VOLUME 245 MARCH 2024 NUMBER 03

NATIONAL GEOGRAPHIC

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FROM *the* EDITOR

NATHAN LUMP

FOR 135 YEARS AT *National Geographic,* we've continued to evolve the magazine you hold in your hands. What started as a journal with just words, maps, and a simple monochrome cover became a popular magazine filled with photographs and known for its striking cover images. Our commitment to bringing the world to you and helping you understand it better has never wavered, but the way we've done that has shifted with the times.

We last refreshed the magazine in 2018, so it seemed like a good moment to think about how we could improve it even more. We wanted to give you everything you love about *National Geographic* while making it feel livelier and easier to read.

We kick off the magazine with a set of pages that will appear every month, all demarcated by a yellow border: this welcome note from me, followed by a guide to the entire issue, a selection of the most interesting images just in from our photographers in the field, and an introduction to some of the contributors behind our stories, including National Geographic Explorers.

You'll then arrive at the heart of the issue—stories that bring new insights and fresh perspectives. Between our longer, more in-depth features you'll find shorter articles (differentiated by

PHOTO: MARK THIESSEN

Spotted hyenas, the subject of this month's cover story, are efficient hunters that often work together to capture large prey, such as an adult wildebeest, in short order.

a beige border) in recurring formats that we hope you'll come to recognize and anticipate. A few examples this month are Artifact, which explores history through the lens of a specific object; Charted, which leverages data to explain a phenomenon; and Photo Ark, which uses Explorer Joel Sartore's incredible images to illustrate the wonder of wildlife.

While this magazine is very much at the core of the National Geographic brand, there are many exciting things we do beyond these pages, which we want to share with you. So we close the issue with some suggestions worth checking out, whether that's a guided trip to an intriguing destination, a Nat Geo show to stream on Disney+, or a popular post from our Instagram accounts.

We love this iteration of *National Geographic*—which also features a slightly larger type size throughout—and we hope you do too. What hasn't changed is the exceptional storytelling that you've come to expect.

This month our cover story brings you into the real lives of the misunderstood spotted hyena, which photographer Jen Guyton captured as never before using robot-mounted cameras created by our photo engineering team.

We also take you to dark reaches of the ocean and show what researchers are learning about the unusual creatures that thrive there. We look at the changing ways of assisting people who live with dementia. We explain what laser scans are revealing about the ancient Maya. And we bring you 2024's Best of the World, a list of the top experiences in travel, curated by our global community of experts.

I hope you enjoy the issue.

ILLUSTRATION: MAURICIO ANTÓN

CONTENTS

FEATURES

ON THE COVER Spotted hyenas approach a pond in Kenya's Masai Mara region. In the hyenas' highly structured society, all members inherit their rank from their mother.

Photograph by JEN GUYTON

CULTURE

"The post-Taliban generation, which once experienced RELATIVE FREEDOM, now grapples with a future under a regime that has *abruptly diminished* those freedoms."

KIANA HAYERI, *photographer*

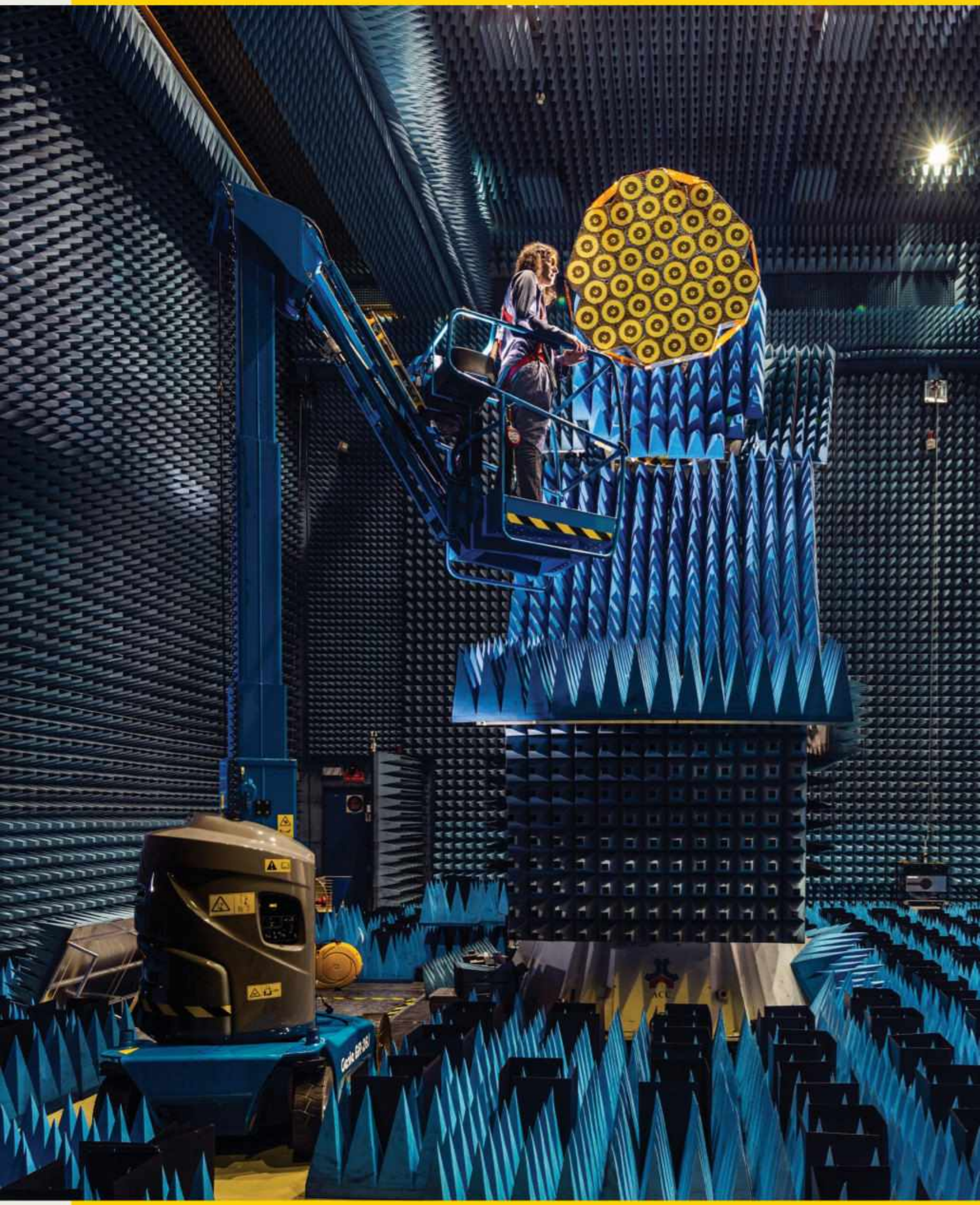
Brides and grooms participate in a mass wedding in Kabul, Afghanistan. During the celebration, sponsored by a local NGO, a play addressed child marriage and the ban on girls' education.

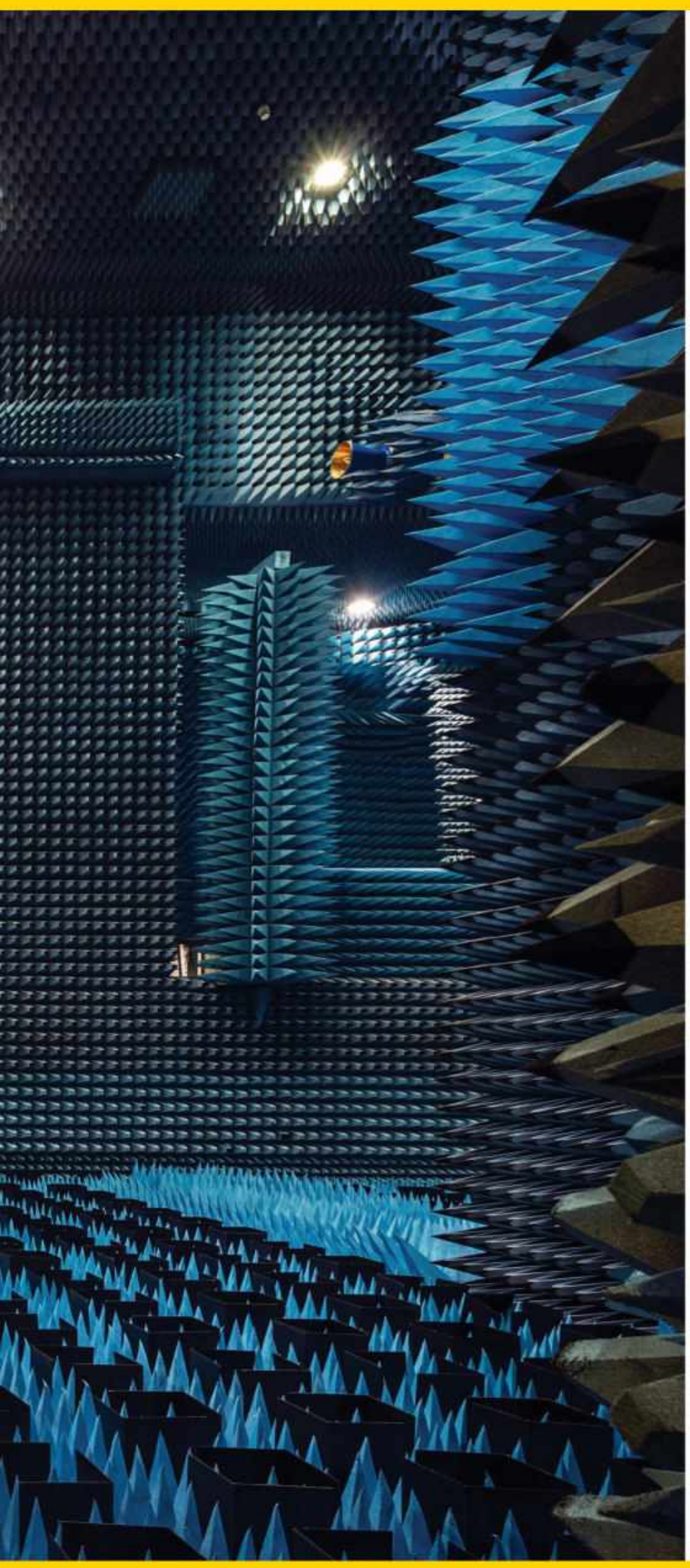
ENVIRONMENT

"The initial *thrill of discovery* was soon tempered by the sad realization that this cave only existed because of CLIMATE CHANGE."

JASON GULLEY, *photographer*

On Nepal's Khumbu Glacier near Mount Everest, glaciologist Doug Benn exits a huge cave created when rising temperatures increased lake levels on the glacier's surface, causing water to surge through cracks in the ice.





SPACE

“Ines was in that moment representing for me ALL THE HUMAN RACE facing the mystery of space and the *challenges to come.* I utilized multiple light sources, resulting in the human presence being ILLUMINATED as if there were multiple suns.”

PAOLO VERZONE,
photographer

Engineer Ines Barbary assesses the performance of antennas, essential elements of space structures, at the European Space Research and Technology Centre in Noordwijk, Netherlands.

ANIMALS

"Documenting the RESCATE ROSADO project was an intense experience. The most amazing part was observing the *powerful efforts* to reverse this situation and sensitize the population about having these migratory birds FLYING FREE."

FERNANDO FACIOLE, *photographer*

A rescued flamingo, one of many whose feathers have been clipped to prevent escape from hotels and resorts, enters rehabilitation at the National Zoological Park of the Dominican Republic.

ORIGINAL SERIES

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CAPTURING NEW VIEWS OF HYENAS

Aided by specialized cameras, this photographer is revealing the secret lives of Africa's most misunderstood animals.

Robot-mounted cameras enabled Jen Guyton to make close-up images of hyenas and their behaviors.

FOR THIS month's cover story on spotted hyenas (page 18), Jen Guyton was determined to do something different and innovative. "Going into this story, I knew that I wanted to go against that trend of taking photos of hyenas during the day," she says. So she photographed the primarily nocturnal animals at night. To avoid spooking them with bright spotlights or flashes, she used infrared lights, which hyenas can't see. National Geographic photo engineers also supplied her with an armored, remotely operated robot that was retrofitted with cameras after an earlier career in bomb disposal. Dubbed Ed by the engineers, the robot helped Guyton capture intimate images, including a portrait that became one of our 2023 Pictures of the Year. –HICKS WOGAN

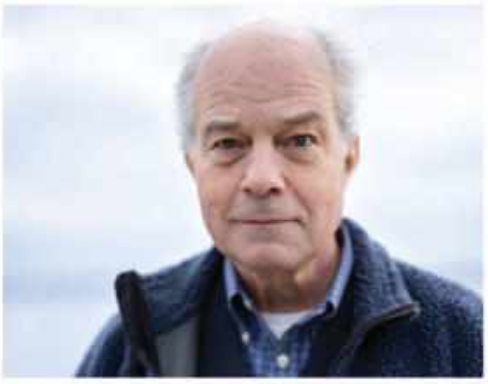
Ed, the armored robot

Photojournalist, ecologist, and a National Geographic Explorer since 2014, Guyton has been working on African wildlife and conservation projects for more than a decade.

PHOTOS: JEN GUYTON; MARK THIESSEN (ROBOT)

NATIONAL GEOGRAPHIC EXPLORERS

These contributors have received funding from the National Geographic Society, which is committed to illuminating and protecting the wonder of our world.



David Liittschwager, p.116

An Explorer since 2018, the San Francisco-based photographer has traveled around the globe to document the natural world—even the surprising biodiversity found within a single cubic foot. This month's story on the sea creatures that thrive at depths with little light is his 17th for the magazine.

Rubén Salgado Escudero, p.48

Born in Spain and now living in Mexico, Salgado Escudero focuses on the human condition, including the realm of the ancient Maya for this feature. His photographs have been exhibited worldwide and published in outlets such as the *New York Times* and the *Guardian*. He became an Explorer in 2018.

Isadora Kosofsky, p.90

A resident of Los Angeles, Kosofsky embeds herself in the lives of those she photographs. For this month's feature on dementia, her first for the magazine, she shadowed some 40 people over the course of three years. A TED Fellow, she gave a talk on documentary photography at the 2018 conference. *Senior Love Triangle,* her first monograph, was published in 2020.

Helen Scales, p.116

The marine biologist, author, and broadcaster has written articles and best-selling books about the ocean. She's a storytelling ambassador for the Save Our Seas Foundation and splits her time between England and France. For the November 2021 issue, Scales wrote about the need to protect the waters around Antarctica, and for this issue, animals of the ocean's twilight zone.

Tom Clynes, p.48

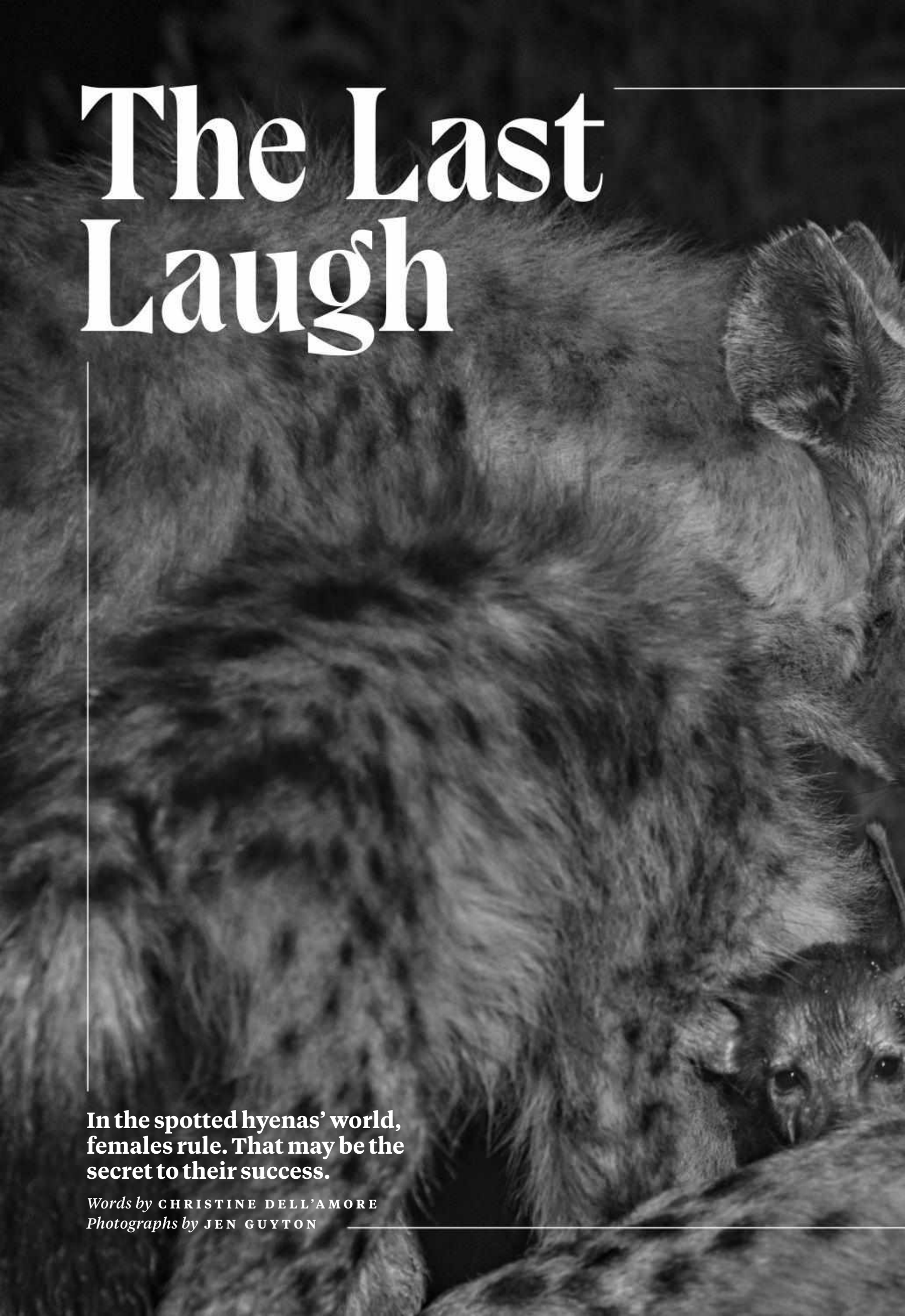
Clynes, a writer and photojournalist, covers the adventurous side of science and the environment. His articles have appeared in *Nature* and *Popular Science,* among others. His work for *National Geographic* has taken him from his Vermont home to the Arctic tundra and, for this feature on how technology is revealing Maya sites, to the rainforests of Guatemala.

Christine Dell'Amore, p.18

As a staff editor for the past 17 years, Dell'Amore has reported for *National Geographic* from all seven continents. She specializes in wildlife, particularly overlooked or misperceived species such as the spotted hyenas in this month's cover story. A lifelong passion for urban wildlife led to her award-winning feature on the ways animals are adapting to city life, published in July 2022.

PHOTOS (CLOCKWISE FROM TOP RIGHT): MARK ABRAMSON; HELEN SCALES; TOM CLYNES; REBECCA HALE; CIRIL JAZBEC; SUZIE RASHKIS

The Last Laugh



In the spotted hyenas' world, females rule. That may be the secret to their success.

Words by CHRISTINE DELL'AMORE
Photographs by JEN GUYTON

Soon after dawn in Kenya's Masai Mara ecosystem, spotted hyenas arrive at the edge of a pond to drink. The predators thrive in a range of habitats, from deserts to forests to cities. Photographer Jen Guyton captured this close-up with a remote-controlled robot.

(Previous photo)
A female hyena researchers named Moulin Rouge towers over another dubbed Palazzo, a lower ranking female that grins submissively. Dominant females use aggression to maintain rank and get first dibs on food.

Thunderclouds rolled across

Kenya's Masai Mara savanna as the spotted hyena cubs played, tumbling over each other in the wet grass. The cubs' mother lounged nearby, rising occasionally to discourage a bigger one-year-old from joining the little play group. When the older animal approached again, one of the pluckier cubs took a cue from its high-ranking mom and stood tall, trying its best to look intimidating. That action seemed comical, but both animals knew their place. The larger, lower ranking hyena stopped short, then bowed its head and slunk off.

Hyena mothers, like Empress Cicada, are doting parents, nursing their offspring with milk rich in protein, fat, and calcium—usually for more than a year.

Photographer Jen Guyton recorded this scene with an infrared camera, allowing an intimate look into hyenas' nocturnal behaviors. In doing so, she provided a small window into the intriguing structure of hyena society, where all members inherit their place in the pecking order from their mother. Females are in charge, and rank means everything—a matrilineal system that has fueled the spotted hyena's rise as the most abundant large carnivore in Africa.

These and other insights into hyena behavior wouldn't be possible were it not for 35 years of on-the-ground research by Kay Holekamp, founder of the Mara Hyena Project. Her efforts have helped reveal a creature noted for its advanced society, cognition, and ability to adjust to new surroundings.

Holekamp, a biologist at Michigan State University, has been studying the African species in the Masai Mara since 1988—one of the longest running investigations of any mammal ever. "I thought I'd be there for two years," she says, "but I got hooked."

