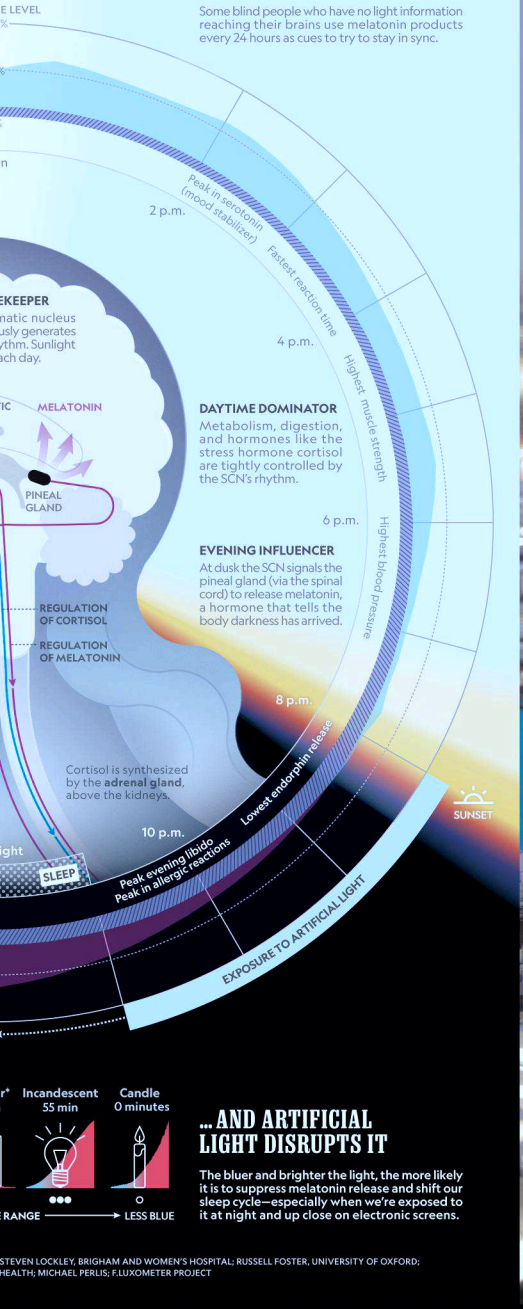
WE ENTER A DEEP, COMA-LIKE SLEEP THAT IS AS ESSENTIAL TO OUR BRAIN AS FOOD IS TO OUR BODY. IT'S A TIME FOR PHYSIOLOGICAL HOUSEKEEPING—NOT FOR DREAMING.

Every animal, without exception, exhibits at least a primitive form of sleep. Three-toed sloths snooze about 10 hours a day, a disappointing display of languor, but some fruit bats manage 15 hours, and little brown bats have been reported to laze for 20. Giraffes sleep less than five. Horses typically sleep part of the night standing up and part lying down. Dolphins sleep one hemisphere at a time—half the brain sleeps while the other half is awake, allowing them to swim continuously. Great frigatebirds can nap while gliding, and other birds may do the same. Nurse sharks rest in a pile on the ocean floor. Cockroaches lower their



THE POWER OF ARTIFICIAL LIGHT

The war on sleep began when incandescent bulbs first made it easy to banish night. Big cities such as Tokyo are now often illuminated with LED bulbs. They're more energy-efficient, but they tend to produce a lot of blue light, the most sleep-disrupting kind.



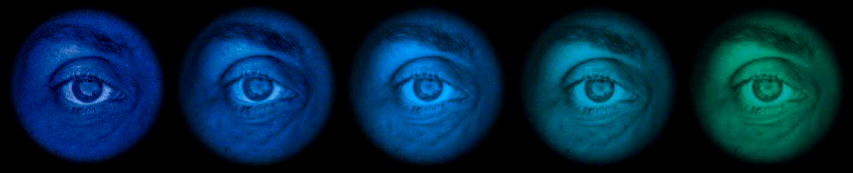
...AND ARTIFICIAL LIGHT DISRUPTS IT

The bluer and brighter the light, the more likely it is to suppress melatonin release and shift our sleep cycle—especially when we're exposed to it at night and up close on electronic screens.

STEVEN LOCKLEY, BRIGHAM AND WOMEN'S HOSPITAL; RUSSELL FOSTER, UNIVERSITY OF OXFORD; HEALTH; MICHAEL PERLIS; F.LUXOMETER PROJECT

THE EFFECT OF COLORED LIGHT

Steven Lockley's lab at Brigham and Women's Hospital in Boston studies a phenomenon that buffets us all every day: Light, and how specific wavelengths of it falling on the eye affect our brain, our behavior, and our physiology. Light rich in red wavelengths, he says, is best at night, because it has the least power to promote alertness or reset our 24-hour biological clock.



FOUND LIGHT IN TOKYO

Portraits taken on the nighttime streets of Tokyo, in the ambient glow from neon signs, show the rainbow of colors that can either stimulate or relax us, a topsy-turvy experience that subverts the natural flow of light and dark our bodies have adapted to over millions of years.

NIGHT LIGHTS

To get a clear view of how humans are changing the night sky, NASA has created composite satellite images of the entire Earth at night. Using a series of techniques referred to as "turning off the moon," NASA scientists filter out all natural emitters and absorbers of light, such as fires, auroras, clouds, and snow and ice. The results, updated regularly, provide the best picture yet of the evolving pattern of human settlement—and of our relentless drive to light up the night.


ASIA
Seoul
South Korea
Tokyo
Japan
Delhi
India
Shanghai
China
umbai
India
Hong Kong
China
Bangkok
Thailand
Singapore
RYAN MORRIS, NGM STAFF
SOURCES: NASA BLACK MARBLE SCIENCE TEAM;
NASA EARTH OBSERVATORY

antennae while napping, and they're also sensitive to caffeine.

Sleep, defined as a behavior marked by diminished responsiveness and reduced mobility that is easily disrupted (unlike hibernation or coma), exists in creatures without brains at all. Jellyfish sleep, the pulsing action of their bodies noticeably slowing, and one-celled organisms such as plankton and yeast display clear cycles of activity and rest. This implies that sleep is ancient and that its original and universal function is not about organizing memories or promoting learning but more about the preservation of life itself. It's evidently natural law that a creature, no matter the size, cannot go full throttle 24 hours a day.

'You're talking about a level of brain deactivation that is really rather intense,' says Michael Perlis, the director of the Behavioral Sleep Medicine program at the University of Pennsylvania. 'Stage 4 sleep is not far removed from coma or brain death. While restorative, it's not something you'd want to overdose on.'

"Being awake is demanding," says Thomas Scammell, a neurology professor at Harvard Medical School. "You've got to go out there and outcompete every other organism to survive, and the consequences are that you need a period of rest to help cells recuperate."

For humans this happens chiefly during deep sleep, stages 3 and 4, which differ in the percentage of brain activity that's composed of big, rolling delta waves, as measured on an EEG. In stage 3, delta waves are present less than half the time; in stage 4, more than half. (Some scientists consider the two to be a single deep-sleep stage.) It's in deep sleep that our cells produce most growth hormone, which is needed throughout life to service bones and muscles.

There is further evidence that sleep is essential for maintaining a healthy immune system, body temperature, and blood pressure. Without enough of it, we can't regulate our moods well or recover swiftly from injuries. Sleep may be more essential to us than food; animals will die of sleep deprivation before starvation, says Steven Lockley of Brigham and Women's Hospital in Boston.

Good sleep likely also reduces one's risk of developing dementia. A study done in mice by Maiken Nedergaard at the University of Rochester, in New York, suggests that while we're awake, our neurons are packed tightly together, but when we're asleep, some brain cells deflate by 60 percent, widening the spaces between them. These intercellular spaces are dumping grounds for the cells' metabolic waste—notably a substance called beta-amyloid, which disrupts communication between neurons and is closely linked to Alzheimer's. Only during sleep can spinal fluid slosh like detergent through these broader hallways of our brain, washing beta-amyloid away.

While all this housekeeping and repair occurs, our muscles are fully relaxed. Mental activity is minimal: Stage 4 waves are similar to patterns produced by coma patients. We do not typically dream during stage 4; we may not even be able to feel pain. In Greek mythology the gods Hypnos (sleep) and Thanatos (death) are twin brothers. The Greeks may have been right.

"You're talking about a level of brain deactivation that is really rather intense," says Michael Perlis, the director of the Behavioral Sleep Medicine program at the University of Pennsylvania. "Stage 4 sleep is not far removed from coma or brain death. While recuperative and restorative, it's not something you'd want to overdose on."

At most, we can remain in stage 4 for only about 30 minutes before the brain kicks itself out. (In sleepwalkers at least, that shift can be accompanied by a bodily jerk.) We often sail straight through stages 3, 2, and 1 into awakeness.

Even healthy sleepers wake several times a night, though most don't notice. We drop back to sleep in a matter of seconds. But at this point, rather than repeating the stages again, the brain resets itself for something entirely new—a trip into the truly bizarre.

According to the U.S. Centers for Disease Control and Prevention, more than 80 million American adults are chronically sleep deprived, meaning they sleep less than the recommended minimum of seven hours a night. Fatigue contributes to more than

a million auto accidents each year, as well as to a significant number of medical errors. Even small adjustments in sleep can be problematic. The Monday after a daylight saving time change in the U.S., there's a 24 percent increase in heart attacks, compared with other Mondays, and a jump in fatal car crashes too.

During our lifetimes, about a third of us will suffer from at least one diagnosable sleep disorder. They range from chronic insomnia to sleep apnea to restless leg syndrome to much rarer and stranger conditions.

In exploding head syndrome, booming sounds seem to reverberate in your brain as you try to sleep. A Harvard study found that sleep paralysis—the inability to move for a few minutes after you've woken from dreaming—is the genesis of many alien abduction stories. Narcoleptic attacks, uncontrollable episodes of sudden sleep onset, often are triggered by strongly positive emotions, such as listening to a joke, being tickled, or tasting delicious food. People with Kleine-Levin syndrome will, every few years, sleep nearly nonstop for a week or two. They return to regular cycles of consciousness without any discernible side effects.

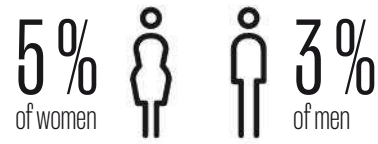
Insomnia is by far the most common problem, the main reason 4 percent of U.S. adults take sleeping pills in any given month. Insomniacs generally take longer to fall asleep, wake up for prolonged periods during the night, or both. If sleep is such a ubiquitous natural phenomenon, refined across the eons, you might wonder, why do so many of us have such trouble with it? Blame evolution; blame the modern world. Or blame the mismatch between the two.

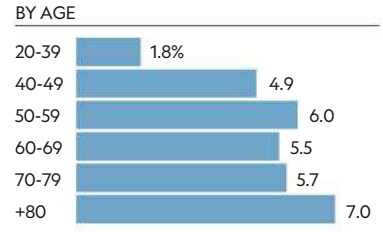
Evolution endowed us, like other creatures, with sleep that is malleable in its timing and readily interruptible, so it can be subordinated to higher priorities. The brain has an override system, operating in all stages of sleep, that can rouse us when it perceives an emergency—the cry of a child, say, or the footfall of an approaching predator.

The problem is that in the modern world, our ancient, innate wake-up call is constantly triggered by non–life-threatening situations, like anxiety before an exam, worries about finances, or every car alarm in the neighborhood. Before the industrial revolution, which brought us alarm clocks and fixed work schedules, we could often counteract insomnia simply by sleeping in. No longer. And if you're one

THE AGE OF SLEEP AIDS

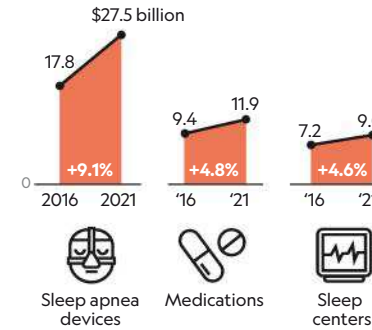
A Centers for Disease Control and Prevention study found that older Americans are more likely to use prescription sleep aids than their younger counterparts. Women were also slightly more likely than men to report they used sleep aids.





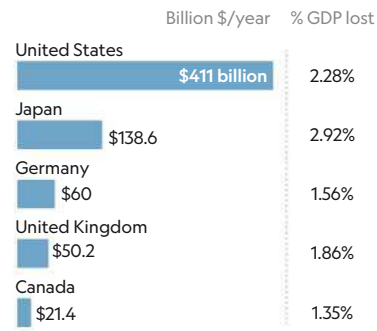
THE MARKET FOR SLEEP

Sleep-deprived consumers paid $66 billion in 2016 for devices, medications, and sleep studies. The figure could rise to $85 billion by 2021.



THE COST OF SLEEPLESSNESS

A 2017 Rand study found that lack of sleep can result in reduced productivity as well as more work absences, industrial and road accidents, health care expenses, and medical errors.



NGM STAFF. SOURCES: U.S. CENTERS FOR DISEASE CONTROL AND PREVENTION; BCC RESEARCH; RAND EUROPE

Anyone who regularly sleeps less than six hours has a higher risk of depression, psychosis, stroke, and obesity. Sleeplessness undermines your whole body.

In Sweden hundreds of immigrant children whose families face deportation have contracted resignation syndrome, a baffling disorder in which the child withdraws from the world, won't react even to painful stimuli, and must be nourished with a feeding tube—sometimes for years. "She is not suffering now," physician Elisabeth Hultcrantz says of Leyla Ahmed, 10, a Syrian refugee.

NEXT PHOTO

Mike Morris, an Army veteran of two tours in Iraq, wears an EEG cap as he sleeps with his therapy dog, Olive. He's part of a study by Jeffrey Ellenbogen of Johns Hopkins University that explores how companionship and the sounds a sleeper is exposed to affect recovery from trauma.

U.S. ARMY
MORRIS

of those people who are proud of being able to fall asleep quickly just about anywhere, you can stop gloating—it's a distinct sign, especially if you're less than 40 years old, that you're acutely sleep deprived.

The first segment of the brain that begins to fizzle when we don't get enough sleep is the prefrontal cortex, the cradle of decision-making and problem-solving. Underslept people are more irritable, moody, and irrational. "Every cognitive function to some extent seems to be affected by sleep loss," says Chiara Cirelli, a neuroscientist at the Wisconsin Institute for Sleep and Consciousness. Sleep-deprived suspects held by the police, it's been shown, will confess to anything in exchange for rest.

Anyone who regularly sleeps less than six hours a night has an elevated risk of depression, psychosis, and stroke. Lack of sleep is also directly tied to obesity: Without enough sleep, the stomach and other organs overproduce ghrelin, the hunger hormone, causing us to eat more than we need. Proving a cause-and-effect relationship in these cases is challenging, because you can't subject humans to the necessary experiments. But it's clear that sleeplessness undermines the whole body.

Power naps don't solve the problem; nor do pharmaceuticals. "Sleep is not monolithic," says Jeffrey Ellenbogen, a sleep scientist at Johns Hopkins University who directs the Sound Sleep Project, which counsels businesses on how their employees can achieve better performance through healthier rest. "It's not a marathon; it's more like a decathlon. It's a thousand different things. It's tempting to manipulate sleep with drugs or devices, but we don't yet understand sleep enough to risk artificially manipulating the parts."

Ellenbogen and other experts argue against shortcuts, especially the original one—the notion that we can mostly do without sleep. It was a glorious idea: If we could just cut the unnecessary parts of sleep, it'd be like adding decades to our life. In the early days of sleep science, the 1930s and '40s, the second half of the night was considered by some to be the doldrums of rest. Some thought we might not need it at all.

That period turns out, instead, to be the wellspring of a completely separate but just as essential form of sleep, practically another type of consciousness altogether.

