FEBRUARY 2011

NATIONAL GEOGRAPHIC

INTERACTIVE EDITION

UNDER PARIS

Can Afghanistan Win the War Against Opium?

Why Fish Flock to Sunken Ships

China's Snub-Nosed Monkeys

INTERACTIVE GRAPHIC & VIDEO

THE CURIOUS HISTORY OF FEATHERS

NATIONAL GEOGRAPHIC

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February 2011

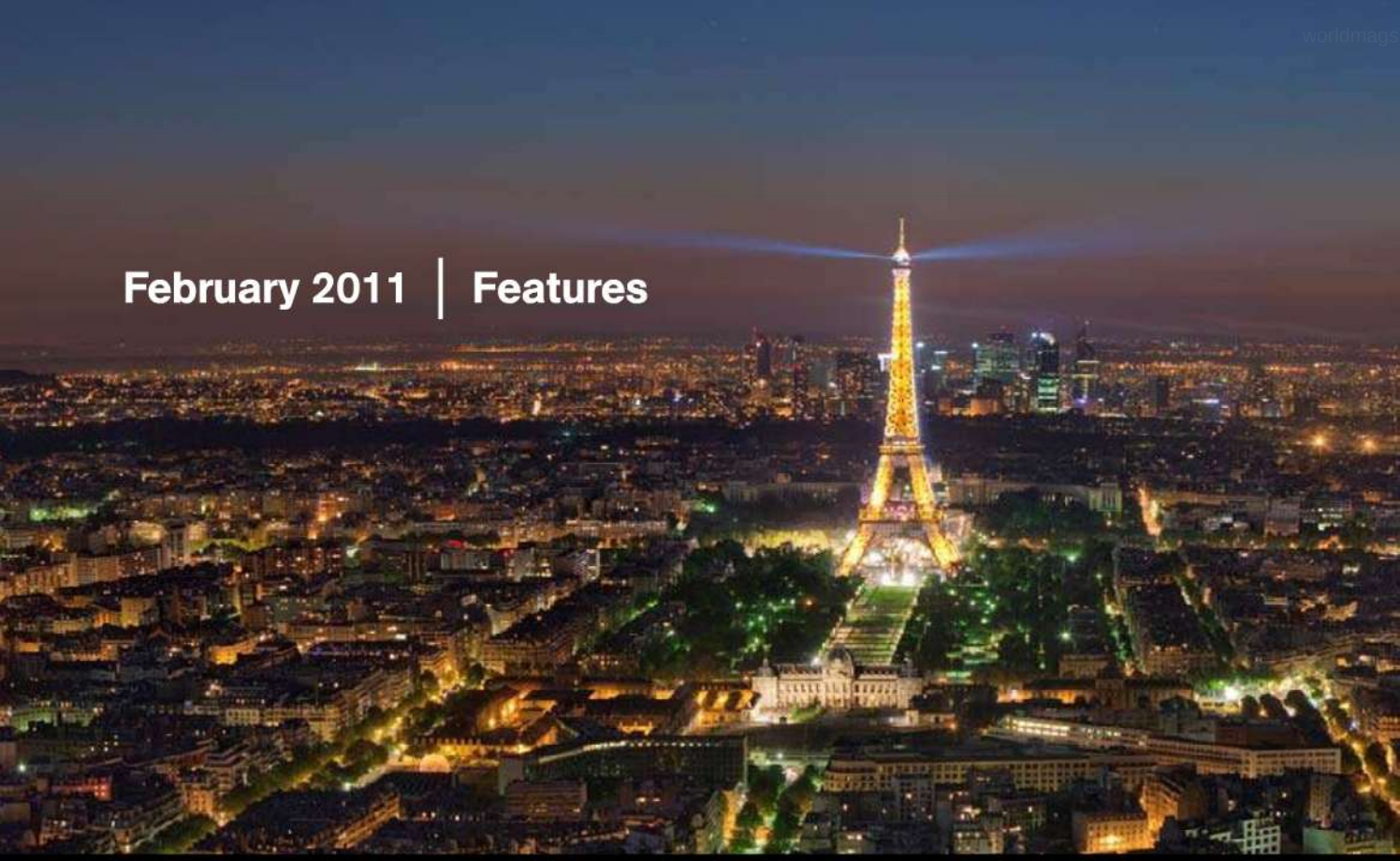
The Evolution of Feathers

Their origin may have had nothing to do with flight.

INTERACTIVE GRAPHIC & VIDEO

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

MORE



Under Paris

You'll find bones, stones, and fetes.

INTERACTIVE GRAPHICS & E-EXTRA TEXT

Opium Wars

A key step toward Afghan peace is to wipe out poppies.

Artificial Reefs

Fish can't resist a sunken ship.

VIDEO

Snub-Nosed Monkeys

Their odd face may help them weather China's cold.

On the Cover
A rainy sidewalk shows the Eiffel Tower going down as well as up. *Impossible!* But what does lie beneath Paris? *Photo by Fernand Ivaldi, Getty Images*

GEOGRAPHY

What's in a Surname?

America is a nation of Smiths, Johnsons, and Sullivans—but also of Garcias and Nguyens.

INTERACTIVE GRAPHIC

CONSERVATION

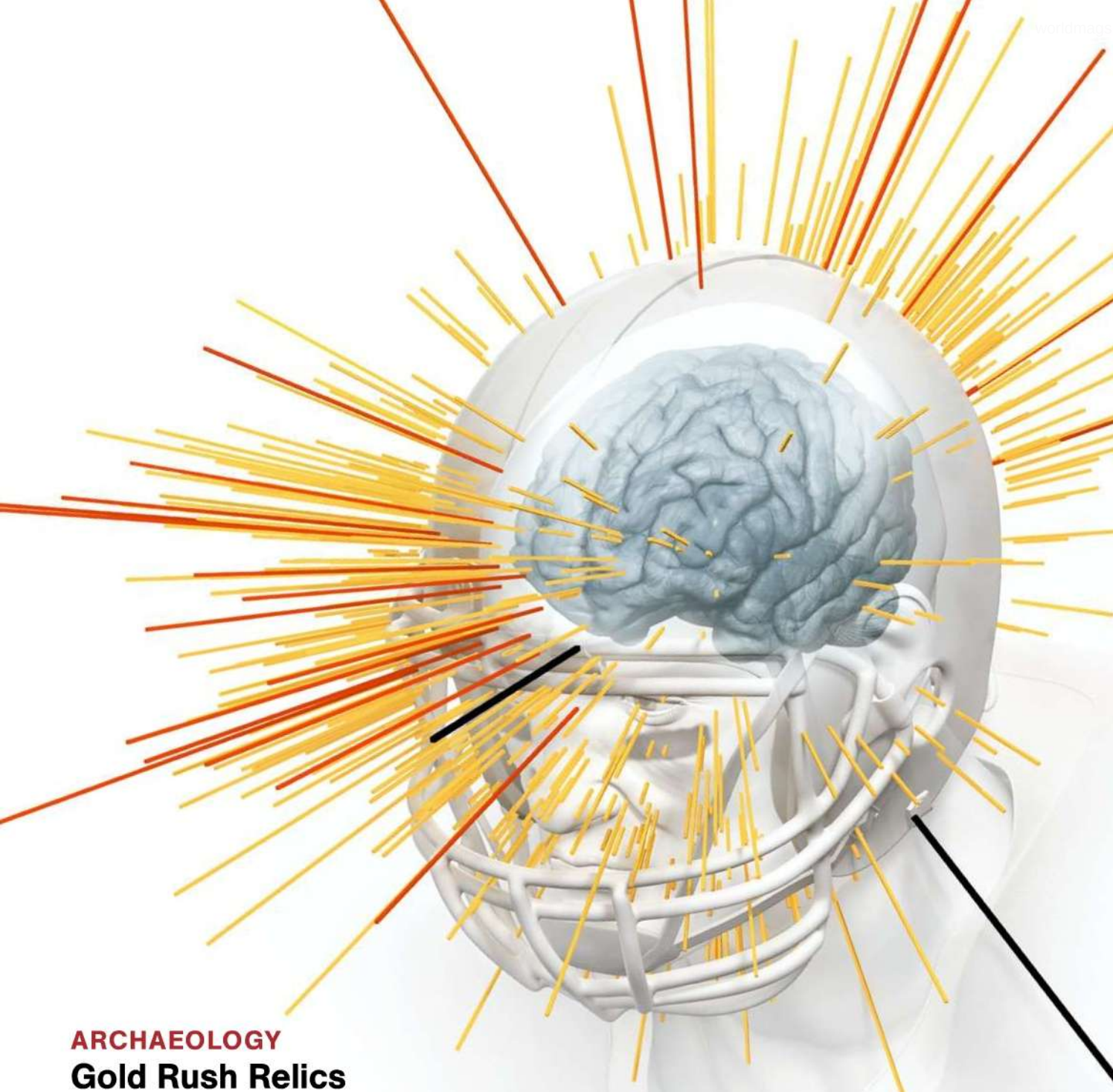
Dinner Don'ts

Africa's ant-eating pangolin is one of many animals victimized by the poorly policed, illicit bush-meat trade.

SCIENCE

Bye-Bye, Helium

The gas that pumps up party balloons and purges rocket engines is running out.



ARCHAEOLOGY

Gold Rush Relics

Three boots, a bottle of vanilla, and a phonograph are among the artifacts discovered in a sunken steamboat.

THE BIG IDEA

Your Brain on Football

Even small hits to the head can lead to brain deterioration. The NFL is seeking solutions.

NATIONAL GEOGRAPHIC *Inspiring people to care about the planet*

EDITOR'S NOTE

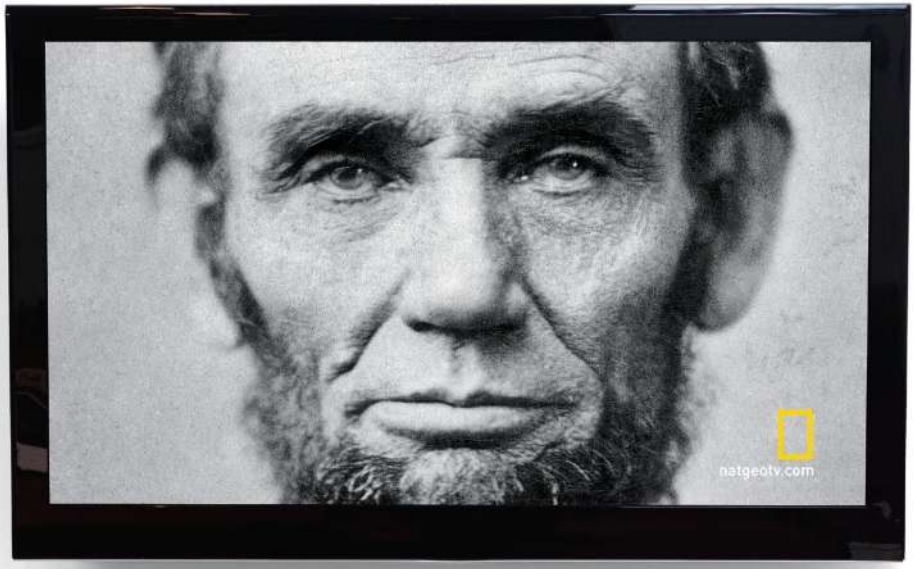
PHOTO: NICK HORNE

Linda Norgrove was taken hostage by the Taliban in September and died during a rescue attempt.

Local intelligence is everything when it comes to traveling in difficult conditions and dangerous places. Fixers, inside sources, and guides are the unsung heroes of every coverage. They point you in the right direction. They watch your back, saying, "Careful, not that close." They tell you, "Go there," or perhaps, "Don't go there."

Covering this month's story on opium, writer Robert Draper and photographer David Guttenfelder depended on many people, including Linda Norgrove—the Scottish aid worker taken hostage by the Taliban in eastern Afghanistan and killed in a failed rescue attempt in October 2010. Norgrove, Draper reports, spent evenings advising them on which of her projects to visit around Jalalabad's outskirts—communities that had once relied on opium for subsistence—and which areas to avoid. "More than once," he says, "Linda reminded us that certain roads were unsafe to travel. Sometimes, we had to take them anyway. Sometimes, she did too."

Draper and Guttenfelder were seldom out of danger. Kidnapping and being killed were constant threats for them and their sources. In Kabul a former government official allowed himself to be interviewed, knowing that if he was found out, he and his family would be killed. "Covering this part of the world is a crucial undertaking," Draper says. "But I confess I spent the entire month with my heart in my throat."



THIS MONTH

Lincoln's Secret Killer?

Monday, February 21, 10 p.m. ET

The tragic death of Abraham Lincoln is hardly a mystery. What isn't clear, however, is the state of the President's health at the time of his assassination. His gaunt frame and prematurely aged looks have led to speculation that he was gravely ill and possibly dying of cancer. In *Lincoln's Secret Killer?* diagnosis expert John Sotos sets out to prove it. Follow him as he tracks down relics from Lincoln's past—including bloodstained fabric that may harbor traces of DNA—and attempts to have them tested for the first time ever, by geneticists in Ohio and New Zealand. *Lincoln's Secret Killer?* airs February 21 at 10 p.m. ET on the National Geographic Channel.

PHOTOS: ALEXANDER GARDNER (TOP); NATIONAL GEOGRAPHIC TELEVISION

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PHOTOS: ALEXANDER GARDNER (TOP); NATIONAL GEOGRAPHIC TELEVISION

The Spill

Immediately upon learning about the oil spill in the Gulf, I was overwhelmed with remorse. As I stood in the kitchen, I saw the evidence of my personal addiction to oil in the everyday objects that surrounded me. I had to sit down and ask God's forgiveness for the blame that rests on my shoulders. When I read the Editor's Note that preceded the article about the spill, I was heartened to see Chris Johns state that "the fault can be said to lie in no small part within ourselves and our appetite for oil." In a time when the government and oil executives are busy pointing fingers at one another, I find it encouraging to know that individuals are taking responsibility for providing the demand that keeps this industry going. It is obvious that we are addicted to oil. What is not so obvious is what we should do now.

REBECCA DRURY
Rockville, Maryland

In the "The Gulf of Oil", biogeochemist Mandy Joye says, "The *Deepwater Horizon* incident is a direct consequence of our global addiction to oil." I disagree. I believe the real reason for the spill and resulting damage to the Gulf was BP's addiction to higher profits at the expense of proper safety measures. It appears that this was not the first time the company ignored safety to achieve higher profits. Had BP been willing to spend the money before the *(Touch* Text *button to read more.)*

October 2010

Immediately upon learning about the oil spill in the Gulf, I was overwhelmed with remorse. As I stood in the kitchen, I saw the evidence of my personal addiction to oil in the everyday objects that surrounded me.

Text

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Email ngsforum@ngm.com

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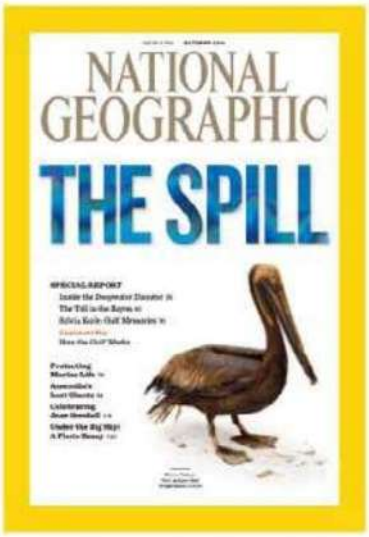

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D I N G

EDITORS' CHOICE **David Sose** North Miami, Florida
In the stern of a boat on South America's Lake Titicaca, Sose, 70, saw a sleeping girl juxtaposed with a standing boatman. "Cropping out his head actually made it more mysterious," Sose says. "It was like a dream, and I was lucky to capture it."

Slide Show

Selections from our editors

Selections from our editors

D I N G

California Like a high-speed Cupid's arrow, an air-rifle pellet pierces the heart of a rose at some 800 feet per second. The flower, flash frozen in liquid nitrogen, shatters in a spray of petal fragments.

PHOTO: ALAN SAILER, WHITEHOTPIX/ZUMA PRESS

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flash frozen in liquid nitrogen, shatters in a spray of petal fragments.

PHOTO: ALAN SAILER, WHITEHOTPIX/ZUMA PRESS

Russia Embracing love in the time of wildfires, newlyweds celebrate as smog engulfs the city of Ryazan. The region was one of the worst hit when last summer's blazes, fueled by drought and severe heat, ailed the country.

PHOTO: SERGEY PONOMAREV, AP IMAGES

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t and severe heat, ailed the country.

PHOTO: SERGEY PONOMAREV, AP IMAGES

Japan Scarlet greater flamingos and their Chilean relatives get cozy at the Sapporo Maruyama Zoo. The birds' color arises from carotenoid pigments in their algae-and-crustacean diet, often supplemented in captivity.

PHOTO: ISSEI KATO, REUTERS

Sapporo Maruyama Zoo. The birds'
ften supplemented in captivity.

Order prints of *National Geographic* photos at **PrintsNGS.com.**

PHOTO: ISSEI KATO, REUTERS

What's in a Surname? A new view of the United States based on the distribution of common last names shows centuries of history and echoes some of America's great immigration sagas. To compile this data, geographers at University College London used phone directories to find the predominant surnames in each state. Software then identified the probable provenances of the 181 names that emerged.

Many of these names came from Great Britain, reflecting the long head start the British had over many other settlers. The low diversity of names in parts of the British Isles also had an impact. Williams, for example, was a common name among Welsh immigrants—and is still among the top names in many American states.

But that's not the only factor. Slaves often took their owners' names, so about one in five Americans now named Smith are African American. In addition, many newcomers' names were anglicized to ease assimilation. The map's scale matters too. "If we did a map of New York like this," says project member James Cheshire, "the diversity would be phenomenal" —a testament to that city's role as a once-and-present gateway to America. *—A. R. Williams*

A World of Names
The geographers behind this map have created a website that lets visitors find hot spots for surnames around the globe: *www.worldnames.publicprofiler.org.*

MORE

A World of Names

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Origin of

GEOGRAPHY

Spanish
Areas near the U.S.-Mexico border show a significant Latin American presence.

ZOOM IN TO EXPLORE THE MAP.

MAP: MINA LIU; OLIVER UBERTI, NGM STAFF
SOURCE: JAMES CHESHIRE, PAUL LONGLEY, AND PABLO MATEOS, UNIVERSITY COLLEGE LONDON


German and Scandinavian
Northern European farmers settled in the upper Midwest.
French and Spanish
Louisiana has an Acadian heritage. South Florida is heavily Cuban.
Asian
Labor for Hawaii's sugar plantations came in part from the western Pacific.
Irish
Ireland's potato famine in the mid-1800s sent 1.5 million people to the U.S.
CONNECTICUT, MASSACHUSETTS, NEW HAMPSHIRE, RHODE ISLAND, AND VERMONT SHOW THE TOP 25 NAMES FOR THOSE FIVE STATES COMBINED.
Top 25 surnames in each state, 2000
Smith Less than 10,000
Smith 10,000-24,999
Smith 25,000-49,999
Smith 50,000-74,999
Smith 75,000-99,999
Smith 100,000-125,000
Smith More than 125,000
SMITH IS THE MOST COMMON SURNAME IN THE U.S.
Origin of surname
Europe
England
France
Germany
Ireland
Scandinavia
Scotland
Spain
Wales
Asia
China
Japan
Other
Alaska
Hawaii

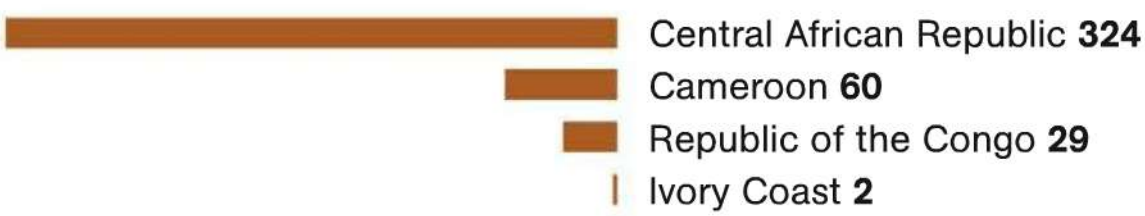
Trafficking in Bush Meat Duikers, pangolins, and brush-tailed porcupines aren't well-known animals in Europe or the U.S. But a new study estimates that each week, thousands of pounds of their meat moves illegally from Africa into European markets for human consumption, often via luggage.

At Paris's Charles de Gaulle Airport, an 18-day customs survey led to the seizure of more than 400 pounds of meat from wild animals, including cane rats and imperiled monkeys. One passenger was found carrying fresh crocodile wrapped in plastic. Anne-Lise Chaber, who led the study by European scientists, notes that bush meat is an essential part of diets in some regions of Africa. But the poorly policed illicit trade contributes to declining animal populations and poses public health hazards. A luxury item in foreign markets, bush meat tends to command a premium price there.

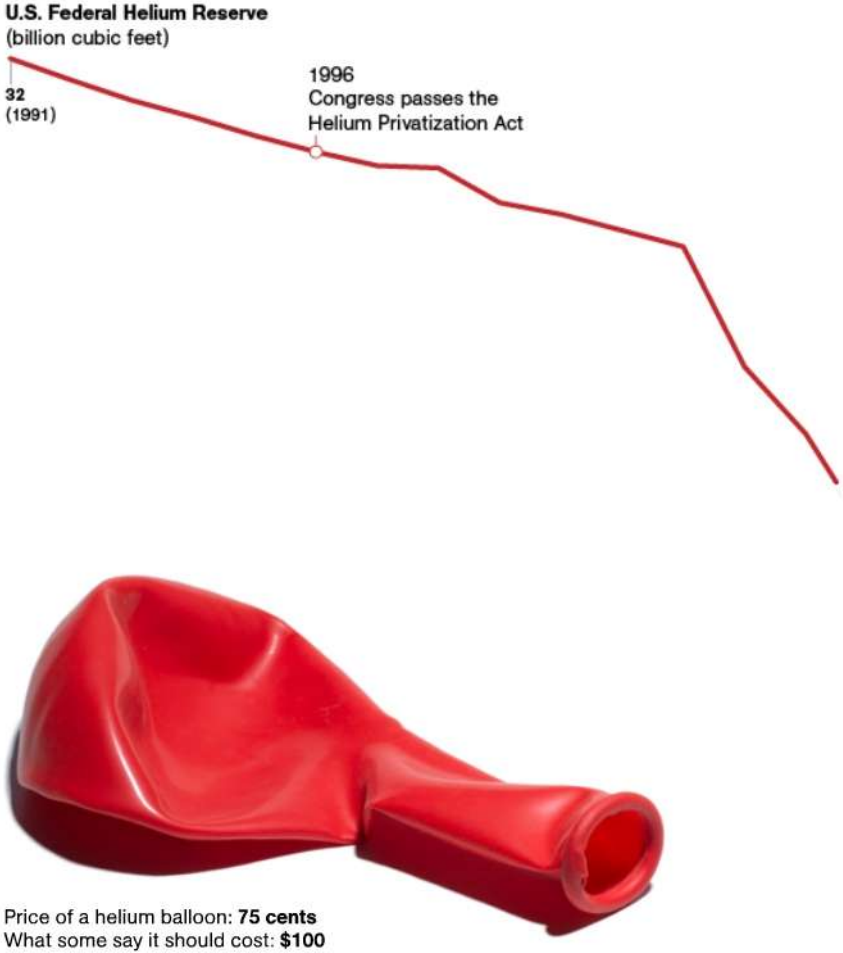
In the U.S., the New York–New Jersey area and metropolitan Washington, D.C., are hot spots for import and trade, according to Heather Eves of the Bushmeat-free Eastern Africa Network. "Only 10 percent of the planet isn't accessible to large urban areas within two days' time," she says. "A lot of smoked, dried, and even fresh bush meat can be transferred from the bush in that time." *—Luna Shyr*

Customs officials in Houston last summer seized these pangolin carcasses (above) from a passenger arriving from Nigeria. Many species of pangolin (left) are popular as bush meat.

Bush meat seized at France's Charles de Gaulle Airport
In pounds, from country of origin, over 18 days



PHOTOS: U.S. CUSTOMS AND BORDER PROTECTION (TOP); PHOTOSHOT HOLDINGS LTD/ALAMY. CHART SOURCE: ANNE-LISE CHABER



Price of a helium balloon: **75 cents**
What some say it should cost: **$100**

Bye-Bye, Helium Most of us know it as the gas that floats party balloons, blimps, and giant superheroes in holiday parades. But helium also purges rocket engines for NASA and the military and is crucial for diving equipment, particle accelerators, and MRIs.

The deflating news, says the National Research Council, is that we're running out. Most of the world's helium comes from beneath America's Great Plains, where it's trapped in natural gas. The U.S. began stockpiling it in the 1960s, but in 1996 opted to recoup its investment and sell off the reserve by 2015. After that, other producers—including Russia, Algeria, and Qatar—will control what's left of the global market: perhaps a mere 40 years' worth.