Hooked on hyenas? Mention their name, and most people grimace. Aristotle described them as "exceedingly fond of putrefied flesh." Theodore Roosevelt called them a "singular mixture of abject cowardice and the utmost ferocity." Across Africa, hyenas are seen as evil, greedy, and associated with witchcraft and sexual deviance. Even the 1994 movie *The Lion King* portrayed them as cunning and malicious.

While four hyena species—brown, striped, spotted, and aardwolves—roam through various parts of Africa, the spotted has been the most maligned. One reason may be that the animals get a little too close for comfort.

"Rats, cockroaches, coyotes—all these different things—we just come into contact with them more," says National Geographic Explorer Christine Wilkinson, a carnivore ecologist at the University of California, Berkeley, who studies hyenas in Kenya's Lake Nakuru National Park. "Your most vilified species are often the ones that live alongside people, so those that are generalists and adaptable."

As Wilkinson, Holekamp, and other researchers unravel more about spotted hyenas' biology and behavior, they continue to upend our understanding of who rules the wild kingdom and how they do it.

Soup, an alpha female, brings a juvenile giraffe carcass to share with her two cubs. It takes three years for a hyena's skull and jaws to develop the bone-cracking strength necessary for hunting, putting pressure on mothers to provide for their young ones.

SURVIVAL SKILL 1

HUNTING PROWESS

IT'S A CLASSIC SAFARI MOMENT: A lion stands over a fresh carcass while hyenas skulk at the periphery, heads low. The lion has made a kill, and the hyenas are awaiting their chance for scraps, right? Not exactly.

When biologist Hans Kruuk began studying hyenas in Tanzania in the 1960s, he discovered that their reputation as cowardly scavengers was a myth. When spotted hyenas and lions shared a carcass, he found, it was the hyenas that scored the kill more than half the time. More recently, researchers in Kenya have learned that hyenas in the Masai Mara get an average of two-thirds of their food primarily by hunting, often working together seamlessly to take down wildebeests, zebras, buffalo, and other large prey.

How they choreograph these hunts is still a mystery. So in late 2022 Holekamp and colleague Ariana Strandburg-Peshkin from the University of Konstanz in Germany outfitted an entire hyena clan with GPS collars featuring microphones and accelerometers to analyze their movements and vocalizations—including the trademark hyena laugh, which likely expresses great excitement.

"The collars allow us to know where everyone is, who is saying what to whom, which group mates respond and which do not, and what all the hyenas are doing," Holekamp says. All these data are now being run through AI algorithms to decipher specific behaviors.

One thing has long been clear: Hyena queens are the "backbone of hyena society," Holekamp says. Part of that matrilineal dominance is physiological. Both female and male fetuses of higher ranking females are imbued in the womb with a boost of sex hormones such as testosterone, which likely increases aggression. Another part is anatomical: As the only mammal without an external vaginal opening, female spotted hyenas have an elongated clitoris that hangs between their legs and strongly resembles a male's penis. During mating, the female retracts this "pseudopenis" into her abdomen, making it impossible for the male to gain entry

Clan alpha Silver Nugget and her sister Stardust (foreground, center and right) visit a communal den after dusk. Guyton used infrared light, invisible to hyenas and humans, to document nocturnal behaviors.

without her cooperation and ensuring that she decides who fathers her offspring. (Remarkably, the female will also give birth through her clitoris.)

"They're like a chimera—a blend of multiple organisms," Holekamp says. "Some of their behaviors are heavily masculinized, and others are not."

Females care for their young for several years, longer than any other African predator. During this time, the young hyena's skull is developing, so it's unable to hunt and kill large prey. Holekamp theorizes this prolonged dependence may be one reason female hyenas evolved to be more aggressive than males, which play no role in parenting.

Though cubs of both sexes inherit the rank of their mother, they fall lower in the hierarchy as new siblings are born. Tagging and tracking studies have also revealed that most males, starting around three years old, leave their birth clans to join another, a strategic choice that can raise their chances of mating and passing on their genes.

RAW INTELLIGENCE

SEVERAL YEARS AGO, Holekamp's colleague Lily Johnson-Ulrich, a cognitive ecologist from the University of Zürich, drove into the city of Mekele in northern Ethiopia, where hyenas have lived alongside people for hundreds of years. There, she identified appropriate study locations and unloaded a "puzzle box," a 16-inch square, steel container with four small doors. Inside was a piece of raw meat or some milk powder, and each door required a different motor skill to open it: push, pull, slide, or draw out.

Her team conducted trials at three sites: a city where hyenas had long been resident; a rural, protected reserve; and a burgeoning town on the edge of the reserve where hyenas had lived for only about 20 years. In each spot the team videotaped what happened next from behind their vehicle.

When they tallied the results, they were floored. Based on multiple trials, the rural animals were more adept at opening the doors—a measure of innovation—than were the town and city dwellers. This discovery, published in 2021, runs counter to the theory that urban animals are better problem solvers.

Although hyenas are simply smart to begin with, regardless of where they live, Johnson-Ulrich suspects it's more than that: While urban hyenas tend to scavenge more and kill livestock, rural hyenas hunt more of what they eat, requiring more innovative thinking and dexterous motor skills.

In earlier experiments, including one in which Holekamp tracked the behavior of a longtime puzzle-box champion named Gucci, it became clear that hyenas can also remember how they solved earlier problems.

"As soon as Gucci saw us put the baited puzzle box on the ground, she arose from her resting site, went directly to the box, and opened it in only a couple of seconds, sliding the bolt holding the door closed backward with her teeth until the box popped open," Holekamp says.

Arjun Dheer, a wildlife ecologist and National Geographic Explorer who studied hyenas in Tanzania's Ngorongoro Crater, is also impressed by the species' cognitive skills. "When you look at a hyena," he says, "you can see the wheels turning—there's a lot going on behind those eyes. We underestimate them."

Hyenas' teeth and powerful jaws—among the strongest of any mammal—enable them to hunt a wide range of prey and eat as much of it as possible, even the hardest bones. But it's their built-in innovativeness that has driven the species' spread and success across the continent.

Clan size depends mostly on the abundance of prey and ranges from fewer than 10 members in some desert areas to around 130 animals at resource-rich sites like the Masai Mara and Ngorongoro Crater. Regardless of their numbers, however, hyenas maintain fission-fusion societies, in which groups of animals split (fission) or merge (fusion) depending on the need of the moment. For instance, some animals may rest and forage solo or in smaller groups, then abruptly join up with a larger group to hunt or defend against attacking lions.

Such fluidity is part of what makes spotted hyenas "the most socially complex carnivores in the world," says Dheer. Unlike many other African predators, hyenas can also breed anytime and anywhere and raise cubs in habitats that have been degraded by people and their livestock. This flexibility may be why the species has not declined in the same way as have African carnivores that are less able to cope with unexpected stressors.

URBAN ADAPTABILITY

ON A DRY, SCORCHING DAY, Wilkinson steers a beat-up, teal 4x4 through Soysambu Conservancy, a rural area on the outskirts of the Kenyan city of Nakuru. The country's long-standing drought is obvious; the grass is brittle from lack of rain, and Lake Elmenteita, known for its flocks of lesser flamingos that sometimes fall prey to hyenas, is quiet and still, with no birds in sight.

About 37,000 people live next to the conservancy, which is popular for wildlife tourism, but at least one animal continues to cause some concern. "When you are interviewing people here, asking them about their experiences of conflict," Wilkinson says, "hyenas come out on top in almost every conversation that you have."

In a recent study, Wilkinson attached GPS collars to seven hyenas, and now she opens her laptop to see where they've traveled overnight. By reviewing GPS data and thousands of camera-trap images, she has discovered that at night hyenas regularly leave Lake Nakuru National Park—one of only two fully fenced national parks in Kenya—and head toward neighboring communities between the park and the conservancy to eat butchers' scraps and carcass waste. They'll also occasionally kill and eat livestock not held in predator-proof enclosures, returning to the safety of the park in the morning. Once hyenas find a hole in the fence, they perform what Wilkinson jokingly calls a "downward-facing hyena" to squeeze themselves through.

Her fieldwork shows that when rangers fix the fence, the hyenas quickly go to work dismantling the repair, often opening the same hole—making it a challenge to keep this clever species at bay. The fence cameras have also captured funny moments, such as hyenas sliding easily under the perimeter early in the night but struggling to do so on the way back because of their bulging bellies.

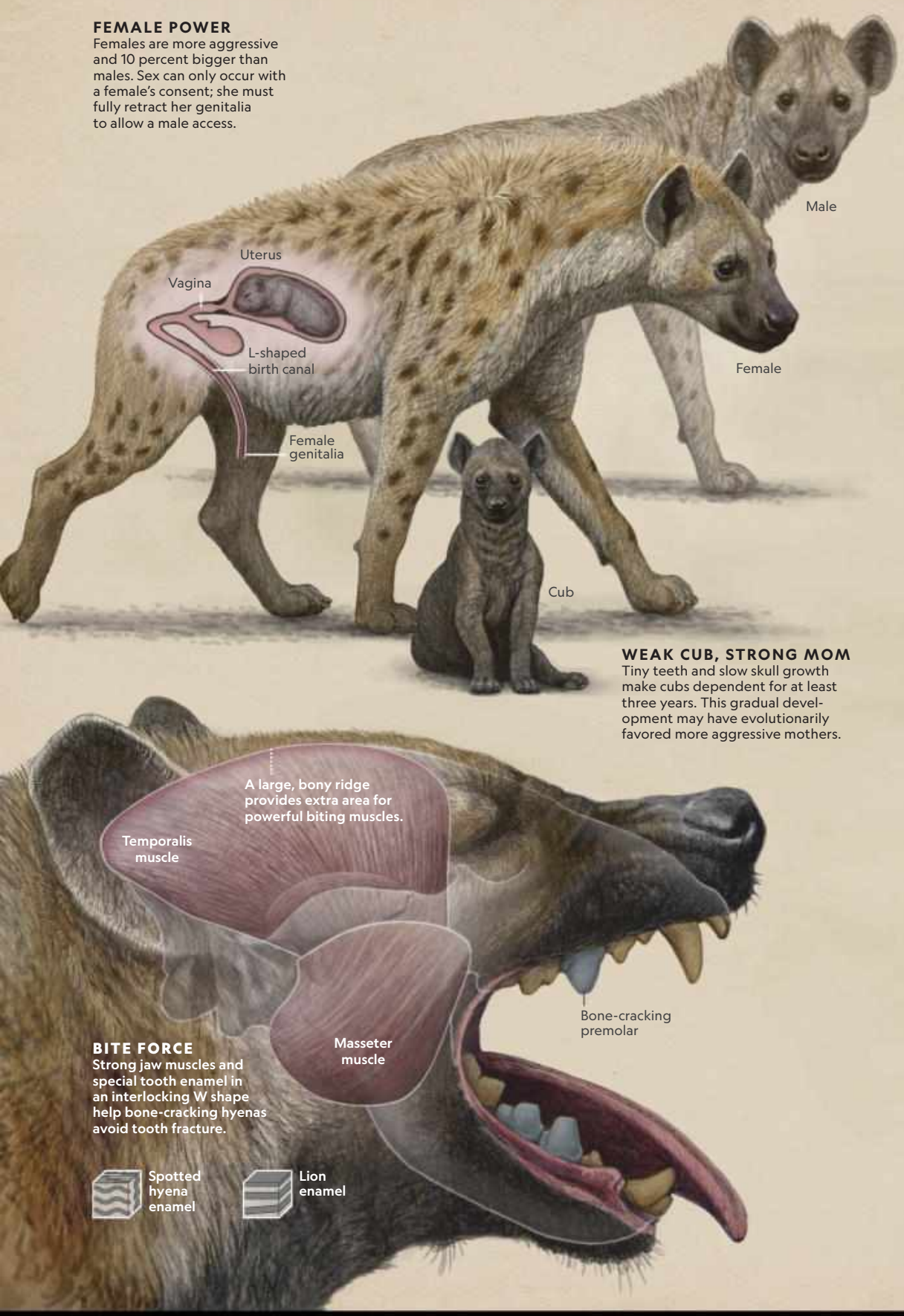
Wilkinson's research demonstrates how readily spotted hyenas adapt to living alongside humans and how they can deftly tackle roadblocks, such as finding work-arounds in fences that people rely on to keep them out.

As human settlements increasingly abut hyena habitat, the animals have learned to actively avoid people in some situations. Dheer's research revealed that hyenas living in Ngorongoro Crater were not bothered by herders who move their livestock across the landscape. These hyenas' cortisol, or stress hormone, levels were the same when compared with those of hyenas in the crater not visited by people, and their fertility and ability to rear young were unaffected.

In fact, Ngorongoro hyenas have learned to anticipate and avoid people's movements by becoming more active at night. "Not every animal can make such a change without negative consequences, but hyenas can," Dheer says. "They're able to use every inch of the landscape and find a way to survive and persist even in places where they're really disliked."

Hyenas will obviously enter human habitats when their wild prey have been largely wiped out, as is the case in northern Ethiopia, where forests have been converted to farms and grazing areas over centuries. But in these places, hyenas live relatively peacefully near people, in part because locals believe the animals consume evil spirits. During the day in Mekele, for instance, hyenas mostly stay hidden in remaining forest patches outside the city and around churchyards. They emerge in darkness to feed on carcasses—mainly equines and poultry—discarded in open landfills and on roadsides because of the city's poor waste collection service.

FEMALE POWER
Females are more aggressive and 10 percent bigger than males. Sex can only occur with a female's consent; she must fully retract her genitalia to allow a male access.



WEAK CUB, STRONG MOM
Tiny teeth and slow skull growth make cubs dependent for at least three years. This gradual development may have evolutionarily favored more aggressive mothers.

COOPERATIVE
Spotted hyenas can hunt alone, but cooperative hunting increases their success at capturing large prey such as adult wildebeests, buffalo, and giraffes. Most hunts last under a minute.

BITE FORCE
Strong jaw muscles and special tooth enamel in an interlocking W shape help bone-cracking hyenas avoid tooth fracture.

Ultimate

Spotted hyenas live in socially com
from six to 130 animals. Although t
cats. Contrary to popular belief, th
hunters that kill up to 95 percent o
advanced communication strategie

Graphic by MONICA SERRANO

STRATEGIC
Hunting techniques include selecting a herd's weakest member, using topography to ambush or corral prey, and walking upwind in a zigzag pattern to detect the scent of hidden quarry.

STRONG
Big front paws help hyenas hold down a carcass while they tear off flesh. To carry off hunks of meat and bones, the animals rely on their muscular front legs.

SAVVY
Hyenas are known to hide carcasses in vegetation or water. Food caching reduces odor and detection by vultures and other scavengers. When it comes to social intelligence, hyenas match baboons.

Wildebeest

Rank, inherited from the mother, sets priority of access to food.

Each hyena has a distinct whooping call; females have the deepest voices. Calls are used to recruit clan mates to defend food and territory.

e Hunters

plex, female-dominated clans that can range
hey look like dogs, they're more closely related to
ey're not just scavengers but also highly efficient
f their food. From their powerful jaws to their
es, these hyenas reign when on the hunt.

and KELSEY NOWAKOWSKI

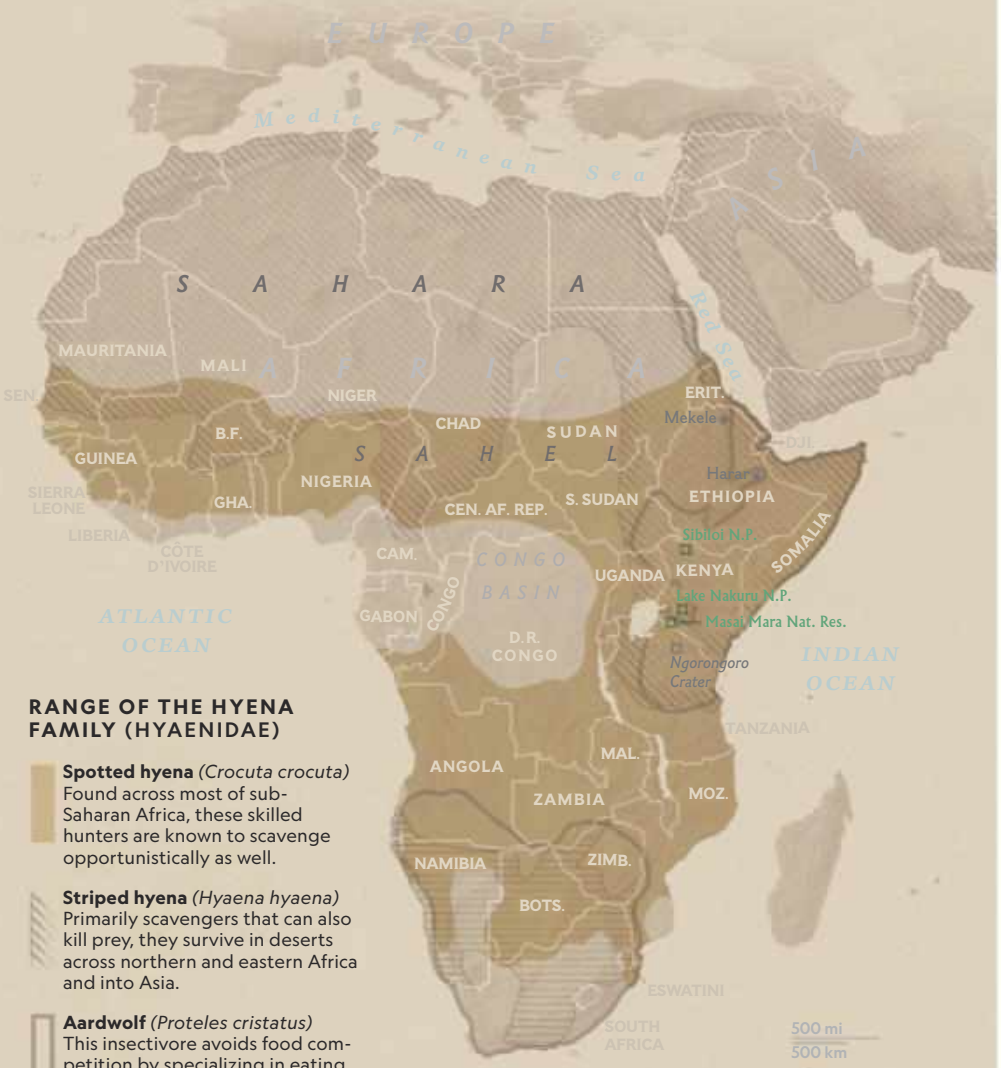
ADAPTABLE EATERS
The hyena diet encompasses foods from termites to eggs and elephants. They're able to digest any organic matter—including anthrax-infected carcasses—except hair and hooves.

Ostrich egg

ART: MAURICIO ANTÓN. SOURCES: KAY HOLEKAMP, MICHIGAN STATE U.; LILY JOHNSON-ULRICH, U. OF ZÜRICH; CYBIL NICOLE CAVALIERI, MICH. STATE U. MUSEUM

Realm of the Hyena

Adapted to nearly every habitat—from deserts to savannas, open woodlands to urban areas—four species of hyenas have made Africa their home. The most abundant large carnivore on the continent: the spotted hyena.



RANGE OF THE HYENA FAMILY (HYAENIDAE)

Spotted hyena *(Crocuta crocuta)*
Found across most of sub-Saharan Africa, these skilled hunters are known to scavenge opportunistically as well.

Striped hyena *(Hyaena hyaena)*
Primarily scavengers that can also kill prey, they survive in deserts across northern and eastern Africa and into Asia.

Aardwolf *(Proteles cristatus)*
This insectivore avoids food competition by specializing in eating termites—as many as 250,000 in one meal.

Brown hyena *(Parahyaena brunnea)*
This long-haired scavenger lives in the desert, semidesert, and open woodlands of southern Africa.

MAP: CHRISTINE FELLENZ, NGM STAFF
SOURCE: ANDREW JACOBSON, HYAENA DISTRIBUTION MAPPING PROJECT, IUCN

By observing the feeding behavior and population size of hyenas in Mekele and plugging the data into a disease-transmission model, Harvard University's Chinmay Sonawane and colleagues made a seminal discovery: Hyenas remove more than 200 tons of disease-carrying carcasses from Mekele each year. That translates to fewer deaths from anthrax and bovine tuberculosis, and the hyenas' "disease-control service" saves the local economy more than $50,000 annually by reducing livestock losses and human treatment costs.

While the animals have been known to bite people, these incidents are often related to humans leaving livestock enclosures unsecured or sleeping out in the open. As Wilkinson puts it, conservationists are now "trying to shift the narrative from conflicts to benefits," which have been historically underrated.

SURVIVAL SKILL 4

PUBLIC RELATIONS

EVERY FIVE YEARS, there's one particular test that Holekamp has kept running. Using a stopwatch and a pencil, she'll watch as safarigoers stop by whatever clan she may be observing. The animals might be devouring a freshly killed wildebeest or young giraffe or maybe just lounging together in the grass.

Back in the early 1990s, the average time tourists watched hyenas was one minute 38 seconds. For years, it seemed most people considered the animals unappealing and preferred seeing "real" predators like lions or cheetahs.

