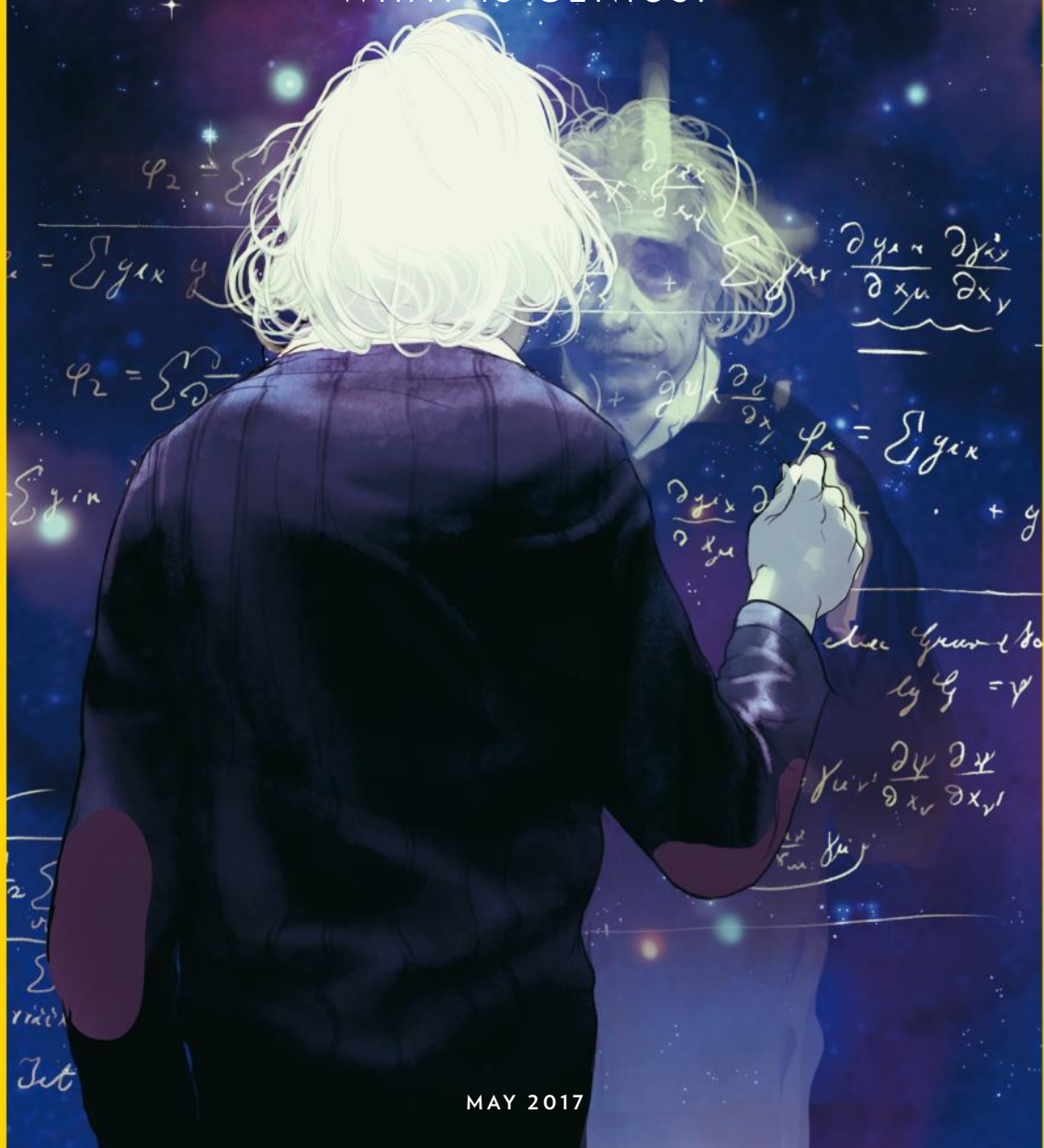


Genius. 10-PART SERIES PREMIERES APRIL 25 AT 9/8C ON NATIONAL GEOGRAPHIC

NATIONAL GEOGRAPHIC

WHAT IS GENIUS?



MAY 2017



Wrybill (*Anarhynchus frontalis*)

Size: Body length, 20 - 21 cm (7.9 - 8.3 inches) **Weight:** 43 - 68 g (1.5 - 2.4 oz) **Habitat:** Shallow estuaries on sheltered coasts; breeds along large, fast-flowing rivers **Surviving number:** Estimated at 4,500 - 5,000



Photographed by Tom Marshall

WILDLIFE AS CANON SEES IT

Curves ahead. There's no mistaking New Zealand's wrybill, the only bird in the world to sport a laterally curved bill. It uses this bill, which always curves to the right, to scoop up meals of mayfly larvae, flatworms, spiders, fish eggs and more. During the winter months, the wrybill forages during both night and day; its heavy-set frame is evidence of a tireless quest

for food. But signs are not promising for the continued survival of this singular bird, faced as it is with serious habitat loss in addition to predation by stoats and cats.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.



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Scotland has lost more than 25 percent of its heather moorland since World War II. For what's left of this signature landscape, the future is clouded by debates about class, culture, and nature.

By Cathy Newman, Photographs by Jim Richardson



On the Cover Albert Einstein revolutionized our understanding of how the universe works. More than 60 years after his death, we're just beginning to understand how minds like his work. *Illustration by Tomer Hanuka*

Corrections and Clarifications
Go to natgeo.com/corrections.

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TELEVISION

EINSTEIN THROUGH THE AGES, IN *GENIUS* ON NATIONAL GEOGRAPHIC

Actor-musician Johnny Flynn (far left) and Academy Award winner Geoffrey Rush both portray Albert Einstein in *Genius*, a 10-part series based on Walter Isaacson's acclaimed biography of the brilliant scientist. The series airs starting April 25 at 9/8c on National Geographic.

TELEVISION

HOW WE ROLL: ON *ORIGINS*, A LOOK AT TRANSPORTATION'S HISTORY AND LEGACY

Human innovation has carried us faster and farther than we could ever have imagined. Trace the routes we've taken to conquer space and time on the April 24 episode of *Origins*, airing at 9/8c on National Geographic.

NAT GEO WILD

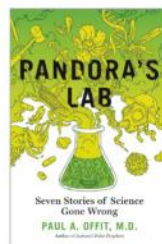
NURTURING WILDLIFE WITH *BANDIT PATROL*

Join Kentucky wildlife rehabilitators as they care for injured and orphaned raptors, raccoons, and other species. Once the animals are ready, the team places them back in the wild. *Bandit Patrol* returns on April 22, airing Saturdays at 9/8c on Nat Geo WILD.

BOOKS

BEWARE OF BAD SCIENCE

What happens when ideas billed as "scientific truths" are false? In *Pandora's Lab: Seven Stories of Science Gone Wrong*, physician Paul Offit distinguishes facts from fiction. Read excerpts in June's *National Geographic*; the book is available at shopng.com and wherever books are sold.



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GENIUS TAKES MANY FORMS

Who is a genius? This question has fascinated humankind for centuries—and it bedeviled us in putting together the cover story of this month’s issue.

Let’s stipulate: Einstein was a genius. His face (his hair!) is virtually the international symbol for genius, so revered is he as an intellectual titan. But for our story we wanted to go beyond one man and explore the nature of genius itself. Why is it that some people are so much more intelligent or creative than the rest of us? And who are they?

That’s where the trouble begins. When editors here first gathered portraits to create a gallery of geniuses past (because it’s hard to tell who among the living truly is a genius), the uniformity was obvious—and unsettling. In the sciences and arts, statecraft and literature, philosophy and industry, those hailed as geniuses were most often white men, of European origin.

Perhaps this is not a surprise. It’s said that history is written by the victors, and those victors—the ruling class, the dominant culture—set the standards for admission to the exclusive genius club. When contributions were made by geniuses outside the club—women, or

people of a different color or creed—they were unacknowledged, rejected, even misappropriated and claimed by others.

The stereotypes endure. A study recently published by *Science* found that as young as age six, girls are less likely than boys to say that members of their gender are “really, really smart.” Even worse, the study found that girls act on that belief: Around age six they start to avoid activities said to be for children who are “really, really smart.”

Can our planet afford to have *any* great thinkers become discouraged or intimidated and give up? It doesn’t take a genius to know the answer: absolutely not.

Here’s the good news. In a wired world with constant global communication, we’re all positioned to see flashes of genius wherever they appear. And the more we look, the more we will see that social factors like gender, race, and class neither ensure genius nor preclude it.

In other words, as Claudia Kalb writes in our cover story, future genius may reside wherever there are individuals with “intelligence, creativity, perseverance, and simple good fortune...capable of changing the world.”

Susan Goldberg, *Editor in Chief*

At Shotoku Gakuen Elementary School—a selective private school in Tokyo, Japan—admission depends in part on children’s IQ test scores.

Sunrise jogs. **Midnight vet runs.**
Selfie close-ups. **Routine check-ups.**
Puppy mistakes. **Whatever it takes.**



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Paleoanthropologist **Lee Berger**, 51, searches for fossils of human ancestors – sometimes in unorthodox ways. He empowers early career scientists, makes all his data open source, and publicizes discoveries for general (and not just academic) audiences. His new book, *Almost Human*, unveils his recent work and poses new questions about how humans developed.

How does your latest find, *Homo naledi*, challenge theories of human origins?

Homo naledi is between 200,000 and 300,000 years old. That's a best guess. That means you have a small-brain, primitive hominin that existed in Africa right down to the late middle Pleistocene, which was a complex-tools era thought to coincide with the rise of modern humans. We've also discovered a second, utterly discrete cave chamber containing *Homo naledi*, including a skeleton. So now we have two occurrences of this extraordinary concept. You can imagine the questions that are going to arise.

Doesn't publishing your raw data invite premature criticism?

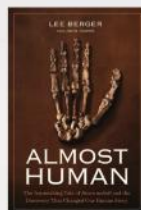
Yes, there is public criticism, but that's peculiar to any science in transition. The philosophy behind open sourcing and sharing our data and 3-D file images is that we're turning paleoanthropology into an experimental science. Our field has not typically operated like that. Unless others can test the hypotheses you're putting forward, it's not an experimental science.

Does pairing new scientists with such big questions risk their careers if the science is sloppy—or wrong?

That concept is fiction. Other fields of experimental science embrace early career scientists. They bring the freshest ideas and the newest applications of technology. Scientists should never be perceived as risking their careers by being wrong. That's the nature of hypotheses.



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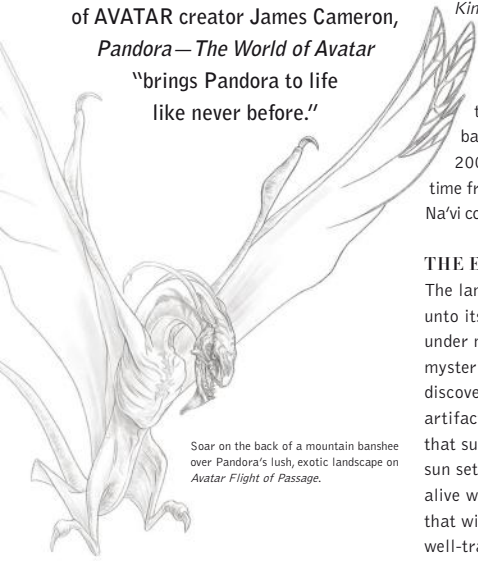




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Climb aboard a reed boat and experience a mystical Pandoran river where every moment tells a story and the rainforest canopy glows around you on *Na'vi River Journey*.



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At *Walt Disney World*® Resort, there is an amazing new 12-acre land within *Disney's Animal Kingdom*® Theme Park where Guests will be transported to a distant world that challenges everything they think they know. It's all based on the record-breaking 2009 film AVATAR, but in a time frame after the film's human-Na'vi conflict has been resolved.

THE EXPERIENCES

The land is an adventure unto itself. Guests will hike under mountains that float mysteriously above, while they discover the totems, cuisine and artifacts of the Na'vi culture that surrounds them. And as the sun sets, the forest will come alive with bioluminescence that will amaze even the most well-traveled. For even more adventure, Guests climb aboard the back of a living, breathing

banshee on *Avatar Flight of Passage*. They'll experience flight like never before linked to a predator with a 45-foot wingspan—and go soaring over a thrilling vista populated by herds of Pandoran animals, diving under mountains and over rushing rivers like nothing on Earth; or board a reed boat and experience a mystical Pandoran river on *Na'vi River Journey*, where they'll discover exotic plants and creatures as the Na'vi Shaman of Songs beckons.

A PARK AFTER DARK

The addition of *Pandora—The World of Avatar* completes the day-to-night transformation of *Disney's Animal Kingdom*® Theme Park, which now offers such after-dark experiences as the Rivers of Light show, *Tree of Life* Awakenings and street parties featuring live entertainment. *Pandora—The*

World of Avatar also enhances our appreciation of the natural world by showing what life may be like on a distant moon. The message of conservation and nature's intrinsic value pulses throughout the Park, and a visit might inspire people in unexpected ways.

IMAGINEERING

Disney and Lightstorm Entertainment, the creators of AVATAR, partnered closely to bring incomparable, high-tech Imagineering and experiential storytelling together to deliver a uniquely immersive experience. 🦋

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A large flock of birds, possibly terns, is captured in flight against a clear blue sky. The birds are scattered throughout the frame, with a dense concentration in the lower half. In the foreground, the dark, gnarled branches of a tree are visible, extending from the bottom right towards the center. The overall scene conveys a sense of natural movement and abundance.

VISIONS

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Madagascar

A cloud of hungry migratory locusts descends on a tree near Isalo National Park. Swarms like this one – the result of a robust rainy season, when the insect's population swells dramatically – appear once or twice a decade.

PHOTO: INGO ARNDT

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CLIMATE CHANGE: IN FOCUS

ASSIGNMENT Melting glaciers. Rising seas. Mass extinction. These are the terms. We asked to see what climate change *looks* like.

Arka Dutta
Kolkata, India

Dutta visited India's Ganges River Delta last summer to see conditions that could possibly be attributed to climate change. Rising water is encroaching on islands and eroding homes, in some cases forcing people to relocate. This woman stands where her house once was.

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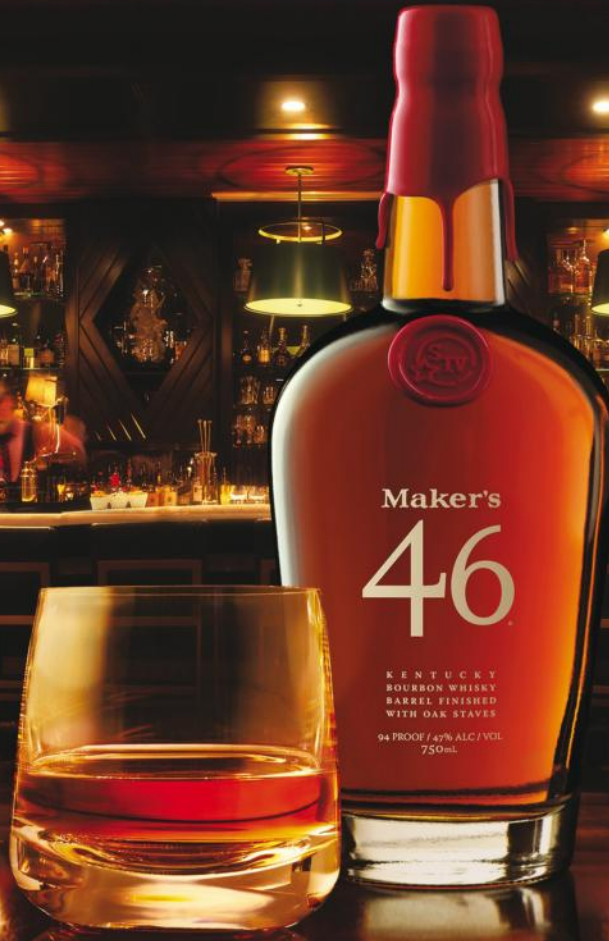
Kira Morris

Wichita, Kansas

One winter when Morris was working at the U.S.'s McMurdo Station in Antarctica, ice took much longer than usual to form. On the Hut Point Peninsula she watched a group of emperor penguins survey an unusual crack. Eventually, they dived in.