Scientists, including Nobel Prize-winning physicist Robert Richardson, think increasing the price would help conserve the element. Richardson knows that charging big bucks ($100) for a little balloon is a party-pooping idea. But it would also encourage the major helium users, like NASA, to recycle—and help the world hold on to its up, up, and away. *—Gretchen Parker*

PHOTO: REBECCA HALE, NGM STAFF.
CHART SOURCES: JOE PETERSON, HELIUM RESOURCES, BUREAU OF LAND MANAGEMENT; USGS MINERALS YEARBOOK

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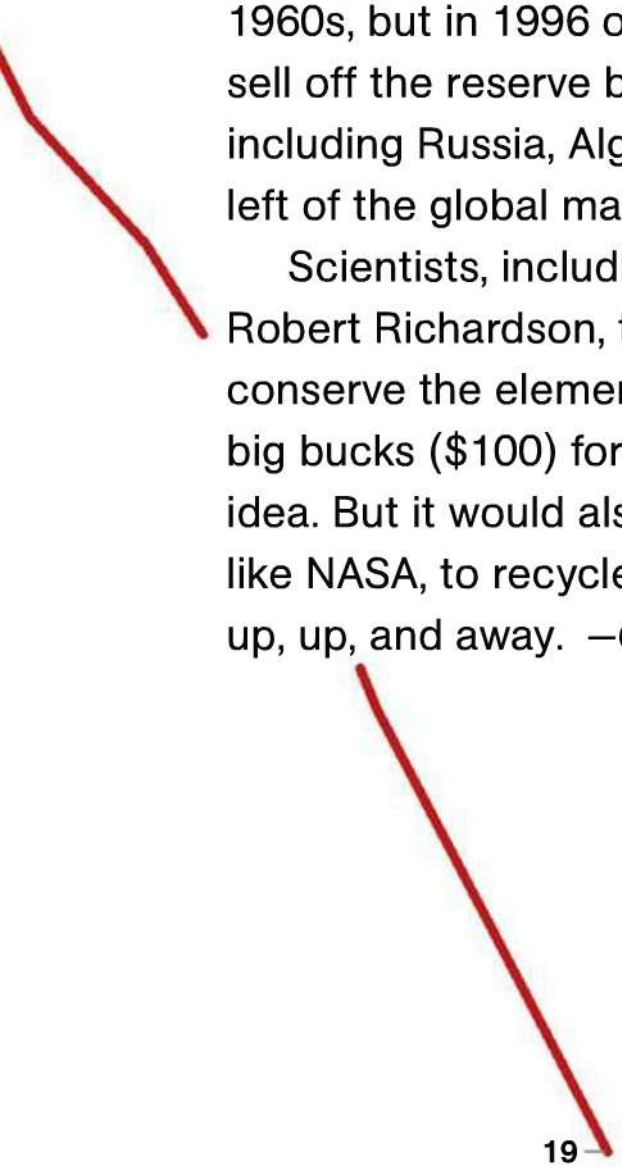


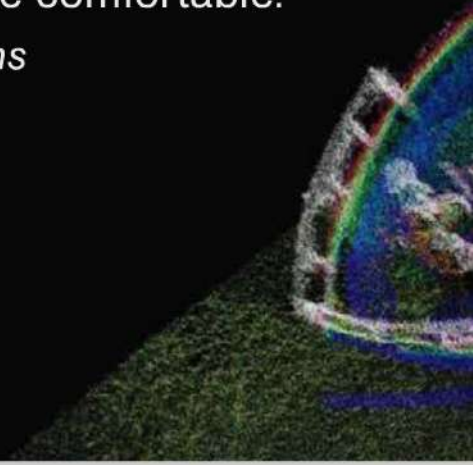
PHOTO: REBECCA HALE, NGM STAFF.
CHART SOURCES: JOE PETERSON, HELIUM RESOURCES, BUREAU OF LAND MANAGEMENT; USGS MINERALS YEARBOOK

NG GRANT

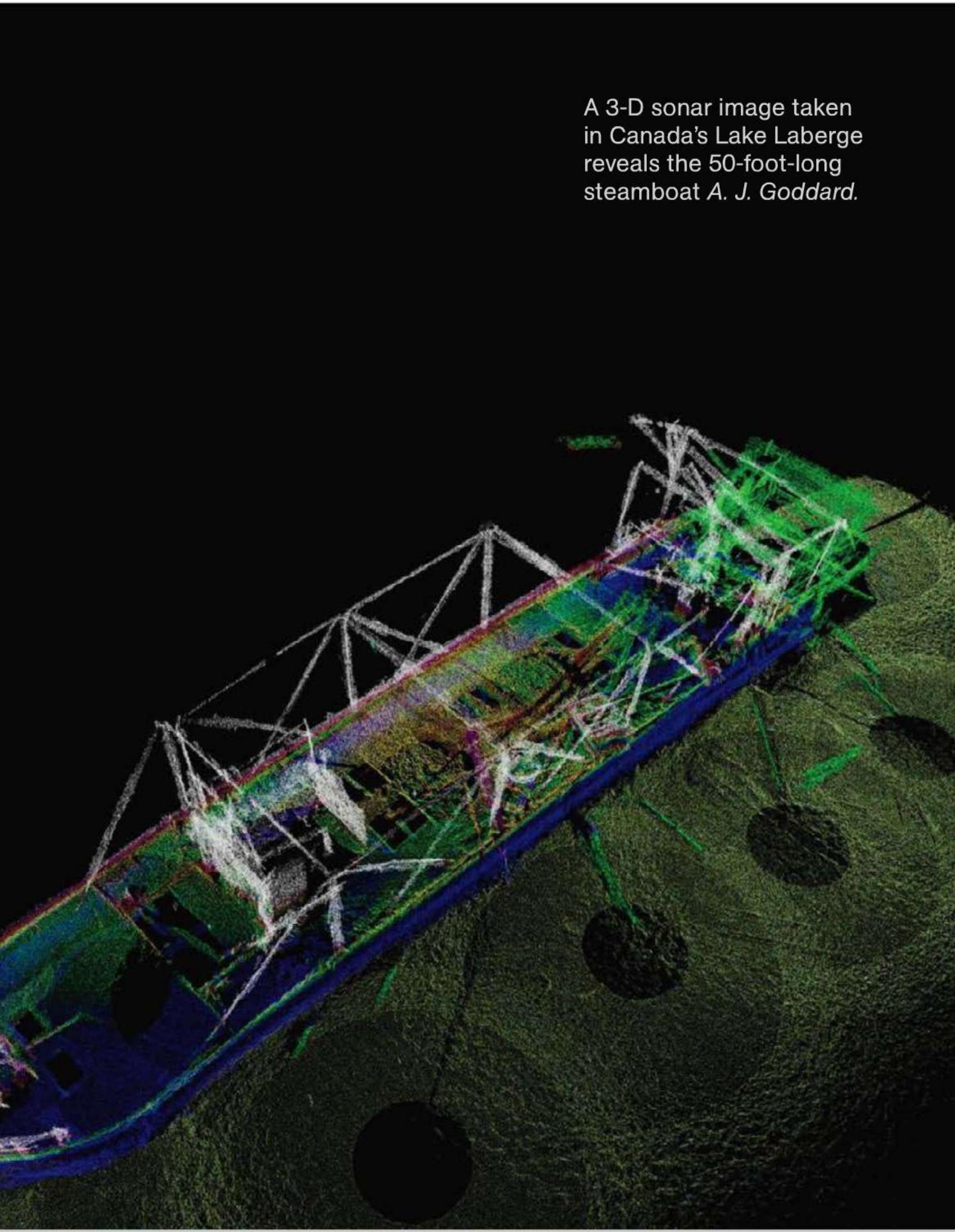
Gold Rush Relics More than 30 feet below the surface of a Yukon lake, a shipwreck is offering a fresh glimpse of conditions on the Canadian frontier. After the 1896 gold strike near the remote Klondike River launched a stampede to the territory, the *A. J. Goddard*—named for its owner, a U.S. businessman—became one of the first steamboats to ferry prospectors and their supplies from Whitehorse to Dawson. A storm sent it to its grave in 1901, but the frigid waters of Lake Laberge have kept it almost perfectly preserved.

Since 2008 a multidisciplinary team of scientists has been documenting the iron-hulled stern-wheeler and its contents.

Discoveries include three boots, corked bottles of vanilla and Bromo-Seltzer, and a spring-motored phonograph with three records. "In the midst of a rough-and-tumble life," says James Delgado of the Institute of Nautical Archaeology, "the crew put on music to make it a little more comfortable." *—A. R. Williams*



3-D IMAGE COURTESY BLUEVIEW TECHNOLOGIES, INC. NGM MAPS



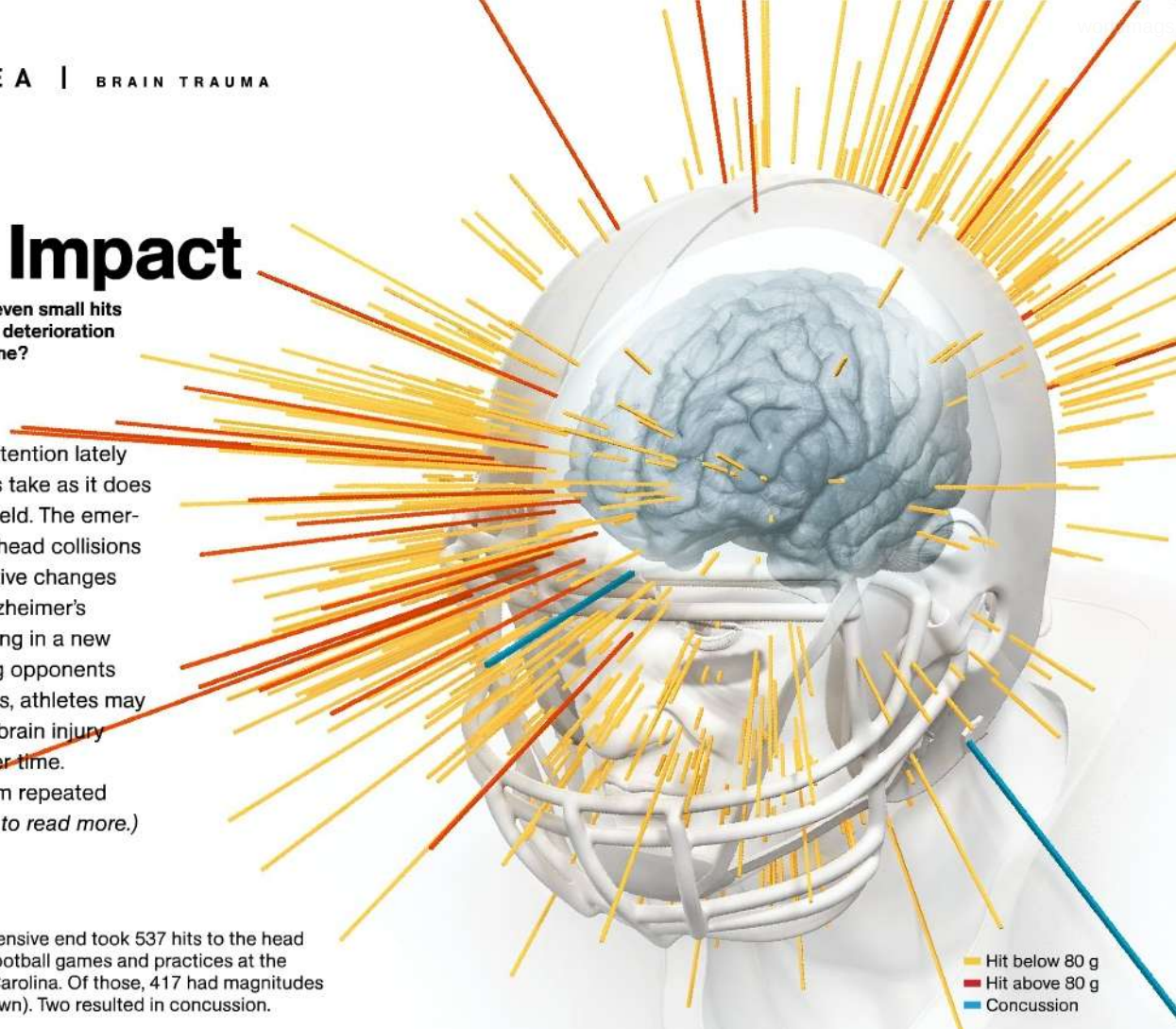
A 3-D sonar image taken in Canada's Lake Laberge reveals the 50-foot-long steamboat *A. J. Goddard.*

Lasting Impact

New research suggests that even small hits to the head may lead to brain deterioration over time. So what can be done?

Football draws as much attention lately for the knocks that players take as it does for their drives down the field. The emergence of research linking head collisions with behavioral and cognitive changes similar to those seen in Alzheimer's patients puts the pummeling in a new context. Whether ramming opponents head-on or butting helmets, athletes may face the risk of long-term brain injury from hits accumulated over time.

Brain degeneration from repeated blows *(Touch* Text *button to read more.)*



One 21-year-old defensive end took 537 hits to the head during a season of football games and practices at the University of North Carolina. Of those, 417 had magnitudes of 10 g or more (shown). Two resulted in concussion.

Text

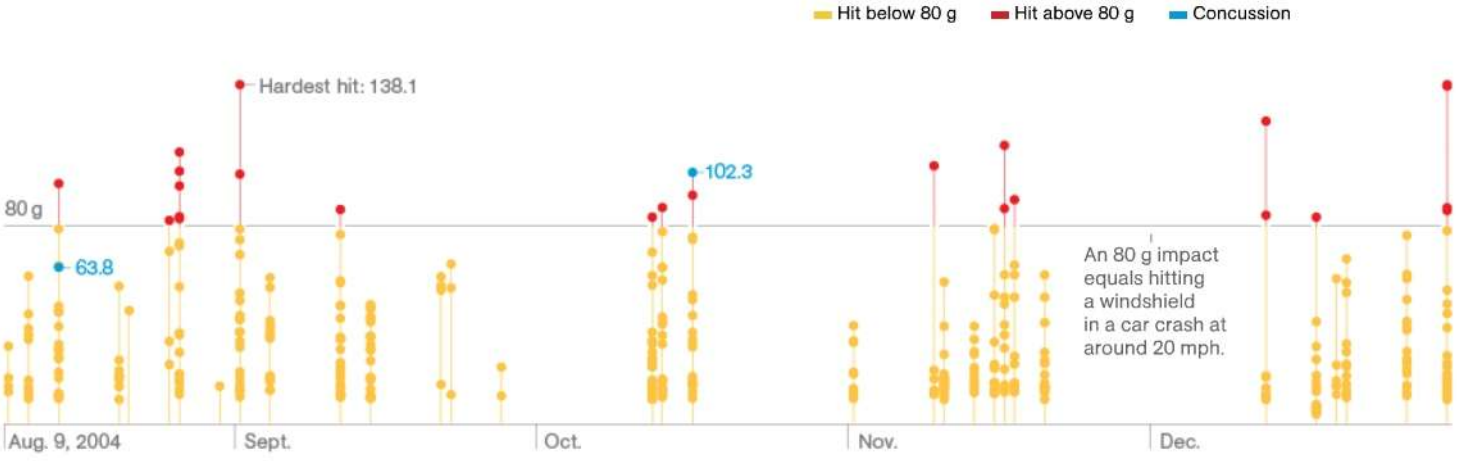
ART: BRYAN CHRISTIE. SOURCE: KEVIN GUSKIEWICZ, MATTHEW GFELLER SPORT-RELATED TRAUMATIC BRAIN INJURY RESEARCH CENTER AT UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

DING

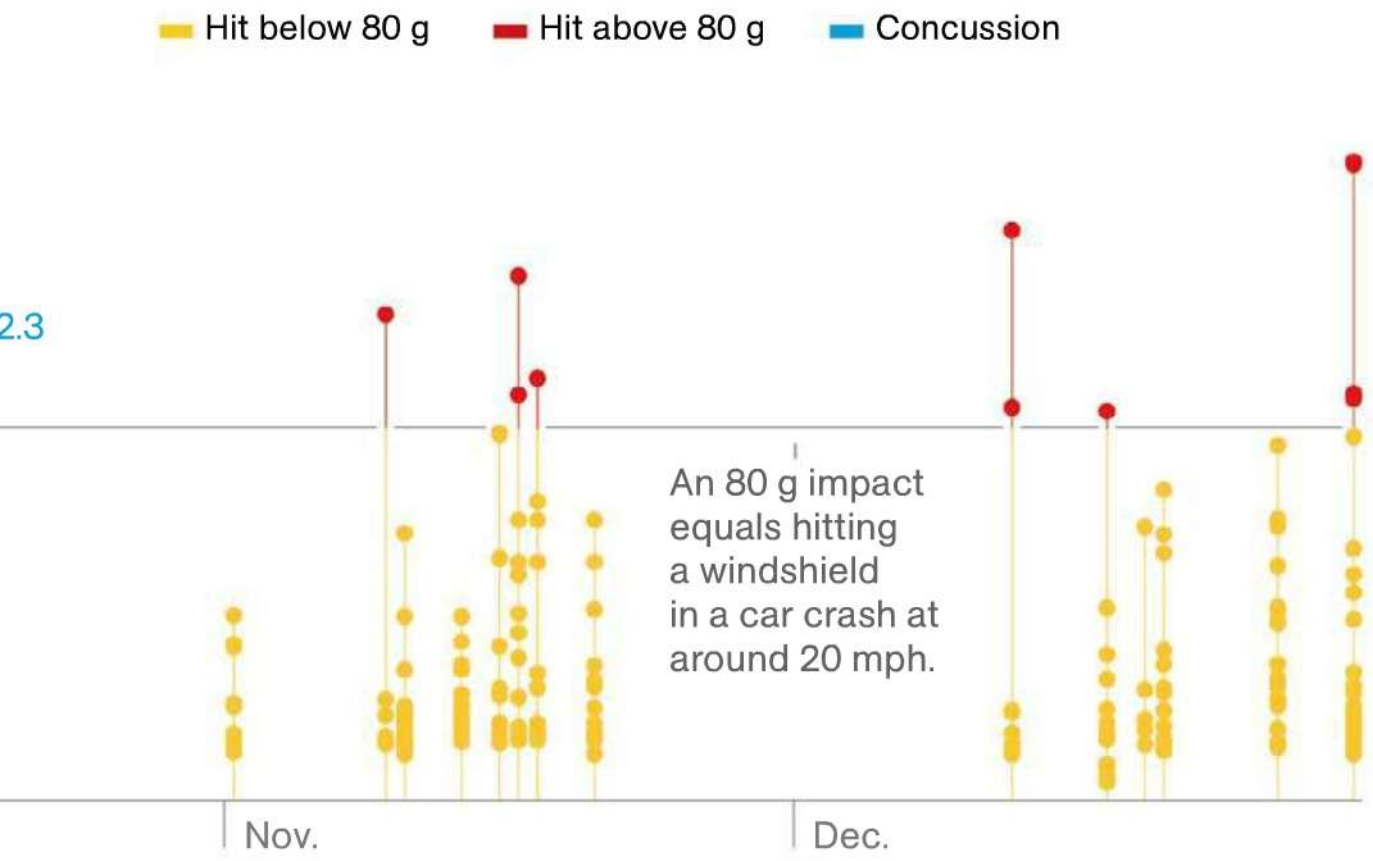
ART: BRYAN CHRISTIE. SOURCE: KEVIN GUSKIEWICZ, MATTHEW GFELLER SPORT-RELATED TRAUMATIC BRAIN INJURY RESEARCH CENTER AT UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

A Season of Collisions

When tracking head collisions, researchers focus on three variables: an impact's location and magnitude, as well as the frequency of hits (below). While magnitude matters, the biggest hits aren't necessarily the most damaging. Milder ones can add up to injury.



*g = A MEASURE OF ACCELERATION IN TERMS OF GRAVITY



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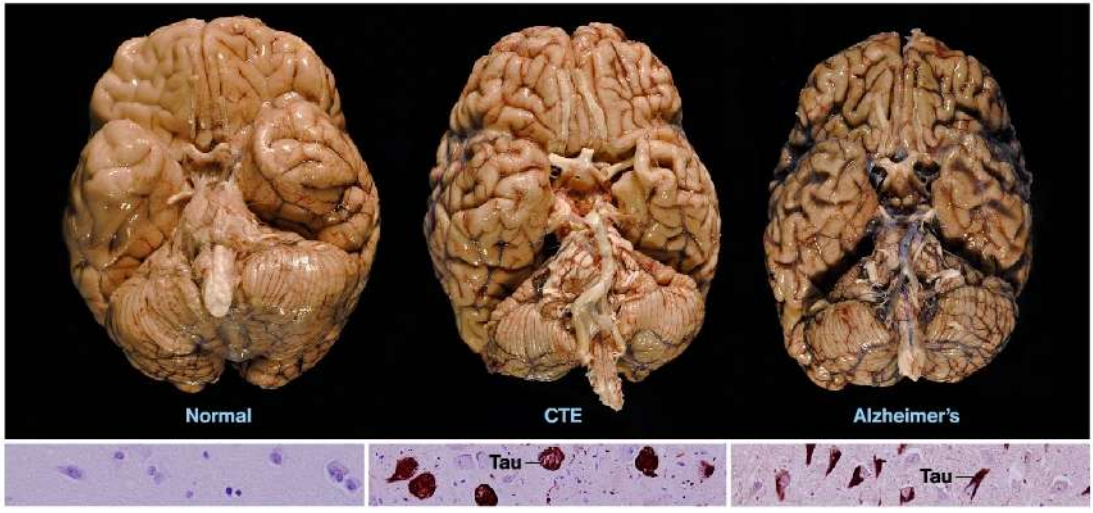


A MICROSCOPIC SIGNATURE

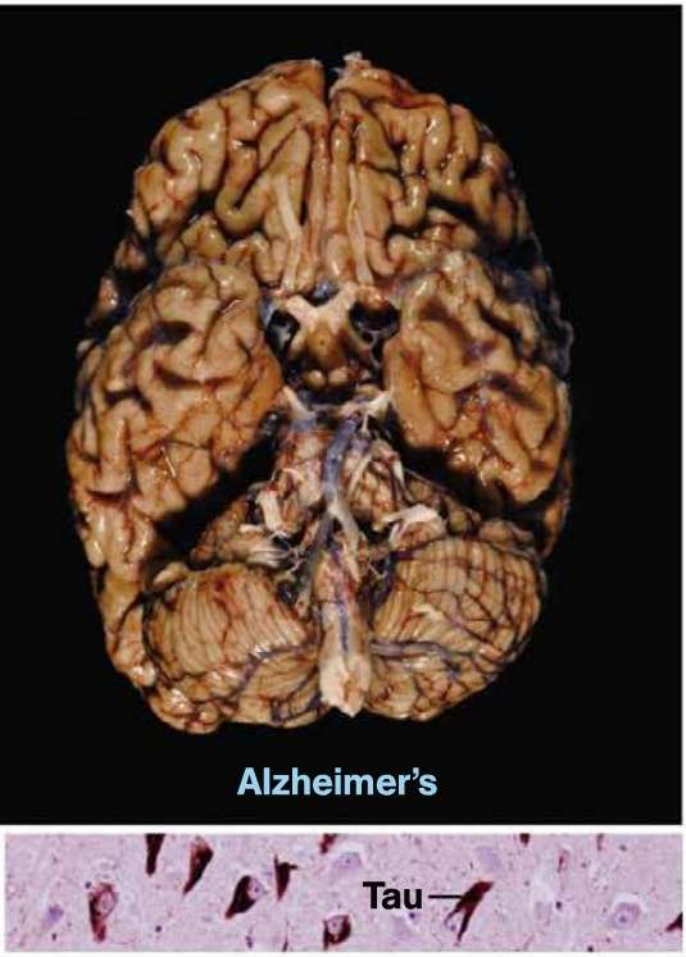
The key mark of chronic traumatic encephalopathy (CTE), a disorder found in some athletes who have sustained repetitive head blows, reveals itself in the details of stained slices of brain (bottom left) rather than the organ's overall appearance. CTE's microscopic imprint bears a striking resemblance to Alzheimer's; both exhibit deposits of abnormal tau, a protein that normally helps support the structure of a nerve cell.

FOOTBALL DRAWS AS MUCH ATTENTION lately for the knocks that players take as it does for their drives down the field. The emergence of research linking head collisions with behavioral and cognitive changes similar to those seen in Alzheimer's patients puts the pummeling in a new context. Whether ramming opponents head-on or butting helmets, athletes may face the risk of long-term brain injury from hits accumulated over time.

Brain degeneration from repeated blows to the head has been known in boxers since *(Touch* Text *button to read more.)*

PHOTOS: ANN C. McKEE, BOSTON UNIVERSITY/BEDFORD VETERANS HOSPITAL (TOP); BENNET OMALU, BRAIN INJURY RESEARCH INSTITUTE, WEST VIRGINIA UNIVERSITY (BOTTOM ROW)

Text



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D I N G

TAIL FEATHER OF A BLUE-FRONTED AMAZON PARROT;
AT INSTITUTE OF ZOOLOGY AND ZOOLOGICAL MUSEUM, UNIVERSITY OF HAMBURG

The long curious extravagant evolution of feathers

FIRST CAME FUZZ

Birds evolved from dinosaurs, but the origin of their feathers may trace back even deeper in time, to the common ancestor of dinosaurs and pterosaurs, like the fossil at left. These flying reptiles were covered with thin filaments that may have looked something like the down on this pheasant chick.

JEHOLOPTERUS NINGCHENGENSIS
168-152 MILLION YEARS AGO, CHINA
AT INSTITUTE OF VERTEBRATE PALEONTOLOGY AND PALEOANTHROPOLOGY, BEIJING

Etched in limestone, a single 150-million-year-old plume of the early bird *Archaeopteryx*, discovered in a German quarry in 1861, triggered a still unresolved debate over the origin of one of nature's most elegant inventions: the feather.

ARCHAEOPTERYX LITHOGRAPHICA, 150 TO 148 MYA, GERMANY
AT MUSEUM OF NATURAL HISTORY, HUMBOLDT UNIVERSITY, BERLIN

BY CARL ZIMMER | PHOTOGRAPHS BY ROBERT CLARK | ART BY XING LIDA

MOST OF US WILL NEVER GET TO SEE NATURE'S GREATEST marvels in person. We won't get a glimpse of a colossal squid's eye, as big as a basketball. The closest we'll get to a narwhal's unicornlike tusk is a photograph. But there is one natural wonder that just about all of us can see, simply by stepping outside: dinosaurs using their feathers to fly.

Birds are so common, even in the most paved-over places on Earth, that it's easy to take for granted both their dinosaur heritage and the ingenious plumage that keeps them aloft. To withstand the force of the oncoming air, a flight feather is shaped asymmetrically, the *(Touch* Text *button to read more.)*

Carl Zimmer wrote about carnivorous plants in the March 2010 issue of National Geographic. *Robert Clark is a frequent contributor. Xing Lida's dinosaur books are best sellers in China.*

Text

DING

FEATHER EVOLUTION

Long assumed to have evolved from reptilian scales, the first feathers are now thought by some scientists to have been entirely new structures erupting from skin patches called placodes. First simple hollow tubes, they later evolved into more elaborate structures with interconnected barbs forming flat vanes, enabling flight.

SOURCE: RICHARD PRUM, YALE UNIVERSITY

Branches on barbs, called barbules, evolve.

Barbule hooklets interlock, forming vanes.