That antipathy has taken a toll. There are

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ore than 50,000 spotted hyenas cross sub-Saharan Africa (the last ount was done 25 years ago), but nbers are declining. Spotted hyenas same threats as other large African s, but hyenas—whose leading cause is killing by humans—are targeted ns that lions and other carnivores hey're snared or poisoned not only tion for preying on livestock but also they're considered vermin and pur- black magic.

lpha female eats first at a kill, she's e first to die from poison-laced car- hrowing the clan into chaos until a mber takes the helm. The poisoned cubs, now shorn of their matrilineal , are not adopted by other females eft to starve. "The biggest obstacle to nservation," says Holekamp, "is that on't like hyenas."

at may be changing. In a study of ist communities in Kenya, Uni- f Helsinki conservation biologist onal Geographic Explorer Miquel -Ticó found that on group ranches l Kenya, where conservancies and vate reserves make high investments e conservation, residents were more view spotted hyenas favorably com- others living in northern Kenya, biloi National Park has "meager" ation initiatives. People in both ho have family members in conser- tourism attributed more benefits, ourism revenue, to hyenas.

one morning in 2022, Holekamp a group of safarigoers stay glued to a kill for over 20 minutes—and the viewing time is now more than four This may mark a small but notable nt toward respecting the "coolness" rnivores, says Holekamp. The closer ook, the more they can see the true the jungle.

orting by Ayenat Mersie in Kenya

One of Palazzo's male cubs stares down a bigger but lower ranking female at a communal den. Cubs of both sexes inherit the rank of their mother, though after puberty most males leave their natal clans to find mates and thus lose their rank.

In a photo taken with the robot, hyenas feed on a freshly killed wildebeest. Hyenas are both hunters and scavengers, and in the latter role they help remove pathogens such as anthrax and bovine tuberculosis from the ecosystem.

Michigan State University biologist Kay Holekamp and her team treat an injured male hyena likely wounded in a fight. Holekamp's decades-long studies reveal that far from being the slobbering, stupid animals of popular myth, hyenas are whip-smart with social skills on par with those of primates.

Clouds spread over the Masai Mara as spotted hyenas patrol the savanna in search of prey. The animals hunt day or night and eat almost anything—two of many reasons they are Africa's most successful large predators.

Her SECRET GUARDIANS

When Anne Boleyn was executed in 1536, her prized book of hours went missing for centuries. Now we know who helped keep it safe.

Words by
LESLIE PATRICK

→ **ANNE BOLEYN,** King Henry VIII's second queen, is often portrayed as a seductress and ultimately the woman responsible for changing the face of religion in England. Boleyn is now recognized as a fiercely intelligent and pious figure dedicated to education and religious reform. But after her arrest and execution on questionable charges of adultery and incest in May 1536, Henry VIII was determined to erase her. Her royal emblems were removed from palace walls, her sparkling jewels tucked away in dark coffers, and her precious books disappeared from the annals of time.

But one of Boleyn's possessions, her book of hours, reappeared. The stunning prayer book, printed around 1527 with devotional texts designed to be read throughout the day, features hand-painted woodcuts, as well as a rare example of the queen's own writing. In the margins of one of the beautifully decorated pages, she penned a rhyming couplet followed by her signature: "Remember me when you do pray, that hope doth lead from day to day, Anne Boleyn."

The book vanished after Boleyn's execution, then resurfaced in the early 20th century, when American millionaire William Waldorf Astor bought Hever Castle, Boleyn's childhood home in the English countryside. The journey of the disgraced queen's devotional book remained a mystery, however, until new research revealed previously unknown signatures on its pages, which helped trace part of its path through history.

THE REVELATION

The book's whereabouts in the 360-odd years between Boleyn's death and its reemergence remained puzzling until 2020. That's when Kate McCaffrey, then a graduate student at the University of Kent

PHOTO: ROBERT ALEXANDER, GETTY IMAGES

Anne Boleyn, shown here in a late 16th-century painting by an unknown artist, was the second wife of Henry VIII and executed on charges of adultery and incest.

working on her master's thesis about the queen's book of hours, found something unexpected in the margins.

"I noticed what appeared to be smudges to the naked eye," recalls McCaffrey, an assistant curator at Hever Castle since 2021. Intrigued, she borrowed an industrial-strength ultraviolet light and set it up in the castle's darkest room. This type of light is often used to examine historical documents because ink absorbs the ultraviolet wavelength, causing it to appear darker against the page when exposed. "The words just came through. It was incredible to see them underneath the light—they were completely illuminated," the curator recalls.

McCaffrey's theory is that the "invisible" words were erased during the late Victorian era, when it was popular to cleanse "unnecessary" marginalia from books or manuscripts. But thanks to her detective work, the erased words turned out to be the key that unlocked the tale of the book's secret escape from likely destruction at the royal court to safety in the hands of a dedicated group of Boleyn's supporters.

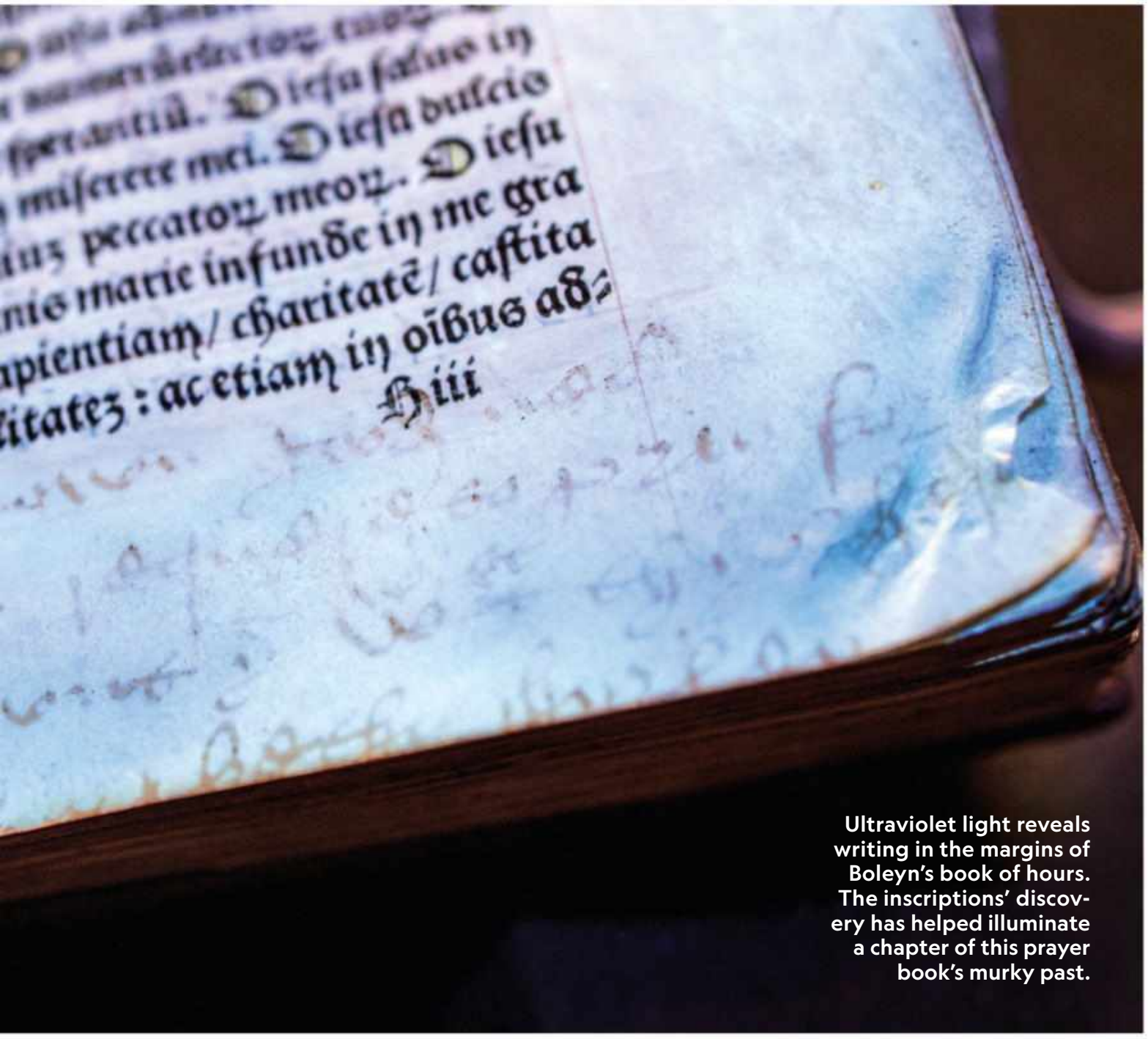
THE WOMEN

Various pages throughout the text reveal the names and notations of a string of Kentish women—including Elizabeth Shirley, Philippa Gage, and Mary West—who banded together to safeguard Boleyn's treasured book of hours and to keep her memory alive.

While it's not yet clear who among them was the first to receive the book, Boleyn expert Natalie Grueninger suggests it was given to Elizabeth Hill by the queen. Hill grew up near Hever Castle, and her husband, Richard, was sergeant of the King's Cellar at Henry's court. There are records of the couple playing cards with the king, and a possible friendship with Hill might have prompted Boleyn to pass on her prayer book before her execution. "This extended Kentish family kept the book safe following Anne's demise, which was an incredibly brave and bold act considering it could have been treasonous," says Grueninger, author of *The Final Year of Anne Boleyn*.

The book of hours was handed among mothers, daughters, sisters, and nieces until the late 1500s, when the final name appears in its margins. "The fact that the women have kept it safe is a really

PHOTO: COURTESY HEVER CASTLE & GARDENS



Ultraviolet light reveals writing in the margins of Boleyn's book of hours. The inscriptions' discovery has helped illuminate a chapter of this prayer book's murky past.

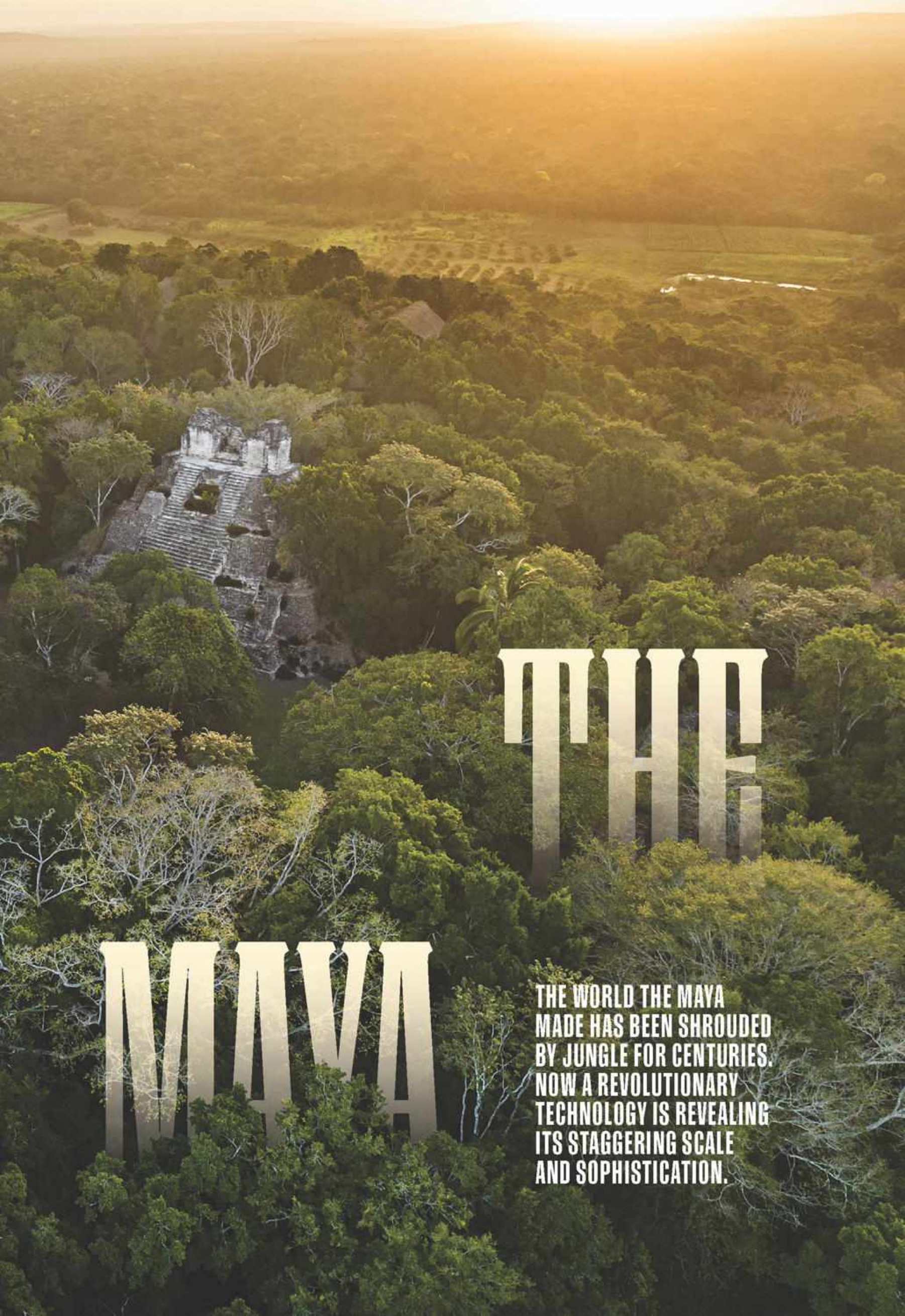
beautiful story of solidarity, community, and bravery," says McCaffrey.

The book, now on display at Hever Castle, is a touchstone of the enigma that was Boleyn. Historian Owen Emmerson points out that her DNA is on the pages she touched and kissed during her daily devotions. "This was a really beloved possession of hers," says Emmerson. "Because of what happened to Anne Boleyn, we don't have a vast amount of information in Anne's own words. But the physical remnants of her use of the book, and the construction of that beautiful little couplet, have her identity in them."

While Boleyn's book of hours found its way home, the research into this intriguing mystery is not over. McCaffrey continues to chart the book's provenance through the centuries to find out more about its furtive course—and its owner, who has engendered fascination for more than 500 years. ▯

Words by TOM CLYNES
Photographs by RUBÉN SALGADO ESCUDERO

UNVEILING


THE
MAYA
THE WORLD THE MAYA MADE HAS BEEN SHROUDED BY JUNGLE FOR CENTURIES. NOW A REVOLUTIONARY TECHNOLOGY IS REVEALING ITS STAGGERING SCALE AND SOPHISTICATION.

THE TWO ARCHAEOLOGISTS, both National Geographic Explorers with research posts at Tulane University, had collectively spent decades working in the jungles of Central America. Grueling heat and humidity, as well as encounters with deadly wildlife and armed looters, were inextricably part of discovering the treasures of the ancient Maya, a civilization that flourished for thousands of years and then mysteriously vanished beneath the dense forest. And so, it seemed ironic—almost unfair—that their biggest discovery would come while huddling around a computer in an air-conditioned office in New Orleans. While his colleague Francisco Estrada-Belli looked on, Marcello Canuto opened an aerial image of a tract of forest in northern Guatemala. At first, the screen showed nothing but treetops. But this image had been made with a technology called lidar (short for "light detection and ranging"). Lidar devices mounted on aircraft shoot billions of laser bursts downward and then measure the ones that reflect back. The small fraction of pulses that penetrate the foliage provide enough data points to assemble an image of the jungle floor.

With a few keyboard clicks, Canuto digitally peeled away the vegetation to reveal a three-dimensional image of the ground. Far

Discovered at the Maya city of Holmul, in Guatemala, a censer for burning resin during rituals depicts the god of the underworld.

(Previous Photo)

An aerial view hardly hints at the true size of Dzibanche in Mexico's Yucatan. Lidar—laser technology that digitally removes the forest canopy—reveals that the Maya city sprawled more than seven square miles.

from any population centers, the region they were viewing was thought to have been mostly uninhabited, even at the peak of Maya civilization more than 1,100 years ago. But suddenly, what had looked like ordinary hillsides were shown to have been carved with human-built reservoirs, agricultural terraces, and irrigation canals. What had appeared to be small mountains were in fact large pyramids, topped with ceremonial buildings. Settlements that generations of archaeologists had assumed to be regional capitals were mere suburbs of far larger pre-Columbian cities, connected by paved, raised highways.

Archaeologist and National Geographic Explorer Thomas Garrison, who viewed the data around the same time, was stunned by what he saw. "I think we were feeling something similar to what astronomers felt the first time they looked through the Hubble Telescope and saw all those empty spaces suddenly teeming with stars and galaxies," he says. "Here was this vast jungle that everyone thought was nearly empty. And then, when we peeled off the trees, there were human signatures everywhere."

The use of lidar is revolutionizing Maya archaeology, not only guiding researchers to promising sites but also giving them a big-picture view of the ancient landscape. Dozens of lidar surveys—including the breakthrough project unveiled in New Orleans in 2018, funded by the Guatemalan Foundation for Maya Cultural and Natural Heritage (Pacunam)—have upended long-established impressions of a civilization that thrived in one of Earth's least hospitable regions.

"It's almost impossible to overstate the extent to which lidar is energizing Maya archaeology," says Guatemalan archaeologist Edwin Román-Ramírez. "We'll always need to go in and dig to understand the people who built these structures, but this technology is showing us exactly where and how to dig."

In particular, the imagery overturns the idea that the Maya lowlands were a sparsely populated landscape peppered with a few scattered and autonomous city-states. Each new lidar survey makes it increasingly clear that the Maya were an interconnected civilization of dazzling scale and complexity—a Maya megalopolis, with millions of farmers and fighters and builders of infrastructure more extraordinary than anyone had previously imagined. The revelation has

The nonprofit National Geographic Society, working to conserve Earth's resources, helped fund this research.

Dig team member Clara Alexander inspects a burial near Holmul that was breached by robbers. As lidar reveals thousands of previously unknown tombs, temples, and other Maya structures, it's also uncovering evidence of widespread looting.

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ARTIFACTS PHOTOGRAPHED AT THE HOLMUL ARCHAEOLOGICAL PROJECT LABORATORY, ANTIGUA, GUATEMALA

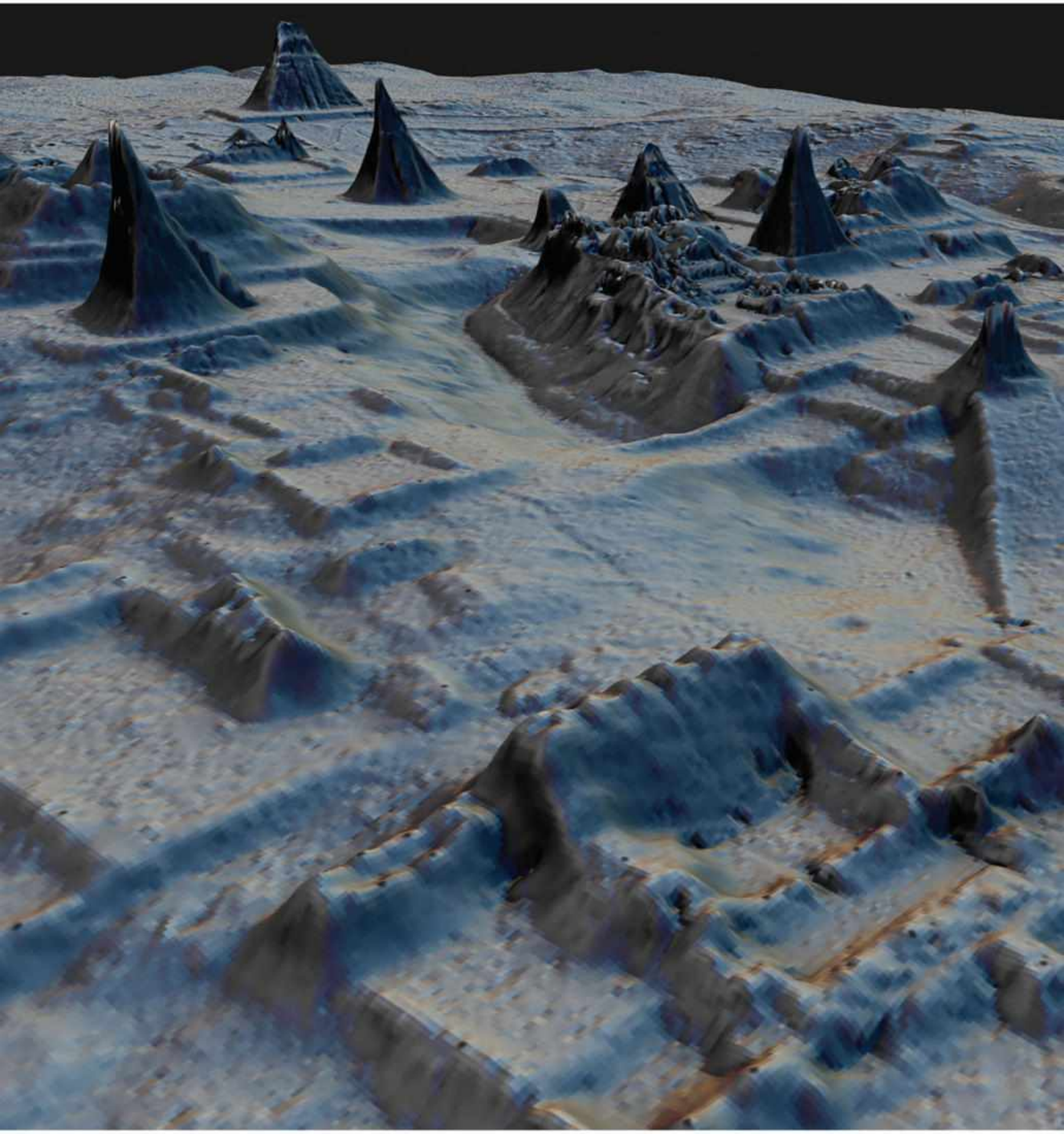
the power to not only rewrite the region's past but also radically reshape its future.

