

NEW WONDERS Smithsonian

April 2016 | smithsonian.com

EVOLUTION IN AMERICA

EXPERIENCE
THE SCOPES
MONKEY
TRIAL FOR
YOURSELF

WORSHIP AT
THE SISTINE
CHAPEL OF
EVOLUTION

SEE WHERE
DINOSAURS
MET THEIR
MATCH

EXPLORING
THE NEWLY
DISCOVERED
EMPIRE
THAT RULED
CAMBODIA
BEFORE
ANGKOR WAT

INVISIBLE KINGDOM



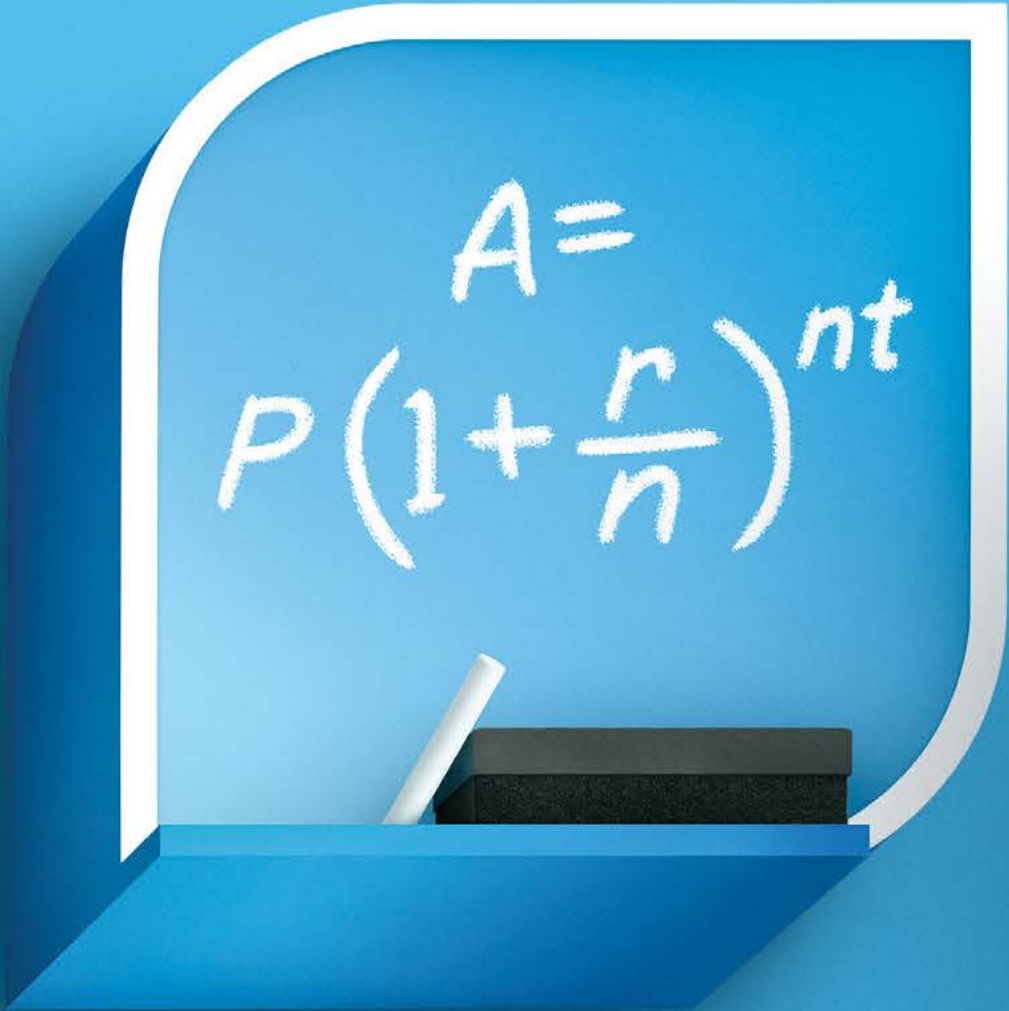
CANDID CAMERA
FOR AFRICA'S
ANIMALS

THE DEADLY
MATING DANCE OF
THE BLACK HOLES

UNBUTTONING
THE INFLUENCE
OF THE ZOOT SUIT

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DO WELL.**




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Welcome to
Monkey Town

Each July, the city of Dayton, Tennessee, celebrates its role in the famous Scopes Trial with a re-enactment and festival

BY FRANZ LIDZ

Gaby Alberts, playing a juror, stands by in a dramatic re-staging of the evolution trial at the same Dayton courthouse.

Contributors



Discussion



Phenomena



- American Icon: Zoot Suit
- Art: Robert Clark
- History: Casual Cushing
- Small Talk: Ariel Waldman
- Adaptation: Big Toe
- Culture: Questlove on Cooking

Catching a Wave



The first-ever detection of gravitational waves is a major breakthrough in scientists' ability to probe the cosmos

BY BRIAN GREENE

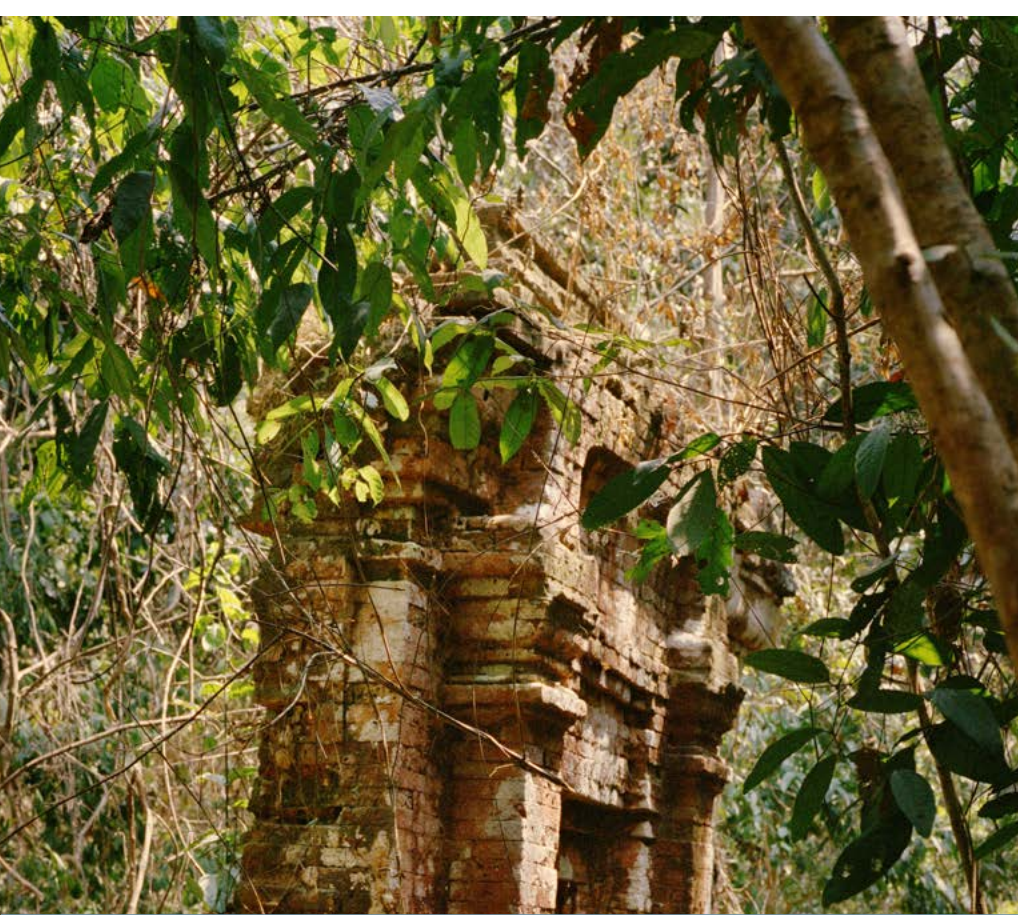
Drawing Fire



With pen and brush, the artist, activist and reporter Molly Crabapple rivets our attention on humanitarian crises

BY RON ROSENBAUM

Ask Smithsonian



Invisible Kingdom

Deep in the jungles of Cambodia, French archaeologists have rediscovered the remains of a splendid lost city that may have been the template for Angkor Wat

BY JOSHUA HAMMER



Driving While Black

Listing hotels, restaurants and other businesses open to African-Americans, the *Negro Motorist Green-Book* was an invaluable guide for Jim Crow-era travelers

BY JACINDA TOWNSEND

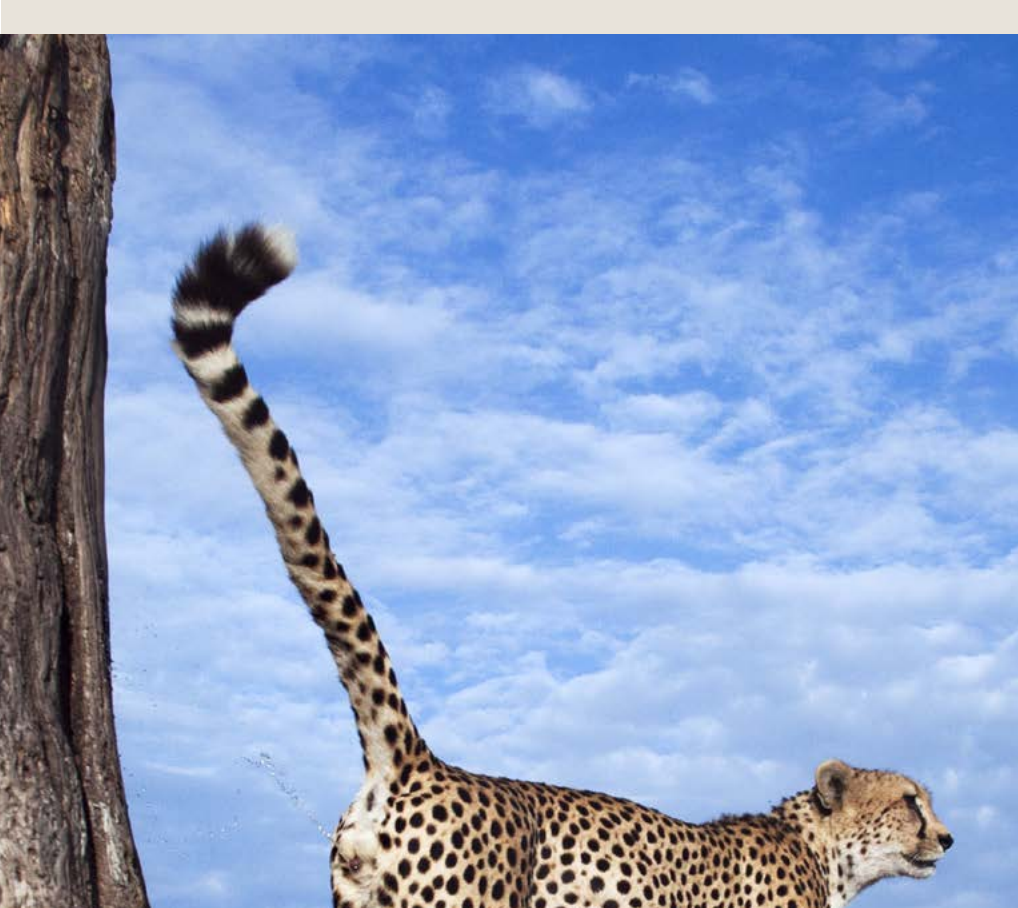


EVO TOURISM 2016

Darwin's Favorite Fossils

The 150-year-old Yale Peabody Museum houses crucial specimens that the famous British naturalist considered the best evidence for his theory of evolution

BY RICHARD CONNIFF



The Secret Lives of Animals

Using a remote-controlled camera, a wildlife photographer captures the beasts of the Masai Mara and Serengeti from the ground up

BY ABIGAIL TUCKER



Dawn of the Dinosaur

Recent surprise discoveries at Petrified Forest National Park in Arizona have prompted a complete rethinking about the creatures of the Triassic Era

BY BRIAN SWITEK



Ford

C-MAX HYBRID



Contributors



Jacinda Townsend

The author of *Saint Monkey*, a novel set in 1950s Kentucky, and a former broadcast journalist, Townsend writes about a segregation-era guidebook that advised black Americans on how to travel the country safely (“**Driving While Black**”). The *Green-Book* continued briefly after segregation was outlawed, and though its sudden irrelevance was a sign of progress, “we lost a community,” Townsend says of the guide’s cessation after 1966. “There was a vibrant community of people who would host people. Today, when we go to nameless, faceless hotels, we lose that culture.”



Richard Conniff

A longtime contributor, Conniff has a new book out this month, *House of Lost Worlds: Dinosaurs, Dynasties, and the Story of Life on Earth* (Yale University Press). His feature on the **Yale Peabody Museum of Natural History** draws on his extensive book research, but in a way it was decades in the making. He first visited the museum as a Yale undergraduate and often took his children there when they were growing up.

Joshua Hammer

No stranger to exotic archaeological digs or dangerous assignments, Hammer says that accompanying researchers in Cambodia to the rediscovered **lost city of Mahendraparvata** was “some of the most difficult jungle hiking I’ve done, getting torn to pieces by thorns.” A frequent contributor to this magazine for more than ten years, reporting from Africa, Asia, Europe and even the United States, the Berlin-based writer has found time to work for other publications, too. His story in *Matter* about the Ebola epidemic won a 2016 National Magazine Award for reporting. Hammer’s latest book, *The Bad-Ass Librarians of Timbuktu*, which originated as an assignment for *Smithsonian*, comes out in April.

Chiara Goia

To reach the site of the abandoned city of Mahendraparvata, Goia, like Hammer, had to struggle through the **Cambodian forest**. But she insists she enjoyed the adventure, despite having to haul her bulky photography equipment. “It was very hot, without much light,” recalls Goia, “but the light came through every now and then in very interesting ways.” Goia’s atmospheric images have often appeared in the *New Yorker*.



Anup Shah

The Wiltshire, England-based wildlife photographer, whose work has often roared to life in these pages over the last 15 years, says he learned a lot about animal behavior when he set out to document the creatures in Masai Mara and the Serengeti with **hidden cameras**. “I had to think hard about where to place the cameras based on the habits and personalities of the animals,” he says. His upcoming book, *The Mara*, is devoted to intimate views of animals.

Corby Kummer

The recipient of five James Beard Journalism Awards, Kummer is the author of acclaimed books about coffee and slow cooking. He is also a restaurant critic for *Boston* magazine and *Atlanta* magazine and a senior editor at the *Atlantic*. In “**If Music Be the Food of Questlove**,” Kummer savors the connections between cooking and music in the new book *Something to Food About* by “Tonight Show” bandleader and drummer Questlove.

Brian Greene

The indefatigable Greene is the director of the center for theoretical physics at Columbia University, the co-founder of the World Science Festival and the author of *The Hidden Reality* and other lyrical books about cosmology. In this month’s column, he tells the story of the biggest **breakthrough in astrophysics** in years. “To discover gravitational waves in the 100th anniversary year of general relativity itself is kind of crazy,” says Greene. “Almost looks like Einstein planned it this way.”



Trinity College

DISCOVER DUBLIN

Gateway to Adventure

The first thing that often strikes visitors to Dublin isn't a thing at all, it's a feeling of warmth emanating from the friendliness of the locals. If the entire city seems to be throwing out its arms in welcome, perhaps it's because Dubliners have so much they are proud to share. This thousand-year-old city founded by Vikings has been a seat of medieval culture, the birthplace of literary heroes Samuel Beckett, Oscar Wilde and James Joyce, and the cradle of Irish music, theater and design.

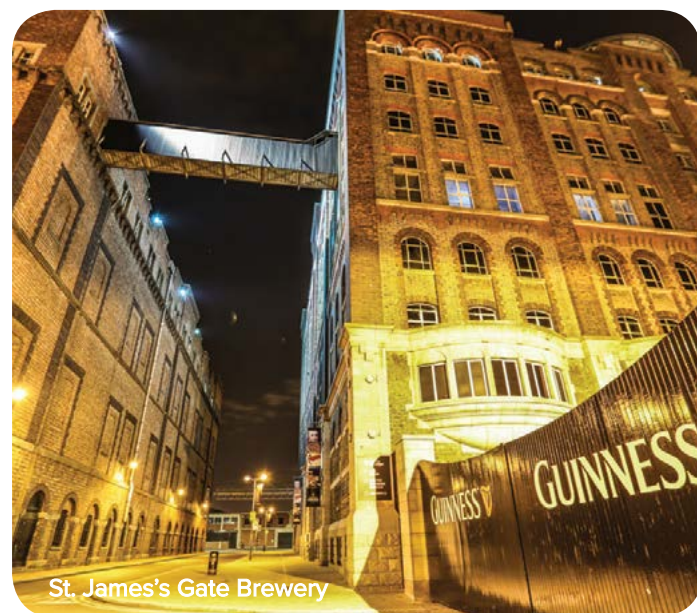
So, where to begin your adventure of discovery? A visit to **Trinity College** to view the **Book of Kells** is an excellent start. This beautifully illuminated manuscript of the four gospels, created in the ninth century, unites ancient Celtic art and ornamentation with Christian symbolism to give birth to something wholly new and magnificent, which still holds the power to astonish half a million visitors each year. Freshly inspired by this land's rich heritage, dive a bit deeper via a visit to the **National Museum of Ireland—Archaeology**, where you'll see the largest collection of prehistoric gold artifacts in Europe and preserved bog bodies dating back to the Iron Age.

If strolling back to 7,000 B.C. leaves you feeling a bit parched, head straight to the **St. James's Gate Brewery** and the **Guinness Storehouse**—where you'll learn how to pour the perfect pint of ale before enjoying one in the Gravity Bar, with its panoramic view high atop Dublin's rooftops. The vista inland stretches far away and back in time to **Ireland's Ancient East**, a lush green region replete with monasteries, castles and fortresses. Enter the lottery to tour **Newgrange**, a Stone Age monument constructed over 5,000 years ago, during the winter solstice when a beam of light penetrates the chamber and grows wider as the sun rises. Many gather at this ancient time-telling device to mark the beginning of a new year as their ancestors likely did thousands of years ago. To calm your spirit, explore **Glendalough**, home to one of the most important monastic sites in Ireland. Founded by St. Kevin in the sixth century, this ethereal place will soothe your soul as you walk the trails of **Wicklow Mountains National Park**.

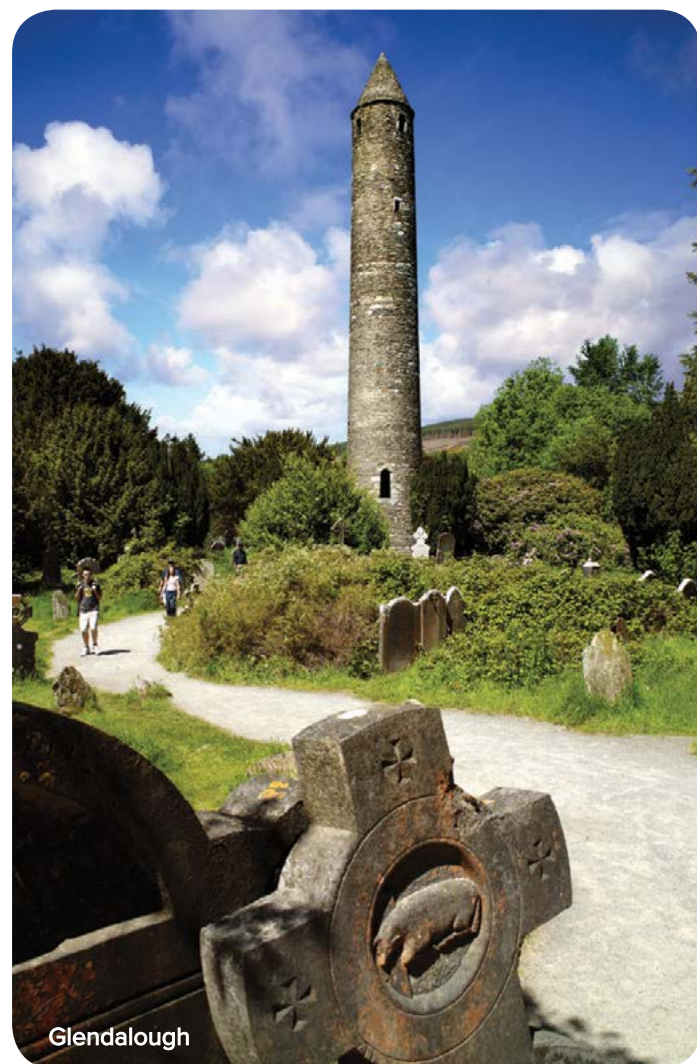
Dublin is the gateway through which you can journey to experience landmarks of Ireland's prehistory, see the relics of the early Christian age of saints and scholars, hear the tales of medieval invasions and rebellions, and gaze at the Georgian Empire splendor of Anglo Ireland's past. Explore 5,000 years of Europe's history in Ireland's fabled countryside—and you might just begin to feel like a friendly local yourself.



Newgrange



St. James's Gate Brewery



Glendalough



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Discussion

Borneo's forests & peoples being ravaged by #palmoil - intense story in @smithsonianmag
@christinehalvor ON TWITTER

FROM THE EDITORS *The stories in March that spotlighted cultural and ecological crises around the world were just a bit too much for some readers. “The vanishing snow leopard, deforestation in Borneo and the destruction of cultural treasures in the Middle East, all in the same issue,” John Chapman emailed. “What a downer!” But judging by social media traffic, tens of thousands of others appreciated the coverage, and advocates praised the stories as urgently needed. James Harkin’s eyewitness account of the destruction of historical treasures in Syria was tweeted by SAFE (Saving Antiquities for Everyone), and Harkin was interviewed on NPR. The Bruno Manser Fund, the American Forests organization and the founder of the Orangutan Land Trust all tweeted Alex Shoumatoff’s article about Borneo, which also inspired reader Rebecca Tripp to say on Facebook: “This story breaks my heart while simultaneously strengthening my resolve to be a better steward of this extraordinary planet.”*



Raging Rebellion

I read “The Raging Rebellion of Jones County” with great interest and was left in awe at my own ignorance. I was born and have lived my entire adult life (I am now 68) in Alabama. I am fairly well versed in the history of the Civil War, but, despite having married a girl from Mississippi and despite having traveled the length and width of that state many times, I had never heard of the “Free State of Jones.” Alabama was home to another county that was not in love with the idea of secession, the “Free State of Winston.”

James M. Reed

HOOVER, ALABAMA

The piece about Jones County, Mississippi, was a great tale of little-known history. It contains an incorrectly used kinship term, however, when it states that Knight’s children “started marrying their white half-siblings instead.” The examples listed do not describe marriages to half-siblings but rather step-siblings. This is an important legal and social distinction. If there were incestuous marriages among Knight’s children, the article does not give an example of one.

Donald Wesolowski

MADISON, WISCONSIN

Another senseless beat-down of my home state. Even the most casual student of Civil War-era American history knows that the South was no more sociopolitically monolithic than was the North. To assume so, or to find it necessary to disprove such, gives no credit to the vast majority of common folk who had to struggle daily just to get by, or to their descendants. I’m tired of this. Most of us here in Mississippi work hard every day to overcome this stereotypical portrayal.

John Boyte Anthony

CLINTON, MISSISSIPPI

Vanishing Cat

I traveled in China in 1994 and was saddened to see pelts of snow leopards [“Into Thin Air”] openly displayed for sale at the Kashgar Sunday Market, \$150 for a large, \$125 for a smaller pelt.

Christa McReynolds

LA JOLLA, CALIFORNIA

I don’t find the idea of scientists and hunters becoming allies in conservation at all “unlikely.” Many hunters are subsistence hunters, and have a vested interest in protecting and maintaining the ecosystems they inhabit, and the wildlife populations therein. Sport and trophy hunting are quite different from subsistence hunting, but those hunters can also have a great effect on conservation, albeit in an often controversial manner. There is evidence that hunting fees, permits and so on aid the conservation effort. Properly managed, hunting can be quite helpful to conservation efforts.

Storm Blakley

FACEBOOK

Lost Treasures

This destruction [Murdering History] harkens the imagination back in time to the devastating loss of the Library at Alexandria. We are not just losing our history, we are losing our humanity.

Jennifer Leigh Anthony

FACEBOOK

CONTACT US

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henomena

A CURATED LOOK AT SCIENCE, HISTORY AND CULTURE



Cab Calloway (above) called the zoot suit “the ultimate in clothes.”

Zooting Up

Unraveling the jazzy life of a snazzy style

It was June 1943 when the riots broke

out. For over a week, white U.S. soldiers and sailors traversed Los Angeles beating up allegedly “unpatriotic” Mexican-American men, identifiable by their conspicuously voluminous attire.

It was, as the historian Kathy Peiss writes in *Zoot Suit: The Enigmatic Career of an Extreme Style*, “perhaps the first time in American history that fashion was believed to be the cause of widespread civil unrest.” Starting this month, the Los Angeles County Museum of Art will feature an authentic example of one of these catalyzing ensembles as part of a new exhibition, “Reigning Men: Fashion in Menswear, 1715–2015.”