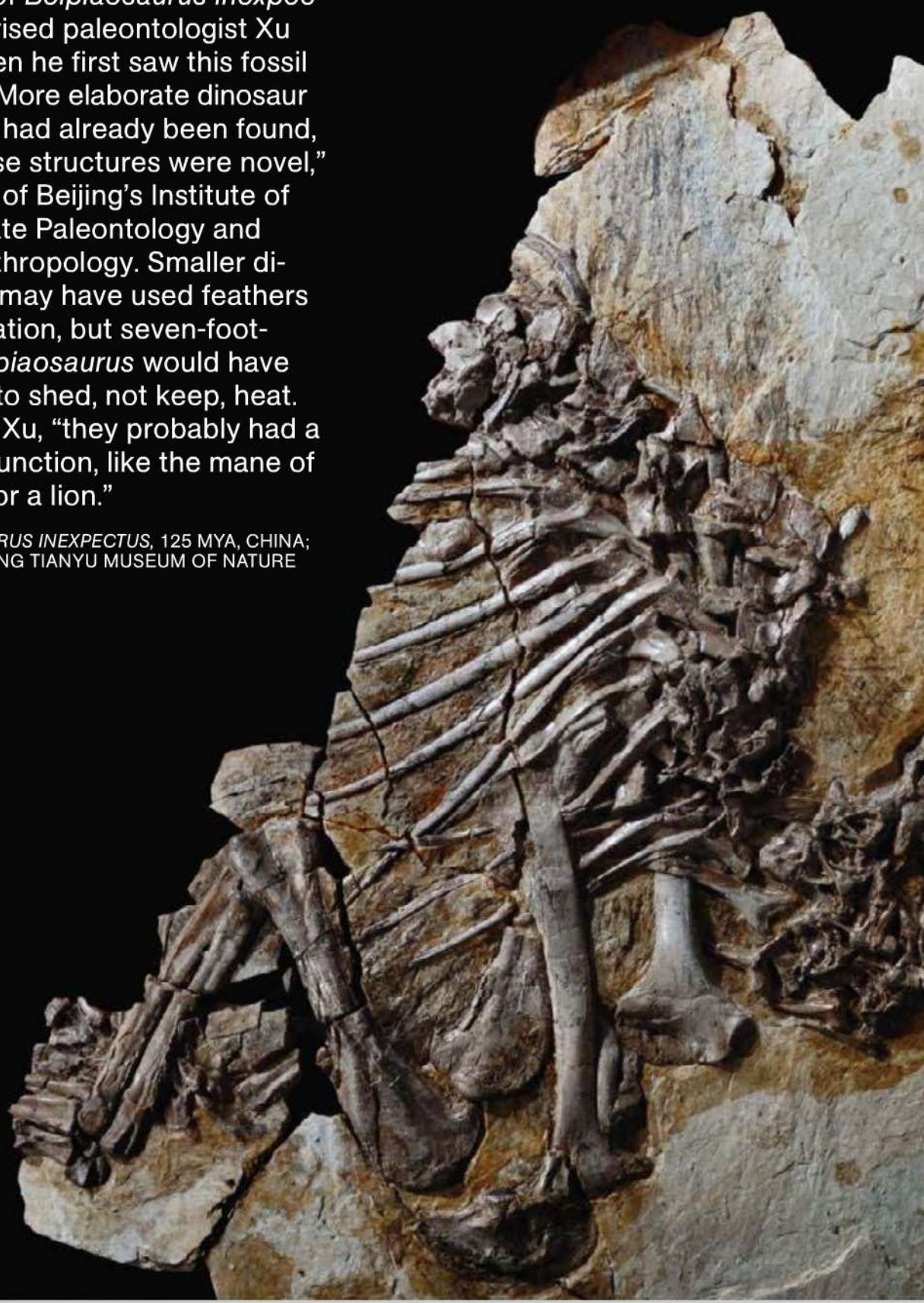
Asymmetrical vanes evolve, aiding flight.

SOURCE: RICHARD PRUM, YALE UNIVERSITY

SHAGGY DINO

Simple, quill-like filaments on the head (upper right on fossil), back, and tail of *Beipiaosaurus inexpectus* surprised paleontologist Xu Xing when he first saw this fossil in 1997. More elaborate dinosaur feathers had already been found, but "these structures were novel," says Xu, of Beijing's Institute of Vertebrate Paleontology and Paleoanthropology. Smaller dinosaurs may have used feathers for insulation, but seven-foot-long *Beipiaosaurus* would have needed to shed, not keep, heat. So, says Xu, "they probably had a display function, like the mane of a horse or a lion."

BEIPIAOSAURUS INEXPECTUS, 125 MYA, CHINA; AT SHANDONG TIANYU MUSEUM OF NATURE



FRINGE CHARACTER

Until 2001 feathered dinosaurs were known only on the saurischian branch of the dinosaur tree, which includes birds. That year a fossil from the other branch, the ornithischians, surfaced on the international market, with long, curved filaments on its tail. Without more information on *Psittacosaurus,* scientists were reluctant to believe dinosaurs so distantly related to birds bore featherlike structures. The 2009 announcement of similar filaments on another ornithischian, *Tianyulong,* changed many minds. But did the trait evolve independently in the two branches, or in their common ancestor?

PSITTACOSAURUS SP., 125 TO 121 MYA, CHINA; SMUGGLED SPECIMEN OF UNKNOWN PROVENANCE, CURRENTLY IN CUSTODY OF SENCKENBERG RESEARCH INSTITUTE, GERMANY, PENDING REPATRIATION TO CHINA

JURASSIC PEACOCK

Sporting a quartet of long, ribbonlike feathers with barbs arranged in vanes, pigeon-size *Epidexipteryx* may provide the earliest evidence of a dinosaur flaunting its feathers for display. Such extravagant plumage would have been virtually useless for insulation or flying, but it might have attracted mates or allowed individuals of the species to recognize one another.

EPIDEXIPTERYX HUI, 168 TO 152 MYA, CHINA;
AT SHANDONG TIANYU MUSEUM OF NATURE

BEASTS OF A FEATHER

Until recently, feathers had been found only on birds and closely related theropod dinosaurs, ranging from pigeon-size *Epidexipteryx* to seven-foot-long *Beipiaosaurus*. The discovery of featherlike structures on ornithischians—beaked dinosaurs far removed from birds—hints that the ancestor of all dinosaurs may have had feathers. "Fuzz" on pterosaurs suggests that protofeathers may have evolved even earlier, in the common ancestor of pterosaurs and dinosaurs.

FAMILY TREE OF ARCHOSAURS

X Basal archosaurs

ORNITHISCHIANS

DINOSAURS

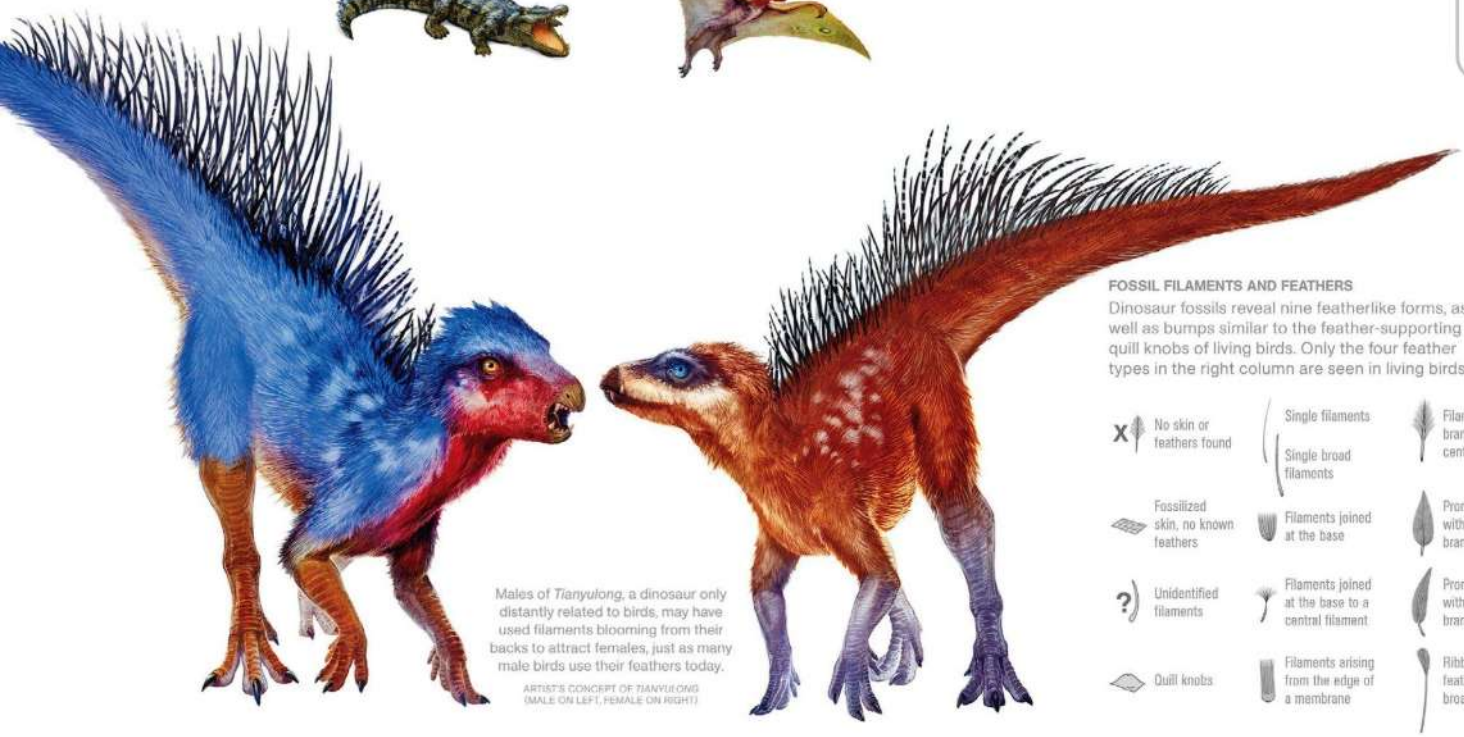
Sauropods

SAURISCHIANS

Theropods

Crocs

? Pterosaurs



Males of *Tianyulong*, a dinosaur only distantly related to birds, may have used filaments blooming from their backs to attract females, just as many male birds use their feathers today.

ARTIST'S CONCEPT OF *TIANYULONG* (MALE ON LEFT, FEMALE ON RIGHT)

FOSSIL FILAMENTS AND FEATHERS

Dinosaur fossils reveal nine featherlike forms, as well as bumps similar to the feather-supporting quill knobs of living birds. Only the four feather types in the right column are seen in living birds.

X No skin or feathers found

Fossilized skin, no known feathers

? Unidentified filaments

Quill knobs

Single filaments

Single broad filaments

Filaments joined at the base

Filaments joined at the base to a central filament

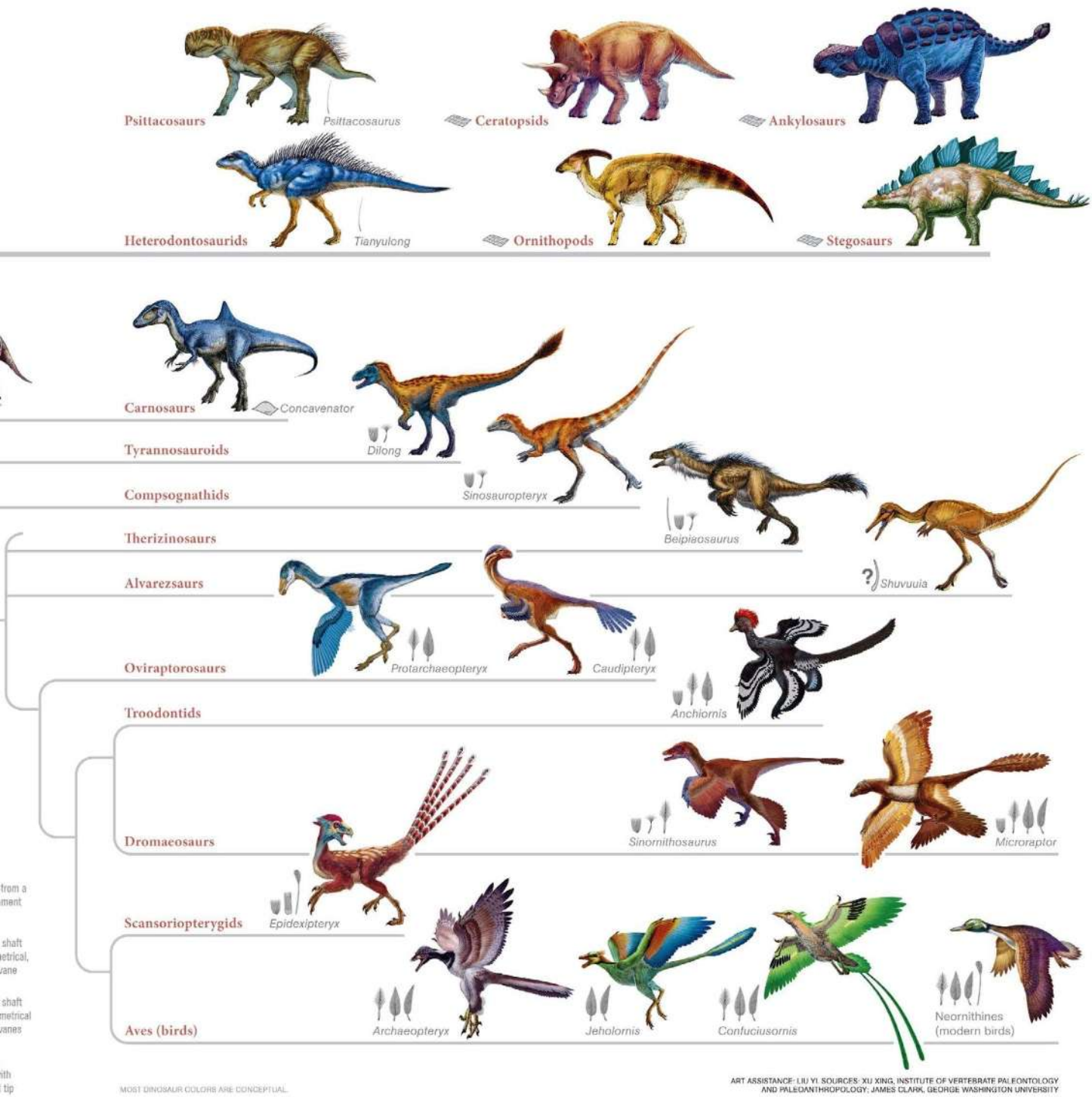
Filaments arising from the edge of a membrane

Filaments branching central fil

Prominent with symm branched

Prominent with asym branched

Ribbonlik feathers w broadene



MOST DINOSAUR COLORS ARE CONCEPTUAL.

ART ASSISTANCE: LIU YI. SOURCES: XU XING, INSTITUTE OF VERTEBRATE PALEONTOLOGY AND PALEOANTHROPOLOGY; JAMES CLARK, GEORGE WASHINGTON UNIVERSITY

In an 1860 letter Charles Darwin despaired over how natural selection could account for such an impediment to flight as a peacock's train. He later came up with sexual selection: Gaudy peacocks please peahens and pass on their genes.

COMPOSITE OF THREE IMAGES; AT PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY

MORE

FORM AND FUNCTION

Living birds display a mesmerizing diversity of feathers, each suited to a particular task. If the familiar form of a long vane were varied much, it could fail in flight. Evolution can be more creative, however, when it comes to courtship demonstrations, many of which depend on colorful plumes. Various birds also use feathers to keep cool or warm, make or muffle noise, float or snowshoe, concentrate sound to improve hearing, build nests, assist digestion, carry water, and escape from predators by shedding feathers the way a lizard sheds its tail. “Feathers are the most complex thing that grows out of the skin of any organism,” says Richard Prum of Yale University. “It is astounding how thousands of diverse structures work together to create plumage.”

3

1

1 **King bird of paradise**
Disk tail-feather tip, wobbles during display

2 **Gray peacock pheasant**
Tail covert, fan display

3 **Ostrich (chick)**
Body feathers, first and second stage, insulation

FEATHER 1, COURTESY PETER MULLEN, PH.D.; FEATHERS 2 & 3, INSTITUTE OF ZOOLOGY AND ZOOLOGICAL MUSEUM, UNIVERSITY OF HAMBURG

2

1

2

1 **Red bird of paradise**
Flank plumes, display

2 **Spotted eagle-owl**
Wing feather with serrated edge, muffles sound

3 **Scarlet macaw**
Wing covert feather, flight

FEATHERS 1 & 3, INSTITUTE OF ZOOLOGY AND ZOOLOGICAL MUSEUM, UNIVERSITY OF HAMBURG; FEATHER 2, COURTESY PETER MULLEN, PH.D.

3

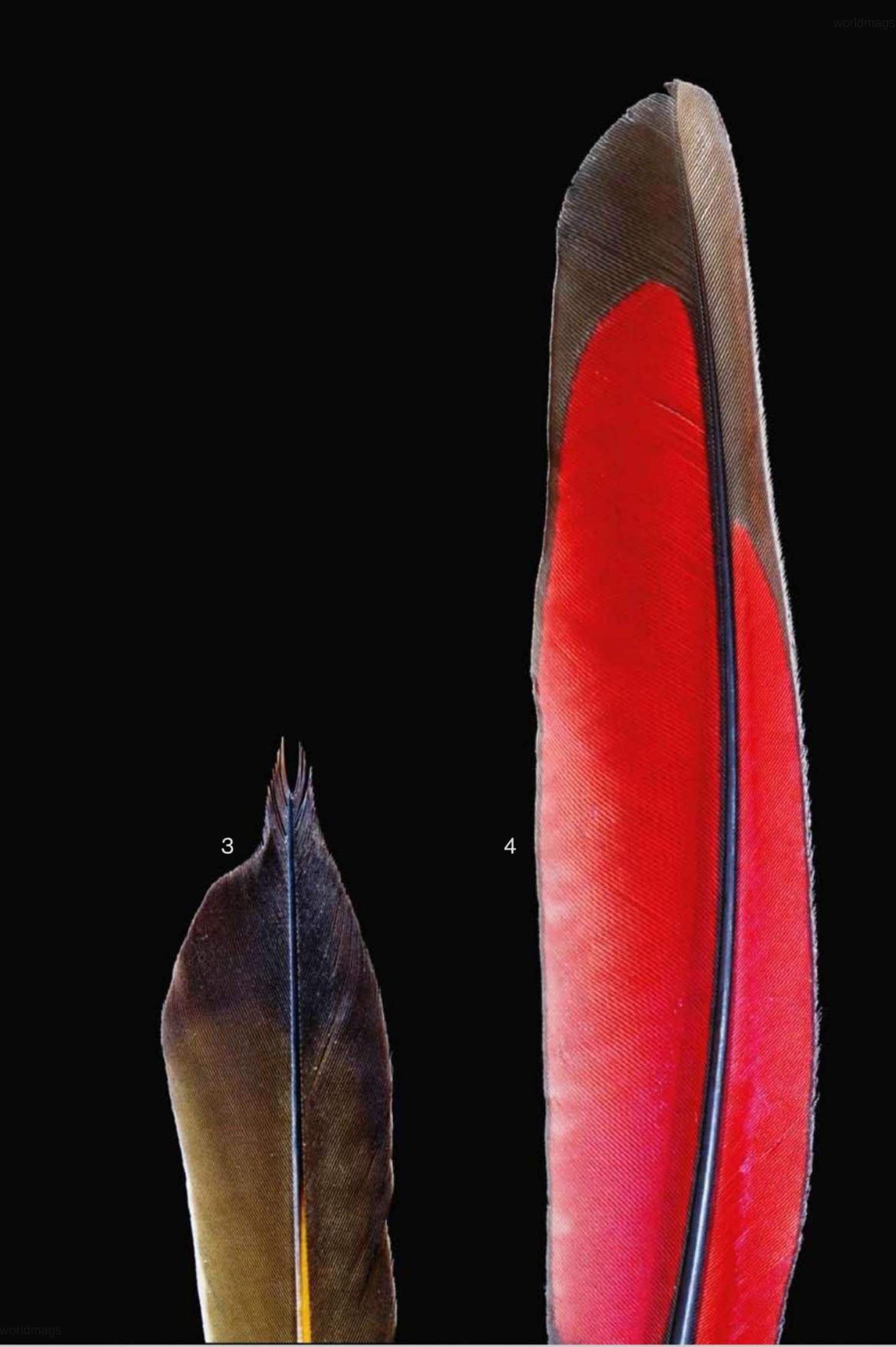
1 **Golden-headed quetzal**
Tail covert, display

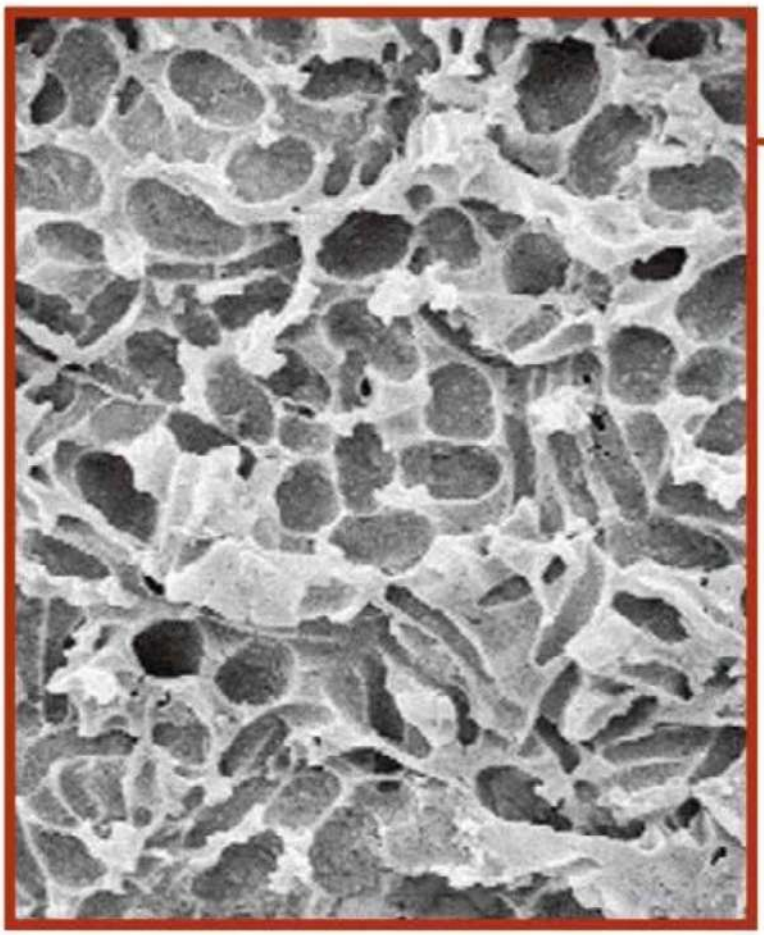
2 **Golden pheasant**
Head crest, display

3 **Northern flicker**
Tail feather, assists in climbing

4 **Red-crested turaco**
Wing feather with copper-containing pigment, flight and display

FEATHERS 1 & 3, INSTITUTE OF ZOOLOGY AND ZOOLOGICAL MUSEUM, UNIVERSITY OF HAMBURG; FEATHERS 2 & 4, COURTESY PETER MULLEN, PH.D.





TRUE COLORS

Colorful depictions of feathered dinosaurs—including most in this article—reflect artistic license. But in 2010 chicken-size *Anchiornis* made paleontological history by becoming the first dinosaur to have the color of its plumage brought back to life. A year earlier Jakob Vinther and his colleagues had discovered microscopic pigment sacs, called melanosomes, in the feathers of an extinct bird. The finding triggered a frenetic race to find colors in dinosaur feathers as well. In February 2010 a team of Chinese and British scientists announced that they had found melanosomes in individual feathers of several dinosaurs that would have produced black and reddish hues. Merely a week later…

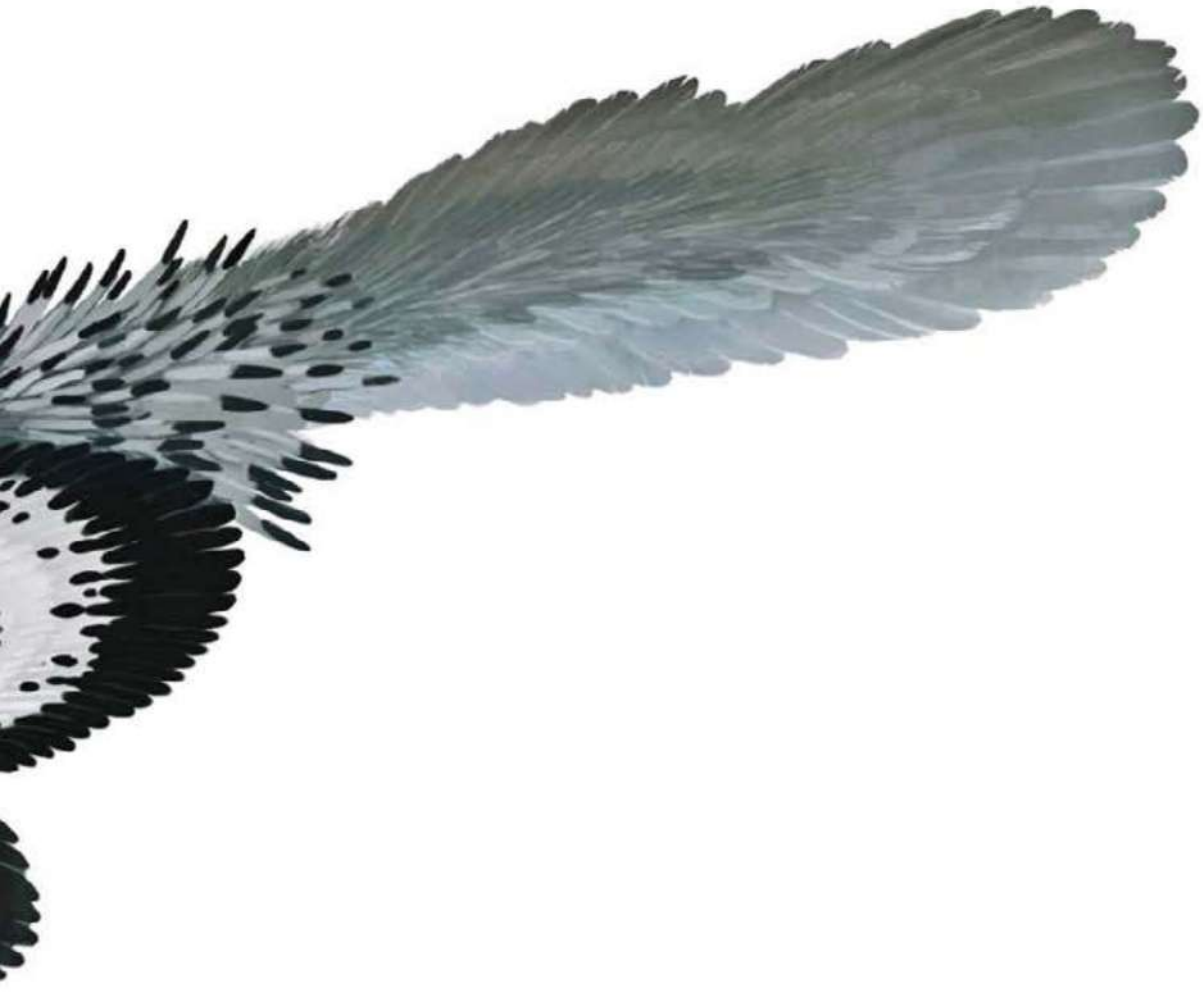
Society Grant The discovery of color in dinosaur feathers was funded in part by your National Geographic Society membership.