UNWIND AMBITIOUSLY.

CHARLESTON, SC



SIP DELICIOUSLY.



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Terence Chiew Teck Tzer
Singapore

Wanting to shoot images of pollution, Teck Tzer visited the Jurong Hill Lookout Tower so he could view some of Singapore's industrial production. He shot during the day, then returned at night. "I was trying to show pollution in areas and times where we are least aware of it," he says.

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EXPLORE

INNOVATION

DIGITIZED MENAGERIE

By Rachel Hartigan Shea

Capturing a three-dimensional image of an animal is tricky. “If it blinks or breathes or twitches its leg, you have to start over,” says Duncan Irschick.

The University of Massachusetts biologist was lucky with a cane toad he encountered in the Philippines: It didn’t stray from its leaf while he took some 30 shots, from all angles, with a handheld camera—enough to stitch together the 3-D version of the image below.

Now Irschick uses a technology called the Beastcam, a portable and adaptable multi-camera setup similar to what video-game designers use to create lifelike images of humans. The cameras, arrayed

around the animal, capture images simultaneously—insurance against fidgets. “Not a lot of people have tried this in the animal world,” says colleague Christine Shepard, a photographer.

Irschick and Shepard employ the Beastcam for an ambitious project called Digital Life, which aims “to create accurate high-resolution models of life on Earth,” says Irschick.

The digital models give the public the chance to examine animals up close. They also serve scientific purposes: Researchers can use them to collect measurements more accurately than is possible in real life. Beastcams also allow specimens to be collected digitally from countries that forbid physical exports.

The long-term goal for Digital Life is to capture “everything,” says Irschick. “But that’s going to take several lifetimes.”



IMAGE, ABOVE: DUNCAN J. IRSCHICK AND CHRISTINE SHEPARD (RENDERING OF 3-D MODEL)
PHOTO, RIGHT: CHRISTINE SHEPARD

HOW IT WORKS

STEP 1: An animal is placed on the platform. Beastcams can photograph creatures as small as an inch or as long as eight feet.

STEP 2: A wireless trigger allows multiple cameras – 30 for the cane toad at right – to shoot at once. “We can collect literally hundreds of animal models in a day,” says Irschick.

ONLINE

See the toad in 3-D at ngm.com/May2017.



SUSTAINING OUR CITIES

By Kelsey Nowakowski

Today's cities are finding it hard to be both livable and economically strong. Not one has truly balanced people, profit, and the planet, according to a new report on an index that ranks cities by sustainability. The index, from global design firm Arcadis and the Centre for Economics and Business Research, ranks cities' success based on social, environmental, and economic factors.

Rapidly urbanizing places, such as Dubai, in the United Arab Emirates, tend to prioritize fiscal growth over environmental or health matters—at least at first, says Arcadis's global director of cities, John Batten. For example, only after it had built a robust economy did Dubai begin investing in mass transit projects that would cut pollution and improve pedestrian safety.

Increasingly, city leaders are seeing the value of raising the quality of life. Seoul, South Korea—ranked first for “people” in the index—is using the fruits of a decades-long boom to enhance its environment. Among the projects: reclaiming once polluted land to create recreational spaces and improve flood control.

RANKING WORLD CITIES

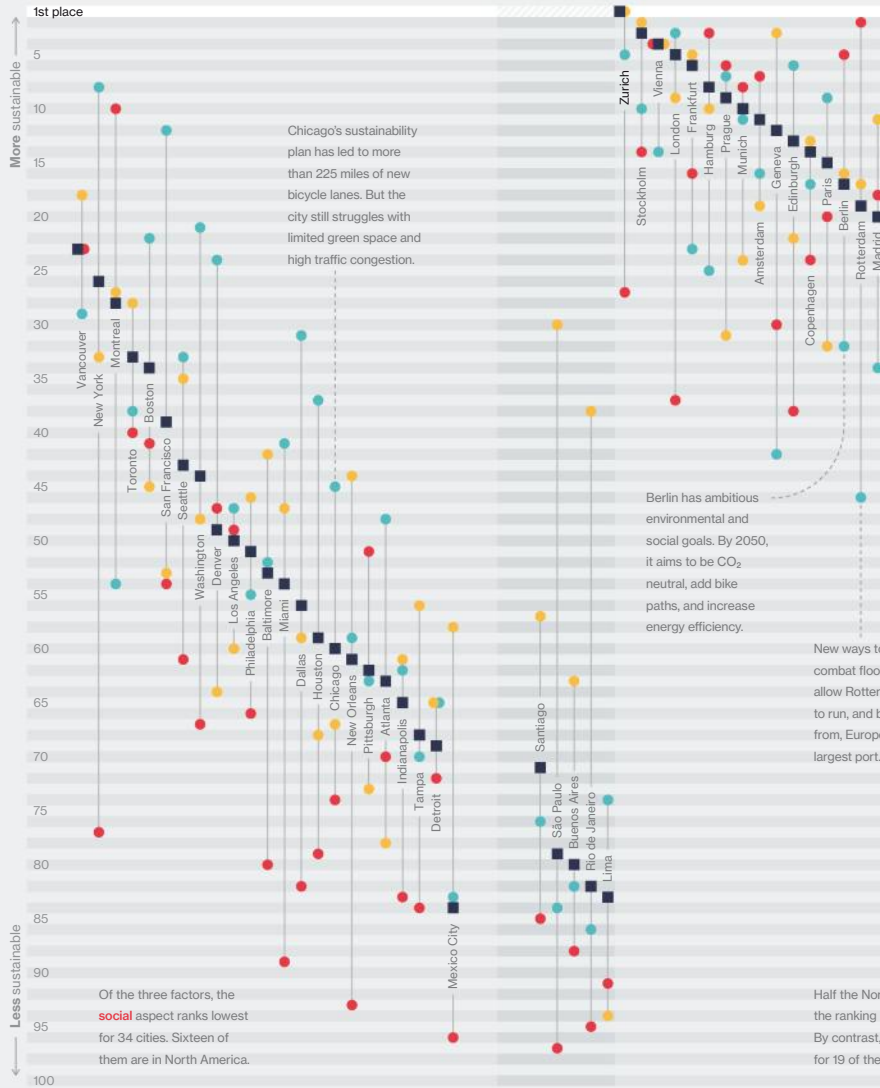
The Arcadis Sustainable Cities Index charts three sustainability factors to rank 100 of the world's major cities.

- **People (Social)**
Rates health, education, income inequality, work-life balance, ratio of wage earners to dependents, crime, housing, and living costs
- **Planet (Environmental)**
Energy consumption and renewable energy share, waste management, green space, sanitation, water, greenhouse gas emissions, natural catastrophe risk, and air pollution
- **Profit (Economic health)**
Transport infrastructure, ease of doing business, tourism, GDP per capita, the city's importance in global economic networks, Internet connectivity, and employment rates

NORTH AMERICA
23 cities rated. 12 rank highest in the profit category

SOUTH AMERICA
5: 4 planet

EUROPE
32 cities rated. 14 rank highest in the profit category



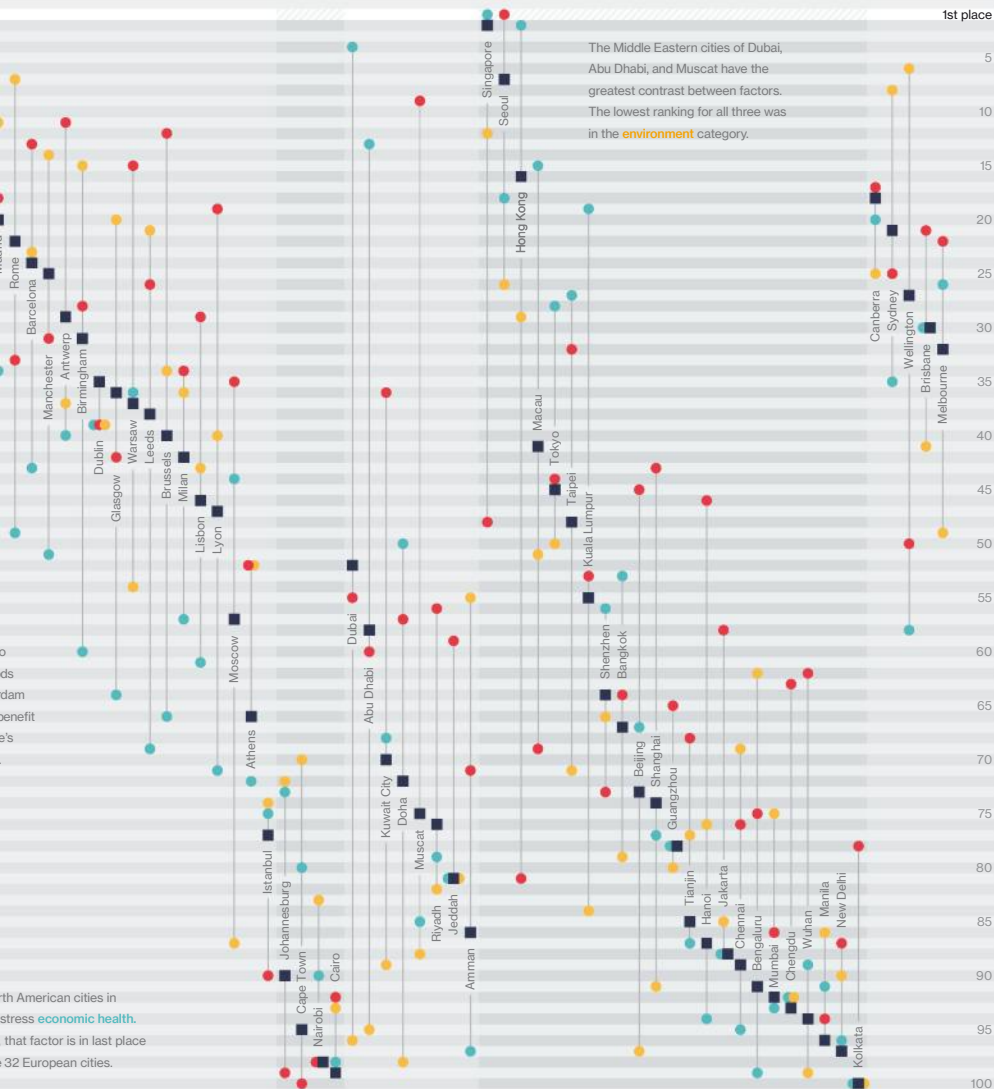
PE
rank highest in people

AFRICA
4: 3 planet

MIDDLE
EAST
8: 4 people

ASIA
23 cities rated. 11 rank highest in people

OCEANIA
5: 3 people



TOP FIVE BY...



1. Seoul
2. Rotterdam
3. Hamburg
4. Vienna
5. Berlin

PEOPLE

European cities dominate this category, but Seoul's strengths in health and education give it the top spot. The city's sustainability plan aims to bolster South Korea's cultural identity through historic preservation, and to promote stronger communities by improving public transit.



1. Zurich
2. Stockholm
3. Geneva
4. Vienna
5. Frankfurt

PLANET

Ranked first in the overall index, Zurich is recognized for its environmental priorities, including energy efficiency and renewable power. The city is a model, running a sustainable public transit system and holding annual "environment days" to raise public awareness.



1. Singapore
2. Hong Kong
3. London
4. Dubai
5. Zurich

PROFIT

Singapore ranks high on matters of commerce. It was awarded first place for ease of doing business and for accessibility to tourists. To improve the mobility of its growing population, the city is investing in public transit by building more subways and high-speed rail.



What does urbanization mean for the future of food?

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Food moves.

Seventy percent of the population will live on less than 10 percent of the world's landmass by 2050. And yet, only 16 percent of food crosses borders—a number that is expected to increase as climate pressure and urbanization continue to rise. Cargill is committed to nourishing the world by moving goods to where they're needed most, relocating some production closer to city centers, and also working to partner with local food banks and organizations to strengthen local school nutrition programs.

Sustainable agriculture flourishes

People across the world may live in cities, but farms remain the starting point for food. Cargill is partnering with 2.4 million farmers across the planet—from large-scale farms in the Midwest to small family farms in major cities—to provide training and best practices. In Côte d'Ivoire, we've helped 30,000 farmers on safe, efficient practices that helped increase yields by more than 50 percent.

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million farmers across
arms in the American
in India to urban farms
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Technology conserves resources.

As more of the population moves to cities, we will need to leverage the power of technology to nourish the world and protect the planet. Cargill's been working since 2004 to preserve forests in the Amazon and reduce the amount of soy purchased from deforested regions. Today we continue to advance responsible land and water use by collaborating with governments, NGOs, partners and 15,000 soy farmers, and using the latest technology—such as geospatial analysis and satellites—to produce sustainable soy.

Learn more about how we're
helping a growing world *thrive* at
cargill.com/sustainability

FASHIONING FOOD WASTE

By Catherine Zuckerman

If today's sustainability mantra is "from farm to fork," tomorrow's could be "from farm to fashion." That's because, for a growing cadre of eco-minded designers, food waste is the new black.

Sacha Laurin's medium of choice is the bacterial "colony" left after brewing the tart, fermented tea known as *kombucha*. Once dried, the material becomes a rather pungent faux leather, which the California designer sews into haute couture dresses (right), jackets, skirts, and more. In Sicily, a start-up is working with discarded citrus peels, seeds, and other juicing by-products to produce a silky yarn. And a London company is helping support Filipino pineapple farmers by turning the plants' unused leaves into a textile that can be crafted into shoes, bags, and laptop computer cases.

More than a billion tons of food is lost or wasted every year globally, according to the UN Food and Agriculture Organization, some of it the result of large-scale production. This excess offers an opportunity to create a range of sustainable fabrics, says University of Leeds textile chemist Richard Blackburn, such as a renewable polyester from the sugar in surplus crops, including corn.

Kombucha apparel is not yet commercially available. But it is scientifically viable, says Australian biochemist Peter Musk, who oversees college art students working with the tea. If they have anything to do with it, the drink could one day be coming to a closet near you.



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RECORDS OF REBELLION

By Natasha Daly

Many forms of music were forbidden in the Soviet Union, especially in the first years of the Cold War. Western jazz and rock-and-roll were deemed the music of the enemy; Russian-émigré pop, the music of traitors. The Soviets banned “any music with a sort of swing to it,” says Stephen Coates, a British musician who founded the X-Ray Audio Project to chronicle one effort to evade state control.