With its super-sized shoulder pads, sprawling lapels and peg leg pants, the zoot suit grew out of the “drape” suits popular in Harlem dance halls in the mid-1930s. The flowing trousers were tapered at the ankles to prevent jitterbugging couples from getting tripped up while they twirled. By the ’40s, the suits were worn by minority men in working-class neighborhoods throughout the country. Though the zoot suit would be donned by the likes of Dizzy Gillespie and Louis Armstrong, it was “not a costume or uniform from the world of entertainment,” the Chicago big-band trumpeter and clothier Harold Fox once said. “It came right off the street and out of the ghetto.”

Fox was one among many, from Chicago to Harlem to Memphis, who took credit for inventing the zoot suit—the term came out of African-American slang—but it was actually unbranded and illicit: There was no one designer associated with the look, no department store where you could buy one. These were ad hoc outfits, regular suits bought two sizes too large and then creatively tailored to dandyish effect.

To some men, the suit’s ostentatiousness was a way of refusing to be ignored. The garment had “profound political meaning,” wrote Ralph Ellison, author of *Invisible Man*. “For those without other forms of cultural capital,” says Peiss, “fashion can be a way of claiming space for yourself.”

Wartime rations on fabric made wearing such oversized clothing an inherently disobedient act. Langston Hughes wrote in 1943 that for people with a history of cultural and economic poverty, “too much becomes JUST ENOUGH for them.” To underscore the style’s almost treasonous indulgence, press accounts exaggerated the price of zoot suits by upwards of 50 percent. But even the real cost of one was near-prohibitive for the young men who coveted them—Malcolm X, in his autobiography, recounts buying one on credit.

Though policemen slashed some zoot suits to ruins, the more likely reason for their disappearance once the craze faded in the 1950s was less dramatic—most were simply refashioned into other garments. Original specimens are mythically hard to come by: It took curators from LACMA over a decade to find one, and when they did, in 2011, it cost them nearly \$80,000, an auction record for an item of 20th-century menswear.

But the suit had a luxuriant afterlife, influencing styles from Canada and France to the Soviet Union and South Africa. It was the subject of the Who’s first single. In 1978, the actor and playwright Luis Valdez wrote *Zoot Suit*, the first Chicano play on Broadway. The outfit’s iconic shape was taken up in the ’80s by Japanese avant-garde designers, who sent models down the runway in tumescent suiting around the time that MC Hammer put on his drop-crotch pants—causing outrage in the form of widespread hand-wringing over the alleged immorality of sagging pants, a style that has never quite gone out of fashion. By the time a record called “Zoot Suit Riot,” by the swing-revival band the Cherry Poppin’ Daddies, became a hit in the late-’90s, the suit’s provenance had largely been forgotten. No longer was the zoot suit evocative of the expressive power of fashion for the disenfranchised so much as it was a historical oddity known by a charming name. **BY ALICE GREGORY**

AMERICAN ICON

The Los Angeles Museum of Art purchased this rare 1940–42 zoot suit for its permanent collection of 20th-century menswear. Adding to the flamboyant look are a wide necktie called a belly warmer and two-tone spectator shoes.



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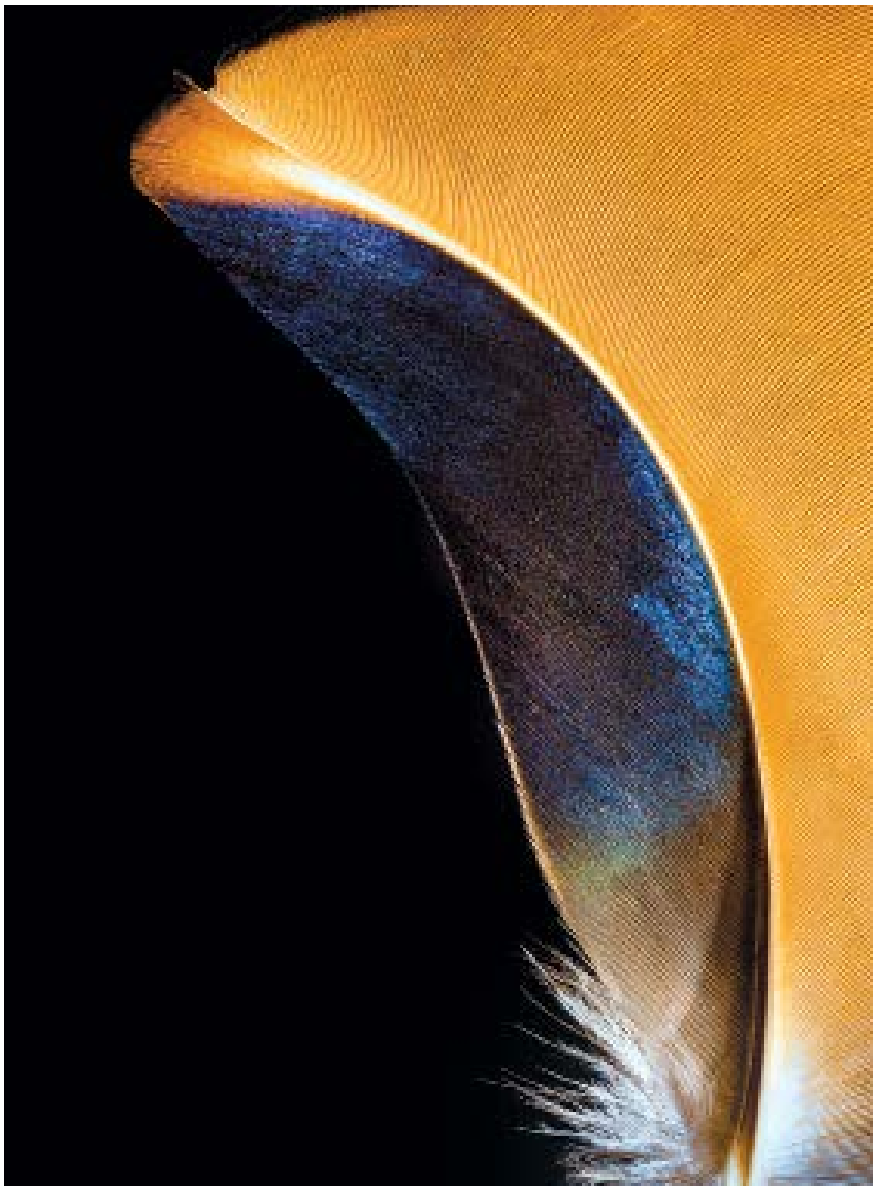
@jake_of_all_trades Went on a supsquatch ride
and met a new friend. #LetHawaiiHappen #VisitOahu



Koʻolīna

Plume Power

A new book spotlights the astonishing beauty and diversity of feathers



Is there anything in nature that is both so extravagantly beautiful and so dang useful as a feather? It makes flight possible, insulates against heat and cold, and disguises, camouflages or flamboyantly advertises, sometimes depending on the season. Whether adorning a red bird of paradise in New Guinea, China's golden pheasant, a Eurasian jay or a Mandarin duck, these intricate structures are a tribute to the power of natural selection, says **Robert Clark**, a New York City-based photojournalist whose new book, *Feathers*, appears this month. His plumage project began with an assignment to shoot bird fossils in China, and it has opened his eyes to an astonishing world of color and form. A feather is "in-nately more interesting than other still-lives," Clark says. "At one angle it might be purple, then you turn it and it's green or blue. There are a million ways to place your camera, but the feather does most of the work." —**AMY CRAWFORD**

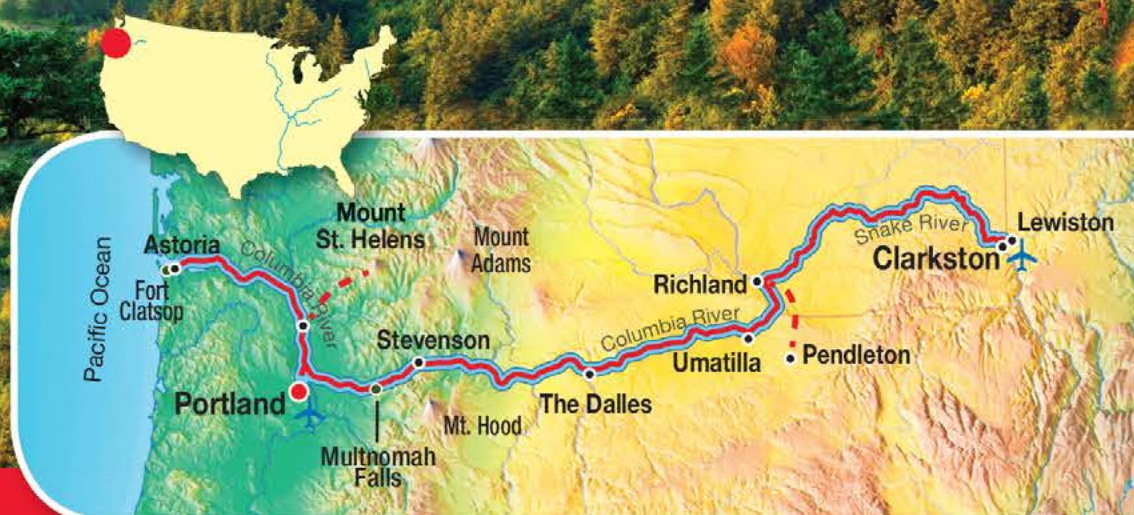
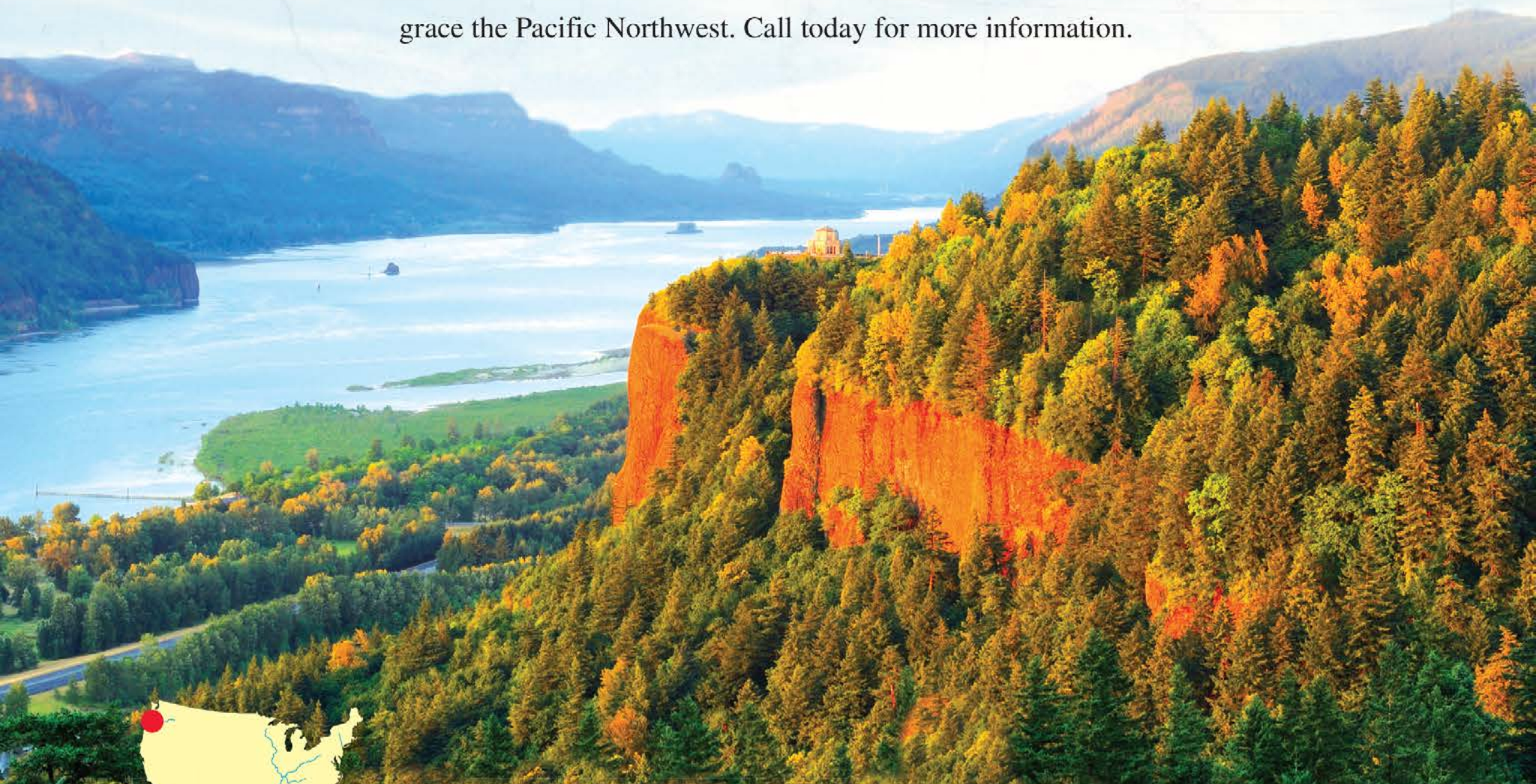


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American Idol

A fresh look
at the Civil
War's most
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officer



He stands on the deck of the USS *Malvern* in December 1864, under the lens of Alexander Gardner, one of the country's most famous photographers. He is the youngest lieutenant commander in the Navy, and in fact the *Malvern* is his ship, although his posture in this unusually casual portrait—recently donated by the collector Peter Tuite to the U.S. Naval Academy Museum in Annapolis, which has granted *Smithsonian* permission to publish it for the first time—is more a pool sharp's than a naval officer's. No matter. He has just returned from a whirlwind leave in which he was awarded the Thanks of Congress, promoted a full rank and honored in New York, Philadelphia and tiny Fredonia, New York, his hometown.

Only four years before, he was expelled from the Naval Academy in his senior year. (He had “a talent for buffoonery,” a superior observed.) But soon he was readmitted to the service, where his talent for combat was never more evident than in late October, when he led his men up the Roanoke River to Plymouth, North Carolina, on what was regarded as a suicide mission—to sink the CSS *Albemarle*, a 158-foot ironclad that had run the Army out of Plymouth and the Navy off the Roanoke. Under fire from the ironclad and from shore, his launch steamed full speed ahead into a log boom built to foil raiders, mere feet from the *Albemarle*. As Rebel gunners struggled to aim a cannon low enough to destroy him, he slipped a mine known as a spar torpedo into the river. Standing coolly in the prow of his launch, he waited. Bullets hit his sleeve and his boot; buckshot removed the back of his coat; still he waited for the torpedo to drift under his target. Just as the Rebel cannoneers fired (and missed), he pulled the detonation cord. Minutes later, the *Albemarle* was sunk.

Now he is back with the fleet, under Adm. David Porter, the hero of Vicksburg. It is Porter who stands behind him, scowling under his Brillo beard. Nonetheless, the admiral waits for the lieutenant commander. He is William Barker Cushing, and his face is on the cover of *Harper's Weekly*. He has just turned 22, and youth must be served. -JAMIE MALANOWSKI

HISTORY

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Ariel Waldman

Author of *What's It Like in Space? Stories From Astronauts Who've Been There* and member of NASA's Innovative Advanced Concepts Program



SMALL TALK

What does space smell like?

Burnt almond cookies. At least, that was what one astronaut reported after sniffing the inside of an air lock. In fact, no one can quite agree on what space smells like. Others have said everything from welding fumes to “wet clothes after rolling in snow.”

What's the most useful item a person can bring into space?

A towel, of course! *The Hitchhiker's Guide to the Galaxy* got it right. Turns out being in space means a lot of bodily fluids management.

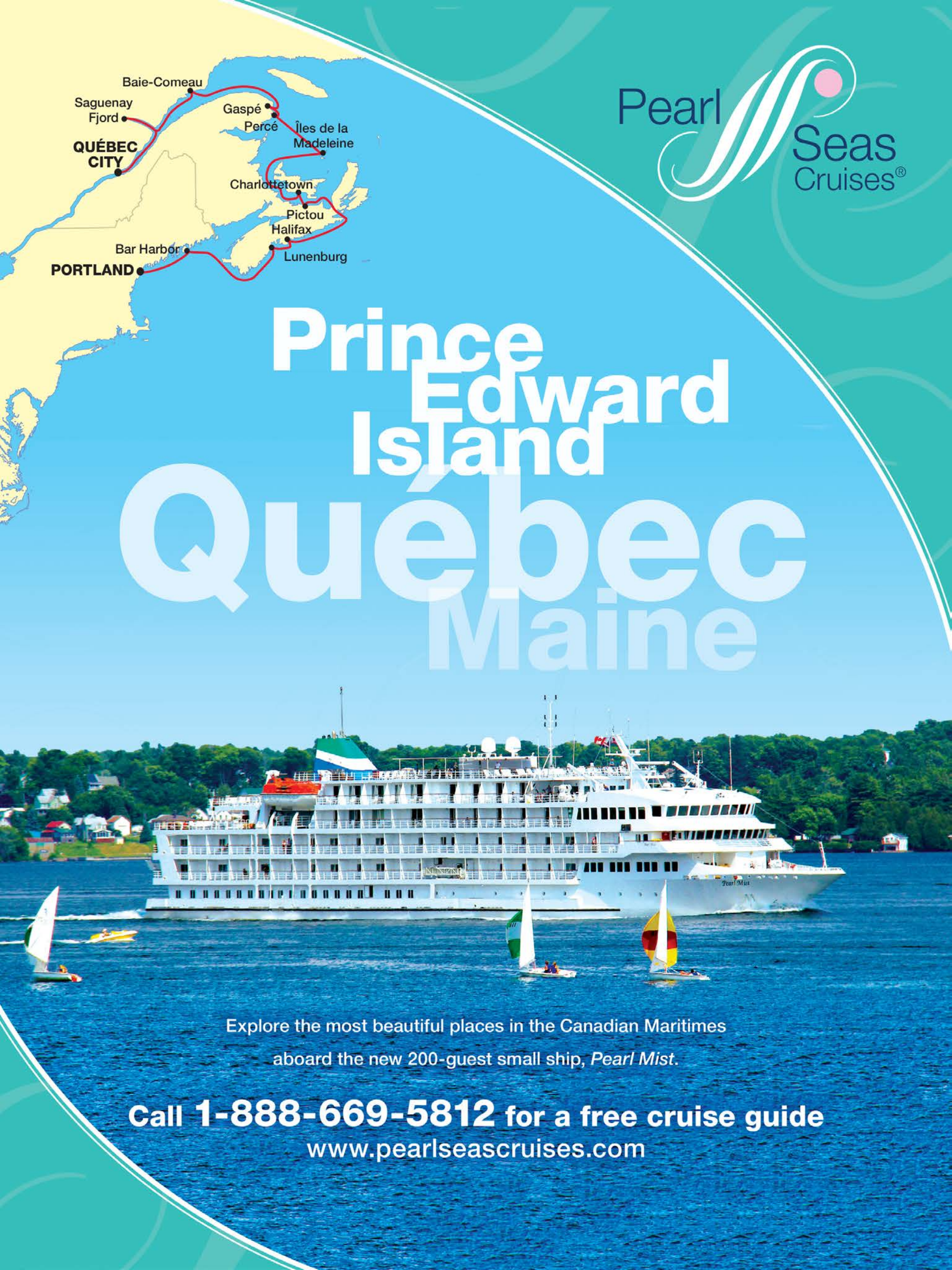
How have other creatures reacted to weightlessness?

Butterflies, while graceful on Earth, are anything but in space. But moths have learned how to float, flapping their wings only occasionally to move from place to place.

If you could visit any place in the solar system or beyond, where would it be?

I'd like to visit Enceladus, the moon of Saturn that has a hydrothermally active ocean beneath its ice. Because of its distance from Earth, if it contained life it would likely be a second genesis of life—essentially, truly alien. Outside the solar system I would visit an intelligent alien civilization somewhere, hopefully in our galaxy, if there is one.

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Giant Step

Scientists stumble on a fishy insight into how humans stood up

You'd think that the latest leap forward in our understanding of human locomotion would come from studying feet. Yet scientists have discovered a surprising new clue to the origins of human bipedalism in a commonplace, pinkie-size fish.

Analyzing the DNA of the threespine stickleback, researchers led by David Kingsley, a biologist at Stanford University, identified a so-called genetic enhancer, a kind of volume control knob that works during body development to help sculpt the bony plates that cloak the stickleback in lieu of scales. The enhancer modulates the release of a bone-related protein known as GDF6, turning it up or down to alter the plates to suit the fish's setting. For marine sticklebacks that live in open water with a multitude of toothy predators, the enhancer spins out enough GDF6 protein to help build hefty protective plates. But freshwater sticklebacks do better to dart off and hide, and so, through enhancer-driven twiddling of protein release, those fish end up with slimmer and more pliable plates.

A genetic toggler's response varies from one setting to the next, while its target—the brick-and-mortar proteins—remains the same, lending evolution considerable flexibility. "It's such a good mechanism for evolving traits that you see it used over and over," Kingsley says.

When the researchers explored the role of the GDF6 protein and its enhancers in shaping the bones of mammals, including the chimpanzee, our nearest genetic kin, they found an enhancer that affected development of rear limbs but not forelimbs. The gene's greatest impact was on the length and curvature of the toes. In human DNA, however, the enhancer was deleted.

That single genetic change could help explain important differences between a chimpanzee foot and our own—and how our ancestors gained the power to rise up and walk on two feet. A chimpanzee's toes are long and splayed, and its big-toe equivalent pulls away from the other digits like a thumb: a prehensile foot designed for quick climbing. By contrast, in the human foot, the sole is enlarged while the bone of the big toe is thickened and aligned with the other, now-foreshortened toes: This is a sturdy platform, able to support an upright load in motion.

Aside from showing that our big toe deserves far more respect than most of us know, the new finding demonstrates that minor alterations in DNA can have profound evolutionary impacts, and that nature is a tireless recycler and collage artist, mixing and matching a few favorite techniques to generate a seemingly bottomless diversity of forms.

"Our shared history with fish," says Neil Shubin, author of *Your Inner Fish* and a paleontologist, "makes them a wonderful arena for exploring the fundamentals of our own bodies." -NATALIE ANGIER

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ADAPTATION

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352-463-3467 | 36. Old Fenimore Mill Condominiums
352-543-9803 |
| 5. Bradenton/Anna Maria Island/Longboat Key, FL
941-729-9177 | 22. Greater Miami Convention & Visitors Bureau
305-539-3000 | 37. Oldest Wooden School House
904-824-0192 |
| 6. Charlotte Harbor and the Gulf Islands
1-800-652-6090 | 23. Gumbo Limbo Nature Center
561-544-8605 | 38. Putnam County Chamber of Commerce
386-328-1503 |
| 7. Columbia County Tourist Development Council
386-758-1312 | 24. Historic Tours of Flagler College
904-819-6400 | 39. Sebastian River Area Chamber of Commerce & Visitor's Center
772-589-5969 |
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1-866-778-5002 |
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850-245-2094 | 29. Madison County Tourist Development Council
850-973-2788 | 44. Visit Natural North Florida
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850-245-6000 | 30. Martin County Office of Tourism and Marketing
1-877-585-0085 | 45. Visit Pasco
1-800-842-1873 |
| 14. The Florida Keys & Key West
1-800-FLA-KEYS | 31. The Mennello Museum of American Art
407-246-4278 | 46. Visit Pensacola
1-800-874-1234 |
| 15. Florida's Adventure Coast Visitors Bureau
1-800-601-4580 | 32. Morikami Museum and Japanese Gardens
561-495-0233 | 47. Visit Sarasota County
239-225-1006 |
| 16. Fort Pierce, St. Lucie County
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If Music Be the Food of Questlove

In a new book, the bandleader and hip-hop star stirs up music and cooking

Chefs may or may not be performing artists. That's open to debate.

Cooking is a craft, but some would argue that preparing the same dish again and again—the hallmark of professional consistency—is imagination-free rote repetition. Still, in this age of cooking shows and open kitchens, chefs are undeniably onstage, and a new book reveals their rich creative process. Eccentrically titled *Something to Food About*, it's a collection of conversations between ten chefs and the Philadelphia-born hip-hop drummer and “Tonight Show” bandleader Questlove.

It shouldn't come as a surprise that a musician is able to unlock chefs' innermost thoughts about creativity. Performers often make restaurants an obsession while they're on the road, and few more than Questlove: His Instagram feed features snapshots of food from fried chicken and waffles to Jiro Ono's triple-Michelin-starred sushi. Chefs also tend to be music-obsessed. Many of the dozens I've interviewed have played in a band at one time or another. The two professions have striking similarities. Each relies on a script—a score or a menu—that can be interpreted as an infinitely variable set of instructions.

Chefs and musicians also face a similar challenge: pleasing an audience while opening it to new ideas. In one passage, Questlove recalls a meal he ate at the Chicago restaurant Next—a discomfiting mixture of eggshells, eyes and bones. “Not only did I manage to put it in my mouth, but it was one of the best things I ever had,” he says—and then compares the experience to playing the white frat-boy hit “Sweet Caroline” at a DJ set for a mostly black crowd. “They stopped and looked at me like they might rush the booth and flip over the turntable,” he recalls.

“But then they caught the taste of the song and started to sing.”