Microscopic pigment sacs responsible for color in fossil feathers resemble "sausages and meatballs," says Jakob Vinther, at Yale University. Sausage shapes impart black; meatball shapes, red and brown. Both appear in a sample from the cheek feathers of *Anchiornis.*

SEM IMAGE: JAKOB VINTHER
PHOTO: AT SHANDONG TIANYU MUSEUM OF NATURE

MORE

FEATHERED SURPRISES
Dinosaurs come back to life in their true colors on the National Geographic Channel's *Dinomorphosis,* **January 27, 2011, at 8 p.m. ET/PT in the U.S.**

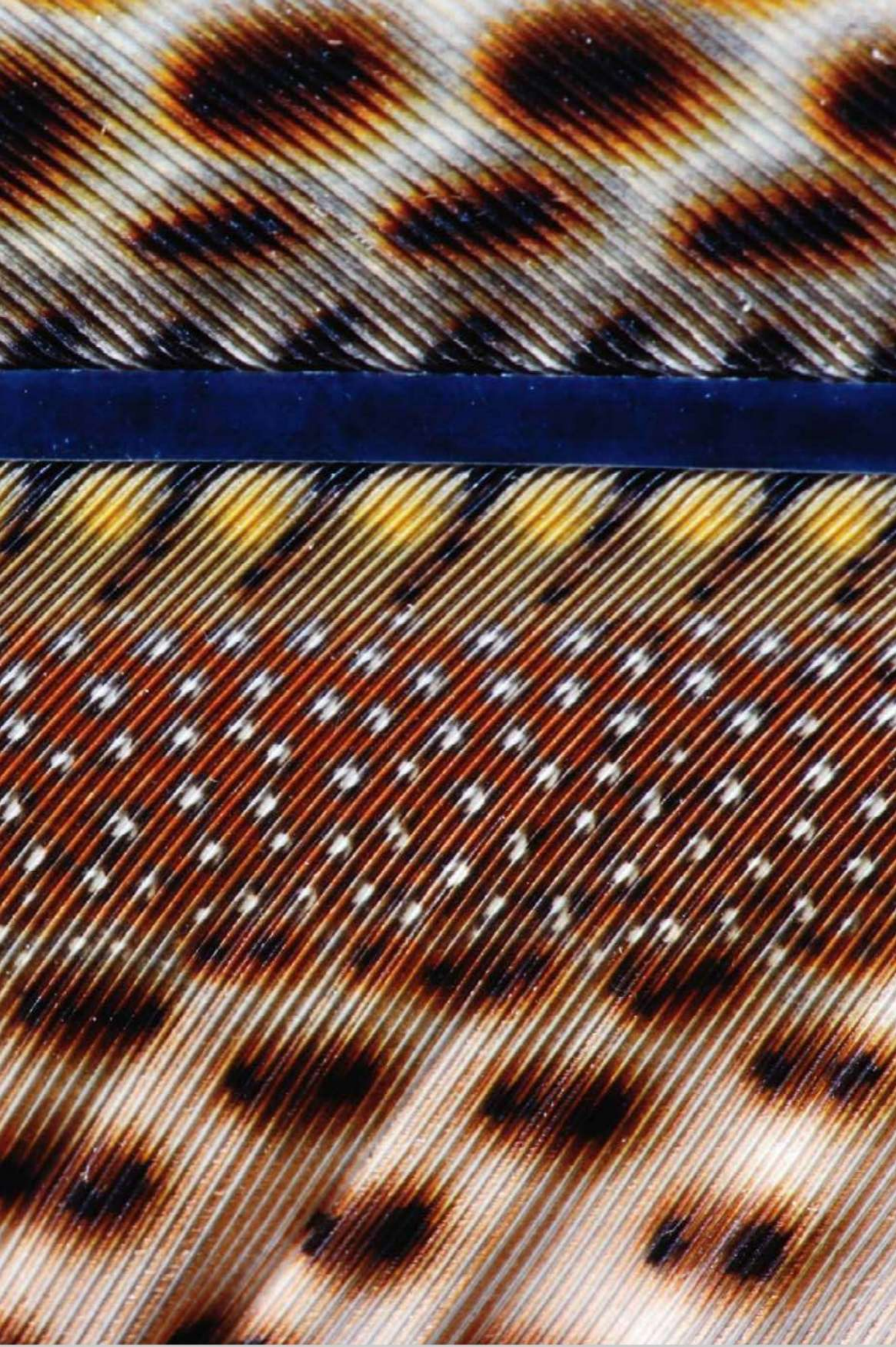


…Vinther and his colleagues decoded the full-body coloration of *Anchiornis* seen here: rusty red crown, dark gray body, and black-and-white-striped wings.

THE EYES HAVE IT

The male great argus of Southeast Asia is a fairly drab pheasant—until he dances before a female with his enormous wing feathers fanned open, revealing the spectacular inner surface shown on this four-inch section. Hundreds of jewel-like ocelli, or eyespots, keep hens enchanted.

AT INSTITUTE OF ZOOLOGY AND ZOOLOGICAL MUSEUM, UNIVERSITY OF HAMBURG



TAKING WING

Scientists now know that feathers evolved long before they were used for flight. How did the transition to powered flight take place?

Luis Chiappe, an expert on early birds at the Natural History Museum of Los Angeles County, suggests that flight likely occurred as a by-product of arm flapping in ground-dwelling dinosaurs, as the predecessors of birds used their feathered arms to increase their running speed or balance themselves as they made fast turns. Over generations, muscles used for such actions evolved to become stronger, bodies smaller and lighter, and feathers longer and more aerodynamic. Eventually the flapping of feathery arms evolved into the repetitive strokes of wings. "Even *Archaeopteryx*, which is often cast as a poor flier, could have taken off from the ground," says Chiappe.

It is also possible that before powered flight, dinosaurs went through a gliding stage, taking advantage of the greater lift associated with the speeds they could achieve by dropping from trees or launching from cliffs. But the old "ground up versus trees down" arguments are likely too simplistic. "The important question is, how did the ancestors of birds employ their hind limbs and forelimbs to negotiate 3-D environments?" says Ken Dial, of the flight lab at the University of Montana-Missoula. "I would argue that everything we need to know about the origin of the flight stroke is right here in front of us in living birds."

OUTTA HERE

Furiously flapping, a chukar partridge speeds up a ramp at the University of Montana flight lab. Studies show that even before a young bird is able to fly, its flapping wings act like a car spoiler, pushing its body down to gain traction when running from predators up steep inclines—a clue perhaps to how flight first evolved.

Video

VIDEO: UM FLIGHT LAB

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VIDEO: UM FLIGHT LAB

FEATHER EXPERIMENTS

The fossils of feathered nonavian dinosaurs (the three at left) and early birds (at right) from northeast China's Liaoning Province are all about 125 million years old, but they show different approaches to feathers and flight. Because they lived at the same time, sorting out stages in the evolution of flight is difficult.

Sinosauropteryx
Colorful banding in the tail feathers suggests they were for camouflage or communication.

Caudipteryx
Broad feathers in running dinosaurs may have provided bursts of speed or been simply for display.

Microraptor
This dromaeosaur's feathered legs may have acted like airfoils, providing lift for gliding from trees.

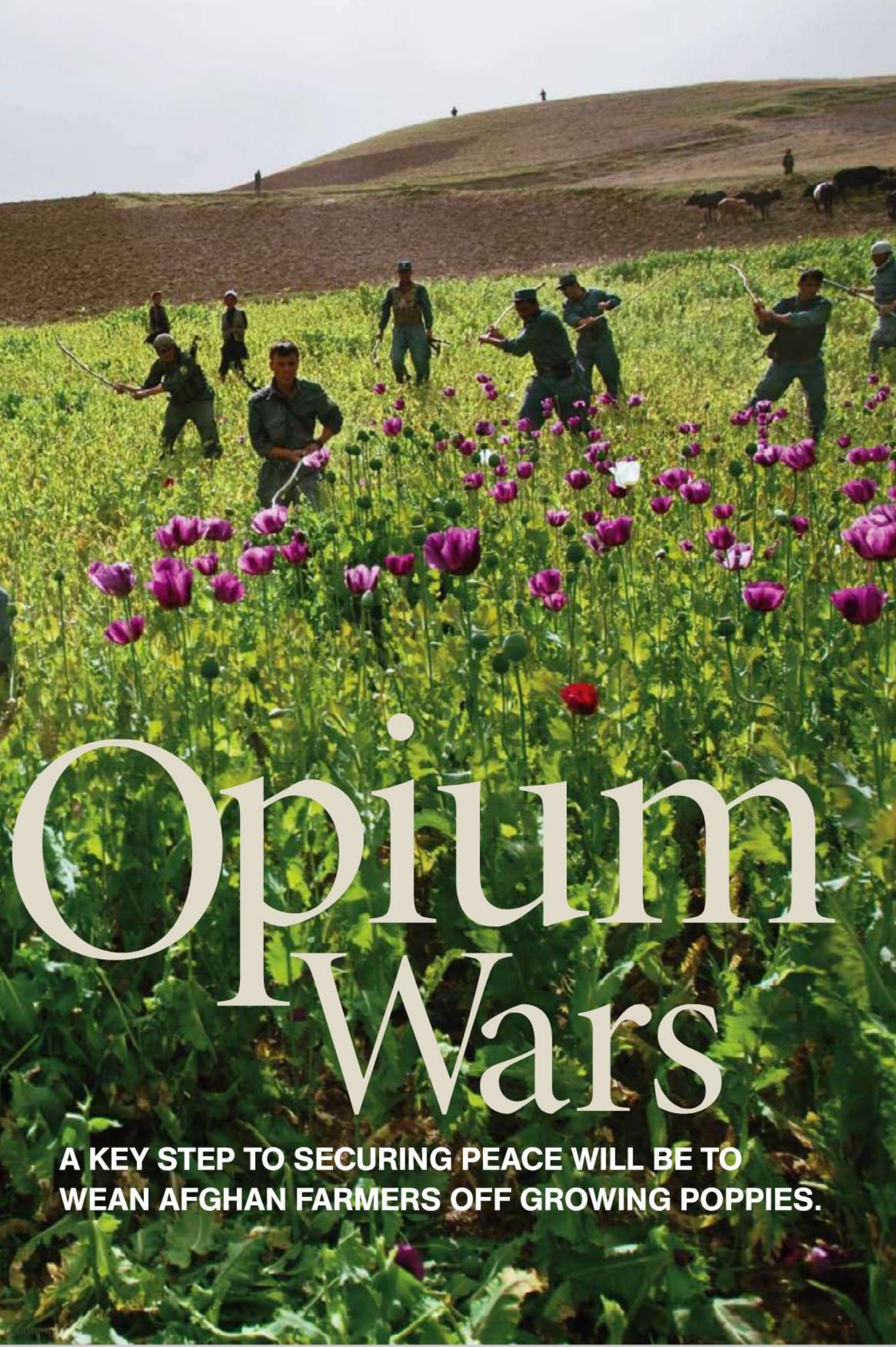
Jeholornis
This early bird was likely a powerful flier. Its long tail could have been used as a rudder or an airfoil.

POISED FOR FLIGHT

The wings of a *Confuciusornis* (far right) and a modern cock of the rock (below) convey the evolutionary distance traveled since the origin of flight. *Confuciusornis* and other early birds retained primitive claws on their wings that may have been used for climbing or predation; narrow feathers and weak flight muscles suggest it was not a powerful flier. In contrast, the male cock of the rock's wing is designed for agility and tricked up for display. A tiny feathered "thumb," the alula, improves flight control. The protruding shaft on the first wing feather makes a loud, rustling sound—adding acoustics to the visual display.

CONFUCIUSORNIS SANCTUS, 125 TO 120 MYA, CHINA
AT PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY (ABOVE); AT SHANDONG TIANYU MUSEUM OF NATURE (RIGHT)

Afghan police use sticks to destroy a poppy field in Badakhshan Province. Despite such efforts, Afghanistan is the world's top opium supplier.



Opium Wars

A KEY STEP TO SECURING PEACE WILL BE TO WEAN AFGHAN FARMERS OFF GROWING POPPIES.

Opium addiction is epidemic in Sar Ab, a village in Badakhshan. “My whole family is addicted,” says Juma Gul (at right), smoking opium with a friend as his daughters sit nearby. “But so are the mice, the snakes.” Opium is often used as medicine in remote areas with no health care.

A marine's handheld digital device scans the iris of a farmer who cultivates poppies in Helmand Province, where most of Afghanistan's opium is grown. Coalition personnel use the scans and other biometric measurements to create identity cards that they compare against a security database.

Poppies are illegal to grow but more lucrative for Afghan farmers than most other crops. At harvest, each bulb is scored to release a purplish gum. Once dry, the resin is scraped off with a metal tool and formed into raw opium bricks.

BY ROBERT DRAPER

PHOTOGRAPHS BY DAVID GUTTENFELDER

The chief of police

has a memorable way of demonstrating that he's not afraid of the drug smugglers. He holds up his right hand, revealing the absence of his middle finger. Four years ago, Brig. Gen. Aqa Noor Kintuz was hired as provincial chief of police in the northeastern Afghan province of Badakhshan and charged with destroying its plentiful poppy fields. "After I finished one of the first eradications," he says, "my vehicle was blown up by a remote-control bomb." He rolls up his right shirtsleeve. His forearm is badly mangled. In the years since, he has received innumerable death threats. Women *(Touch* Text *button to read more.)*

Robert Draper is a contributing writer. Photographer David Guttenfelder has covered Afghanistan for the past nine years.

Text

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PHOTOGRAPHS BY DAVID GUTTENFELDER

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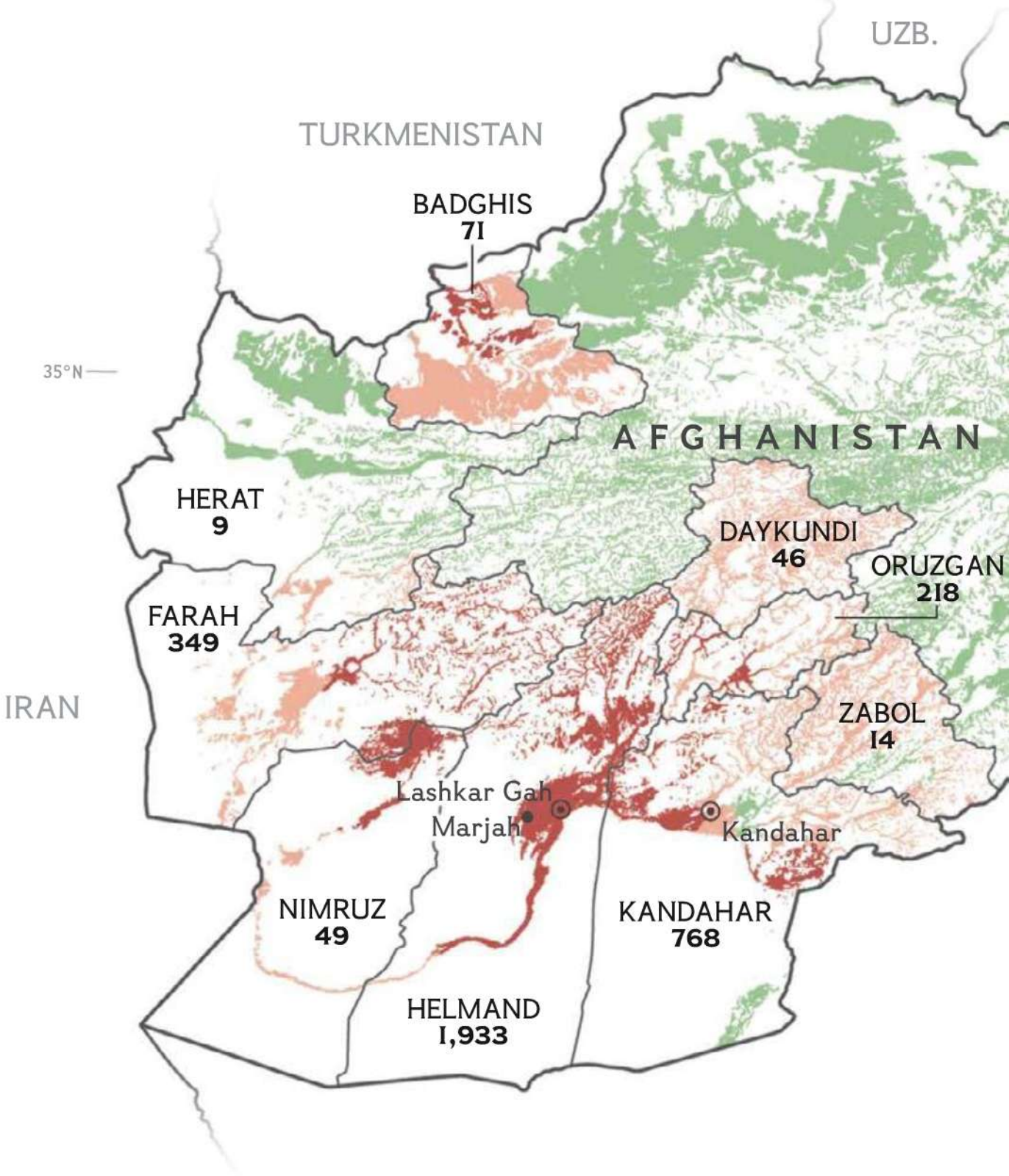
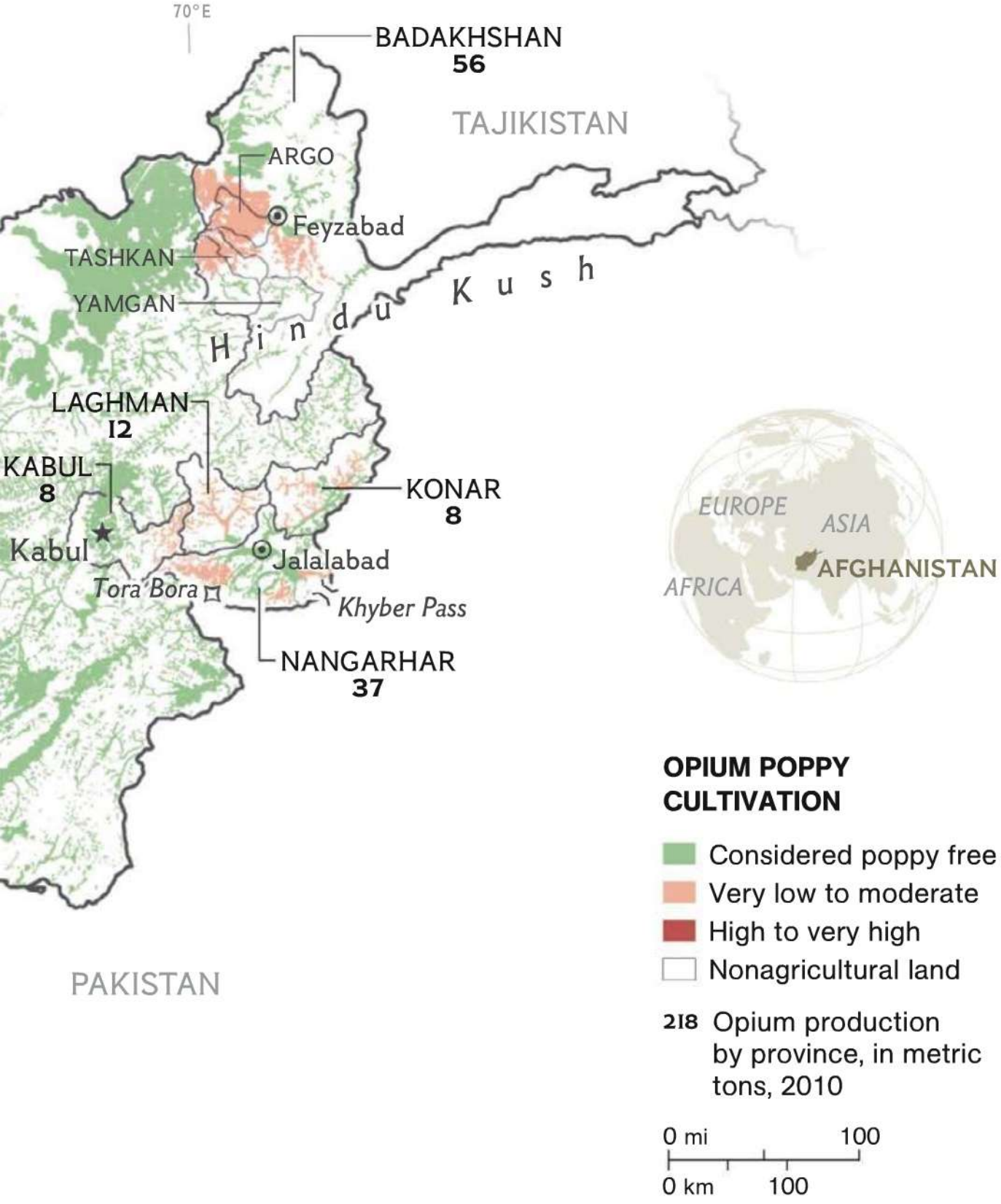
Robert Draper is a contributing writer. Photographer David Guttenfelder has covered Afghanistan for the past nine years.

D I N G

Opium Harvest

Years of war and upheaval that began with the 1979 Soviet invasion have made the opium poppy the mainstay of Afghanistan's largely agricultural economy. The country produces more than 80 percent of the world's illegal opium, generating as much as $4 billion a year.



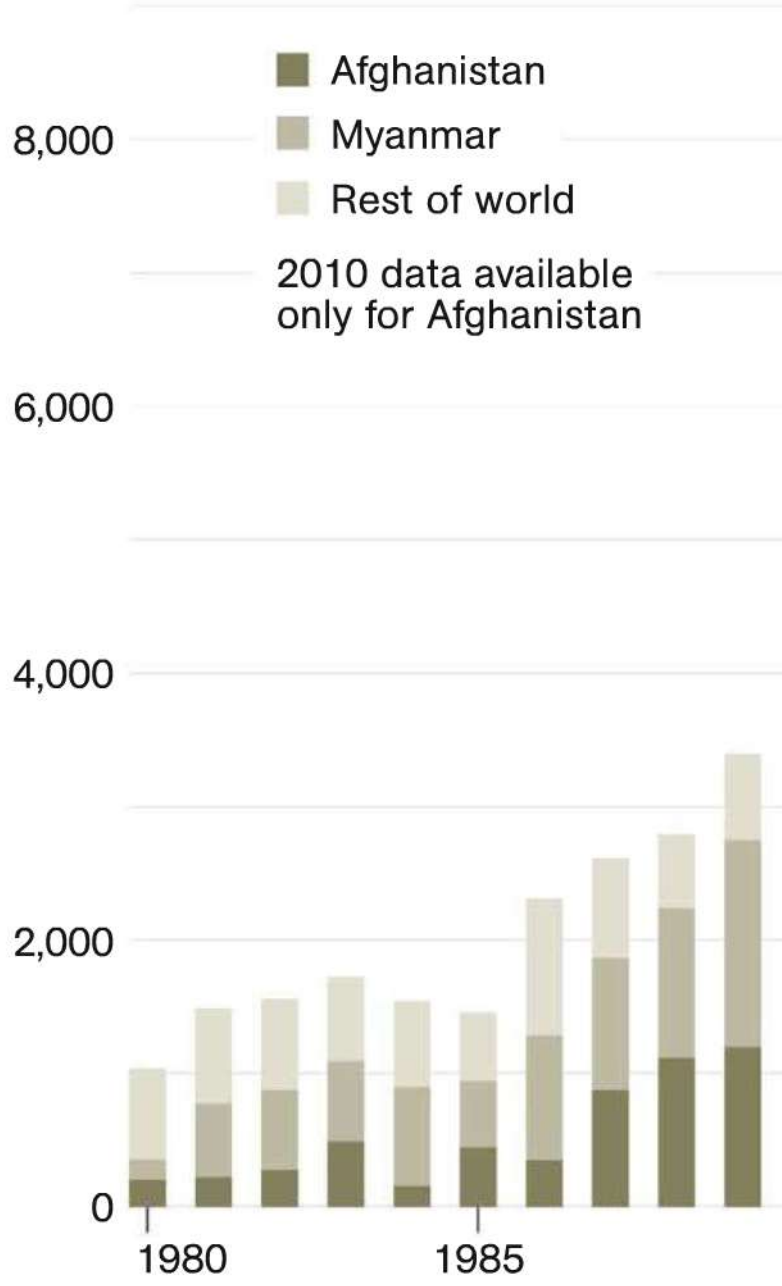


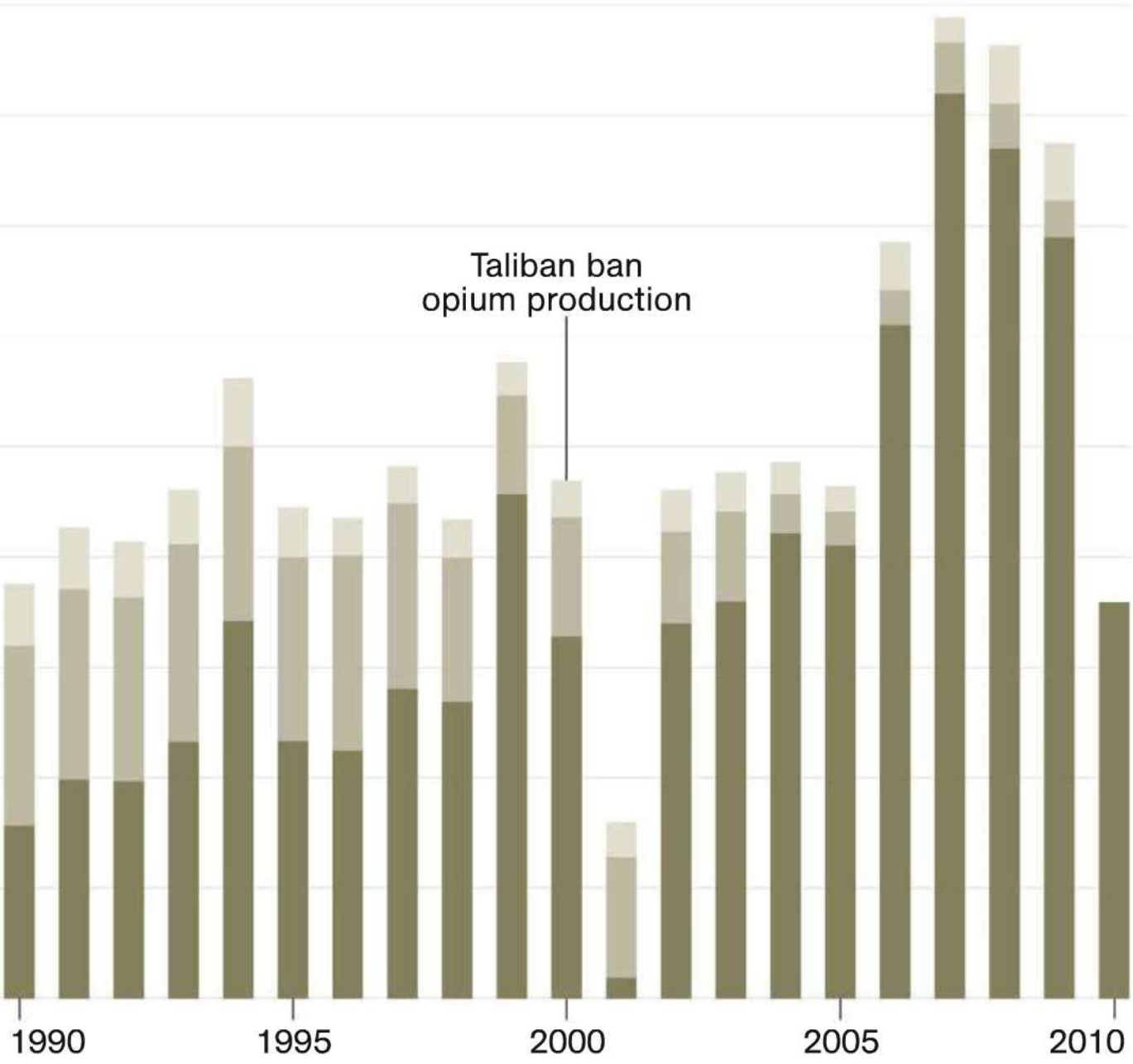
JEROME N. COOKSON AND MARGUERITE B. HUNSIKER, NGM STAFF
SOURCE: ILLICIT CROP MONITORING PROGRAMME, UNITED NATIONS OFFICE ON DRUGS AND CRIME

ILLICIT OPIUM PRODUCTION

1980-2010, in metric tons

Afghanistan overtook Myanmar as top producer of illicit opium in 1991 and is expected to hold that spot even though its 2010 crop was halved by frost and disease. When cultivation plummeted after the Taliban banned poppy growing in 2000, stockpiled opium is thought to have sustained sales. Recent years of bumper production may have swelled stockpiles beyond 13,000 tons.