REM

IN A WILD STATE OF PSYCHOSIS, WE'RE DREAMING, WE'RE FLYING, AND WE'RE FALLING—WHETHER WE REMEMBER IT OR NOT. WE'RE ALSO REGULATING OUR MOOD AND CONSOLIDATING OUR MEMORIES.

Rapid eye movement, or REM, sleep was discovered in 1953—more than 15 years after stages 1 through 4 had been mapped—by Eugene Aserinsky and Nathaniel Kleitman at the University of Chicago. Before then, because of its unremarkable pattern on early EEGs, this period was usually thought of as a variant form of stage 1, and not particularly significant. But once the distinctive eye darting was documented, and the engorgement of sexual organs that always goes with it, and it was understood that virtually all vivid dreaming takes place in this phase, the science of sleep was upended.

Generally, a healthy sleep begins with a spiral down to stage 4, a momentary return to wakefulness, and a five- to 20-minute REM session. With each ensuing cycle, REM time roughly doubles. Overall, REM sleep occupies about one-fifth of total rest time in adults. Yet stages 1 through 4 have been labeled as non-REM sleep, or NREM—80 percent of sleep is defined by what it's not. Sleep scientists speculate that specific sequences of NREM and REM sleep somehow optimize our physical and mental recuperation. At the cellular level, protein synthesis peaks during REM sleep, keeping the body working properly. REM sleep also seems essential for regulating mood and consolidating memories.

Every time we experience REM sleep, we literally go mad. By definition, psychosis is a condition characterized by hallucinations and delusions. Dreaming, some sleep scientists say, *is* a psychotic state—we fully believe that we see what is not there, and we accept that time, location, and people themselves can morph and disappear without warning.

From ancient Greeks to Sigmund Freud to back-alley fortune-tellers, dreams have always been a source of enchantment and mystery—interpreted as messages from the gods or our unconscious. Today many sleep experts aren't interested in the specific images and events in our dreams. They believe that dreams result

from the chaotic firing of neurons and, even if imbued with emotional resonance, are devoid of significance. It's only after we wake that the conscious brain, seeking meaning, quickly stitches together a whole cloth out of haphazard scraps.

Other sleep scientists strongly disagree. "The content of dreams," says Stickgold of Harvard, "is part of an evolved mechanism for looking at the larger significance of new memories and how they could be useful in the future."

Even if you never recall a single image, you still dream. Everyone does. Lack of dream recollection is actually an indication of a healthy sleeper. The action in dream sleep takes place too deep in the brain to register well on an EEG, but with newer technology, we've inferred what's going on, physically and chemically. Dreams also occur in NREM sleep, especially stage 2, but these are generally thought to be more like overtures. Only in REM sleep do we encounter the full potent force of our nighttime madness.

Dreams, often falsely said to be just momentary flashes, are instead thought to span almost all of REM sleep, typically about two hours per night, though this decreases as we age—perhaps because our less pliant brains are not learning as much while awake and have fewer new memories to process as we sleep. Newborn infants sleep up to 17 hours a day and spend about half of that in an active, REM-like condition. And for about a month in the womb, starting at week 26 of gestation, it seems that fetuses remain without pause in a state very similar to REM sleep. All this REM time, it has been theorized, is the equivalent of the brain testing its software, preparing to come fully on line. The process is called telencephalization. It's nothing less than the opening of the mind.

The body doesn't thermoregulate in REM sleep; our internal temperature remains at its lowest setting. We are truly out cold. Our heart rate increases compared with other sleep stages, and our breathing is irregular. Our muscles, with a few exceptions—eyes, ears, heart, diaphragm—are immobilized. Sadly, this doesn't keep some of us from snoring; this bane of the bed partner, impetus for hundreds of anti-snoring gadgets, is caused when turbulent airflow vibrates the relaxed tissues of the throat or nose. It's common in stages 3 and 4 too. In REM sleep, whether snoring or not, we're completely incapable of physical response, slack-jawed, unable to regulate even our blood pressure. Yet our brain is able to convince us that we're surfing on clouds, slaying dragons.

Belief in the unbelievable happens because in REM sleep, stewardship of the brain is transferred away from the logic centers and impulse-control regions. Production of two specific chemicals, serotonin and norepinephrine, is completely shut off. Both are essential neurotransmitters, permitting brain cells to communicate, and without them, our ability to learn and remember is severely impaired—we're in a chemically altered state of consciousness. But it's not a coma-like state, as in stage 4. Our brain during REM sleep is fully active, guzzling as much energy as when we're awake.

REM sleep is ruled by the limbic system—a deep-brain region, the untamed jungle of the mind, where some of our most savage and base instincts arise. Freud was right, in effect, that dreams do tap our primitive emotions. The limbic system is home to our sex drive, aggression, and fear, though it also allows us to feel elation and joy and love.

Every time we experience REM sleep, we literally go mad. Psychosis is a condition characterized by hallucinations and delusions. Dreaming, some sleep scientists say, *is* a psychotic state—we fully believe that we see what is not there, and we accept that time, location, and people can morph and disappear.

While it sometimes seems as if we have more nightmares than pleasant dreams, this probably isn't true. Frightening dreams are simply more likely to trigger our override system and wake us.

Down in the brain stem, a little bulge called the pons is supercharged during REM sleep. Electrical pulses from the pons often target the part of the brain that controls muscles in the eyes and ears. Our lids usually remain shut, but our eyeballs bounce from side to side, possibly in response to the intensity of the dream. Our inner ears too are active while we dream.

The Japanese term *inemuri,* or "sleeping while present," is a distinct form of napping in which a person dozes in a place not meant for sleep, such as the subway—or even at a dinner party or the office. "Since you're officially not sleeping," says Brigitte Steger, a Japan specialist at the University of Cambridge in England, "to be socially acceptable you should behave as is appropriate in a certain situation. For example in a meeting, you half pretend listening or hide your sleeping head behind paperwork." If you're not already known as a slacker, Steger adds, a little inemuri may even enhance your business reputation: It demonstrates that you're working yourself to exhaustion.

So are the parts of the brain that generate motion—which is why there's frequently a sense of flying or falling in dreams. We dream, as well, in full color, unless we've been blind from birth, in which case dreams do not have visual imagery but remain emotionally intense. Men's and women's dreams seem to be similar in emotional content. Every time a man dreams, even if the content isn't sexual, he has an erection; in women, blood vessels in the vagina are engorged. And while we dream, no matter how absurd, despite all transgressions against the laws of physics, we're almost always convinced we're awake. The ultimate virtual-reality machine resides inside our head.

Thank goodness we're paralyzed. When you dream, your brain is actually trying to produce movements, but a system in the brain stem completely shuts down the motor-neuron gate. There's a parasomnia—a sleep abnormality that affects the nervous system—called REM behavior disorder in which the gate does not fully lower, and people act out their dreams in spectacular fashion, punching, kicking, swearing, all while their eyes are closed and they're fully asleep. This often results in injuries to the sleeper and his or her bedmate.

The end of a REM session, like the end of stage 4, is usually marked with a brief awakening. If we rest naturally, without an alarm clock, our last dream of the night often concludes our sleep. Though the amount of time we've been asleep helps determine the optimal moment to wake, daylight has immediate alerting properties. When light seeps through our eyelids and touches our retinas, a signal is sent to a deep-brain region called the suprachiasmatic nucleus. This is the time, for many of us, that our last dream dissolves, we open our eyes, and we rejoin our real life.

Or do we? Perhaps the most remarkable thing about REM sleep is that it proves the brain can operate independently of sensory input. Like an artist ensconced in a secret studio, our mind appears to experiment without inhibition, let loose on its own personal mission.

When we're awake, the brain is occupied with busy work—all those limbs to control, the constant driving and shopping and texting and talking. The money-earning, the child-rearing.

But when we're sleeping, and we commence

Joe Diemand, 76, has spent the past 20 years as a truck driver, sometimes driving all night. Such work, he says, leaves you "so tired that you can't sleep." The World Health Organization has described night shift work as "probably carcinogenic to humans."

our first REM session, the most elaborate and complex instrument known in the universe is free to do what it wishes. It self-activates. It dreams. This, one could say, is the playtime of the brain. Some sleep theorists postulate that REM sleep is when we are our most intelligent, insightful, creative, and free. It's when we truly come alive. "REM sleep may be the thing that makes us the most human, both for what it does for the brain and body, and for the sheer experience of it," says Michael Perlis.

Maybe, then, we've been asking the wrong question about sleep, ever since Aristotle. The real wonder isn't why we sleep. It's why, with such an incredible alternative available, do we bother to stay awake?

And the answer might be that we need to attend to the basics of life—the eating and mating and fighting—only to ensure that the body is fully ready for sleep. □

Michael Finkel's latest book, *The Stranger in the Woods,* is about a hermit who, after 27 years alone, had achieved this insight: "Get enough sleep." Swedish photographer **Magnus Wennman**'s exhibit on refugees, Where the Children Sleep, has toured worldwide.

A young male lion was one of three members of Kenya's famous Marsh Pride to die in 2015 after eating a cow carcass that Maasai herders had laced with carbosulfan, an insecticide. The lions had killed several cows.

BY EDWIN DOBB
PHOTOGRAPHS BY CHARLIE HAMILTON JAMES

Poisoning Africa

DEADLY, CHEAP **PESTICIDES...**

A traditional way to kill animals with poison is to tip arrows—like these made by Maasai at a market in Olpusi Moru, on Kenya's border with Tanzania—with a lethal substance from the bark of the *Acocanthera* tree.

...ARE POTENT WEAPONS IN **AFRICA...**

Conservationists hold a sickened gray heron and birds that died after aerial spraying of the pesticide fenthion in the Bunyala rice-growing area. Villagers collect and eat the birds, even though they're poisoned.

...AND ARE RAVAGING ITS **WILDLIFE.**

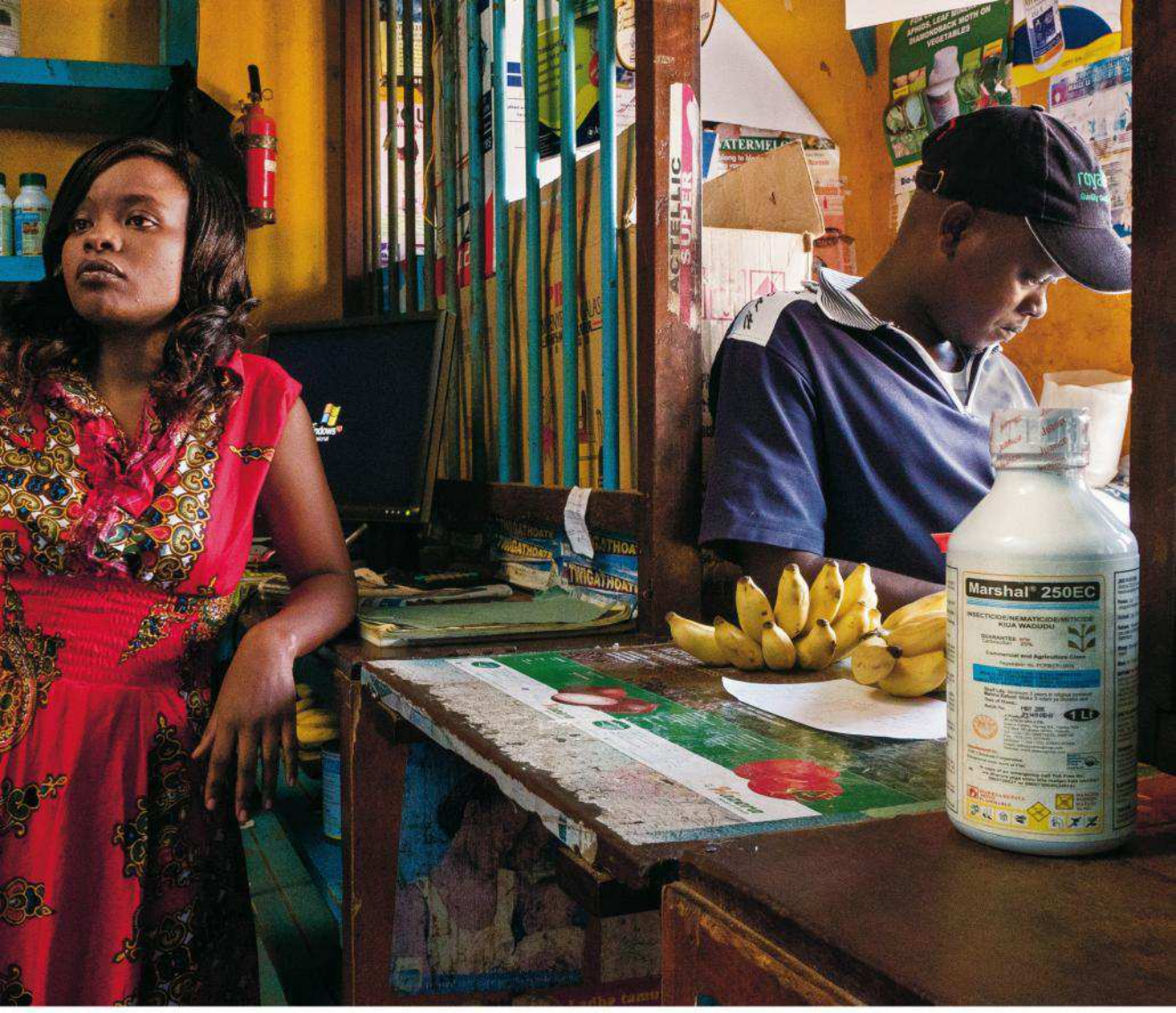
Two male lions had been killing cattle and goats for weeks. The Maasai herdsmen in Kenya's Osewan region had seen enough.

The legal insecticide Marshal (at far right) is readily available in Kenya, including at this shop near Amboseli and Tsavo West National Parks. The saleswoman, Faithy Ndungu, says she wouldn't knowingly sell Marshal to someone wanting to kill wildlife, but it has shown up on carcasses to bait predators. The U.S. company that makes Marshal, FMC, says it doesn't know of any misuse of the poison and is investigating.

Solve the problem by Christmas, the Maasai told the Kenya Wildlife Service in late December last year, or we'll solve it for you. "We know how to kill lions," one young Maasai warrior said in Swahili during a heated community meeting, and he didn't mean only the spears that he and his fellow Maasai carry. He also meant poison, now a weapon of choice for herders who see lions as threats to their livelihood rather than the national symbols the wildlife service tries to protect.

Kenneth Ole Nashuu, a senior warden with KWS, as people call the wildlife service, decided that the best solution was to relocate the lions from Osewan, north of Amboseli National Park, where they'd come in contact with grazing livestock, to a neighboring national park, Tsavo West. But first they had to be tranquilized.

On Christmas Eve night Ole Nashuu and other rangers were joined by Luke Maamai, from



the conservation group Lion Guardians. They climbed into a Land Cruiser, drove to a clearing in the bush, and parked. Under a big, bright moon, with lights off, they waited for the rogue predators—young brothers—to appear.

Maamai, who's Maasai, placed a speaker on the roof of the vehicle and broadcast into the darkness the recorded bleating of a dying buffalo calf, a sound lions can't resist. After just 15 minutes a large animal stepped from the shadows on the right. Ole Nashuu switched on his headlights. It was a lioness, one of two sisters that partnered with but weren't related to the brothers. The lioness, about 10 yards in front of the vehicle, moved cautiously toward a small tree Maamai had baited with goat innards. Ole Nashuu signaled to a veterinarian who was sitting in a second Land Cruiser, his rifle loaded with a tranquilizer dart.

After directing his men to shimmy the passed-out lioness into a cage, Ole Nashuu congratulated the group on a successful mission. The removal of the female, he said, would disrupt the pride and stop the brothers from preying on the community's livestock—a curious claim, it seemed, because the young male lions, the primary mischief-makers, were still out there.