Questlove is like an irrepressible adolescent surrendering to any riff he hears in his head. Speaking with New Orleans Cajun chef Donald Link, he refers, in a short space, to The Police, the Epcot theme park and the movie version of *The Wiz*. There's plenty of talk, too, about specific dishes, and for those who want to see them, moody, harshly lit photographs by Kyoko Hamada.

Sheer, baffling novelty is part of the performance. The cerebral Seattle software visionary-turned-chef Nathan Myhrvold, whose food lab gave birth to the masterly five-volume *Modernist Cuisine*, admits that some of the “new, weird things” chefs

put in front of diners are designed to make them say, “What the f--- is this?” But

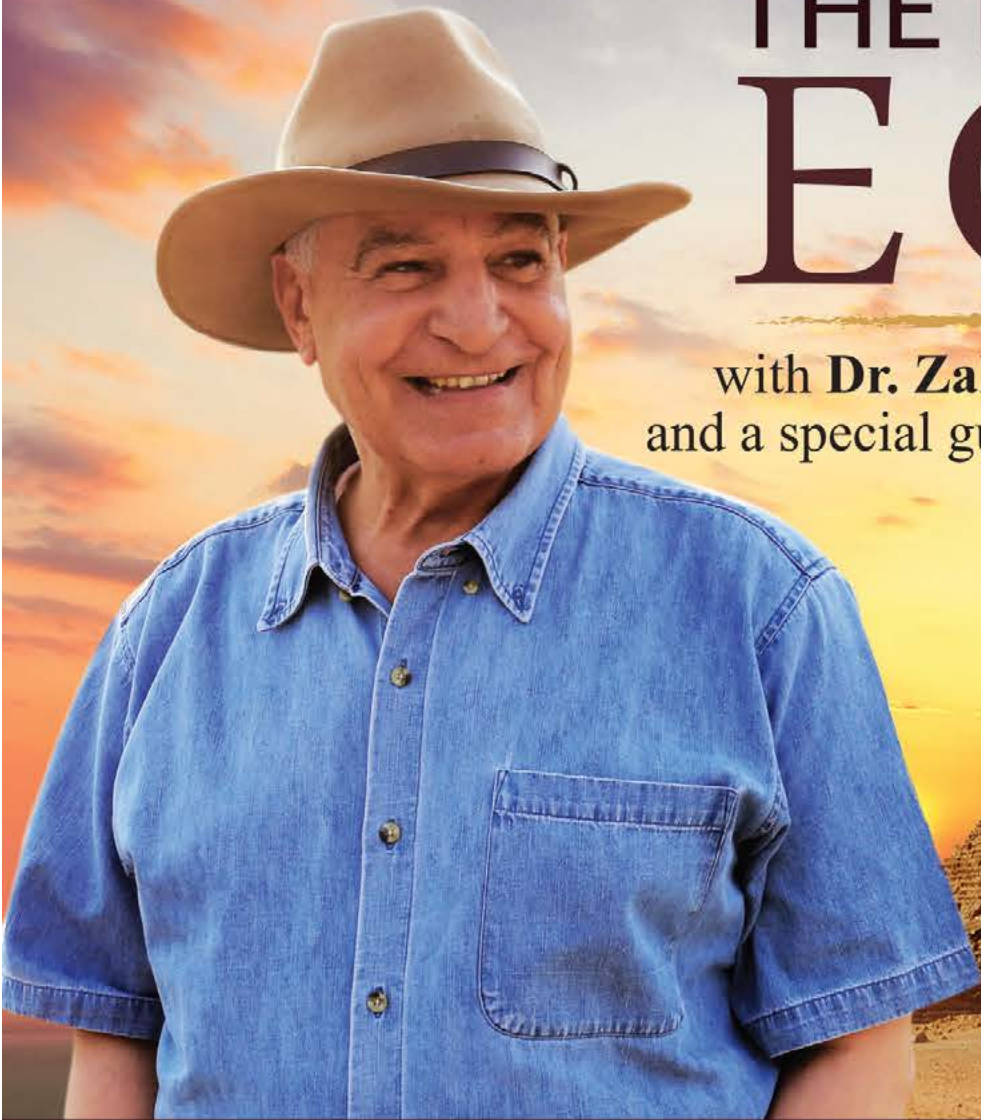
it's these riffs the food industry turns to when looking to attract disenchanted consumers. We wouldn't have, say, sriracha-roasted peanuts if it weren't for the kind of back-street trips American chefs have taken through northern Thailand. Even if food can't be reproduced, it can be stolen, re-invented, reimagined—and Questlove's freewheeling conversations make us feel present at the creation. -CORBY KUMMER

“I worked in a fast-food place once,” says Questlove. “I lasted about four months.”



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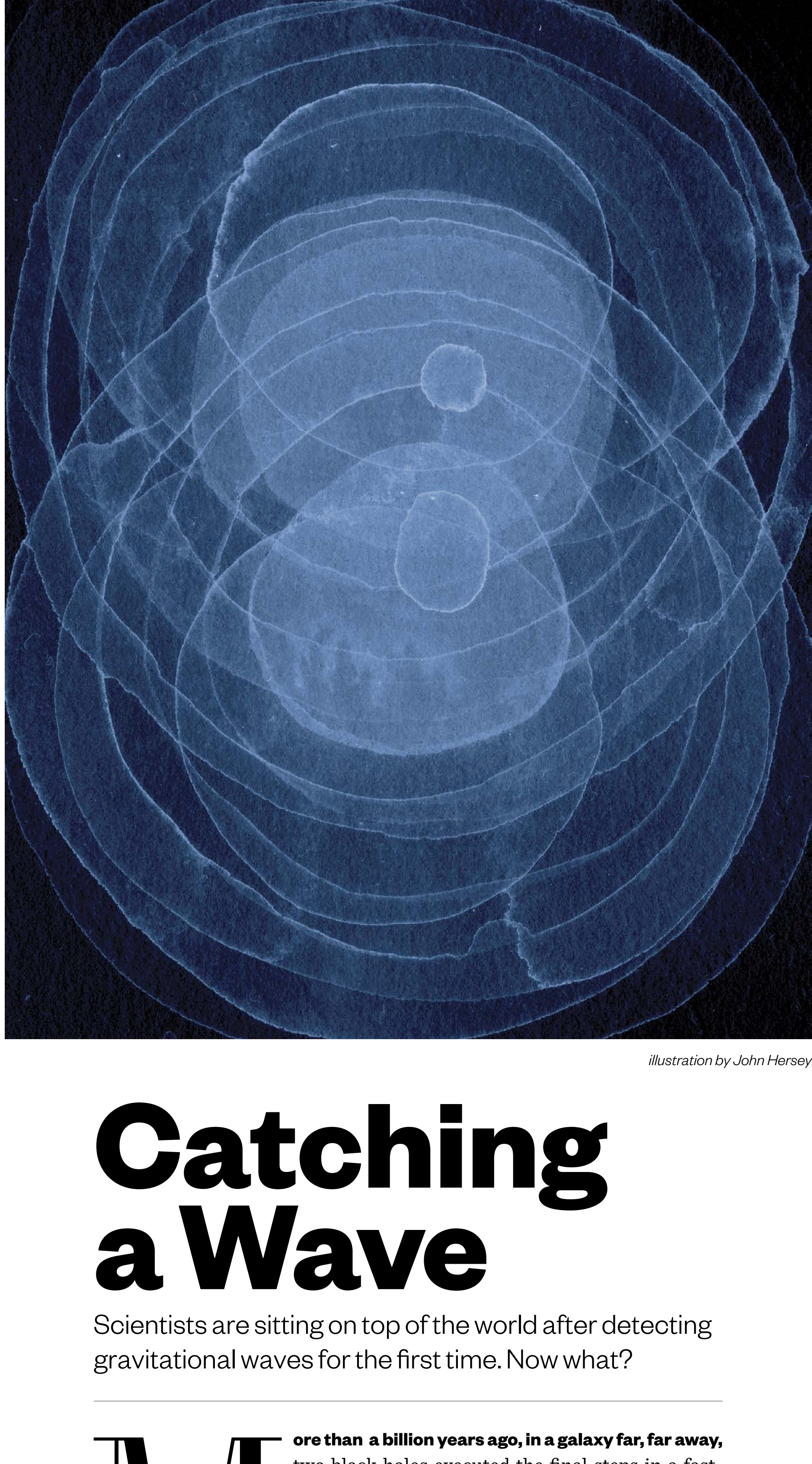


illustration by John Hershey

Catching a Wave

Scientists are sitting on top of the world after detecting gravitational waves for the first time. Now what?

More than a billion years ago, in a galaxy far, far away, two black holes executed the final steps in a fast-footed pas de deux, concluding with a final embrace so violent it released more energy than the combined output of every star in every galaxy in the observable universe. Yet, unlike starlight, the energy was dark, being carried by the invisible force of gravity. On September 14, 2015, at 5:51 a.m. Eastern Daylight Time, a fragment of that energy, in the form of a “gravitational wave,” reached Earth, reduced by its vast transit across space and time to a mere whisper of its thunderous beginning.

As far as we know, Earth has been bathed in this type of gravitational disturbance before. Frequently. The difference this time is that two stupendously precise detectors, one in Livingston, Louisiana, and the other in Hanford, Washington, were standing at the ready. When the gravitational wave rolled by, it tickled the detectors, providing the unmistakable signature of colliding black holes on the other side of the universe and marking the beginning of a new chapter in humankind’s exploration of the cosmos.

When rumors of the discovery started circulating in January, I rolled my eyes at what was clearly a false alarm or a ploy to stir up a little buzz. As a research program well into its fifth decade, the hunt for gravitational waves had long since become the major discovery that was always hovering on the horizon. Physicists had become resigned to waiting for their gravitational Godot.

But human ingenuity and perseverance have triumphed. It’s one of those victories that give even those of us cheering from the sidelines spine-tingling shivers.

Here’s the story, in a nutshell.

This past November, the world celebrated the centenary of Einstein’s greatest discovery, the general theory of relativity, which revealed a new paradigm for understanding gravity. Isaac Newton’s approach correctly predicts the gravitational attraction between any two objects but gives no insight into how something *here* can reach out across empty space and pull on something *there*. Einstein spent a decade trying to determine how gravity is communicated, and finally concluded that space and time form the invisible hand that does gravity’s bidding.

The metaphor of choice, overused but evocative, is to think of space as a trampoline. Place a bowling ball in the middle of the trampoline causing it to curve, and a marble will be nudged to travel along a curved trajectory. Similarly, Einstein professed that near an astronomical body like the Sun, the spacetime environment curves, which explains why Earth, much like the marble, follows a curved trajectory. By 1919, astronomical observations confirmed this remarkable vision, and made Einstein Einstein.

Einstein pushed his momentous discovery further. To that point, he had focused on static situations: determining the fixed shape of a region of spacetime arising from a given amount of matter. But Einstein then turned to dynamic situations: What would happen to the spacetime fabric if matter were to move and shake? He realized that much as kids jumping on a trampoline generate waves in the surface that ripple outward, matter that moves this way and that will generate waves in the fabric of spacetime that ripple outward, too. And since, according to general relativity, curved spacetime is gravity, a wave of curved spacetime is a wave of gravity.

Gravitational waves represent general relativity’s most significant departure from Newtonian gravity. Flexible spacetime is surely a profound recasting of gravity, yet in familiar contexts like the gravitational pull of the Sun or Earth, Einstein’s predictions barely differ from those of Newton. However, because Newtonian gravity is silent regarding how gravity is transmitted, the notion of traveling gravitational disturbances has no place in Newton’s theory.

Einstein himself had misgivings about his predication of gravitational waves. When first encountering the subtle equations of general relativity, it’s challenging to disentangle abstract math from measurable physics. Einstein was the first to engage in this tussle, and there were features that even he, the cynosure of relativity, failed to fully understand. But by the 1960s, scientists using more refined mathematical methods established beyond any doubt that gravitational waves were a distinguishing feature of the general theory of relativity.

How, then, could this iconic prediction be tested? In 1974, using the Arecibo Radio Telescope, Joseph Taylor and Russell Hulse discovered a binary pulsar: two orbiting neutron stars whose orbital period could be tracked with great precision. According to general relativity, the orbiting stars generate a steady march of gravitational waves that drain energy, causing the stars to fall closer together and orbit more quickly. Observations confirmed this prediction to a T, providing evidence, albeit indirect, that gravitational waves are real. Hulse and Taylor received the 1993 Nobel Prize.

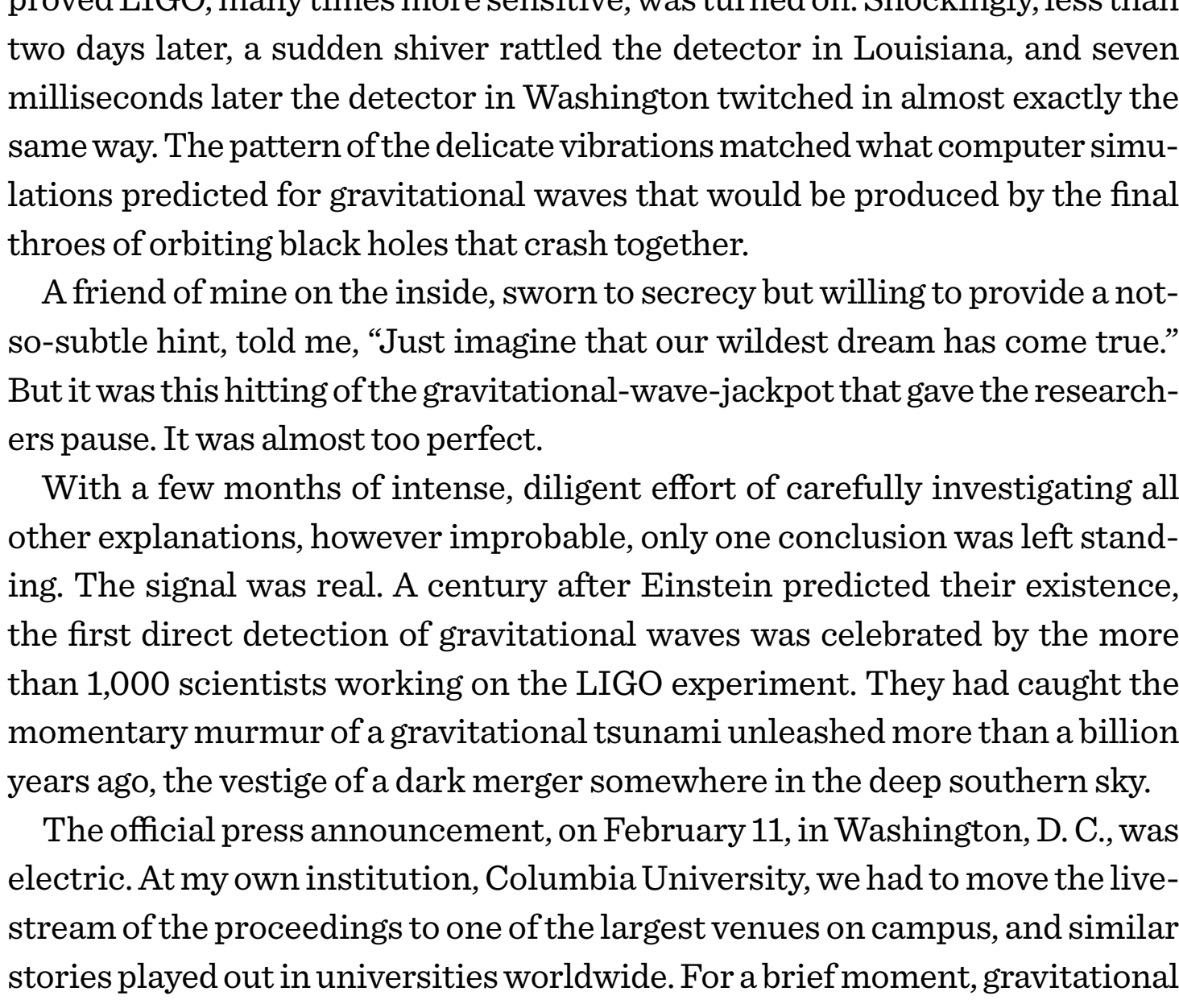


Astrophysicist Kip Thorne dared to dream of a machine to find gravitational waves.

The achievement only made the direct detection of gravitational waves all the more alluring. But the task was daunting. Calculations show that as a gravitational wave ripples through space, anything in its path will be alternately stretched and squeezed along the axes perpendicular to the wave’s direction of motion. A gravitational wave headed straight toward the United States would alternately stretch and squeeze the space between New York and California, and that between Texas and North Dakota. By precisely monitoring such distances, we should thus be able to pinpoint the wave’s passing.

The challenge is that much as a ripple in a pond dies down as it spreads out, a gravitational ripple dilutes as it travels from its source. Since major cosmic collisions typically happen very far from us (thankfully), by the time the gravitational waves spawned reach Earth, the amount of stretching and squeezing they cause is tiny—less than an atomic diameter. Detecting such changes is on par with measuring the distance from Earth to the nearest star beyond the solar system with an accuracy better than the thickness of a sheet of paper.

The first attempt, pioneered by the University of Maryland’s Joseph Weber in the 1960s, used multi-ton solid aluminum cylinders, in the hope that they would gently resonate like giant tuning forks in response to a passing gravitational wave. By the early 1970s, Weber claimed success, big time. He reported that gravitational waves were ringing his detector almost on a daily basis. This momentous achievement inspired others to corroborate Weber’s claims, but after years of trying, no one could catch even a single wave.



The LIGO apparatus depends on precisely engineered—and perfectly clean—mirrors.

Weber’s tenacious belief in his results, long after the amassed evidence suggested otherwise, contributed to a perspective that has colored the field for decades. Over the years, many scientists believed, as did Einstein, that even if gravitational waves were real, they would simply be too weak to ever be detected. Those who set out to find them were on a fool’s errand, and those who believed claims of detection were being fooled.

By the 1970s, the few who still had the gravitational wave bug turned to a more promising detection scheme in which lasers would be used to compare the lengths of two long identical tunnels oriented at 90 degrees to each other. A passing gravitational wave would stretch one tunnel while squeezing the other, slightly changing the distances traveled by laser beams fired along each. When the two laser beams are subsequently recombined, the resulting pattern that the light forms is sensitive to minute differences in how far each beam has traveled. If a gravitational wave rolls by, even the minuscule disturbance it creates would leave a modified laser pattern in its wake.

It’s a beautiful idea. But nearby jackhammers, rumbling trucks, gusts of wind or falling trees could disturb such an experiment. When seeking length differences of less than a billionth of a billionth of a meter, the ability to shield the apparatus from every possible environmental agitation, however slight, becomes paramount. With that seemingly insurmountable requirement, the naysayers were provided yet more ammunition. Catching a gravitational wave would render Horton’s hearing a Who, even over the roaring din of the New York City subway, mere child’s play.

Nevertheless, the American physicists Kip Thorne and Rainer Weiss, later joined by the Scottish physicist Ronald Drever, dreamed of building a laser-based gravitational wave detector, and they set the wheels in motion to make that dream a reality.

In 2002, after a couple of decades of research and development and more than a \$250 million investment from the National Science Foundation, two scientific and technological marvels that make up LIGO (Laser Interferometer Gravitational-Wave Observatory) were deployed in Livingston, Louisiana, and Hanford, Washington. Four-kilometer-long evacuated tunnels in the shape of a giant letter “L” would house a laser beam some 50,000 times more potent than a standard laser pointer. The laser light would bounce back and forth between the world’s smoothest mirrors, placed at opposite ends of each arm, seeking a tiny mismatch in the time it takes each to complete the journey.

Pointing, to be sure, but as the research teams argued, not surprising. Calculations had shown that LIGO was barely at the sensitivity threshold necessary to detect gravitational waves. So in 2010, LIGO was shut down for various upgrades, to the tune of more than \$200 million, and in the fall of 2015, an improved LIGO, many times more sensitive, was turned on. Shockingly, less than two days later, a sudden shiver rattled the detector in Louisiana, and seven milliseconds later the detector in Washington twitched in almost exactly the same way. The pattern of the delicate vibrations matched what computer simulations predicted for gravitational waves that would be produced by the final throes of orbiting black holes that crash together.

A friend of mine on the inside, sworn to secrecy but willing to provide a not-so-subtle hint, told me, “Just imagine that our wildest dream has come true.” But it was this hitting of the gravitational-wave-jackpot that gave the researchers pause. It was almost too perfect.

With a few months of intense, diligent effort of carefully investigating all other explanations, however improbable, only one conclusion was left standing. The signal was real. A century after Einstein predicted their existence, the first direct detection of gravitational waves was celebrated by the more than 1,000 scientists working on the LIGO experiment. They had caught the momentary murmur of a gravitational tsunami unleashed more than a billion years ago, the vestige of a dark merger somewhere in the deep southern sky.

The official press announcement, on February 11, in Washington, D.C., was electric. At my own institution, Columbia University, we had to move the live-stream of the proceedings to one of the largest venues on campus, and similar stories played out in universities worldwide. For a brief moment, gravitational waves trumped presidential prognostication.

The excitement was warranted. History will look back on the discovery as one of those few inflection points that change the course of science. Ever since the first human looked skyward, we have explored the universe using waves of light. The telescope substantially enhanced this ability, and with it we encountered the splendor of new cosmic landscapes. During the 20th century, we broadened the kinds of light signals we detect—infrared, radio, ultraviolet, gamma and X-rays—all forms of light but with wavelengths outside the range we can see with the naked eye. And with these new probes, the cosmic landscape grew richer still.

Gravitational waves are a completely different kind of cosmic probe, with the potential of yielding even more dramatic consequences. Light can be blocked. An opaque material, like a window shade, can block visible light. A metal cage can block radio waves. By contrast, gravity passes through everything, virtually unchanged.

And so, with gravitational waves as our probe we will be able to examine realms that are off-limits to light, like the chaotic spacetime scramble as two black holes collide or perhaps the wild rumble of the big bang itself, 13.8 billion years ago. Already, the observation has confirmed the idea that black holes might form binary pairs. More tantalizing still, we may find a dark landscape populated by things we’ve yet to even imagine.

As network of detectors across the globe—in Italy, Germany, soon Japan and likely India—pool their data, hopefully to be joined in the future by an enormous detector operating in space, our ability to probe the cosmos will take another giant leap forward. Which is utterly thrilling. There’s nothing more inspiring than our capacity, in the midst of our ever-present terrestrial struggles, to look up, to wonder, and to have the ingenuity and dedication to see a little farther. **O**

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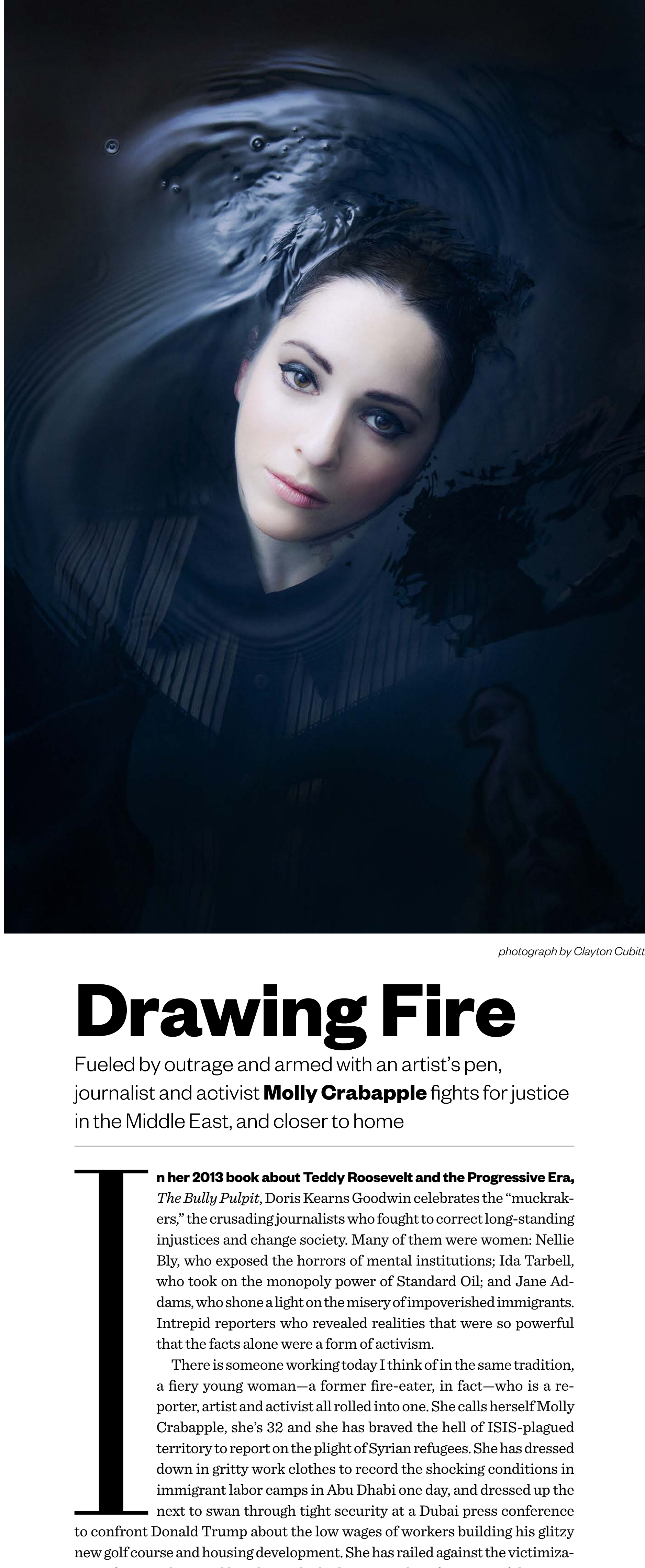
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photograph by Clayton Cubitt

Drawing Fire

Fueled by outrage and armed with an artist's pen, journalist and activist **Molly Crabapple** fights for justice in the Middle East, and closer to home

In her 2013 book about Teddy Roosevelt and the Progressive Era, *The Bully Pulpit*, Doris Kearns Goodwin celebrates the “muckrakers,” the crusading journalists who fought to correct long-standing injustices and change society. Many of them were women: Nellie Bly, who exposed the horrors of mental institutions; Ida Tarbell, who took on the monopoly power of Standard Oil; and Jane Adams, who shone a light on the misery of impoverished immigrants. Intrepid reporters who revealed realities that were so powerful that the facts alone were a form of activism.