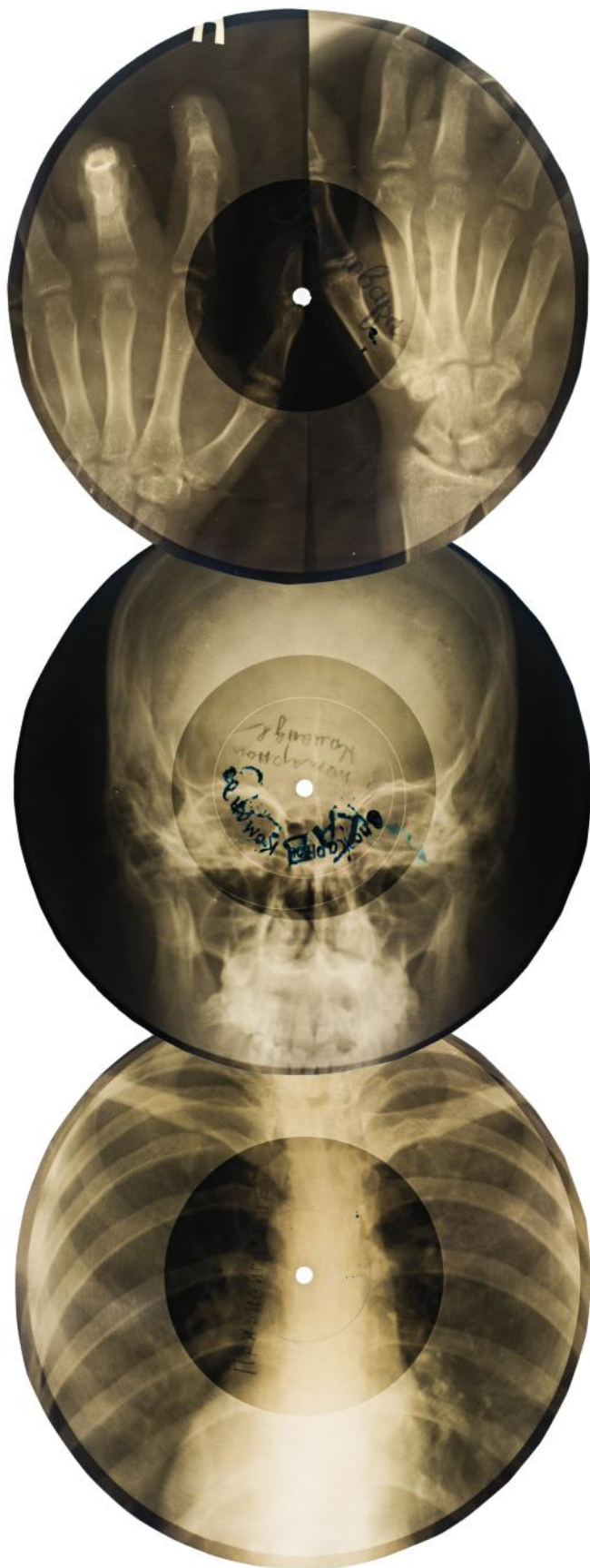
In 1946 two enterprising music lovers in Leningrad, Ruslan Bugaslovski and Boris Taigin, figured out a way to copy records. The original music was smuggled into the country, often by sailors. Because materials in the U.S.S.R. were scarce, the two men scavenged parts from tools, such as drills, and old gramophones to build a recording machine. For the records themselves, they turned to an unlikely source: discarded x-rays, which were made of plastic soft enough to be cut by the recording machine.

The pair’s creations were striking: An x-ray image of broken ribs emitted the lilt of Russian tango. A Broadway show tune quavered from a dislocated pelvis. A human skull was the morbid backdrop for American jazz. “You have these pictures of the insides of Soviet citizens, impressed with the music they secretly loved,” says Coates, who stumbled across one of these “bone records” a few years ago in St. Petersburg.

Bootleggers in other cities picked up the duo’s methods, creating an underground record culture that lasted nearly two decades. But the authorities caught on too: Bugaslovski was imprisoned three times. “That’s how much music can matter,” says Coates.

GO FURTHER

Give “bone records” a spin at x-rayaudio.com. Learn more about the records in Stephen Coates’s book, *X-Ray Audio: The Strange Story of Soviet Music on the Bone*.



BBC
earth

“OUT OF THIS WORLD”

NEWSDAY

“BREATHTAKING”

THE WALL STREET JOURNAL

“SPECTACULAR”

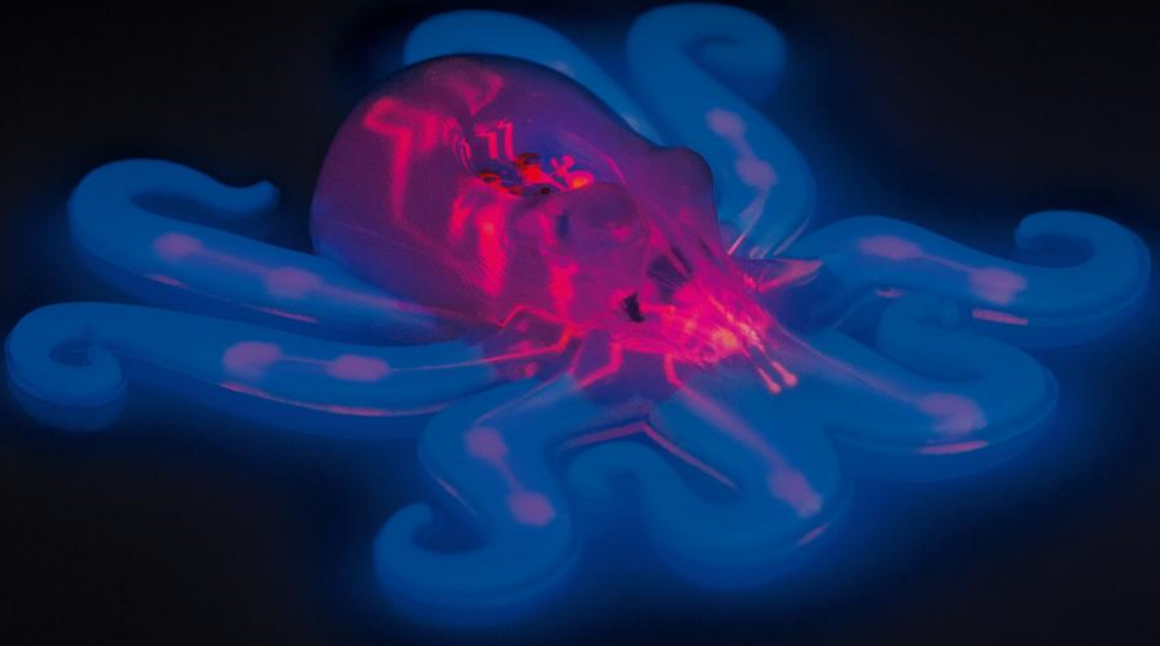
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THE SOFTER SIDE OF ROBOTICS

By Natasha Daly

Banish your preconceptions of robots as stiff, herky-jerky metal machines. An “octobot” less than three inches wide is changing the robotics landscape.

The octobot is the world’s first completely soft, autonomous, and untethered robot. It is free of wires, batteries, and any hard material—like its namesake, the octopus, which has no internal skeleton.

A Harvard University research team led by engineering professors Robert Wood and Jennifer Lewis tried more than 300 designs before they came up with one that worked. And now the octobot could revolutionize the use of robots. Traditional robots are “fantastic for what they do in terms of automation, but they’re not geared toward human interaction,” Wood says. Soft robots provide a safer solution: “If they run into something, it’d be like bumping into a basketball. It won’t hurt you.”

Before the octobot, soft robots were either hybrids—pliable exteriors with hard

guts of batteries or wires—or soft models tethered to an external cord. The octobot eliminates these restrictions. It moves by pneumatic power (indicated by pink dye, above): An internal circuit triggers chemical reactions, turning its liquid hydrogen peroxide fuel into a gas, which inflates the robot’s limbs and allows them to move. The whole assembly is created from silicone using a 3-D printer.

The octobot is currently a prototype, but its writhing arms prove that the technology works. The goal, says Wood, is to find viable applications, such as in health care. Soft robots could be made from biocompatible and biodegradable materials—and, he says, might even be formed into capsules to be swallowed for more effective and less invasive endoscopies.

Another use might be in braces worn by football players: The robot would detect an incoming tackle and deploy quickly enough to prevent injury.

This smooth and flexible robot, modeled after an octopus, glows under black light. It took two years to perfect but only a few dollars’ worth of materials to produce.



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DREAM CATCHERS

By Nina Storchlic

Do androids, as sci-fi novelist Philip K. Dick asked, really dream of electric sheep? The purpose and meaning of dreams have long been debated. Now scientists are getting closer to deciphering what humans see as they sleep—and how a robot can simulate it.

In 2013 neuroscientist Yukiyasu Kamitani had test subjects take hundreds of brief naps in an MRI machine, repeatedly waking them so they could describe their dreams. Kamitani had already isolated the unique brain patterns for certain objects he'd shown subjects while awake. Their brains were scanned for those patterns as they napped, and a computer program automatically turned the basic contents of their dreams into short videos. The study found these were 70 percent accurate compared with what subjects remembered of their real dreams.

Two years later Google engineers also captured the dreamlike images of a computer. They fed millions of images into a brain-inspired computer algorithm—a network of artificial neurons—to study how it learned to identify objects. Then they put it through DeepDream, a program that enables the network to build its own algorithm-fueled dreamscape by finding shapes in an image of random visual noise, like the static on an old TV. The computer generated a psychedelic scene from its machine-learned knowledge. As in a dream, previously seen images were reconfigured into new patterns.

It won't be possible to produce a precise recording of human dreams until scientists discover how dreams originate in the brain, says Jack Gallant, a professor of psychology at UC Berkeley—or they build an encyclopedia of brain activity that corresponds to every thought. He likens it to building a language translation program: “You have a language but nothing it references to.”

Google's network of artificial neurons generated this image of its “dreams.” See more online at ngm.com/May2017.

IMAGE (COMPUTER GENERATED): MIKE TYKA, GOOGLE



CSI TOOL FROM ANCIENT EGYPT

By A. R. Williams

Crime scene investigators are about to get an assist from the land of the pharaohs. New research has shown that a pigment called Egyptian blue, formulated some 5,250 years ago, can be used as dusting powder to detect fingerprints on complicated surfaces.

The earliest known synthetic pigment, Egyptian blue is found in some of the paint that still colors ancient statues, coffins, and tomb walls. Modern scientists were intrigued by this long-lasting tint and figured out its chemical components decades ago. More recently they discovered that it emits near-infrared radiation when exposed to a certain kind of light. Researchers have now

demonstrated the forensic potential of that rare, invisible luminescence.

After a crime is committed, police may dust relevant surfaces with a powder of a contrasting color. The powder sticks to the unique features of any fingerprints, providing visual proof that an individual was there. But prints may be hard to pick out on a shiny or highly patterned surface. That's where Egyptian blue can make a difference.

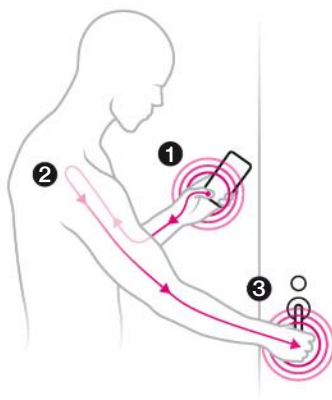
The pigment is brushed on as usual. But the surface is then photographed under a white light with a modified camera and a filter sensitive to near-infrared rays. If fingerprints exist, they glow clearly in the resulting image.

One company is already marketing the powder, says Australian forensic chemist Simon Lewis, a member of the research team. "We expect it won't be long before it's used by law enforcement."

Egyptian blue, shown here as a powder, is made by heating a mixture of copper, quartz sand, lime, and an alkali such as natron, a salt found in dry lake beds.

BODY SIGNALS

Here's a puzzle that troubled Shyam Gollakota, a computer scientist at the University of Washington: How do you transmit a password to a smart device – say, a door lock – without using hacker-prone Wi-Fi or Bluetooth? "The human body was the perfect solution," says Gollakota. He found that a relatively low frequency signal can be sent from a smartphone's fingerprint sensor via the body to the object that needs to be unlocked. —*Nina Storchlic*



How it works

- 1 A signal is generated by the fingerprint sensor on a smartphone.
- 2 The signal is transmitted via a small electric current across the body, with no known health impacts.
- 3 When the signal reaches a sensor on a terminus (such as a doorknob), the object is unlocked.

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WASHERS AND DRYERS

THE SECRET LIFE OF PLANTS

By Daniel Stone

The inside workings of plants are the unexplored frontier of botany. What happens when a nematode or fungus attacks a crop? How does this stress affect the plant, and how does it physically change the roots, stem, and flowers?

Japanese researchers have devised a way to find out: Make the plant transparent. With a chemical bath, they reduce the plant's visible chlorophyll, the pigment that makes it green. Days to weeks later the entire plant becomes clear, and scientists can observe its inside tissue at a cellular level.

Death is part of the process. While the plant is still alive, researchers introduce

genes for fluorescent proteins, then kill the plant with formaldehyde to freeze the processes the researchers want to study. The method yields information broadly useful in plant research—about reproduction, for instance. Understanding exactly how a plant selects one of the hundreds of grains of pollen that land on a pistil can help breeders propagate better apples or peaches—or any other crop that reproduces by pollination.

So far researchers have tested the transparent effect on rice, tobacco, tomato, cucumber, moss, and other flowering plants. But this sort of botanical x-ray can be applied to anything that sprouts. “Any researcher can use it,” says project lead Daisuke Kurihara, a plant cell biologist at Nagoya University, “and the plant's interior can be clearly observed and analyzed in detail.”

—With Takao Fujiwara

Fluorescent proteins in this transparent *Arabidopsis* help scientists track precisely how different proteins interact with the plant's tissue.



PHOTO: DAISUKE KURIHARA AND YOKO MIZUTA



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EXCEDRIN
The Headache Expert

SHE MATES, HE INCUBATES

By Patricia Edmonds

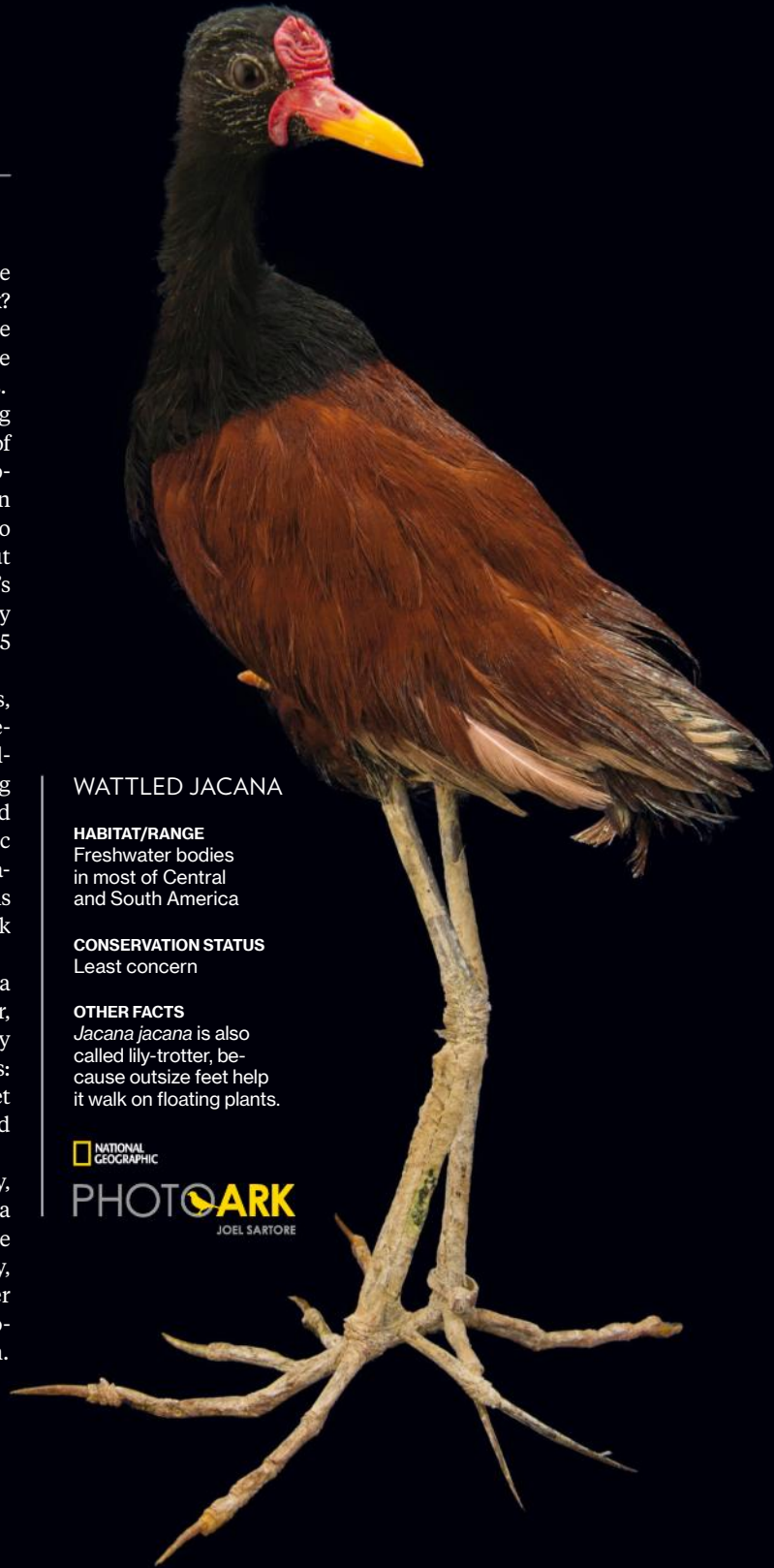
What kind of dad stays home with the kids while their mother is out having sex? A wattled jacana dad—even when he knows that he’s being cuckolded and the offspring he’s minding may not be his.