JEROME N. COOKSON AND MARGUERITE B. HUNSIKER, NGM STAFF
SOURCE: ILLICIT CROP MONITORING PROGRAMME, UNITED NATIONS OFFICE ON DRUGS AND CRIME

The Hindu Kush mountains create hellish terrain for International Security Assistance Force troops but offer protection for poppy farmers and hidden highways for smugglers. Illicit trade routes deliver opium to Russia and Europe; with 1.5 million addicts, Russia is the largest consumer of heroin.

A mother (in red scarf) and her children weep as Afghan policemen flatten her poppy field during a raid in northeastern Afghanistan. The woman's husband was killed by insurgents, she says, and poppies are her only income.

"The Taliban's involvement with the drug mafia shows they don't want a truly Islamic government.

—Maulawi Abdul Wali Arshad, religious director of Badakhshan Province

Sunlight pours through shrapnel holes in a shipping container in Kabul's Old City (left), where users gather for a hit of opium. Eight percent of Afghans are addicted to drugs, often opium or heroin, a rate that has risen sharply in the past five years. Only one in ten addicts receives any drug treatment, because programs are rare and underfunded. At the 40-bed Jangalak center, also in the capital, recovering addicts celebrate after a two-month rehabilitation program.

Eradication patrols have cut poppy production in several provinces, but high opium prices just push farmers into less accessible territory, like the mountains of Argo district. The Taliban support poppy growth and enforce a tax on opium. Their cut, up to $400 million a year, funds the insurgency.

Marines unload fertilizer in the Marjah district of Helmand Province as part of a program encouraging farmers to renounce poppies for alternative crops like corn and beans. The goal is to bolster agriculture rather than destroy poppy fields.

Today more than six million Afghans lack enough to eat. Instead of direct food handouts, some aid groups are providing high-quality seeds, so wheat farms like this one near Kabul can increase yields.

"They'll keep growing poppies here—unless they're forced not to. Force is the solution for everything."

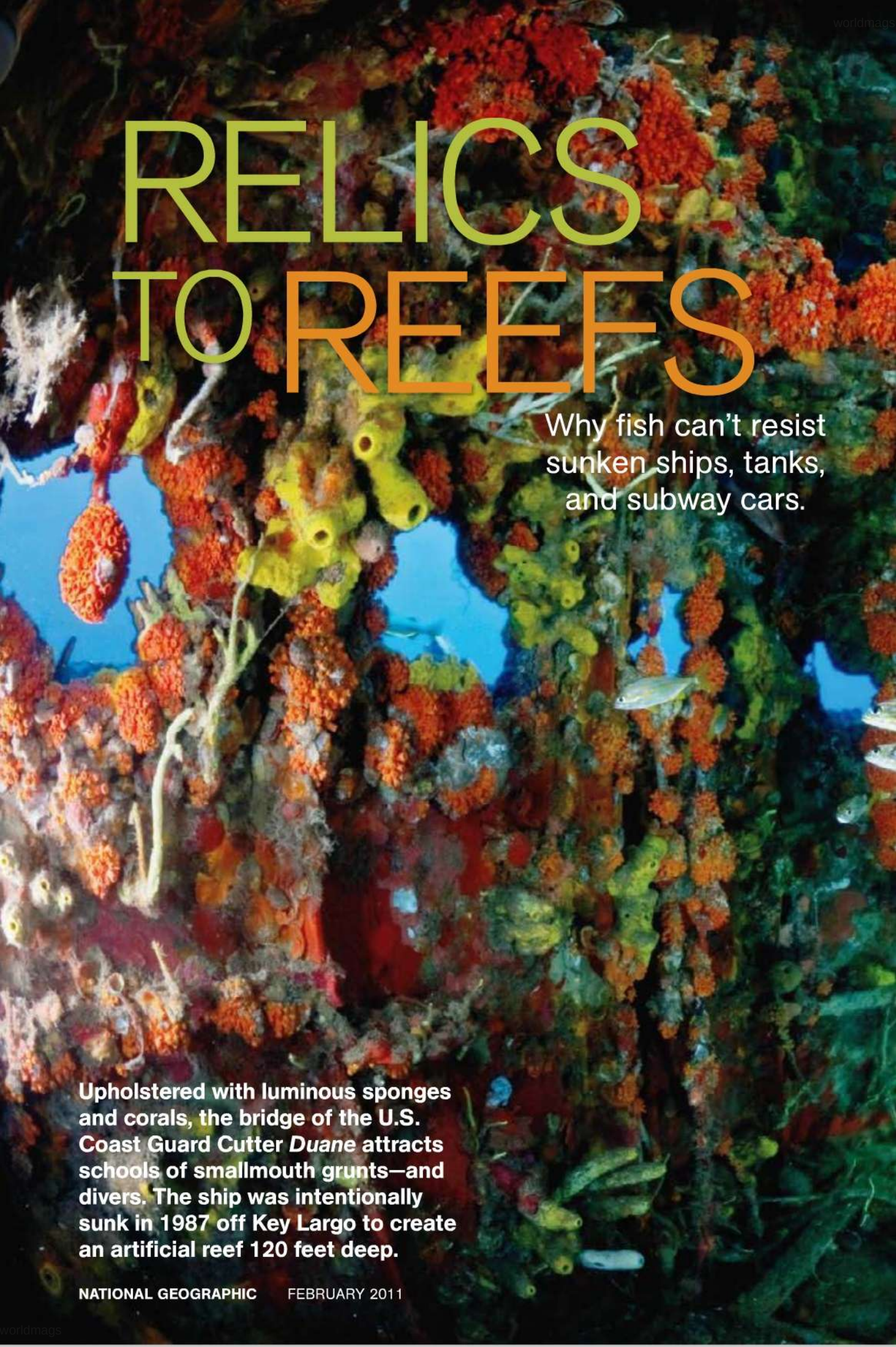
—Rehmatou, a 33-year-old farmer in Helmand Province

Afghan farmers were once known for their pomegranates, grapes, and apricots, like these being sold at a market in Kabul (left). Today aid groups promote the growth of such high-value crops by improving irrigation or refurbishing markets such as this one in Jalalabad funded by USAID.

At Camp Hanson, in Marjah, a marine rests near an elder awaiting news of his son, arrested for allegedly building roadside bombs. Restoring security will depend in part on reviving a once thriving agricultural economy—one that does not depend on opium.

RELICS TO REEFS

Why fish can't resist sunken ships, tanks, and subway cars.



Upholstered with luminous sponges and corals, the bridge of the U.S. Coast Guard Cutter *Duane* attracts schools of smallmouth grunts—and divers. The ship was intentionally sunk in 1987 off Key Largo to create an artificial reef 120 feet deep.

This M60 is one of a hundred tanks sunk in 1994 in a 1,200-square-mile zone of artificial reefs off the coast of Alabama. The 50-ton tanks survive hurricanes better than lighter, less stable objects.

BY STEPHEN HARRIGAN
PHOTOGRAPHS BY DAVID DOUBILET

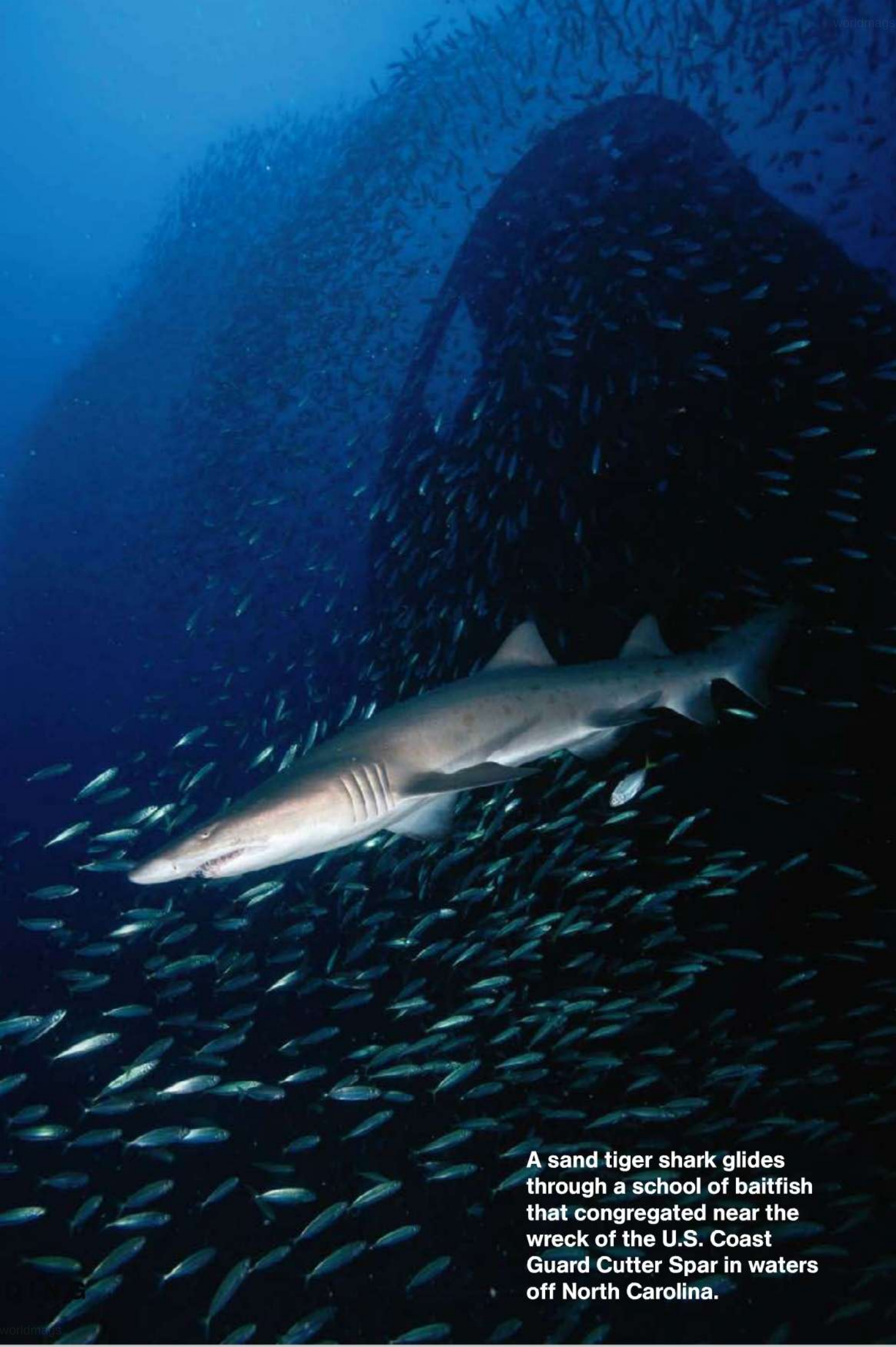
It took just over two minutes for the missile-tracking ship *General Hoyt S. Vandenberg* to sink to the bottom of the ocean. On a clear morning in May 2009, seven miles off Key West, a series of hollow booms erupted from inside the vessel's hull, where 46 explosive charges had been buried deep below the waterline. The sharp smell of gunpowder drifted on the breeze, and an obscuring veil of black smoke began to rise, but for a long moment the ship didn't seem to register the shock. She just hung there level in the water, 523 feet long, a rusting, decommissioned hulk with two useless radar dishes that towered above the ocean surface.

Then, as news helicopters circled above and thousands of onlookers watched from boats idling beyond the blast zone, the *Vandenberg* slowly hitched downward into the Atlantic, remaining perfectly horizontal until finally the bow dropped and the stern rose, leaving nothing but a roiling *(Touch* Text *button to read more.)*

Stephen Harrigan is a journalist and novelist living in Austin. Underwater photographer David Doubilet co-authored Face to Face With Sharks.

A sand tiger shark glides through a school of baitfish that congregated near the wreck of the U.S. Coast Guard Cutter Spar in waters off North Carolina.

Text

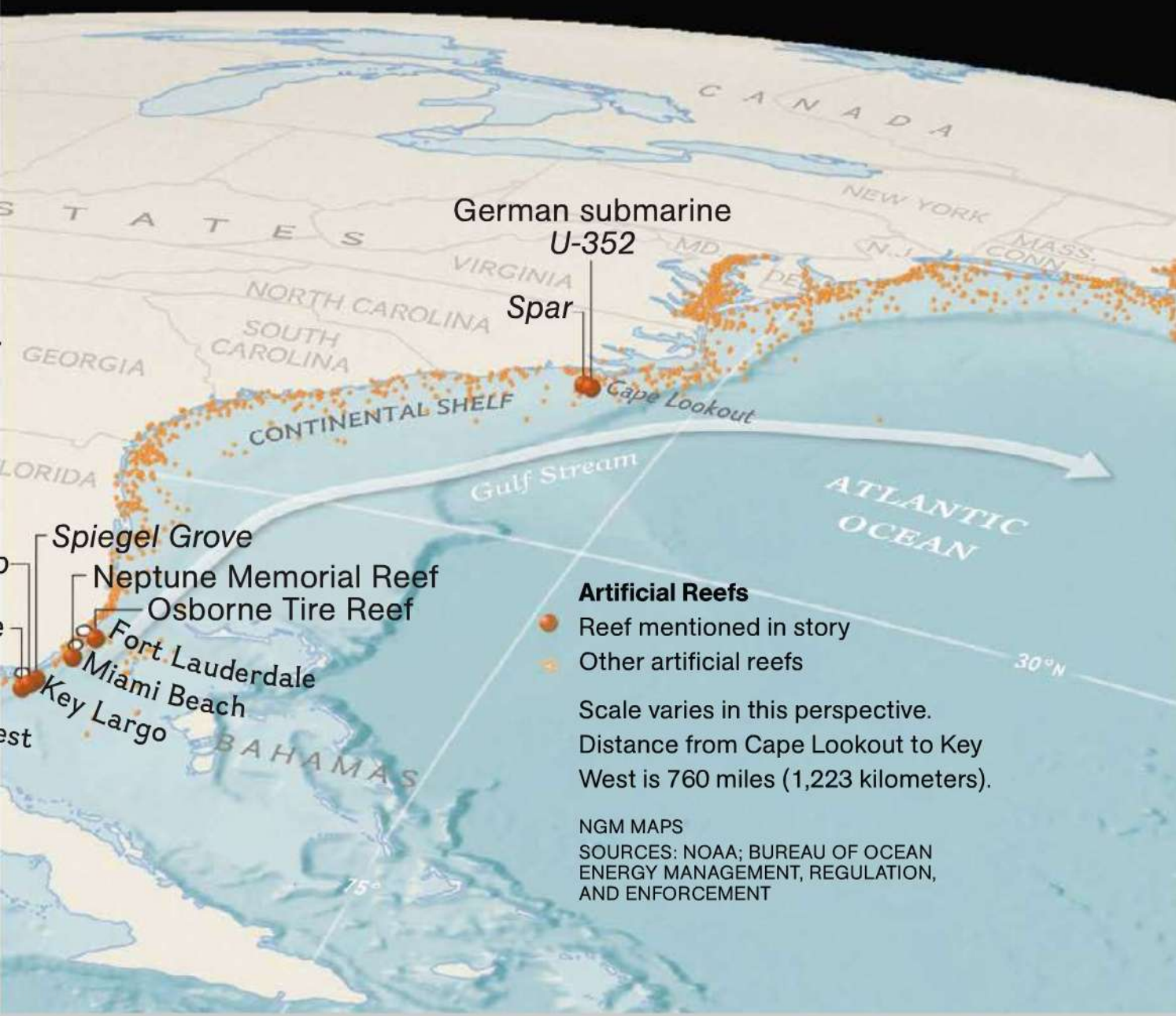


A sand tiger shark glides through a school of baitfish that congregated near the wreck of the U.S. Coast Guard Cutter Spar in waters off North Carolina.

The muzzle of an M60 tank makes a cozy home for a whitespotted soapfish off Alabama. Reefs provide small fish protection from predators.

Buried Treasures

Ships, tanks, tires, and subs have been transformed into artificial reefs all along the Gulf and Atlantic coasts. Ships that are intentionally submerged must follow the strict guidelines of the U.S. government's National Artificial Reef Plan.

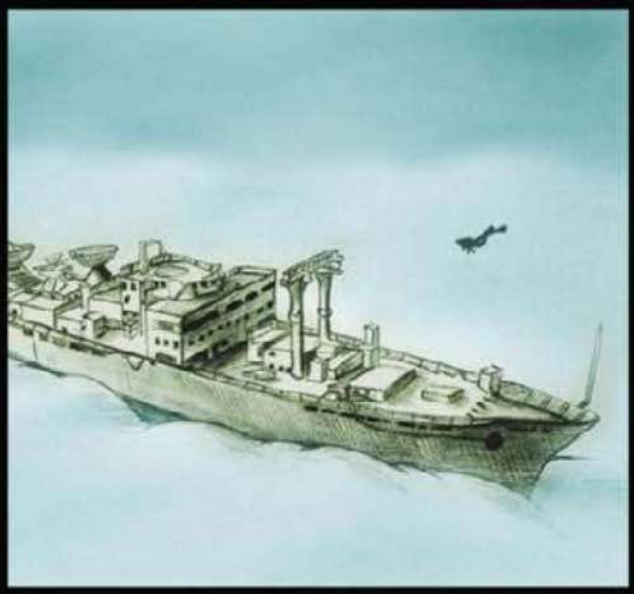

CANADA
NEW YORK
MASS.
CONN.
N.J.
MD.
DEL.
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
German submarine
U-352
Spar
Cape Lookout
CONTINENTAL SHELF
Gulf Stream
ATLANTIC OCEAN
Spiegel Grove
Neptune Memorial Reef
Osborne Tire Reef
Fort Lauderdale
Miami Beach
Key Largo
BAHAMAS
30°N
75°
Artificial Reefs
Reef mentioned in story
Other artificial reefs
Scale varies in this perspective.
Distance from Cape Lookout to Key West is 760 miles (1,223 kilometers).
NGM MAPS
SOURCES: NOAA; BUREAU OF OCEAN ENERGY MANAGEMENT, REGULATION, AND ENFORCEMENT

Bottom Dwellings

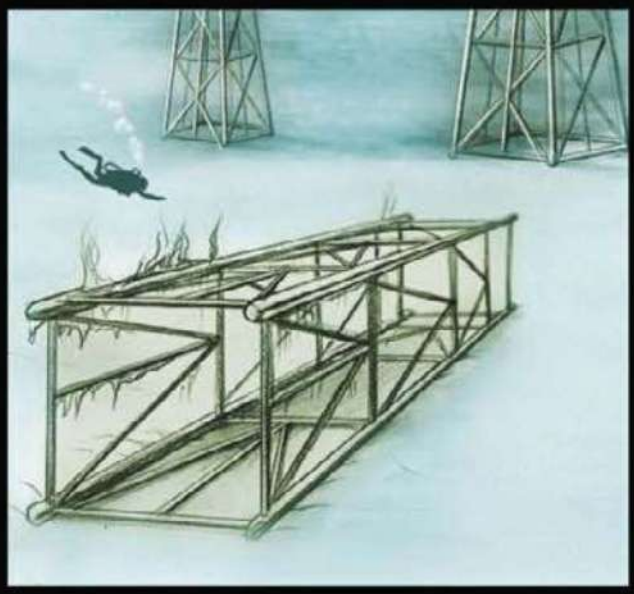
Just about any object can become an artificial reef, from intentionally sunk boats, rigs, and trains to warships torpedoed in the heat of battle. Once underwater, they provide a habitat that attracts fish and may nurture the growth of coral.

Reef Balls are engineered, hollow, concrete structures 1.5 to 6.5 feet across. Some have a rough surface designed to promote the growth of corals and algae.

Subway cars and other defunct transport vehicles have been deployed as reefs off East Coast states. Their structures can remain intact for nearly 20 years.



Large sunken ships with strong hulls can last for decades on the seafloor, luring not only sea life but also adventurers seeking a dive through history.



Oil and gas rigs provide habitat among their frameworks; thousands of them line the Gulf coast. The legs of rigs no longer in use can be toppled to preserve the reefs.

ART: SHIZUKA AOKI

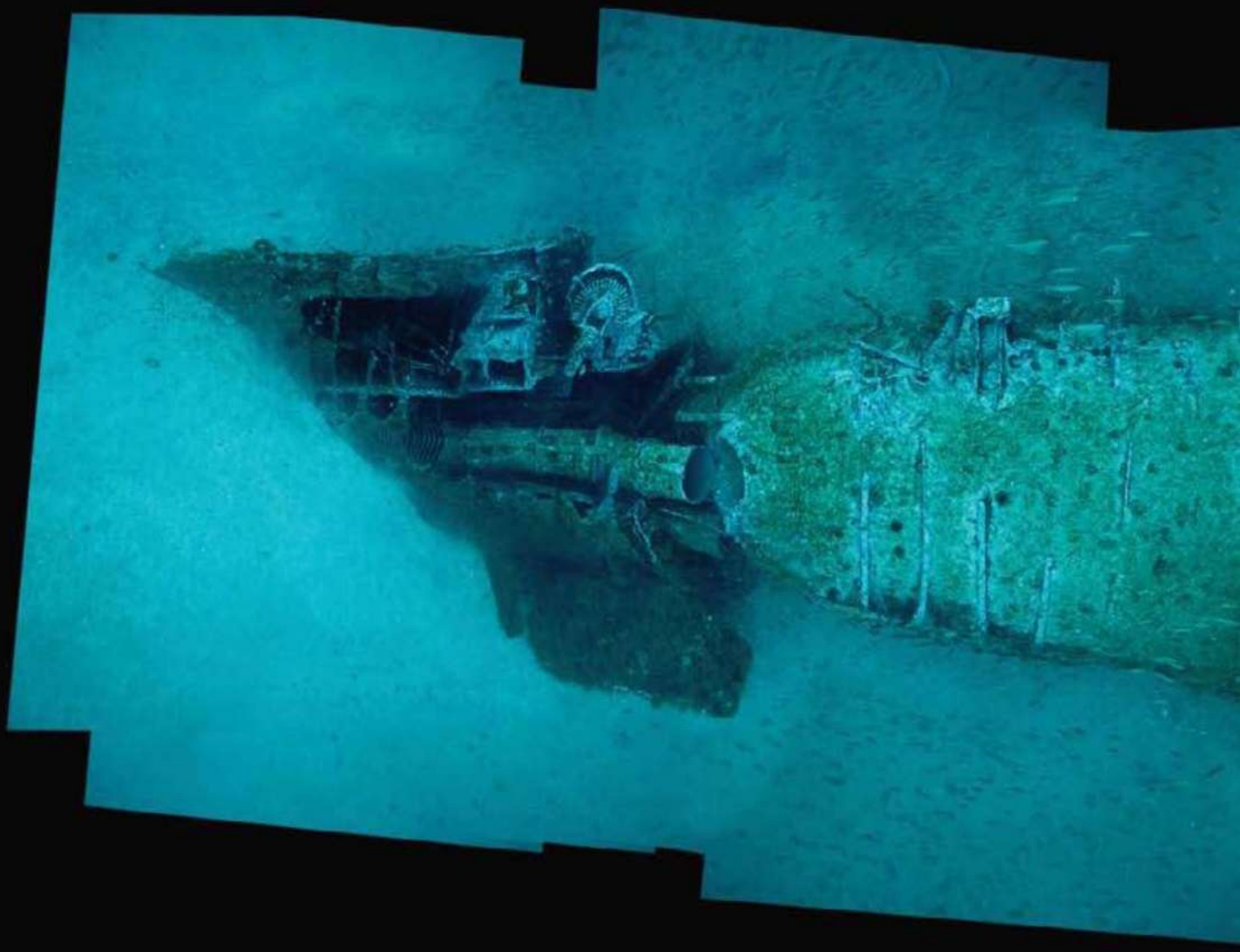
On May 27, 2009, the *General Hoyt S. Vandenberg* was sunk to create an artificial reef. It landed perfectly upright.

▶ Video

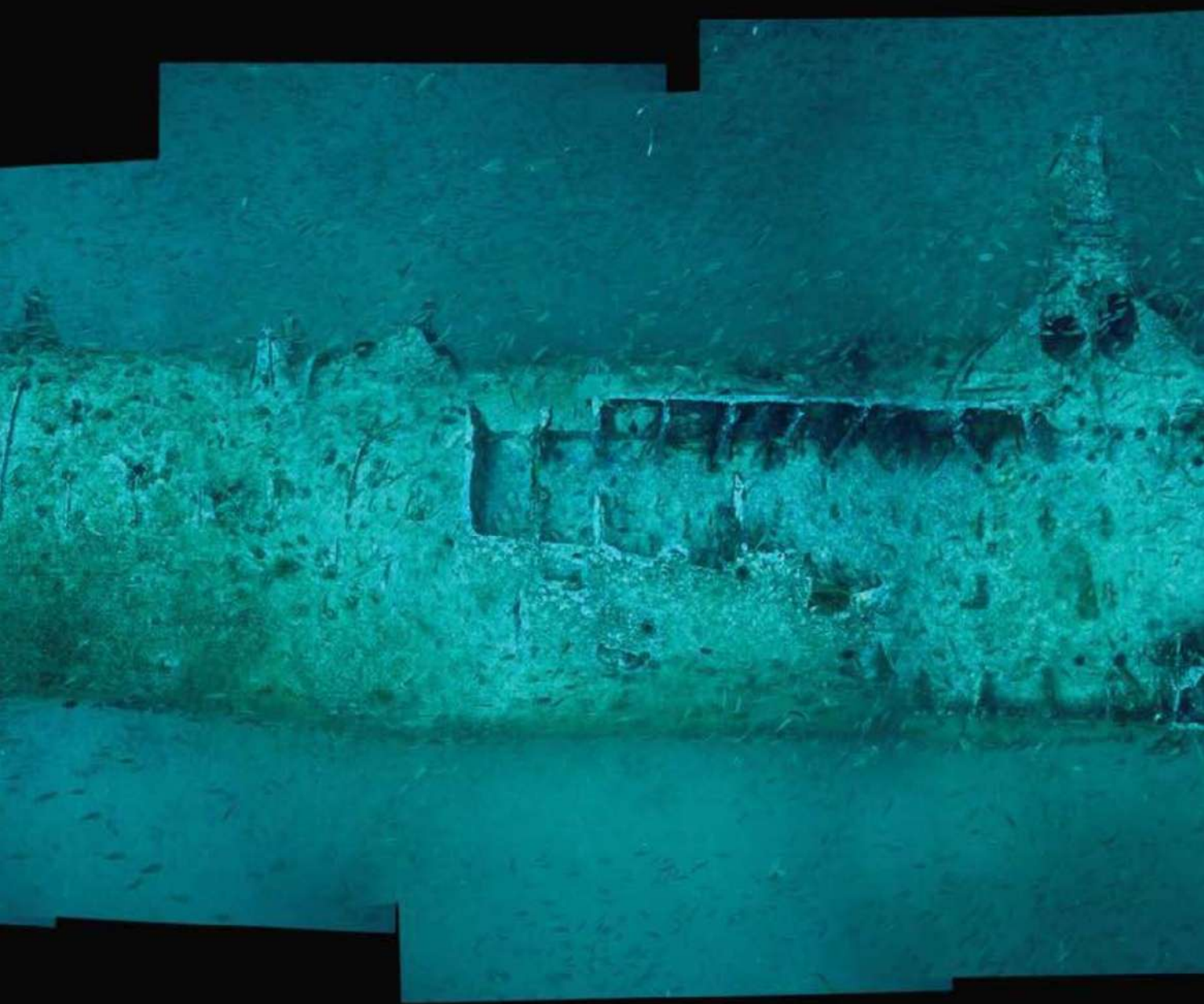
Watch how fast the ship sinks.