There is someone working today I think of in the same tradition, a fiery young woman—a former fire-eater, in fact—who is a reporter, artist and activist all rolled into one. She calls herself Molly Crabapple, she's 32 and she has braved the hell of ISIS-plagued territory to report on the plight of Syrian refugees. She has dressed down in gritty work clothes to record the shocking conditions in immigrant labor camps in Abu Dhabi one day, and dressed up the next to swan through tight security at a Dubai press conference to confront Donald Trump about the low wages of workers building his glitzy new golf course and housing development. She has railed against the victimization of sex workers and has dug up leaked prison videos from one of the worst solitary confinement ‘holes’ in the American prison system in Pennsylvania to draw attention to the wretched souls incarcerated there. She's traveled to Guantanamo, Gaza, Lebanon, Istanbul and riot-torn Athens.

Unlike her predecessors, Crabapple makes her weapons of choice the artist's pen and paintbrush. Her frenzied arabesque strokes recall the savagery of Daumier and Thomas Nast and Ralph Steadman, as well as the tenderness of Toulouse-Lautrec. She makes us look at what we don't want to see—searing vistas devastated by war, cities in ruins, people in agony. This is what the female version of the gonzo spirit looks like today. Less self-absorbed, more empathetic. But still fueled by outrage.

As she puts it, “There are so many photos from Syria of every possible atrocity—this is the most documented war in history—and people are kind of numb. You need to try to get people in the West to give a s--t. Drawing is very slow, it's very invested.”

Her words and pictures appear in traditional media like the *New York Times* and *Vanity Fair*. But this barely scratches the surface of the dazzling array of projects by a woman who's been called an art movement of her own. Her work has appeared in major galleries on three continents, she's whipped up multiple graphic novels, and she's recently established herself as a writer with a blazing memoir called *Drawing Blood*. One reviewer has called her “a punk Joan Didion, a young Patti Smith with paint on her hands.”

And then there are the unique stop-motion drawings she posts to cutting-edge digital video platforms like Fusion. I've never seen anything like them before; they are mesmerizing. The speed sketching gives the images dramatic energy and the stories a memorable impact. The story of the Chinese computer engineer, for instance, who'd been living in America for 17 years and was married to an American citizen, but whose green card renewal paperwork was screwed up. Suddenly, immigration agents arrested him and threw him into a detention center a couple of thousand miles from home, with no access to desperately needed medicine. He died of bone cancer before he had a chance to make his case.

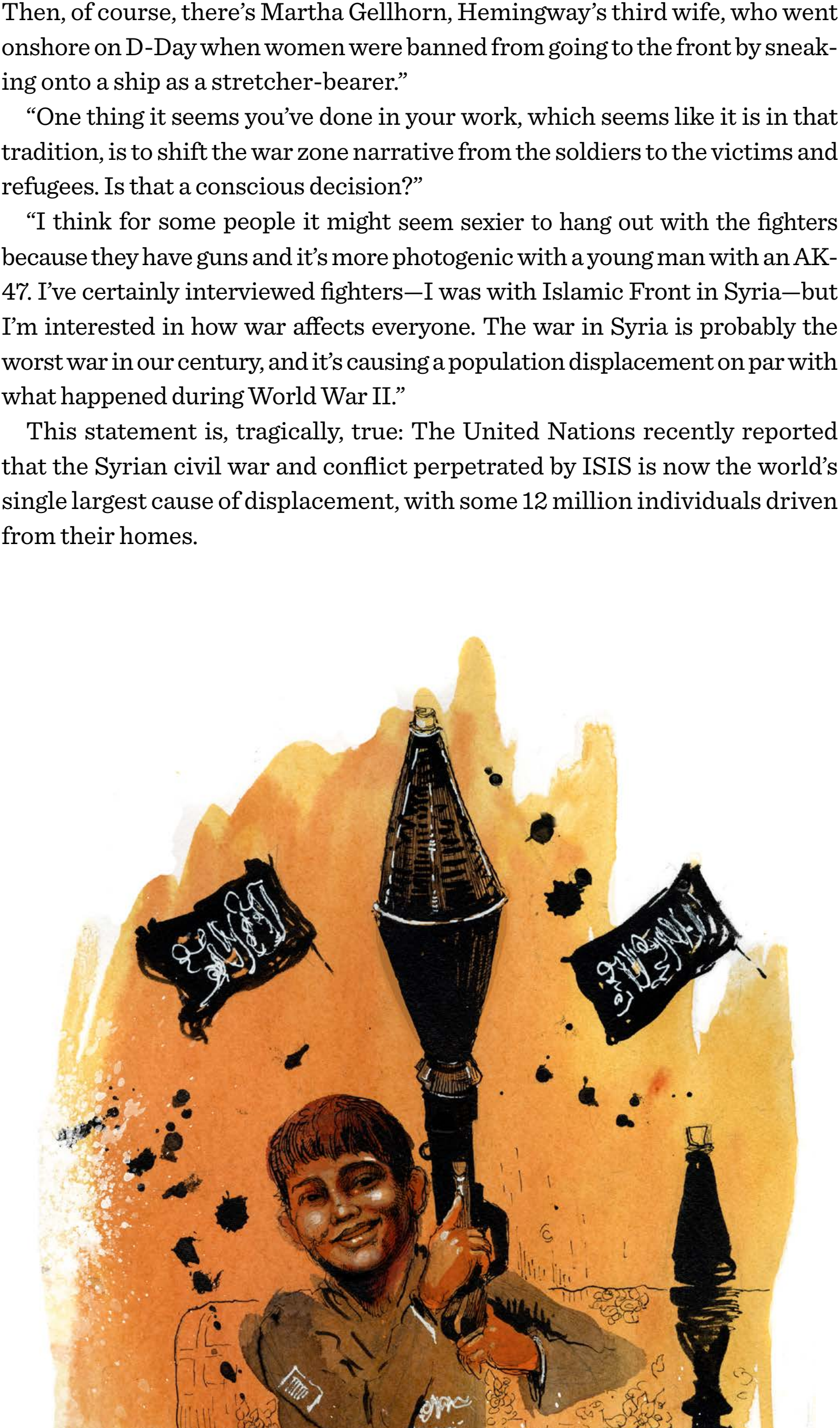
Crabapple's activist side benefits from her social media expertise. She sells original pages from her animations, advertising them on Twitter, to raise money to aid Syrian refugees.

If you were to ask me how to sum up her impact, I'd say that it has to do with the so-called “economy of attention.” She focuses our minds, now so scattered and divided, on serious, heart-wrenching global issues.

“If you want the truth, you speak to people on the ground, whether that person is a grandma living in a refugee camp or a young fighter, or a cynical young man living in Aleppo.”

Most people don't think of Wall Street as a residential neighborhood, but there are still a few small, scattered centuries-old apartment buildings bravely weathering the floods that battered financial district skyscrapers. The location of Crabapple's apartment, on a narrow street chastely named Maiden Lane, not far from the famous bronze bull, turned out to be the catalyst for a turning point in her life.

She grew up a long subway ride and a world away, in Far Rockaway and Long Island. Her Puerto Rican father was a Marxist professor; her Jewish mother was a book illustrator. (Her given name was Jennifer Caban.) She was a rebellious goth brat, reading the Marquis de Sade and Oscar Wilde, and found herself inspired by Mexican muralist Diego Rivera and his partner, the artist Frida Kahlo.



Crabapple sketched scenes of daily life from photos taken in ISIS-controlled Mosul, Iraq.

She reincarnated herself more than once, evolving from art student to artist's model to performer and impresario of a kind of underground bohemian performance-art burlesque/circus scene in downtown New York. An ex-boyfriend chose the name “Molly Crabapple” for her. “He said it fit my personality,” she says, laughing.

She has been a whirlwind. But all was quiet as we sat at her cluttered kitchen table. She has a Scheherazade kind of beauty, which matches her apartment, decorated in an antique Ottoman style.

I began by observing that some of the most daring reporting on the current catastrophe of the Middle East has been done by women, often freelancers, risking life and kidnapping and worse. Writers like Ann Marlowe, photojournalists like Heidi Levine and the late Anja Niedringhaus.

“There's a legacy of women doing conflict reporting,” Crabapple replied. “Women like Nellie Bly and Djuna Barnes. They've been underestimated and written out of history by the men that control official narratives.”

“When Djuna Barnes was a young woman, she endured force-feeding so she could write articles about what it was like for a suffragette hunger striker to be force-fed. Her first job was a journalist—and she was an illustrator as well. Then, of course, there's Martha Gellhorn, Hemingway's third wife, who went onshore on D-Day when women were banned from going to the front by sneaking onto a ship as a stretcher-bearer.”

“One thing it seems you've done in your work, which seems like it is in that tradition, is to shift the war zone narrative from the soldiers to the victims and refugees. Is that a conscious decision?”

“I think for some people it might seem sexier to hang out with the fighters because they have guns and it's more photogenic with a young man with an AK-47. I've certainly interviewed fighters—I was with Islamic Front in Syria—but I'm interested in how war affects everyone. The war in Syria is probably the worst war in our century, and it's causing a population displacement on par with what happened during World War II.”

This statement is, tragically, true: The United Nations recently reported that the Syrian civil war and conflict perpetrated by ISIS is now the world's single largest cause of displacement, with some 12 million individuals driven from their homes.



In Lebanon, Crabapple captured a community swept up by extremism (Mohammed, 9).

“And I was interested in ground-level people—not necessarily victims. I feel like when you interview big muckety-mucks, whoever they are, you get pre-packaged statements, a narrative that is very polished. If you want the truth, you speak to the people on the ground, whether that person is a grandma living in a refugee camp or a young fighter, or a cynical young man living in Aleppo.”

“Let's pause for just a moment. Did you say you were with the Islamic Front?”

“Not the Islamic State. That's a very important distinction. I was in Syria very, very briefly, and there was a coalition of groups that were Islamist groups that, at that time, had kicked ISIS out of a number of northern towns and was controlling the border crossing [into Turkey].”

“What were the Syrian rebel fighters like?”

“They were just young guys who had been in college. Obviously, since they work with the media, they're very educated, they speak English. They were funny, sarcastic young men who had been through a lot of trauma and had seen too much. They had really seen too much.”

She recalls “one young guy who kept talking about seeing a C-section performed without anesthesia, at one of these makeshift field hospitals. And they've seen people die in bombings, they've killed people. One of the young guys I was with, he had killed several ISIS members. They've interrogated people; they've seen things that fundamentally change you as a person.”

“How does seeing so much horror affect you?”

“I guess you develop a sense of anger at the injustice of the world and the way people live and die according to the papers that they hold. But I feel silly talking about how it affected me and I'm here in a beautiful apartment. You know, what does it matter? It really affects the people who are living it.”

“Do you think your view of human nature has been changed by your exposure to all this suffering?”

“I've always been kind of cynical. But I think my view of human nature has been elevated because I've met so many people working in the most extreme adversity who are so decent and clever and fundamentally defiant, refusing to accept the roles that life has allotted to them. I have such admiration for people like that. I always feel I can learn from them, they're people I feel very lucky to know and honor very much.”

I asked her where she's been that she felt the most in danger.

“OK, there are these two neighborhoods in Tripoli [in Lebanon],” she remembers. “The best way to describe it is they're like the Sharks and the Jets. Sunni militia and another group, which is Shia. And the neighborhoods have been fighting each other for 40 years, and there's a street that divides them—they shoot over it, they throw grenades over it.”

“So I did a piece for the *New York Times* about how Syrian refugees were fleeing Syria and going to Tripoli and still finding themselves amidst sectarian warfare, and I interviewed snipers in the local militias. I didn't sketch them while they were shooting; I just sketched them in their little hide-outs.”

“Does anyone get killed in this or is it more a harassing kind of thing?”

“No, people were dying.”

“And these guys didn't mind you . . . ?”

“No, they were happy; they wanted to show off. They're macho. This is something I find about getting access to a lot of stuff—people from all walks of life want to be acknowledged for what they do. And they don't think what they do is bad at all. They're quite proud of what they do. Like here's my big gun, here's my kid who I'm having throw grenades at people. It's not just them. People from all cultures. You'll find the same thing in America.”

I've often wondered about people who are drawn to witness suffering, sacrifice and survival. “Did you grow up feeling sensitive to suffering in some way?”

“I grew up in a very political house. My dad is a Marxist. He's Puerto Rican and when I was a little girl he made up this story about this anti-colonialist pirate who would travel around the Caribbean and liberate slaves from sugar plantations. My dad was a sugar cane cutter, like my granddad [her father later became an academic]. So I grew up in a household that was very concerned with injustice and very concerned with bulls--t. My dad told me when I was a little girl, I have two rules for you: Question authority and be interesting.”

“Well,” I said, “You managed that. You were a fire-eater at one point, weren't you?”

Her performance art included a stint as a fire-eater. It struck me as a metaphor for her fire-breathing art. Of course, metaphors are fine, but I still found the actual fire-eating hard to believe. “How does that work?”

“OK,” she says, “fire-breathing is really hard but fire-eating is pretty easy.”

Who knew?

“So you take your torch . . .” She mimes holding a torch above her head, throwing her head back and dunking the burning end into her mouth.

“Your mouth isn't going to get burned because the heat's all going up, right?”

Um, sure.

“And then when you close your lips around the torch, it cuts off the oxygen and cuts off the flame.”

She is so nonchalant about it, she almost makes you forget what a crazy idea it is to eat fire.

How did Molly Crabapple go from fire-eating downtown New York performance artist to flame-throwing journalist?

It started when she graduated high school early, at 17, traveled to Paris, got a job at the famous Shakespeare and Company bookstore and fell in with the ex-pat Bohemian scene. She started drawing in a big notebook a boyfriend gave her, decided to learn Arabic, became intrigued by the Ottoman Empire and its art, and took off for far Eastern Turkey.

There she became fascinated by a magically carved mosque. She had found her stylistic muse. “It's on the Turkish-Armenian border,” she says, “and it's so beautiful. It's like this crazy, Dr. Seuss ruin with striped minarets and domes. [Back in New York] I spent long times sitting in Islamic rooms at the Met, staring at the miniatures, seeing how they did these subtle colors and detailed patterns. A lot of the reason why I admire art from the Islamic world is that in a lot of these countries figurative art is religiously prohibited, and so instead, they did the most intellectually rigorous but sensual abstraction in the world.”

“I like that. Intellectually rigorous and sensual.”

“Yeah, it's like math, like math made into art.”

She pulls a book out of a pile on her kitchen table and opens to a page of intricate Islamic tile work. “Look at these patterned repetitions. It's incredibly lush, but it's based on math. All my sense of wonderment is aroused by this.”

In fact, she was so captivated by wonder at the arabesque forms in that mosque in eastern Turkey that she started sketching them in her notebook—and didn't notice the police approaching to arrest her. She is characteristically blithe about the story. She remembers it as a great artistic experience, her first brush with hostile authorities; I think of *Midnight Express*. (After some suspicious questioning she was able to talk her way out it.)

But her real artistic turning point came during a frenzied period she calls her “Week in Hell”—a kind of artistic nervous breakdown. “I was just sick of my work,” she recalls. “I hated everything I had done. So I decided to lock myself in a hotel room, put paper over the walls and draw until I'd bled all of my clichés out of me and something new emerged.”

The project was later recorded in a graphic-novel-type book, both crazy and irresistible to look at, like a graffiti-covered New York subway car from the '70s.

“You have said, ‘The wall broke me.’ What does that mean?”

“I had just drawn and drawn and drawn and drawn and finally I collapsed.”

And right after “A Week in Hell” ended, Occupy Wall Street started, just a few blocks away from her apartment. She was psychologically ready to throw herself into a movement that was larger than herself, she says. So she began doing a nearly 24/7 chronicle of Occupy, sketching the protests, clashes and arrests. One of her Occupy posters is now in the permanent collection of the Museum of Modern Art.

After Occupy left Wall Street she found herself drawn to seek out the world's trouble spots, to report on the people whose every day was a week in hell. She persuaded Vice to send her to Guantanamo, from which she brought back harrowing images and reportage. Then she began to focus on the blood-soaked Middle East.

Toward the end of our talk I asked about a quote I'd read of hers, something about her career trajectory: “Jaggedness,” she had said, “goads you on.”

She told me she didn't have a big breakthrough success but a dozen or so cracks in the wall and just kept at it however jagged the path. “I didn't have the easiest path to making the sort of life I wanted, and I certainly had a lot of rejection early on, as many artists have. A lot of people who didn't believe in me, as many artists have. But I think that sort of pain, the parts of you that are a bit broken, are the parts of you that are most interesting in a lot of ways. They're the parts of you that give you motivation to keep creating art and to keep fighting. That sort of chip on your shoulder can turn into a diamond, you know.”

“Is it still a chip or has it become a diamond?”

“I think it's become a diamond now.” **O**

THE UN-SNEAKER™

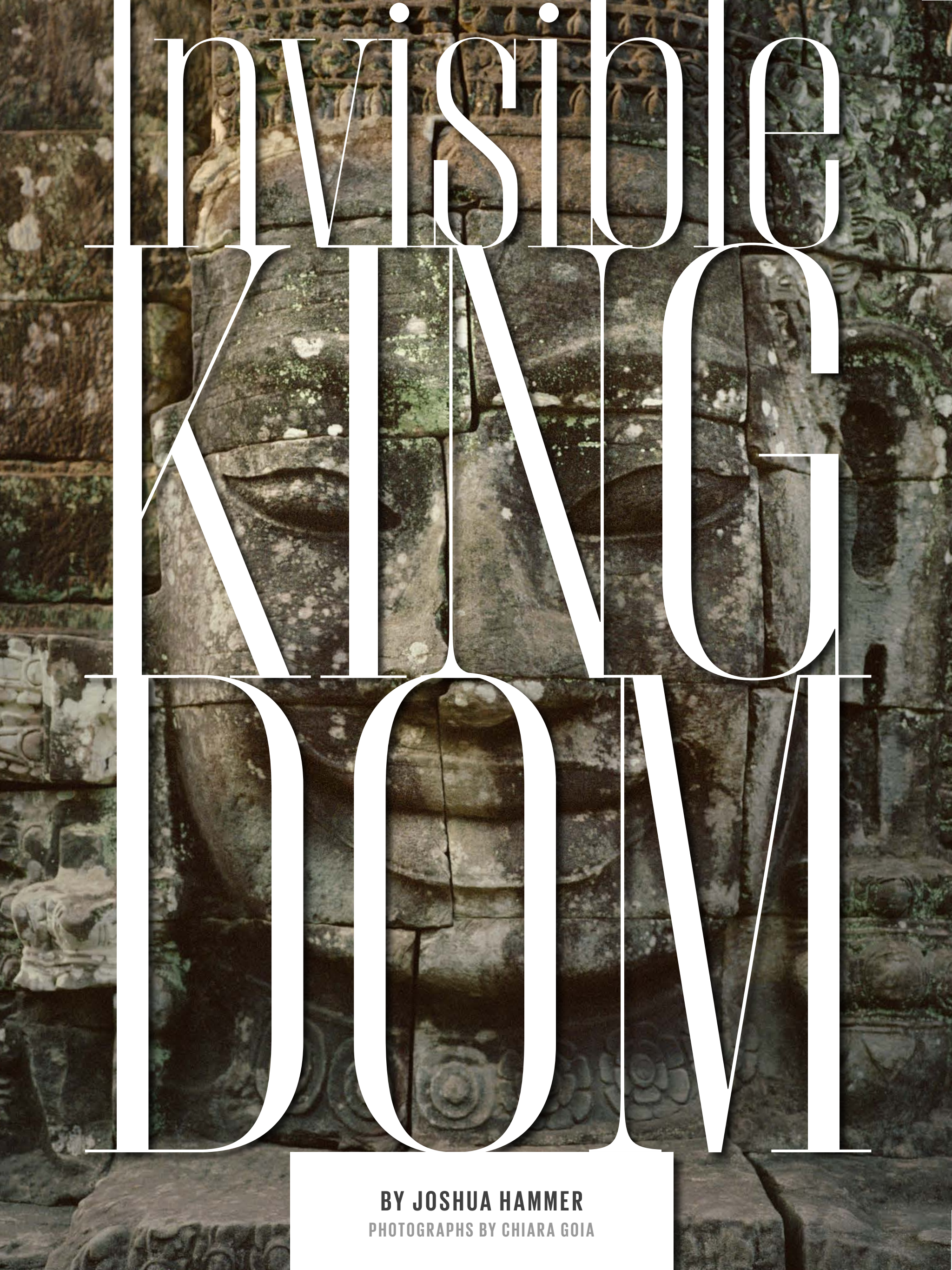


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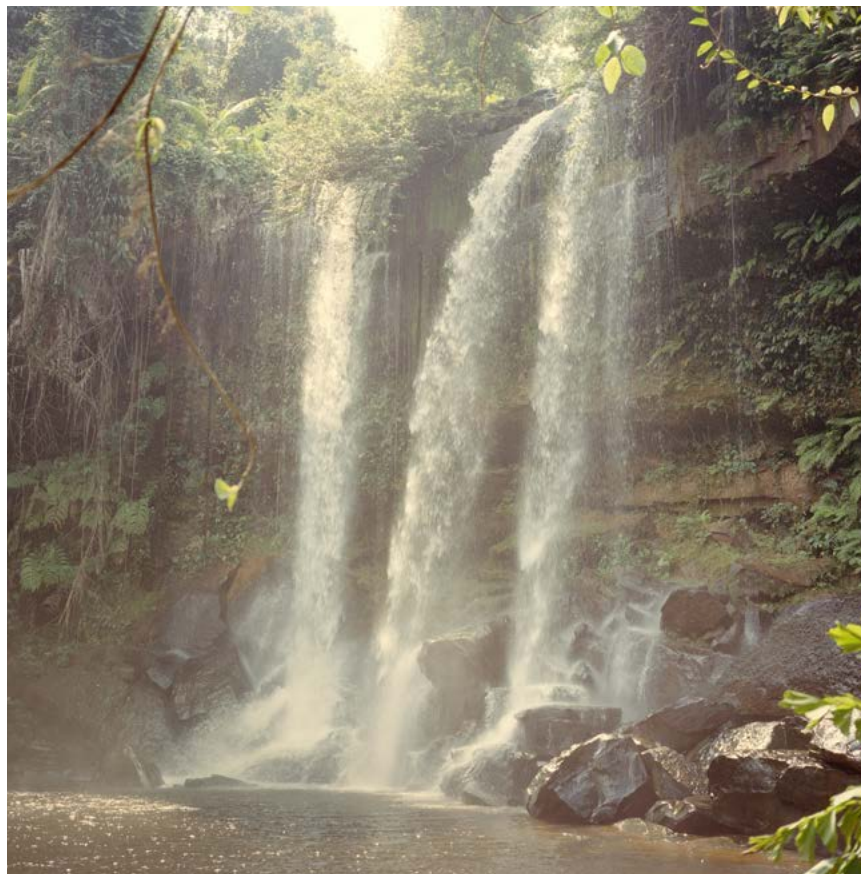
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Invisible Kingdom

BY JOSHUA HAMMER
PHOTOGRAPHS BY CHIARA GOIA



Deep in the jungles of
Cambodia, archaeologists
are uncovering a vast and
SOPHISTICATED METROPOLIS
that is 350 years older
than Angkor Wat

**On a remote plateau (above), researchers reveal
a royal capital whose splendors prefigure the
glories of the Angkor complex (previous page).**

“I was one of the first Westerners to go back to this village **SINCE THE WAR BEGAN.** And I had a *coup de foudre*—the feeling of falling in love—for the people, the landscape, the architecture, the ruins, the forest.”

Braving leeches and cobras, JB Chevance plots ground findings to confirm results from the “biggest Lidar archaeological survey in the world.”