Several species of *Jacana* are among the animal world’s most extreme cases of sex-role reversal, says behavioral ecologist Peter Wrege of Cornell University. An assertive female collects a harem of up to five smaller males. In the span of about a week, she lays four eggs in one male’s nest while continuing to mate openly with him and others—“as many as 65 matings for one clutch,” Wrege says.

Even in monogamous bird species, a female may “sneak copulations elsewhere,” he says. But as Wrege and colleague Stephen Emlen observed during years of research in Panama, the wattled jacana female’s cuckoldry is both public and frequent. To see how that affects paternity of offspring, they tracked dozens of birds’ mating and egg laying, took blood samples, and ran DNA tests.

The researchers concluded that for a jacana male with a promiscuous partner, “the risk of raising unrelated young may be as high as 75 percent.” In other words: He’s seen her mating with others, yet for three months he incubates eggs and raises chicks unlikely to all be his.

Why do the males do this? “Basically, they’re stuck,” Wrege says. Hunting for a less promiscuous female would take time better spent trying to sire eggs. This way, although they may end up with other males’ kids, they also achieve the biological imperative of having their own.



WATTLED JACANA

HABITAT/RANGE

Freshwater bodies in most of Central and South America

CONSERVATION STATUS

Least concern

OTHER FACTS

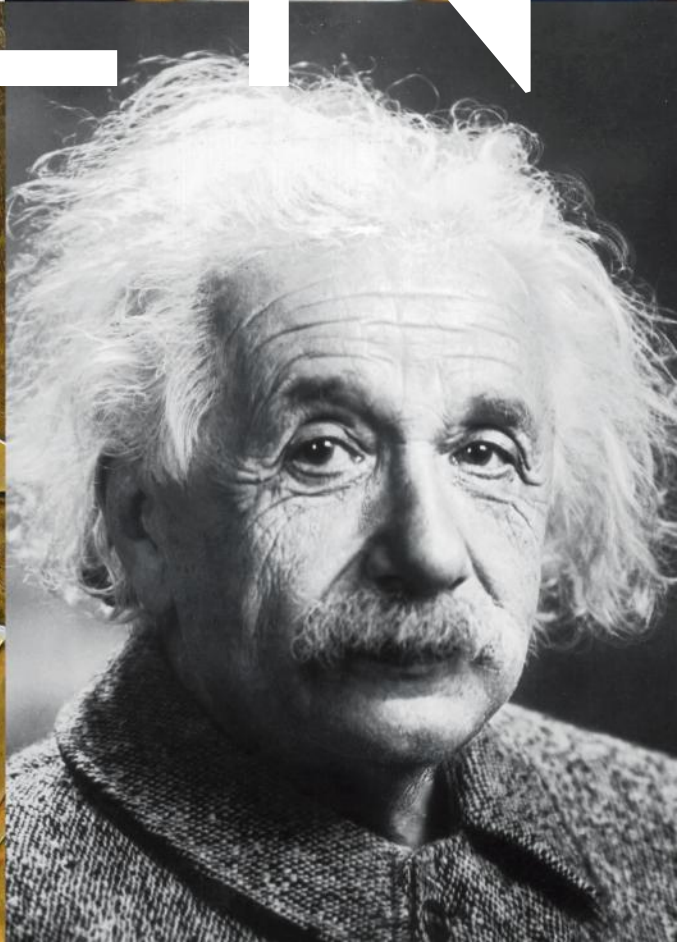
Jacana jacana is also called lily-trotter, because outsize feet help it walk on floating plants.



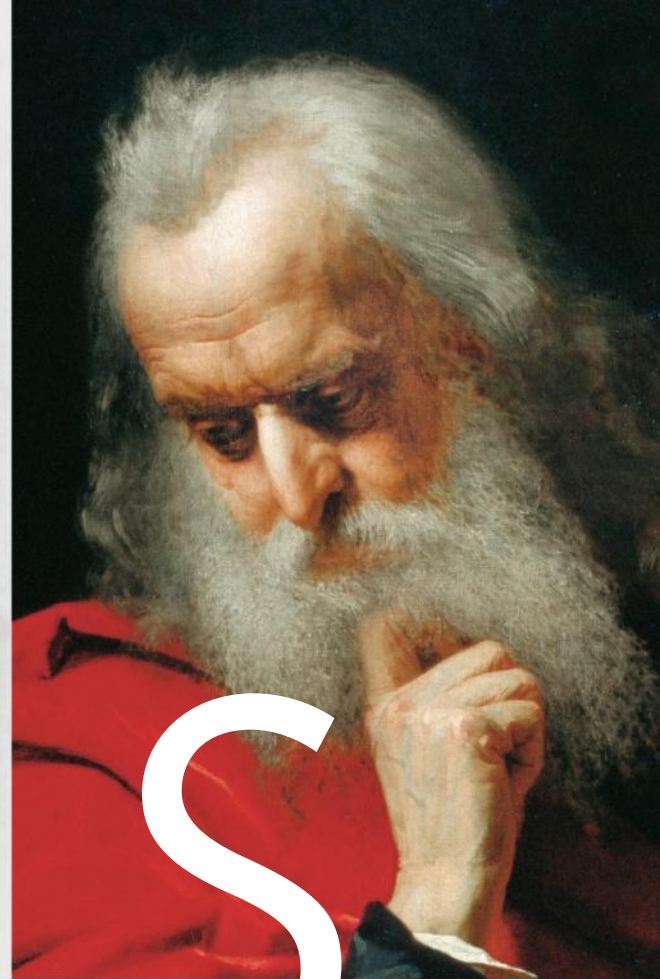
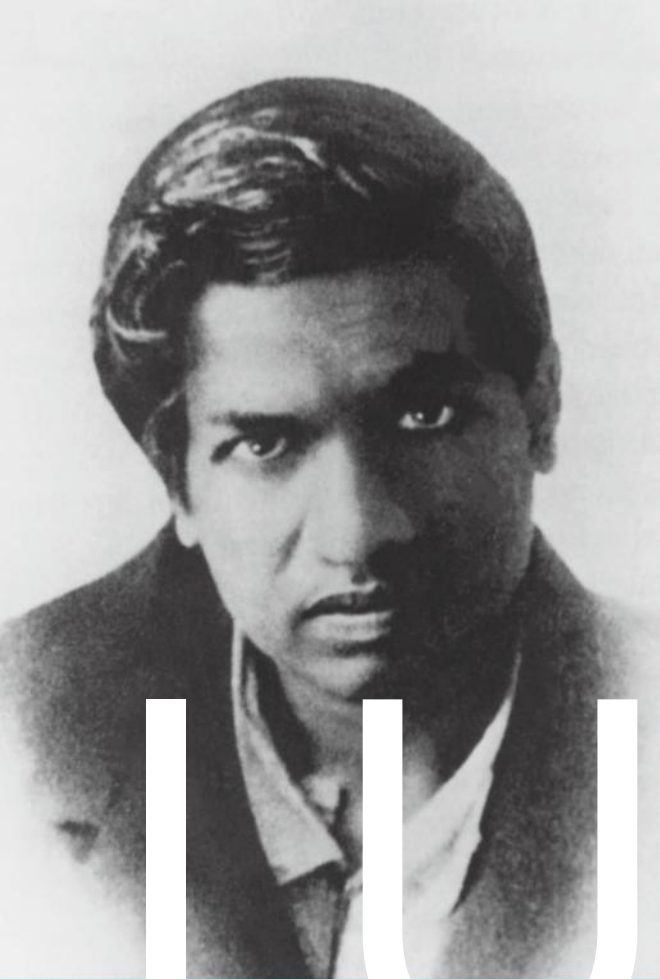
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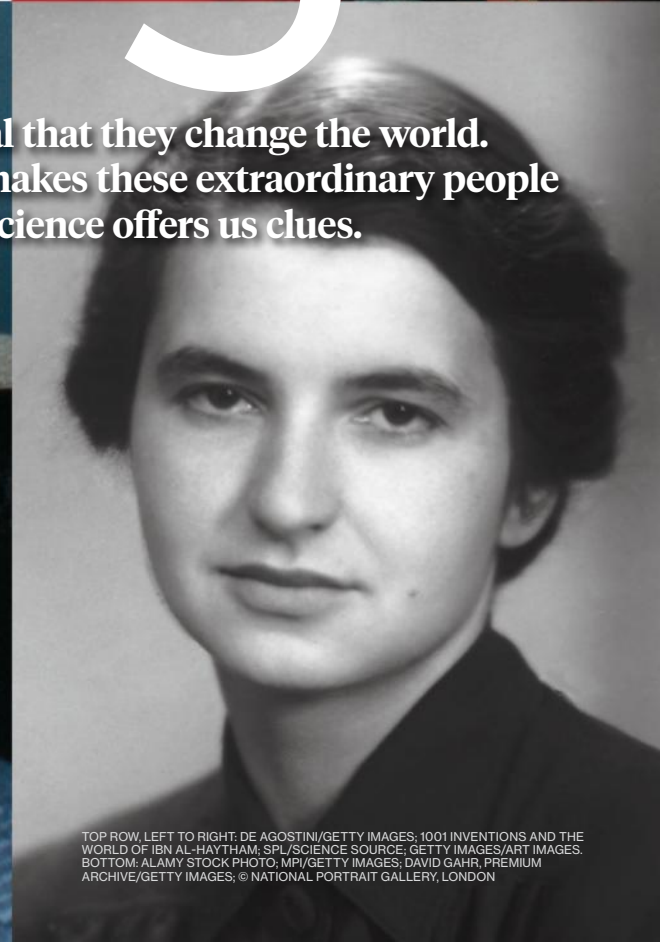
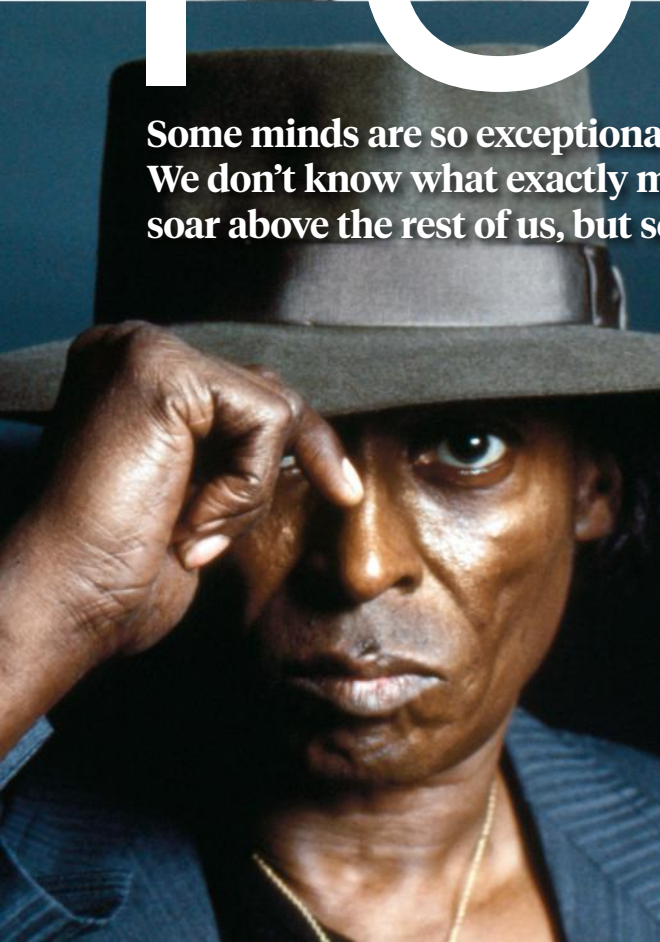


TOP ROW, LEFT TO RIGHT: SOR (SISTER) JUANA INÉS DE LA CRUZ; IBN AL HAYTHAM (ALHAZEN); SRINIVASA RAMANUJAN; GALILEO GALILEI. BOTTOM: CONFUCIUS; ALBERT EINSTEIN; MILES DAVIS; ROSALIND FRANKLIN



IUS

Some minds are so exceptional that they change the world. We don't know what exactly makes these extraordinary people soar above the rest of us, but science offers us clues.

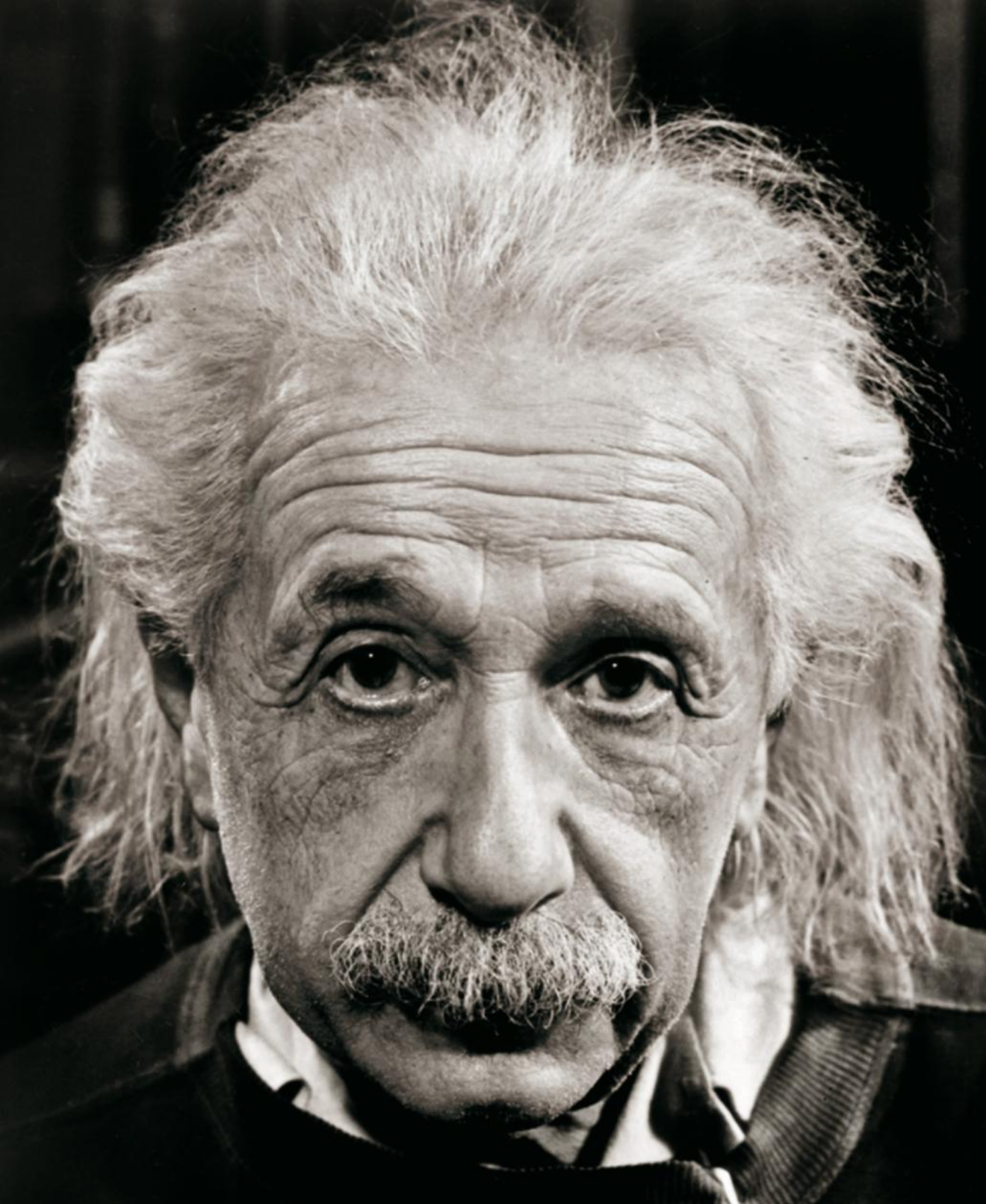


TOP ROW, LEFT TO RIGHT: DE AGOSTINI/GETTY IMAGES; 1001 INVENTIONS AND THE WORLD OF IBN AL-HAYTHAM; SPL/SCIENCE SOURCE; GETTY IMAGES/ART IMAGES. BOTTOM: ALAMY STOCK PHOTO; MPI/GETTY IMAGES; DAVID GAHR, PREMIUM ARCHIVE/GETTY IMAGES; © NATIONAL PORTRAIT GALLERY, LONDON





The truest measure of genius is whether a person's work resonates through the ages. At the Galleria dell'Accademia in Florence, Italy, Michelangelo's "David" towers over admiring visitors more than 500 years after the artist carved the 17-foot-tall statue from a single block of marble discarded by other sculptors.