Later that night my guide, Simon Thomsett, a leading expert on raptors in Kenya, and I were trying to sleep in his Land Cruiser when we heard growling and grunting—first at a distance, then closer. It was the two male lions, presumably searching for the female. The team darted and captured one of the brothers, but the other escaped. The captured male and female eventually were released in Tsavo West. Previous experience suggests they probably haven't survived: Lions dumped without acclimation into another pride's territory are treated as intruders

and often experience a torturous death.

"We want to give them a second chance," says Francis Gakuya, head of veterinary services at KWS, which is responsible for the welfare of all wildlife in Kenya. But many lion experts believe that in such situations, it would have been more humane to kill the troublesome lions on the spot.

Meanwhile, contrary to the warden's theory about disrupted prides, the remaining male continued to prey on livestock. This time herdsmen—possibly not local—didn't seek outside help. They poisoned the male and the other female by lacing a goat or cow carcass with chemicals that killed the lions after they fed on the dead animal. By the time KWS heard about it and sent a veterinarian to investigate, the lions' bodies had rotted.

The vet also found the remains of vultures and a hyena, probably only a fraction of the animals that had died after feeding on the contaminated livestock carcass—the extended "crime scene" that's common in wildlife poisonings. Unfortunately the vet didn't take samples for testing, even though certain poisons can stay in a body for a long time. So the only people who know what substance killed the lions are those least likely to talk about it.

IN KENYA AND ACROSS AFRICA, poison is used to kill small creatures for food (the impact on human health is unclear), poach elephants and rhinos for their tusks and horns, and acquire animal parts for traditional medicine. Another vexing use of poison results from encounters between people and wild animals—when a lion or hyena kills livestock, for example, or an elephant destroys property—and it usually involves a pesticide, because pesticides are cheap, readily available, and deadly.

"Poisoning is a big problem," Gakuya acknowledges. And judging from the Osewan episode, it's a problem that continues to elude solution. Retaliatory poisoning can happen anywhere anytime, but the evidence of it is often anecdotal and almost always incomplete. Even so, nearly everyone monitoring Kenya's wildlife—biologists, KWS staff, and conservation groups—agrees that poisoning is likely to increase because human-wildlife conflicts are increasing.

Kenya's protected areas are under siege, including all the premier reserves and parks in the south: Masai Mara, Amboseli, Tsavo West, and Tsavo East. Rapid development—from highways, railroads, power plants, and power lines to heavy industry, high-tech centers, and growing cities—is encroaching. Kenya's population, already overwhelming local resources, is expected to nearly double to more than 80 million by 2050, and open country is being converted into farms, blocking animal movements.

As a result, lands adjacent to parks—the large, collectively owned tracts known as group ranches, as well as other community lands—are becoming inhospitable to wildlife. For elephants and other large animals that need those areas for migration between parks, for seasonal dispersal to find food and water, and for giving birth, the onslaught is catastrophic.

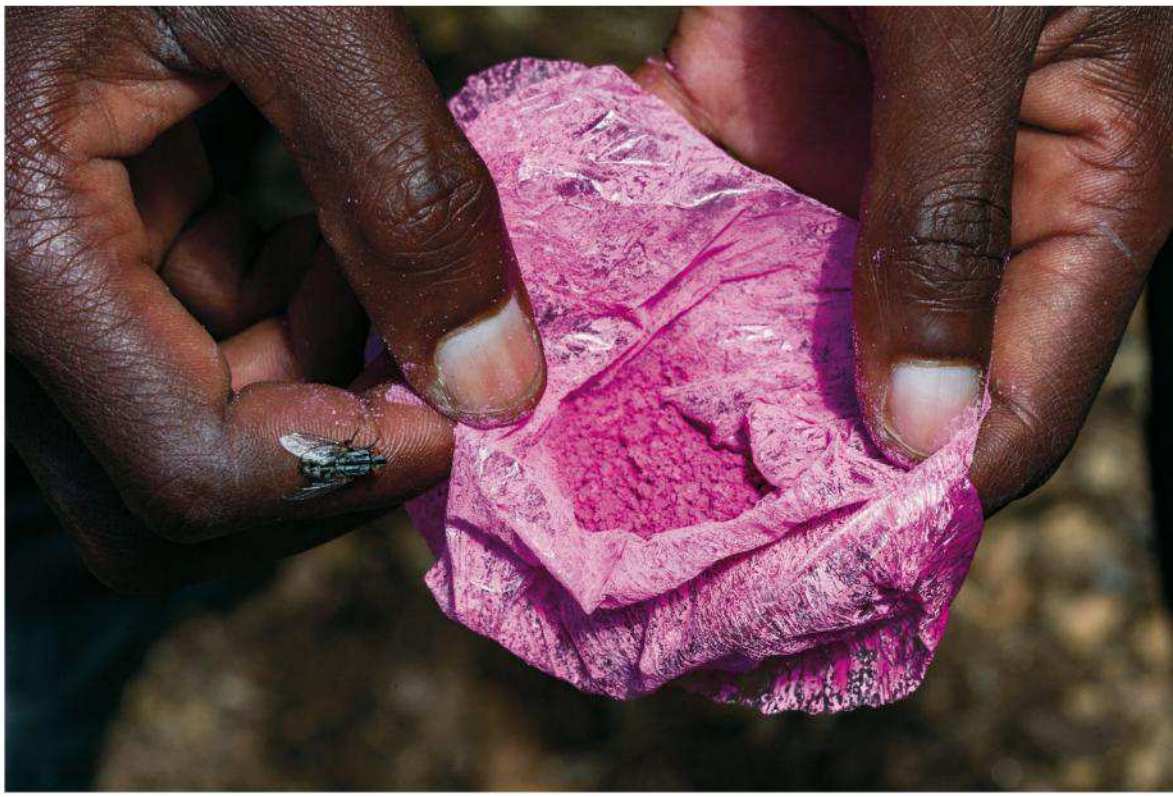
Kenya has arrived at a crossroads. "We're no longer preserving our nation as a haven for wildlife," Thomsett says, referring to Kenya's accelerating economic growth. "We're trying to become the Dubai of Africa." That may seem extreme, but it's hard to argue with the facts.

The lion is Kenya's signature wild animal, but fewer than 2,000 remain in the entire country, down from an estimated 20,000 five decades ago, and the species has vanished from about

Ornithologist Martin Odino (at right) and a helper burn African mourning doves poisoned by pesticide in the Bunyala rice fields. Incinerating the doves prevents more deaths of birds and scavengers that would feed on the carcasses. Vulture populations in Kenya have crashed because of wildlife poisonings.

BELOW

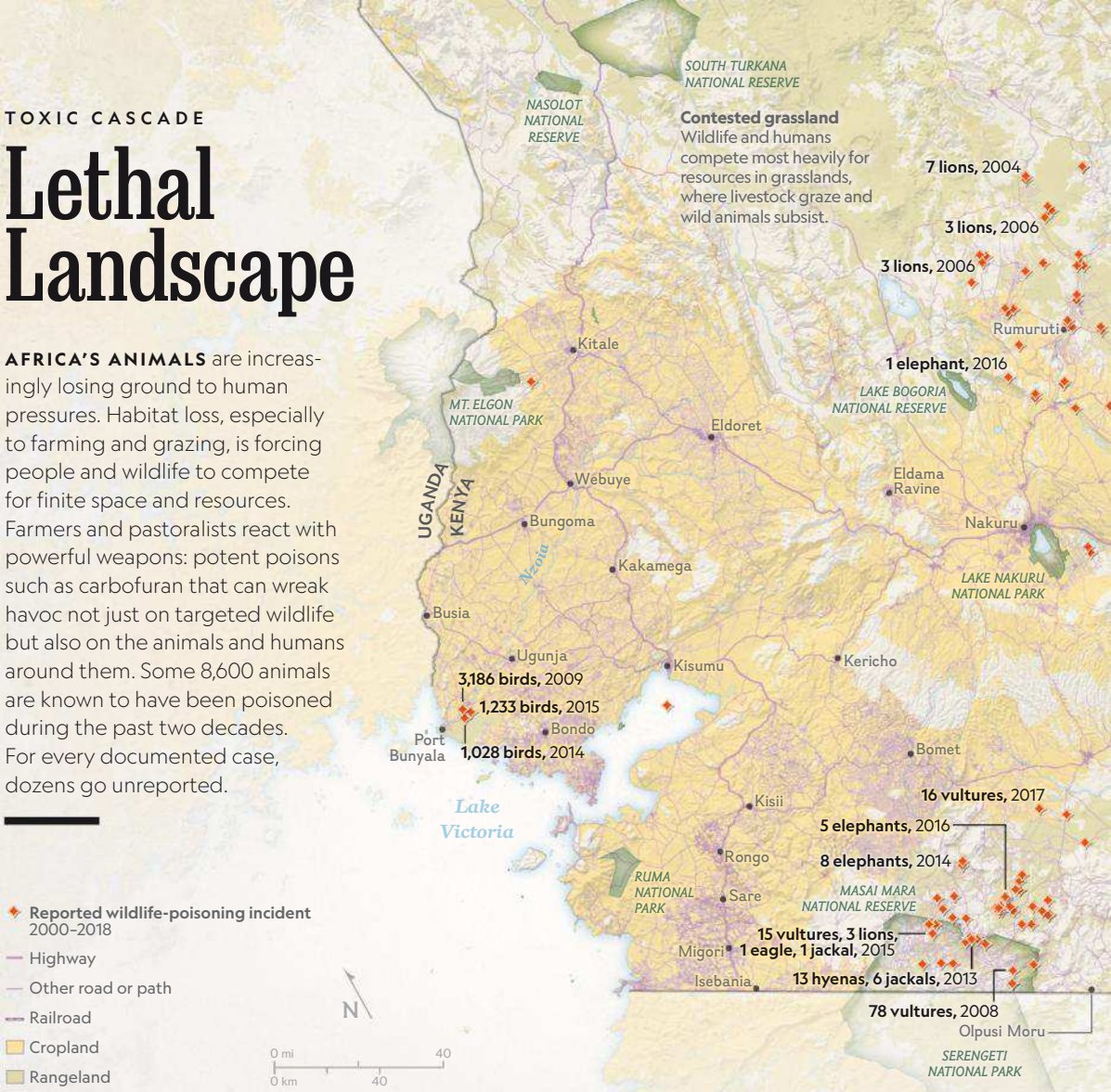
A Maasai herder reveals the carbosulfan he stashes near his home. The night before, he used the poison to kill a hyena that had preyed on his goats.



TOXIC CASCADE

Lethal Landscape

AFRICA'S ANIMALS are increasingly losing ground to human pressures. Habitat loss, especially to farming and grazing, is forcing people and wildlife to compete for finite space and resources. Farmers and pastoralists react with powerful weapons: potent poisons such as carbofuran that can wreak havoc not just on targeted wildlife but also on the animals and humans around them. Some 8,600 animals are known to have been poisoned during the past two decades. For every documented case, dozens go unreported.



WHY PESTICIDES ARE MISUSED

To protect livestock
Predators are poisoned in retaliation for eating cattle, chickens, and goats.

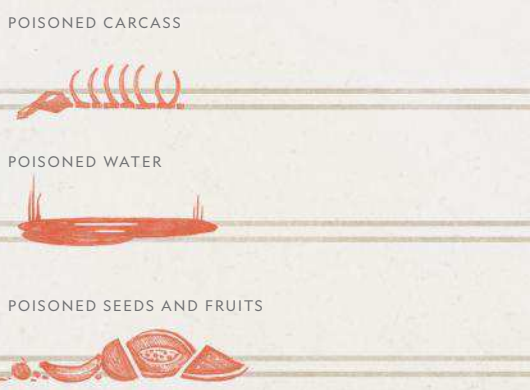
To hunt animals for trade
A China-driven global demand for animal parts—including ivory and fur—fuels the trade.

To kill animals for meat
Meat of fish and birds is sold without disclosing that the animals were killed with poison.

To safeguard crops
Crop-eating elephants, monkeys, and birds are targeted to reduce farmers' losses.

WHERE THEY'RE APPLIED

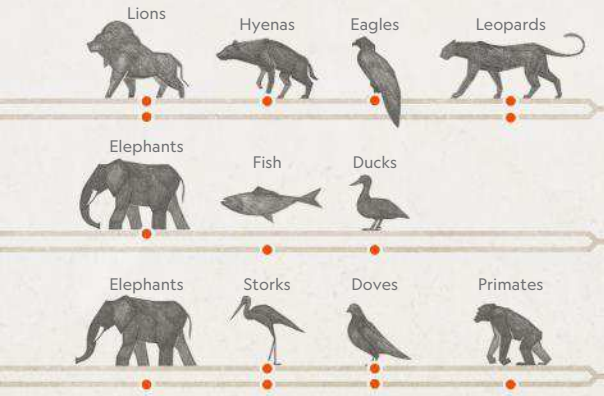
Pesticides are added to carcasses placed to bait wildlife as well as to natural water and food sources.



MATTHEW W. CHWASTYK AND MANUEL CANALES, NGM STAFF. KELSEY NOWAKOWSKI. SOURCES: DARCY OGADA, PEREGRINE FUND; AFRICAN RAPTOR DATABANK, HABITAT INFO; WAGENINGEN UNIVERSITY & RESEARCH; AFRICAN WILDLIFE POISONING DATABASE, ENDANGERED WILDLIFE TRUST; DUTCH MINISTRY OF ECONOMIC AFFAIRS; WWF-NETHERLANDS; RAPTORS MOU, UNEP/CMS; LIVING WITH LIONS; NORTH CAROLINA ZOO; WDPA; NASA EOSDIS LAND PROCESSES CROP EXTENT; WRI; ROAD DATA © OPENSTREETMAP CONTRIBUTORS, AVAILABLE UNDER OPEN DATABASE LICENSE: *OPENSTREETMAP.ORG/COPYRIGHT*

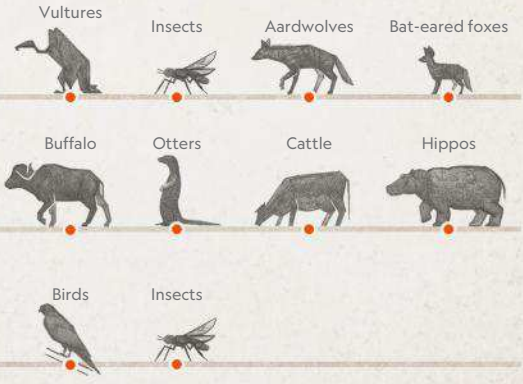
PRIMARY TARGETS

Animals that are directly targeted include lions that are poisoned to protect cattle and elephants poached for their tusks.



COLLATERAL DAMAGE

Because chemicals linger in the environment and the food chain, victims are widespread. Humans too can get sickened.



Until recently Maasai drove tens of thousands of cattle into the Masai Mara National Reserve. Cattle incursions fluctuate in response to subdivision of neighboring lands, population growth, local politics, and drought.

These Maasai drive cattle and sheep from their village into Masai Mara reserve, reducing forage for wildlife hunted by lions and hyenas. The predators kill livestock, and herders retaliate by poisoning carcasses.

90 percent of its original range. Some experts predict that within another 20 years, lions will be reduced to zoo-like numbers, living under zoo-like conditions. Every deliberate poisoning brings Kenya one step closer to what the African-wildlife photographer Peter Beard famously called "the end of the game."

PEOPLE AROUND THE WORLD have long used poisons to hunt game and kill enemies. In East Africa the *Acocanthera* tree contains a compound that even in small doses can arrest the heart of a large mammal and has been popular for centuries. More recently the use of strychnine for "pest" control was so routine that none other than George Adamson, the celebrated conservationist known fondly in Kenya as Baba ya Simba (Father of Lions in Swahili), used it to dispatch hyenas he deemed a nuisance.