Jean-Baptiste Chevance senses that we're

closing in on our target. Paused in a jungle clearing in northwestern Cambodia, the French archaeologist studies his GPS and mops the sweat from his forehead with a bandanna. The temperature is pushing 95, and the equatorial sun beats down through the forest canopy. For two hours, Chevance, known to everyone as JB, has been leading me, along with a two-man Cambodian research team, on a grueling trek. We've ripped our arms and faces on six-foot shrubs studded with thorns, been savaged by red biting ants, and stumbled over vines that stretch at ankle height across the forest floor. Chevance checks the coordinates. "You can see that the vegetation here is very green, and the plants are different from the ones we have seen," he says. "That's an indication of a permanent water source."

Seconds later, as if on cue, the ground beneath our feet gives way, and we sink into a three-foot-deep muddy pool. Chevance, a lanky 41-year-old dressed in olive drab and toting a black backpack, smiles triumphantly. We are quite possibly the first human beings to set foot in this square-shaped, man-made reservoir in more than 1,000 years. Yet this isn't merely an overgrown pond we've stumbled into. It's proof of an advanced engineering system that propelled and sustained a vanished civilization.

The vast urban center that Chevance is now exploring was first described more than a century ago, but it had been lost to the jungle until researchers led by him and an Australian colleague, Damian Evans, rediscovered it in 2012. It lies on this overgrown 1,300-foot plateau, known as Phnom Kulen (Mountain of the Lychee fruit), northeast of Siem Reap. Numerous excavations as well as high-tech laser surveys conducted from helicopters have revealed that the lost city was far more sophisticated than anyone had ever imagined—a sprawling network of temples, palaces, ordinary dwellings and waterworks infrastructure. "We knew this might be out there," says Chevance, as we roar back down a jungle trail toward his house in a rural village on the plateau. "But this gave us the evidence we were hoping for."

Phnom Kulen is only some 25 miles north of a metropolis that reached its zenith three centuries later—the greatest city of the Khmer Empire, and possibly the

most glorious religious center in the history of mankind: Angkor, derived from the Sanskrit word *nagara*, or holy city, site of the famed temple Angkor Wat. But first there arose Phnom Kulen, the birthplace of the great Khmer civilization that dominated most of Southeast Asia from the 9th to the 15th centuries. The Khmer Empire would find its highest expression at Angkor. But the defining elements of Kulen—sacred temples, reflecting the influence of Hinduism, decorated with images of regional deities and the Hindu god Vishnu, and a brilliantly engineered water-supply system to support this early Khmer capital—would later be mirrored and enlarged at Angkor. By the 12th century, at Angkor, adherence to Buddhism would also put its own stamp on the temples there.

Nothing ignites an archaeologist's imagination like the prospect of a lost city. In the late 19th century, French explorers and scholars, pursuing fragmentary clues about the existence of Phnom Kulen, hacked their way through the jungles of Southeast Asia. Inscriptions found on temple doors and walls made mention of a splendid hilltop capital called Mahendraparvata (the mountain of the great Indra, king of the gods), and its warrior-priest monarch, Jayavarman II, who organized several independent principalities into a single kingdom in the beginning of the ninth century.

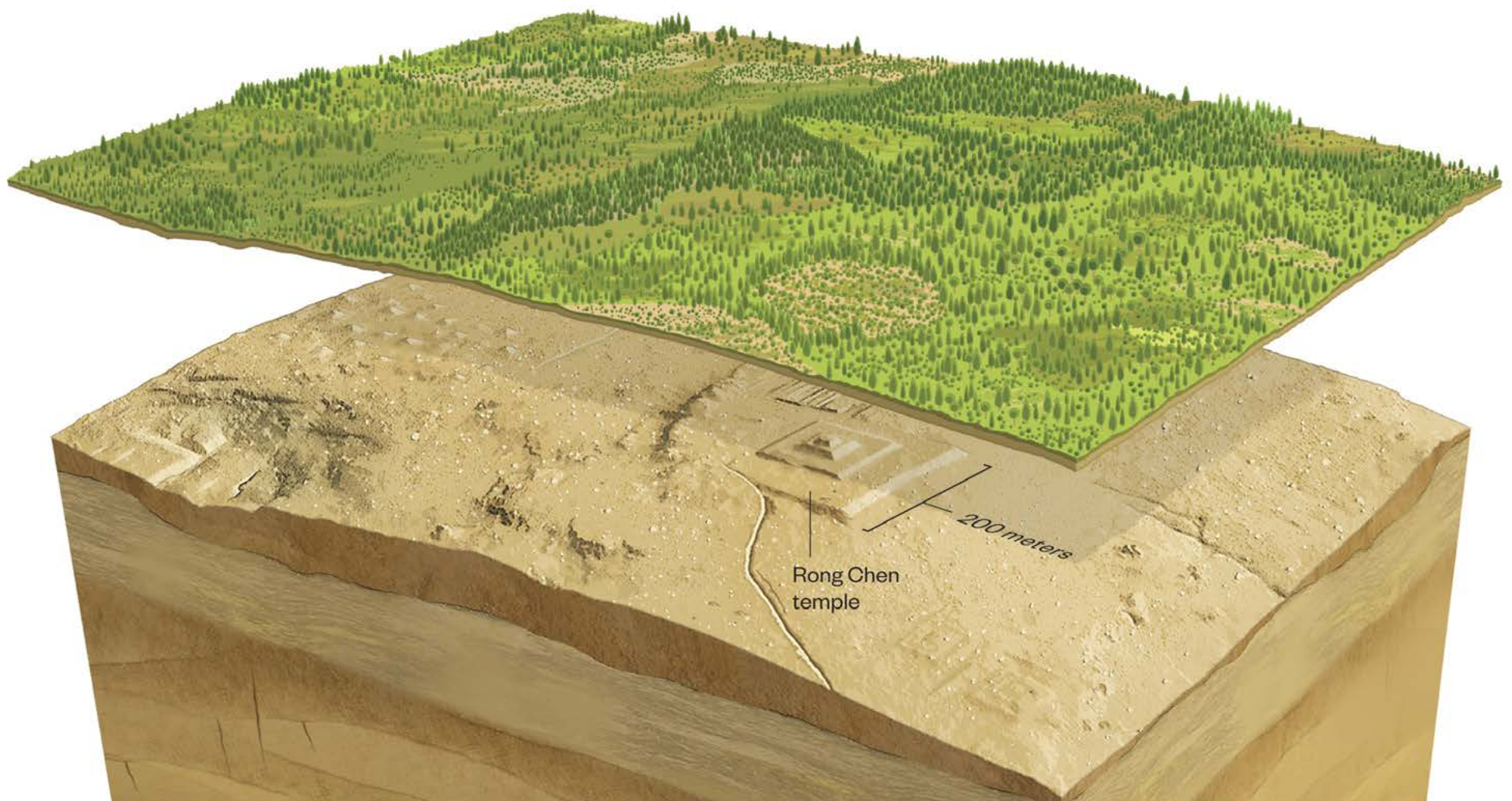
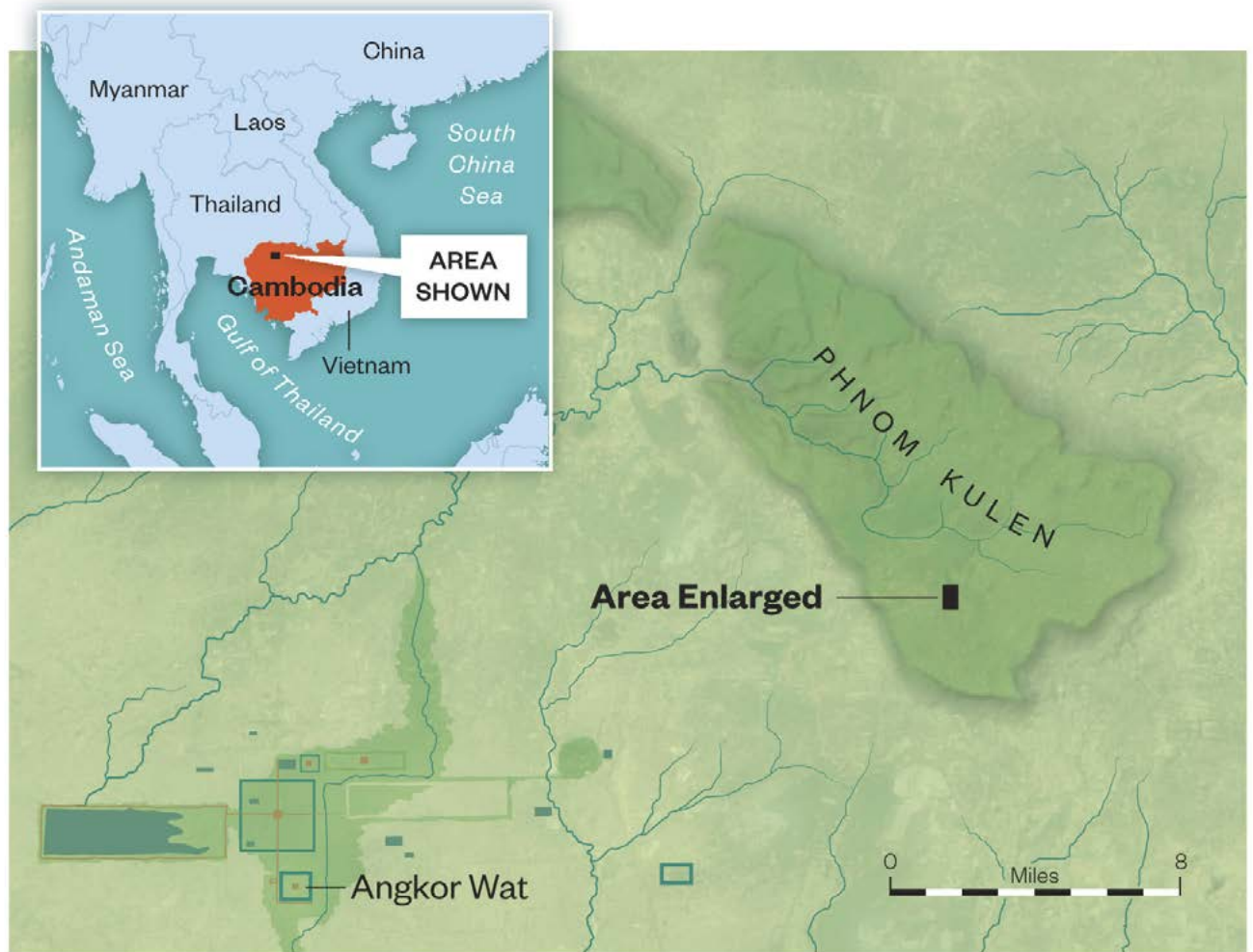
Another French archaeologist, Philippe Stern, trekked to the top of the Phnom Kulen plateau in 1936, and in five weeks of excavations he and his co-workers uncovered the ruins of 17 Hindu temples, fallen carved lintels, statues of the Hindu god Vishnu, and remnants of a great stone pyramid. Stern believed that he had located Mahendraparvata. But the temples of Angkor, built on a more accessible flat plain and visible on a larger scale, were more compelling to archaeologists, and the excavations at Phnom Kulen never advanced much beyond Stern's initial dig. Then came decades of neglect and horror.

In 1965, at the height of the Vietnam War, Norodom Sihanouk allowed the North Vietnamese to set up bases inside Cambodia to attack the U.S.-backed South Vietnamese Army. Four years later, President Nixon escalated a secret bombing campaign of Cambodia, killing tens of thousands and helping to turn a ragtag group of Communist guerrillas into the fanatical Khmer Rouge.

A jungle yields up its long-buried secrets

by 5W Infographics • research by Nona Yates

When archaeologists conducted Lidar overflights on the Phnom Kulen plateau (area of survey: black-square inset on green map), the technology effectively stripped away dense forest to produce a new 3-D model (diagram, below) of sites including the Rong Chen temple (raised rectangles, center of image). The relationship between Phnom Kulen and Angkor Wat—where urban centers are defined by a monumental temple at the center—suddenly became apparent: “They have the same fundamental elements,” says scientist Damian Evans.



This radicalized army marched into Cambodia's capital, Phnom Penh, in April 1975, declared the Year Zero, emptied out cities and herded millions into rice-growing communes. About two million people—nearly one-quarter of the population—were executed or died of starvation and disease before the Vietnamese toppled the Khmer Rouge in 1979. Phnom Kulen became the last sanctuary of the Khmer Rouge, and their leader, Pol Pot, known as Brother Number One. The last of the guerrillas didn't surrender and descend from the plateau until 1998—Pol Pot died that year near the Thai border, not far from Phnom Kulen—leaving behind a traumatized population and a landscape strewn with unexploded ordnance.

Chevance reached Phnom Kulen in 2000, while conducting research for advanced degrees in Khmer archaeology. "There were no bridges, no roads; it was just after the end of the

war," Chevance says as we eat steamed rice and pork with members of his staff, all of us seated on the wood-plank floor of a traditional stilted house, their headquarters in Anlong Thom, a village on the plateau. "I was one of the first Westerners to go back to this village since the war began," Chevance says. "People were, like, 'Wow.' And I had a *coup de foudre*—the feeling of falling in love—for the people, the landscape, the architecture, the ruins, the forest."

It wasn't until 2012, though, that Chevance marshaled high-tech evidence for a lost city, after he teamed up with Evans, who is based in Siem Reap with the French School of Asian Studies. Evans had become fascinated by Lidar (for Light Detection and Ranging), which uses lasers to probe a landscape, including concealed structures. Mounted on a helicopter, the laser continually aims pulses toward the ground below, so many that a large number streak through the spaces between the leaves and branches, and are reflected back to the aircraft and registered by a GPS unit. By calculating the precise distances between the airborne laser and myriad points on the earth's surface, computer software can generate a three-dimensional digital image of what lies below. Lidar had recently revealed details of the Mayan ruins of Caracol in Belize's rainforest, and exposed La Ciudad

At Phnom Kulen, archaeologists excavated kiln-fired pottery, but many riches were looted centuries ago.



Blanca, or The White City, a legendary settlement in the Honduran jungle that had eluded ground searches for centuries.

The jungles of Kulen presented a problem, however: Rampant illegal logging of valuable hardwoods had stripped away much of the primary forest, allowing dense new undergrowth to fill in the gaps. It was unclear whether the lasers could locate enough holes in the canopy to penetrate to the forest floor. Despite skepticism, Evans, with help from Chevance, raised enough money to survey more than 90,000 acres in both Phnom Kulen and Angkor. “The whole thing was pulled together with chewing gum and duct tape,” Evans says.

In April 2012, Evans joined Lidar technicians as they flew in a helicopter at 2,600 feet in a crosshatch pattern over Phnom Kulen. About two months after the overflights, Evans, awaiting the processing of visual data they had collected, switched on his desktop. He stared “in astonishment,” he says, as the ghostly legendary kingdom resolved before his eyes into an intricate cityscape: remnants of boulevards, reservoirs, ponds, dams, dikes, irrigation canals, agricultural plots, low-density settlement complexes and orderly rows of temples. They were all clustered around what the archaeologists realized must be a royal palace, a vast structure surrounded by a network of earthen dikes—the ninth-century fortress of King Jayavarman II. “To suspect that a city is there, somewhere underneath the forest, and then to see the entire structure revealed with such clarity and precision was extraordinary,” Evans told me. “It was amazing.”

Now the two archaeologists are using the Lidar images to understand how Mahendraparvata developed as a royal capital. The early water-management system they now saw in detail demonstrates how water was diverted to areas on the plateau that lacked a steady flow, and how various structures controlled supplies during rainless periods. “They employed a complex series of diversions, dikes and dams. Those dams are huge, and they required huge manpower,” Chevance says. At the dawn of the Khmer Empire, he goes on, “They were already showing an engineering capacity that translated into wealth and stability and political power.”

The Lidar imagery also has revealed the presence of dozens of ten-foot-high, 30-foot-wide mounds in symmetrical rows

on the jungle floor. Chevance and Evans at first speculated that they were burial sites—but, in succeeding excavations, they found no bones, ashes, urns, sarcophagi or other artifacts to support that hypothesis. “They were archaeologically sterile,” says Evans. “They are a mystery, and they may remain a mystery. We may never know what those things are.” Lidar surveys of Angkor also detected several mounds that are virtually identical to those at Phnom Kulen—just one of many startling similarities of the two cities. Indeed, as the archaeologists studied the images of Mahendraparvata, they realized with a flash of insight that they were looking at the template for Angkor.

Chevance and I set out on dirt bikes, bouncing over rickety wooden bridges that cross silt-laden streams, groaning up steep hills and plunging down switchback trails hemmed in by dense stands of cashew trees (grown illegally in this reserve). In one large clearing we come across the discarded remnants of huge mahogany trees that have been felled with a chain saw, cut into pieces and dragged out in ox carts. Chevance suspects the culprit is an affluent resident in the village of Anlong Thom, but says that fingering him will be pointless. “We will send a report to a government minister, but nothing will change,” he says. “The rangers are on the take.”

At the highest point on the plateau, Chevance leads me on foot up a slope to a monumental five-tiered platform made of sandstone and laterite (a rusty-red rock): the mountaintop pyramid of Rong Chen. The name translates as Garden of the Chinese, and refers to a local myth in which Chinese seafarers smashed their ship against the mountaintop at a time when an ocean supposedly surrounded the peak. It was here, in A.D. 802, according to an inscription in Sanskrit and ancient Khmer found in an 11th-century temple in eastern Thailand, that Jayavarman II had himself consecrated king of the Khmer Empire, at that time a dominion probably a bit smaller than contemporary Cambodia. And it was here, too, that the king created a cult of divinely ordained royal authority. More than 1,200 years later, in 2008, Chevance had arrived at the mountaintop with a team of 120 locally hired laborers. Government experts demined the area; then the team began digging.

“To suspect that a city is there, somewhere underneath the forest, and then to see the entire **STRUCTURE REVEALED** with such clarity and precision was extraordinary,” Evans told me. “It was amazing.”

On the Angkor plain, the tenth-century Prasat Pram temple (below) lies in ruins. The entire site here once housed 10,000 inhabitants.



The excavation suggested that it was the centerpiece of a royal metropolis—a conviction later confirmed by the Lidar overflights. “You don’t build a pyramid temple in the middle of nowhere,” Chevance tells me. “It’s an archaeological type that belongs to a capital city.”

Today Rong Chen is a darkly numinous place, where the glories of an ancient Khmer civilization collide with the terrors of a modern one. Unexploded mines still lie buried here—the result of Khmer Rouge efforts to protect their mountain redoubt from assault. “We saw a few mines at the last moment when we were doing the excavations,” Chevance tells me, warning me not to venture too far from the pyramid. “Most of the villages on Phnom Kulen were mined. The road between the villages was mined.”

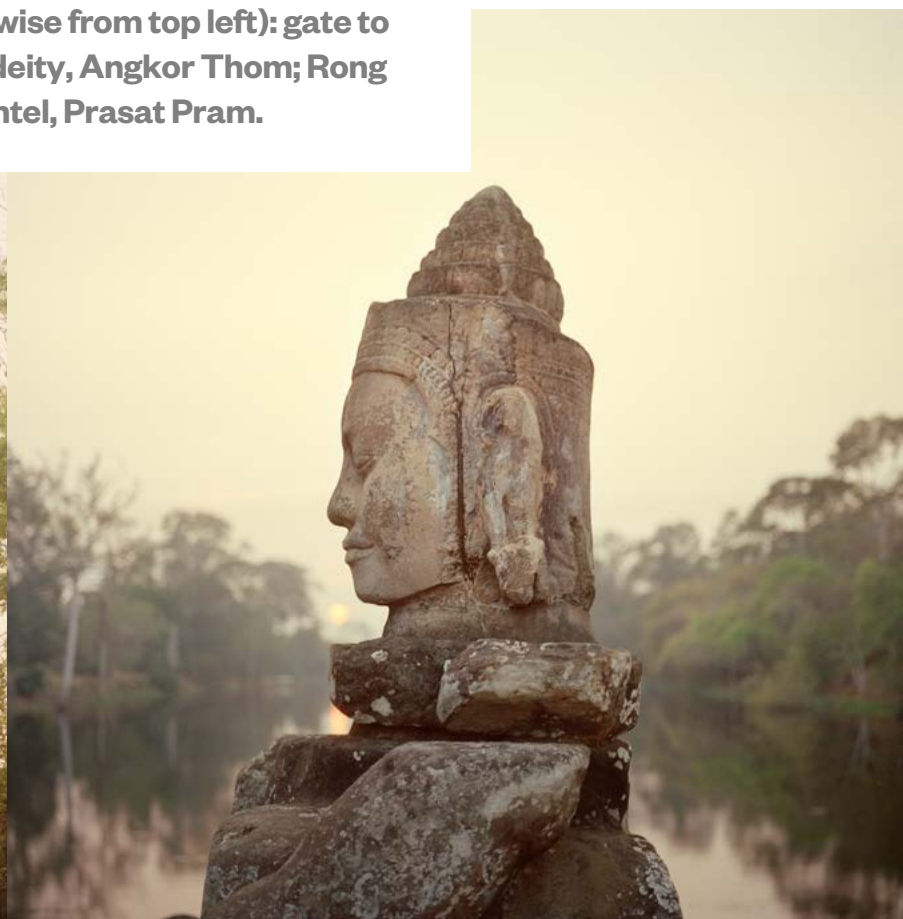
The hilltop camp afforded the Communist fighters a sanctuary near the strategic city of Siem Reap, then in government hands, and served as the base from which the Khmer Rouge carried out acts of sabotage—including blocking a spillway that carried water from Phnom Kulen into the city. “They prevented water from reaching Siem Reap, and the Cambodian Army knew that.” The result, Chevance says, was that the mountain was bombed. “You can still find B-52 bomb craters here.”

Chevance and I get back on our dirt bikes and bounce down a path to the best-preserved remnant of Jayavarman II’s capital: an 80-foot-high tower, Prasat O Paong (Temple of the Tree of the Small River), standing alone in a jungle clearing. The facade of the Hindu temple glows a burnished red in the setting sun, and intricate brickwork reaches to the apex of the tapered column. Ceramics inside this and other temples excavated on Phnom Kulen prove that they remained pilgrimage sites as late as the 11th century—an indicator that the structures continued to influence the rest of the Khmer Empire long after Jayavarman II moved his capital from Phnom Kulen to the Angkor plain and the city’s original population had disappeared.

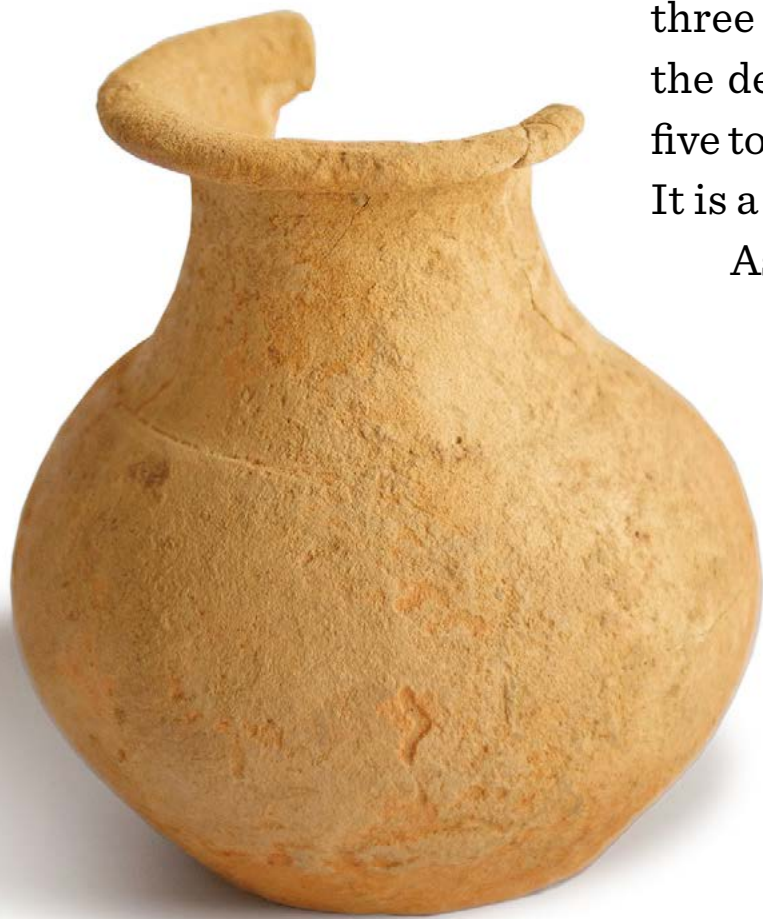
Angkor—which Chevance and Evans describe as “an engineered landscape on a scale perhaps without parallel in the preindustrial world”—is a place that inspires superlatives. Achieving its apogee in the late 12th and early 13th centuries, the site, at its peak, was an urban center extending over nearly 400 square miles.

“We saw a few mines at the last moment when we were doing the excavations,” Chevance says, **WARNING ME NOT TO VENTURE** too far. “Most of the villages on Phnom Kulen were mined. The road between the villages was mined.”

Khmer grandeur (clockwise from top left): gate to Angkor Thom; head of deity, Angkor Thom; Rong Chen temple; lintel, Prasat Pram.



A ninth-century clay jar is a modest fragment from Kulen's royal palace, the 74-acre complex in the heart of the city.