Albert Einstein epitomizes genius, which has led to an abiding interest in his brain. In 1951 the physicist's brain waves were recorded; after his death in 1955, a pathologist mounted and dyed slices of it on glass slides. Many of those slides (right) are at the National Museum of Health and Medicine in Silver Spring, Maryland.



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no. 0000



BY CLAUDIA KALB
PHOTOGRAPHS BY PAOLO WOODS

The Mütter Museum in Philadelphia houses an array of singular medical specimens. On the lower level the fused livers of 19th-century conjoined twins Chang and Eng float in a glass vessel. Nearby, visitors can gawk at hands swollen with gout, the bladder stones of Chief Justice John Marshall, the cancerous tumor extracted from President Grover Cleveland's jaw, and a thighbone from a Civil War soldier with the wounding bullet still in place. But there's one exhibit near the entrance that elicits unmatched awe. Look closely at the display, and you can see smudge marks left by museumgoers pressing their foreheads against the glass.

The object that fascinates them is a small wooden box containing 46 microscope slides, each displaying a slice of Albert Einstein's brain. A magnifying glass positioned over one of the slides reveals a piece of tissue about the size of a stamp, its graceful branches and curves resembling an aerial view of an estuary. These remnants of brain tissue are mesmerizing even though—or perhaps because—they reveal little about the physicist's vaunted powers of cognition. Other displays in the museum show disease and disfigurement—the results of something gone wrong. Einstein's brain represents potential, the ability of one exceptional mind, one genius, to catapult ahead of everyone else. “He saw differently from the rest of us,” says visitor Karen O’Hair as she peers at the tea-colored sample. “And he could extend beyond that to what he couldn’t see, which is absolutely amazing.”

■ To learn more about Albert Einstein, tune in to National Geographic's 10-part series *Genius*, which airs Tuesdays starting April 25.



Throughout history rare individuals have stood out for their meteoric contributions to a field. Lady Murasaki for her literary inventiveness. Michelangelo for his masterful touch. Marie Curie for her scientific acuity. “The genius,” wrote German philosopher Arthur Schopenhauer, “lights on his age like a comet into the paths of the planets.” Consider Einstein’s impact on physics. With no tools at his disposal other than the force of his own thoughts, he predicted in his general theory of relativity that massive accelerating objects—like black holes orbiting each other—would create



A century after Einstein predicted the existence of gravitational waves – ripples in the fabric of space-time – in his general theory of relativity, scientists like Kazuhiro Yamamoto (on bicycle) plan to use the first underground gravitational wave telescope, KAGRA, in Hida, Japan, to explore what he deduced but could not detect.

ripples in the fabric of space-time. It took one hundred years, enormous computational power, and massively sophisticated technology to definitively prove him right, with the physical detection of such gravitational waves less than two years ago.

Einstein revolutionized our understanding of the very laws of the universe. But our understanding of how a mind like his works remains stubbornly earthbound. What set his brainpower, his thought processes, apart from those of his merely brilliant peers? What makes a genius?

Philosophers have long been pondering

the origins of genius. Early Greek thinkers believed an overabundance of black bile—one of the four bodily humors proposed by Hippocrates—endowed poets, philosophers, and other eminent souls with “exalted powers,” says historian Darrin McMahon, author of *Divine Fury: A History of Genius*. Phrenologists attempted to find genius in bumps on the head; craniometrists collected skulls—including philosopher Immanuel Kant’s—which they probed, measured, and weighed.

None of them discovered a single source of



Unexpected flashes of insight still require some thought. After seeing an apple fall perpendicularly to the ground in 1666, Isaac Newton reasoned that, in a friend's telling, "there must be a drawing power in matter." The tree that sparked his law of gravity remains rooted next to his childhood home at Woolsthorpe Manor, England.

WITH PERMISSION OF BRITISH NATIONAL TRUST





Prodigious productivity is a defining characteristic of genius. Charcoal sketches cover the walls of a once concealed room beneath the Medici Chapel in Florence, where Michelangelo hid for three months in 1530 after defying his patrons. The drawings include a sketch of a seated figure (right) who appears on a tomb in the chapel above.



genius, and such a thing is unlikely to be found. Genius is too elusive, too subjective, too wedded to the verdict of history to be easily identified. And it requires the ultimate expression of too many traits to be simplified into the highest point on one human scale. Instead we can try to understand it by unraveling the complex and tangled qualities—intelligence, creativity, perseverance, and simple good fortune, to name a few—that entwine to create a person capable of changing the world.

INTELLIGENCE HAS OFTEN been considered the default yardstick of genius—a measurable quality generating tremendous accomplishment. Lewis Terman, the Stanford University psychologist who helped pioneer the IQ test, believed a test that captured intelligence would also reveal genius. In the 1920s he began tracking more than 1,500 Californian schoolkids with IQs generally above 140—a threshold he labeled as “near genius or genius”—to see how they fared in life and how they compared with other children. Terman and his collaborators followed the participants, nicknamed “Termites,” for their lifetimes and mapped their successes in a series of reports, *Genetic Studies of Genius*. The group included members of the National Academy of Sciences, politicians, doctors, professors, and musicians. Forty years after the study began, the researchers documented the thousands of academic reports and books they published, as well as the number of patents granted (350) and short stories written (about 400).

But monumental intelligence on its own is no guarantee of monumental achievement, as Terman and his collaborators would discover. A number of the study’s participants struggled to thrive, despite their towering IQ scores. Several dozen flunked out of college at first. Others, tested for the study but with IQs that weren’t high enough to make the cut, grew up to become renowned in their fields, most famously Luis Alvarez and William Shockley, both of whom won Nobel Prizes in physics. There’s precedent for such underestimation: Charles Darwin recalled being considered “a very ordinary boy, rather below the common standard in intellect.” As an

adult he solved the mystery of how the splendid diversity of life came into being.

Scientific breakthroughs like Darwin’s theory of evolution by natural selection would be impossible without creativity, a strand of genius that Terman couldn’t measure. But creativity and its processes can be explained, to a certain extent, by creative people themselves. Scott Barry Kaufman, scientific director of the Imagination Institute in Philadelphia, has been bringing together individuals who stand out as trailblazers in their fields—people like psychologist Steven Pinker and





Stephen Wiltshire, a British artist with autism, created an exquisitely accurate panorama of Mexico City after one afternoon's viewing and five days of drawing. Psychiatrist Darold Treffert believes that unique wiring between the brain's right and left hemispheres allows people like Wiltshire to access reserves of creativity.

comedian Anne Libera of the Second City—to talk about how their ideas and insights are kindled. Kaufman's goal is not to elucidate genius—he considers the word to be a societal judgment that elevates a chosen few while overlooking others—but to nurture imagination in everyone.

These discussions have revealed that the aha moment, the flash of clarity that arises at unexpected times—in a dream, in the shower, on a walk—often emerges after a period of contemplation. Information comes in consciously, but the problem is processed unconsciously, the resulting

solution leaping out when the mind least expects it. “Great ideas don't tend to come when you're narrowly focusing on them,” says Kaufman.

Studies of the brain offer hints at how these aha moments might happen. The creative process, says Rex Jung, a neuroscientist at the University of New Mexico, relies on the dynamic interplay of neural networks operating in concert and drawing from different parts of the brain at once—both the right and left hemispheres and especially regions in the prefrontal cortex. One of these networks fosters our ability to meet external

'If you believe that genius is this thing that can be cultivated and nurtured, what an incredible tragedy that thousands of potential geniuses have withered and died.'

Darrin McMahon, historian

demands—activities we must act on, like going to work and paying our taxes—and resides largely in outer areas of the brain. The other cultivates internal thought processes, including daydreaming and imagining, and stretches mainly across the brain's middle region.

Jazz improvisation provides a compelling example of how neural networks interact during the creative process. Charles Limb, a hearing specialist and auditory surgeon at UC San Francisco, designed an iron-free keyboard small enough to be played inside the confines of an MRI scanner. Six jazz pianists were asked to play a scale and a piece of memorized music and then to improvise solos as they listened to the sounds of a jazz quartet. Their scans demonstrate that brain activity was “fundamentally different” while the musicians were improvising, says Limb. The internal network, associated with self-expression, showed increased activity, while the outer network, linked to focused attention and also self-censoring, quieted down. “It’s almost as if the brain turned off its own ability to criticize itself,” he says.

This may help explain the astounding performances of jazz pianist Keith Jarrett. Jarrett, who improvises concerts that last for as long as two hours, finds it difficult—impossible, actually—to explain how his music takes shape. But when he sits down in front of audiences, he purposefully pushes notes out of his mind, moving his hands to keys he had no intention of playing. “I’m bypassing the brain completely,” he tells me. “I am being pulled by a force that I can only be thankful for.” Jarrett specifically remembers one concert in Munich, where he felt as if he had disappeared

into the high notes of the keyboard. His creative artistry, nurtured by decades of listening, learning, and practicing melodies, emerges when he is least in control. “It’s a vast space in which I trust there will be music,” he says.

One sign of creativity is being able to make connections between seemingly disparate concepts. Richer communication between areas of the brain may help make those intuitive leaps possible. Andrew Newberg, director of research at the Marcus Institute of Integrative Health at Thomas Jefferson University Hospitals, is using diffusion tensor imaging, an MRI contrast technique, to map neural pathways in the brains of creative people. His participants, who come from Kaufman’s pool of big thinkers, are given standard creativity tests, which ask them to come up with novel uses for everyday objects like baseball bats and toothbrushes. Newberg aims to compare the connectivity in the brains of these high achievers against that of a group of controls to see if there is a difference in how effectively the various regions of their brains interact. His ultimate goal is to scan as many as 25 in each category and then pool the data so he can look for similarities within each group as well as differences that may appear across vocations. For instance, are certain areas more active in a comedian’s brain compared with a psychologist’s?

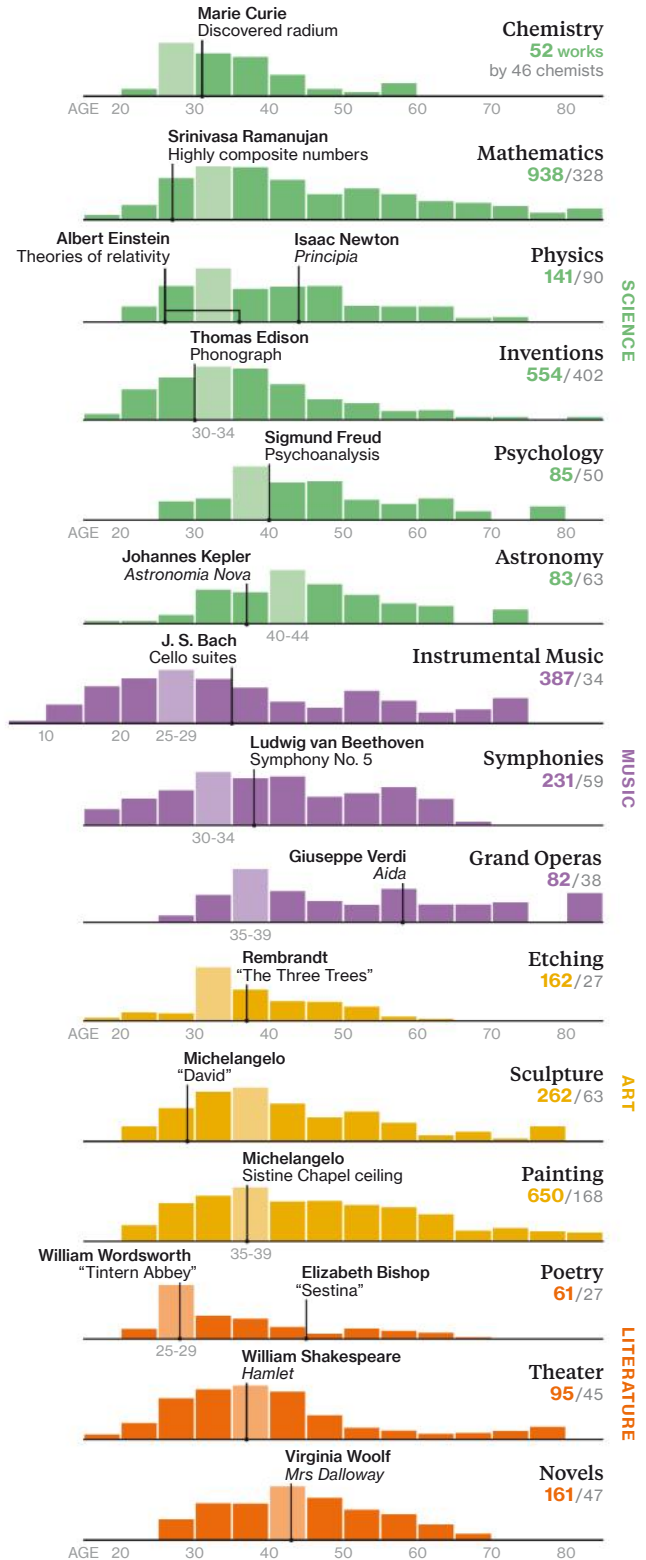
A preliminary comparison of one “genius”—Newberg uses the word loosely to distinguish the two groups of participants—and one control reveals an intriguing contrast. On the subjects’ brain scans, swaths of red, green, and blue illuminate tracts of white matter, which contain the wiring that allows neurons to transmit electrical messages. The red blotch on each image is the corpus callosum, a centrally located bundle of more than 200 million nerve fibers that joins the two hemispheres of the brain and facilitates connectivity between them. “The more red you see,” Newberg says, “the more connecting fibers there are.” The difference is notable: The red section of the “genius” brain appears to be about twice as wide as the red of the control brain.

“This implies that there’s more communication going on between the left and the right hemispheres, which one might expect in people

Age and Achievement

Are you over the hill? Depends on what you're trying to achieve. In 1953 psychologist Harvey Lehman published what remains the most comprehensive study of age and achievement. Using the most cited works at the time – and the age of each work's creator – he illustrated when outstanding achievement is most likely by discipline. There are exceptions: Giuseppe Verdi composed *Aida* at 58, two decades older than grand opera's peak age range. Lehman offered 16 factors for why achievement occurs when it does, including declining health and motivation as we age.