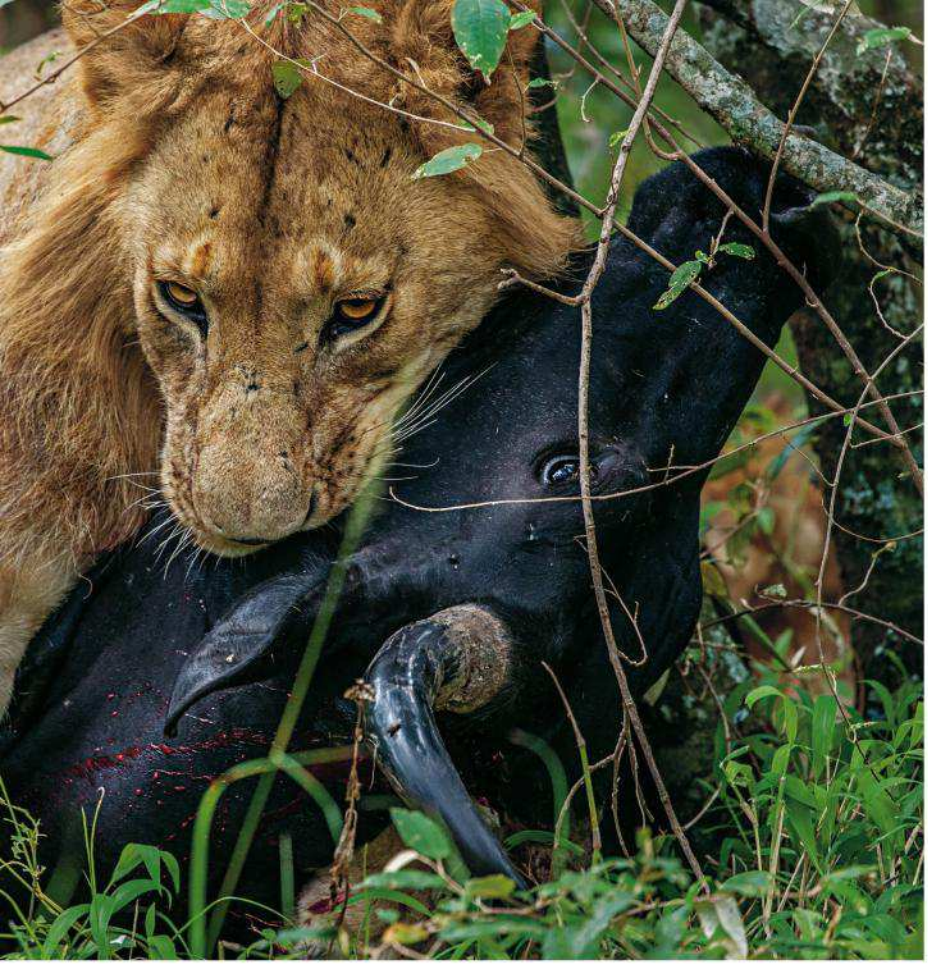
But the most fateful change, the mixed blessing that still plagues much of Africa and countries elsewhere, including the United States, was the development of synthetic poisons—insecticides and herbicides—for agriculture. Beginning in the 1980s, when the human population started to explode across Africa and competition for space and food increased sharply, landowners and pastoralists found that pesticides could also be employed to kill predators (lions, leopards, wild dogs, jackals), scavengers (hyenas, vultures), and crop raiders (elephants, certain birds). At some point people also started using the deadly compounds to poach ducks and other waterfowl and then sell them as food.

A national movement to address poisoning began when Nature Kenya, East Africa's oldest natural history organization, learned that farmers were using pesticides to kill lions in the north. Darcy Ogada, who was on Nature Kenya's Bird Committee, volunteered to design and oversee surveys to gauge the extent of the problem. She enlisted an aspiring ornithologist named Martin Odino to conduct the surveys.

One place they focused on was the Bunyala rice fields, in western Kenya, along Lake Victoria. According to unofficial reports, people there were killing birds with the pesticide Furadan 5G, a purple granular substance made by a U.S. company, Philadelphia-based FMC. Furadan 5G contains the compound carbofuran, a neurotoxin so poisonous that it had been banned or severely restricted in Canada, the European Union, Australia, and China and had been prohibited for use on food crops in the U.S. Yet Kenya had allowed the substance to be imported via the Juanco Group, a distributor in Nairobi.

During his first visit to the Bunyala region, Odino found that most agro-vets—small agricultural-supply stores in rural areas—sold Furadan 5G to anyone. He confirmed that poachers were applying Furadan to rice to kill ducks and to snails to kill African openbill storks that feed on them. Animals were dying by the thousands. Poachers sold the birds to local residents, who believed that contaminated bush meat, if properly prepared, could be rendered harmless, or almost so. Men eating soup containing poisoned bird parts told Odino that their knees felt weak afterward, a symptom consistent with a compound that can disrupt brain-cell activity. But no studies have been conducted.

Ogada took the findings to Paula Kahumbu, CEO of WildlifeDirect and one of the most influential conservationists in Kenya, who had been hearing about similar incidents elsewhere in the country. Kahumbu assembled a task force to address the problem. The inaugural meeting, held



Lions of the Talek Pride often prey on Maasai cattle. In this attack they killed two cows and injured another. The herders chased off the lions, but this young male was killed months later, likely with a poisoned arrow.

BELOW

Villagers in Empopogi, east of Masai Mara, treat an injured goat with brightly colored antiseptic spray. The night before, hyenas killed more than a hundred goats and sheep, ripping open their bellies.

A Maasai girl bounces on the carcass of a 52-year-old female elephant near Amboseli National Park, which is hemmed by farms. Rangers suspect the elephant was poisoned for raiding grain stores and removed her tusks.

In Masai Mara, villagers, along with rangers, community leaders, veterinarians, and NGO staff, participate in a three-day poison-response workshop under the auspices of the Endangered Wildlife Trust. They learn how to conduct forensic examinations, using dead animals like this goat, and revive wildlife sickened by poison.

BELOW

This young elephant, lovingly cared for at a retreat in Nairobi, was orphaned in Masai Mara when her mother was shot with a poisoned arrow.

in April 2008, was "pivotal," Ogada says. "For the first time a whole group of conservationists were talking about the issue in the same room." Still, Kahumbu knew it would be difficult to persuade the government to ban a chemical that Kenya's booming agricultural industry had become dependent on. "They don't have a cheaper and equally effective alternative," she says.

The poisoning problem received worldwide attention in early 2009, when a U.S. television newsmagazine, CBS's *60 Minutes,* aired a report about Furadan 5G killing lions in Kenya and highlighted Furadan's availability. Citing "30-plus poisonings" in the Amboseli region and "another 35 or 40" in pastoral lands (not conservation ranches) in Laikipia, northwest of Mount Kenya, carnivore biologist Laurence Frank told correspondent Bob Simon, "That's gotta be just the tiny tip of the iceberg."

The exposure embarrassed FMC, which pulled Furadan 5G from the market in Kenya and set up a buyback program. The strategy was effective, to a point: Since about 2010, agro-vet shops haven't sold Furadan 5G. But carbofuran is still very much available. Occasionally Furadan enters the country from elsewhere in Africa. And now counterfeit Furadan is in circulation, as are other carbofuran-based products from China and India. Meanwhile another FMC pesticide, a pink substance called Marshal, has shown up on carcasses meant to lure predators. Marshal contains carbosulfan, which breaks down into carbofuran in low, yet still toxic, concentrations. Despite the efforts of Kahumbu, Odino, Ogada, and others, Kenya's government has not outlawed carbofuran. President Uhuru Kenyatta has prioritized food security, and the nation's population growth makes a ban doubtful. More food means more intensive farming, with more herbicides and insecticides, according to Kahumbu. "Banning any pesticide is quite unlikely," she says.

As for FMC, Cori Anne Natoli, a company spokeswoman, wrote in an email that "this is the first that we have heard of any misuse of Marshal insecticide," adding that the company is investigating and claims no responsibility for any availability in Kenya of Furadan.

PERHAPS THE MOST GLARING reminder that Kenya continued to be a pesticide free-for-all after the Furadan recall was a poisoning incident nearly three years ago involving the Marsh Pride, the immensely popular lions that were featured on the BBC series *Big Cat Diary.* In early December 2015, the pride, which breeds in the Musiara Marsh, near the northwestern boundary of Masai Mara, killed several cattle. In response, herders spiked a carcass with poison. One lioness died, and a second, severely weakened, was mauled to death by hyenas. Shortly afterward a debilitated male was trampled by buffalo and had to be euthanized by a KWS vet. A postmortem revealed traces of carbosulfan as well as old spear wounds—battle scars from herders' previous attempts at retaliation.

The edges of all protected areas have become more dangerous for wildlife, but nowhere is the threat to large, highly mobile animals more obvious than in the eastern part of the Mara region. Outside the reserve, ranch livestock herds have been expanding and open land shrinking, prompting Maasai pastoralists to drive more and more cattle into the reserve to graze, especially during the dry season or times of drought.

At the height of the incursions, thousands of cattle amble illegally into lion habitat. The lions develop a taste for witless, slow-moving prey, taking victims on both sides of the boundary.

In a country where guns are difficult to acquire legally, the herders turn to the weapons at hand: poison or spears. "At night it's mayhem," Thomsett says, evoking a part of the wildlife experience tourists don't see.

Recognizing that ending the mayhem, or at least containing it, will rely on the cooperation of local people, nongovernmental organizations have tested a new approach—community-based conservation—to try to reduce retaliatory poisonings, poaching, and other kinds of violence toward Kenya's wildlife.

The most notable of the organizations use similar strategies. They include patrolling for homemade wire snares—a cheap and effective method for disabling zebras and similar animals for bush meat—compensating livestock owners for lost cattle and goats (with government and private money), and providing sturdier bomas, the often flimsy stick-and-branch corrals where animals are kept at night. Since 2010 the Anne Kent Taylor Fund has fortified nearly 800 bomas in the Mara region, and in almost every case livestock predation has decreased, which means the main motive for retaliatory and protective poisoning was eliminated.

One of the groups' most promising strategies has been to hire area residents as rangers, conflict mediators, and conservationists. "Wildlife management is people management," says Richard Bonham, co-founder of Big Life and its Africa director of operations, referring to the problem of human-wildlife conflict around Amboseli.

IT WOULD BE EASY to hold the Kenya Wildlife Service primarily responsible for the failure to stop wildlife poisoning, and some people do. The agency's ambitious vision—"to save the last great species and places on Earth for humanity"—seems to exceed its capacity.

Everywhere I traveled, I heard accounts of incompetence: samples from poisoned animals not taken, samples lost, samples misidentified, samples not being tested, and results never coming back from the lab. There also were complaints about improper treatment of injured but recoverable animals that led to needless deaths, poorly executed crime-scene investigations, and a lack of consistent, comprehensive data on which to base policies and procedures.

But KWS is at the mercy of larger forces, and chief among them is inadequate funding, says Brian Heath, head of the Mara Conservancy, which manages the Mara Triangle—the western and most ecologically robust section of Masai Mara. "At the national level, conservation is not a high priority," he says. Heath, also a former KWS trustee, points out that the government gives considerably more money to the tourism board than to KWS, even though the tourism industry, the second largest sector of Kenya's economy, would collapse without the great species and places KWS is charged with protecting.

The country's national parks are understaffed, and many staff members are undertrained. Veterinarians often are overworked because they're required by law to treat every human-inflicted injury to wildlife, even minor snare wounds, which can delay them from responding to a poisoning incident with multiple animal deaths. "It's very frustrating," says KWS's Francis Gakuya. Everywhere basic resources are insufficient, from too few vehicles to not enough fuel.

Another overlooked piece of the national puzzle is the role of police and judges. Mara Conservancy rangers caught two of the suspects in the Marsh Pride poisoning. But their Maasai neighbors raised bail, and the men were released. That was the end of it—no follow-up, no trial, no one held responsible. Prosecutions for poisoning wildlife in Kenya have increased recently, but most offenders go unpunished. "The most important thing to do is to start arresting people," says ornithologist Odino, echoing the lament of everyone who believes the gravity of animal-poisoning crimes is still not appreciated.

And so the poisonings continue. Carbofuran remains popular, but anything handy and lethal will do. Some 40 vultures died in a single incident in Masai Mara this year, almost certainly the collateral damage of retaliation against lions. Traditional concoctions are still used, especially among elephant poachers in Tsavo East, where at least half the elephants killed are felled by poisoned arrows—possibly as many as 15 last year. It's easy to smuggle strychnine from Tanzania on a motorbike, and any employee of a flower farm can divert a new insecticide to the local black market. Even cement has been used to poison wildlife, a perverse irony in a country booming with construction. Near Nairobi I saw a billboard advertising Simba Cement, which is made in Kenya. The sign depicted the face of a male lion over which the following words were superimposed: "King of the Concrete Jungle." If nothing

else, the species will survive as a symbol.

ONE DAY THE ANTI-POACHING PATROL of the Anne Kent Taylor Fund escorted me on a behind-the-scenes safari into Nyakweri Forest, atop the Siria Escarpment, outside Masai Mara. Patrol leader Elias Kamande, a young Kenyan conservationist, showed me a wooded area that until recently had been an elephant nursery.

"Two hundred females giving birth at one time," Kamande said. Today the refuge is being decimated by charcoal producers. Where months before had stood large, leafy hardwood trees was now a clear-cut area the size of four football fields—one of hundreds such treeless scars scattered throughout the remaining patches of escarpment forest. The lucrative but illicit charcoal industry is a by-product of land subdivision. Maasai here and outside other protected areas have been dividing up group ranches, with every male age 18 or older receiving a share—essentially privatizing the land while transitioning to sedentary life.

"Five years from now," Kamande said, referring to the Nyakweri Forest, "all this will be gone." What will replace it? Settlements, herds, crops, and fences, lots of fences. That's likely to lead to the elimination of animals—elephants, lions, giraffes, hyenas, buffalo—that have moved freely between the Mara Triangle and the escarpment, both of which are part of the larger Mara ecosystem.

Kenya still has time to save crucial dispersal areas and migration corridors. Doing so hinges in large part on areas called conservancies that are managed to make it attractive, by providing local people with income from tourist lodges, as well as other incentives, for landowners outside protected areas to set aside habitat for wildlife. When conservancies are established—from the regions of Masai Mara and Amboseli to the Tsavos—poisoning tends to decrease, at least in the short term. "It's still an experiment," Heath says, noting that drought, population growth, or government policy could undo everything.

Around Amboseli, Big Life recently started another experiment on neighboring group ranches: purchasing conservation easements, which are agreements not to put up fences, construct new buildings, or otherwise disrupt wildlife habitat.

What will happen if the easements and conservancies fail?

"The park is dead," Big Life's Bonham says.

During certain times of the year, almost all of Amboseli's roughly 200 lions, like the two rogue brothers near Osewan, live outside the protected area, in the greater Amboseli ecosystem. As long as big animals such as lions and elephants have safe access to the overall ecosystem, which at two million acres is more than 10 times as large as the park, they'll likely remain resilient. Both populations have crashed before, in the case of lions mostly because of retaliatory spearings by Maasai. But they'd never have rebounded to today's numbers (about 1,600 elephants) if they'd been confined to the "island" known as Amboseli National Park. Managing the livestock ranches for the benefit of wildlife as well as agriculture would keep alive the *possibility* of lions and elephants surviving in Kenya.

Kenyans and visitors are getting used to seeing fewer and fewer lions. It's not hard to imagine a time when pesticides are not a concern: NO WILDLIFE, NO CONFLICT.

Either way people are adept at living without things once deemed indispensable, a phenomenon Peter Beard described in terms of elephants. The animal's "ability to destroy its habitat while adapting with great cunning to that destruction," he wrote, is also a trait of *Homo sapiens*.

Kenyans and visitors to Kenya are growing accustomed to seeing fewer and fewer lions—so few now that each lion has its own name, like a domestic pet, and an online fan club. It's not hard to imagine a time when pesticides are no longer a concern: no wildlife, no conflict. Or as Simon Thomsett says, "There will be nothing left to poison. Game over." □

Edwin Dobb's previous stories include "Alaska's Choice," about a controversial mine, in the December 2010 issue. **Charlie Hamilton James** covers conservation issues in Africa and the Amazon. This is his seventh story for the magazine.