Chevance leads me up the near-vertical stone steps of Pre Rup, a soaring tenth-century structure with a platform made of laterite and sandstone. It represents a transition point, a synthesis of the two extraordinary temples we explored on the plateau, Prasat O Paong and Rong Chen. “It is a pyramid with three levels,” Chevance tells me, as we clamber among the deserted ruins in the heat. “On top you also have five towers similar to the ones we saw on the mountain. It is a combination of two architectural styles.”

As has now become clear, thanks to Lidar, Phnom Kulen, faintly visible on the horizon 25 miles away, influenced far more than the later city's sacred architecture. To support Angkor's expanding population, which may have reached one million, engineers developed a water-distribution system that mirrored the one used on the plateau. They collected water from the Siem Reap River, a tributary of the Mekong, that flows from the plateau, in two enormous reservoirs, then built an intricate series of irrigation channels, dams and dikes that distributed water evenly across the plain. Although Angkor's soil is sandy and not highly fertile, the masterful engineering allowed farmers to produce several rice crops annually, among the highest yields in Asia. “The secret to their success was their ability to even out the peaks and troughs seasonally and annually, to stabilize water and therefore maximize food production,” Damian Evans tells me.

Angkor was at its height during the reign of Jayavarman VII (circa 1181-1220), regarded by scholars as the greatest king of the Khmer Empire. Two days after my arrival in Angkor, I'm standing with Evans on the highest platform of the king's masterpiece, the temple known as the Bayon. Evans gestures across a stunning tableau of sandstone terraces, pillars and towers, as well as galleries carved with bas-reliefs depicting warriors marching into battle. “No king who came afterward ever built on this scale again,” says Evans. Jayavarman VII, who made Mahayana Buddhism the Khmer Empire's state religion, grafted what are commonly believed to be his own features onto a serenely smiling Buddhist divinity. Its mas-



BEYOND ANGKOR

Phnom Kulen's royal

capital was lost in the jungle for a millennium, but the 95-square-mile plateau on which it sits has long been a Buddhist pilgrimage site and, increasingly today, a destination for day-tripping tourists seeking to escape the crowds at Angkor Wat.

Most of the popular attractions lie around the village of Preah Ang Thom, a ramshackle commercial center packed with souvenir kiosks and open-air restaurants. Among them: two spectacular cataracts that spill down a cliffside, and a series of rock carvings rising from the banks and streambed of the Kbal Spean river, or River of a Thousand Lingas. Also close by are the ancient sandstone elephant of Srah Damrei and the reclining Buddha at Preah Ang Thom monastery—a 16th-century figure chiseled from an immense block of stone, reached by a precipitous climb up a concrete staircase.

Several travel agencies have sprung up in recent years to help intrepid tourists reach the more remote sites, most notably Terre Cambodge, based in Siem Reap (terrecambodge.com). Founded in 1998, this agency offers custom-designed tours, including dirt-bike trips, to see the plateau's archaeological treasures and visit rural villages where the Archaeology and Development Foundation, JB Chevance's sponsoring organization, implements development work. "They are committed to promoting responsible and environmentally friendly eco-tours," says Chevance, who advises tourists to stay close to their guides and avoid venturing alone into the surrounding jungle, which the Khmer Rouge used as a sanctuary against possible attacks by the Cambodian Army. "Nobody has ever been injured by mines," says Chevance, "but they're still out there." —J.H.

sive stone face beams in dozens of iterations throughout this complex, radiating compassion and kindness across the four corners of the empire.

It is here, in the heart of Jayavarman VII's capital, that the histories of Angkor and Mahendraparvata converge most powerfully. "You are looking at cities that are widely separated in space and time," Evans tells me. "But each has an urban core defined by a grid of streets and a central state temple—the Bayon here, Rong Chen there—at the center."

Yet the Lidar data show that the cities followed divergent paths. While Mahendraparvata was a masterpiece of urban planning, with temples and dwellings carefully laid out by Jayavarman II around wide boulevards—a Khmer version of Haussmann's Paris—Angkor developed haphazardly. Densely populated neighborhoods of wooden houses squeezed against the edges of the Bayon. Evans describes Angkor as a "messy aggregation of centuries of development, with features superimposed one on top of another."

Beneath the jungle canopy south of the city, Evans' Lidar surveys have detected huge spirals inscribed into the landscape, covering one square mile, reminiscent of the ancient geoglyphs discovered in the Nazca Desert of southern Peru. Like the mystery mounds, the spirals contained no artifacts, no clues about their function. "They could have a meaning encoded in them that may never be known," Evans says.

The sheer ambition of the Khmer kings, their re-engineering of a jungled landscape into an urban one, sowed the seeds of destruction. New research has provided a clearer picture of the sequence of events that may have doomed Mahendraparvata. The Lidar data revealed that its population didn't engage in terraced rice farming in their mountain metropolis—which meant that they almost certainly relied on slash-and-burn agriculture. That would have depleted the soil rapidly, and probably contributed to the decline and fall of the city. The evidence backs up research conducted by Chevance and a colleague, who analyzed soil samples taken from a reservoir on Phnom Kulen. Evidence showed that vast amounts of soil and sand "got washed down the valley, indicating deforestation," says Chevance. Soil from a later date contained a high concentra-

tion of jungle vegetation, which suggests that the land had been abandoned and taken over again by the tropical forest.

In the case of Mahendraparvata, this process likely occurred more rapidly than at Angkor—a major population center for about 600 years—where decline came more slowly. Over time, the artificially engineered landscape almost certainly led to topsoil degradation, deforestation and other changes that drastically reduced the capacity to feed the population and made Angkor increasingly difficult to manage.

Leaders of the rival kingdom of Ayutthaya, in what is now Thailand, sacked Angkor in 1431. It was abandoned and left to decay, doomed to the same fate as its predecessor, Mahendraparvata. “There are in the kingdom of Cambodia the ruins of an ancient city, which some say was constructed by Romans or by Alexander the Great,” the Spanish explorer Marcelo de Ribadeneyra wrote when he chanced upon Angkor nearly two centuries later. “It is a marvelous fact that none of the natives can live in these ruins, which are the resorts of wild beasts.”

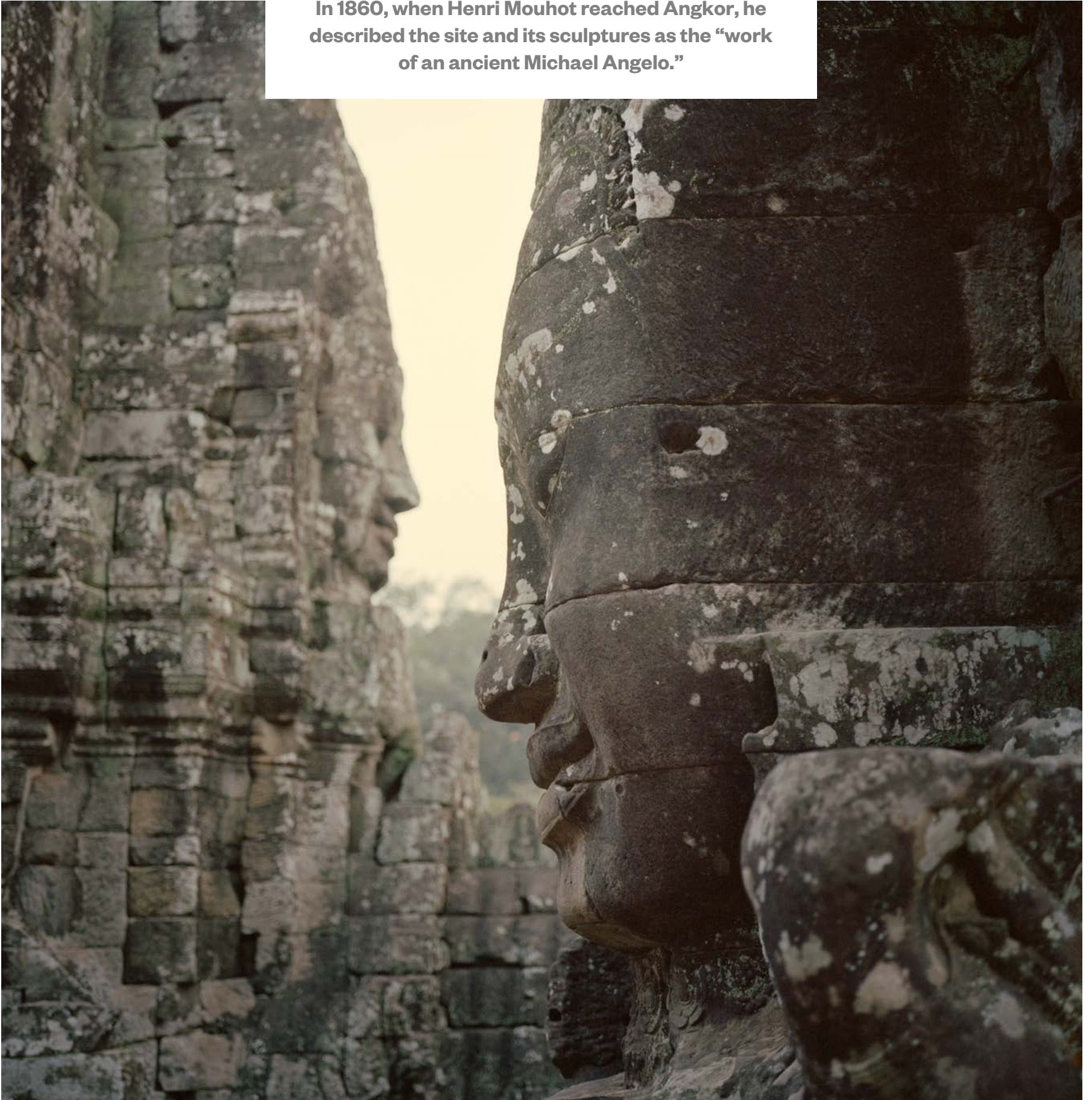
“There are still many questions to answer,” Chevance tells me. “We know more about temples and kings than everyday life.” When it comes to the inhabitants of Mahendraparvata, Chevance adds, a fundamental question underlies his work: “How did they live?”

Answering that query will be difficult, because few traces of ordinary Khmer life remain: While temples—built for the ages—endure, Mahendraparvata’s population constructed their dwelling places out of wood, which rotted away long ago. Even the royal palace, which probably employed thousands of people, has been reduced to a few crumbling platforms, pavements, gutters, dikes and roof tiles.

Last year, as part of the Cambodian Archaeological Lidar Initiative, Evans and Chevance conducted a new series of helicopter surveys of Phnom Kulen to take in “the entire mountain range,” says Evans—more than 100 square miles encompassing archaeological sites, rock quarries and traces of ancient cities. The CALI project also included overflights to investigate ancient provincial centers of military and industrial significance, as well as the Khmer capital of Sambor Prei Kuk, 100 miles south of Angkor. The city endured from the seventh to the ninth centuries, declining just as Angkor was on the rise.

“There are in the kingdom of Cambodia the ruins of an ancient city, which some say was **CONSTRUCTED BY ROMANS** or by Alexander the Great....These ruins are the resorts of wild beasts.”

In 1860, when Henri Mouhot reached Angkor, he described the site and its sculptures as the “work of an ancient Michael Angelo.”



In total, the CALI campaign covered more than 700 square miles.

Ten ground teams worked alongside the aerial survey teams in remote areas, and in extreme heat, refueling choppers, conferring with local authorities, collecting precision GPS data at ground stations, and persuading local people to stop burning off forest, so that flights relying on aerial sensors would not have the ground obscured by smoke.

The result of this ambitious effort, funded by the European Research Council, was a “unique archive,” says Evans, of the ways that human beings transformed the natural environment and shaped Khmer history over 2,000 years. The results will be published in a peer-reviewed journal later this year. Further surveys are planned using drones and satellites. Evans’ teams are currently on the ground across Cambodia, investigating surface remains shown by Lidar. This ambitious effort, he believes, eventually will reveal the entire mosaic of Southeast Asia’s greatest civilization, only now beginning to come into focus. Ultimately, he believes, what will emerge is a dazzling, nuanced understanding of a “complex hierarchy with an unmatched scale.” ●

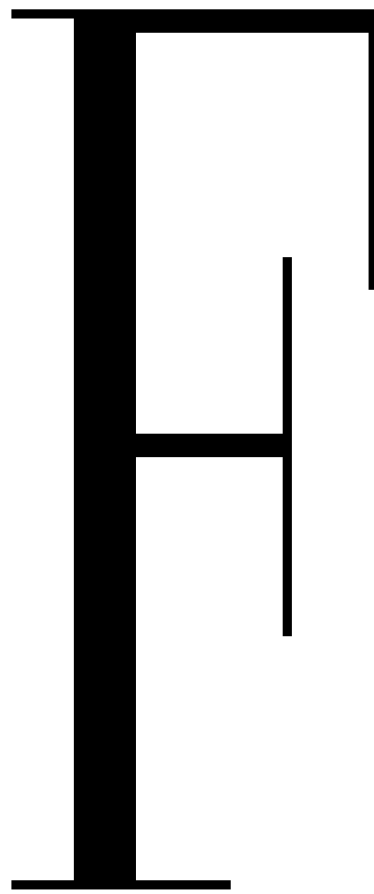
by Jacinda Townsend

Driving While Black

African-Americans
used a crowd-
sourced guide to
navigate segregation



FROM THE
SMITHSONIAN
NATIONAL MUSEUM
OF AFRICAN
AMERICAN HISTORY
AND CULTURE



For black Americans traveling by car in the era of segregation, the open road presented serious dangers. Driving interstate distances to unfamiliar locales, black motorists ran into institutionalized racism in a number of pernicious forms, from hotels and restaurants that refused to accommodate them to hostile “sundown towns,” where posted signs might warn people of color that they were banned after nightfall.

Paula Wynter, a Manhattan-based artist, recalls a frightening road trip when she was a young girl during the 1950s. In North Carolina, her family hid in their Buick after a local sheriff passed them, made a U-turn and gave chase. Wynter’s father, Richard Irby, switched off his headlights and parked under a tree. “We sat until the sun came up,” she says. “We saw his lights pass back and forth. My sister was crying; my mother was hysterical.”

“It didn’t matter if you were Lena Horne or Duke Ellington or Ralph Bunche traveling state to state, if the road was not friendly or obliging,” says New York City-based filmmaker and playwright Calvin Alexander Ramsey. With director and co-producer Becky Wible Searles, he interviewed Wynter for their forthcoming documentary about the visionary entrepreneur who set out to make travel easier and safer for African-Americans. Victor H. Green, a 44-year-old black postal carrier in Harlem, relied on his own experiences and on recommendations from black members of his postal service union for the inaugural guide bearing his name, *The Negro Motorist Green-Book*, in 1937. The 15-page directory covered Green’s home turf, the New York metropolitan area, listing establishments that welcomed blacks. The power of the guide, says Ramsey, also the author of a children’s book and a play focused on *Green-Book* history, was that it “created a safety net. If a person could travel by car—and those who could, did—they would feel more in control of their destiny. The *Green-Book* was what they needed.”

The *Green-Book* final edition, in 1966-67, filled 99 pages and embraced the entire nation and even some international cities. The guide pointed black travelers to places including hotels, restau-

rants, beauty parlors, nightclubs, golf courses and state parks. (The 1941 edition above resides in the Smithsonian National Museum of African American History and Culture.)

Mail carriers, Ramsey explains, were uniquely situated to know which homes would accommodate travelers; they mailed reams of listings to Green. And black travelers were soon assisting Green—submitting suggestions, in an early example of what today would be called user-generated content. Another of Green’s innovations prefigured today’s residential lodging networks; like Airbnb, his guide listed private residences where black travelers could stay safely. Indeed, it was an honor to have one’s home listed as a rooming house in the *Green-Book*, though the listings themselves were minimalist: “ANDALUSIA (Alabama) TOURIST HOMES: Mrs. Ed. Andrews, 69 N. Cotton Street.”

The *Green-Book* was indispensable to black-owned businesses. For historians, says Smithsonian curator Joanne Hyppolite, the listings offer a record of the “rise of the black middle class, and in particular, of the entrepreneurship of black women.”

In 1952, Green retired from the postal service to become a full-time publisher. He charged enough to make a modest profit—25 cents for the first edition, \$1 for the last—but he never became rich. “It was really all about helping,” says Ramsey. At the height of its circulation, Green printed 20,000 books annually, which were sold at black churches, the Negro Urban League and Esso gas stations.

Writing in the 1948 edition, Green predicted, “There will be a day in the near future when this guide will not have to be published. That is when we as a race will have equal opportunities and privileges in the United States.” He died in 1960, four years before Congress passed the Civil Rights Act.

Green’s lasting influence, says Ramsey, “was showing the way for the next generation of black entrepreneurs.” Beyond that, he adds, “Think about asking people to open their homes to people traveling—just the beauty of that alone. Some folks charged a little, but many didn’t charge anything.”

Today, filmmaker Ric Burns is working on his own *Green-Book* documentary. “This project began with historian Gretchen Sorin, who knows more than anyone about the *Green-Book*,” says Burns. The film, he says, shows the open road as a place of “shadows, conflicts and excruciating circumstances.” (View clips from his film at [Smithsonian.com/greenbook](https://www.smithsonian.com/greenbook))

Washington, D.C.-based architectural historian Jennifer Reut, who created the blog “Mapping the Green Book” in 2011, travels the country to document surviving *Green-Book* sites, such as Las Vegas, Nevada’s Moulin Rouge casino and hotel, and the La Dale Motel in Los Angeles. Much of her focus, she says, is to look at places “in the middle of nowhere. That is where it was much more dangerous for people to go.” ●



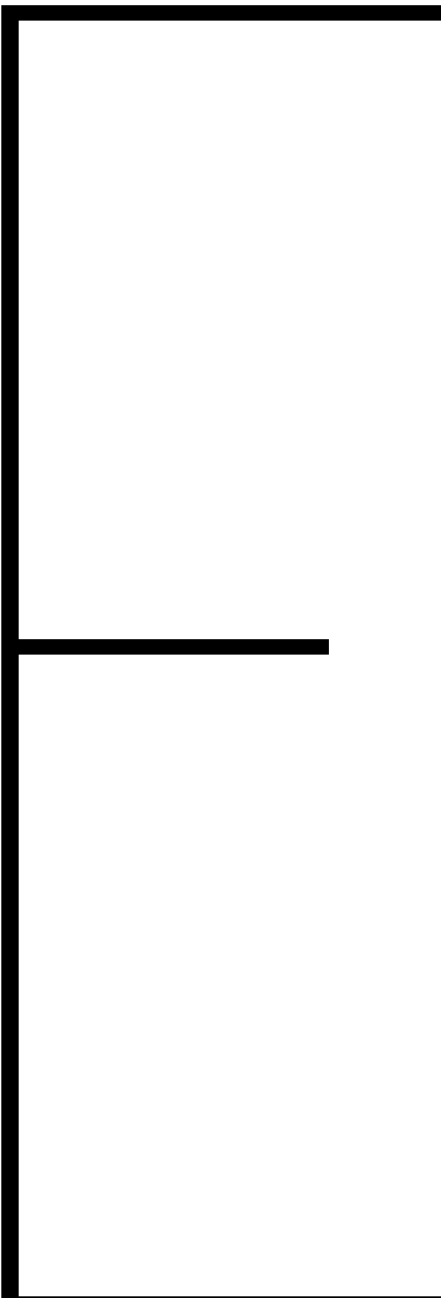
THE SECRET LIVES OF ANIMALS

PHOTOGRAPHS
BY **ANUP SHAH**

HOOFIN' IT

Wildebeests and zebras drink from the Mara River, one of the only water sources during the Masai Mara's dry season.

**AN INNOVATIVE
PHOTOGRAPHER
REVEALS WHAT
AFRICAN ANIMALS
DO WHEN THEY
THINK NO ONE
IS WATCHING
BY ABIGAIL TUCKER**



elephants are best photographed on

overcast days. Their gray hides tend to look smudgy black against sapphire African skies, but they glow against charcoals and whites, Anup Shah explains. Besides, elephants and clouds travel in the same lazy, majestic manner: they drift.

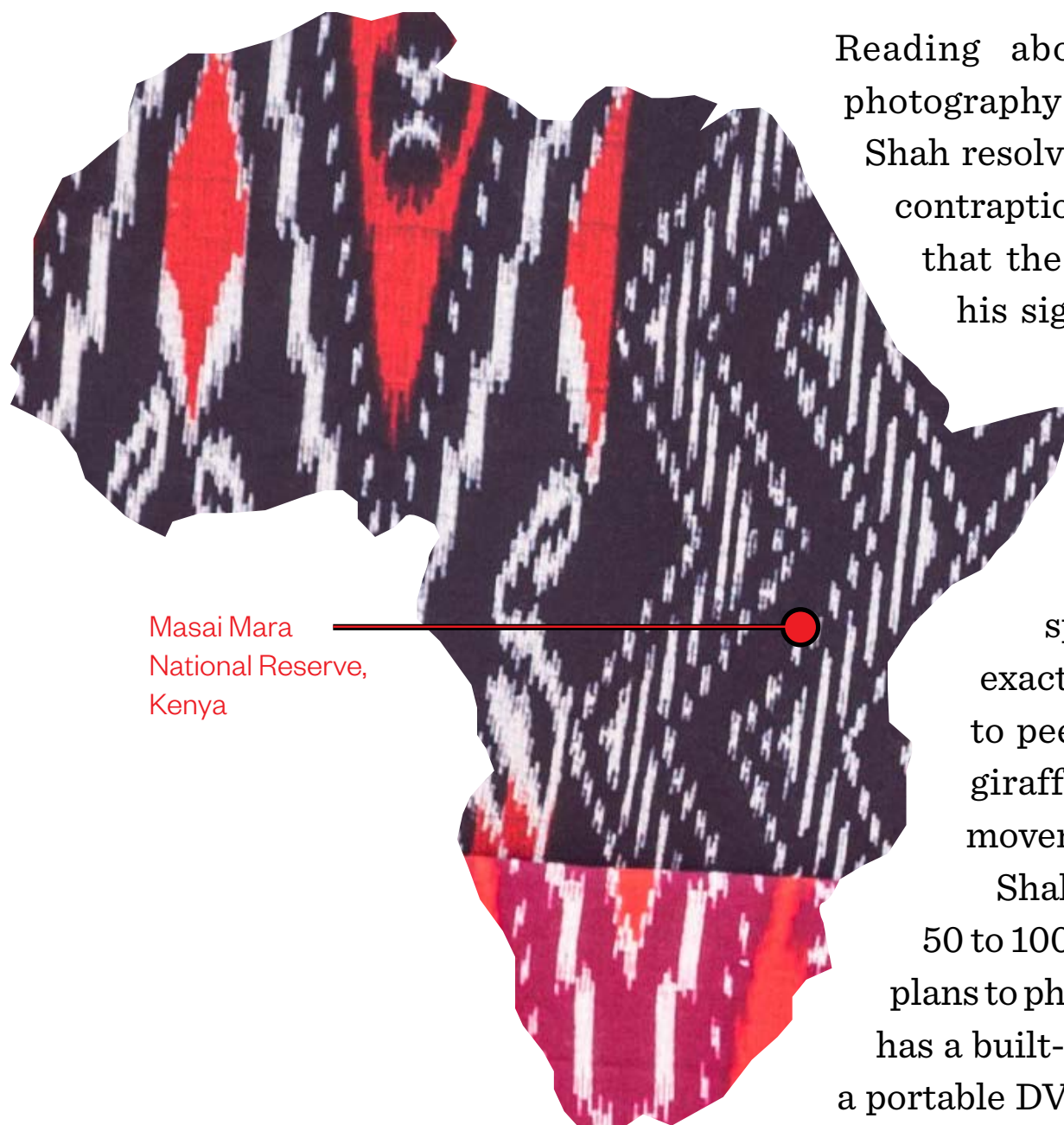
Like most veteran wildlife photographers working in the Serengeti and Masai Mara ecosystems, Shah has spent his career “at a respectful distance” from his subjects, clicking away with a foot-long telephoto lens from an off-road vehicle’s rolled-down window. For his safety and the animals’, stepping out of the truck isn’t an option—and neither is getting close.

Some animals flee at the first distant rumble of his engine—especially warthogs, whose posteriors are perhaps their most frequently immortalized part. But even with lions and other large creatures that don’t startle as easily, “there is no intimacy or immediacy,” Shah says. “There is a barrier—your car and that huge photographic space between you and the animals.”



READY TO RUMBLE

An elephant family gathers against the backdrop of an approaching storm. As they wander the savanna, elephants are thought to make vocalizations that create seismic waves in the ground. Their feet act like broad, flat receivers, picking up other elephants' signals from miles away.



Masai Mara
National Reserve,
Kenya

Reading about hidden cameras in a photography magazine a few years ago, Shah resolved to conceal remote-control contraptions around the grasslands, so that the animals would wander into his sights while still at ease. As he positions his cameras in the vastness of the savanna, he relies on an old-school understanding of animal behavior: identifying ambush spots and wallows, finding the exact trees where cheetahs prefer to pee, learning the habits of baby giraffes and calculating the daily movements of clouds and elephants. Shah usually parks his truck about 50 to 100 yards away from the scene he plans to photograph. Each hidden camera has a built-in video link, connecting it to a portable DVD player. After disguising the camera with dirt and dung, he returns to his vehicle and studies the screen, ready to snap close-ups by tripping the shutter with a button.