FOR GUATEMALA, economically impoverished but rich in cultural and ecological treasures, the discoveries offer an exciting prospect: Many of the new sites could become the centerpiece of a cultural and ecotourism industry that could help the nation blaze a sustainable path out of poverty. But for Estrada-Belli, Román-Ramírez, and other Guatemalan archaeologists and conservationists, the high-tech imagery has also exposed a more troubling development that could render those plans moot: the telltale marks of looters, loggers, land-grabbers, and narco-traffickers who are laying siege to the second largest remaining tropical rainforest in the Americas. Many Guatemalans fear that they may lose the high-stakes race to protect the landscapes and treasures that could illuminate even more lessons the ancient Maya have to teach us.

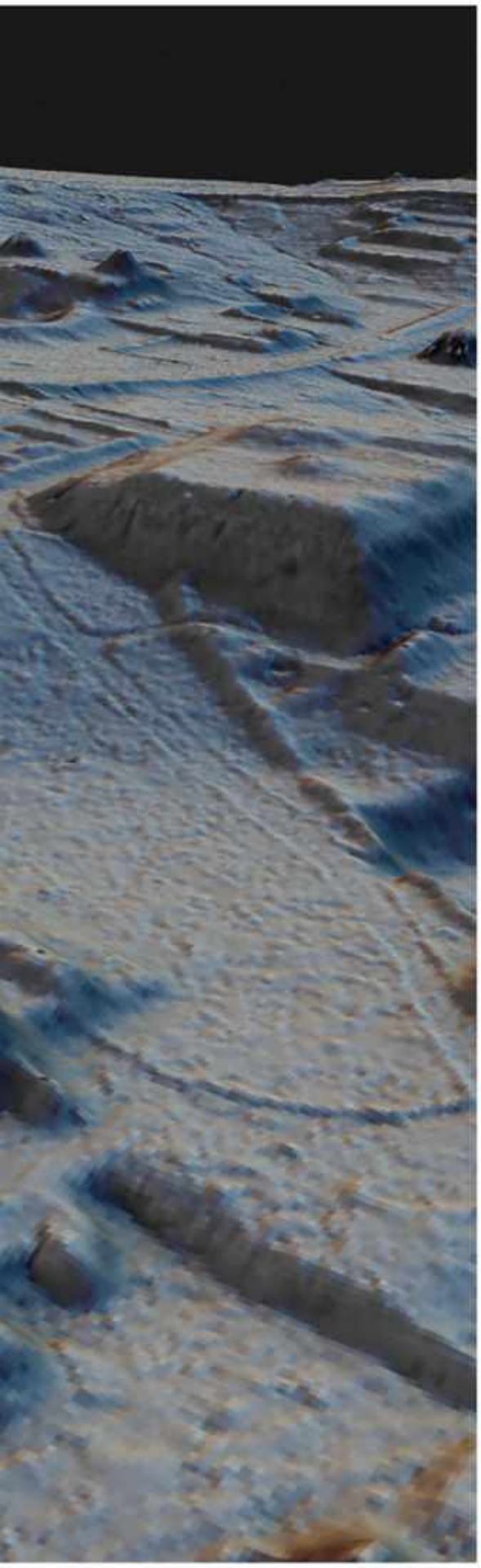
Much of the country's most important cultural patrimony is sheltered within the Maya Biosphere Reserve, a jumble of national parks, wildlife reserves, and forestry concessions where residents harvest timber and other forest products. Comprising about a fifth of Guatemala's territory, the reserve is home to jaguars and scarlet macaws, as well as hundreds of other species of birds, butterflies, reptiles, and mammals.

In contrast to more arid cradles of civilization such as Egypt and Mesopotamia, Central America's humid forests have rarely given up their buried secrets easily. In the mid-19th century, American writer John Lloyd Stephens and his British companion, the artist Frederick Catherwood, explored some of the abandoned Maya cities on Mexico's Yucatan Peninsula. Their descriptions and drawings of overgrown pyramids and palaces drew other researchers, but

A trove of Maya treasures recovered from two rare unlooted tombs includes a painted bowl (1); an exquisite jade mosaic mask (2) and a jade figure depicting the corn god (7); obsidian projectile points remade into ritual objects (3, 5); tall cups for chocolate (4, 6); and a human thigh bone inscribed with a portrait of a Maya king buried in one of the tombs (8). "We didn't realize this was a royal shrine until we saw the lidar images," says archaeologist Francisco Estrada-Belli.



Archaeologists thought they knew Tikal well, but lidar revealed that Guatemala's largest Maya city was at least four times as large as previously thought—a complex network of elevated roads, terraced fields, reservoirs, and defensive fortifications.



FRANCISCO ESTRADA-BELLI (LIDAR DATA: PACUNAM LIDAR INITIATIVE/NCALM)

after decades of digging, archaeologists managed to open only a few small windows into the Maya world.

In 2009 archaeologists Diane and Arlen Chase, currently with the University of Houston, tried something new at Caracol, an ancient city in Belize they'd been excavating since 1985. Lidar scanners, initially used for meteorology and tracking celestial bodies, were increasingly being mounted to aircraft to aid mapping and surveying.

"At the beginning of the project we'd thought Caracol was just a few pyramids and temple groups," Arlen Chase says. "But when we lidar-surveyed the outlying areas, we discovered that it was actually a huge, elaborately planned city." The metropolis likely supported at least 100,000 people, almost twice the present-day population of Belize City.

The Chases' findings awakened other archaeologists to the technology's potential. In 2021, excavations based on the Pacunam data yielded surprises even at Tikal, Guatemala's largest archaeological site. The city was at least four times as big as previously thought, and partly surrounded by a massive ditch and defensive wall stretching for miles. Also revealed were a large pyramid and a mysterious compound with links to Teotihuacan, an ancient superpower more than 800 miles to the west.

"To find major new monuments in the heart of Tikal—one of the most extensively studied sites in the Maya area—reinforces how many doors lidar is opening," says Román-Ramírez, who directs the South Tikal Archaeological Project. "We're discovering features that we couldn't perceive even when we were walking on top of them."

ABOUT 40 MILES northwest of Tikal, archaeologist Richard Hansen climbs a low embankment and pauses to stomp the mud off his boots. "Years ago, we relocated our supply path to this higher, drier stretch," says Hansen, a National Geographic Explorer affiliated with Idaho State University who co-directs research at the ancient city of El Mirador. "It wasn't until the lidar that we realized we were walking on an ancient superhighway."

The causeway is now covered by two feet of dirt, but centuries ago it was raised six feet above the surrounding swamp and paved with stucco. Part of a complex network of roads that connect Mirador to more than 400 ancient settlements, it

18+

WHAT IS AVAXHOME?

AVAXHOME-

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'TO FIND MAJOR NEW MONUMENTS ... REINFORCES HOW MANY DOORS LIDAR IS OPENING. WE'RE DISCOVERING FEATURES THAT WE COULDN'T PERCEIVE EVEN WHEN WE WERE WALKING ON TOP OF THEM.'

Edwin Román-Ramírez, archaeologist

widens to 130 feet as it approaches the city center—the width of a modern eight-lane freeway.

"Can you imagine how many people must have been moving around here to justify committing the resources to build something like this?" Hansen asks. Carbon dating and analysis of pollen and soils suggest that the site was occupied as early as 2600 B.C. At its zenith between 300 and 100 B.C., El Mirador may have been one of the largest cities in the Americas.

Nowhere in the Maya lowlands is the environment easy on humans. What few nutrients the soil contains are regularly washed away by months of torrential rains, often followed by withering droughts. Hansen's research suggests that the rise in population at El Mirador was enabled by hauling fertile mud from low-lying swamps and depositing it on terraces cut into the hillsides. Farmers elevated the pH by adding lime to the soil, producing abundant harvests of corn, squash, beans, peppers, and cotton.

In a region often plagued by too much or too little precipitation, the flow of water was meticulously controlled via canals, dams, reservoirs, and agricultural terraces—an immense infrastructure that is now being revealed.

"You couldn't feed as many people as the ancient Maya did with the kind of slash-and-burn agriculture people in this part of the world use today," says Tulane's Canuto, who models population density. He estimates that 10 million to 15 million people lived throughout the Maya realm at its peak, including many in swampy regions that most archaeologists had thought uninhabitable.

To build El Mirador's towering 230-foot pyramid, known as La Danta, armies of workers used hammerstones and obsidian blades to cut and drill into the limestone, then pried the rectangular blocks apart. Hansen and his research partners replicated the process, using tools found at the site's quarries as models. Workers built wooden litters to carry blocks weighing an average of 900 pounds. "With enough men and the means to feed them," Hansen says, "a king could complete it in his lifetime."

BUT MANY OF the newly discovered sites are not new to looters. "The state doesn't have the financial resources to protect our patrimony," says Marianne Hernández, president of the Pacunam foundation. "With the new data, we're at least figuring out where the sites are. If we had an army of archaeologists, we could send them out to study them before they are torn apart."

Looting is only one of the threats facing the Maya Biosphere Reserve. Illegal settlers often set fires to clear land for cattle ranches—frequently used by narco-traffickers for money laundering. Many have cut airstrips out of the jungle to land smugglers' planes.

Guatemala's government is making some effort to stop deforestation—which has diminished the country's old-growth forests by about 20 percent over the past two decades—and reclaim illegally occupied territory. But its work is hampered by a lack of equipment, fuel, reliable intelligence, and clear approaches *(Continued on page 66)*

THE MIGHTY M

Dozens of Maya city-states strove
over two millennia—trading, mingl
until the last of them were conque
the 16th century. Today, remote se
nology called lidar is peering throu
jungle to reveal a fuller picture of
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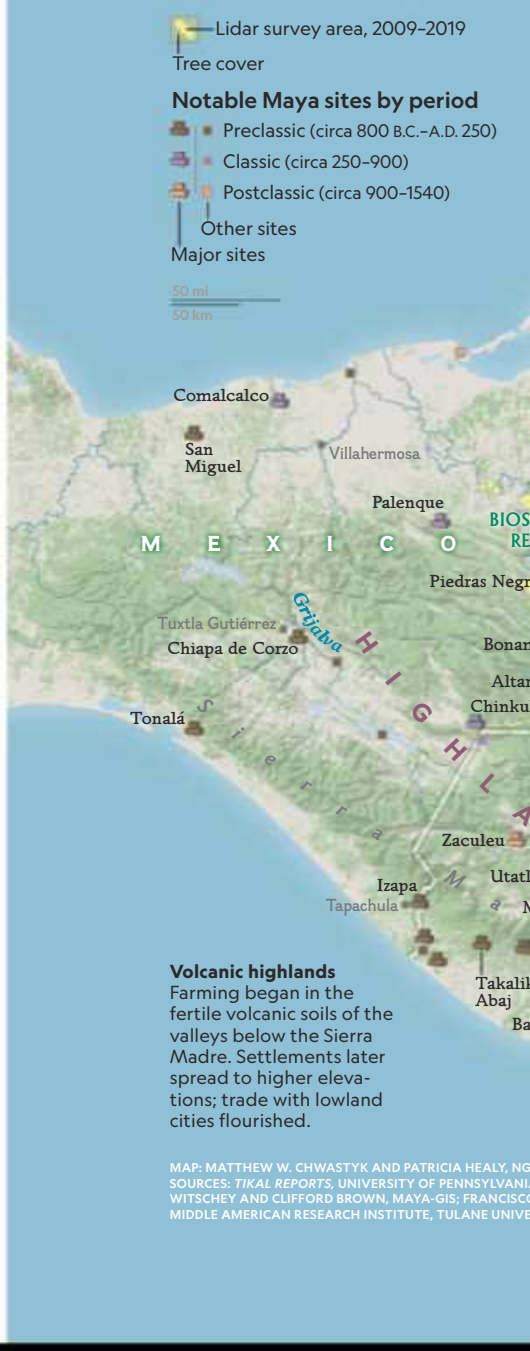

MAP: MATTHEW W. CHWASTYK AND PATRICIA HEALY, NG
SOURCES: *TIKAL REPORTS*, UNIVERSITY OF PENNSYLVANI
WITSCHEY AND CLIFFORD BROWN, MAYA-GIS; FRANCISC
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Rising cities
Lowland settlements were able to grow abundant crops in forests and wetlands. This gave rise to densely populated metropolises defined by monumental architecture.

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HIDDEN CITY SPRAWL

DENSE FORESTS HAVE CLOAKED THE EXTENT OF MAYA CIVILIZATION FOR NEARLY A THOUSAND YEARS. NOW IT'S COMING TO LIGHT.

SCALE VARIES IN THIS PERSPECTIVE.
ART: OWEN FREEMAN. SOURCE: FRANCISCO ESTRADA-BELLI, TULANE UNIVERSITY

SUBURBAN STRENGTH

Beyond Tikal's urban core were clusters of residential compounds with plazas surrounded by homes, kitchens, and gardens. In these social, administrative, and commercial hubs, people sold goods in the market and paid tribute—sometimes in the form of exotic items and even captives—to local elites. This scene, based on the work of archaeologists from the region and other experts, illustrates how this network of neighborhoods throughout the hinterland supported the flow of a city's resources.

ELITE'S HOUSE

MARKET

COMMUNITY PLAZA

CONSTRUCTION AND CLASS
Maya architecture consisted of thick-walled stone buildings with vaulted roofs, as well as less permanent structures with thatched roofs and wattle and daub. Labor-intensive stone homes found in suburbs suggest elites lived among commoners and served as local leaders.

TEMPLE IV, UNDER CONSTRUCTION IN CITY CENTER

POLITICS AND CONQUESTS
Warfare in the Classic period (A.D. 200 to 900) was aimed at the conquest of rival cities and involved large armies and massive defensive earthworks. High-ranking captives taken during raids or conflict could be used for ransom and increased the prestige of the victors.

WARRIOR WITH CAPTIVES

FEEDING THE CITY
Kitchen gardens with fruit orchards grew avocados, guava, squash, and beans. Distant fields yielded corn and starchy root crops, including manioc and sweet potatoes. Terracing of steep slopes, along with farming on the edges of reservoirs and fertile swamps *(bajos)*, produced enough crops for large populations.

ART: SAMSON J. GOETZE
SOURCES: FRANCISCO ESTRADA-BELLI AND MARCELLO CANUTO, TULANE U.; NICHOLAS DUNNING, U. OF CINCINNATI; JESSICA J. CHRISTIE, EAST CAROLINA U.; KAZUO AOYAMA, IBARAKI U.; MARCO ANTONIO CERVERA OBREGÓN, NATIONAL SCHOOL OF ANTHROPOLOGY AND HISTORY OF MEXICO; TRACI ARDREN, U. OF MIAMI; SIMON MARTIN, U. OF PENNSYLVANIA

Lidar data captured by aircraft flying above the Maya heartland are unveiling a web of cities and suburbs that were far more populous and interconnected than previously suspected. At Tikal, a Maya megacity that once dominated northern Guatemala, archaeologists have recorded signs of more than 11,900 structures extending out from the city's core.

Map and graphic by ALBERTO LUCAS LÓPEZ, MATTHEW W. CHWASTYK, *and* PATRICIA HEALY

Tikal's city center, with its pyramids, plazas, palaces, and temples, was extensively mapped from 1956 to 1961. While traditional methods of archaeological surveying took years, lidar has detected new structures and patterns in just a few months (visualized here on a treeless landscape).

(Continued from page 58) to dealing with invading communities.

"The park guards are on a mission impossible," says Roan Balas McNab, who until recently directed the Wildlife Conservation Society's Guatemala office. "They just don't have the resources."

Tourism may be one way to boost those resources. Across the border in southeastern Mexico, Maya sites like Chichén Itzá and Palenque draw millions of visitors each year and are major drivers of local economies. Mexico is also constructing a controversial railway—the so-called Maya Train—to connect beachgoers and cruise ship passengers with inland ruins.

Hansen would also like to build a railway. He envisions a miniature train that would shuttle tourists and researchers to El Mirador and eight other sites while barring unwanted intruders. "We need to let in the people who want to see and study these ancient wonders and keep out the looters and settlers, the narco-traffickers and loggers," he says.

He has proposed a binational sanctuary that would be Latin America's first wilderness area, free of roads, vehicles, and aircraft but accessible via rail.

Hansen even hired a lobbyist in Washington, D.C., and is hoping the U.S. Congress will allocate $72 million to build the railway and ecolodges that will provide jobs for Guatemalans and help stem the flow of economic migrants to the U.S. border. His proposal, he says, "would protect habitat and wildlife while facilitating a sustainable economy to employ the local communities."

Although Hansen has garnered some support for the proposal within Guatemala's government, some Guatemalans say he's appropriating their country's cultural heritage to personally profit by transforming the Maya lowlands into an archaeological theme park. Tulane's Estrada-Belli, a Guatemalan who dire
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uatemala," says Estrada-Belli. "But
appears to be more about him con-
large portion of the country than
g the Guatemalan people or science."
n counters that his proposal has
ssly misrepresented by critics who
ar him as a "gringo colonizer." He
vant to develop a Maya theme park,
"and I have no private interest
ver economically in anything in the
Basin."
nmentalists also balk at the idea of
ff the region. "There's a good reason
e aren't other wilderness areas in
erica that exclude locals who depend
al resources, and that's because it
work," says McNab. "Whenever you
people to stay out and give them
ns to sustainably harvest resources,
d to find ways to do it illegally, and
vely."
a dozen forestry concessions in the
llow communities to harvest tim-
rding to strict guidelines. Although
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ave found that logging within the
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am's Hernández believes some sort of
rivate approach has the best chance
ss. "Ecotourism and cultural tour-
eys to protecting this extraordinary
t we'd like to see it done respectfully
inably, with the involvement of local
ities."
cunam has also come under fire
me Guatemalans who point to the
organization's proposals to develop roads and other infrastructure in the fragile region.

"Pacunam cannot explain how all their ideas will conserve nature," says Alejandro Santos, director of the Rainforest Alliance's Guatemala office. "Pacunam is talking about ecohotels, but at the end of the day the destruction of nature is the same. The hidden interest is to use the [Maya Biosphere] reserve to transport other kinds of resources, like natural gas and petroleum."

WHY DID THE MAYA ABANDON SUCH HIGHLY FUNCTIONING COMMUNITIES? FOR NOW, THERE'S NO CLEAR ANSWER.

ATOP THE WIND-WHIPPED El Tigre pyramid, I ask Hansen what he'd wish for at El Mirador if unhindered by budget or technology.

"A time machine," he says. "I'd like to have even 15 minutes up here when it was in its heyday. I'd like to watch it all being built, to see the armies of workers, the scribes and the craftsmen, the farms, the royal pageants that mobilized everyone."

Lidar imaging, with its 3D realism, has made it much easier to envision the landscape of the ancients—the terraced hillsides, the broad roads and spacious plazas, the palaces and workshops and watchtowers. All of which highlights the biggest unanswered question: Why did the Maya abandon such highly functioning communities? For now, there's no clear answer.

A turbulent pattern of collapse, rebuilding, and revival was followed in the mid to late ninth century by a series of severe droughts that likely slashed crop yields throughout the region. Julie Hoggarth of Baylor University, who researches the effects of drought on Maya agriculture and health, says population growth and land clearing likely led to environmental degradation in some areas.

"On top of all of this," Hoggarth says, "the Maya kings were considered divine intermediaries with the gods, so you can imagine how their legitimacy could have been diminished if they didn't bring the rains and how the populace could have voted with their feet and left those cities."

Whatever the causes, by the late ninth century, the Maya were deserting their settlements. They stopped building monuments—and began smashing them in earnest. Violence and warfare seem to have been among the multiple factors that led to the society's eventual collapse.

One evening just before sunset, I hike solo to the summit of El Tigre. An unbroken forest stretches in all directions, punctuated by bumps in the landscape—jungled-over ruins that could one day be carefully excavated and preserved or looted and lost.

Accompanied by the throaty growls of howler monkeys, I walk down to an ancient quarry near Mirador's central complex of pyramids and palaces. In the gathering darkness a single block of cut stone lies on the ground, partially covered by roots, vines, and rubble. Whatever structure the block was destined to support remains incomplete—along with our understanding of this society, which reached heights of sophistication unrivaled in its time.