Psychologist Dean Keith Simonton, an expert on genius, maintains that the arc of a career depends on two things: your chosen discipline, and how soon you master it. Poets tend to turn ideas into finished works faster than novelists; within a field, geniuses are the quickest studies. "Individual differences are actually so large that they swamp the impact of age," wrote Simonton. "A first-rate genius at 80 is worth more than a second-rate talent at half that age."

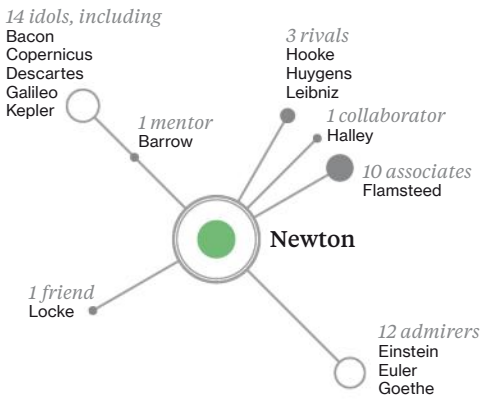


A LIFE'S WORK

Lehman divided the number of works produced in each discipline during each five-year interval by the number of creators who were alive in that span. He charted those rates as percentages of peak output.

Social Networks of Genius

Lone geniuses are exceedingly rare. Dean Keith Simonton scoured biographical dictionaries for mentions of relationships among 2,026 scientists and 772 artists. He found that members of each field created within a web of connections, as shown below for Isaac Newton and Michelangelo.



According to the poet William Wordsworth, Isaac Newton was “a mind for ever Voyaging through strange seas of Thought, alone.” But Newton knew the leading scientists in Europe. He read their work, and they read his. In a letter Newton wrote, “If I have seen further it is by standing on the shoulders of Giants.”



With help from his father, Michelangelo landed an apprenticeship with Domenico Ghirlandaio, a Florentine painter. The teacher soon sent his gifted student to work in Lorenzo de’ Medici’s sculpture garden. That break immersed Michelangelo in some of the world’s greatest art – and its deepest pockets.

who are highly creative,” says Newberg, stressing that this is an ongoing study. “There’s more flexibility in their thought processes, more contributions from different parts of the brain.” The green and blue swaths show other areas of connectivity, stretching from front to back—including dialogue among the frontal, parietal, and temporal lobes—and may reveal additional clues, says Newberg. “I don’t know yet what else we might find out. This is just one piece.”

EVEN AS NEUROSCIENTISTS try to understand how the brain fosters the development of paradigm-shifting thought processes, other researchers are wrestling with the question of when and from what this capacity develops. Are geniuses born or made? Francis Galton, a cousin of Darwin, objected to what he called “pretensions of natural equality,” believing that genius was passed down through family bloodlines. To prove it, he mapped the lineages of an array of European leaders in disparate fields—from Mozart and Haydn to Byron, Chaucer, Titus, and Napoleon. In 1869 Galton published his results in *Hereditary Genius*, a book that would launch the “nature versus nurture” debate and spur the misbegotten field of eugenics. Geniuses were rare, Galton concluded, numbering roughly one in a million. What was not unusual, he wrote, were the many instances “in which men who are more or less illustrious have eminent kinsfolk.”

Advances in genetic research now make it possible to examine human traits at the molecular level. Over the past several decades, scientists have been searching for genes that contribute to intelligence, behavior, and even unique qualities like perfect pitch. In the case of intelligence, this research triggers ethical concerns about how it might be used; it is also exceedingly complex, as thousands of genes may be involved—each one with a very small effect. What about other kinds of abilities? Is there something innate in having an ear for music? Numerous accomplished musicians, including Mozart and Ella Fitzgerald, are believed to have had perfect pitch, which may have played a role in their extraordinary careers.

Genetic potential alone does not predict actual



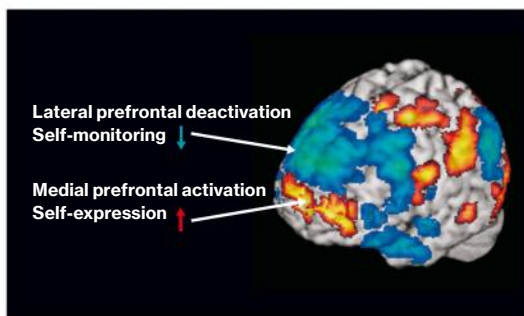
Some 10,000 pairs of identical and fraternal twins are part of geneticist Robert Plomin's longitudinal study at King's College London, providing clues about how genes and environment affect development. The genetics of intelligence are enormously complex. "Most geniuses," says Plomin, "don't come from genius parents."

accomplishment. It also takes nurture to grow a genius. Social and cultural influences can provide that nourishment, creating clusters of genius at moments and places in history: Baghdad during Islam's Golden Age, Kolkata during the Bengal Renaissance, Silicon Valley today.

A hungry mind can also find the intellectual stimulation it needs at home—as in suburban Adelaide, Australia, in the case of Terence Tao, widely considered one of the greatest minds currently working in mathematics. Tao showed a remarkable grasp of language and numbers early in life, but his parents created the environment in which he could flourish. They provided him with books, toys, and games and encouraged him to play and learn on his own—a practice his father, Billy, believes stimulated his son's originality and problem-solving skills. Billy and his wife, Grace, also sought out advanced learning opportunities for their son as he began his formal education, and he was fortunate to meet educators who helped foster and stretch his mind. Tao enrolled in high

school classes when he was seven years old, scored 760 on the math section of the SAT at age eight, went to university full-time when he was 13, and became a professor at UCLA at 21. "Talent is important," he once wrote on his blog, "but how one develops and nurtures it is even more so."

Natural gifts and a nurturing environment can still fall short of producing a genius, without motivation and tenacity propelling one forward. These personality traits, which pushed Darwin to spend two decades perfecting *Origin of Species* and Indian mathematician Srinivasa Ramanujan to produce thousands of formulas, inspire the work of psychologist Angela Duckworth. She believes that a combination of passion and perseverance—what she calls "grit"—drives people to achieve. Duckworth, herself a MacArthur Foundation "genius" and a professor of psychology at the University of Pennsylvania, says the concept of genius is too easily cloaked in layers of magic, as if great achievement erupts spontaneously with no hard work. She believes there are



CHARLES LIMB

Using fMRI brain scans (left), hearing specialist Charles Limb has found that jazz musicians and freestyle rappers suppress the self-monitoring part of their brains as they improvise. Limb plans to use electroencephalography, or EEG, to measure electrical activity in the brains of other creative individuals, including comedians; he tries it out on himself in his lab at UC San Francisco (above). “The only thing that works,” says jazz pianist Keith Jarrett, improvising at right, “is letting go.”

differences when it comes to individual talent, but no matter how brilliant a person, fortitude and discipline are critical to success. “When you really look at somebody who accomplishes something great,” she says, “it is not effortless.”

Nor does it happen on the first try. “The number one predictor of impact is productivity,” says Dean Keith Simonton, professor emeritus of psychology at UC Davis and a longtime scholar of genius. Big hits emerge after many attempts. “Most articles published in the sciences are never cited by anybody,” says Simonton. “Most compositions are not recorded. Most works of art aren’t

displayed.” Thomas Edison invented the phonograph and the first commercially viable light bulb, but these were just two of the thousand-plus U.S. patents he was awarded.

Lack of support can stunt prospects for potential geniuses; they never get the chance to be productive. Throughout history women have been denied formal education, deterred from advancing professionally, and under-recognized for their achievements. Mozart’s older sister, Maria Anna, a brilliant harpsichordist, had her career cut short by her father when she reached the marriageable age of 18. Half the women in the



Terman study ended up as homemakers. People born into poverty or oppression don't get a shot at working toward anything other than staying alive. "If you do believe that genius is this thing that can be singled out and cultivated and nurtured," says historian Darrin McMahon, "what an incredible tragedy that thousands of geniuses or potential geniuses have withered and died."

SOMETIMES, BY SHEER good fortune, promise and opportunity collide. If there were ever an individual who personified the concept of genius in every aspect, from its ingredients to its far-reaching impact, it would be Leonardo da Vinci. Born in 1452 to unmarried parents, Leonardo began life in a stone farmhouse in Italy's Tuscan hills, where olive trees and dusky blue clouds blanket the Arno Valley. From these simple beginnings, Leonardo's intellect and artistry soared like Schopenhauer's comet. The breadth of his abilities—his artistic insights, his expertise in human anatomy, his prescient engineering—is unparalleled.

Leonardo's pathway to genius began with an apprenticeship with master artist Andrea del Verrocchio in Florence when he was a teenager.

Leonardo's creativity was so robust that in his lifetime he filled thousands of pages in his notebooks, which brimmed with studies and designs, from the science of optics to his famed inventions, including a revolving bridge and a flying machine. He persisted no matter the challenge. "Obstacles cannot crush me," he wrote. "He who is fixed to a star does not change his mind." Leonardo also lived in a place (Florence) and at a time (the Italian Renaissance) when the arts were cultivated by wealthy patrons and inventiveness coursed through the streets, where great minds, including Michelangelo and Raphael, jostled for acclaim.

Leonardo delighted in envisioning the impossible—hitting a target that, as Schopenhauer wrote, "others cannot even see." Today an international group of scholars and scientists has taken on a similar mission, and its subject is just as elusive: Leonardo himself. The Leonardo Project is tracing the artist's genealogy and hunting down his DNA to learn more about his ancestry and physical characteristics, to verify paintings that have been attributed to him—and, most remarkably, to search for clues to his extraordinary talent.

Team member David Caramelli's high-tech



Legendary Cyphers, a freestyle rap group, performs on Friday nights at Union Square Park in New York City. Collaboration fuels the event as artists take turns "spitting" lyrics. Like any creative undertaking, rapping requires practice. "If you do this enough, it's like a muscle," says Palladium Philoz, one of the group's organizers.





Throughout history bright minds have flocked to nexuses of creativity like Silicon Valley, where Wenzhao Lian, a researcher at Vicarious, an artificial intelligence company, teaches a robot how to recognize and manipulate objects. The company aims to develop programs that mimic the brain's capacity for vision, language, and motor control.





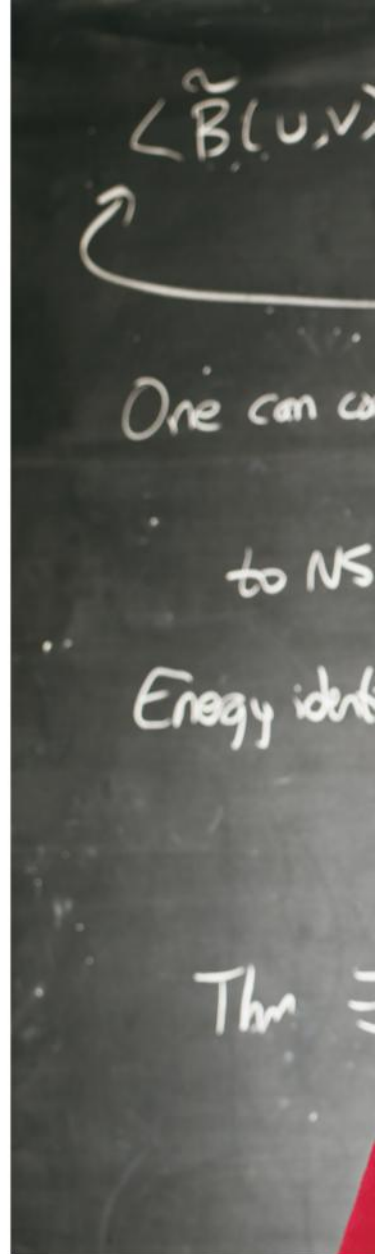
molecular anthropology lab at the University of Florence sits in a 16th-century building with a glorious view of the Florentine skyline. Jutting out majestically is the dome of the city's prominent cathedral, Santa Maria del Fiore, whose original crowning copper-gilt ball was made by Verrocchio and raised to the top of the cupola with Leonardo's help in 1471. This juxtaposition of past and present is a fitting setting for Caramelli's expertise in ancient DNA. Two years ago he published preliminary genetic analyses of a Neanderthal skeleton. Now he is poised to apply similar techniques to Leonardo's DNA, which the team is hoping to extract from some form of biological relic—the artist's bones, a strand of hair, skin cells left behind on his paintings or notebooks, or perhaps even saliva, which Leonardo may have used to prepare canvases for his silverpoint drawings.

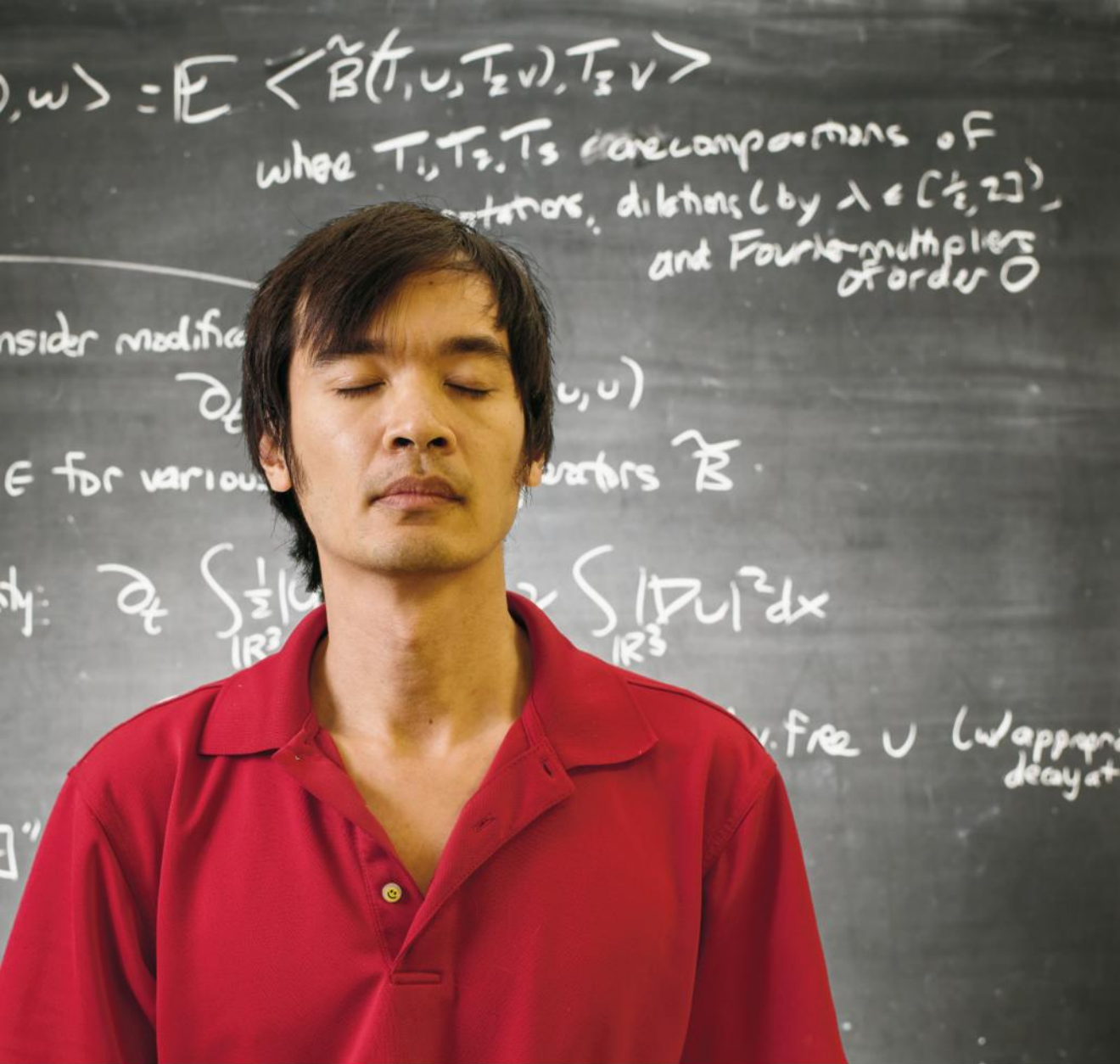
It is an ambitious plan, but team members are optimistically laying the groundwork. Genealogists are tracking down Leonardo's living relatives on his father's side for cheek swabs, which Caramelli will use to identify a genetic marker to confirm the authenticity of Leonardo's DNA if it is found. Physical anthropologists are seeking access to remains that are believed to be Leonardo's at Amboise castle in France's Loire Valley, where he was buried in 1519. Art historians and geneticists, including specialists at the institute of genomics pioneer J. Craig Venter, are experimenting with techniques to obtain DNA from fragile Renaissance-era paintings and paper. "The wheels are starting to turn," says Jesse Ausubel, vice chairman of the Richard Lounsbery Foundation and an environmental scientist at Rockefeller University in New York City, who is coordinating the project.