His goal is to take himself out of the scene as much as possible, and get the viewer even closer to the animals. “When I look at pictures that excite me,” Shah says, “it is intimate photography from the streets of New York City, where the photographer has been within a yard or two of the subject, and that gives you the feeling that you are there in the middle of the street talking to this stranger. I wanted to bring people right to the streets of the Serengeti.”

Shah’s hidden camera photos reveal unseen details of familiar animals: mazes of elephant wrinkles, the shaggy geometry of a zebra’s belly, a warthog’s ecstatic expression as a family of hungry mongooses harvests ticks from its thick skin. While telephoto lenses often look down on a subject, Shah’s cameras gaze up from the ground where they’re hidden. Dirt is an important narrative tool: a long curve of dust describes a migration, juicy mud holes suggest the private pleasures of elephants.

WHAT CAMERA?

Giraffes make their way across the Mara River. Whether they're ambling or galloping, giraffes maintain balance by moving their necks in synchrony with their legs.





LOOKS COULD KILL

The aggressive Cape buffalo can be difficult to photograph face to face. When it feels threatened, it's known for stampeding or goring human onlookers, even in tourist-heavy park settings. The animal's unpredictable nature has kept it from ever being domesticated like the water buffalo.



ROOM TO RUN

The Masai Mara's cheetah population has dropped sharply over the past half century, as Kenya's human population has tripled. Because cheetahs hunt and roam across vast distances, the land shortage has impacted them more severely than it has other species.



STEPPIN' OUT

A male baboon, foraging for food, startles at the click of the camera shutter. Baboons tend to feed in the morning, before the heat of the day settles in. Each member of a given troop remains within sight or sound of its fellow members as it searches for leaves, herbs and seeds.

TWO-TON SPLASH

A hippo bursts out of the water, creating the effect the photographer strives to achieve: making viewers feel as if they're in the middle of the action.





**Wildbeests advance
toward the Mara River.**

Despite the horrific smell, Shah often targets animals feeding on carcasses. Zebra ribs rise like steel beams, new construction in a streetscape of grass.

Often the scene that unfolds is not exactly what he'd envisioned. Herds dillydally; baboons photobomb; crocodiles linger. Half a dozen of his hidden cameras have met less-than-picturesque ends, stolen by cunning animals or crushed under their hooves. Secreting a camera on a riverbank one morning, in anticipation of a wildebeest crossing, "I waited and waited and waited," Shah recalls, "and to my horror, the river water rose and rose and rose." As the herd debated whether to cross, Shah debated whether to rescue his camera: "Should I save an expensive object and risk scaring the animals?" The camera drowned.

In addition to lots of no-shows, Shah struggles with subjects that materialize more suddenly than expected. Shortly after he placed his camera near one pond, a 4,000-pound hippo popped up from the water with the buoyancy of a bath toy, its pink ears pert and alert. "I had to beat a hasty retreat," Shah says, "But that is probably the best hippo picture I'll ever get." ●

EVOLUTIONISM 2016

DARWIN'S



HE NEVER VISITED THE YALE MUSEUM, BUT YOU CAN—AND SEE FOR YOURSELF THE SPECIMENS
THAT DARWIN PRAISED AS THE BEST EVIDENCE FOR HIS THEORY OF EVOLUTION

FAVORITE

BY RICHARD CONNIFF

FOSSTLS

PHOTOGRAPHS BY ROBERT LORENZ





WHEN VISITORS GO TO THE

Yale Peabody Museum of Natural History, they are not exactly wrong to think that dinosaurs are the stars of the show. This is, after all, the museum that discovered *Stegosaurus*, *Brontosaurus*, *Apatosaurus*, *Allosaurus*, *Triceratops*, *Diplodocus* and *Atlantosaurus*, among others.

There's even a 7,350-pound bronze *Torosaurus* on the sidewalk in front of this red brick Gothic Revival building on the outskirts of downtown New Haven. It was the Peabody that led the great age of paleontological discovery in the 19th century. It also went on to launch the modern dinosaur renaissance in the late 1960s, setting off a global wave of dinomania and incidentally inspiring the *Jurassic Park* franchise. And Peabody researchers continue to make groundbreaking discoveries. In 2010, they determined, for the first time, the exact coloration of an entire dinosaur, feather by feather. *Anchiornis huxleyi* is unfortunately still in China, where it was discovered: It looked like a Las Vegas showgirl

crossed with a spangled Hamburg chicken. Plus, the Peabody houses one of the most revered images in all of paleontology: *The Age of Reptiles*, by Rudolph Zallinger, is a 110-foot-long mural depicting dinosaurs and other life-forms in a 362-million-year panorama of Earth's history, moving one writer to call the museum "a Sistine Chapel of evolution."

So why on earth go to the Peabody for any reason other than dinosaurs? One answer: for the fossil, mammal and bird discoveries that most visitors miss, but which Charles Darwin himself considered the best evidence for the theory of evolution in his lifetime.

These discoveries were largely the work of a brilliant and intensely competitive Yale paleontologist named Othniel Charles Marsh. Though raised in a poor upstate New York farming family, Marsh was a nephew of George Peabody, a merchant banker and promoter of all things American in mid-19th-century London. Peabody built a vast fortune from scratch and then gave much of it away in his lifetime, with an emphasis on the formal education he lacked. The Yale Peabody Museum of Natural History, founded at his nephew's urging in 1866 and now celebrating its 150th anniversary, was one result. Peabody's wealth also enabled Marsh to lead a series of four pioneering Yale expeditions in the early 1870s, traveling via the new transcontinental railroad and on horseback to explore the American West.

Marsh focused at first not on dinosaurs, then little known, but on a creature of ardent popular and scientific interest: the horse. In January 1870, Thomas Henry Huxley, a British paleontologist nicknamed "Darwin's Bulldog" for his fierce advocacy of evolutionary theory, used fossils to trace the horse back 60 million years to its supposed origin in Europe. But Marsh and his Yale crews were accumulating a rich fossil record proving, he thought, that the horse had evolved in North America. Huxley was so intrigued that he visited Yale in 1876, intent on seeing the evidence for himself. The two men spent much of an August week at "hard labor" reviewing fossils.

It was a revelation: Huxley would ask to see a specimen illustrating some point about horse evolution, and as Huxley's son and biographer Leonard later recounted, "Professor Marsh would simply turn to his assistant and bid him fetch box num-

FIELD NOTES



KIRK JOHNSON

DIRECTOR OF THE NATIONAL
MUSEUM OF NATURAL HISTORY

When I was 24 and 25, I spent

two summers on Ellesmere Island, Canada, way up in the Arctic Circle. The sun just went around the sky, dipping a little at midnight and going up a bit at noon. So I'd get up in the middle of the night and go exploring. I saw musk oxen, dwarf caribou and big Arctic hares that stood up on their hind legs and looked for white wolves. There were no trees, so there was no sense of scale. You could see a hill 30 miles away. And everything looked like the ice age: There were these huge polar ice caps lying on the landscape. But we were finding fossils from a much warmer world. We found a rhinoceros skeleton on an unnamed river, so we named it—it's the only Rhinoceros River in Canada. We found petrified forests and crocodiles and turtles and early mammals. I've spent much of my career reconstructing ancient worlds, and Ellesmere Island was where that interest got jarred into action. I realized, "Wow, this is a really wild place, both then and today."

ber so and so," until Huxley finally exclaimed, "I believe you are a magician; whatever I want, you just conjure it up."

Huxley became a ready convert to Marsh's argument that horses evolved in North America, and at his request, Marsh cobbled together a celebrated—though not particularly striking—illustration. You can see it now in a display case just past the dinosaurs, in the Peabody's Hall of Mammals. It's a lineup of leg bones and molars of different North American species. They show the horse increasing in size and evolving over 50 million years, from *Orohippus*, with four toes on its front legs, on up to the modern horse with a single hoof—an evolutionary development that allows it to gallop even across hard, flat prairies and deserts.

Huxley presented this diagram and outlined the North American story at a lecture that September in New York. He thought Marsh had already discovered enough about the horse "to demonstrate the truth of the evolution hypothesis," a truth, as the *New York Times* put it, "which could not be shaken by the raising of side issues." Huxley also predicted that a more primitive horse would eventually turn up with a fifth toe. He and Marsh had discussed this theoretical "dawn horse," dubbed *Eohippus*, and one evening in New Haven, Huxley had sketched a fanciful five-toed horse. Then he'd penciled in an equally fanciful hominid, riding bareback. With a swirling flourish, Marsh had added the caption "Eohippus & Eohomo," as if horse and cowboy were ambling together out of the sunrise of some ancient American West. Writing a few days after his visit about what he had seen at the Peabody, Huxley remarked, "There is no collection of fossil vertebrates in existence, which can be compared to it."

What caught the attention of Darwin himself, though, wasn't so much the horses as a pair of late Cretaceous birds. In the early 1870s, Marsh managed to obtain two spectacular fossil birds—*Hesperornis* and *Ichthyornis*—from 80 million-year-old deposits in the Smoky Hills region of north-central Kansas. These specimens had heads, unlike the only specimen of the ancient bird *Archaeopteryx* then known, and these heads had distinctly reptilian teeth for catching hold of fish underwater.

The discovery, Marsh announced triumphantly, "does much to break down the old distinction between Birds and Reptiles."

In a monograph on the toothed birds of North America, he predicted correctly that *Archaeopteryx* would also turn out to have had teeth. In 1880, a correspondent was moved to write Marsh, “Your work on these old birds, and on the many fossil animals of North America, has afforded the best support to the theory of Evolution, which has appeared within the last twenty years”—that is, since the publication of *On the Origin of Species*. The letter was signed, “With cordial thanks, believe me, Yours very sincerely, Charles Darwin.”

Hesperornis and *Ichthyornis* now occupy a little-noticed display case at the side of the Great Hall of Dinosaurs, overshadowed by the 70-foot-long *Brontosaurus* hulking nearby and the huge mural overhead. But they are worth a look for one added reason. Marsh eventually published his monograph about the toothed birds through the U.S. Geological Survey (USGS). Much later, in the 1890s, a congressman held up a copy of this book as an instance of taxpayer spending on “atheistic rubbish.” His incredulously repeated phrase—“birds with teeth, birds with teeth!”—helped drive a Congressional attack on the USGS, which was then arguing that scientific mapping of the water supply should shape the settlement of the West. Congress soon slashed USGS funding and overrode its warning that pell-mell settlement would yield “a heritage of conflict and litigation over water rights.” People fighting over water in the drought-stricken American West are still feeling the bite of those “birds with teeth.”

I took a seat on a wooden bench, alone except for a guard, in a room with a dozen or so gigantic dinosaurs on display. *Brontosaurus* dominates the scene, and it’s easy enough to see why Marsh gave it a name that means “thunder lizard.” The discovery of such enormous dinosaurs began one day in March 1877 when two scientifically minded friends, on a hike above Morrison, Colorado, suddenly found themselves gawking in silence at an enormous fossil vertebra embedded in stone. It was “so monstrous,” one of them wrote in his journal, “so utterly beyond anything I had ever read or conceived possible that I could hardly believe my eyes.”

Marsh had by then withdrawn from fieldwork, instead using his inherited wealth to deploy hired collectors. He was also deeply engaged in a bitter rivalry, now remembered as

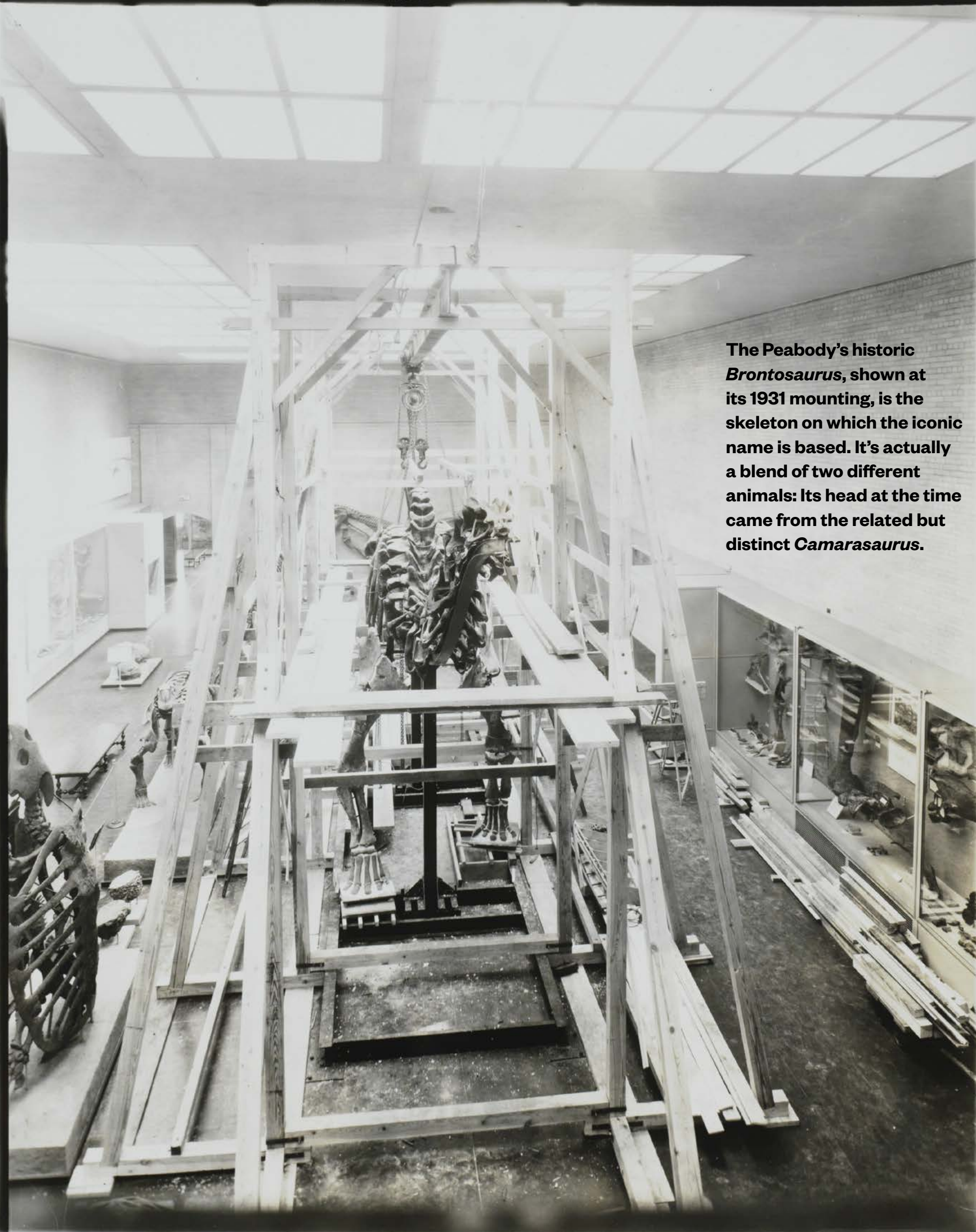
“the Bone Wars,” with Edward Drinker Cope at the Academy of Natural Sciences of Philadelphia. Marsh managed to edge out Cope for that huge new specimen, naming it *Titanosaurus* (later *Atlantosaurus*).

That same year, Marsh’s collectors also found and shipped him the meat-eating Jurassic monster *Allosaurus* and the plant-eaters *Apatosaurus* and *Stegosaurus*. Visitors to the museum today are liable to run their eyes over the massive bulk of *Stegosaurus*—which weighed five tons, when alive—and notice that its skull seems far too small for an adequate brain. Marsh thought so, too, and conjectured that *Stegosaurus* must have had a second brain in a large hollow area of its lower vertebrae. His *Stegosaurus* was long believed to be the inspiration for a celebrated bit of light verse in *The Chicago Tribune* in 1903, which included these lines:

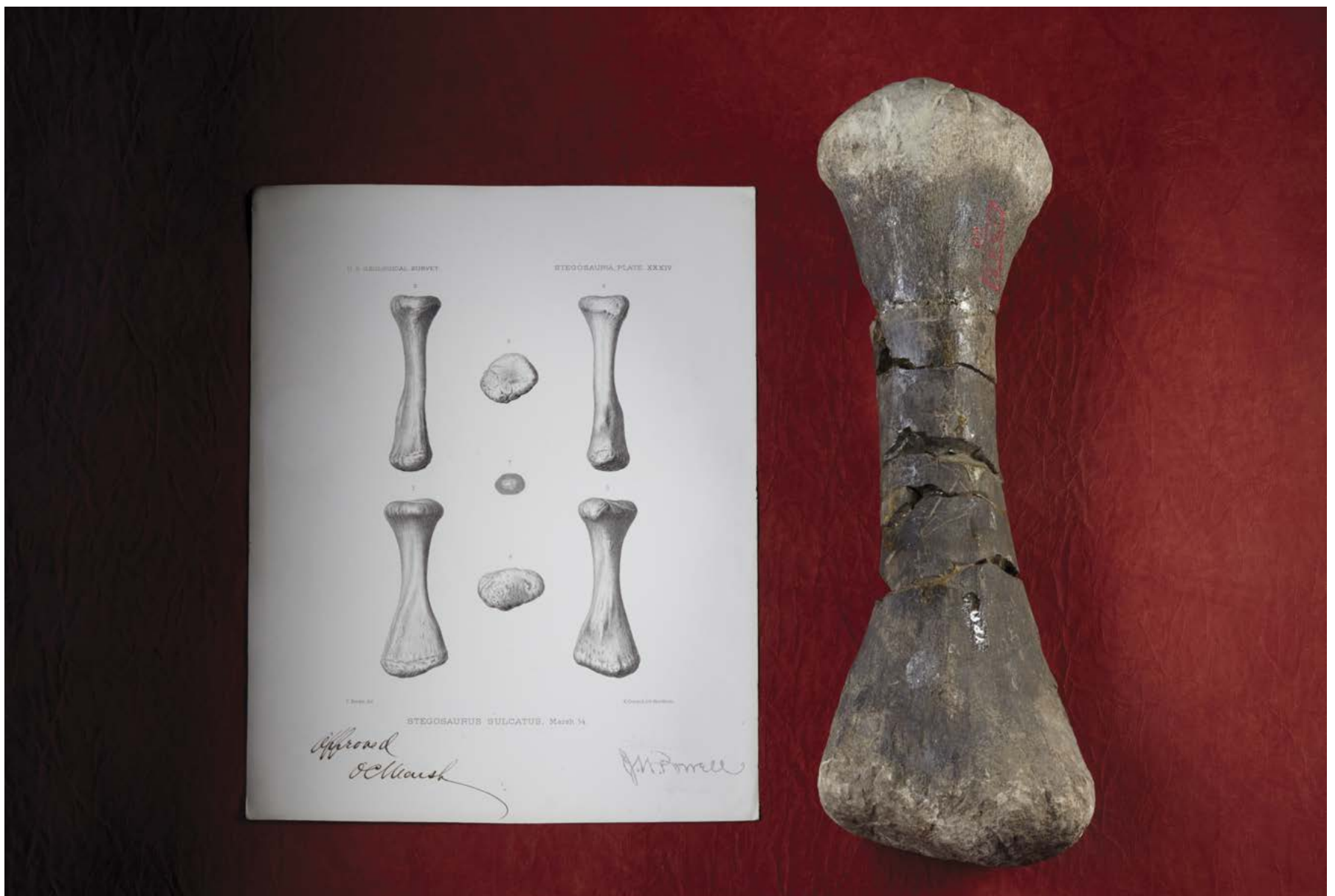
*The creature had two sets of brains—
One in his head (the usual place),
The other at his spinal base.
Thus he could reason a priori
As well as a posteriori.*

Although numerous popular books still associate this poem with the *Stegosaurus*, that connection turns out to be false. In reality, a former student of Marsh’s merely borrowed his two-brain idea and slapped it onto an entirely different dinosaur, *Brachiosaurus*, at the Field Museum in Chicago. It was the *Brachiosaurus* that inspired this verse. But let’s at least credit *Stegosaurus* with an assist. Credit it, too, with only a single brain, described by one modern paleontologist, as roughly “the size and shape of a bent hotdog.”

Nine of Marsh’s dinosaurs turn up in the mural overhead, but only three of Cope’s. (Old rivalries die hard.) Artist Rudolph Zallinger was a 23-year-old at the start in 1942, and later admitted that he did not know “the front end from the rear end of a dinosaur.” He spent four years on the project, and one art historian called the resulting Garden of Eden for dinosaurs the most important mural since the 15th century. In 1953, *Life* magazine published a fold-out reprint of the original study of the mural, with a detail of *Brontosaurus* and *Stegosaurus* on the cover. The mural thus inspired a generation of future paleontologists.



The Peabody's historic *Brontosaurus*, shown at its 1931 mounting, is the skeleton on which the iconic name is based. It's actually a blend of two different animals: Its head at the time came from the related but distinct *Camarasaurus*.



A radius from the left forelimb of a *Stegosaurus*. O.C. Marsh described and named the dinosaur based on fossils gathered in Wyoming. It's still debated whether the animal's spikes pointed up or in a more horizontal direction.

It also caught the attention of a moviemaker in Tokyo, who borrowed heavily from Zallinger's dinosaurs to put together a new monster—Godzilla.

Zallinger's mural incorporated the then-current dogma, from O.C. Marsh and others, that dinosaurs were plodding tail-dridders. But in 1964, John Ostrom, a paleontologist at the museum, made a discovery that shattered this stereotype. He and an assistant were out for a walk in Bridger, Montana, at the end of that year's field season, when they spotted what looked like a hand with an outsized claw eroding out of a rocky slope. It was in fact a foot, and that sharp, sickle-shaped claw projecting almost five inches from the innermost toe eventually gave the species its name, *Deinonychus*, or "terrible claw."

Studying his find over the next few years, Ostrom began to think that instead of being slow and stupid, *Deinonychus* "must have been a fleet-footed, highly predaceous, extremely agile and very active animal, sensitive to many stimuli and quick in its responses." He took this idea an audacious leap forward before the North American Paleontological Conven-

tion in 1969. Evidence suggested, he declared, that many dinosaurs “were characterized by mammalian or avian levels of metabolism.” This idea elicited “shrieks of horror” from traditionalists in the audience, according to the paleontologist Robert Bakker, who had been Ostrom’s undergraduate student at Yale and went on to popularize this new view of dinosaurs. It was the beginning of the modern dinosaur renaissance.

The following year, Ostrom began to compare the many similarities between *Deinonychus* and the ancient bird *Archaeopteryx*. From that insight, he went on in a series of groundbreaking papers to establish that the bipedal theropod dinosaurs, including *Deinonychus*, were in fact the ancestors of modern birds. This idea is now so commonplace that researchers debate why birds were the only dinosaurs to survive the mass extinction of 66 million years ago.

The novelist Michael Crichton later spent time interviewing Ostrom in person and by phone, paying particular attention to the capabilities of *Deinonychus*. He later told Ostrom apologetically that his book *Jurassic Park* would instead feature *Velociraptor*, a *Deinonychus* relative, because the name sounded “more dramatic.” Visitors to the Peabody Museum can, however, still see the original *Deinonychus* model with its arms and legs flung back and out, elbows bent, claws flared. During a recent visit, a former graduate student of Ostrom’s pointed out an intriguing resemblance: If you take those outstretched arms and swing them back just a little farther (with a few small evolutionary adaptations), that hand-snatching gesture becomes the wingbeat of birds.

The museum is currently raising funds to undertake a dramatic updating of both the Great Hall of Dinosaurs and the Hall of Mammals. (*Brontosaurus* will no longer drag its tail and *Stegosaurus* will do combat with *Allosaurus*.) But it’s worth going now because the outdated displays and the dinosaur reconstructions are somehow evocative of another era in paleontology.

When you go, take a look at another fossil most visitors skip past: It’s a Uintathere, a “beast of the Uinta Mountains.” It lived roughly 45 million years ago on the present-day Utah-Wyoming border, and it looked like a rhinoceros, but with long, saber-like upper canines, and three sets of knobs, like the ones on the head of a giraffe, running from its nose to the top of its oddly flattened head.



Among the holdings are herbarium sheets of ladyslipper specimens and a vasculum used for collecting plants at the Osborn Botanical Laboratory.

This Uintathere was one of the first reconstructions O.C. Marsh approved for display in the museum. Marsh generally liked to reconstruct fossil animals only on paper, with the actual bones safely stored away for study. So he nervously ordered his preparator to construct a Uintathere entirely out of papier-mâché. Because of the scale of the Uintathere, this required paper with a high fiber content. According to backroom lore, the perfect raw material arrived at the museum one day after Marsh prevailed on friends in high places to provide U.S. currency otherwise destined for destruction.

The sign on the display does not say so. But you can pass on the tale to your companions: What you are looking at may be quite literally the first “million-dollar fossil.” ○

WELCOME

TO

BOBBY BEARD RUNS HIS CLIPPERS OVER

an imposing but largely bald head, leaving behind a gray-white fuzz, short and tight as a cap of worn velvet. We're looking here at years and years of experience, perseverance and endurance.