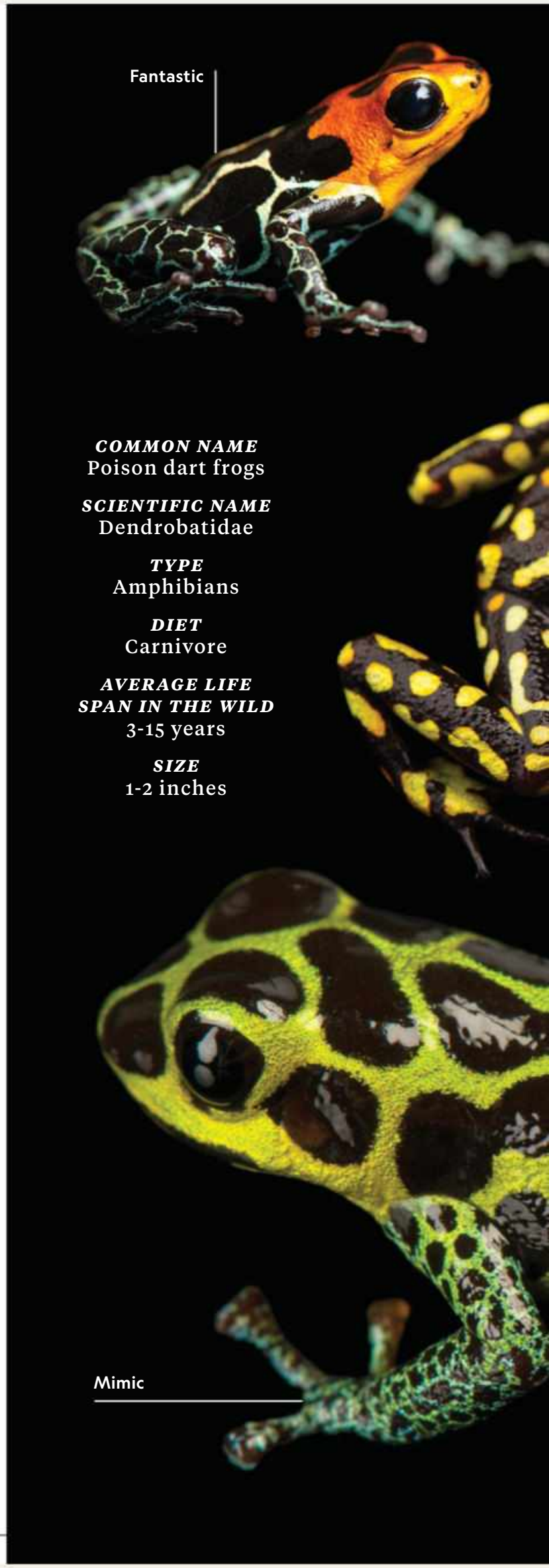
There's still more to be discovered—especially when you change the way you look at the world. ▯

TOXIC BEAUTY

Photographs by
JOEL SARTORE

POISON DART FROGS, members of the Dendrobatidae family, wear some of the most brilliant and beautiful colors on Earth. Depending on their habitats, which extend from the tropical forests of Nicaragua to Brazil, the amphibians can be yellow, silver, orange, pink, green, blue, or black. Their elaborate designs and hues are deliberately ostentatious to ward off potential predators. And if hungry animals dare take a bite, they'll quickly discover their meal is highly poisonous. A two-inch-long golden poison frog, for example, contains enough toxin on its skin to kill 10 adult humans. The Indigenous Emberá people of Colombia have carefully gathered the frogs' poison for centuries to use on the tips of their blowgun darts when hunting—hence the family's common name. Poison dart frogs are also unusual among amphibians for their intense devotion to their offspring. Fathers of the strawberry species will guard eggs until they hatch, and the mothers will carry tadpoles to pools of water.

The National Geographic Society has funded Explorer Joel Sartore's work since 2012, including his Photo Ark project documenting the world's animal species.




Strawberry
Harlequin
Strawberry
Strawberry

BEST OF THE

ISSUE
March 2024

FROM A HORSEBACK SAFARI IN KENYA TO RIVER RAFTING IN WEST VIRGINIA, HERE'S OUR LIST OF THE TOP 20 TRAVEL EXPERIENCES RIGHT NOW, CURATED BY NATIONAL GEOGRAPHIC EXPLORERS, PHOTOGRAPHERS, AND EDITORS.

WORLD 2024

THIS PAGE IS A PORTAL. No, really, it is: Our annual Best of the World list is a gateway to the streets of Paris, the snowy Caucasus Mountains of Georgia, the ancient rock art of Algeria. To help us engage with places more deeply and meaningfully, we drew on National Geographic's global community of experts to create a ranked list of great adventures. This year we expanded our recommendations online to include the hotels, restaurants, cultural spots, and wellness retreats that we love, as well as the game changers who inspire us to explore and the gear we don't want to leave home without. (Scan the QR code at the end of this article to dive into the treasure trove of travel intelligence in our Best of the World hub.) Most of all, this is a celebration—of travel's power to transform us and our connections with one another.

Ultimate Safari on Horseback

WHERE
Kenya

NUMBER
01

WHEN
JULY-SEPT

A safari in Africa usually conjures an image of mud-spattered 4x4 vehicles bouncing through the bush. But there's another way to travel: on horseback.

Although horse safaris originated in Kenya in the 1970s, they're a perfect fit for today's growing number of travelers looking for more engaging, sustainable wildlife encounters. At the 32,000-acre Borana Conservancy, two stables house thoroughbreds and ex-polo ponies for riders of all skill levels. Visitors can book half-day, full-day, or overnight rides *(borana.co.ke/riding-wild)*. Since wildlife perceive equines as just another animal, exploring the landscape atop a horse makes for an intimate experience. "To journey on horseback is to break down the walls—meant to protect but also to separate—between oneself and the natural world," says Nichole Sobecki, a photographer and equestrian who's ridden in Borana. "Your horse is your translator, responding to the low growl of the lion, the soft scent of a herd of elephants." A horse's ears are an advance warning system, she says, helping knowledgeable guides navigate routes.

NICHOLE SOBECKI

WATCHING WILDLIFE

Visitors to Borana might encounter zebras, leopards, impalas, elephants, and the area's population of 200 rhinos—a relative of the horse.

BEST OF THE WORLD 2024

Run Like Olympians

NUMBER 02

WHEN AUGUST 10

WHERE *Paris, France*

For the first time, members of the public will be able to run their own marathon during the 2024 Summer Olympics, just one initiative aimed at creating a more inclusive Games. Held in the evening between the men's and women's official races, the Marathon for All will allow 20,024 qualifying lottery winners on the 26.2-mile route that links Paris and Versailles. Before or after the big event, learn the route to follow in their tracks *(paris2024.org)*.

FUN FACT

The Olympic marathon route is inspired by the Women's March on Versailles in 1789, a pivotal moment of the French Revolution.

BEST OF THE WORLD 2024

CIRIL JAZBEC

Join the Bears

NUMBER 04

WHERE *Katmai N.P., Alaska*

WHEN JUNE-SEPT

Katmai National Park is home to one of the highest concentrations of brown bears in the world. Far from the crowded viewing platforms of the Brooks Camp visitors center, a guided trip along the Katmai coast with outfitters like AK Adventures reveals a different side of the park. Here the bears feast on a diversity of foods: sedges, grasses, razor clams, salmon. “For me, seeing a single brown bear in the wild is meaningful,” says Acacia Johnson, a photographer from Alaska, “because it is a sign that the landscape is healthy enough to support it.”

Hear It Live

NUMBER 05

WHERE *Kyoto, Japan*

WHEN YEAR-ROUND

Guidebooks speak of Kyoto as frozen in time, with hushed temples and meditative gardens. But after hours, Japan’s former imperial capital reveals a live music scene that can be loud and irreverent. At venues like Jittoku and Field, rock, swing, and even Irish music echo into the night. Whatever you’re into, from jazz to punk, there’s a community to share your jam. “This is what happens in Japan when the mask comes off,” says Kyoto guide Van Milton.

Ski New Peaks

NUMBER 03

WHERE *Georgia*

WHEN DEC-APR

Long a means of transportation, exploration, and hunting, skiing is still a way of life in the mountainous republic of Georgia. Now visitors can enjoy some of the nation’s best backcountry skiing in the Caucasus with the help of outfitters such as Svaneti Ski and Georgia Ski Touring. In Svaneti, excursions may lead skiers through Gvibari Pass (above) or to Ushguli villages, among the highest continuously inhabited in Europe.

BEST OF THE WORLD 2024

Cruise an Epic River

NUMBER
06

WHERE
Colombia

WHEN
DEC-MAR

About 80 percent of Colombia's population lives in the river basin of the Magdalena, which flows for nearly a thousand miles from the Andes to the Caribbean. AmaWaterways' new cruises on the river—said to be the first by a major cruise operator—journey upstream during seven-night trips from Cartagena via Mompós to Barranquilla. Stops at colonial towns, performances of *vallenato* and *cumbia* music, and visits to a stilt-house village highlight the region's culture along this mighty waterway.

Road Trip West

NUMBER
07

WHERE
New Mexico

WHEN
SEPT-NOV

For nearly a century, Route 66 has beckoned to travelers. A trip along the Mother Road through New Mexico hits timeless landmarks, such as quirky motels and curio shops in and around Tucumcari and symbolic etchings in Petroglyph National Monument. And in Gallup—mentioned as one of the places to "get your kicks" in Nat King Cole's 1946 hit song "Route 66"—you can take in performances featuring Zuni, Lakota, and Diné (Navajo) dancers. Some 18 miles of the highway traverse Albuquerque, the longest urban interlude of the route in the United States. And it's getting a half-million-dollar glow-up with the ongoing restoration of vintage neon signs along Central Avenue.

While cruising down the brightened strip, stop at the new West Central Route 66 Visitor Center, with its museum and outdoor amphitheater. The center will host events like lowrider car shows, drive-in movies, and artisan stalls *(wccdg.org/route-66-visitors-center)*.

MATJAZ KRIVIC

Explore Ancient Art

NUMBER 08

WHEN OCT-NOV

WHERE *Algeria*

Algeria is home to Africa's largest national park, which holds one of the world's greatest concentrations of ancient rock art. Tassili n'Ajjer National Park is a geologic wonderland of sandstone towers, arches, and sculpted outcrops. But these rock forests (such as the one at Adrit, above) are only half the story. Neolithic herders and hunter-gatherers carved 15,000 petroglyphs here, including images of elephants, giraffes, and rhinos. These animals are more commonly associated with sub-Saharan Africa—a hint that this arid wilderness was once a grassland crisscrossed by waterways. Five- to seven-day guided tours with Fancy Yellow take in the most spectacular works of Tassili's art, like the "Crying Cows," engraved at the base of a stone pinnacle 7,000 years ago *(fancyalgeria.com)*.

PRO TIP

Visitors with more time might want to combine a trip to Tassili with a visit to the Algerian Sahara's other great geologic marvel: the extraordinary mountain range of Ahaggar National Park.

Dive With Sharks

NUMBER 09

WHEN MAR-JULY

WHERE *Coral Coast, Australia*

Stretching almost 700 miles along the Indian Ocean north of Perth, Western Australia's Coral Coast is studded with natural wonders. But Ningaloo Reef is the star. Here, you can dive with giants: Some 300 to 500 whale sharks, one of the largest congregations on Earth, gather along the reef (below) each year between March and July. Even more megafauna abound around Ningaloo from July to October, when about 40,000 humpback whales migrate along the Australian coast.

WATCHING WILDLIFE

Off the Coral Coast, you can commune with more than 10,000 dugongs in Shark Bay or swim with manta rays at Coral Bay.

KILIII YÜYAN

Hike a Volcano

NUMBER 10

WHERE *Panama*

WHEN DEC-APR

A sustainability leader, Panama recently launched its "1,000 Kilometers of Trails" project, which seeks to bring outdoor recreation and green tourism to rural communities and protected areas.

First out of the gate is the Ruta de la Caldera, a system of five trails around the extinct Valle de Antón volcano *(venalvalle.com)*.

The treks take in waterfall-speckled landscapes, according to photographer Rose Marie Cromwell, who hiked sections of the Ruta de la Caldera over five days.

"There were some spectacular views on top of the volcanic crater—interesting land formations covered in so much green," she says.

Catch an Eclipse

NUMBER 11

WHERE *Niagara Falls*

WHEN APRIL 8

Directly in the path of totality, Niagara Falls will offer views of a total solar eclipse, which won't occur again in the contiguous United States until 2044. For about three and a half minutes, beginning at approximately 3:18 p.m., the sky will darken over the thunderous cataract as the moon crosses between Earth and the sun. On the U.S. side of the falls, Terrapin Point, Prospect Point, and the Observation Tower will be prime viewing areas (if clouds stay away). From the Canadian side, an excellent vantage point is Table Rock. A side bonus: The sunny-day rainbow that hovers above the falls will become pink.

BEST OF THE WORLD 2024

Trek a Glacier

NUMBER 12

WHERE *Chile*

WHEN NOV-MAR

In Patagonian Chile's Laguna San Rafael National Park, visitors can trek atop the Exploradores Glacier, taking in a panorama of pale blue ice massifs and glacial waterways. Some 17,300 glaciers still cover Patagonia's ice fields, but rising temperatures are rapidly melting them. Climate scientists say sustainable tourism, such as hikes with outfitters like Turismo Valle Leones, supports local communities and inspires travelers to learn more about how to protect glaciers *(valleleones.cl)*.

SEBASTIÁN ITURRALDE

Step Back in Time

WHERE
Menorca, Spain

NUMBER
13

WHEN
APR-JUNE

Spain's Balearic Islands are best known for the jet-set beach destinations of Ibiza and Mallorca. But quiet, less developed Menorca has a unique mother lode: the archipelago's greatest repository of ancient architecture.

In an area of just 270 square miles, Menorca has a total of 1,574 inventoried archaeological sites, ranging from the foundation blocks of small dwellings to well-preserved village centers that existed long before the Roman Empire. Most striking are the navetas, megalithic tombs dating back to 1600 B.C.; talayots, watchtowers built from mortarless blocks of limestone; and taulas, shrines exclusive to Menorca that evoke Stonehenge pillars. These remnants of the Talayotic Menorcan culture, the first civilization to inhabit the island, have now been inscribed on UNESCO's World Heritage List. The open-air monuments are easy to visit; the island's Me-1 road passes by some of the best-preserved sites, including the settlement of Talatí de Dalt, Naveta des Tudons (left), and Taula de Torretrencada.

Reenter the 21st century at the new Hauser & Wirth gallery in the picturesque town of Mahón. Housed in repurposed 18th-century hospital buildings, the cultural venue presents contemporary art exhibits and has an outdoor sculpture trail with works by Louise Bourgeois and Joan Miró.

PRO TIP

S'Albufera des Grau Natural Park—with its dunes, marshlands, tamarisk shrublands, and olive groves all wrapped around a lagoon—offers some of Menorca's best walks and bird-watching.

BEST OF THE WORLD 2024

Ride Classic Rails

NUMBER	WHERE	WHEN
14	*Scottish Highlands*	APR-OCT

Exploring Scotland's wild, scenic Highlands doesn't have to mean roughing it. The Royal Scotsman train glides among the moody lochs and dramatic peaks in style. New suites debuting in May 2024 sport interiors that reflect the compelling landscapes through dark woods, wool tweeds, and richly patterned bespoke tartans crafted by Scottish brand Araminta Campbell. Guests can wind down after a day spent hiking to waterfalls or playing rounds of golf, a sport inextricably tied to Scotland, with a massage at the onboard spa.

Departing Edinburgh's Waverly Station, the two- to seven-night rail journeys cross the heart of the Highlands, from Perthshire to Inverness to the rugged west coast. During stops guests can tour castles, stargaze in Cairngorms National Park, sample whisky at revered distilleries, and even take a dip in a loch.

BEST OF THE WORLD 2024

Find Authentic Flavor

NUMBER	WHERE	WHEN
15	*Isaan, Thailand*	DEC-FEB

The Isaan region is known for its distinctive cuisine that reflects influences from bordering Laos and Cambodia. "Isaan is a hidden gem of Thailand," says Weerawat "Num" Triyasenawat, chef of Michelin Guide–recommended Samuay & Sons in the Isaan city of Udon Thani. One key ingredient of the region's delicious food is *pla ra,* a fermented-fish seasoning that boosts umami flavor. Local dishes include *laab* (minced meat salad), traditionally served during celebrations.

TOM SIGLER

Wander Tea Trails

NUMBER 16

WHEN JAN-MAR

WHERE *Sri Lanka*

Sri Lanka is virtually synonymous with tea. Now visitors can trace the footsteps of historic tea planters on the new, nearly 200-mile Pekoe Trail (above), the country's first long-distance walking route. Starting just outside Kandy, the trail follows the 19th-century tracks upon which workers and horse-drawn carts transported freshly plucked leaves. Hikers pass through hill towns and tea plantations and can stop to take a cooking class or savor a cup of aromatic Ceylon tea *(thepekoetrailsrilanka.com)*.

FUN FACT

The island nation of Sri Lanka is one of the world's top producers of tea leaves. British colonists planted the first tea bushes about 200 years ago.

Gallery Hop

NUMBER
17

WHERE
São Paulo, Brazil

WHEN
SEPT-NOV

São Paulo, Brazil's largest city, is an art lover's paradise, home to numerous galleries, exhibitions, and street art. The crowning jewel is the Museu de Arte de São Paulo, which is expanding to showcase more of its 11,000-plus artworks, from pre-Renaissance paintings to contemporary sculptures. Departing from the usual model of exhibiting works on the wall, MASP hangs some pieces against clear panels, allowing visitors to view the art from all angles.

BEST OF THE WORLD 2024

Raft the Rapids

NUMBER
18

WHEN
APR-OCT

WHERE *West Virginia*

Despite its name, West Virginia's New River is actually one of the oldest on Earth, perhaps as old as 360 million years. The river falls 750 feet in only 50 miles between sandstone cliffs. It eventually merges with the Gauley River (above). Outfitters such as ACE Adventure Resort can arrange white-water rafting trips here on Class III to V rapids through the longest and deepest river gorge in the Appalachians.

JAY YOUNG

Go Antiquing

NUMBER 19

WHERE *Hudson Valley, New York*

WHEN YEAR-ROUND

The bucolic Hudson Valley is booming, thanks to an influx of New York City residents during the pandemic. But it's long been a mecca for artists: Its landscapes inspired America's first artistic fraternity, the Hudson River School. Antique collectors will be drawn to the hundreds of stores, boutiques, craft shops, and flea markets that sell everything from colonial furniture and rare books to mid-century modern decor. "There's a common denominator here—the charming historic villages," says Sarah Gray Miller, owner of Coxsackie antique store UnQuiet. From Athens to Saugerties, these towns "share a strong commitment to preservation."

PRO TIP

For vintage finds, head to the Antique Warehouse in Hudson, Sister Salvage in Catskill, and Opera House Co. in Athens.

Sleep on Water

NUMBER 20

WHERE *Tofino, British Columbia*

WHEN MAY-OCT

The newly reopened Tofino Wilderness Resort, owned by the Ahousaht First Nation, is an idyllic base from which to explore the western coast of British Columbia's Vancouver Island. In the heart of Clayoquot Sound, the luxury floating lodge was renovated with lumber from previously fallen timber on-site. Through guided whale-watching trips or visits to the Freedom Cove artists' sanctuary, the Ahousaht share with guests their philosophy, *hishuk ish tsawalk* ("everything is one"), celebrating the interconnectedness of people and nature in a land they've occupied for thousands of years.

EXPLORE MORE

Scan to discover the full Best of the World list, as well as travel tips on how to have these experiences yourself.

Words by Karen Carmichael. Additional reporting by Robert Draper, Acacia Johnson, Nichole Sobecki, Daniel Stables, Eva van den Berg, and Henry Wismayer

ARTIFACT

CLUES *in the* STONE AGE BEADS

Words by
AMY BRIGGS

WHAT
Necklace

WHEN
Neolithic period
(7400-6800 B.C.)

WHERE
Jordan

TINY SPLASHES of color astonished archaeologists excavating a 9,000-year-old grave at the Ba`ja site in Jordan, in 2018. They found it held the remains of an eight-year-old, and those multihued surprises once made up a stunning necklace of more than 2,500 beads.

Located north of Petra, Ba`ja was home to a remote community of farmers and herders who buried the child with this adornment. From 2018 to 2020, researchers studied the carefully crafted beads and reassembled the necklace as closely as possible to its original design: symmetrical strands attached to a mother-of-pearl ring and fastened with a hematite clasp.