DING

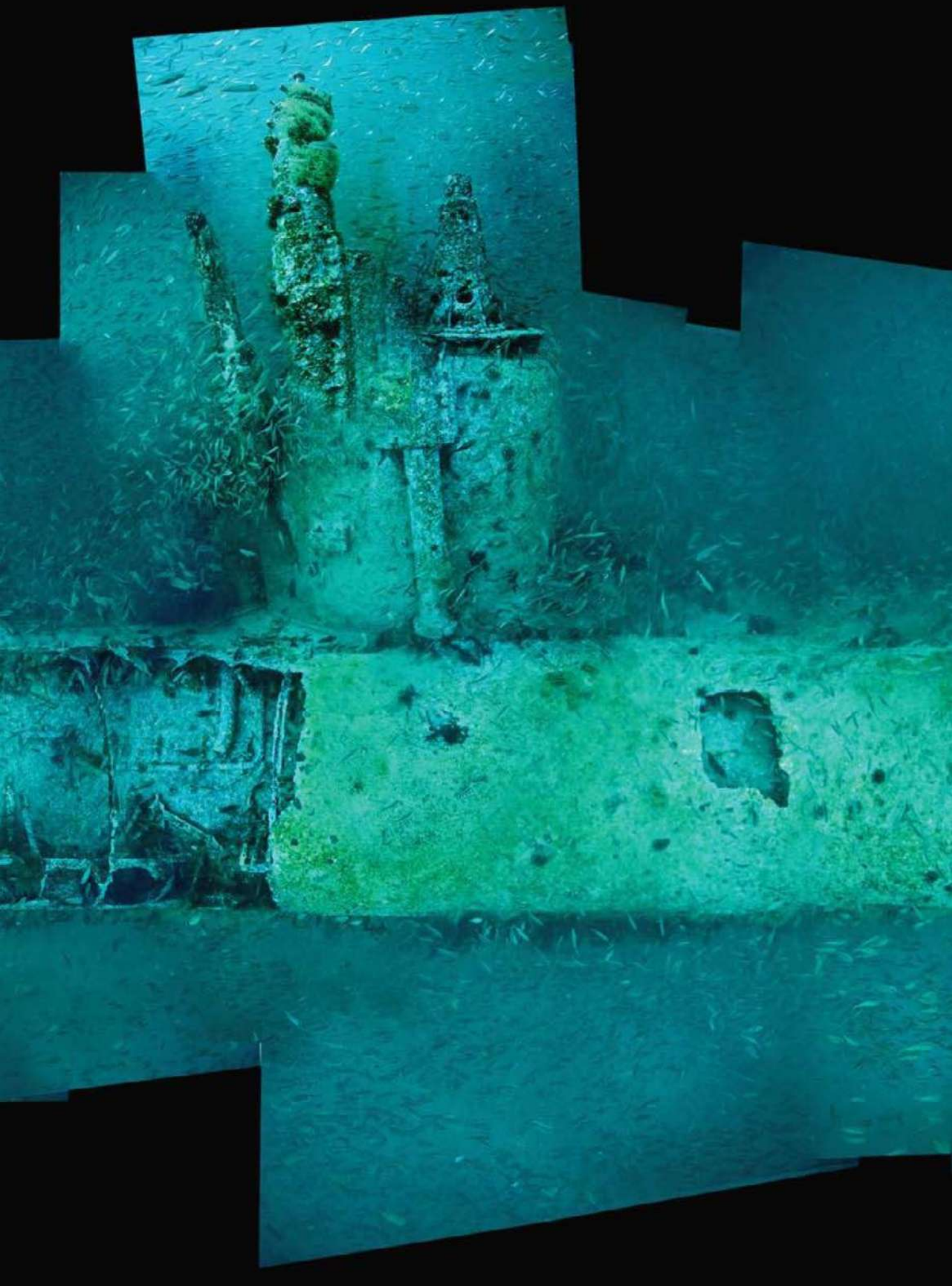
Fish swarm the bared ribs of the German submarine U-352, sunk by the U.S. Coast Guard off Cape Lookout, North Carolina, during World War II. Today the 220-foot wreck sits about 110 feet deep in clear Gulf Stream waters and is sometimes obscured from view by fish.

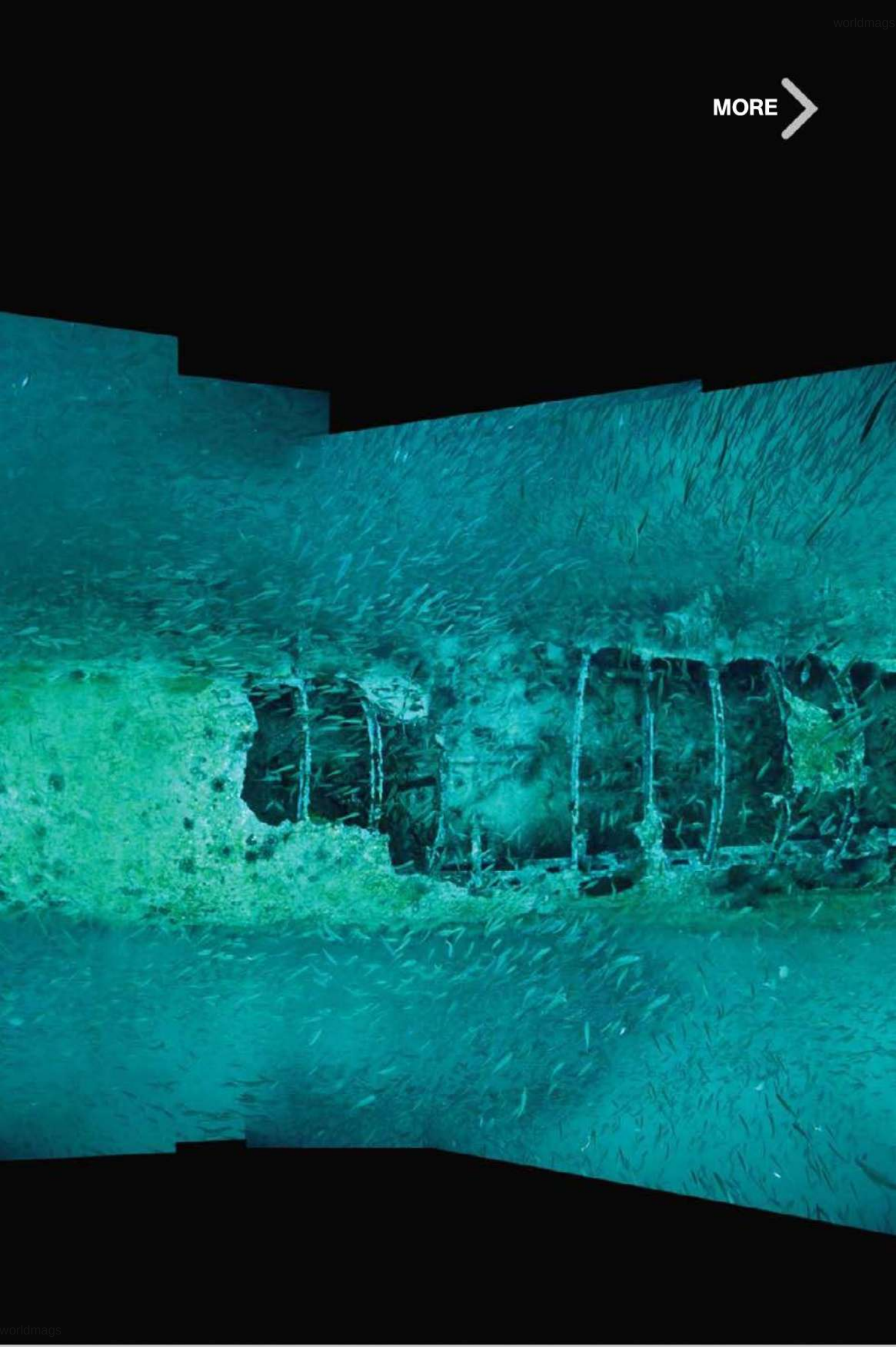


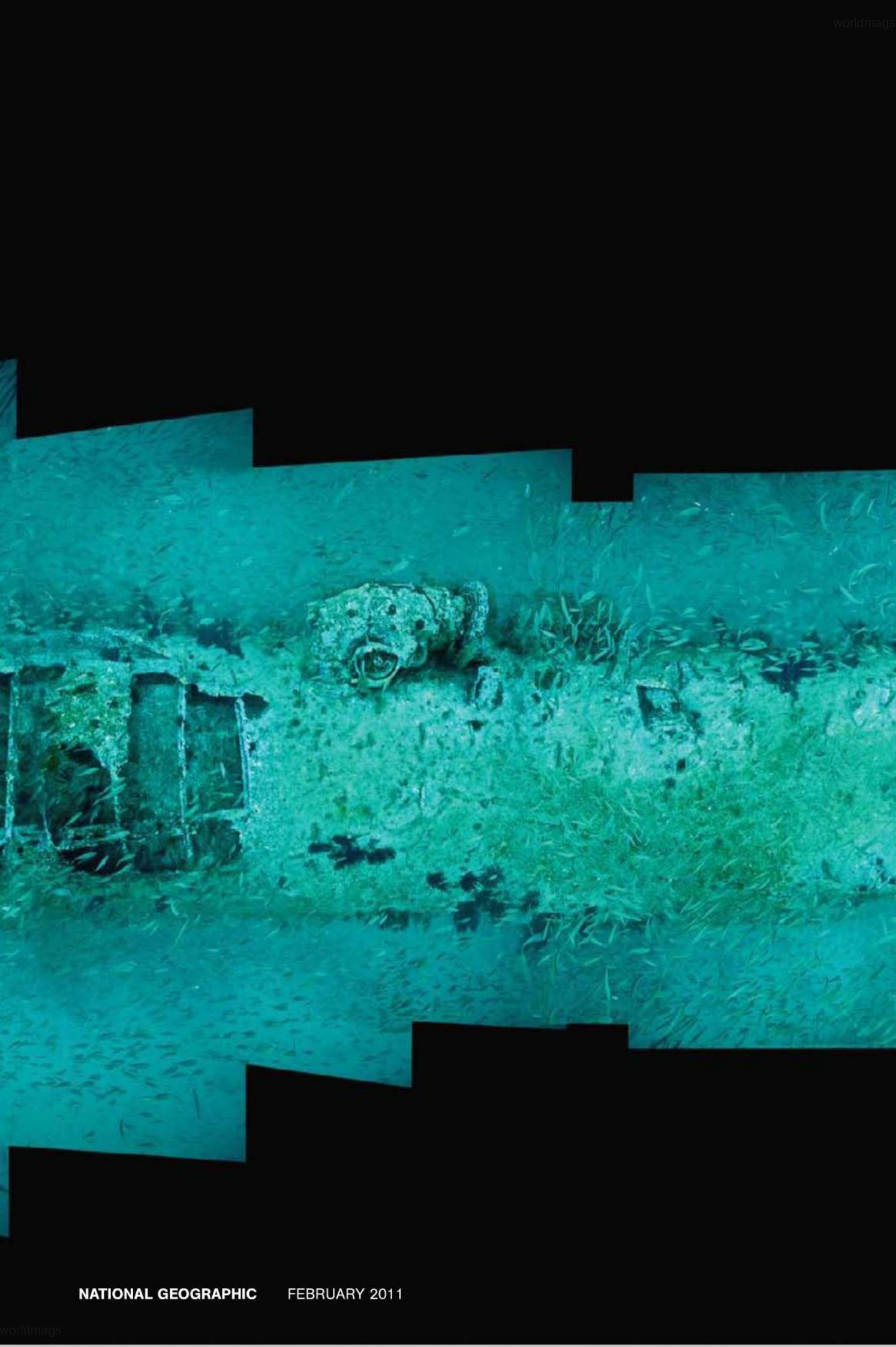
MORE

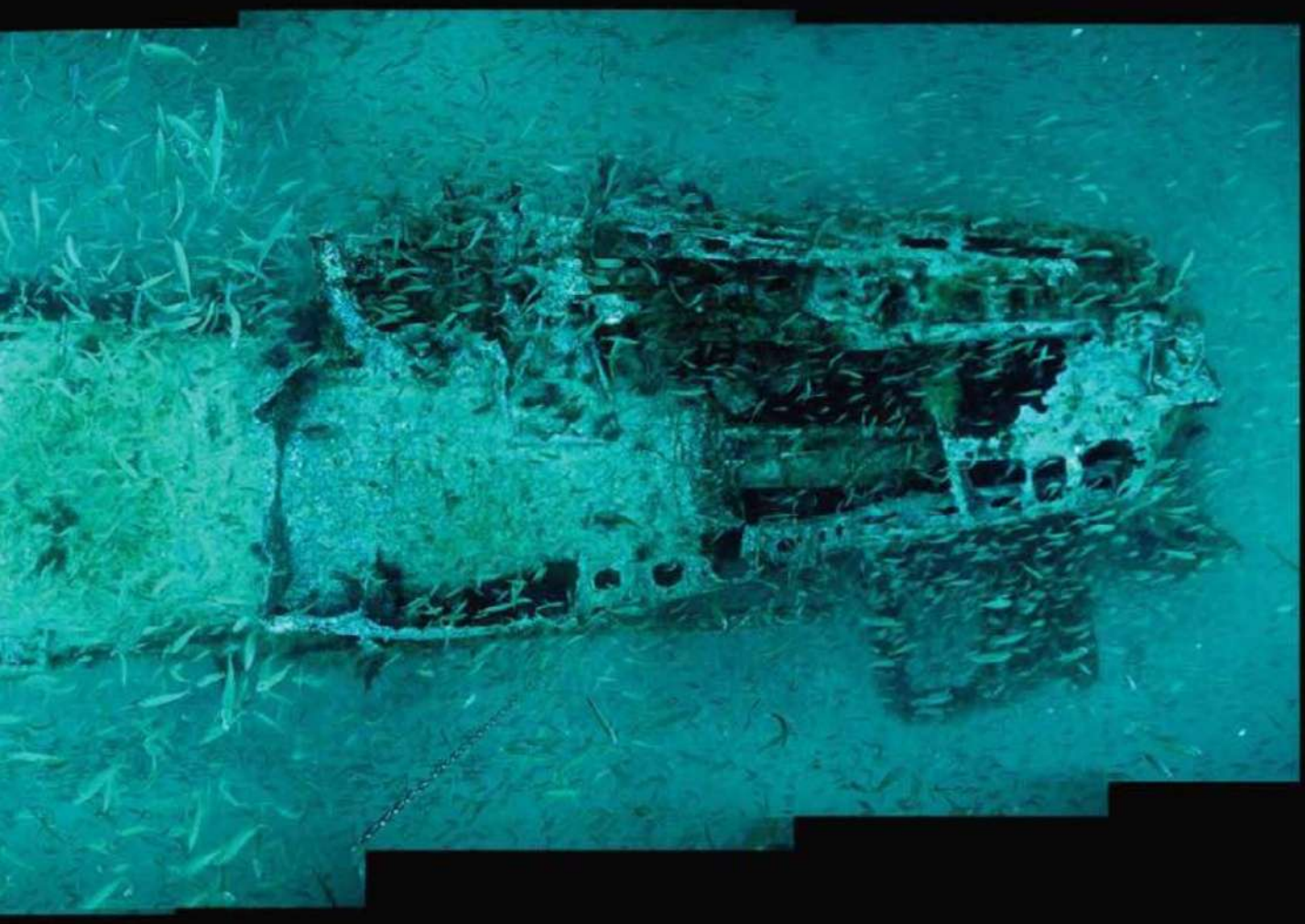


MOSAIC COMPOSED OF 33 IMAGES BY DAVID DOUBILET AND HAL SILVERMAN



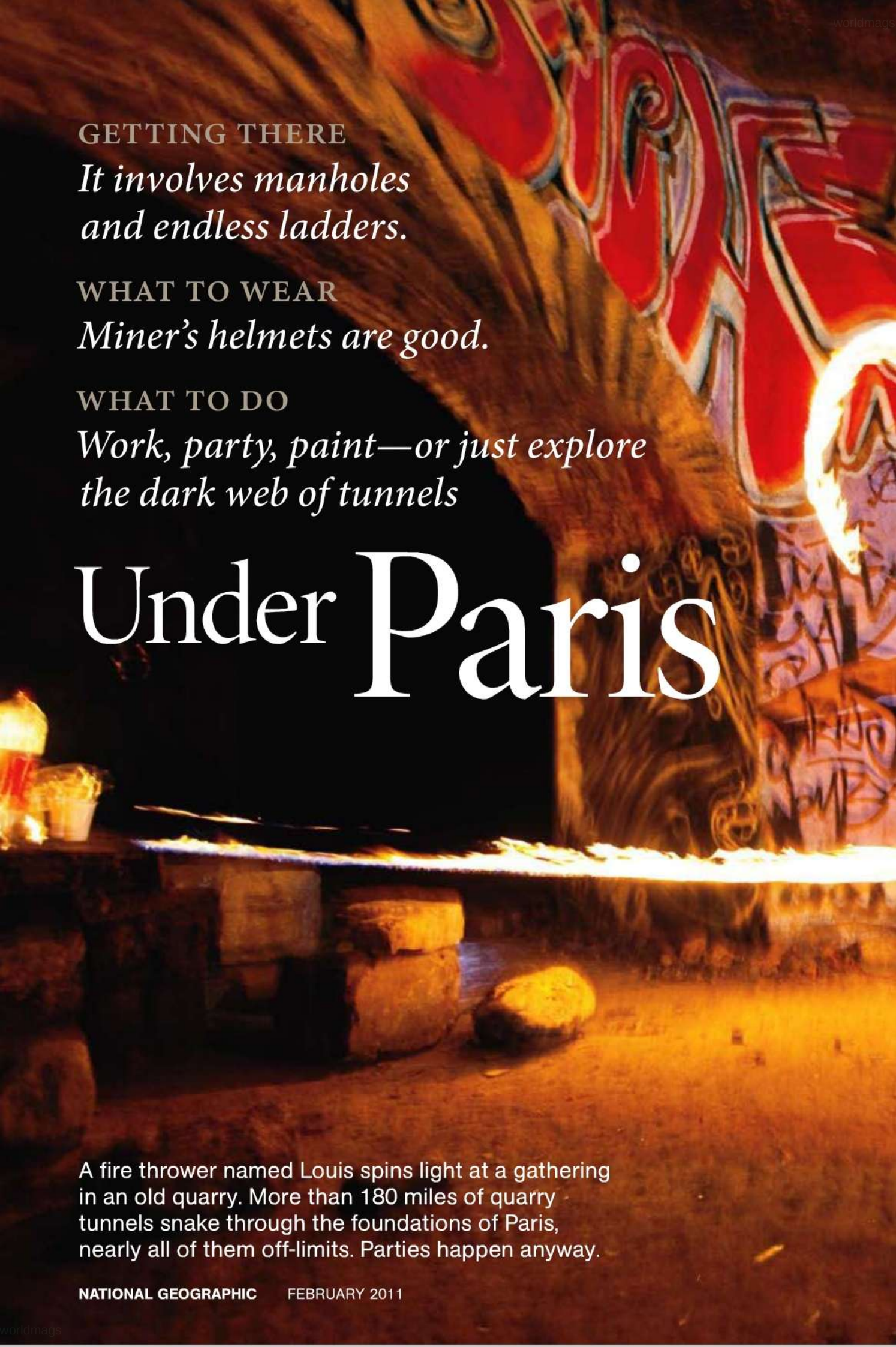






In the Gulf of Mexico, steel pillars supporting a gas platform are encrusted with tube sponges.

Tomtate grunts and yellowtail snapper swim through Neptune Memorial Reef, an underwater cemetery with decorative arches and columns installed on the ocean floor off Miami Beach. The cremated remains of about 200 people have been mixed with cement and molded into memorial sculptures.



GETTING THERE

It involves manholes and endless ladders.

WHAT TO WEAR

Miner's helmets are good.

WHAT TO DO

Work, party, paint—or just explore the dark web of tunnels

Under Paris

A fire thrower named Louis spins light at a gathering in an old quarry. More than 180 miles of quarry tunnels snake through the foundations of Paris, nearly all of them off-limits. Parties happen anyway.


LSD

MOSAIC COMPOSED OF 22 IMAGES

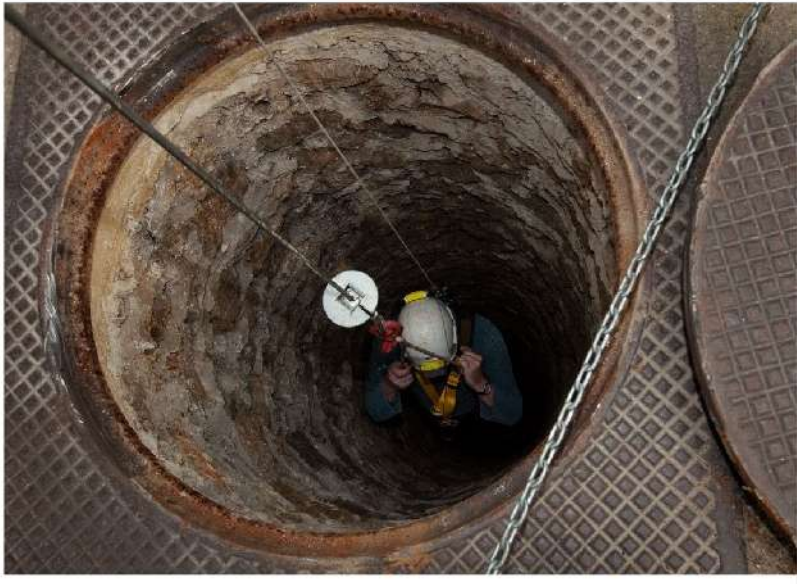
Light Touches Dark Night falls on the famously well lit city, which spreads out over an underground labyrinth of immense scope and some danger.

Phantom Fish A small pond lies under the Opéra Garnier, the old opera house, in addition to the Métro. Created during construction in the 1860s to contain water that flooded the foundation pit, the pond is inhabited by large fish, which are fed by opera employees.

BY NEIL SHEA
PHOTOGRAPHS BY STEPHEN ALVAREZ

THE CAB GLIDES THROUGH SATURDAY MORNING. The great avenues are quiet, the shops closed. From a bakery comes the scent of fresh bread. At a stoplight a blur of movement draws my attention. A man in blue coveralls is emerging from a hole in the sidewalk. His hair falls in dreadlocks, and there is a lamp on his head. Now a young woman emerges, holding a lantern. She has long, slender legs and wears very short shorts. Both wear rubber boots, both are smeared with beige mud, like a tribal decoration. The man shoves the iron cover back over the hole and takes the woman's hand, and together they run grinning down the street.