PORT OF PASAJES, SPAIN

ON THE HUNT WITH THE BASQUE WHALERS

After the wreck of a Basque galleon—thought to be the *San Juan*—was discovered off the coast of Canada, *National Geographic* wrote about its exploration (July 1985 issue, at left). Now, we revisit the 16th-century ship's history to illustrate what we've learned about the risks and rewards faced by the Basques in the new lands they called Terranova. Their quarry: baleen whales and the oil from their blubber, worth millions in today's dollars.

BY **FERNANDO G. BAPTISTA**

Whaling timeline 1 Provisioning

JAN.

A DISTANT CHASE

It was voyages to North America to fish for cod that first led the Basques to the whaling grounds more than 2,000 miles from home.

St.

Icel

Bris

Galleon *San Juan* 79 ft

Cannon *(bombarda)*

Sma
(mec
barric
15-26

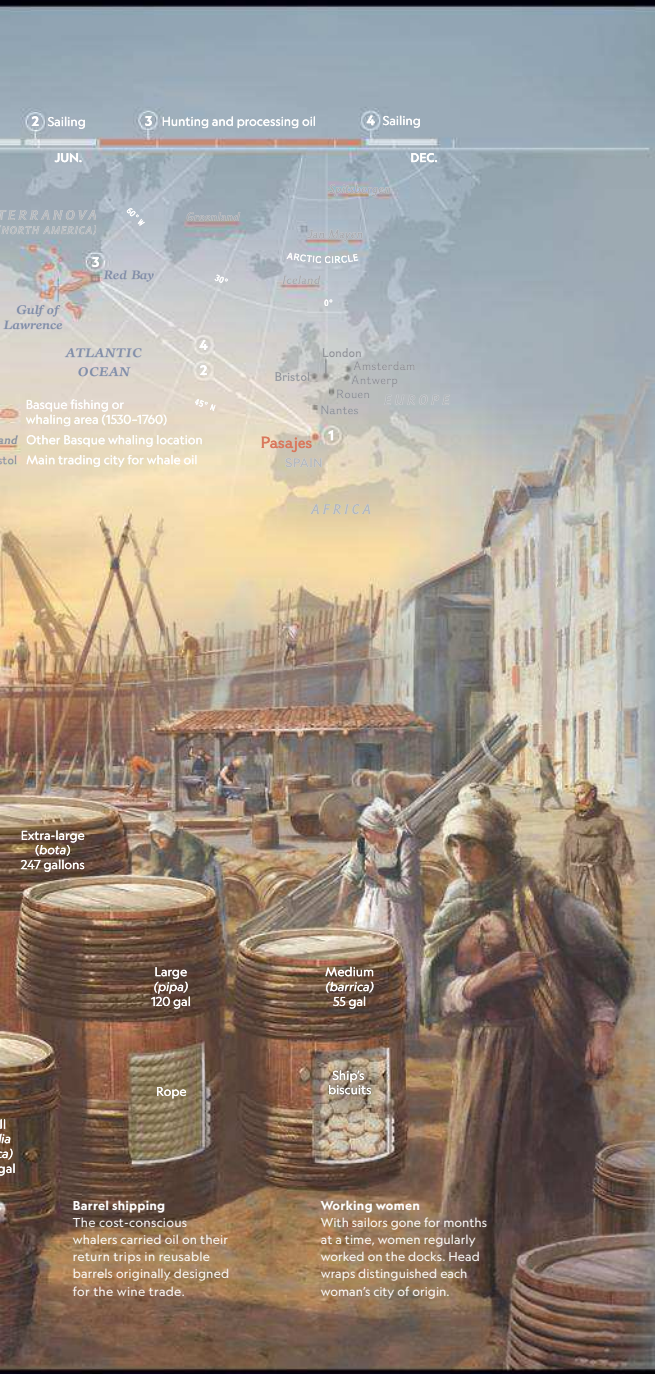
PREPARING FOR THE TRIP

Casks loaded with beans, dried peas, bacon, and ship's biscuits (flour-and-water crackers) sustained the crew. Hearty meals were washed down with wine and hard cider and supplemented with berries, fish, and whale meat, when available.

Heavy weapons
Ships carried artillery such as swivel guns and cannons to guard whaling waters and project sovereignty over European rivals.

Personal items
Combs, breeches, woolen stockings, leather shoes and boots, and other basic gear were packed in small barrels or chests.

Shore-station supplies
Whalers brought roofing tiles, nails, knives, saws, and other materials for the onshore oil-processing stations.



Barrel shipping
The cost-conscious whalers carried oil on their return trips in reusable barrels originally designed for the wine trade.

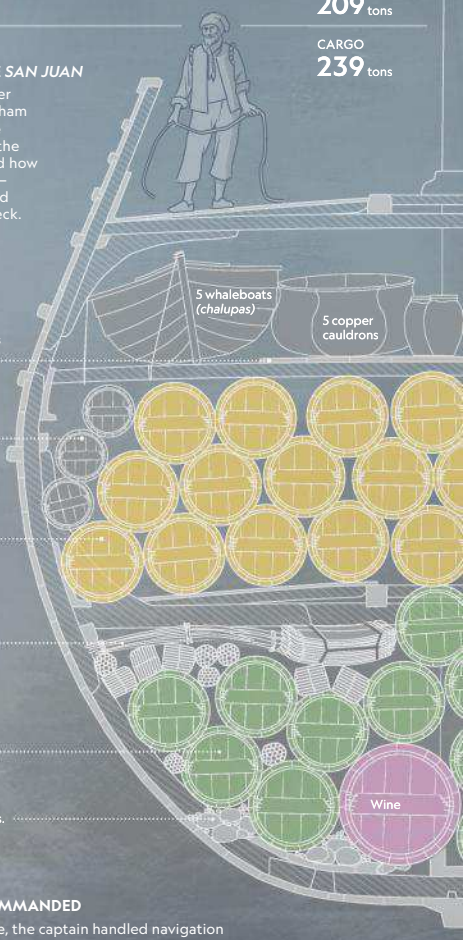
Working women
With sailors gone for months at a time, women regularly worked on the docks. Head wraps distinguished each woman's city of origin.

SHIP WEIGHT
209 tons

CARGO
239 tons

OUTFITTING THE *SAN JUAN*

Canadian researcher Selma Huxley Barkham pored over Basque archives detailing the fate of the ship and how it was provisioned—analysis that helped locate the 1565 wreck.



MASTER AND COMMANDED

On a typical voyage, the captain handled navigation and ship operations; the master managed shore operations and cargo. A ship of this size usually had a crew made up of 60 to 65 men and boys.

STRAIT OF BELLE ISLE, CANADA

HOW THEY HUNTED

Scouts patrolled in small boats called chalupas, signaling to other crews when they spotted whales in the Strait of Belle Isle. Skippers of the chalupas, each typically carrying six oarsmen and a harpooner, directed their crews to row in haste—but stealthily—toward the surfacing or sleeping giants.

Sneak attack

Quietly rowing, the crew would close in on the whale from behind—its blind spot.

First harpoon

Standing in the bow, the harpooner struck the whale's body when it surfaced to breathe.

Second harpoon

If the whale broke free of a first harpoon, a buoy on a second one helped track the animal.

Harpooner

Saddle Island

Chalupa skipper

Lances

Sails

Masts

Whale line, 720 ft

Ax to cut the whale line

Buoy

THE CHALUPA

Oak whaleboats, called chalupas, were so fast and maneuverable that native peoples of the region adopted the technology. With adjustable masts, chalupas could also be sailed.

The top two planks of a chalupa overlapped (clinker style), while the rest were set edge to edge (carvel style).

BOWHEADS AND RIGHT WHALES

A thick layer of blubber made these slow-swimming baleen whales a prime target. Bowheads—the whalers' prize catch for their higher oil yield—often swam near pack ice alone or in family groups.

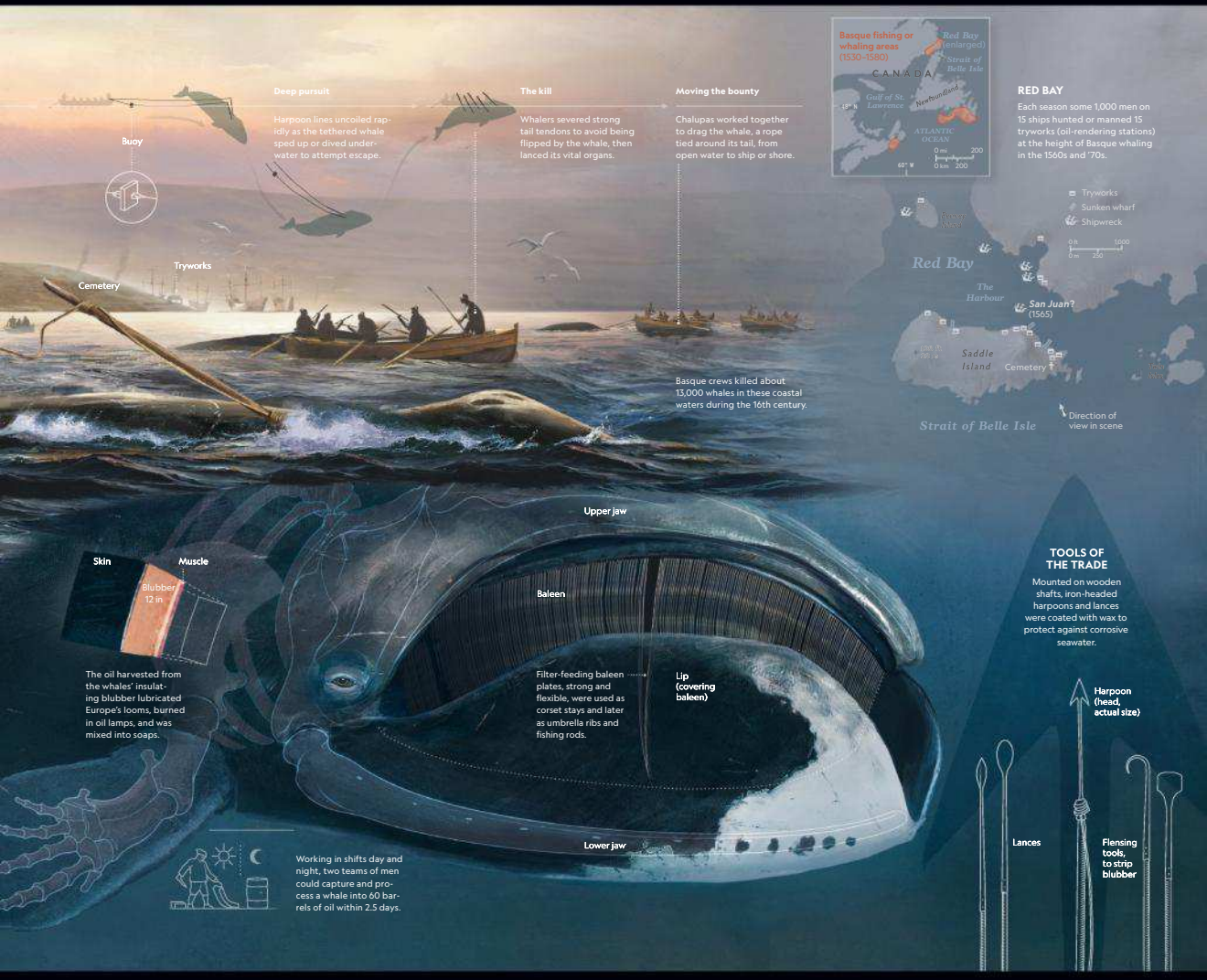
PROCESSING THE PRIZE

The whale carcass was buoyant, so processing could begin on the water. At land-based tryworks, blubber was boiled down to oil; barrels of it were floated back to the ships.

First, slings were attached to the whale; the capstan and pulleys were then used to rotate the carcass as men stripped blubber.

Hunks of blubber were boiled down in onshore tryworks, tiled-roof shelters covering stone ovens with cauldrons.

Blubber was slowly melted, purified, and poured into barrels. Baleen was extracted, cleaned, and bundled.


Buoy
Tryworks
Cemetery
Deep pursuit
Harpoon lines uncoiled rapidly as the tethered whale sped up or dived underwater to attempt escape.
The kill
Whalers severed strong tail tendons to avoid being flipped by the whale, then lanced its vital organs.
Moving the bounty
Chalupas worked together to drag the whale, a rope tied around its tail, from open water to ship or shore.
Basque crews killed about 13,000 whales in these coastal waters during the 16th century.
Basque fishing or whaling areas (1530–1580)
Red Bay (enlarged)
Strait of Belle Isle
CANADA
Gulf of St. Lawrence
Newfoundland
ATLANTIC OCEAN
RED BAY
Each season some 1,000 men on 15 ships hunted or manned 15 tryworks (oil-rendering stations) at the height of Basque whaling in the 1560s and '70s.
Tryworks
Sunken wharf
Shipwreck
Red Bay
The Harbour
San Juan? (1565)
Saddle Island
Cemetery
Strait of Belle Isle
Direction of view in scene
Upper jaw
Skin
Muscle
Blubber 12 in
Baleen
Lip (covering baleen)
Filter-feeding baleen plates, strong and flexible, were used as corset stays and later as umbrella ribs and fishing rods.
Lower jaw
The oil harvested from the whales' insulating blubber lubricated Europe's looms, burned in oil lamps, and was mixed into soaps.
Working in shifts day and night, two teams of men could capture and process a whale into 60 barrels of oil within 2.5 days.
TOOLS OF THE TRADE
Mounted on wooden shafts, iron-headed harpoons and lances were coated with wax to protect against corrosive seawater.
Harpoon (head, actual size)
Lances
Flensing tools, to strip blubber

RED BAY, CANADA

READY TO RETURN

The Basques were the master whalers of their day, but n
their ships weathered the voyages. Seamen's court testimon
insurance claims tell of a costly end to the *San Juan:* drive
the rocks by violent winds before departure in 1565. But th
survived, many barrels were recovered, and the Basques
nated the hunting grounds of the north into the next cent

PACKING THE WHALE OIL

Barrels were interlocked to prevent shifting and maximize space. On a typical return voyage, chalupas may have been left behind and some men given extra wages to winter in Red Bay to allow more room for oil.

16TH-CENTURY PROFIT SHARING

The ship's owners, outfitters, and crew each got a third of the cargo. The captain and master negotiated their share with the owners and outfitters, and the crewmembers' shares varied based on their position.