The necklace, now on display at the Petra Museum, has yielded insights into Ba`ja's place in the Neolithic world. While the piece was likely made locally, some elements came from a distance. The shells originated from the Red Sea and the turquoise from the Sinai Peninsula. The amber, the region's first such documented use of the resin, may be from even farther away, in Lebanon. These materials suggest Ba`ja wasn't isolated but was connected to the wider area through trade networks. ▯

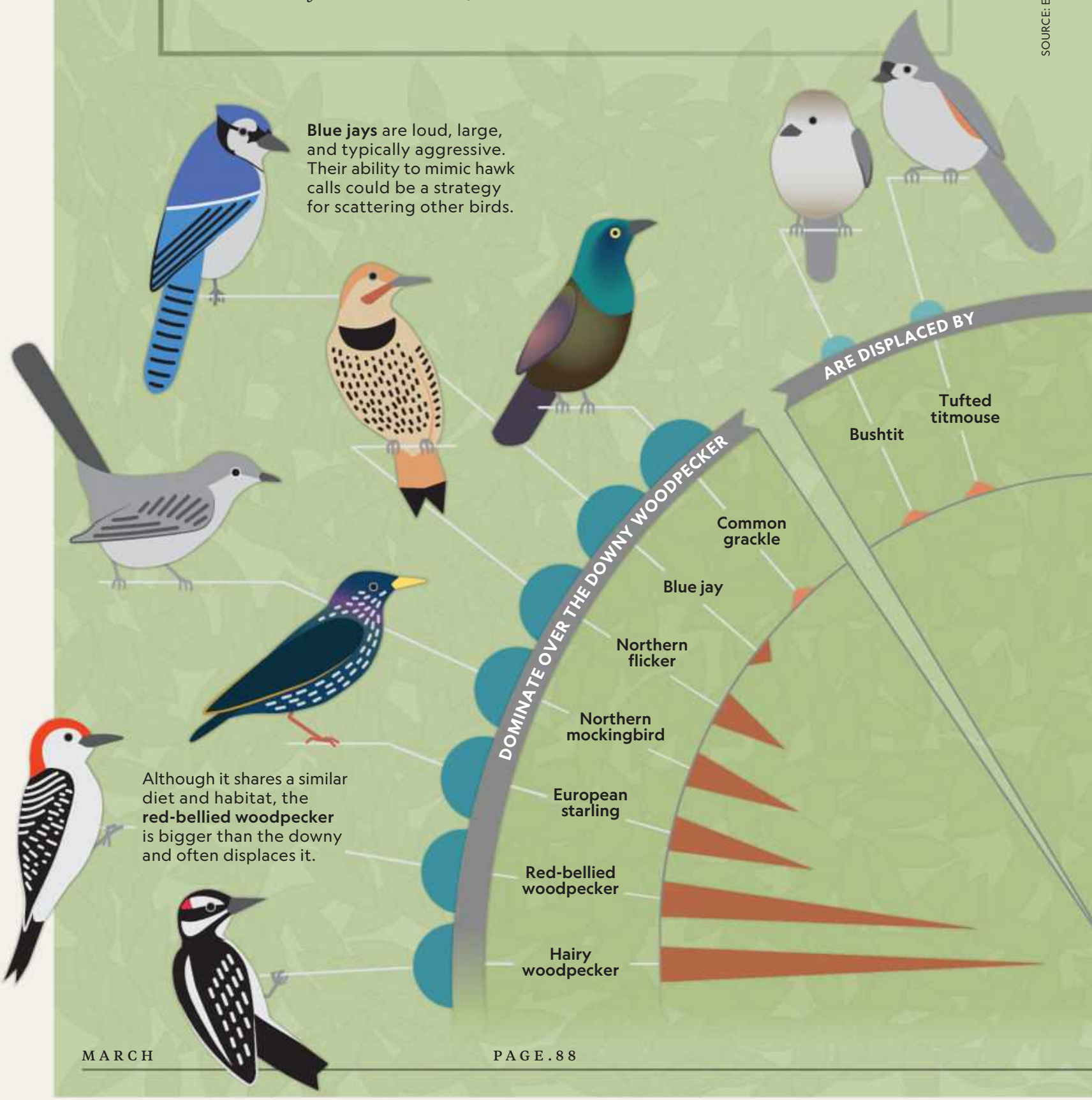
PHOTO: A. BURKHARDT

FOOD FIGHT

Interactions between birds at a feeder may look chaotic, but there's a method to the madness. A hierarchy of species' social dominance—shown here with the downy woodpecker as a point of comparison—governs everything from food access to perch position.

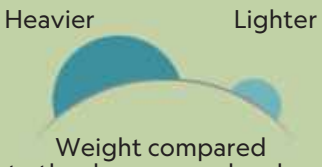
by DIANA MARQUES *and* KELSEY NOWAKOWSKI

SOURCE: ELIOT MILLER, CORNELL LAB OF ORNITHOLOGY



Downy woodpecker

Geographically widespread and a feeder regular, the downy woodpecker can often be spotted in encounters with other North American bird species. The data below highlight two factors that influence social rankings between the downy and other species.*

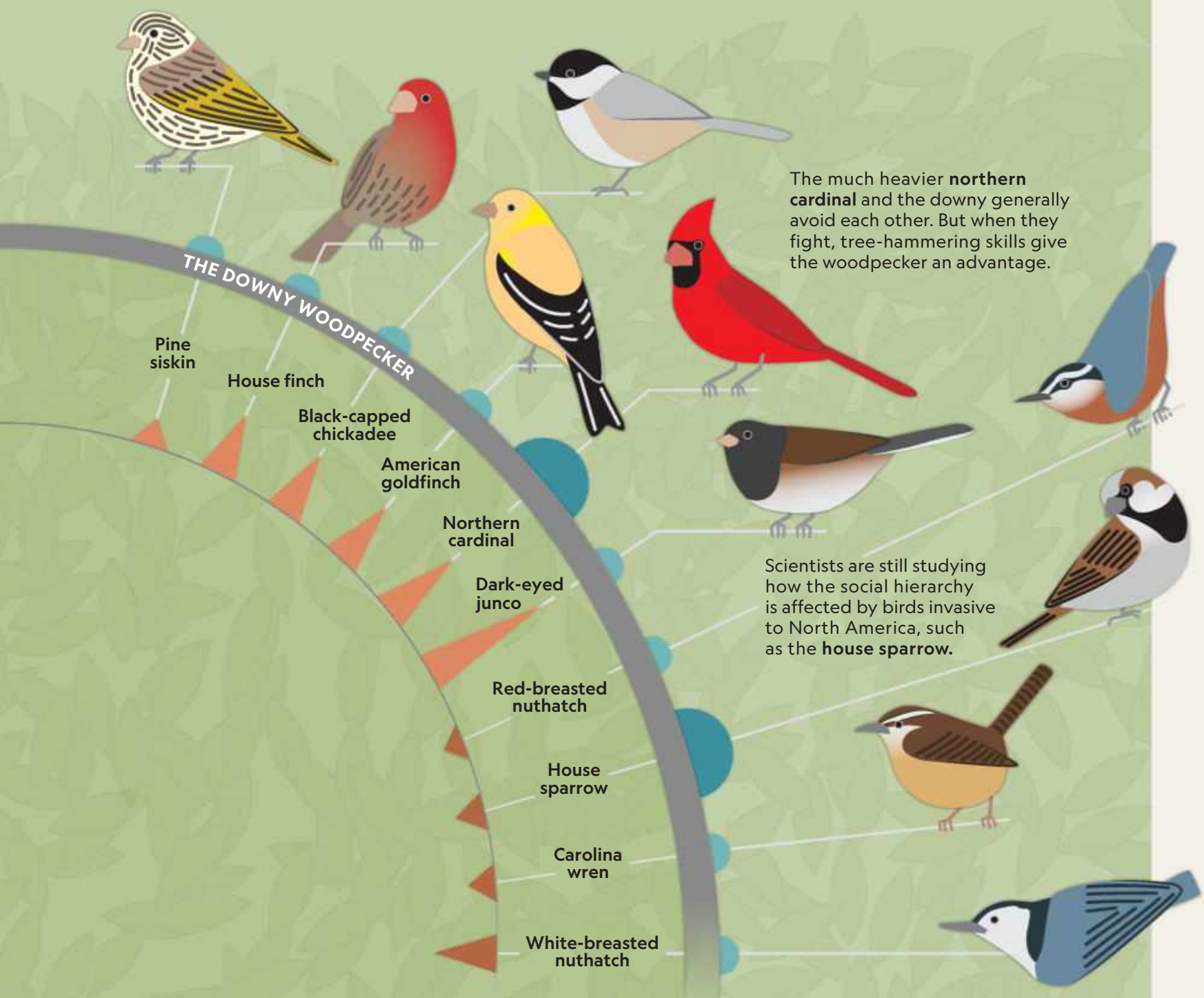


DOMINANCE

Higher body weight is a frequent indicator that a bird species will be able to perch longer and gain superior access to foods of greater value.

INTERACTIONS

Some birds fight often, while others ignore each other, regardless of which might win. Diet and how closely species are related influence quarreling.

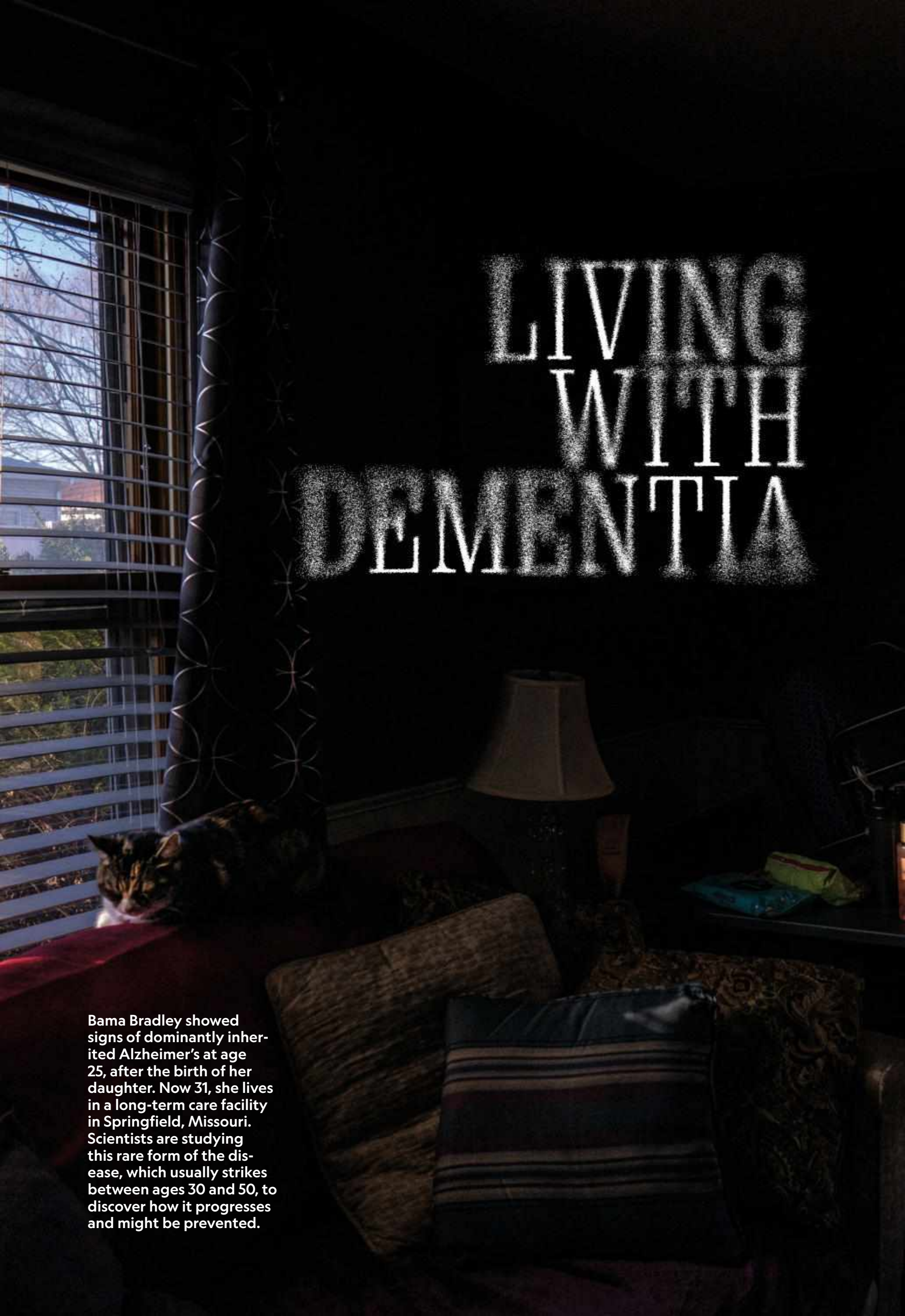


The much heavier **northern cardinal** and the downy generally avoid each other. But when they fight, tree-hammering skills give the woodpecker an advantage.

Scientists are still studying how the social hierarchy is affected by birds invasive to North America, such as the **house sparrow.**

*DATA COLLECTED BY ABOUT 9,500 CITIZEN SCIENTISTS WITH PROJECT FEEDERWATCH BETWEEN 2016 AND 2022

LIVING WITH DEMENTIA



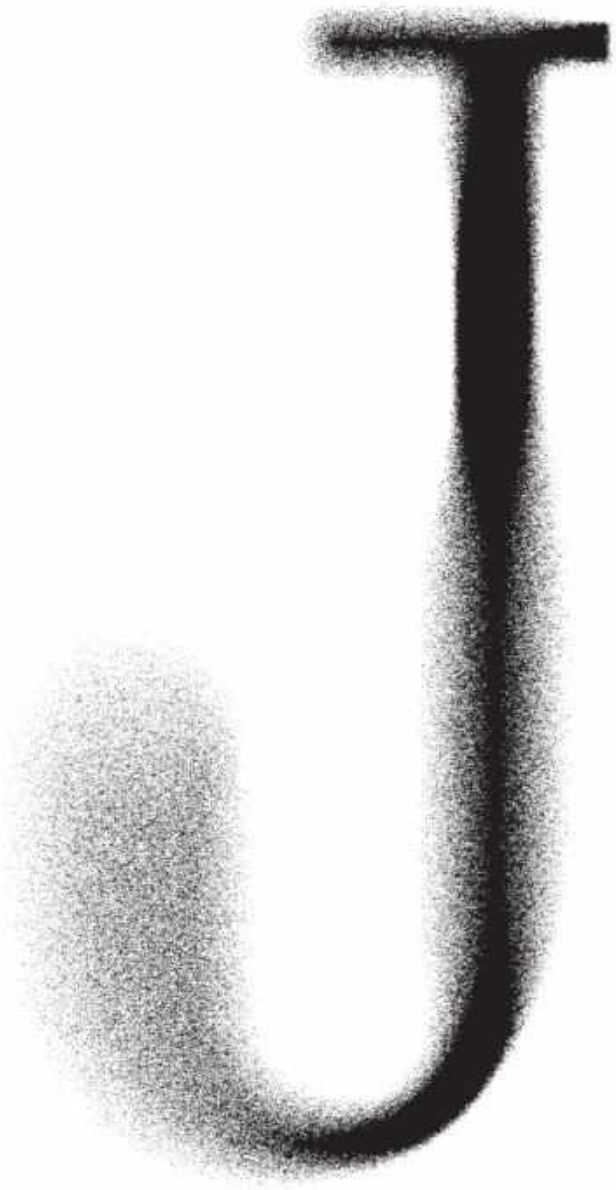
Bama Bradley showed signs of dominantly inherited Alzheimer's at age 25, after the birth of her daughter. Now 31, she lives in a long-term care facility in Springfield, Missouri. Scientists are studying this rare form of the disease, which usually strikes between ages 30 and 50, to discover how it progresses and might be prevented.

Cases of dementia are rising around the world. The disease has no cure, but caregivers and families are finding innovative ways for patients to live with dignity.

Words by CLAUDIA KALB *Photographs by* ISADORA KOSOFSKY

Residents of the memory care unit at Kontu, a retirement community in Tampere, Finland, attend the midsummer festival in a nearby town wearing customary flower crowns. They have a very active life, says staff member Iiwo Ahola (in blue jacket).

Dona Blackman, 89, peers out of a 1950s-style diner, one of many nostalgic settings at Glenner Town Square, a dementia day care center in Chula Vista, California. Based on reminiscence therapy, Town Square locations have been built across the United States.



JACKIE VORHAUER and her sister noticed their mother's behavior begin to change in 2012. Nancy Vorhauer, a glass artist in her early 70s, forgot to call Jackie on her birthday. She lost her phone. She didn't pay her bills. She made multiple copies of her keys. As Nancy's symptoms intensified, Jackie made trips from her Los Angeles home to Millville, New Jersey, to check on her mother. One evening, Jackie arrived to find the apartment locked. A few hours later, at about 10:30 p.m., Nancy showed up with a rolling suitcase containing a stack of bus schedules, a cat toy, a broken Christmas ornament, and a handful of glass marbles—Nancy's signature art pieces. "Hey Jack," she said casually to her daughter. "What are you doing here?"

Married for 65 years, Melvin Schantz, 91, and wife Meme, 90, both have Alzheimer's. Though Melvin's is less advanced, he opted to join Meme in Aegis Living's memory care section in Laguna Niguel, California.

Nancy later told her daughters that she felt as if she had a "black hole in her memory." It turned out to be dementia. After her diagnosis in 2017, Nancy spent four years in two different memory care units. The first tended to rely on an antipsychotic medication often used to treat behavioral problems in people with dementia. The second had some wonderful caregivers, but it was short-staffed and the caregivers lacked dementia training, says Jackie. Also, the physical space felt institutional. When Nancy wanted to go outside to the garden, the heavy doors set off an alarm.

"What you are seeing now is not sustainable," says Jackie, 43. "It doesn't work for people who are in memory care now, and it's certainly not going to work for my generation."

Today an estimated 57 million people globally have dementia—about 12 percent live in the United States—and cases are projected to rise to 153 million by 2050. By then, medical and caregiving costs are expected to reach $16.9 trillion worldwide. Numerous factors are contributing to the increase, most notably a

Nadia Bergese, 40 (at right), has dominantly inherited Alzheimer's, which has claimed the lives of six family members, including Nadia's father. Her mother and her sister, Marisa (at left), care for Nadia at home in Florencio Varela, Argentina. Marisa does not carry the gene for the disease.

growing older population; a rise in risk factors like obesity and diabetes; and worsening air pollution, which, studies show, damages brain health. Add in declining birth rates—meaning less help—and a looming crisis emerges. "It's going to get harder and harder as the numbers go up," says Kenneth Langa, a dementia research scientist at the University of Michigan. "We need to figure this out."

For those living with dementia now, the priority is more-humane care. Many individuals who support people with the condition feel this deeply. They know the agony of seeing a mother struggling to speak or a widowed grandfather believing his wife will come home for dinner. They also regard sufferers as people, not a constellation of symptoms. This conviction, sparked by personal experience, is fueling a movement to scrap outdated care in favor of holistic approaches.

It's not about dying, says Elroy Jespersen, co-founder of Canada's Village Langley, the first large-scale "dementia village" in North America. It's about "enriched living." We can do this, he says, "if we just focus on the person—who that person is, who that person still wants to be, and what brings them joy."

DEMENTIA, WHICH TYPICALLY develops after age 65, is an umbrella term for numerous conditions, including Alzheimer's disease, vascular dementia, Lewy Body dementia, and frontotemporal dementia. A rare form known as dominantly inherited Alzheimer's disease usually strikes between ages 30 and 50 and is the result of a gene mutation passed from parent to child. The disorders differ biologically—Alzheimer's, for example, is characterized by brain plaques formed by a protein called beta-amyloid, while vascular dementia is brought on by a blockage of blood flow to the brain—and people can be afflicted by more than one. But the outcome is the same: a breakdown in brain cell communication and eventually brain cell death.

Memory lapses, such as forgetting someone's name, are common as we age. These instances become a problem when they impair everyday routines—a person no longer remembers to pay the bills or becomes disoriented in a familiar environment. Such symptoms are typical of mild cognitive impairment (MCI), a precursor to Alzheimer's, or mild Alzheimer's, the first stage of the disease. As dementia worsens, individuals become increasingly confused and may become agitated or even aggressive. Severe dementia often leads to loss of language, hallucinations, and incontinence. In the final stages of the disease, brain cell damage can inhibit core functions such as heart rate and breathing and also increase the likelihood of infection, which can be fatal.

Given the complexity of the disease, dementia is inherently difficult to treat. In 2021 and 2023, respectively, the U.S. Food and Drug Administration approved two new Alzheimer's drugs—aducanumab and lecanemab—the first to target the underlying biology of the disease: plaques in the brain. Lecanemab's trials clearly show a slowing of cognitive decline in people with MCI or mild Alzheimer's; aducanumab's

Memory lapses, such as forgetting someone's name, are common as we age. They become a problem when they impair everyday routines.

data are mixed. But neither drug is intended for other forms of dementia, they're expensive infusions (lecanemab's list price is $26,500 a year), and both can have serious side effects, including bleeding in the brain. "Dementia is going to be with us for the foreseeable future, even with these potential breakthroughs," says Langa.