One of the group's early goals is to explore the possibility that Leonardo's genius stemmed not only from his intellect, creativity, and cultured environment but also from his exemplary powers of perception. "In the same way that Mozart may have had extraordinary hearing," says Ausubel, "Leonardo appears to have had extraordinary visual acuity." Some of the genetic components of vision are well identified, including the red and green color-vision pigment genes, located on the X chromosome. Thomas Sakmar, a specialist

in sensory neuroscience at Rockefeller, says it's conceivable that scientists could explore those regions of the genome to see if Leonardo had any unique variations that changed his color palette, allowing him to see more hues of red or green than most people are able to perceive.

The Leonardo Project team doesn't yet know where to look for answers to other questions, such as how to explain Leonardo's remarkable ability to visualize birds in flight. "It's as if he was creating stroboscopic photographs of stop-action," says Sakmar. "It's not far-fetched that





Mathematician Terence Tao's formulas on fluid dynamics are written on the blackboard behind him. Hailed for his "otherworldly ingenuity," Tao won the prestigious Fields Medal in 2006 at the age of 31. Yet he rejects lofty notions of genius. What really matters, he writes, is "hard work, directed by intuition, literature, and a bit of luck."

there would be genes related to that ability." He and his colleagues view their work as the beginning of an expedition that will lead them down new pathways as DNA gives up its secrets.

The quest to unravel the origins of genius may never reach an end point. Like the universe, its mysteries will continue to challenge us, even as we reach for the stars. For some, that is as it should be. "I don't want to figure it out at all," says Keith Jarrett when I ask if he is comfortable not knowing how his music takes hold. "If someone offered me the answer, I'd say, Take it away." In

the end it may be that the journey is illuminating enough and that the insights it reveals along the way—about the brain, about our genes, about the way we think—will nurture glimmers of genius in not just the rare individual but in us all. □

Claudia Kalb wrote *Andy Warhol Was a Hoarder: Inside the Minds of History's Great Personalities* for National Geographic Books. Photographer **Paolo Woods** lives in Florence, Italy. This is his first story for the magazine.

Find out if you could be related to a genius with the new Geno 2.0 kit, available at genographic.com/genius.



The Burning Heart of Africa

The Central African Republic is one of the continent's most bountiful nations. So how did it become a failed state?



A neighborhood in the capital, Bangui, smolders in 2014 after Christian-led militias attacked predominantly Muslim rebels who had ousted the government. The faiths once coexisted in relative peace, but chaos has reigned in much of the nation for the past four years.





A Christian girl mourns the death of her sister, who was shot in 2014 during street fighting near her home in Bangui. Despite the arrival of United Nations peacekeepers, Muslims and Christians continue to attack each other, as do rival Muslim rebel groups.

By Peter Gwin
Photographs by Marcus Bleasdale

To reach the butterfly artist's house, you have to navigate a maze of mud-brick homes near the wide, brown Oubangui River. Four years ago Muslim rebels and Christian militias rampaged through, fighting for control of Bangui, the capital of the Central African Republic. Today the neighborhood is filled with squealing children playing soccer and chattering vendors hawking peanuts and eggs, avocados and mangoes, wild honey and peppercorns. But violence still plagues the city, and the people here remain keenly alert to the sounds of gunshots and military helicopters.

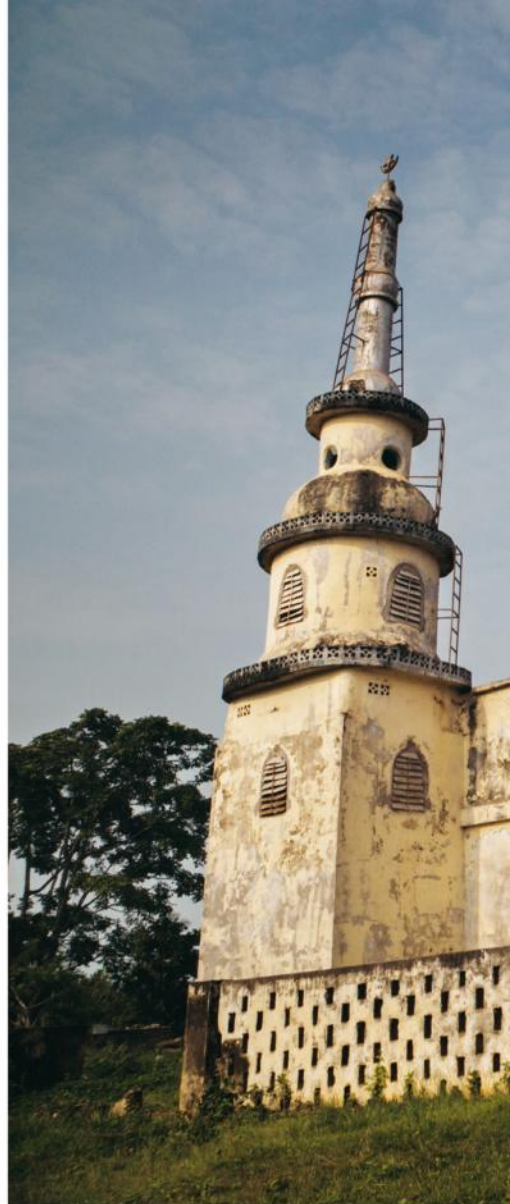
Philippe Andé is oblivious to all of that. A slight, balding man, he hunches over a worktable covered in butterfly wings—a constellation of electric colors, flamboyant shapes, and exotic patterns. The Central African Republic is home to 597 identified species, and it's common to suddenly find yourself amid a cloud of the silent, fluttering creatures, as though you'd wandered into a flurry of confetti. Andé, a farmer, catches them in his fields and sends boys to collect them in the hills and along the river.

With tweezers, a razor blade, and rubber cement, he painstakingly arranges the tissue-thin wings into radiant scenes of Central African life, each a miniature stained glass window. A man catches a speckled green fish in a swirling turquoise river. Women in orange dresses with sleeping babies tied to their backs pound cassavas into flour. A boy climbs a tree to harvest coconuts. There are fields filled with cotton; portraits of elephants, gorillas, parrots, antelope; even a faceted

diamond, the country's most famous export.

This is the Central African Republic that Andé chooses to see when he closes his eyes: the time before 2013, the year the Seleka—an alliance of predominantly Muslim rebel groups—looted, raped, killed, and burned its way across the country; toppled the corrupt Christian-dominated government; and ignited a brutal, still smoldering civil war that has killed thousands, displaced nearly a million others, and created food shortages.

To be honest, Andé's enchanting pictures represent some of my own idealized impressions of the Central African Republic. The country caught my attention when I saw it highlighted on a





Berbérati's main mosque was looted and abandoned after Christian-led militias forced Muslims out in 2014. Before the conflict Muslims made up a quarter of the town's population and ran many businesses. "They are very important to this community," says Mayor Albert Eustache Nakombo. "We want them to return."

conservation map, an island of green roughly the size of France containing some of Africa's last pristine wilderness. I learned that vast stretches of its forests remain uninhabited and teem with wildlife. Beneath this bounty lies a wealth of resources, including diamonds, gold, uranium, and possibly oil. It seemed reasonable that such a sparsely populated country—only five million people, compared with France's 65 million—would thrive. But it was failing. Why? That question has plagued me

over the past three years as I've reported on what Central Africans refer to as the Crisis, their term for the war and the chaos that has followed.

On my first trip to Bangui, I put the question to a French Army officer as we sat on an Air France flight about to take off from Paris. It can be a touchy subject for the French, who colonized the country during the European rush for Africa in the 19th century. The Central African Republic gained independence in 1960, but the French

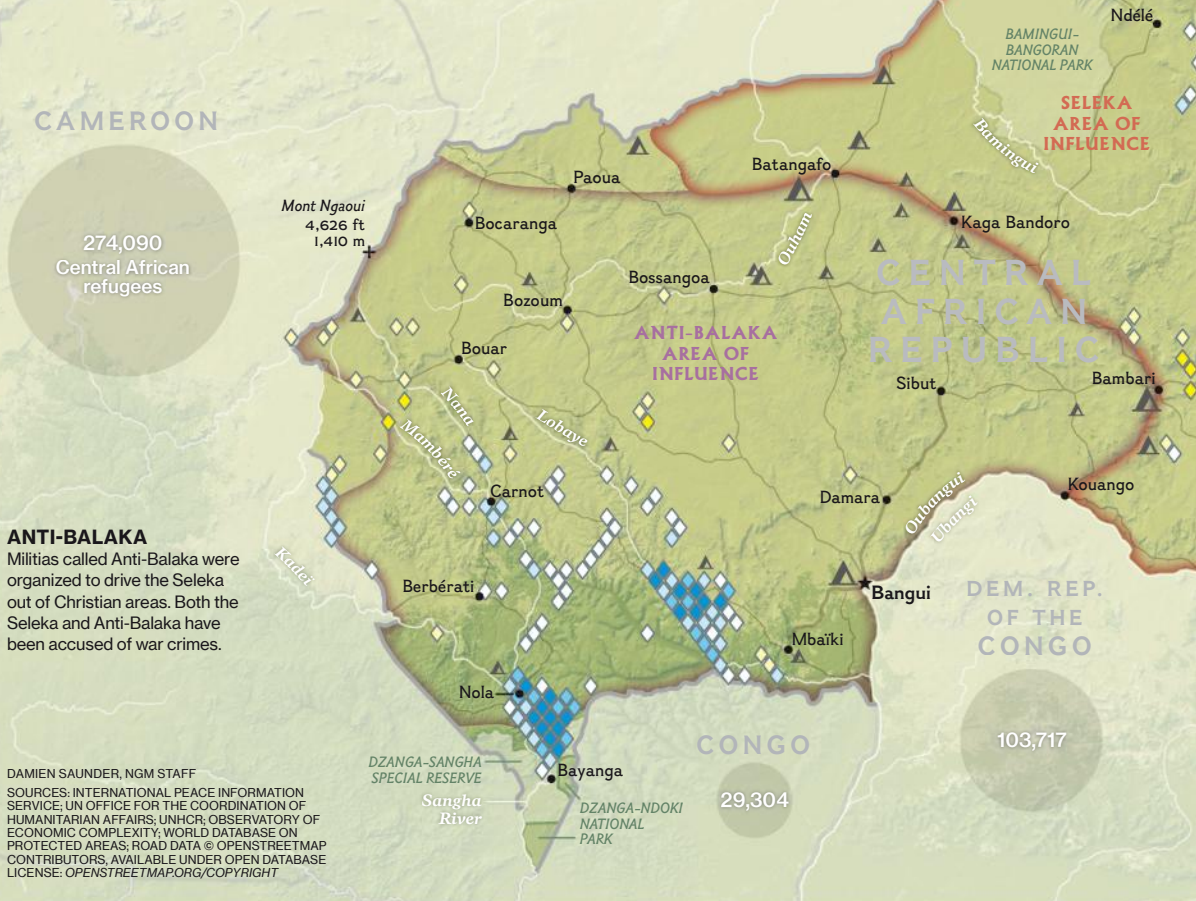
A Muslim rebel stands guard as men and boys dig for gold at a mine near Bambari. The rebels claim a share for "security." Gold is plentiful in the Central African Republic, but corruption and political instability have kept the profits from benefiting the people.





State of Turmoil

Over the past four years a brutal conflict has pitted minority Muslims against majority Christians in the Central African Republic, a country the size of France but with just five million citizens. People in the Muslim-dominated north have long felt ignored by leaders in Bangui, the capital. Their rebellion triggered the violence.



ANTI-BALAKA
 Militias called Anti-Balaka were organized to drive the Seleka out of Christian areas. Both the Seleka and Anti-Balaka have been accused of war crimes.

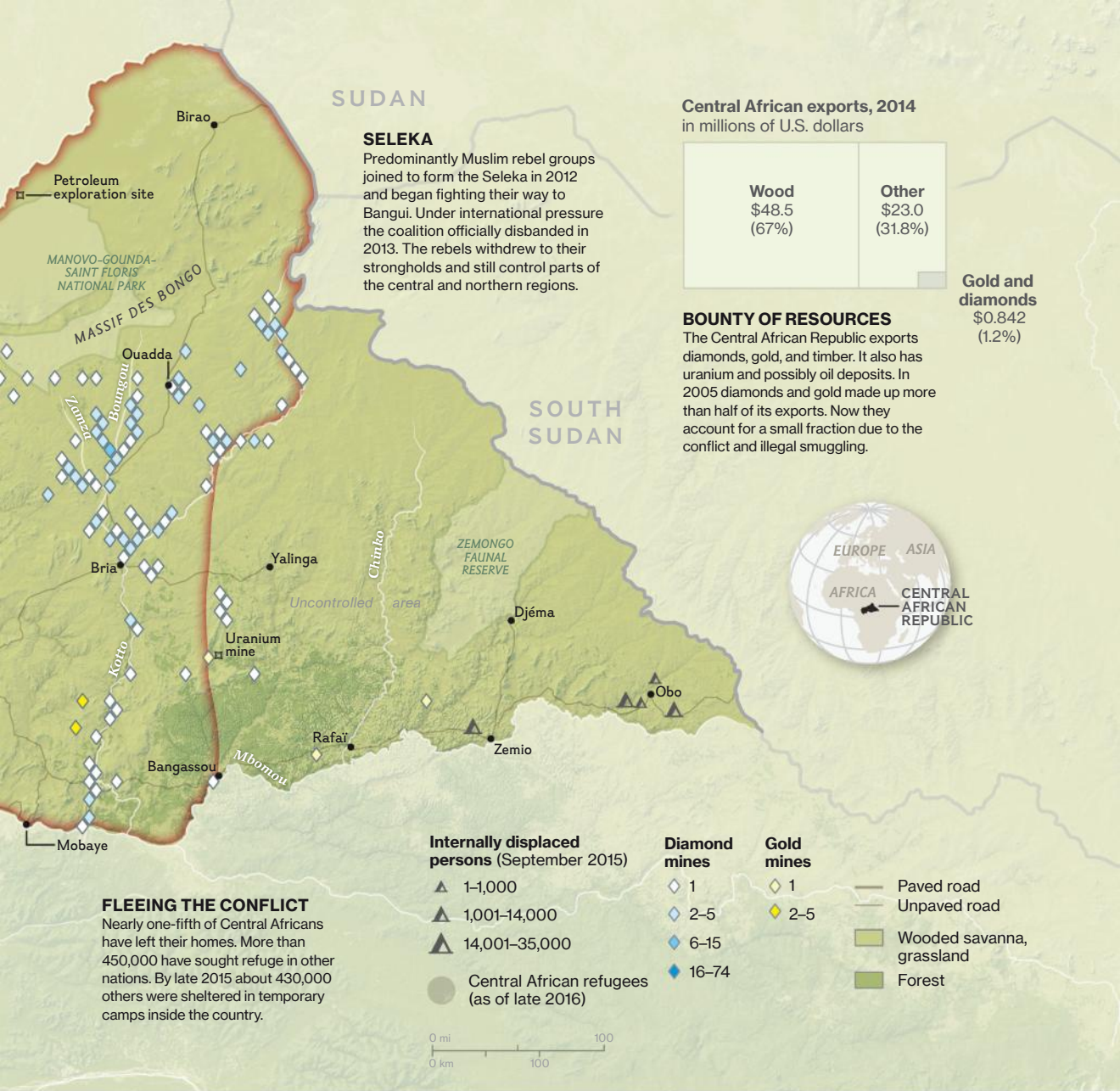
DAMIEN SAUNDER, NGM STAFF
 SOURCES: INTERNATIONAL PEACE INFORMATION SERVICE; UN OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS; UNHCR; OBSERVATORY OF ECONOMIC COMPLEXITY; WORLD DATABASE ON PROTECTED AREAS; ROAD DATA © OPENSTREETMAP CONTRIBUTORS, AVAILABLE UNDER OPEN DATABASE LICENSE; OPENSTREETMAP.ORG/COPYRIGHT

have remained deeply involved in its affairs. Today Central Africans rely on Total, a French company, for much of their gasoline, and the currency the nation uses is backed by the French treasury.