Paris has a deeper and stranger connection to its underground than almost any city, and that underground is one of the richest. The arteries and intestines of Paris, the hundreds of miles of tunnels that make up some of the oldest and densest subway and sewer networks in the world, are just the start of it. Under Paris there are spaces of all kinds: canals and reservoirs, crypts and bank vaults, wine *(Touch* Text *button to read more.)*

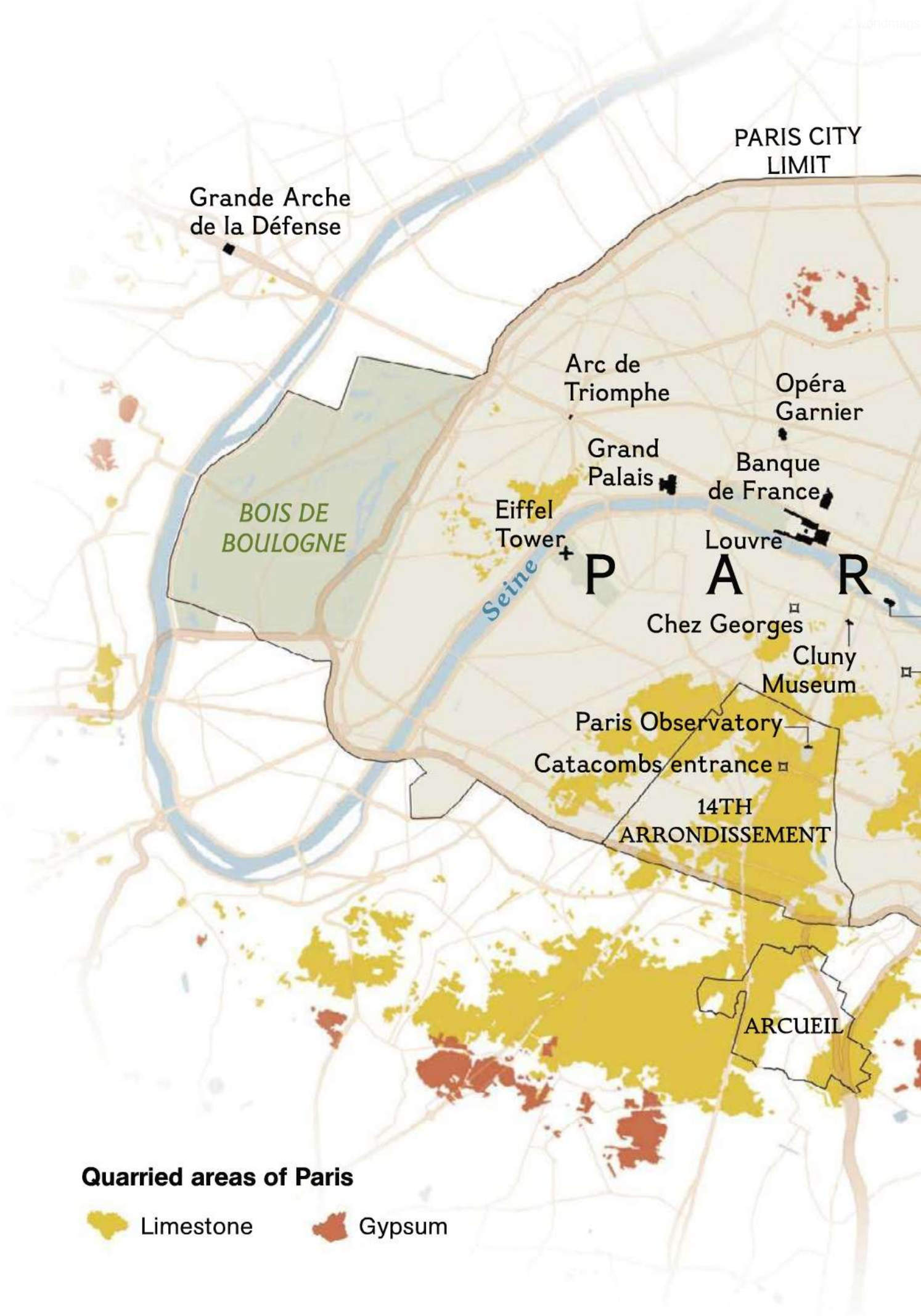


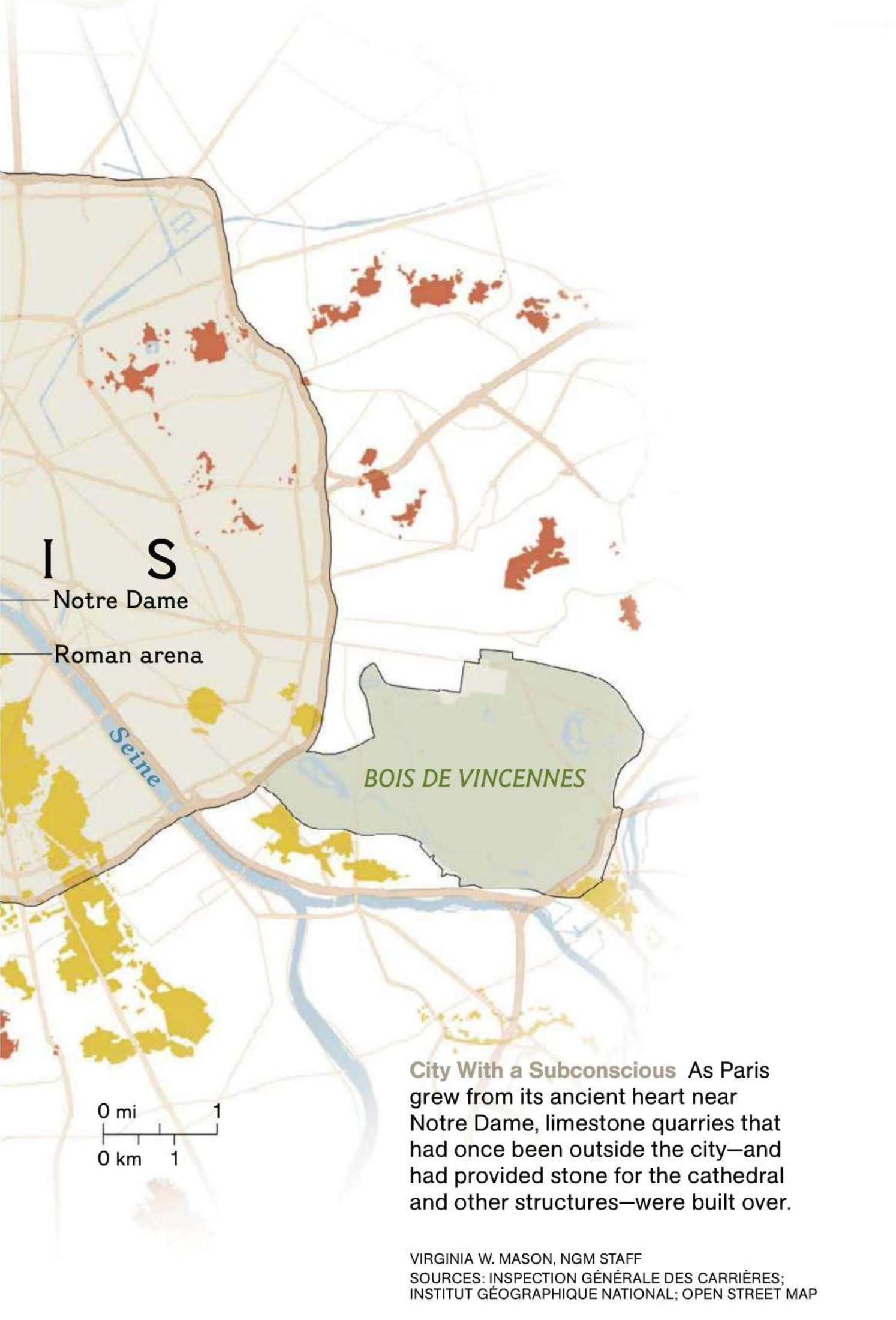
A city inspector drops down a shaft into a quarry for an inspection. Tunnels occasionally collapse.

Cave-loving contributors Neil Shea and Stephen Alvarez last collaborated on a 2009 article on Madagascar's Tsingy de Bemaraha National Park.

Text

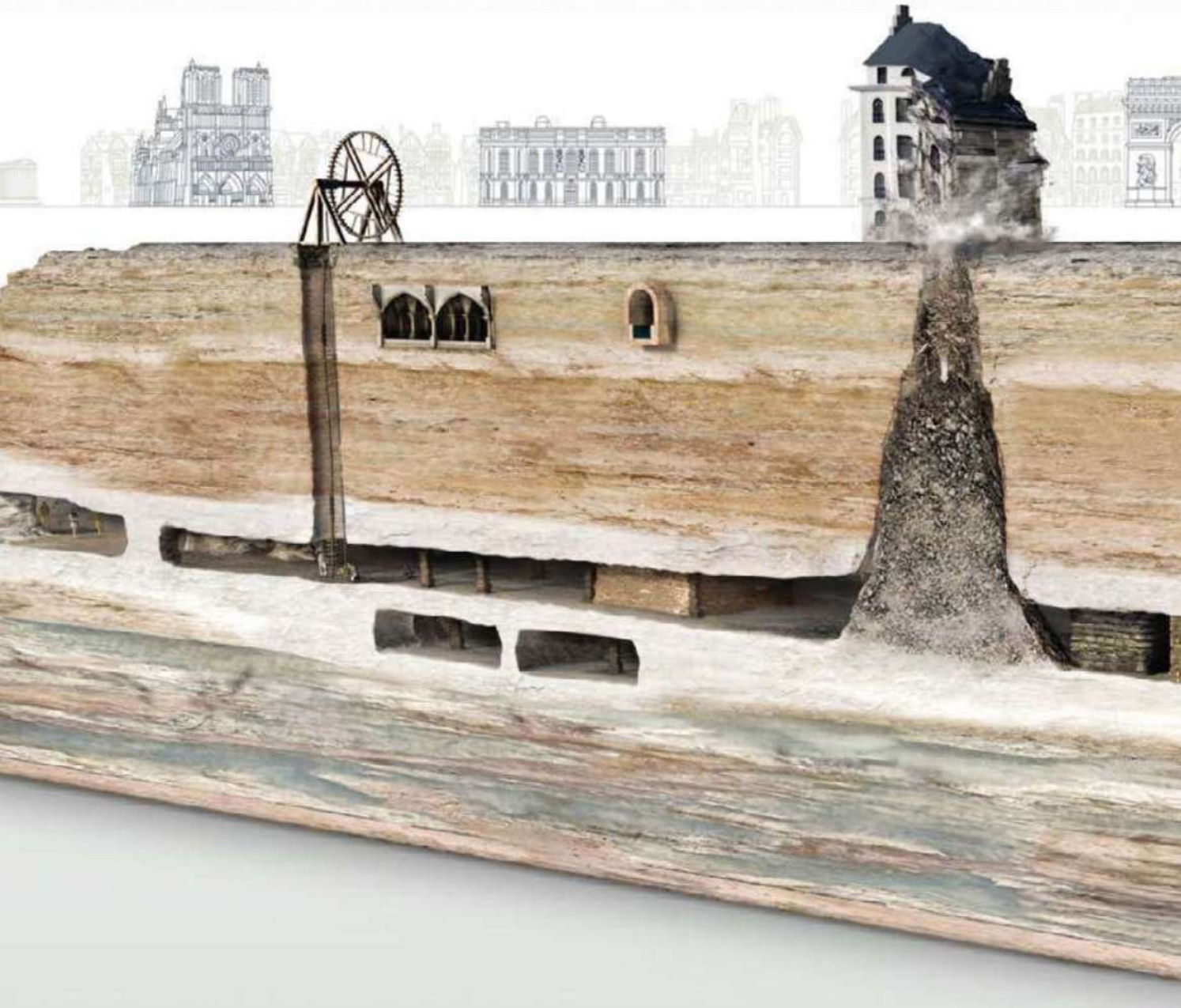
A city inspector drops down a shaft into a quarry for an inspection. Tunnels occasionally collapse.


PARIS CITY LIMIT
Grande Arche de la Défense
Arc de Triomphe
Opéra Garnier
Grand Palais
Banque de France
BOIS DE BOULOGNE
Eiffel Tower
Louvre
Seine
P A R
Chez Georges
Cluny Museum
Paris Observatory
Catacombs entrance
14TH ARRONDISSEMENT
ARCUEIL
Quarried areas of Paris
Limestone
Gypsum



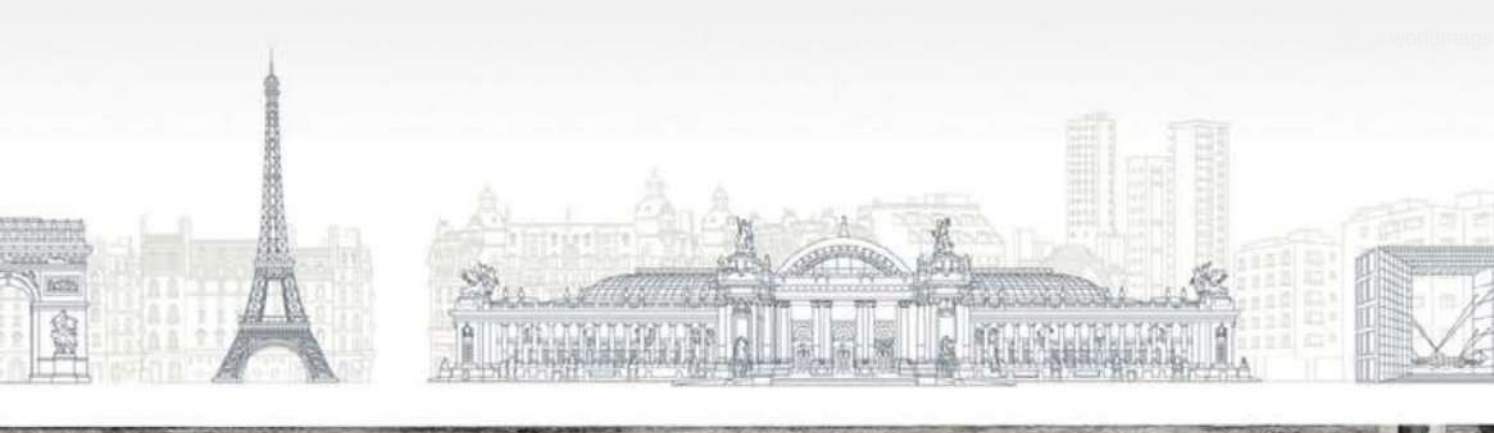
City With a Subconscious As Paris grew from its ancient heart near Notre Dame, limestone quarries that had once been outside the city—and had provided stone for the cathedral and other structures—were built over.

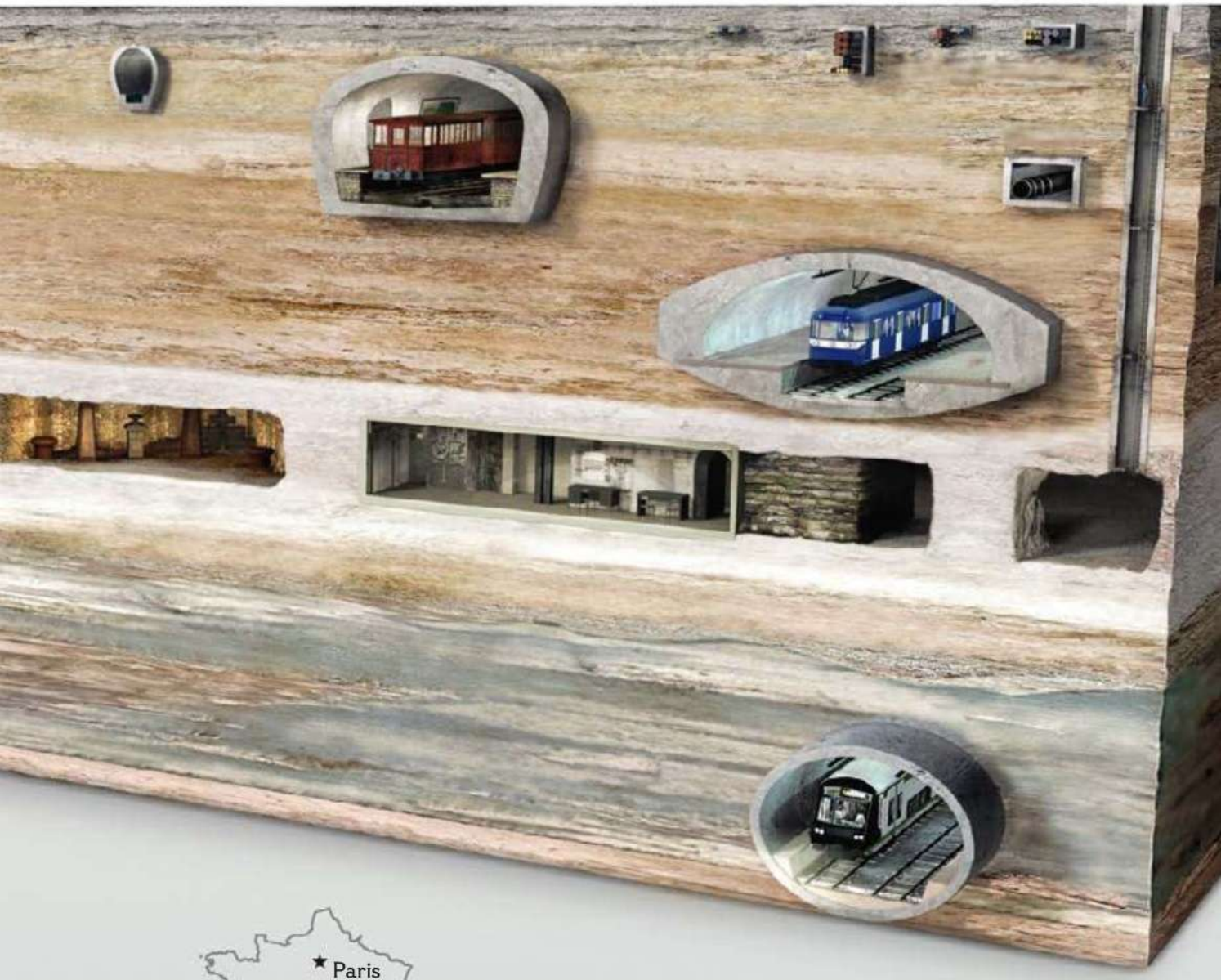
VIRGINIA W. MASON, NGM STAFF
SOURCES: INSPECTION GÉNÉRALE DES CARRIÈRES; INSTITUT GÉOGRAPHIQUE NATIONAL; OPEN STREET MAP



Paris Through Time

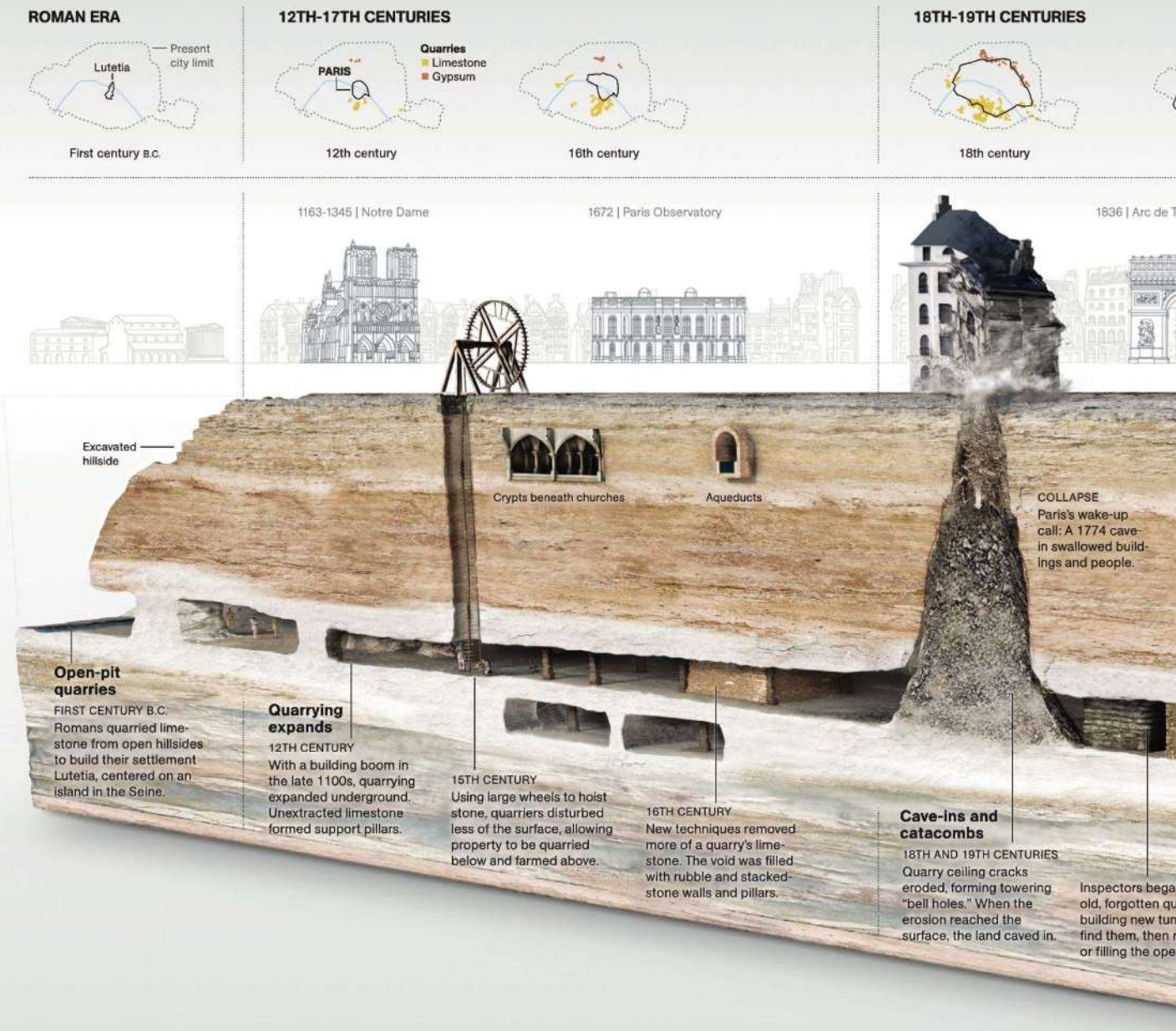
Century by century, the city's underbelly took on a geography all its own. The extent of the limestone quarries, or *carrières,* beneath Paris was unknown until a deadly collapse in 1774 prompted Louis XVI to create a department to map them. The Inspection Général des Carrières (IGC) is still at work today, monitoring the maze of tunnels it created to find and reinforce the quarries. By 1860 the last limestone quarries had closed; gypsum was quarried, for plaster of paris, until 1873.





MORE

ALEJANDRO TUMAS; AMANDA HOBBS, NGM STAFF
ART: HERNÁN CAÑELLAS
MAPS: SAM PEPPLE, NGM STAFF. CITY SKYLINE: JORGE PORTAZ
SOURCES: GILLES THOMAS; INSPECTION GÉNÉRAL DES CARRIÈRES

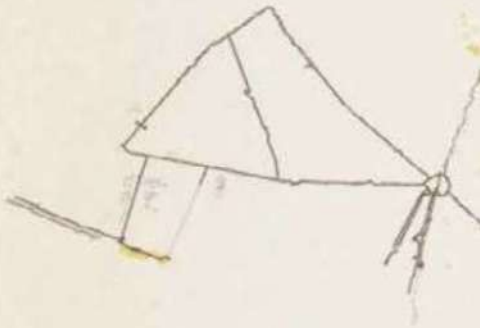


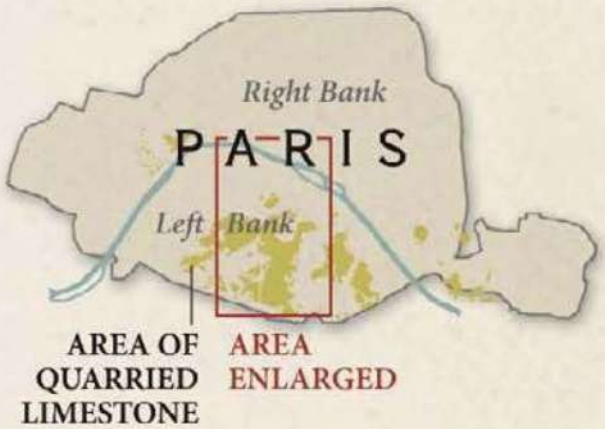
ZOOM IN TO EXPLORE

ALEJANDRO TUMAS; AMANDA HOBBS, NGM STAFF. ART: HERNÁN CAÑELLAS
MAPS: SAM PEPPLE, NGM STAFF. CITY SKYLINE: JORGE PORTAZ
SOURCES: GILLES THOMAS; INSPECTION GÉNÉRALE DES CARRIÈRES

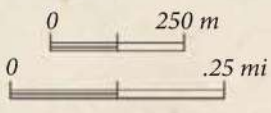
Beneath the Left Bank

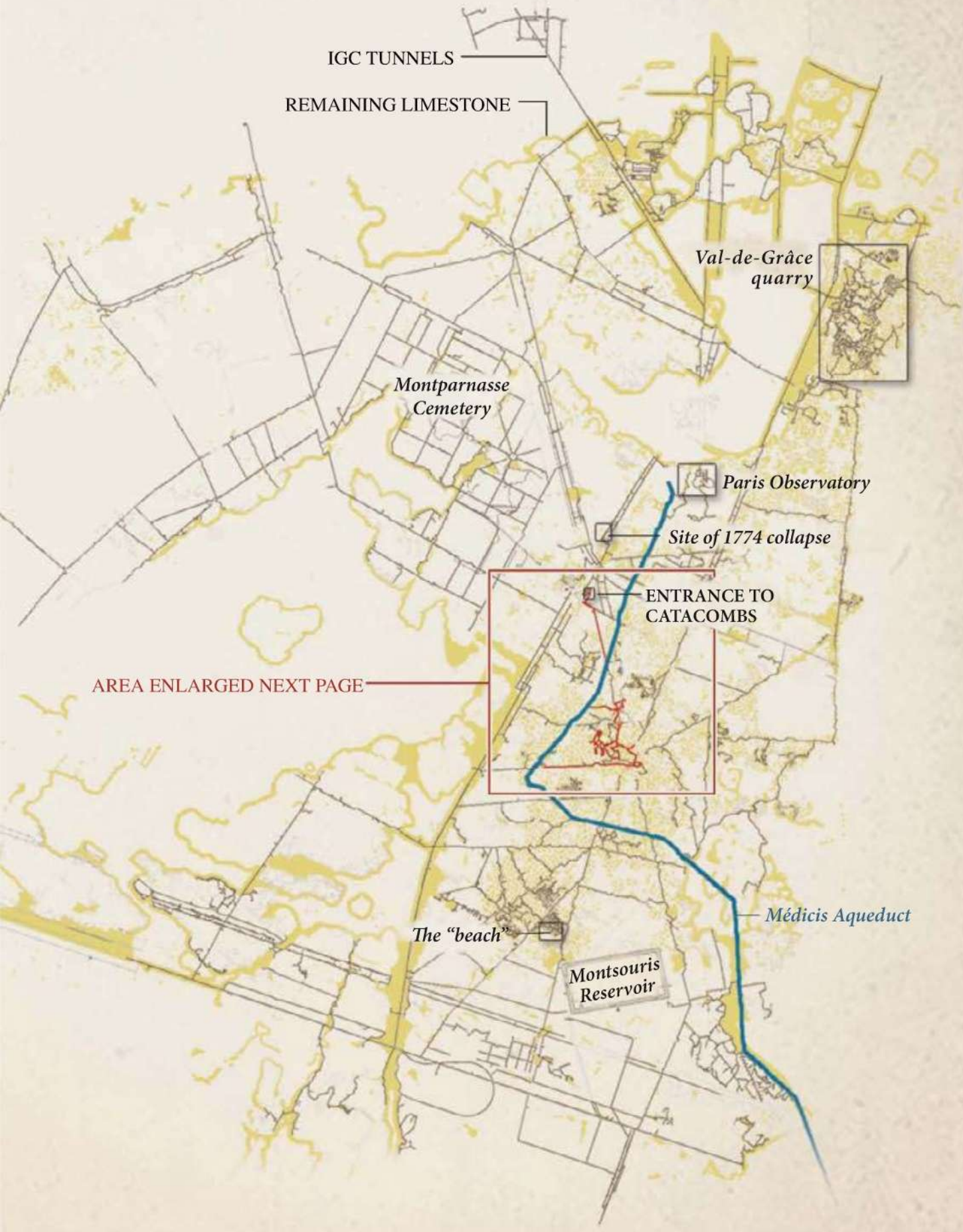
"Mapping the underground is like mapping the soul of a place," says a Parisian cataphile who goes by the pseudonym Nexus. He created these maps, adding his explorations to city records. Most of the more than 180 miles of tunnels maintained by the Inspection Générale des Carrières are on the Left Bank; only a mile of them—the catacombs—is open to the public.





VIRGINIA W. MASON, NGM STAFF
MAP: NEXUS. SOURCES: NEXUS; IGC; GILLES THOMAS




IGC TUNNELS
REMAINING LIMESTONE
Val-de-Grâce quarry
Montparnasse Cemetery
Paris Observatory
Site of 1774 collapse
ENTRANCE TO CATACOMBS
AREA ENLARGED NEXT PAGE
Médicis Aqueduct
The "beach"
Montsouris Reservoir

THE REMAINS OF QUARRIES

The limestone left behind in this heavily quarried area is colored yellow. Except where connected by tunnels, the old quarries between the limestone remnants are largely filled with rubble and pillars of stacked stone. The quarries linked by government-built tunnels have reinforced walls and hold two types of pillars (art below).