Traditional care prioritizes medical needs, often sidelining a person's identity, personality, and desires. Opened in 2019, the Village Langley is rooted instead in a philosophy that applauds individual choice. Used to sleeping in until 10 a.m.? Fine. Enjoy an afternoon walk? Go ahead. There's a barn on-site with chickens and goats, and vegetable beds for growing cucumbers and tomatoes. Jeannette Wright, a longtime gardener who has mild dementia, is especially proud of the sunflowers she planted. One tall stem arches upward, its yellow petals brightening a damp Vancouver, British Columbia, sky. "I don't know why they grow like crazy," says Wright, 84. "But they do."

Research shows that social connections reduce anxiety and depression. Each of the Village's six cottages has an open kitchen and living room with a fireplace, drawing residents out of their bedrooms to mingle. The community center houses a salon, a small store, and a café where residents can chat over a cappuccino and lemon tart. Some like to visit Cowboy, a 33-pound French bulldog that comes to work with his owner, Lisa Yarosloski, the Village's health and wellness manager.

Natural light, which boosts mood and helps regulate sleep, is a key design element. One wall of the community center is composed of floor-to-ceiling windows. Sunshine dances off the tables and permeates the cottages, which line a main pedestrian street adorned with spruces, maples, and wisteria clinging to trellises. At one point Village staff thought about constructing overhangs for bad weather, but one of the residents disapproved. "I want to feel the rain," she said.

After a 30-year career in senior health care, Jespersen had seen the best of traditional services up close. But when his wife's aunt was diagnosed with dementia, he realized they weren't good enough. There was too much regimentation, with meals at precise times and fixed activities. Jespersen especially disapproved of locked doors, which he felt contributed to residents' agitation. "When we are focused so much on keeping people safe, we sterilize an environment and suck the potential life out of it," he says.

Jespersen, 75, schooled himself in the Green House Project, which set out to transform the nursing home industry in 2003 when it opened its first 10-person, family-style dwellings for older residents in Tupelo, Mississippi. Since then, almost 400 Green Houses have been built across the U.S. Jespersen liked the small-scale approach, but it wasn't until he attended a presentation about the Hogeweyk, the world's first dementia village, located in the Netherlands, that he fully realized his vision. Designed to feel like a small Dutch town, the Hogeweyk has a central fountain, pub, and theater. Residents cook or help with laundry, which makes them feel independent and gives them purpose. That kind of freedom, says Jespersen, "is a big, big piece of living a good life."

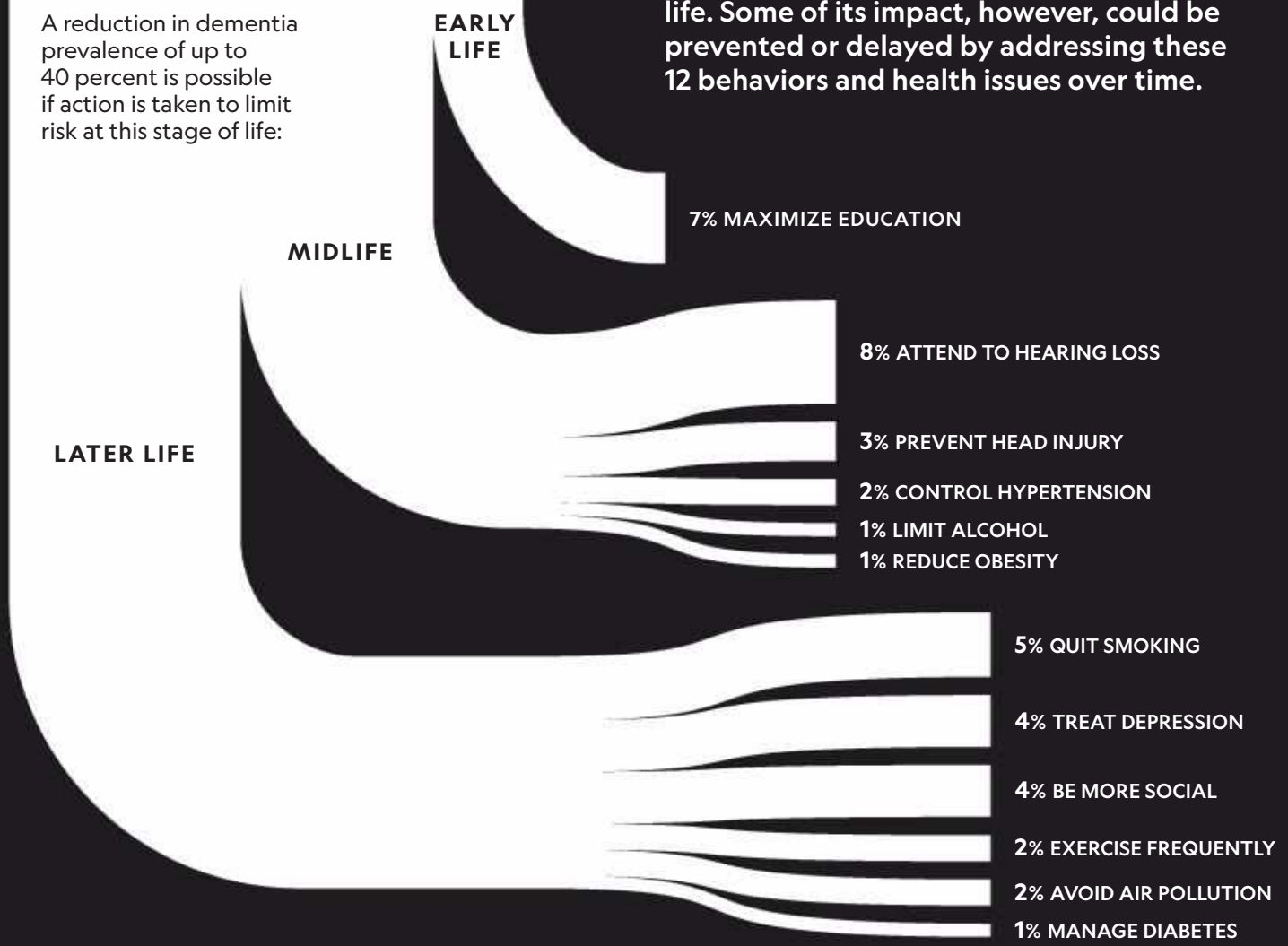
Weaving together threads from these models, Jespersen founded the Village Langley, which is now at capacity with 75 residents who have mild, moderate, or severe dementia. The setting pleases Jeannette Wright's daughter, Shelley Kraan, and Kraan's two-year-old granddaughter, Florence, who loves to visit and ride around on her scooter. "It's a great place to live with dignity," Kraan says.

TO BENEFIT AS MANY LIVES as possible, pioneers in dementia care are actively sharing their knowledge. Since the Hogeweyk opened in 2008, hundreds of curious parties—from architects and clinicians to care providers and families of people with dementia—have toured the community. Similar settings have opened in France, Italy, Australia, New

REDUCING THE RISK OF DEMENTIA

Dementia, a complex group of symptoms caused by brain damage and resulting from multiple diseases, can impair cognitive function and affect a person's daily life. Some of its impact, however, could be prevented or delayed by addressing these 12 behaviors and health issues over time.

A reduction in dementia prevalence of up to 40 percent is possible if action is taken to limit risk at this stage of life:



COMMON TYPES OF DEMENTIA

Percentage of patients and typical age of diagnosis

ALZHEIMER'S

Mid-60s or older

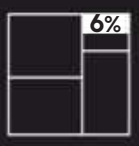
Caused by accumulations of proteins that damage and kill nerve cells, this brain disease affects communication and memory.

VASCULAR

Over 60 years old

Interrupted blood flow, often from a stroke, causes brain damage. Symptoms can include confusion and difficulty making decisions.

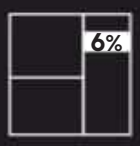
LEWY BODY



50 years old or older

Tremors, rigid muscles, hallucinations, and trouble sleeping are hallmarks of this disease, caused by disruptions in brain cell communications.

FRONTO-TEMPORAL



45 to 64 years old

Impaired emotional regulation, language, and movement stem from degenerated neurons in brain areas that control these functions.

*AN ESTIMATED 27 PERCENT OF PATIENTS HAVE MORE THAN ONE TYPE OF DEMENTIA OR RARER FORMS OF THE DISEASE.

GRAPHIC: ALBERTO LUCAS LÓPEZ AND PATRICIA HEALY, NGM STAFF. SOURCES: EMMA NICHOLS, USC DORNSIFE CENTER FOR ECONOMIC AND SOCIAL RESEARCH; INSTITUTE FOR HEALTH METRICS (STATISTICS FOR TYPES OF DEMENTIA); GILL LIVINGSTON AND OTHERS, *THE LANCET*, AUGUST 2020; NATIONAL INSTITUTE ON AGING, NATIONAL INSTITUTES OF HEALTH

Zealand, and Norway. One of the Hogeweyk's greatest draws is the autonomy it cultivates, which seems to calm aggressive behaviors. Since the village concept was introduced, prescriptions for antipsychotic medications have dropped from 50 percent to about 10 percent, says Eloy van Hal, one of the Hogeweyk's founders. "If you keep busy in normal daily life activities," he says, "you stay more active, and that has a huge effect on how you feel."

Jennifer Sodo learned this lesson when her grandmother, Betty, was diagnosed with dementia. Sodo is haunted by the guilt her mother felt after she moved Betty into a senior living facility and later a memory care unit. Betty protected her family fiercely and loved baking strawberry shortcake; in memory care, she spent most of her time alone indoors. Sodo, an architect who specializes in senior living design, remembers a visit when she took Betty outside. "I saw something stir in her. She felt the heat of the sun. She could see the flowers moving, and the butterflies," says Sodo, 33. "That little moment is what this big-picture design has to lead to. There's a fire in me that says we can do better."

In 2017, Sodo and her then colleagues at the architectural firm Perkins Eastman (she has since moved to a different company) visited the Hogeweyk to inform their design for Avandell, a dementia village slated to be built in Holmdel, New Jersey. Avandell's layout is smaller and its setting more rural, but its philosophy is aligned with the Hogeweyk's, says David Hoglund, co-founder of Perkins Eastman's senior living practice: Create intimate living spaces that honor the simple rhythms of life—scanning the newspaper or sipping a cup of tea. Like Sodo, Hoglund, 68, understands dementia at a personal level. He lost two loved ones to the condition: his mother-in-law in 2012 and his father in 2017. "It's one thing to talk about it. It's another to live it," he says.

This mindset of honoring the person led Dementia Innovations, a nonprofit formed in 2019 in Sheboygan, Wisconsin, to conceive of a different model, which is tentatively scheduled to open in 2025. The team brainstormed with the Hogeweyk leadership and also learned that local people wanted more ownership in their loved ones' care. The group mapped out a neighborhood of privately owned houses on 79 acres (paid for with a private donation) near Lake Michigan. Couples can remain together—a rarity at traditional memory care units unless both have dementia—and caregivers will be available at all times.

Like so many others, Chuck Butler, one of the organization's three founders, is propelled by experience. His grandmother had dementia, but it was a conversation with a stranger when he was Sheboygan's assistant fire chief that hit him the hardest. A man came into the fire station and began sobbing, saying he could no longer care for his wife, who had been diagnosed with the condition. Butler provided community resources, but two months later the man was back, distraught over her treatment at a long-term facility that had an exceedingly rigid schedule. "People with dementia must be able to continue their lives," says Butler, "rather than be slowed or

> 'If you keep busy in normal daily life activities, you stay more active, and that has a huge effect on how you feel.'
>
> *Eloy van Hal, co-founder, the Hogeweyk dementia village*

Eleanor Padula, 90, used to be quick to anger, but dementia surprisingly softened her. “She has a joie de vivre that I never knew existed,” says daughter Cynthia Lacasse, who took Padula into her home in Lake Balboa, California.

stopped." He and his colleagues believe this so fervently that they named their village Livasu—a portmanteau of "living as usual."

One of the greatest challenges of residential facilities is affordability. Because dementia is progressive and often debilitating, the costs can be exorbitant. In the Netherlands, which has socialized medicine, the price tag is covered or subsidized by government programs. But in North America, the cost falls largely on individuals. The Village Langley, a private residence, charges $7,500 to $9,000 a month. "That excludes many, many people who really could benefit," Jespersen says. Even so, there are 150 people on the community's waiting list.

Day programs provide an alternative for the vast number of people who are cared for at home (up to 80 percent in the U.S.), often by spouses or children who need respite. In 2018, Glenner Town Square, a 9,000-square-foot space fashioned to mimic a 1950s town, opened in Chula Vista, California. Inspired by reminiscence therapy, which aims to prompt

Bessie Williams once belonged to a Los Angeles social group known as the "elegant ladies." When Williams was diagnosed with dementia in 2008, her daughter Robin became her full-time caregiver. Williams died in 2022, at 99.

memories by going back in time, Town Square has a vintage pinball machine and a 1959 Ford Thunderbird. Across the country, in South Bend, Indiana, a nonprofit seeking to reconfigure its day care setting received guidance from the Hogeweyk leadership. In 2022, Milton Village opened its doors, featuring a diner-style cafeteria with a jukebox, where residents can socialize at their leisure. A medical focus alone is no longer the answer, says van Hal. "We need to look at what people are still able to do."

ONE DAY, JACKIE VORHAUER got a message from an aide at her mother's memory care unit that Nancy was refusing to eat. Jackie soon discovered the problem wasn't her mother's behavior: The metal fork was uncomfortable. Jackie ran out and bought a set of small, easy-to-grip utensils. "I laid the fork in her hand," says Jackie, "and she started eating." The lesson: Creativity is the key to better care.

Soon after Nancy died in 2021 after contracting COVID-19, Jackie set out to build a place that nourishes the spirit—a place where her mother, the gregarious artist, would have thrived. Jackie became certified in residential care for the elderly in California, and she is studying the Montessori approach to dementia and aging; a core component is using color and light to create a soothing setting. Last fall, Jackie reached out to Jespersen for guidance, just as Jespersen had reached out to van Hal. Her dream is to establish a safe, supportive, and joyful community. "It scares me to think that I would end up in a place where my mom ended up," she says. "I'm pushing forward."

As she sketches out her to-do list, Jackie is putting music near the top. Melodies tend to stick, even after dementia develops; researchers suspect areas of the brain that process music may be more resilient to cell damage. The late neurologist Oliver Sacks noted that personal memories may become embedded in music "as if in amber." This appears to be the case at the Village Langley. One afternoon, Meg Fildes, a music therapist, strums her guitar and begins to sing: "Que será, será. Whatever will be, will be. The future's not ours to see. Que será, será." Two women hold hands and move gently to the music. When it ends, a 78-year-old woman with advanced dementia, who was once a chef and a teacher, smiles. "I love it," she says. ▯

Claudia Kalb is the author of *Spark: How Genius Ignites, From Child Prodigies to Late Bloomers*.

Participating in treasured traditions is a crucial part of care at Kontu. In Finland that means saunas, where Leila Karjalainen holds ceremonial branches to mark the summer solstice as a caregiver rinses another resident.

Resplendent

WRAPPINGS

In the natural world, there's great beauty everywhere—even in bark. One photographer shares a fresh perspective on it.

Photographs by CÉDRIC POLLET

FRAGRANT FLOWERS, colorful leaves, gracefully arching branches. These are the aspects of trees and shrubs that garner our appreciation. The bark? Not so much. Despite the many everyday items derived from it—including rubber, cinnamon, cork, and medicines—bark is often overlooked. French photographer Cédric Pollet is determined to change that. His passion for bark began in 1999 when he encountered an ancient oak tree while studying landscape design in England. "Its tormented trunk opened my eyes to the world of bark," he says. Since then, he's been traveling the world and training his camera on the most striking examples he can find. Pollet hopes his photographs will inspire viewers to think of bark as more than simply a commodity or a covering. The protective barrier performs many roles, such as retaining moisture, insulating against temperature extremes, and keeping insects out. It's vital to the survival of trees, the ecosystems they inhabit, and, by extension, humanity. —ANNIE ROTH

OCOTILLO, ***Joshua Tree National Park, California***
Reminiscent of a river, a yellow swath cuts a curving path through the bark of this semi-succulent desert plant, punctuated with spikes to deter hungry animals.

Clockwise from near right

RAINBOW EUCALYPTUS
West Java, Indonesia

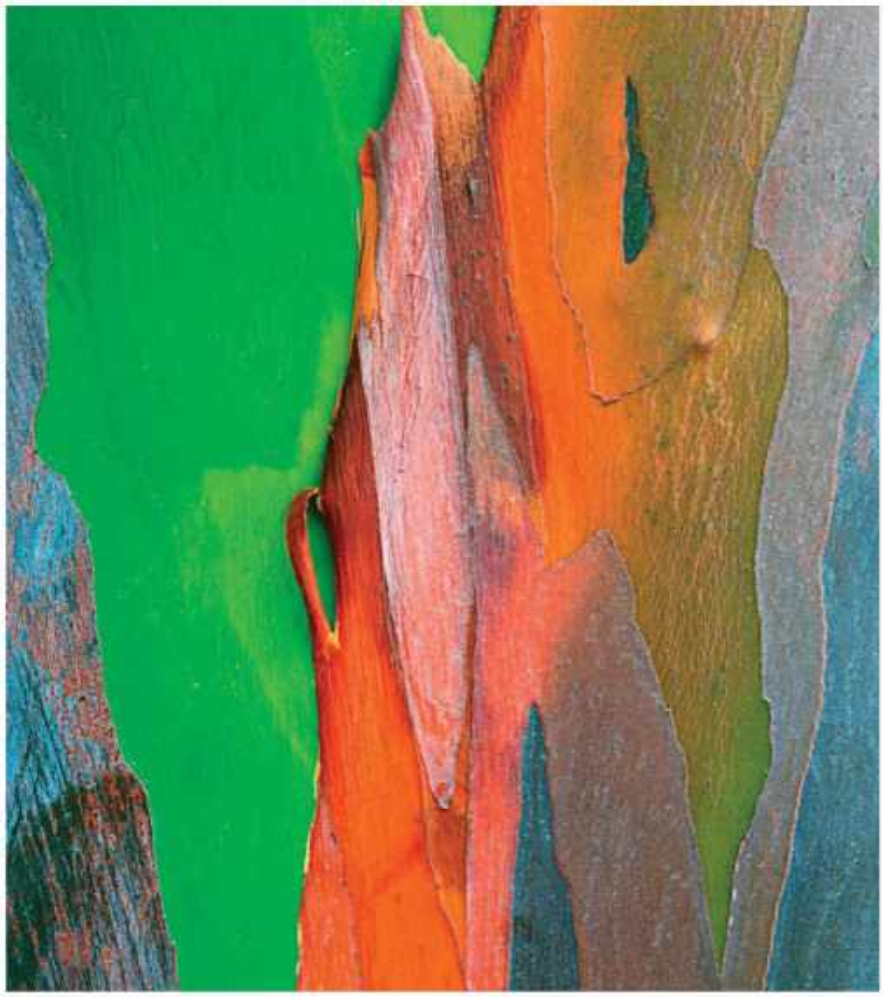
This aptly named tree is a personal favorite of Pollet's. Its bark spans nearly the entire color spectrum, unlike its flowers, which are a subtle shade of white.