$10,000,000
total value of cargo in 2018 dollars

$10,000
per barrel

Barrels per person

12	Harpooners
4	Seamen
3	Apprentices
8	Officers

FERNANDO G. BAPTISTA, RILEY D. CHAMPINE, DAISY CHUNG, AND EVE CONANT, NGM STAFF; PATRICIA HEALY. SHIZUKA AOKI AND ELIJAH LEE, BIORENDER (BOWHEAD WHALE, INTERNAL ANATOMY). SOURCES: XABIER AGOTE AND MIKEL LEOZ AIZPURU, ALBAOLA BASQUE MARITIME HERITAGE ASSOCIATION; BRAD LOEWEN, UNIVERSITÉ DE MONTRÉAL; NINYA MIKHAILA AND JANE MALCOLM-DAVIES, THE TUDOR TAILOR; J. CRAIG GEORGE, DEPARTMENT OF WILDLIFE MANAGEMENT, UTQIAGVIK, ALASKA; ROSALIND ROLLAND, ANDERSON CABOT CENTER FOR OCEAN LIFE, NEW ENGLAND AQUARIUM; BRENNA FRASIER, SAINT MARY'S UNIVERSITY, NOVA SCOTIA; CINDY GIBBONS, PARKS CANADA

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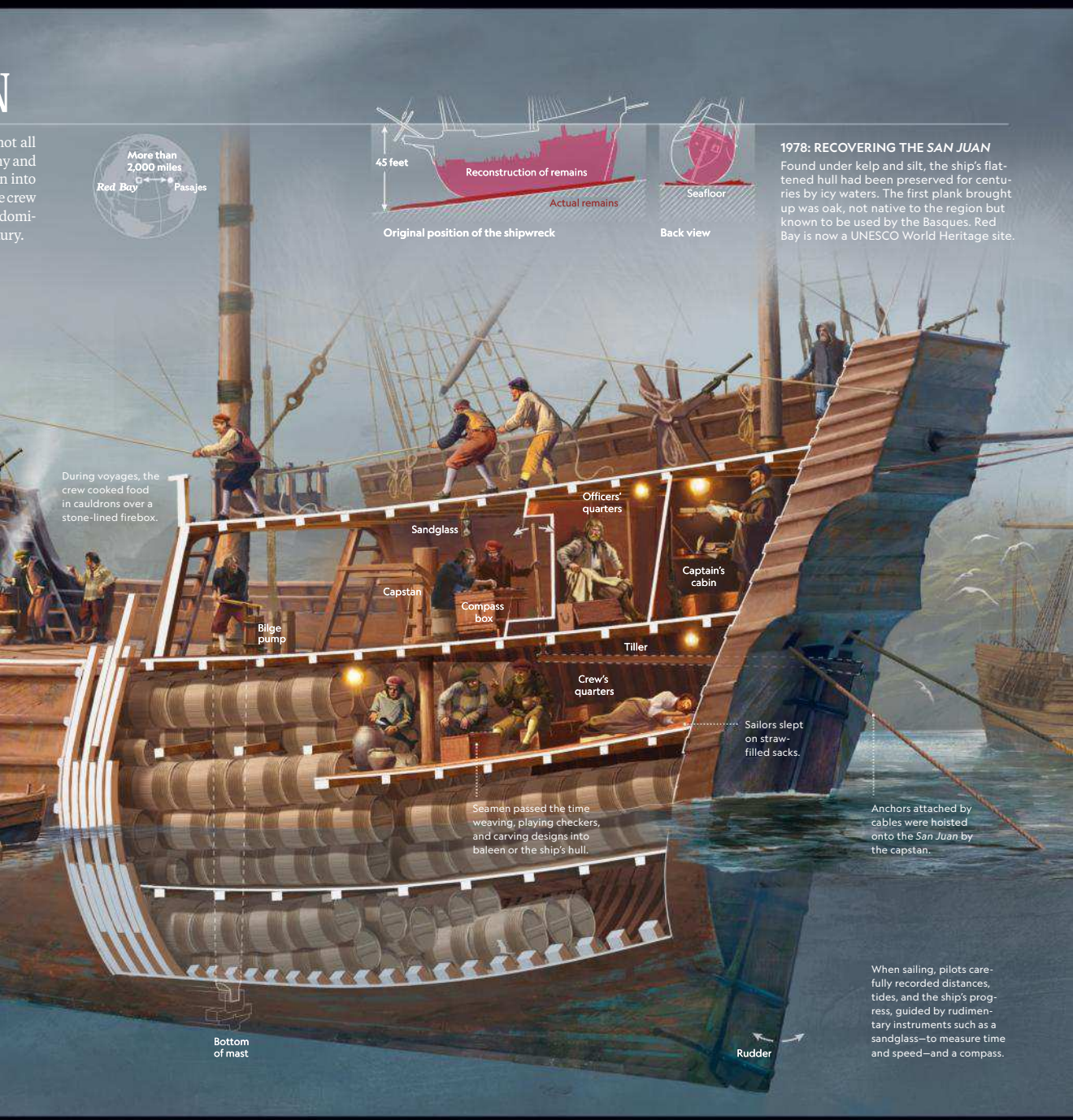
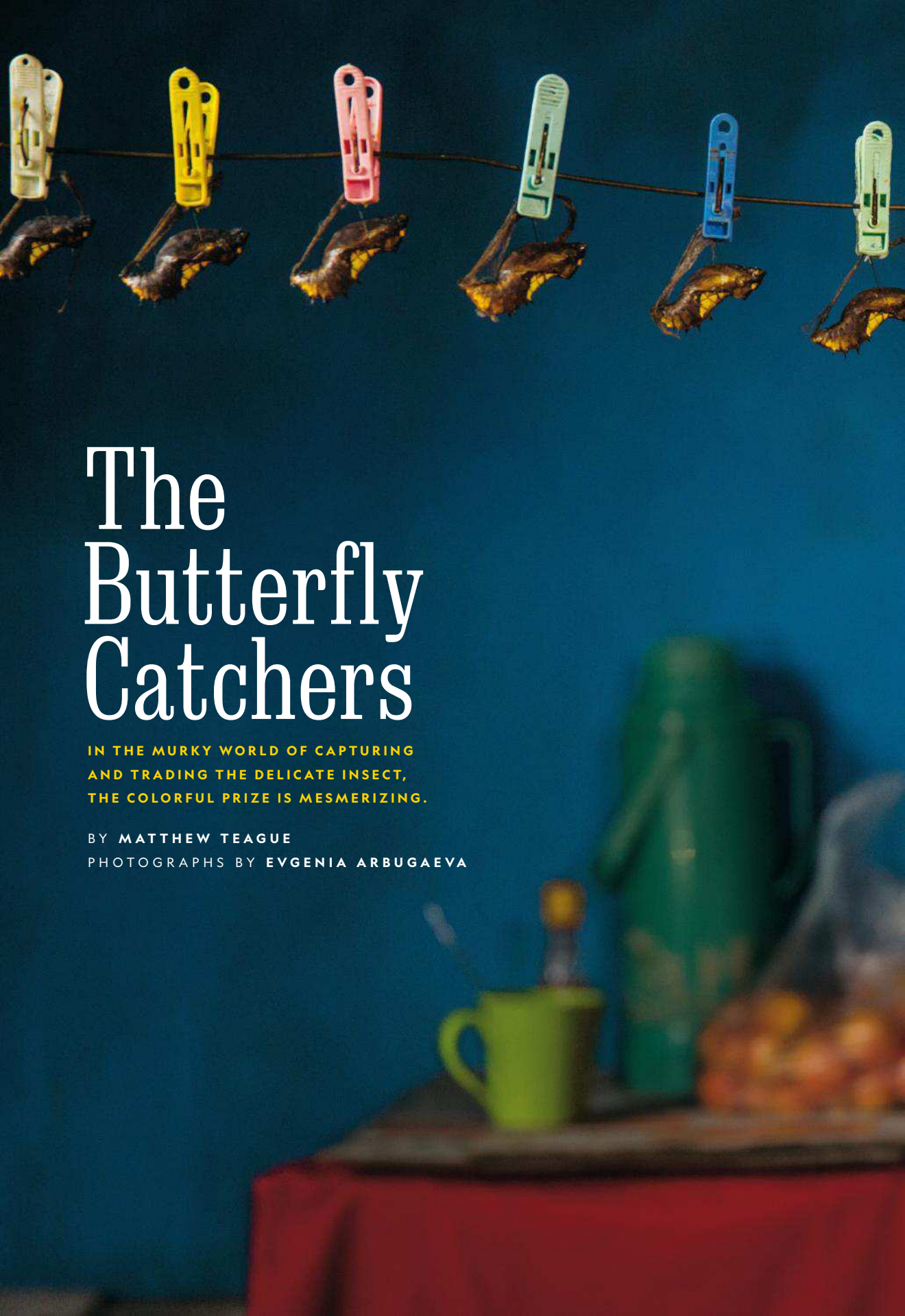


1978: RECOVERING THE *SAN JUAN*

Found under kelp and silt, the ship's flattened hull had been preserved for centuries by icy waters. The first plank brought up was oak, not native to the region but known to be used by the Basques. Red Bay is now a UNESCO World Heritage site.



The Butterfly Catchers

IN THE MURKY WORLD OF CAPTURING AND TRADING THE DELICATE INSECT, THE COLORFUL PRIZE IS MESMERIZING.

BY **MATTHEW TEAGUE**
PHOTOGRAPHS BY **EVGENIA ARBUGAEVA**

A goliath birdwing hatches in the kitchen of a tourist house in West Papua, Indonesia. Hatchlings are killed young, to preserve their wings. The trade in rare butterflies—both legal and illegal—spans the planet, from catchers to middlemen to collectors.

It can be a treacherous thing, hunting this particular butterfly.

The peacock swallowtail, *Papilio blumei,* lives only here, on the Indonesian island of Sulawesi, and only at a certain altitude. Its mountain home is a steep rock covered with a thin layer of wet earth, where every handhold and step sends away a small mudslide. And somewhere along the way, between the valley and the peak, an economy becomes clear: This is why some butterflies are valuable. This is why there's a black market for the rare ones.

The hunter, a man named Jasmin Zainuddin, stops a moment. He carries a stick that he uses to prod the mud, testing it. "Only a little bit higher," he says.

Jasmin has lived his entire life on this island, and over decades he has built a network of informers, transporters, and catchers to move

Baco Bugis follows his own migration pattern from December to March, moving hundreds of miles to follow butterflies deep into remote Indonesian forests. He hunts the elusive birdwings—sometimes finding just one or two a week—for which dealers can pay up to a hundred dollars and foreign collectors much more.

PREVIOUS PHOTO

A catcher on Bacan island, Indonesia, sorts his specimens, which he'll sell in Bali. From there the butterflies are exported throughout Asia and on to collectors worldwide.

 ILLUSTRATION OF *PAPILIO BLUMEI:* MONICA SERRANO, NGM STAFF

butterflies from local mountaintops to collectors around the world. Today his morning started in Makassar, a city at the island's southwestern tip. A van carried him and several helpers on a winding road up from the lowland heat, through jungle, and finally into a mountain village where the road became too steep and slippery. There Jasmin moved his supplies and crew onto the backs of a half dozen motorbikes, mostly driven by small boys. The road crumbled and narrowed into a path, which became a series of swinging bridges that could bear one motorbike at a time, and which ended altogether at the next village. From there everyone disembarked, took up sacks of rice and jugs of water, and started to climb.

It's an arduous journey. But now, leaning on his mud-testing staff, Jasmin breathes hard through an open smile. "Close now," he says.

Eventually the mountainside begins to shape itself into terraced rice paddies, and Jasmin's destination appears above. It's a hut he built himself, raised high on stilts. One by one, he and his helpers climb a log to enter it.

As the sun sets, Jasmin stretches out on the floor of the hut. He's middle-aged now, and hauling supplies gets harder every trip. Tomorrow, he says, the hunt will begin in earnest. For now, two women, one middle-aged and one younger, prepare dinner.

Every word Jasmin speaks, every item he touches, every memory he recollects centers on butterflies. He has studied, followed, and caught them since an encounter with a foreigner

A young mother on Indonesia's Sulawesi island sorts her catch. Closest to the original sources, the butterfly trade is a means of subsistence. Families often tend a farm during one season and catch butterflies in another. Each specimen may earn them a penny or two.

when he was a small boy. Now he pays an army of small boys himself, all equipped with gossamer nets. Together they make up the lowest step in a butterfly market that ends in private parlors and corporate boardrooms in faraway lands, where some collectors pay thousands of dollars for specimens they display under glass.

In the near darkness the women laugh at Jasmin's prone figure as they cook. The older is Mujiauna, his wife of almost 30 years. They smile at each other a lot.

Jasmin sits up. "You must have a wife?" he says.

It's the first time he has veered from the subject of butterflies, and the question is so unexpected I struggle with it.

"No," I say. "Or not anymore."

"Something happened to her?"

"Yes."

He sits in silence a moment and lies down again.

THE HUT SITS ON THE WESTERN FACE of the mountain, so that the next day arrives as a slab of light sliding between the mountainside and low rain clouds.

Jasmin rarely climbs all the way to the top anymore, he says, but today he'll accompany his favorite catcher, a young man named Aris, part of the way. They each carry a net.

A stream runs past the paddies, and they follow it to a small river, and then follow that farther up the mountain. Along the way Jasmin talks freely—butterflies are deaf to human voices—but his eyes read the forest with a specific literacy. In a scene of ferns and vines and dripping water he can pick out any tiny winged thing resting on the underside of a leaf. "No," he says each time. "Too common."

Jasmin's father caught butterflies before him, starting in the early 1970s. They lived in a village called Bantimurung, which Alfred Russel Wallace, the great British naturalist, had visited a century earlier. He described Bantimurung as "a beautiful sight, being dotted with groups of gay butterflies—orange, yellow, white, blue, and green—which on being disturbed rose into the air by hundreds, forming clouds of variegated colours."

The father's technique was rudimentary. He caught whatever creatures floated near the family home and offered them to foreigners who visited the island. Soon the foreigners who came seemed to know more about the butterflies than local people did. For example, when Jasmin was young, a French collector showed him a glass bell in which he trapped butterflies with a bit of ether. "A killing jar," Jasmin says.

A government project forced his family to move soon after that, he says, but that peculiar jar stayed in his imagination: the motion of the butterflies, and how easily they slipped into stillness.

The next turn in his life came a few years later, in the 1980s. A small group of Japanese visitors arrived on Sulawesi with questions about butterflies. One of them, a man Jasmin called Mr. Nishiyama, spoke some Indonesian, and noticed the boy. He thought Jasmin was smart, paid attention, and seemed to have a genuine affinity for the butterflies.

Over the next two decades Mr. Nishiyama returned to the island many times, always hiring Jasmin to help him on expeditions into the mountains. As they hiked, the Japanese man revealed an entire world of butterflies: their patterns of flying, mating, resting; what drew them in, what repelled them. Only years later did Jasmin learn his teacher was Yasusuke Nishiyama, one of Asia's great lepidopterists. He wrote books about the butterflies they found together.

Now Jasmin points beyond a high waterfall. "There," he says. That's where the *blumei* live.

Aris continues climbing. He springs among wet roots and rocks like a leopard. Jasmin remains below. As he recedes into the forest, he doesn't immediately turn away; he lets his eyes linger on the mist above the waterfall. Absently he lets his butterfly net sway in gentle arcs, with the net drifting like a cobweb on the air.

THE WATERFALL, IT TURNS OUT, is the first of a series. Aris climbs them and eventually breaks past the cloud cover, emerging into clear sky framed by high jungle canopy. He stops and reaches into a triangular wooden box that swings at his hip. From it he withdraws a triangular piece of wax paper, and from that he tenderly removes a specimen of the butterfly he hopes to find. *Papilio blumei*.

Its wings look like black velvet, each with a stripe of peacock blue-green. It's a startling object, like a jewel, and it's immediately clear why collectors on distant continents would desire it.

Aris cuts a tiny sliver of wood from a tree, no bigger than a matchstick, and sharpens it to a

point. He uses it to pin his butterfly specimen to a large leaf about waist high, then retreats to watch from a rock outcropping.

"Female," he says, nodding. "The male will come, looking for a mate."

He settles into a hollow spot in the rock to wait.

He has a mate of his own, he says, and a new baby. They live at Jasmin's hut year-round, surviving on rice and income from the butterflies. He and the other catchers bring them to Jasmin, who pays a few cents for each butterfly. Jasmin sells them either at the market in Bantimurung or to a man in Jakarta—an Indonesian butterfly boss—who then sells them to dealers around the world. By the time a *blumei*'s final seller mounts the butterfly in a display case, it might go for close to a hundred dollars. Other species—internationally protected species—sell for astronomical prices.

The idea of trading in butterflies sounds quaint, almost Victorian, but the internet has enabled the modern market. In 2017 British authorities, for the first time, convicted a man for capturing and killing a large blue, one of the United Kingdom's rarest butterflies. Investigators linked Phillip Cullen to an online auction account.