THE NATION'S GREATEST ORATORS CLASHED IN THE FAMED SCOPES EVOLUTION TRIAL NEARLY A CENTURY AGO. NOW YOU CAN SIT IN THE SAME COURTROOM AND REACH YOUR OWN VERDICT

MONKEY

BY FRANZ LIDZ

TOWN



P H O T O G R A P H S B Y F E R N A N D O D E C I L L I S

RYAN
E's TRIAL
MPANY
CINCINNATI, OHIO



X
TRIAL

John Scopes, on display
at the Dayton, Tennessee,
courthouse museum.

CHATTANOOGA, TENN., SUNDAY, AUG. 7, 1932.
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The Eagle's Nest Barber Shop, across the street from the Rhea County Courthouse, has downsized over the decades. "Employees come, employees go," says proprietor Bobby Beard. "Just like wives."

This barber is 74 and his customer 90. "Bobby ain't great at cuttin' hair," confides the customer. "When he gets to playin' music, he'll trim one side of your scalp and let the other go." When not barbering—or sometimes when he is—Beard plays the most mournful pedal steel guitar in Dayton, Tennessee.

On this July morning, the sun beats heavily through the shop's front window. "Isn't it incredible that our planet rotates around the Sun, which throws out all that heat and light?" marvels Beard. "The Sun didn't just pop out from nothing. Somebody had to put it there. The universe is like a seed you sow in the ground and grows into a tomato plant. The amazing thing is God grew the universe in less than a week."

Such a bold statement of belief is very much in keeping with local history. Beard's barbershop looks out on the lawn of the Rhea County Courthouse, where Daytonians are currently gathered for the annual Scopes Trial Festival. The sky is

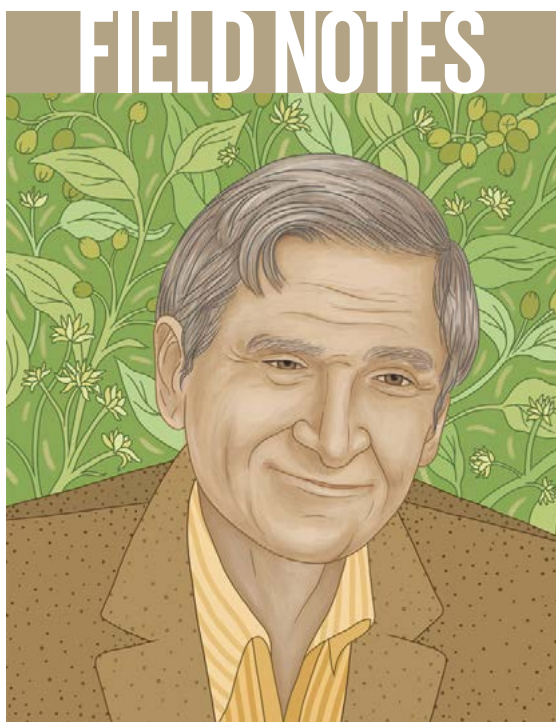


a crisp, clear blue. A dozen or so people are milling around the steps of the building, where, some 90 years ago in the sweltering summer heat, two celebrity advocates debated Darwinism before standing-room-only crowds. A dozen more visitors are scattered around the statue of the fiery orator William Jennings Bryan (once known as “the Great Commoner”), who died in town of a heart attack five days after the trial ended.

Anyone who has seen the 1960 film *Inherit the Wind* is familiar with the basic story: John Scopes, a sports coach and science teacher at Dayton High, was charged with breaking a new state law that banned the teaching of evolution. He was convicted and fined \$100, though the verdict was later overturned on a technicality (the judge, rather than the jury, had determined the penalty). It’s unclear whether Scopes actually taught evolution at all: Dayton’s business leaders enlisted him, in an effort to promote their town, after the American Civil Liberties Union offered to bankroll the defense of any teacher who broke Tennessee’s new law.

Pretty much every summer since 1988, this tiny Appalachian town (pop. 7,200) has roused itself to celebrate that publicity stunt gone viral. The Scopes Trial Festival, held over two weekends in July, features live bluegrass, tractor and craft shows, and a fried-Oreo food truck. A storyteller spins his tales like a barker at a sideshow. The centerpiece of the festival is a town-commissioned musical, *Front Page News*, which re-enacts the trial in the vast courtroom where it was held.

The play, performed by members of the nearby Cumberland County Playhouse, is essentially a rebuttal to *Inherit the Wind*. The Hollywood version of the trial is widely loathed in Dayton, and *Front Page News* does hew much more closely to the court transcript. Director Jim Crabtree says the local production is “about tolerance and respect for those whose beliefs differ from our own.” Yet the actors playing the Yankee characters tend to squawk and snivel, while those playing Southerners—some of whom are careful to pronounce “evolution” so that the first syllable comes out “evil”—are courtly, courteous, even judicious. Periodically, the entire cast suddenly puts the action on hold and stands in a row to sing hymns. Though the audience is encouraged to shout “amen” just as real spectators did in 1925, the earnest two-act play lacks the carnival atmosphere of the



E.O. WILSON

PROFESSOR EMERITUS OF
ENTOMOLOGY AT HARVARD UNIVERSITY

When I was a new PhD, in 1954, I

had the thrill of working on the ecology of New Caledonia. I was the first person to explore the ant fauna there. Not only did I discover large numbers of new species, but I also found evidence of what are called adaptive radiations. That means one species made it to New Caledonia—who knows how many millions of years ago!—and then diversified into a number of other species found only on that island. There was other magic: New Caledonia had been isolated and tropical since the Mesozoic Era, so there were life-forms that could no longer be found anywhere else. There were mountains of ancient conifers and an ancient oak-like species. I saw the most primitive flowering plant in the world. In 2011, I went back and, with the help of a French entomologist, found a remarkable kind of ant I'd failed to discover in 1954. This is why New Caledonia is my favorite place. I went there as a young scientist and then went back as an elderly scientist to make new discoveries.

movie. At times, it seems longer and windier than the actual trial. The production survives on the brio of its bluegrass numbers and the enthusiasm of its actors. Subtlety isn't their forte. Rick Dye, who played the suspender-snapping Chicago defense lawyer Clarence Darrow in 2015, emitted an air of overwhelming vanity combined with some unspecified nastiness. George Miller as Bryan presented the fundamentalist position with the thoughtful dignity of a fruit peddler. Even so, it's quite remarkable to watch them pace the same creaky plank floors, sit at the same oak desks and argue before the same jury box as those two splendid litigators.

The lawyers were what made the trial front-page news. Bryan, a three-time presidential candidate and a believer in the literal Bible, volunteered to help the prosecution as part of his campaign against atheists and agnostics. "Darwinism is not science at all," he maintained, "it is guesses strung together." Fearing the incursion of pious fanaticism into education, Darrow volunteered to lead the defense. His strategy was to secure his client's conviction, then appeal to a higher court so the statute could be ruled unconstitutional. But his *coup de théâtre* was to call Bryan to the stand as an expert witness on the Bible.

It's generally accepted that during the cross-examination, Bryan came off as a buffoon. He got testy when Darrow grilled him about the whale that swallowed Jonah—"You don't know whether it was the ordinary run of fish or made for that purpose?"—and the exact date of Noah's flood: Bryan: "I never made a calculation." Darrow: "What do you think?" Bryan: "I don't think about things I don't think about." The prosecution won in court, but Bryan's name was forever dishonored.

In Rhea County, though, Bryan is still revered. His statue on the courthouse lawn is inscribed with the words "Truth and Eloquence." And the town is home to Bryan College, a Christian-based liberal-arts school founded in 1930 to honor the Great Commoner's crusades at the Dayton trial. It has a total enrollment of 1,500 and a curriculum built around the inerrancy of Scripture. Bryan College found itself in the spotlight in 2014 when its board of trustees required professors to sign a statement of belief saying Adam and Eve were "historical persons created by God in a special formative act, and not from previously existing life-forms." Two tenured professors were fired after they failed to do so.

Some members of the campus community protested: The faculty voted no-confidence in President Stephen Livesay's leadership, 30-2; the student government association ran an open letter to the board in the Bryan *Triangle*; a social media campaign publicized the disapproval. A typical tweet: "I came to Bryan to expand my educational options, not limit them."

Still, many Daytonians maintain that the Earth came into existence over the course of six days around 10,000 years ago. When asked whether he believes in evolution, Beard, the barber, responds with a sharp wince and a look indicating something between disapproval and pity. "I ain't the kin of no monkey," he says with heavy finality.

Monkeys have long been a sensitive subject in this town: During the trial, one of the hundreds of journalists encamped in houses and hotels was the *Baltimore Evening Sun* columnist H.L. Mencken, one of the most distinctive and vituperative American prose stylists of the 20th century. As he observed the frenzied gathering—the narrow streets jammed with Bible salesmen, souvenir hucksters, freak shows, a toy-piano-playing chimp named Joe Mendi, and ministers who preached about the evils of coffee, ice cream and Coca-Cola ("a levantine and hell-sent narcotic")—Mencken called the proceedings a "universal joke"; Bryan, a "charlatan, a mountebank, a zany"; and the townsfolk, "gaping primates" and "rustic ignoramuses."

"Mencken referred to Dayton as 'Monkey Town,'" says Tom Davis, the county's administrator of elections. "As you might guess, that was not a term of endearment."

These days, locals often use the term more playfully: There's a restaurant called Monkey Town Brewing Co. two blocks from the courthouse. In 2010, native daughter Rachel Held Evans titled her memoir *Evolving in Monkey Town*. Evans is Bryan College's most famous graduate, as well as its most famous apostate. Raised in a conservative Christian home, she attended Rhea County Academy, a private Christian school, where she won the "Best Christian Attitude" award four years straight. While studying at Bryan, Evans says, she became increasingly uncomfortable with fundamentalist Christianity's pat responses to complicated questions. "My teachers spoke negatively about evolution," recalls Evans, who now embraces Darwin's theory. "It was described as being contrary to the



David Tromanhauser, a former alumni director for Bryan College, plays the role of Attorney General Tom Stewart in *Front Page News*. The town commissioned the musical specifically for the Scopes Festival.

Christian faith. ‘You can believe the Bible or you can believe evolution,’ one of my professors said. ‘But you can’t believe both.’”

Those professors were not alone: A 2014 Gallup poll showed that 42 percent of Americans reject evolution. The figure hasn’t changed much over the three decades in which the survey has been conducted. Perhaps more surprising: In 2007, Penn State researchers canvassed 939 high-school biology teachers across the country and found that 16 percent said they personally believed God created human beings in the last 10,000 years.

Courts routinely overturn statutes that require science teachers to place equal emphasis on evolution and creation events. But just as routinely, anti-evolution activists introduce new variations. Louisiana skirted federal law with a 2008 act that allows teachers to use “supplemental textbooks and other instructional materials to help students understand, analyze, critique, and review scientific theories in an objective man-

ner.” The legislation singled out theories on evolution, human cloning and climate change. Tennessee schools are not allowed to teach creationism or intelligent design, but they can present the “scientific strengths and scientific weaknesses” of theories that can “cause controversy.”

Dayton is home to the Core Academy of Science, a local ministry that offers online courses in biology, chemistry and earth science. Its president, Todd Charles Wood, came to Dayton in 2000 to preside over the now-defunct Center for Origins Research at Bryan College. Before a 2015 performance of *Front Page News*, Wood delivered a lecture called “The Ironic History of Evolution in the Scopes Era.” “I will not be baited into a debate by proxy with Rachel Held Evans or any other promoter of evolution,” he said afterward. “If they don’t like what I’m doing, that’s their problem. I have to answer to God for what I’m doing, not for what they’re doing. If Rachel thinks she can face Christ’s coming judgment with confidence and a clear conscience, good for her. Who am I to judge another servant?”

Evans, who still lives in Dayton, says locals continue to be profoundly shaped by the events of 90 years ago. “The characters in the Scopes Trial drama were in many ways overdrawn, even without added theatrical flourish,” says Evans. “And I often wonder if that forever changed how we view the tension between science and faith. If science is represented by the aggressively atheist Darrow and the disdainful cynic Mencken, and if faith is represented by the thundering yet unprepared Bryan, no wonder we have trouble dialoguing with one another. It’s as if we have been fighting caricatures of one another ever since 1925.” ○

EV  TOURISM 2016

DAWN OF THE

BY BRIAN SWITEK

DINOSAUR

IN THE ARIZONA DESERT, YOU CAN FIND REMAINS OF THE CREATURES THAT CRAWLED THROUGH THE TROPICS BEFORE *T. REX* AND OTHER FIERCE GIANTS DOMINATED EARTH

PETRIFIED FOREST NATIONAL PARK

is the kind of place that sneaks up on you. As you cruise at a brisk 80 miles an hour along Highway 40 in Arizona, a sea of sage, rabbitbush and grass stretches from the road's shoulder to the horizon. This cloaking makes the transformation all the more dramatic once you reach the park. Not far inside the gate, the low scrub opens into the reds, blues and grays of the Painted Desert.

ILLUSTRATION BY VICTO NGAI





Most visitors drive from one end to the other, perhaps stopping to wander loops lined with petrified tree specimens. Gazing at the exposed rocks, they're invited to imagine a time when forests and rivers clothed this corner of the world. They cannot be blamed for picturing various roaring dinosaurs loose on the land, since the rock shops and gas stations just outside the park feature towering concrete or wooden dinosaur statues that hold their jaws in frozen snarls.

But the actual dinosaurs that scurried through these ancient forests and flood plains weren't the fearsome giants featured on children's lunchboxes. In fact, if you were to time-travel back to before the forest was petrified, you'd be quite lucky to glimpse even a fuzzy little dog-size dinosaur darting through the tree stands or striding along the riverbank. Most of the creatures you'd encounter would be distinctly non-dinosaurian, with low, ambling gaits or plate-like armor down their backs. At the time, those other lineages seemed poised to outcompete and dominate dinosaurs altogether. At Petrified Forest, these Triassic weirdos are the main attraction.

You can see some of their remains at the Rainbow Forest Museum, a low beige building that blends into the vast expanses of desert around it. Fluorescent lights shine on skeletons belonging to four prehistoric creatures: an herbivore, a carnivore, a flying pterosaur and a two-tusked protomammal. All of these appeared on the evolutionary stage during the Triassic, between 252 million and 200 million years ago, just after the worst mass extinction of all time. The world's ecosystems had just been wiped clean: More than 75 percent of known species on land and 95 percent



Petrified Forest's chief paleontologist Bill Parker excavates bones from a hill.

of species in the seas had died. But life came roaring back into a world of new possibilities.

The non-dinosaurs that ruled that era haven't found their way onto movie screens the way dinosaurs have. But they're crucial to understanding the prehistoric world, and the park's lead paleontologist, Bill Parker, has spent years unearthing their significance. Standing between shelves of carefully cataloged bones, Parker recalls a day in 2014 when he discovered a key link in the evolutionary chain. He was leading a school group at a fossil-rich area called the "Dying Grounds," a barren patch of gray stone in the middle of the sunbaked desert. Standing on a hill he says he'd stood on "at least 50 times before," Parker spotted a neck vertebra and toe bone sticking out of the ground. These turned out to be the first of more than 800 bones representing a newly discovered carnivorous reptile called an archosauromorph—not a dinosaur or a crocodile but a lineage from an even earlier time before those two groups split from each other. Based on the age of the surrounding rock, the archosauromorph had lived alongside newer forms of reptilian life some 230 million years ago.



**Petrified wood on Long Logs Trail,
a 1.6 mile-hike that starts at the
Rainbow Forest Museum.**

Scientists haven't pinpointed exactly when the first major dinosaur lineages appeared in the American Southwest. In the late 1980s, a paleontologist named Adrian Hunt thought he'd found a clue in the New Mexico desert: 32 teeth in a 220 million-year-old rock. Based on their leaf-like shape, he guessed that they'd belonged to an ornithischian dinosaur, the earliest-known ancestor of later greats such as *Stegosaurus* and *Triceratops*. He named the creature *Revueltosaurus*, and at first it seemed truly revolutionary—concrete evidence that this major lineage had thrived in the American Southwest much longer ago than anyone had ever believed.

In 2004, however, Parker overturned that notion. In Petrified Forest, he found another set of *Revueltosaurus* teeth, but they were lodged in jaws that shared more anatomical features with Triassic reptiles. "It dawned on me that *Revueltosaurus* was not a dinosaur," Parker says. When more *Revueltosaurus* skeletons started coming out of the ground, they had heavy coats of bony armor. "It had a tail club," Parker recalled. "The shape reminded me of manicotti." Based on the armor, the ankle anatomy and

FIELD NOTES



CORRIE MOREAU

THE FIELD MUSEUM OF NATURAL
HISTORY AND UNIVERSITY OF CHICAGO

The first time I visited the Amazon,

I had just started graduate school at Harvard under the guidance of Professors Edward O. Wilson and Naomi E. Pierce. I was amazed at how the rainforest was almost a living, breathing organism in itself. As evolutionary biologists, we often focus on one organism or a few organismal groups. I'd studied ants in Madagascar and in the Southwest desert. But in the rainforest, there were so many different kinds of ants, from predatory army ants to highly specialized herbivores. And there was so much diversity—the plants, and the insects that were feeding on the plants that were being eaten by the vertebrates. Everything was influenced by factors like rainfall, humidity and competition for resources. I realized it's not enough to study an organism on its own. You have to think deeply about the environment in which it's embedded. That trip was an epiphany for me. And once my eyes were opened, I could see that interconnectedness everywhere.

subtle characteristics of the skull, Parker concluded that the *Revueltosaurus* was a pseudosuchian, an ancient reptile that eventually gave rise to modern-day crocodiles.

The implications of Parker's discovery were enormous, according to Hans-Dieter Sues, curator of vertebrate paleontology at Smithsonian's National Museum of Natural History. "The *Revueltosaurus* had been held up as the best record of a late-Triassic ornithischian dinosaur," says Sues. "It was the crown jewel. And then, all of a sudden, poof! It just disappeared." The *Revueltosaurus* revelation led Parker and others to reclassify other creatures that had been regarded as early dinosaurs, and so the number of officially recorded dinosaur fossils from the Triassic period has plummeted. In Petrified Forest there are now only two confirmed dinosaur species, *Coelophysis* and *Chindesaurus*, both about the size of a greyhound.

It's not clear why these small, sleek dinosaurs eventually evolved into enormous Jurassic beasts. "We really don't know yet," says Sues. The transformation seemed to happen around 200 million years ago, just after another massive extinction. "We think that extinction was due to an unprecedented episode of volcanic activity," Sues says. "Initially the world would've been a little cooler. Then it would've gotten really hot. Dinosaurs had a very different physiology and metabolism than other creatures at that time, so it could be they were better suited to that warmer world. All we really know is that they not only survived the extinction but immediately thrived like crazy."

Parker has turned his focus to other mysteries. "We have a pretty good record of all the big stuff," he says, referring to the heavily armored aetosaurs and gharial-like phytosaurs found in the park, "But what I've been really getting interested in is the little stuff." In recent years, he and his colleagues have found precursors of smaller animals such as frogs, lizards and salamanders. Piecing them together involves meticulous work: Unlike the remnants of larger animals, miniature skeletons are easily broken or lost in a gust of wind, and they rarely come out of the ground in one piece.

Even more awaits out in the Painted Desert. During the past two years, Petrified Forest has expanded its boundaries by about 50,000 acres through land transfers and purchases, bringing the park up to about the size of the municipal city of Chicago. "The



Parker holds the lower jawbone of a *Revueltosaurus*. He and his colleagues found 16 of the animal's skeletons in one spot, suggesting that a dramatic event took out a large group of them all at once.

areas we've investigated so far are even richer than those that were already in the park," Parker says. Where he used to visit some familiar sites and think "Uh, this place is starting to get tapped out," Parker says he now has a different view. "We're just getting warmed up. We're just getting started." ○

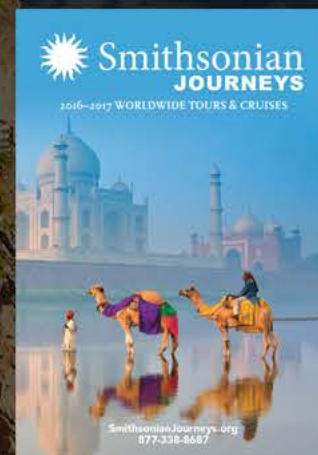
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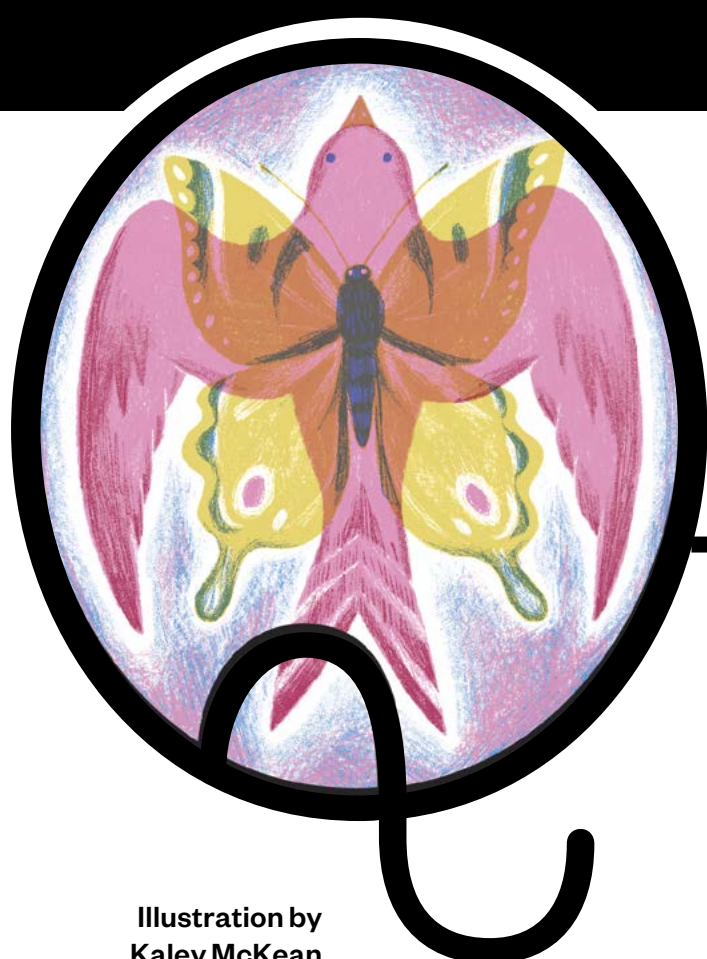


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Kaley McKean

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YOUR QUESTIONS ANSWERED BY OUR EXPERTS

The rounded profile of a bird's wing creates an airfoil, which generates lift and allows the bird to fly. But butterfly wings are flat. How do butterflies fly?

Robert Kacmarcik, Green Valley, Arizona

Flat-winged insects also generate lift by using their wings as airfoils, says *Robert Dudley, research associate at the Smithsonian Tropical Research Institute and professor at the University of California, Berkeley*. Briefly put, the flapping of their forewings creates a low-pressure vortex above the wings, and their hind wings help them turn. Butterflies are less efficient fliers than birds, flapping their wings at a greater angle into the oncoming air and producing much more drag per unit of lift. But their erratic flight helps them evade predators, including birds.

Why have the storms in Jupiter's Great Red Spot raged continuously for 150 years or more?

Michael Landau, Rome, New York

Scientists haven't definitively answered that question, but they expect NASA's Juno spacecraft, which is due to begin orbiting Jupiter this July, to gather vital data. Generally, says *Jim Zimbelman, geologist at the Center for Earth and Planetary Studies at the Air and Space Museum*, storms in any planet's atmosphere occur when air masses of different temperatures collide, and Jupiter's interior generates tremendous heat. And because the solar system's largest planet is made mostly of gases, there are no land forms to slow the wind. In the Great Red Spot, a storm bigger than Earth itself, winds blow up to 425 miles per hour. Recent images from the Hubble telescope suggest that the spot is shrinking, but don't expect calm skies over Jupiter anytime soon.

Ozone up high is considered beneficial, yet near the ground it is considered a hazard. Why the difference?

Marysue Vidro, Columbia, Maryland

Ozone, no matter where it occurs or how it is created, is both protective and reactive, says *Pat Neale, senior scientist at the Smithsonian Environmental Research Center*. Most ozone is produced naturally in the stratosphere, where it filters damaging solar UV-B radiation before it reaches the earth's surface. At ground level, ozone is generated when industrial emissions—specifically, oxides of nitrogen and volatile organic compounds—interact in the presence of sunlight, and it's hazardous because it can harm living tissues. In human beings, exposure to high ozone levels can inflame the lining of the lungs, even causing scarring and boosting susceptibility to infection.

How do scientists measure water flow in rivers and streams? **Howard J. Hammer, Simi Valley, California**

There's actually a tool for that, called a V-notch weir, says *Donald Weller, senior scientist at the Smithsonian Environmental Research Center*. It's a rectangular plate with a V-shaped opening at the top. Place one across the flow, and the water will back up behind it; once you measure that depth, you can use a mathematical formula to calculate the flow rate.



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