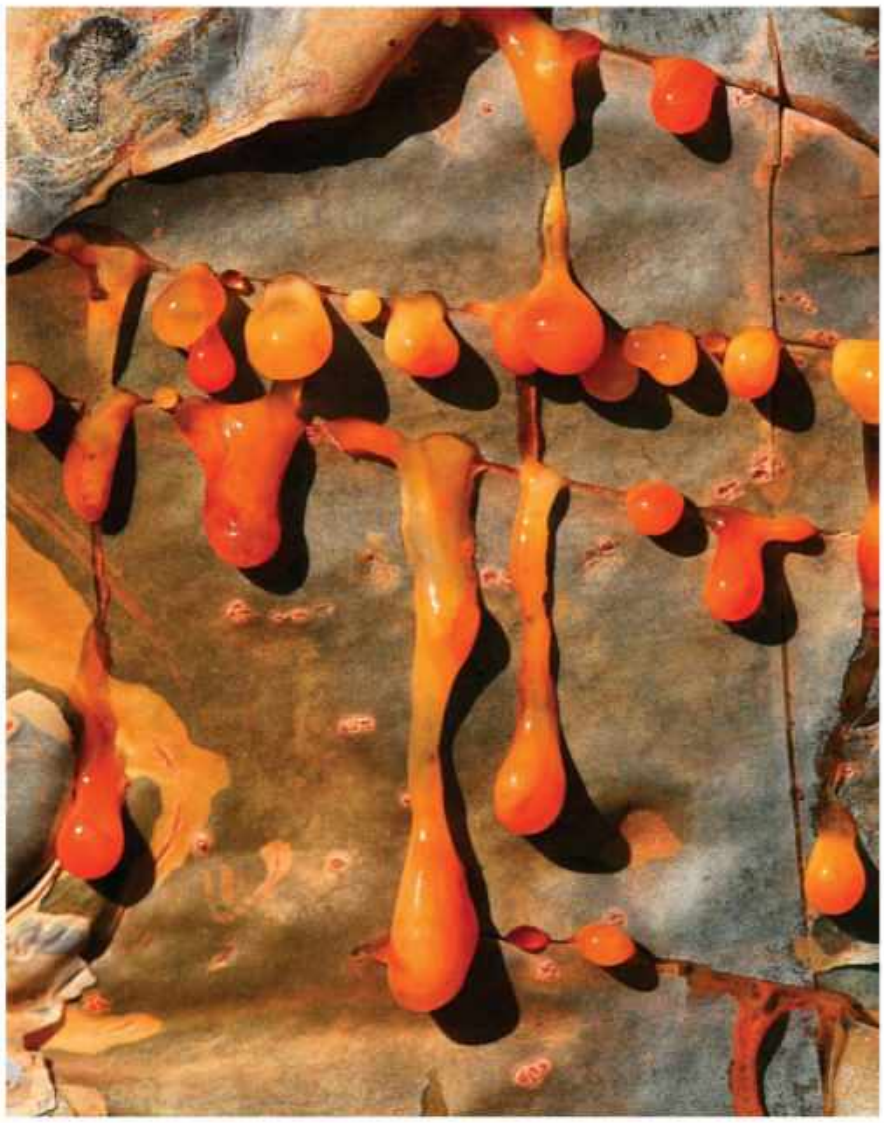
SERPENTINE MANZANITA
Berkeley, California

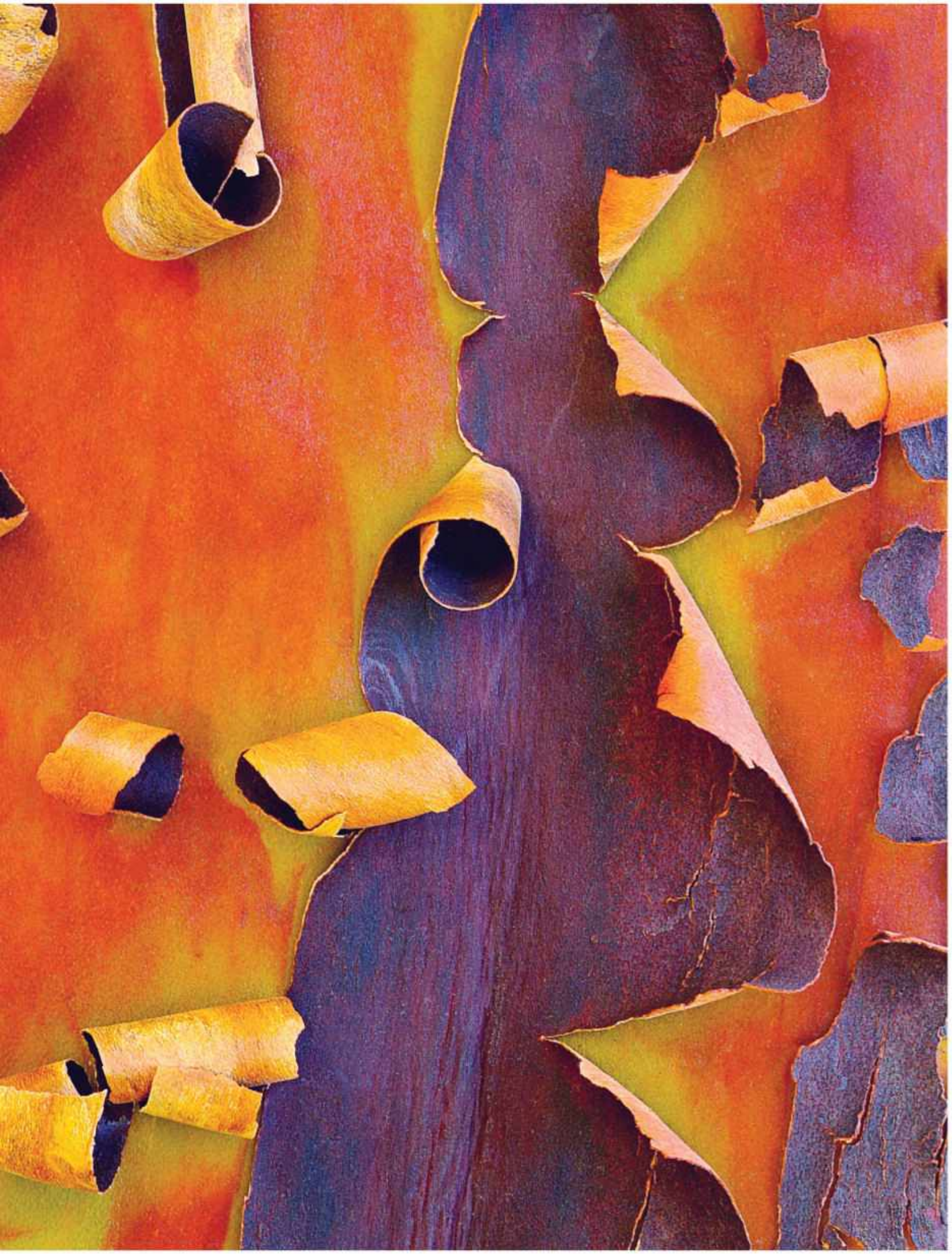
During its annual shedding, the bark of this shrub—endemic to the Golden State—peels off in paperlike curls, making room for the plant to grow.

BOSWELLIA ELONGATA
Socotra, Yemen

Frankincense, an ingredient used for centuries in perfumes and incense, comes from the resin that adorns this tree bark like a beaded necklace.







STRAWBERRY TREE
Antibes, France
The old burgundy bark curves in on itself to reveal a vibrant new layer on this rare hybrid specimen located at the city's Thuret Botanical Garden.

DEEP BENEATH THE SURFACE, EERIE SEA CREATURES HAVE EVOLVED TO LIVE WITH SCARCE LIGHT—AND THE HEALTH OF OUR OCEANS MAY DEPEND ON THEM.

TWILIGHT ZONE

WORDS BY
HELEN SCALES

PHOTOGRAPHS BY
DAVID LIITTSCHWAGER

The terrifyingly toothy Pacific viperfish, about 12 inches long, rises toward the surface at night to hunt. They trap prey in a cage of needle-like teeth.

Two-inch crustaceans from the genus *Cystisoma* have transparent bodies that reflect little light, and their large eyes detect dim illuminations.

Strawberry squid, also known as cock-eye squid, see in two directions at once. What look like strawberry seeds on the squid's skin are photophores that emit their own light.

THE ROLLING DECK of a 56-foot-long research vessel in California's Monterey Bay, Karen Osborn peers into a cooler filled with sloshing seawater and a galaxy of twitching life-forms. Moments earlier, this living constellation emerged from a net that had been slowly towed around 1,500 feet down, through an inky realm of near-total darkness. "It's a good catch," she says.

Most intriguing is a hand-size squid that gleams ruby red. Strawberry squid, as they're known, are well adapted to their habitat. Their red color, when absorbed in the sunless deep, fades into a brownish black, blending them into their surroundings. Occasional flashes of bioluminescent light that shimmer across their bodies startle intruders. And their mismatched eyes look in two directions at once: One, huge and yellow, gazes upward, detecting silhouettes passing overhead. The other, smaller and blue, stares down, watching for glowing prey in the darkness. This specimen is surprisingly pristine. "Usually they're all scraped up," says Osborn. The strawberry squid likely got caught right before the net was carefully pulled to the surface.

Osborn, an invertebrate zoologist at the Smithsonian Institution's National Museum of Natural History in Washington, D.C., is no stranger to the fantastic beasts that inhabit this so-called twilight zone, a dusky, horizontal layer of the ocean at depths of between 660 and 3,300 feet. Over the past 25 years, she's studied it remotely with camera-clad robots and been there herself in deep-diving submersibles. Her co-discoveries include how twilight zone fish make their skin intensely black and how the bodies of crustaceans called *Cystisoma* are so transparent they are almost completely invisible. "Every time we go out, we still see something new that we haven't seen before," she says.

By its very nature, the twilight zone is obviously difficult and expensive to access and study. Also known as the mesopelagic, it makes up a fifth of the ocean's total volume, and much of it remains largely unexplored. The zone begins at a depth where photosynthesis fails and continues down until the last remnants of sunlight taper out. To a human inside a submersible, this realm appears pitch-black, but animals there have evolved all sorts of tricks to navigate the lack of light while at the same time avoiding predators in the open ocean. "We see all these cool shapes and sizes: transparent animals, mirrored animals, red animals, and ultrablack animals," says Osborn. "They're solving the same problem in a bunch of different ways."

This phantasmal region holds a particular lure for Osborn—not simply to uncover its hidden biodiversity but also to find out how living things can survive such extreme conditions. What she and other researchers have discovered, however, is that while many of the twilight zone's inhabitants might at

A few drops of seawater reveal tiny crustaceans called copepods, abundant and critical prey. A female carries a sac of blue eggs.

first appear otherworldly, they're very much earthlings with vital roles in the health of the entire ocean and the balance of our planet's climate.

"It's really important to understand what's going on there and who's living there, what they're doing, what they're eating, how much they're pooping, where they're dying," says Osborn. And it's becoming increasingly apparent that even this remote part of the ocean is not out of the reach of humans, making a better understanding of how the whole ecosystem works more urgent than ever.

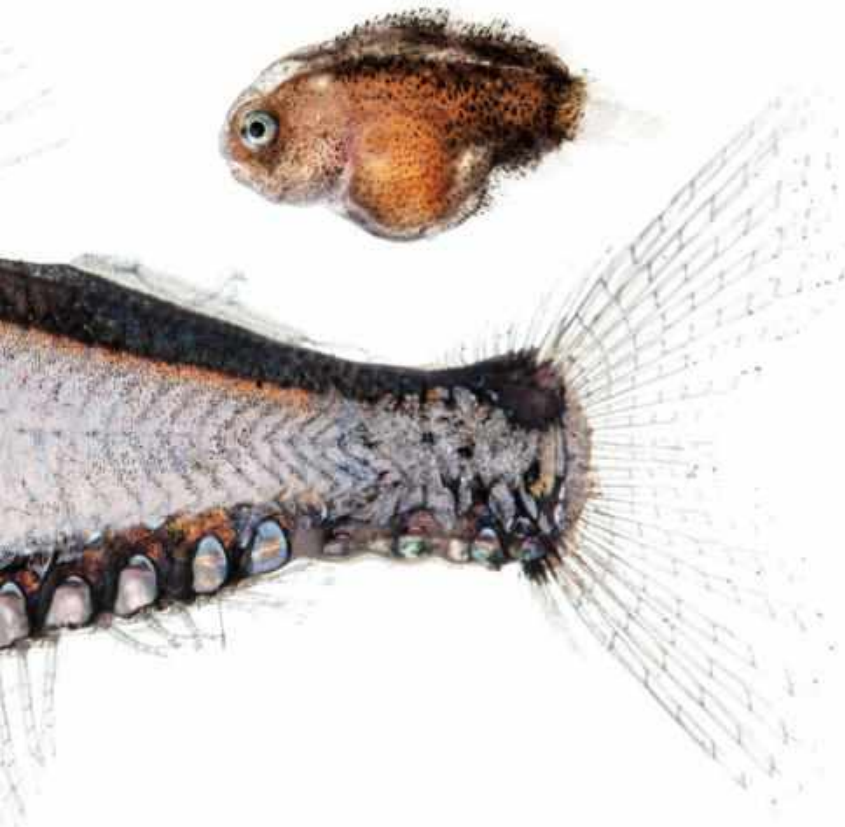
ARRIVING ONSHORE, Osborn's twilight zone catch is transferred to the laboratory at the Monterey Bay Aquarium Research Institute, or MBARI, in Moss Landing, where she and her colleagues begin sorting the mix of minute animals.

"There's a giant *Paraphronima,"* says Osborn, clearly delighted. "It's huge!" Although smaller than a pinkie fingernail, it's a substantial specimen for this group of crustaceans, distant relatives of sand hoppers called hyperiid amphipods that can be flea-size or even tinier. In the twilight zone, amphipods have evolved a variety of unique and elaborate eyes, to catch any snatches of light that make it through to the depths. Glassy eyes take up *Paraphronima*'s entire head; another species in the *Streetsia* genus has a single, cone-shaped eye. Osborn wants to find out why so many highly specialized eyes have evolved among twilight zone amphipods. "This doesn't happen anywhere else," she says, as most animals that live in darkness have reduced eyes or no eyes at all. "Not in caves, not on the deep seafloor."

In the lab, using dessert spoons with the handles bent, Osborn and the other scientists delicately scoop up individual amphipods and place them in jars covered by aluminum foil. When their eyes are once again adapted to the dark, the animals will be sent to other parts of the laboratory to test various aspects of their vision. Some get passed to Jake Manger, a Ph.D. candidate at the University of Western Australia, who will release them into a virtual reality version of their habitat—a small tank of seawater surrounded by digital screens—to see how the animals respond to shapes of different sizes and brightness. Manger plans to build computer simulations of their brains so he can see the twilight zone as amphipods do.

Meanwhile, off Monterey Bay, a dramatic nocturnal shift is getting under way. Most days around sunset, throngs of twilight zone animals embark on a mass commute to the surface. Trillions of fish, shrimps, amphipods, jellyfish, and squid rise to feed, using the cover of darkness to hide from predators. "It's by far the biggest movement of any animals on the planet, and

A 2.5-inch-long hatchetfish (right) stares overhead for passing prey. The twilight zone is home to a mind-boggling array of species (not to scale), all of which evolved unique strategies to survive in the darkness.



Looking like a feather duster, this copepod sports appendages that detect ripples from predators. The structures may also help the tiny crustacean save energy by slowing the rate at which it sinks.

Many animals in their early life stages take part in a nightly mass vertical migration from the twilight zone to the surface. This includes a young crab larva, known as a zoea.

The *Atolla* jelly has a dazzling tactic for evading predators. When attacked, blue flashes of light spin around its five-inch-wide body like a pinwheel, distracting aggressors.

it happens every day, all over the ocean," says Osborn.

As a senior scientist at MBARI, Bruce Robison has witnessed this migration firsthand. Years ago, hundreds of feet down, he drove a submersible through a shoal of lanternfish so big and dense, it was impossible for the sub's sonar to gauge its size. "It was pretty exciting," Robison says of being surrounded by the countless silvery bodies. "It was almost like it should tickle."

People first noticed the massive scale of the ocean's daily vertical migration in the mid-20th century, when U.S. Navy sonar seemed to show the seabed rising toward the surface at night. The deep scattering layer, as it came to be known, is in fact created by sound waves bouncing off the gas-filled swim bladders of twilight zone fish and the bodies of other migrating animals, such as the relatives of jellyfish called siphonophores.

Now scientists are studying the role this phenomenon plays in regulating the global climate. Migrating animals retreat to the deep, usually before dawn, with their bellies full of food, including carbon harnessed from the atmosphere by phytoplankton. Waves of migrants then release much of that carbon down deep, in their feces and through their gills. "Vertical migration is this rapid elevator or conveyor belt connecting the surface ocean to the deep sea," says Kelly Benoit-Bird, a marine acoustician at MBARI.

Approximately a quarter of carbon dioxide emissions from fossil fuel burning and other human-made sources get absorbed by ocean life, a process called the biological carbon pump. Scientific models have tended to focus on processes such as sinking dead plankton and their feces, but more recently attention is turning to living animals. Studies suggest migrating twilight zone animals may move as much as 50 percent of the pump's carbon load into the deep where it's stored, away from the atmosphere, for hundreds or thousands of years.

To decipher more precisely how much carbon is shuttled around, Benoit-Bird and colleagues are using echo sounders to uncover the migration's finer details. For two years, one such device a half mile down in Monterey Bay has been sending a sound pulse upward every two and a half seconds. Underwater transducers detect the patterns of echoes bouncing back, which are converted into charts, called echograms, that give a vertical view of where things are in the water column.

So far, the data show that daily migrations can cease and start within the course of a day or stop altogether for weeks at a time. The presence of predators, such as Risso's dolphins, may also influence the animals' movements.

Despite their best efforts at evasion, many animals still get eaten, playing a key part in the ocean's food web. "They support a lot of fishery species and things that we care about," says Ilysa

Iglesias, a graduate student researcher at the University of California, Santa Cruz. She led a 2023 study revealing how twilight zone fish are commonly found in the diets of dolphins, sea lions, swordfish, sharks, tuna, and sometimes salmon. Some of those are nocturnal hunters that pick off the fish when they rise to the surface, while others are deep-diving foragers that pursue them during the day.

Yet there may be far greater threats to twilight zone animals on the horizon.

THOUGH PREVIOUS ATTEMPTS to establish industrial-scale fisheries in this ultradeep water zone have come up against the high costs of operating far below the surface, advances in harvesting technologies could make twilight zone fisheries viable. Millions of dollars are being spent on research and trial fisheries targeting abundant pelagic fish, such as lanternfish and bristlemouths, in Europe, particularly Norway. And factory ships could continuously pump up catches from huge trawlnets, similar to how krill are extracted from the upper reaches of the twilight zone around Antarctica.

With their high concentrations of indigestible oils and waxes, these fish are not suitable for human consumption. As with Antarctic krill, they would be mashed into meal and oils to be used as animal feed, especially for farmed fish. But because so much remains unknown about these animals' lives, scientists are concerned about trawling. "How old are they when they spawn? How old do they get? Where do they reproduce?" says

Glass squids, about three inches long, rely on transparency to camouflage themselves in the twilight zone. The dots on their bodies are pigment sacs called chromatophores, which can expand to darken their appearance.

Iglesias, who also co-leads the Mesopelagic Fisheries Working Group at the Deep-Ocean Stewardship Initiative. "Really basic life history is missing."

As Benoit-Bird at MBARI frames it, the race is now on for researchers to establish a baseline for what this healthy ecosystem should look like before it disappears. At the same time, plans are accelerating to mine metal-rich rocks from as far as three miles underwater, which would likely cause long-term damage to fragile seabed ecosystems and the species living there. Silty seawater containing rock fragments, toxic heavy metals, and radioactive isotopes could be discharged from ships processing the ores and pumped thousands of feet down, where they would choke delicate life-forms and contaminate food webs. Noise pollution from mining operations would add to the problems, masking the calls of whales and likely changing their behavior.

Some corporations that plan to mine the deep seabed are considering how to minimize their impacts—but developing new wastewater-handling methods and installing environmental monitoring to prove they work will likely take several years. In the meantime, marine heat waves at the surface can also influence what floats beneath. When a massive one, nicknamed the Blob, struck the U.S. West Coast from 2014 to 2016, it killed off swaths of shallow sea life, and the daily migrations of twilight zone animals shifted about 330 feet deeper.

For now, the twilight zone remains one of the least spoiled parts of the planet, and there are growing efforts to keep it that way. Since 2022, dozens of governments and corporations have backed proposals to halt deep-sea mining until the environmental risks are better known. The United States has introduced a precautionary ban on some twilight zone fisheries in its Pacific waters. And a global treaty for the high seas, which nations began signing in 2023, could help protect more of the region from mining and fishing.

Back in the Monterey Bay, in Karen Osborn's lab, the strawberry squid hasn't made it through the night, but it won't go to waste. Its genetic makeup will be sequenced and the unscathed body preserved for future observation. That's a win for science since these animals are inspiring solutions for human-world challenges. From cameras that work in the dark to miniature surgical robots that zip through blood vessels, there are countless ideas to adopt from the living inhabitants of the twilight zone.

"It's the most exciting place in the universe, in my opinion," Osborn says. "It's interesting what's in black holes and what's out there on Mars, but there's so many cool things right here that we don't know anything about that we've gotta get out there and see." □

TELEVISION

GETTING THE SHOT

Krystle Wright checks her setup for a climbing shoot in Moab, Utah, in the television series *Photographer,* which follows storytellers as they pursue their next stunning image.

TRAVEL BEHIND THE SCENES with seven of the world's most extraordinary visual storytellers in *Photographer.* Each episode of this new six-part series spotlights a photographer capturing exceptionally powerful images. Those featured include Muhammed Muheisen, a two-time Pulitzer Prize winner whose conflict coverage led him to work with child refugees, and partners Paul Nicklen and Cristina Mittermeier, whose sea-life images amplify ocean conservation. The photographers discuss how they got their start behind the camera, how they stay focused in extreme circumstances, and what it really takes to create a memorable image. *Photographer* premieres March 18 at 8/7c on National Geographic and the next day on Disney+ and Hulu.

NATIONAL GEOGRAPHIC SOCIETY

Seeking Greater Understanding

Animals continue to adapt, despite unprecedented challenges. To understand how, the Society launched the Wildlife Intelligence Project, which funds scientists providing insight into animal minds. The newly announced grantees are Mauricio Cantor, studying dolphins' cooperative behavior; Felicity Muth, focusing on bee cognition; and Tiago Falótico, researching tool-wielding capuchin monkeys. Learn more at *ngs.org*.

NEWSSTANDS

Planning Your Next Adventure

In this newsstand special issue debuting February 23, find 50 destinations around the globe where flora and fauna flourish, offering awe-inspiring nature escapes.

BOOKS

Saving Lives Under Pressure

A doctor recounts how she defied gender norms to run a hospital in Syria in this memoir, available March 5 wherever books are sold.

PHOTOS: PABLO DURANA (WRIGHT); TIAGO FALÓTICO (MONKEYS)

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