In 2007 a multiyear investigation by the U.S. Fish and Wildlife Service in Los Angeles led to the conviction of Hisayoshi Kojima, a Japanese man who described himself as "the world's most wanted butterfly smuggler." He had offered to sell an undercover agent an illegal collection of butterflies worth more than a quarter million dollars. It's hard to pin down the exact size of the global black market for butterflies today, but estimates range up to hundreds of millions of dollars a year.

"Do you see butterflies at home?" Aris says.

Sometimes, I say.

My hometown of Fairhope, Alabama, is at the center of the migration path for monarch butterflies. One of the last outings my wife and I made with our two girls was to a museum where we watched a documentary called *Flight of the Butterflies,* about the orange-and-black monarchs' great annual movement from Canada to central Mexico and back again. We all fell in love with them, and as we left the museum, my daughters begged us for butterfly-themed books and toys. My wife, Nicole, bought a delicate pair of monarch earrings.

Aris likes the idea of a butterfly movie. It makes him laugh.

So I stop the story there. There's no need to explain about the cancer that had already taken hold in Nicole during that trip and would take her away, in pieces, over the next two years. Sometimes now my girls remove the butterfly earrings from their case and admire them in the mirror. They're inexpensive jewelry, but the girls always handle them like treasures.

"I miss my wife," Aris says.

Me too, I say.

We sit a long time. Hours. Catching butterflies is a lonesome endeavor. Then Aris's finger shoots toward the sky: "Look."

High among the treetops—higher than I would have searched for a butterfly—there's a flicker of blue, like a scrap of confetti. Slowly it descends in a drifting, indirect route toward the decoy.

Butterflies exist on the edge of nonexistence, floating along this side of a mortal veil. Such is their delicacy: unattainable in life, unsatisfying in death.

As it comes closer, I realize just how different it is from the decoy. It is a glittering thing, not one peacock tone but many. Its color has a fourth dimension; moment to moment as it moves, the color changes depending on the angle of its wings in the sun.

Scientists have tried for years to replicate this quality of the *blumei*'s. In 2010 a team of U.K. university researchers from Cambridge and Exeter tried to describe its essence in the journal *Nature Nanotechnology:* "Although the physics of structural colours is well understood, it remains a challenge to create artificial replicas of natural photonic structures. Here we use a combination of layer deposition techniques, including colloidal self-assembly, sputtering and atomic layer deposition, to fabricate photonic structures that mimic the colour mixing effect


HOMERUS SWALLOWTAIL
Papilio homerus
Named after the Greek poet Homer. Featured on Jamaican postage stamps.
Male
NORTH AMERICA
JAMAICA
SOUTH AMERICA
Female
Host plant
Hernandia catalpifolia
Winged Desire
Of the planet's roughly 20,000 species of butterflies, swallowtails are especially intriguing to collectors. The more than 560 swallowtails include the world's largest butterflies—birdwings—and some of the most expensive and threatened (five are shown here). They face a triple menace of habitat loss, climate change, and poaching. Thanks to conservation programs and anti-poaching laws, swallowtails are surviving despite a black market where prices start in the pennies and run into the thousands for protected species.
Actual size of largest O. alexandrae on record.
All other butterflies shown at half actual size.
LUZON PEACOCK SWALLOWTAIL
Papilio chikae
Discovered in 1965; traders often mislabel this species to elude law enforcement.
ASIA
PHILIPPINES
AUSTRALIA
Male
Female
Euodia glauca
WALLACE'S GOLDEN BIRDWING
Ornithoptera croesus
Named after the famed naturalist, who nearly fainted at first sight of its beauty.
Female
Male
ASIA
INDONESIA
AUSTRALIA
Aristolochia gaudichaudii

Females lay eggs after tapping leaves with their forelegs, which have sensors to detect their target plant.

QUEEN ALEXANDRA'S BIRDWING
Ornithoptera alexandrae
The *O. alexandrae* is the largest butterfly known to scientists—its wingspan can reach nearly 12 inches.

Aristolochia dielsiana

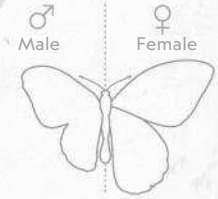
Female

Male

Microscopic scales scatter light, creating iridescent colors and patterns that likely help attract mates.

Flying rarities

A coveted half-male, half-female gynandromorph can occur if a fertilized egg unevenly divides into the two cells that form each side of a butterfly's body.



GYNANDROMORPH

APOLLO
Parnassius apollo
Varied wing patterns led collectors to wildly inflate the number of subspecies.

MONICA SERRANO, LAUREN E. JAMES, AND RYAN T. WILLIAMS, NGM STAFF. LORI PUMA. SOURCES: ED NEWCOMER, U.S. FISH AND WILDLIFE SERVICE; FABIEN CONDAMINE, CNRS; THOMAS TURNER, CARIBBEAN WILDLIFE PUBLICATIONS; BRENT KARNER, BIOQUIP; MARK COLLINS, SWALLOWTAIL AND BIRDWING BUTTERFLY TRUST; MARTIN FEATHER, FAIRCHILD TROPICAL BOTANIC GARDEN; RUDI VEROVNIK, UNIVERSITY OF LJUBLJANA

found on the wings of the Indonesian butterfly *Papilio blumei*."

All of that—the sputtering atomic beauty—is on display as the butterfly descends. It is, in short, alive.

As it moves toward its potential mate, Aris's net shoots out and swallows it whole, like a diaphanous predator.

It's painful to see. I had forgotten, for a moment, about the net.

Aris's face is alight with joy. And of course it is—with great patience and skill he has just captured a prize that will help provide food for his wife and new baby. He reaches gently into the net and takes it in his hands. With its wings pinned back between his thumb and forefinger, he uses the other hand to pinch its body for a moment, and it dies.

He gathers up the decoy, puts it and the new specimen into their little triangular wax paper envelopes, and slips them into his box. As he walks now, he whistles.

As we descend the waterfalls, though, it's difficult to escape the moment the *blumei* ceased to move. It remained beautiful afterward, but in an instant all its fourth-dimensionality had drained away. It had become a mere gemstone or a splash of paint.

More than for the butterfly, I feel sorrow for whoever will eventually hang it on a wall or tilt it on a desk. That person will never know just how exquisite it had been in life.

OVER THE NEXT COUPLE OF DAYS at the hut, catchers bring Jasmin specimens for inspection. They come from all directions, sometimes in the morning, sometimes emerging from darkness.

They bring butterflies, mostly, but a handful of moths and other insects. One evening as the sun sets, a few catchers sit talking on Jasmin's high porch. Then suddenly one—an older man—stands up, grabs his net, and leaps to the ground below. The others cheer as he sprints uphill, waving his net toward a dark, ghostly shape in the air.

He returns, and the men take turns examining

A butterfly dealer in West Papua attracts moths for a Japanese collector by making traps with white sheets and bright lights. The dealer hires villagers to breed butterflies and work as guides, providing jobs that make the butterflies important to the local economy but may harm conservation efforts.

PREVIOUS PHOTO

From subtle hues come vibrant colors: The variations in birdwing chrysalides—the final stage of metamorphosis from which a winged adult emerges—mimic the vegetation surrounding the pupating caterpillars. These specimens are native to Cambodia.

ROBERT CLARK

his catch: a birdwing. A rare butterfly, and a protected species.

"It's just a small one," Jasmin says.

Even so, it is enormous, able to cover a man's entire hand. Its wings appear dull and mottled until Jasmin slides the forewing away from the hind wing, revealing a shock of yellow between. A ribbon of hidden beauty.

The men celebrate. The birdwing will make a good sale, they say, even better than the *blumei*. They don't discuss why: The *blumei* is illegal to capture inside Bantimurung Bulusaraung National Park, but catching the birdwing is restricted everywhere. So it will go to the black market.

The next day Jasmin makes the journey down from the mountain to the market outside Bantimurung park. He and his helpers make their long trek in reverse: the mountainside climb, the motorbikes and swinging bridges, the van, and finally the heat of the lowlands.

You can see Bantimurung park from miles away. It's part of one of the largest karst formations in the world, shaped when limestone and soil washed away and left great cones and towers of rock that rise and lean over the landscape. The corridors between them twist and dive, sometimes underground, and emerge where ancient waterfalls still carve them in slow motion.

The market piles up against the entrance to Bantimurung Ecotourism Park, a gateway to the national park. In contrast to the quiet loneliness of the catchers setting their traps in mountain mist, the market is explosive and many-colored, a carnival. Hawkers call out "*kupukupukupukupu!*"—butterflies! butterflies!—as a crowd moves among rows of stalls. Two types of visitors populate the scene. The first is tourists who wear butterfly T-shirts and sip from butterfly cups; they nibble butterfly candy under butterfly parasols. The other group is mostly men in button-up shirts—dealers who've come to do business. They peruse the stalls where thousands upon thousands of butterflies sit on display, some framed, some encased in shadow boxes.

Indonesia's rules governing the capture, sale, and export of butterflies are complicated and riddled with exceptions, which allow even endangered species bred for the commercial market to be bought and sold in certain instances. But how does one tell a wild butterfly from one raised on a breeding farm?

As Jasmin moves among the stalls, I ask him: Is there a section for legal trade, and a section for the black market? He wraps his arms together, and then interlaces his hands and fingers, to indicate the two markets are intertwined.

If he notices a protected species on display, would he mind pointing it out?

He shakes his head and gives a soft smile, then walks along the stalls, touching frames and displays as he goes. "This," he says. "This... this... this... this... this... this... this..." He indicates about half the butterflies.

When the men in button-up shirts are serious, they duck behind the stalls into back rooms to negotiate private deals. Jasmin is serious. In a room behind a storefront, another man shows him several boxes full of the wax paper triangles. These butterflies started their journey in the nets of boys on far-flung islands, then were transported in vans driven by middlemen, and finally they have been funneled here—heaps and mounds of them, waiting for an overseas buyer.

Surely the government knows about this trade?

Jasmin gives the soft smile again and


TAMAN WISATA ALAM
BANK BRI
ATM

A sculpture of a *Papilio blumei*—symbol of local pride—tops the gateway to Bantimurung Ecotourism Park. The surrounding national park, established in 2004, helps address some threats to butterflies—habitat loss and pesticide use—but also faces challenges from butterfly poachers.

Delicate nature displays have drawn collectors to Deyrolle, a Paris taxidermy shop, since 1831. That's about when butterfly collecting took off in Europe, as lepidopterists began searching worldwide for specimens. Today collecting is especially popular in Japan.

moves to a window, where he points into the crowd: "Look... look... look," he says. He's pointing out men in police uniforms, who seem unperturbed.

"Let me show you something," he says.

We walk into the park itself, where we see a fading hotel and natural water slide and tour guides leading groups toward underground caverns. Butterflies decorate every surface, down to the pavement itself, but there are no actual butterflies to be seen in the air. "The government does not care," Jasmin says.

He points to a building. "That is where my home was when I was small." Bantimurung Ecotourism Park, he says, was the government project that ousted his family when he was a boy.

He walks deeper into the park, past his former home, past a glassed-in terrarium that once held butterflies but now sits empty. Around a corner and down a narrow passage, away from the crowds, he begins to walk more slowly and speak more softly.

"This was my family," he says. He stands before what appears to be a small garden decorated with large rocks. The context is so jarring—we can hear tourists squealing at the water park—that only gradually does the meaning of the stones take shape.

They're grave markers.

BACK AT JASMIN'S HOME, he plays on the floor with his small granddaughter. He wants his son to follow him into the butterfly business, he says, but the young man shows no interest.

As they play, I look over maps of the area. Bantimurung Bulusaraung National Park, I realize, is larger than I had thought. Much larger.

What was the name again, of the village nearest his hut?

"Laiya," he says.

And there on the map is tiny Laiya—at the foot of the mountain. Deep inside the park.

So all the butterflies he and his catchers bring from that mountain are caught illegally.

He shrugs. "As long as there is the forest, there will be butterflies," he says.

Collectors and dealers buy and sell butterfly specimens from Africa, Asia, the Americas, and beyond at the annual Tokyo Insect Fair, which has no website but attracts enthusiasts from around the globe. The international market for butterflies is, like the creatures themselves, quiet and difficult to pin down. Estimates of the trade range as high as hundreds of millions of dollars a year.

He feels an ownership, because his family came from that land. The government took away his birthright, in his view, so he takes it back.

But if everyone does the same, I start to say—and for the first time, Jasmin bristles.

"As long as there is a forest," he repeats. "But they are taking the forest."

He raises an index finger, angry now, and begins to reel off a series of scientific butterfly names. I choose one—*Ixias piepersi*—and look it up in one of his illustrated books. It doesn't seem remarkable in any way, just yellowish and small. But they have existed only in a small stretch of coastline between Bantaeng and Bulukumba on the south edge of the island. Now coastal fish farms have wiped out their habitat, Jasmin says, and he fears they are going extinct.

Now Jasmin's eyes are wet. "No one loves the kupu-kupu more," he says. "Look at my home. Look around."

Butterflies are woven into his tablecloth and painted into the decor. He has signed editions of Mr. Nishiyama's books in Japanese and English that he cannot read, but which he gazes at with his granddaughter. The bricks in the walls themselves are shaped into familiar wings.

There's no part of Jasmin's home, like his life, that isn't touched by butterflies.

IT'S DIFFICULT TO SAY why butterflies inspire such obsession. Why Victorian collectors went mad for them or Japanese businessmen devote whole rooms to them, or why the great novelist Vladimir Nabokov studied them in microscopic detail throughout his lifetime. "I have hunted butterflies in various climes and disguises," he wrote in *Speak, Memory,* "as a pretty boy in knickerbockers and sailor cap; as a lanky cosmopolitan expatriate in flannel bags and beret; as a fat hatless old man in shorts."

I suspect the endurance of their appeal lies in their very ephemerality. Like the *blumei* that Aris pinched so tenderly on the Sulawesi mountaintop, they seem to exist on the edge of nonexistence, to float along just this side of a mortal veil. Such is their delicacy that they are unattainable in life, and unsatisfying in death.

In the spring, back home in Alabama, my younger daughter looked up during a car ride and said, "Do you know something Mommy always wanted us to do?"

She's 11 now, and we've been on our own for four years. Four years that I've flinched at questions like this one. They remind me that because I have not found another mate, my girls have no mother figure; and of everything I haven't done, or can't do, or am too tired to try, alone.

But I can't let her see that, so I say, "Nope, what's that?"

"A butterfly garden."

"That's a good idea," I say. And then, to myself: It really is. I can do that.

So we pick a spot in the yard and dig several holes and lower into them an assortment of plants and flowers that monarchs love. *Lantana camara* and *Bulbine frutescens,* especially.

After the last one we step back for perspective. My older daughter says, "Not bad. I hope they come."