Public access to catacombs

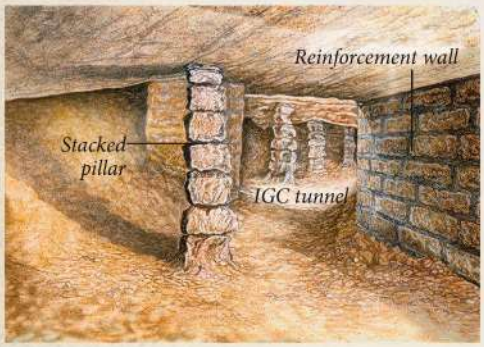
Accessible, closed to the public

Inaccessible

Area filled with concrete to block access

Solid limestone pillars: Stone left intact as support by early quarriers as they excavated surrounding stone

Stacked pillars: Built from inferior rock to support the ceiling after quarriers removed the limestone



Stairwell

Aqueduct

Ceiling erosion (bell hole)

Collapse

INSPECTION GÉNÉRALE DES CARRIÈRES

The IGC monitors the structural integrity of the quarries and tunnels.

Early IGC inspectors inscribed the tunnel walls as they mapped and reinforced the quarries (example below).

IGC HEA

limestone

Unextracted

RENAISSANCE PI

Just belowground, t Médicis Aqueduct w atop forgotten quar soon began to leak i

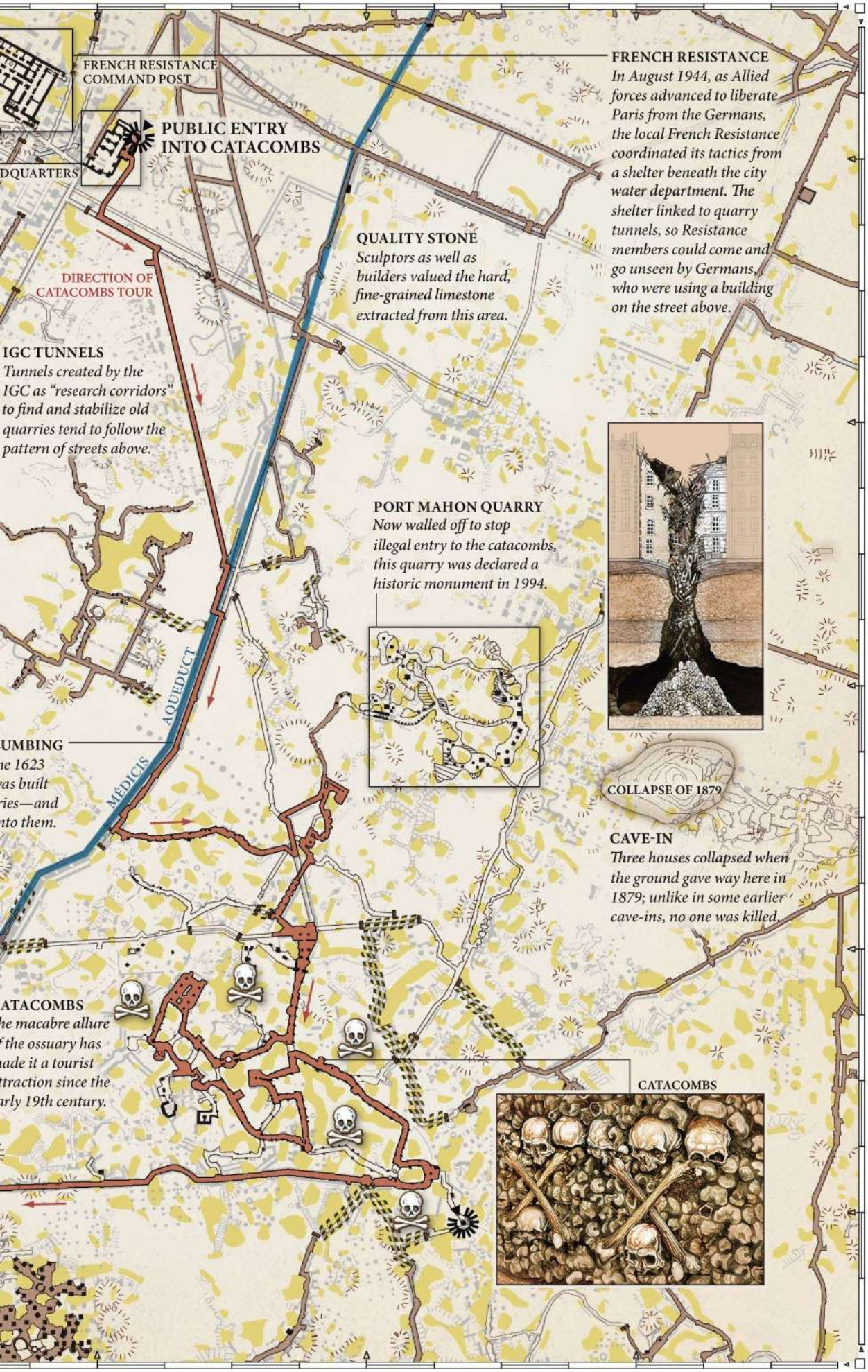
COLLAPSE OF 1784

EXIT

0 40 m

0 200 ft

ZOOM IN TO EXPLORE THE QUARRIES


FRENCH RESISTANCE COMMAND POST
DQUARTERS
PUBLIC ENTRY INTO CATACOMBS
DIRECTION OF CATACOMBS TOUR
FRENCH RESISTANCE
In August 1944, as Allied forces advanced to liberate Paris from the Germans, the local French Resistance coordinated its tactics from a shelter beneath the city water department. The shelter linked to quarry tunnels, so Resistance members could come and go unseen by Germans, who were using a building on the street above.
QUALITY STONE
Sculptors as well as builders valued the hard, fine-grained limestone extracted from this area.
IGC TUNNELS
Tunnels created by the IGC as "research corridors" to find and stabilize old quarries tend to follow the pattern of streets above.
PORT MAHON QUARRY
Now walled off to stop illegal entry to the catacombs, this quarry was declared a historic monument in 1994.
AQUEDUCT
MÉDICIS
UMBING
ne 1623
as built
ries—and
nto them.
COLLAPSE OF 1879
CAVE-IN
Three houses collapsed when the ground gave way here in 1879; unlike in some earlier cave-ins, no one was killed.
ATACOMBS
he macabre allure
f the ossuary has
ade it a tourist
ttraction since the
rly 19th century.
CATACOMBS

Seekers Trespassing *cataphiles*, like the student above, venture into this buried past for the thrill of it; some draw their own elaborate maps of its intricacies.

Deceptive Display Behind the neat stacks of skulls, tibias, and femurs in the Paris catacombs lies a chaos of bones. In the 18th and 19th centuries the city dug up millions of skeletons from overflowing cemeteries and poured them at night into old quarries.

Pillars of Paris City inspector Xavier Duthil checks a crude limestone pillar built by quarrymen in the early 1800s. If it were to fail today, more than a ceiling might collapse. In 1710 workers digging tombs below Notre Dame found the blocks of a more decorative pillar erected 17 centuries earlier by Seine boatmen in what was then Gallo-Roman Lutetia. Displayed now in the Cluny Museum, the find was the first evidence linking names to images of Gallic gods such as Cernunnos (above), whose horns likely symbolized male fertility. “It’s something like the Rosetta stone,” says curator Isabelle Bardiès-Fronty.

Finale Sparks fly from a performance in front of Notre Dame, on the Île de la Cité. Some of the 12th-century cathedral's limestone blocks came from quarries on the Left Bank. "The history of the quarries is a history of the city," says archaeologist Marc Viré.

Paris Gets Down The sweat and rhythm of Saturday night fill the arched cellar of Chez Georges, in Saint-Germain-des-Prés. With limited room aboveground, many clubs and restaurants expand downward, drawing people into spaces once reserved for wine.

Under the Stones, the Beach In a sandy chamber known as the "beach," a wave rolls across a wall painted (and repainted) by cataphiles in the style of Japanese printmaker Hokusai. Such works can take hundreds of hours—the painting but also the carrying in of supplies. At a book party in another quarry, artist Michel Chevereau (above, wearing headlamp) and writer Jack Manini (on Chevereau's left) sign copies of their graphic novel *Le Diable Vert*. Set in and under Paris during the Nazi occupation, it combines history—Resistance fighters hid in the tunnels—with folktales of a subterranean green devil.

Portal Sunlight from a boulevard falls on firefighters practicing underwater rescues in the Canal Saint-Martin, whose construction was ordered by Napoleon in 1802. The canal runs from the Seine near the Bastille to the northern edge of Paris.

Bonjour to All That Cataphiles Yopie and Dominique head for the surface through an abandoned train tunnel after scuba diving in a flooded quarry. Like many of their peers, they love the freedom underground. “At the surface there are too many rules,” Yopie says. “Here we do what we want. Where else is that possible?”

Descent Into Paris

Visiting Paris's vast underground network is essentially *interdit* (forbidden, for those of you who were not French majors). But a handful of legal entrées provides a glimpse of this underbelly of darkness, where history, mystique, and ghoulish underpinnings collide. *—Barbara Noe*

Les Égouts de Paris

This popular underground museum brings you into a portion of the city's 1,300-some-mile sewage system, along murky, slightly odorous waterways carrying you-don't-want-to-know-what on its way to disposal. Giant iron balls and antique flushing machines are on show (both used to clean the system), while panels detail sewer history from the first underground system of 1370—originally aimed at keeping cholera, the plague, and other less deadly but still debilitating diseases at bay. Most of the praise goes to Baron Georges-Eugène Haussmann, who modernized the city between 1852 and 1870 and whose *égouts*—the French word for sewers—are considered among his finest work. Indeed, he figured out how to bring in potable water and drain away wastewater by creating a system beneath the city that resembled a city. If nothing else, you'll appreciate how far we've come from the Middle Ages, when sewage disposal involved tossing a chamber pot's contents out the window *(Touch* Text *button to read more.)*

Way Down Many Parisians visit the underground daily via Métro stations (below, Lamarck-Caulaincourt in the 18th arrondisement). Tourists who'd like a more in-depth underground experience can sign up for a walking tour that includes a stop at a "ghost" station.

MAP: VIRGINIA W. MASON, NGM STAFF; COLTER SIKORA

Text

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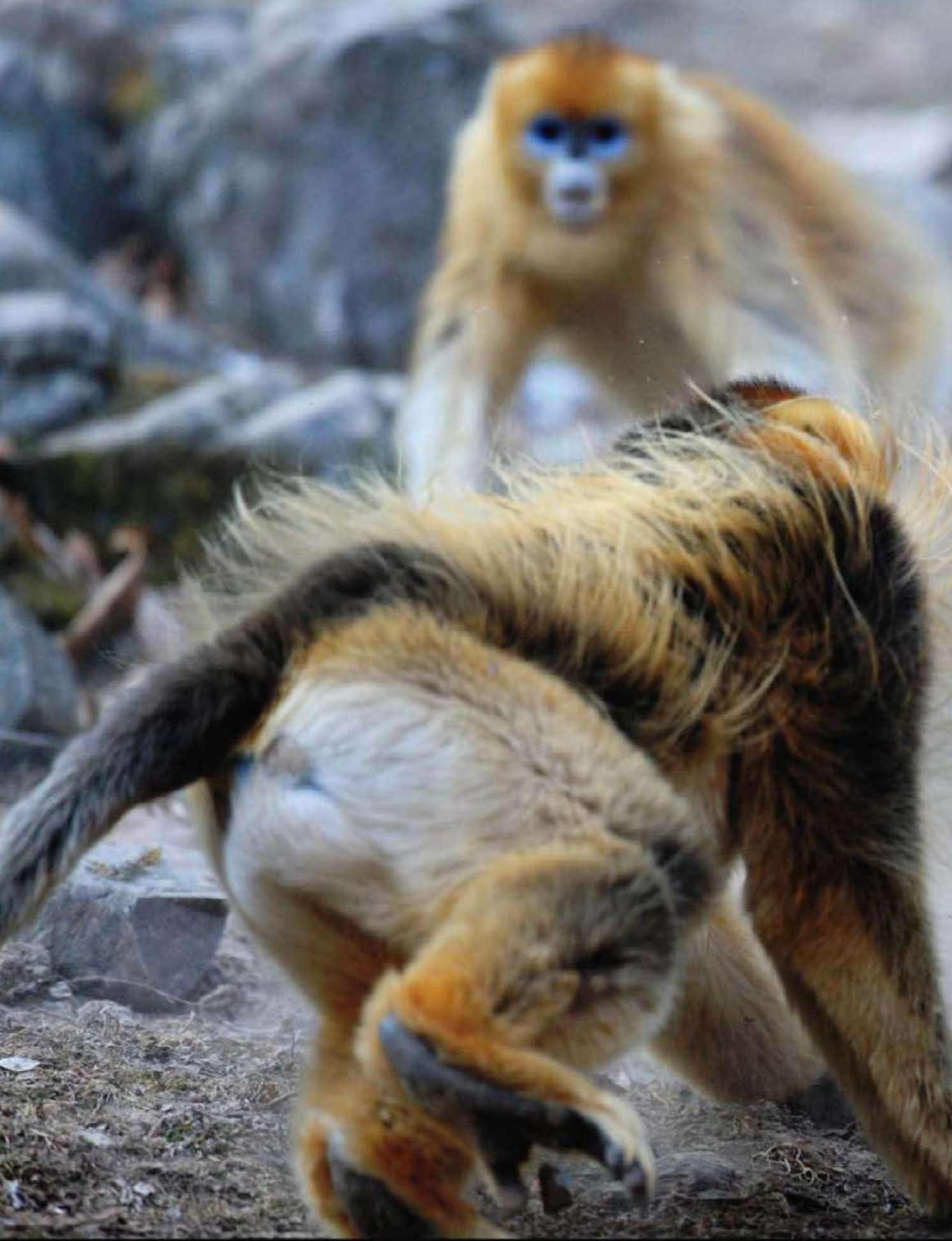
MAP: VIRGINIA W. MASON, NGM STAFF; COLTER SIKORA

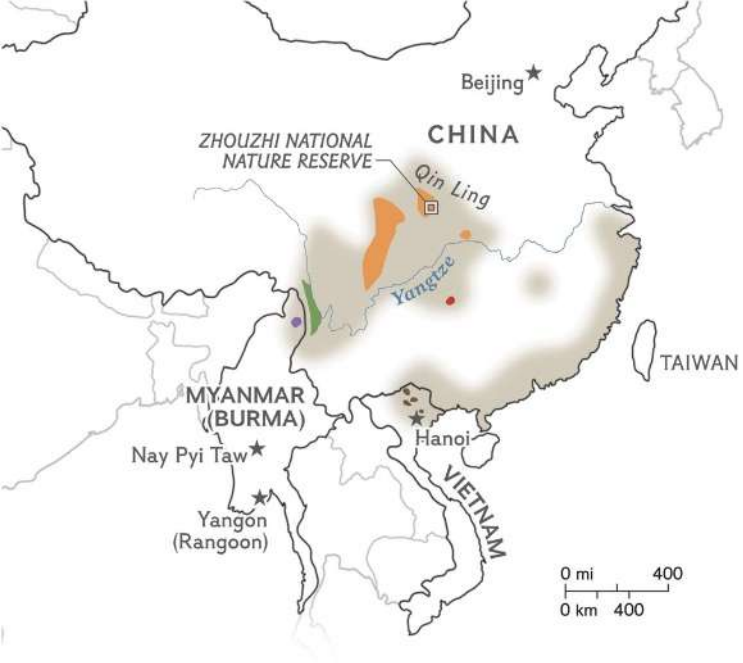
The Monkey Who Went Into the Cold

The heavy fur of China's snub-nosed monkey is a boon in subzero winters. Its quirky face could help too.

Not yet two, a golden snub-nosed monkey perches in a highland forest in China's Zhouzhi National Nature Reserve. Maturity comes by age seven. Life span is unknown.



Battle face forward, a male snarls and barks at his territorial rival as a female—perhaps a mate—looks on. Blood is rarely shed; the fiercest display wins. Females often join in.



Snub-nosed monkey species, by common name
(Present-day population estimate)

- Golden (20,000)
- Myanmar (300)
- Black (2,500)
- Tonkin (200)
- Gray (900)
- Historical range

WHERE THE MONKEYS ARE

Most snub-nosed primates live in China. But scientists have now found a fifth species, *Rhinopithecus strykeri,* in a new locale. In early 2010 hunters in Myanmar's mountains told visitors of a mostly black monkey with fleshy lips that sneezes when rain hits its severely upturned nose. The animal, they said, spends soggy days with its head between its knees.

LISA R. RITTER, NGM STAFF
SOURCES: YONGCHENG LONG, NATURE CONSERVANCY; BAOGUO LI, NORTHWEST UNIVERSITY, CHINA; LE KHAC QUYET; FAUNA & FLORA INTERNATIONAL; PEOPLE RESOURCES AND CONSERVATION FOUNDATION; BIODIVERSITY AND NATURE CONSERVATION ASSOCIATION

Text

PHOTOGRAPHS BY CYRIL RUOSO

TUCKED HIGH IN THE QIN LING MOUNTAINS of central China, a nimble primate with a peculiar mug has conquered a pitiless landscape. The golden snub-nosed monkey is one of five related species—remnants of once widespread populations whose ranges were squeezed by climate change after the last ice age. Enduring groups, living in territorial bands that can top 400 animals, are being squeezed again by logging, human settlement, and hunters wanting meat, bones (said to have medicinal properties), and luxurious fur. Many have been pushed into high-altitude isolation, where they leap across branches, traverse icy rivers, and weather long winters at nearly 10,000 feet, shielded by that coveted coat.

About 20,000 of the golden variety remain on Earth. Some 4,000 inhabit the mountainous region where Chinese officials set up the Zhouzhi National Nature Reserve to protect the species. Living both in and out of reserve boundaries, *Rhinopithecus roxellana,* whose Latin name was allegedly inspired by the snub-nosed concubine of a 1500s sultan, has made *(Touch* Text *button to read more.)*

Cyril Ruoso, author of The Great Apes, *is with JH Editorial/Minden Pictures. Jennifer Holland covered cranes in the June issue.*

PHOTOGRAPHS BY CYRIL RUOSO

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Cyril Ruoso, author of The Great Apes, *is with JH Editorial/Minden Pictures. Jennifer Holland covered cranes in the June issue.*

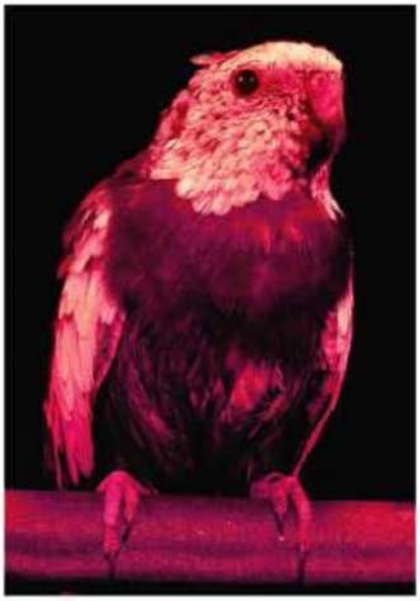
Family members huddle on a slope in central China, where freezing temperatures hang on for weeks and snow cover persists through March. Few monkeys endure a harsher clime.

When seeds, fruits, and leaves are scarce, monkeys ingest lichens, twigs, and bark. Most foraging occurs within a three-mile stretch, though ranges may cover ten square miles.

Monkeys on the move navigate rocks and rivers with grace—
though the photographer saw a few slip and slide on icy ground.

Grooming females choose the safety of a high seat, the preferred post for a species that spends more than 90 percent of its life in the trees.

Juvenile males look poised to strike a deal. Instead, each will try to yank the other down for a bout of play wrestling—good practice for future scraps over rank and space.



ON ASSIGNMENT

Bright as a Feather The setting (right) looks almost comical: Is that parrot giving photographer Robert Clark a headache? No. In fact, Clark, who shot this issue's "Evolution of Feathers," was dead serious as he photographed the bird in his Brooklyn, New York, studio using a strobe fitted with an attachment that changed the light to ultraviolet (above). Clark used the UV setup to show how birds, capable of seeing in that spectrum, perceive themselves and others. But "UV can cause damage to the human eye," he says, "so that's why I'm not looking as I'm firing the strobe packs."

Rob Clark turns away from his camera as he photographs a bird.

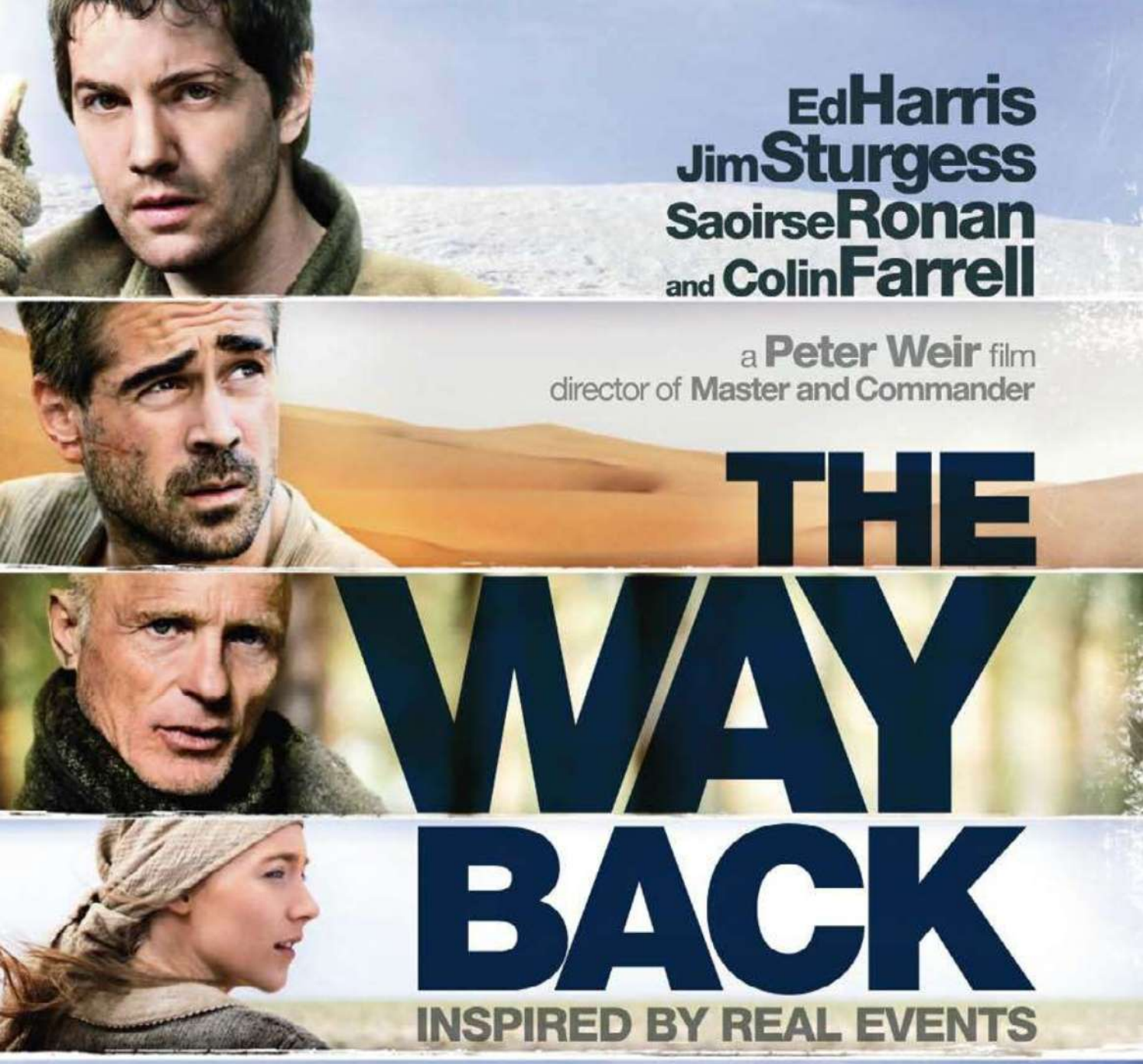
PHOTOS: ROBERT CLARK (BIRDS); DAVID COVENTRY (ABOVE)

NG BOOKS

Few landscapes on Earth remain as pristine as Alaska's 40,000-square-mile Bristol Bay watershed. Discover its great beauty in *Hidden Alaska,* written by Dave Atcheson and featuring more than 80 photographs—from panoramic landscapes to portraits of native people and wildlife—by *National Geographic* photographer Michael Melford. Find it in bookstores February 15 ($24).

ON THE RADIO

Skeletal remains and *cataphiles* weren't the only company that photographer Stephen Alvarez kept while working on this month's feature about the Paris underground. He was also joined by NPR correspondent Jacki Lyden and assisted by a fixer from the *Geographic*'s French edition. On Sunday, January 30, learn even more about the story when Lyden shares her perspective on NPR's *Weekend Edition.*



NATIONAL GEOGRAPHIC
ENTERTAINMENT

The Way Back is an epic story of survival and the strength of the human spirit. Coproduced by National Geographic Entertainment and inspired by true events, the film follows six prisoners who make a daring escape from the horrors of a Soviet gulag in Siberia, then embark on a 4,500-mile odyssey to find freedom in India.

The Way Back opens in theaters across the U.S. on January 21.

thewaybackthemovie.com

Feathers in Her Cap Stylish Mae Vavrea tops off her turban with a black-tailed white Japanese bantam rooster at the Chicago Poultry and Pet Show in 1926. Though not published in the story, this photo was probably acquired for the *Geographic*'s April 1927 article "America's Debt to the Hen." In it author Harry R. Lewis notes, "For untold centuries the hen has been a companion of man in the onward march of civilization… The hen might be termed a universal favorite, in that a greater number of persons are interested and actually concerned with poultry than with any other form of live stock." No mention was made of the bird, however, as headgear. —*Margaret G. Zackowitz*

PHOTO: ACME NEWSPICTURES INC./NATIONAL GEOGRAPHIC STOCK

NEXT MONTH

Bred to be mild: domesticated foxes and their handlers in Siberia.

PHOTO: VINCENT J. MUSI

March 2011

Taming the Wild
A fox can be man's best friend. All it takes is the right genes.

Enter the Age of Man
We remove mountains, raise supercities, transform our planet.

Coelacanths
Fish that date to dinosaur days get rare human visitors.

Kung Fu Kingdom
Near Shaolin Temple in China, old masters train wannabe movie stars.

Gold Dusters
They're pollinators. And they're ready for their close-up.

The Ultimate Alaska Trek
What makes a world-class hiker cry? Ask Andrew Skurka.

SEND US YOUR FEEDBACK
Touch here to take an online survey.