They will. It's just a matter of waiting for the season to change, I tell her. And the days are already getting warmer. ◻

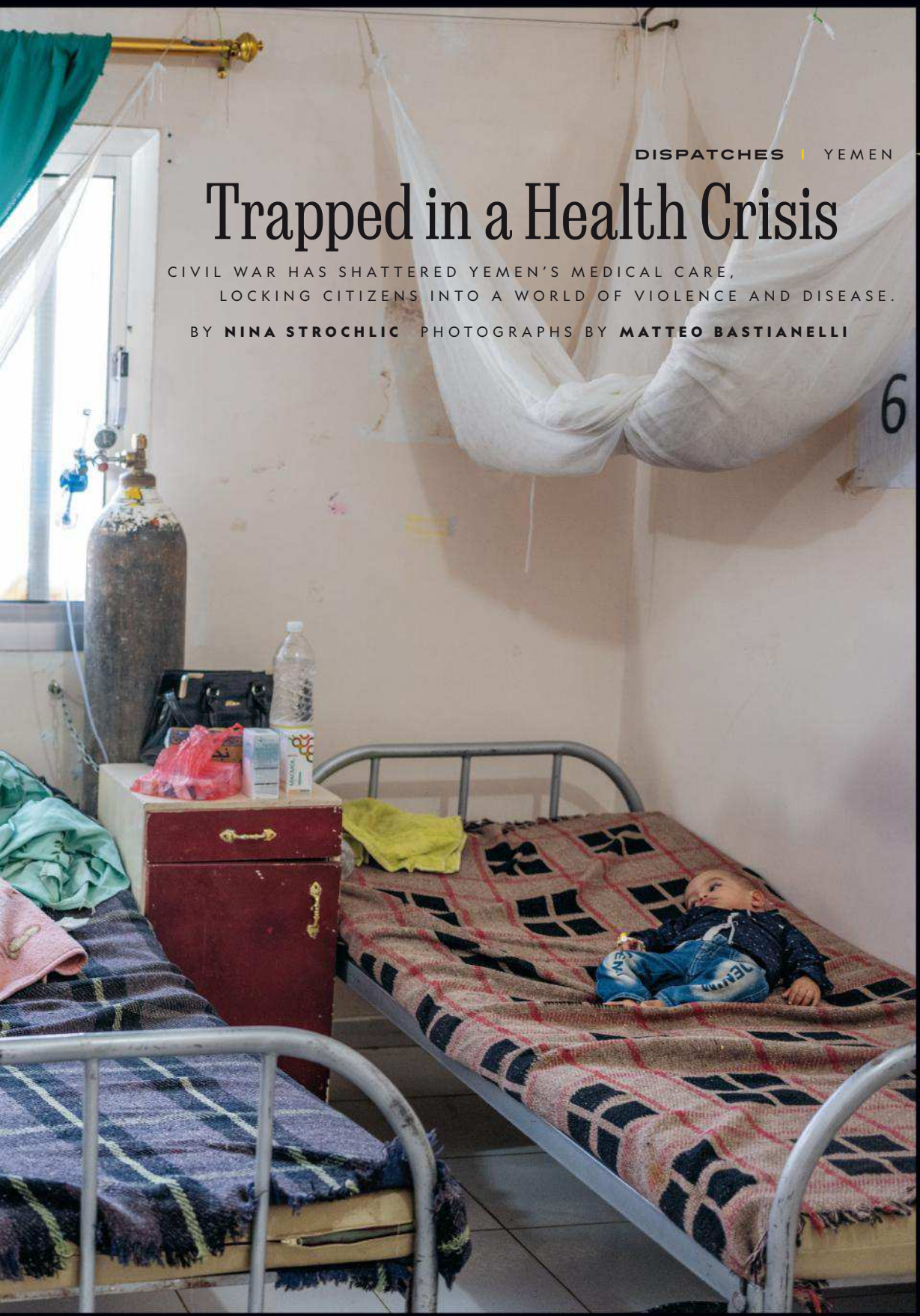
Matthew Teague profiled South Sudanese elephant herds in the November 2010 issue. **Evgenia Arbugaeva** photographed reindeer herders in the Russian Arctic for the October 2017 issue.

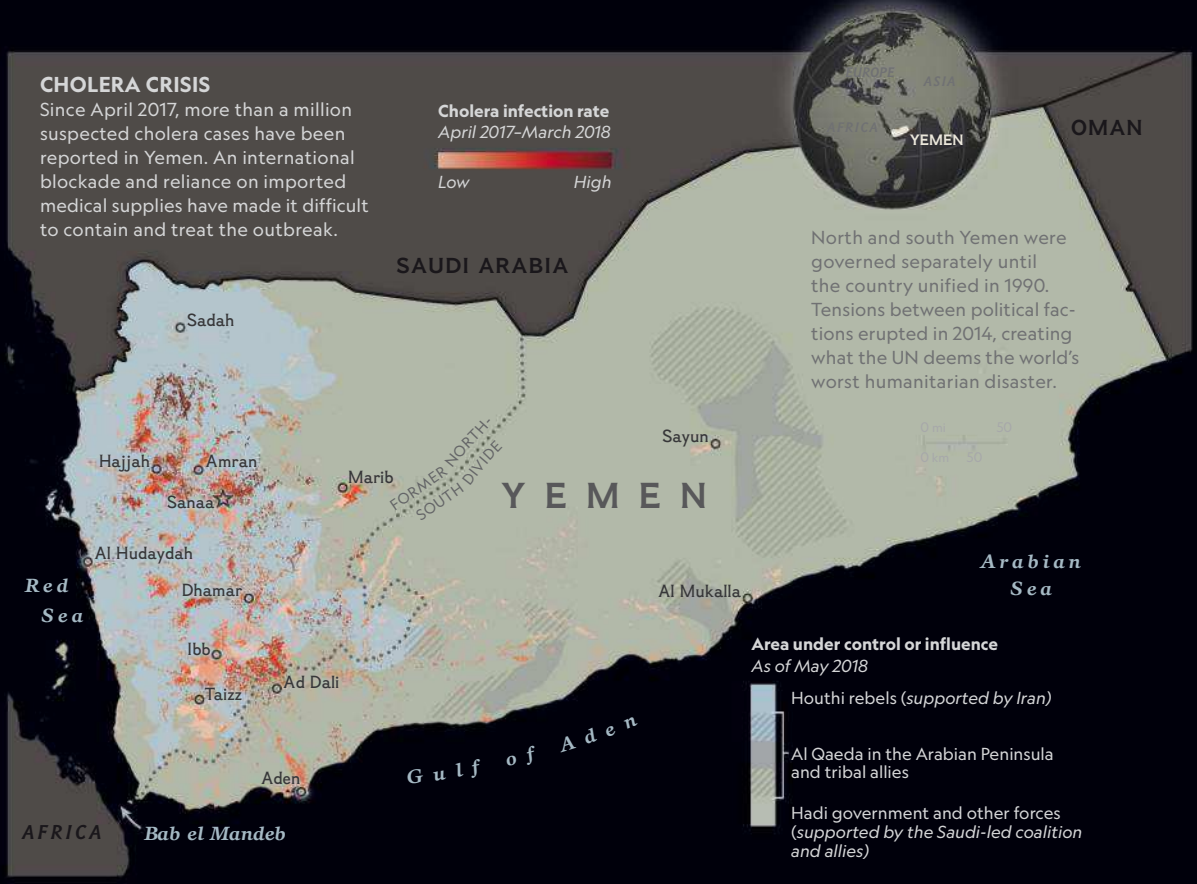

7

Trapped in a Health Crisis

CIVIL WAR HAS SHATTERED YEMEN'S MEDICAL CARE, LOCKING CITIZENS INTO A WORLD OF VIOLENCE AND DISEASE.

BY **NINA STROCHLIC** PHOTOGRAPHS BY **MATTEO BASTIANELLI**





13°34'39" N, 44°01'04" E

A father holds his baby at the Mother and Child Hospital after the child was treated for a respiratory infection. Doctors and nurses have fled Yemen, leaving hospitals stretched thin. "A lot of my colleagues have already left or are trying to travel to the Gulf states to find a better life," says one Yemeni doctor working in Sanaa.

PREVIOUS PHOTO

In a dedicated ward of the Al-Nasser Hospital, babies are treated for malnutrition—they're just two of the estimated 1.8 million acutely malnourished children under age five. Yemen's depleted health ministry relies on humanitarian organizations to provide medical care.

THE YOUNG WOMAN was carried into the hospital at 9:30 a.m. Twenty minutes earlier she had been hanging laundry when a bomb fell in her courtyard on the outskirts of Taizz, an ancient city in southwest Yemen. A man covered in blood, her cousin, cried as the doctors rushed her to the trauma center.

"Both legs?" he asked when the doctor returned and gestured to show where they would amputate. One leg was shredded; the other had a protruding bone. Both, the doctor confirmed. She was put in an ambulance and taken to another hospital. Then there was silence. The nurses scrubbed blood off the floor and waited for the next patient.

That night, Matteo Bastianelli, an Italian photographer who'd watched the scene, wrote in his diary about life in Taizz after three years under siege: "Doctors wait, with the thunder of airplanes in their ears and the dust in their eyes, living with the fear that something terrible and irreparable could happen at any moment."

ONCE KNOWN by the Romans as Arabia Felix, "Fortunate Arabia," Yemen was a strategic port at the entrance to the Red Sea, made rich by spices and scents. Today it's one of the poorest countries in the world. Until 1990 north and south Yemen were governed separately, and this divide continues to fuel conflict. In late 2014 separatist Houthi rebels seized the capital of Sanaa in an attempted coup. Fearing a regional shake-up, neighboring Saudi Arabia intervened on behalf of President Abdrabbuh Mansour Hadi's former government. With support from the U.S., the U.K., and nearly a dozen Arab states, a Saudi-led coalition launched an air campaign to help Yemen's government keep its grasp on large swaths of the country.

After three years of fighting, the numbers are stunning: In a nation of nearly 29 million, 22 million Yemenis are in need of humanitarian assistance, according to the UN. Two million have been displaced. At least 10,000 are dead. With the economy and health care system in shambles, Yemenis make desperate decisions to find medical treatment. Some take dangerous cross-country journeys to hospitals run by humanitarian groups; others spend their savings at private clinics.

CLARE TRAINOR, NGM STAFF. SOURCES: RISK INTELLIGENCE; WHO; EUROPEAN COMMISSION, JOINT RESEARCH CENTRE


BED 6

More than half of Yemen's hospitals are closed or partly functioning, and sometimes administrators must choose between buying medical supplies and fuel for generators. Infectious diseases such as cholera and diphtheria are rampant, reflecting the lack of treated water and other basic government services.

BEFORE 2015 the recently built, five-story white stone building on the outskirts of Taizz was slated to be a hotel. Less than two miles behind a battlefront, it's now a maternity hospital and trauma center run by Doctors Without Borders. Behind the concrete barrier, malnourished babies are fed, cholera patients recover, and war victims are bandaged: young boys hit with shrapnel while playing in their yards, the hospital's own night watchman, hit by a shell while shopping.

Doctors and other health workers at public hospitals haven't been paid since 2016. Humanitarian groups are supporting the health ministry with salaries and supplies. But a Saudi-led coalition blockade on the country's airports and ports in an attempt to stop supplies from reaching the rebels has arbitrarily delayed or diverted aid shipments, says Kristine Beckerle, with Human Rights Watch, adding that both sides "are weaponizing aid."

Since 2017 the country has seen more than a million suspected cholera cases—the worst outbreak in modern history. One NGO ordered a shipment of medication in July 2017. It didn't arrive until April.

Many of Yemen's doctors have moved to private hospitals or fled the country, leaving a shortage of medical professionals. Those who stay behind train their neighbors to treat wounds in case of an emergency overnight, when it's too dangerous to travel.

The private clinics cost more than even a middle-class civilian can afford. If you are dying, one elderly man told Bastianelli, you have to pay to be pronounced dead. The other option is to drive across the front lines to one of the country's two open airports. Few can afford the cost of fuel—or the risk. "They're locked in Yemen. No country is giving them asylum or making a humanitarian corridor," says Bastianelli. "They count the days and wait to die." □

TOP

Long lines to refill canisters are a common sight at gas stations. Since 2015 fuel prices have more than doubled and the country has lost more than 40 percent of its GDP. "The economic disaster is even worse than the killing," says Radhya Almutawakel, co-founder of the Mwatana Organization for Human Rights, in Sanaa. "People are dying behind closed doors."

BOTTOM LEFT

An average of five children have been killed or injured each day since the conflict began, according to UNICEF. At the Mother and Child Hospital, nine-year-old Arzaa Abdalbaqu Abdella received fresh dressing for a fracture.

BOTTOM RIGHT

A seven-year-old boy hit by shrapnel from an explosion is treated by Doctors Without Borders in a hospital outside Taizz. The city has been battered by Saudi-led coalition air strikes.

PREVIOUS PHOTO

Hundreds of schools like this one in Ad Dali have been destroyed by air strikes. Currently two million school-age children are not enrolled in school.

YOUR SHOT

KHAI NGUYEN

PHOTOS FROM OUR COMMUNITY

WHO

Khai Nguyen, a video game animation director in Montréal, Québec

WHERE

A beach famous for its kangaroos in Cape Hillsborough National Park, in Queensland, Australia

WHAT

A Sony a7R II camera, with a Sony FE 55mm F1.8 lens

Nguyen plans his family's vacations around what he calls his "photo bucket list." When he dreamed of photographing kangaroos, Google Earth led him to an Australian beach known as a kangaroo hangout. His first early morning visit was a bust: There were no kangaroos. Risking his family's ire, he returned to discover a dozen kangaroos and wallabies foraging for seaweed in the waves. Two were wrestling—one apparently more interested than the other. "The smaller one reminded me of my son," Nguyen says.

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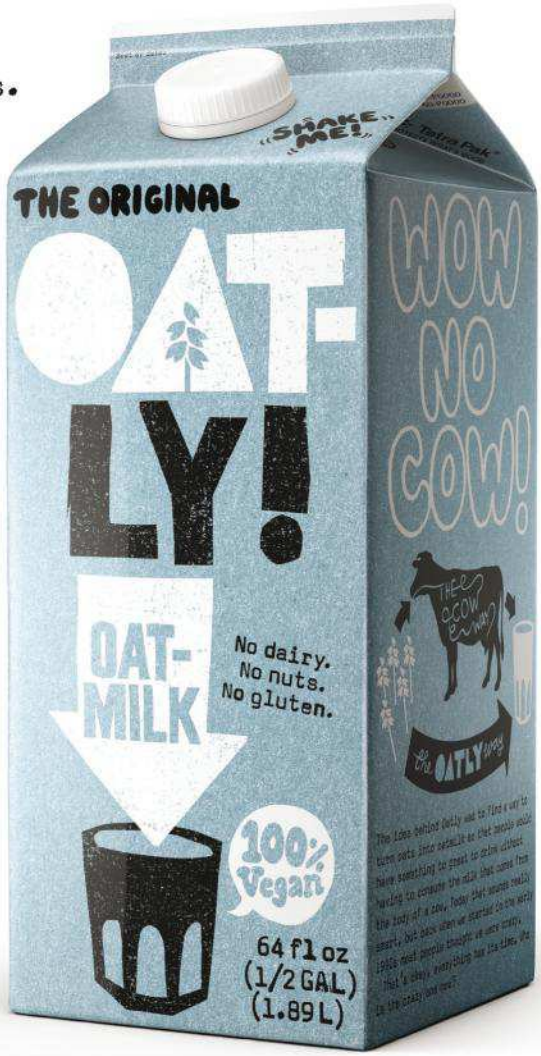
IT TAKES BRAINS TO BE STUPID.

We must look extremely dumb sometimes. This little oat company from the south of Sweden thinking we can help the entire food industry become more accountable for their actions. There's probably a few people from the industry looking down on us right now thinking – haha, you idiots!

That's okay, we didn't expect the establishment to be happy when we took our production chain and made it transparent for everyone on the internet. At oatly.com you can read not only about every ingredient that goes into our products but also where each ingredient comes from. That way you can see all our faults and follow each improvement we make. After all, trust is earned through actions, not talk. However smart or stupid that sounds, one thing is for sure. It's so true.



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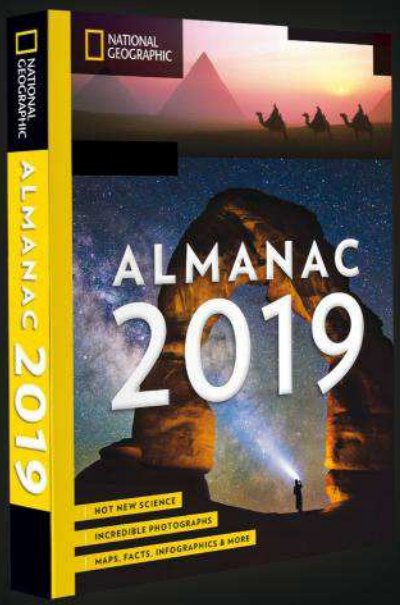

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