The officer, a broad-shouldered man in his 40s, was embarking on his second peacekeeping tour. “Logistics are a big problem,” he said, shaking his head. “It’s a big, landlocked country, and the roads are shit.” He described how during the rainy season, from May to October, villages in the marshy northeast are entirely cut off, shutting down important trade routes. “The economy in the north can’t grow, and the people there are angry,” he said. “That is where the Seleka was born.”

At that point we were interrupted by the screaming of a Central African woman who was being deported. She’d been escorted onto the plane by two policemen and handcuffed to her seat. She strained against the handcuffs, yelling hysterically. The other passengers were a mixture of Central Africans returning to their country, peacekeepers, aid workers, and diplomats.

The woman’s words unsettled the Central Africans. “She is a sorceress,” complained one man. “She is cursing the plane,” said another. The flight attendants tried to calm the passengers, but soon several were trying to pull their bags from the overhead bins and demanding to



get off. After an hour's delay the pilot ordered the police to remove the woman. He announced that because of the delay we would have to lay over that night in Cameroon. "We cannot land in Bangui at night," he explained, "because the airport lights do not work." The officer leaned over and said, "It is also because it is not safe to travel the road from the airport to the city at night." He grinned ruefully. "This is how things work in the Central African Republic."

ON ONE OF MY FIRST DAYS in Bangui, a local guide drove me to a small plaza with six gold-painted statues. An exuberant man in a brightly

colored dashiki, he explained that the plaza illustrated all the history I needed to know. The plaza honors the six men who led the country from its independence movement to the start of the Crisis. The statues were chipped, and goats nibbled weeds growing in cracks in the pavement nearby. "This is Barthélémy Boganda," he began at the first statue, as if he were a professor holding class. "He is to Central Africans what George Washington and Martin Luther King, Jr., are to Americans."

From my reading I knew the story of Boganda, the self-described son of a cannibal, who famously negotiated with Charles de Gaulle for the country's independence. But I didn't



Forest elephants gather in Dzanga-Sangha Special Reserve, a sanctuary for the species. The year the government fell, poachers killed 26 elephants here. With rangers back on the job, the park is once again safe. Elephants and tourists are slowly returning.





Christians pray at a church in Bambari, where Muslims burned hundreds of their homes. Churches in many towns gave refuge to both Christians and Muslims fleeing violence. Says one pastor: "God's people stepped in to help when soldiers and politicians fled."



STRANDEN
VRIJDAG 2
TENT - DEN DRIES
WWW.PALM-STRAN

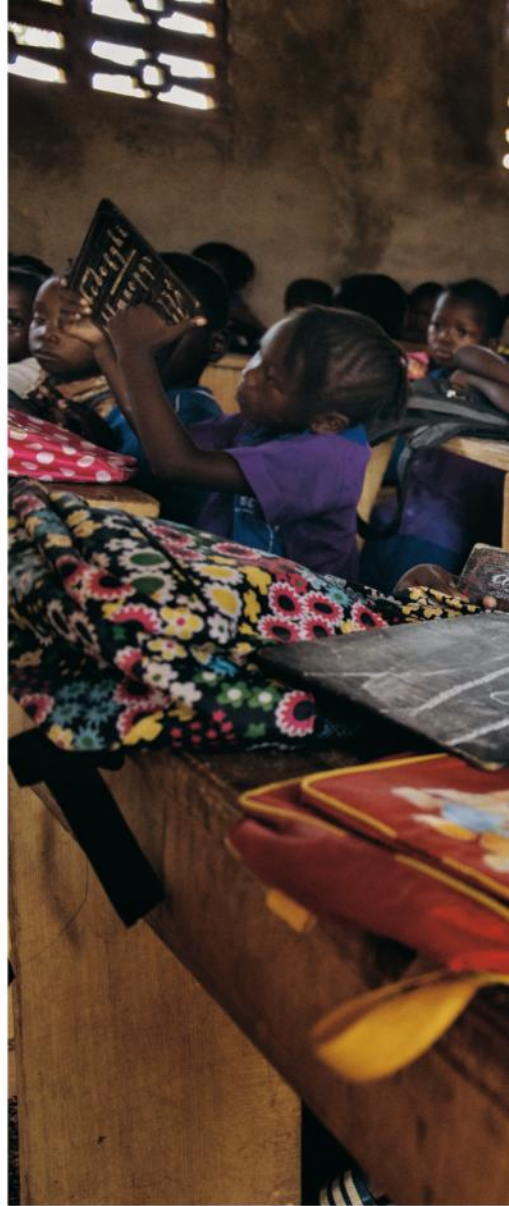
interrupt my guide. He seemed comforted to talk about the one leader nearly every Central African regards as a saint. In conversations with dozens of Christians and Muslims, I never once heard Jesus or Muhammad invoked, but Boganda was cited often. He was born into what was then the French colony of Oubangui-Chari, named for the rivers that defined its southern and northern borders. Private companies ran the colony with impunity, and any notion of justice was left to its administrators. On Bastille Day, 1903, a French official in Kaga Bandoro allowed his men to execute an African prisoner by inserting a stick of dynamite into his anus and igniting it. "It is a bit stupid, but it will dumbfound the natives," the official explained. "After this they will probably keep quiet."

Boganda's life reads like that of an Old Testament prophet. Just before his birth in 1910, French forces killed his father during a raid on his village. Company guards clubbed his mother to death when she refused to collect wild rubber. The orphaned Boganda was taken in by a Roman Catholic priest, and he would go on to take his own vows, becoming Oubangui-Chari's first native priest. He later served as its first native representative in the French National Assembly, becoming an outspoken critic of French rule. When independence was imminent, Boganda was the people's clear choice to be their leader.

He dubbed the nation the Central African Republic, designed its flag, and wrote the country's motto: "Equality for Everyone." But on March 29, 1959, just before the first elections, a plane carrying Boganda exploded in midair. Today people throughout the country believe that the French were behind his death, despite France's denials. The incident has colored the relationship between the countries ever since.

"We were their colony, and they didn't want to let us go," the guide, a forest ranger by trade, said. "You can quote this, but please don't use my name. The French still think we are their colony." He pointed to the statues of the other five men, who had all served as president. "When each one of these guys decided to go against the French, he was replaced by the next guy."

But the leaders who followed Boganda have



their own sins to answer for, he said. Walking down the line of statues, he pointed an accusatory finger at the stern visage of each man, as if he were speaking directly to him. He described how they squandered the nation's wealth, played favorites among the country's numerous ethnic groups, and stirred deep resentment among the 15 percent of the population that is Muslim (the rest practice Christianity or animist beliefs). He stopped at the last statue, the man whom many Central Africans accuse of starting the Crisis, François Bozizé, an army officer who seized power in 2003. "He promised the Muslims he would include them in his government, if they would help him take power.



Students begin the day at a Bangui school that was closed for two years due to the fighting. Muslim-led rebels destroyed schools across the country, affecting some 425,000 children. Teachers were already in short supply before the fighting – about one per 89 students – and many who fled the conflict haven't returned.

Then he betrayed them, and that's how the Seleka came together," the guide said.

SELEKA FIGHTERS achieved their goal of dislodging Bozizé but had little idea how to govern. They controlled Bangui for less than a year before the United Nations sent in a peacekeeping force. The Seleka withdrew to Muslim-dominated regions, and the alliance soon fractured. The disparate rebel groups split their territory into

fiefdoms, each controlled by a former Seleka leader who has tapped into local resources to raise money to pay fighters and buy weapons. During the past year they've begun attacking each other, prompting 70,000 people to flee their homes.

Photographer Marcus Bleasdale and I wanted to explore how these resources, which hold such promise for the nation, have become the lifeblood for the forces that keep it divided. We decided to visit Bambari, a town in the center

The Crisis has shattered what was left of the decrepit court system and the public's shaky confidence in the rule of law.

of the country and the biggest in the territory controlled by former Seleka leaders.

It takes a day to get there from Bangui by 4x4 along a route that cuts through thick forest and passes several villages the Seleka brutalized on its path to the capital. When the UN peacekeepers are patrolling, the road is generally safe. Other times bandits lie in wait. Some are former fighters from the Seleka, or from the Anti-Balaka, militias formed by Christians and animists to fight the Seleka, but it's hard to tell. The nation is awash in desperate people and weapons. Kalashnikovs of varying makes and vintages are sold on the black market, but bandits are just as likely to brandish crude shotguns made from stolen water pipes.

Much of the road is unpaved and pitted with deep ruts that require drivers to slow almost to a walking pace, offering opportunities to stage ambushes or, as we discovered, to sell things. As our driver navigated a particularly rough stretch, a man emerged from the forest waving two large turtles. He walked next to the vehicle calling out prices, slowly reducing them as we pulled away. Later another man held up a freshly butchered antelope shank. Then some giggling boys presented two strings of still wriggling fish. When we paused to look at the fish, a girl dashed out carrying bottles filled with wild honey.

The man Marcus and I wanted to meet in Bambari was Ali Darassa, a former Seleka general who controls the town. Black husks of burned homes are all that remain of its largest Christian neighborhood, and tens of thousands of Christians now live in a tent camp on the edge of town. The market district run by Muslim traders is still open but does a fraction of the business it did

before the Crisis, when Christians frequented its shops, butcheries, and teahouses.

Darassa's fighters roar around in pickup trucks with mounted machine guns, brazenly ignoring the UN peacekeepers, who seem to do little more than flirt with young women. His fighters collect a \$50 tax on every head of the hundreds of cows bound for Bangui markets each week. They also demand protection money from shop owners, collect tolls from vehicles, and tax the area's coffee trade. But the crown jewel in Darassa's portfolio is a gold mine about 40 miles away.

I tried several times to interview Darassa, and his men always made excuses. But they said he didn't have a problem with our visiting the gold mine, which is how, one morning, Marcus and I came to stand on the edge of a deep, terraced gorge that had been dug by a small army of men.

One of the foremen, a fireplug of a man in his early 30s with hands as hard as anvils, told me he'd been working at the mine since it opened three years ago. Before the Crisis, a Canadian company had begun prospecting at the site, but when the violence erupted, it left, along with dozens of other foreign companies that had been exploring for oil, harvesting timber, working on roads and dams. Very few have returned.

The gold is extracted from gravel found at the bottom of the mine, he explained. Some 300 lithe, muscled men and boys were organized in vertical lines stretching up terraced steps to the rim. I watched as the men at the bottom shoveled dirt over their shoulders to the men on the terrace above them. They in turn shoveled it up to the next level and so on, like an escalator of dirt. The men, singing, shouting, and scraping, tended to fall into a rhythm. *Choof, thump, choof, thump, choof, thump*. I watched several men pass a cigarette up their line, each taking a puff before returning to his labors.

Each man, the foreman explained, earns about nine dollars a day. Some of Darassa's fighters, shouldering Kalashnikovs, wandered by. The foreman stopped talking, but when they moved on, he estimated that the mine generates some four million dollars a year. He said Darassa collects 6 percent of the gold "for security."

We spent several hours at the mine and shantytown built to house the men. There were restaurants selling grilled beef, boiled cassava, and Moca beer from Bangui; a cinema showing Vin Diesel and Sylvester Stallone DVDs; and shops selling toothbrushes, soap, and knockoff European soccer jerseys. The foreman told me all the storekeepers take gold as payment. We watched as women and children helped the men sieve the gravel. "There," said a young man, smiling broadly and pointing to a tiny fleck. "That is gold."

AS A FOREIGNER I was often approached by people who wanted to tell me about things that have happened during the Crisis. The first time, a man came to my hotel in Bangui and asked to speak to the American. "I want to tell you what happened to my nephew," he told me.

We took a motorbike to his house, where I met Paul Koli-Miki. He told me that two days before, he had been abducted by Seleka supporters while working near a Muslim neighborhood called PK5. They beat him with a hammer and used a pair of pliers to rip out three of his teeth. His voice was still muffled by the bloody cotton pressed into his gums, and his eyes were wide with shock. He had filed a complaint with a city tribunal in Bangui. "I don't know if I will receive justice," he said.

That is a lament thousands of Central Africans could make. The Crisis has shattered what was left of the decrepit court system and the public's shaky confidence in the rule of law. There are police and some functioning courts—I once got a traffic ticket in Bangui for not wearing my seat belt—but for the most part they are ill prepared to deal with serious crimes, which raises the question: Can the country recover if justice is never served?

Given this void, people have turned to foreigners to register their grievances. A rawboned Muslim man wearing a knitted skullcap once approached me at a mosque in the western town of Berbérati. Thick glasses magnified his pale blue eyes, and his fingers had a slight tremor as he reached out and took my hand as if to hold me in place. "The Anti-Balaka killed all my cows. They cut down my fruit trees. And they killed my son." His voice caught, and he gripped my hand.

"I am 76 years old. What can I do? What can *you* do?" He started weeping.

Among the most troubling of these encounters occurred when I met a girl who said she had been sexually abused by a French peacekeeper. The girl's mother explained that when the Seleka moved closer to her Bangui neighborhood, she fled with her daughter to the airport, which was protected by French troops. "The French soldiers were so kind to us," the mother said. "[They] shared their food and water bottles with us."

The girl listened quietly as her mother spoke. She was about five feet tall and had recently turned 17. Her hair was pulled back in neat cornrows. She kept her eyes on the floor as she described in a timid voice how she met a tall French soldier with a mustache when she passed by his checkpoint, a small sandbag enclosure. "He gave me cookies and sweets," she said. He started saying things in French she didn't understand, so he used sign language to show he meant sexual intercourse and pulled out his penis. She took a deep breath, and her voice grew even softer. "The man showed me some food. He said, 'If you cry, I will beat you. If you don't cry, I will give you food every day.' So I agreed to have intercourse."

She said she had sex with the soldier one other time, and he gave her some rice. Now she was five months pregnant. Her mother sent her to live with a relative to avoid the shame of facing their neighbors. "There are many other girls like her who also got food for sex from the French but have never told this story." There was an investigation, she noted, "but there has been no result." In January French judges decided not to bring charges against soldiers accused of sexually abusing children in the Central African Republic.

IN A VACANT LOT in Bangui, a slender man in a polo shirt plays soccer with a gaggle of energetic boys. He moves with a powerful grace. The ball seems to follow his feet as if he has trained it to obey him. He's trying to teach the boys a fundamental play called give-and-go. He demonstrates, delivering a crisp pass to a boy and then moving fluidly to receive it back. The lesson runs counter to how the boys play street ball, shooting





To escape the fighting, tens of thousands of Bangui residents took refuge among wrecked planes and active runways in a camp at the airport, which UN peacekeepers protect. In December the government began giving people at the camp money to resettle.

every time they touch the ball. They listen intently, almost reverently, because the man speaking to them is a national hero. Ibrahim Bohari, who is known to everyone as I. B. (pronounced ee-bay), is the former captain of the national soccer team. Next to the memory of Boganda, the Wild Beasts may be the country's most unifying force. Its roster includes Muslim and Christian players, and it's one of the few institutions in which no one cares about a person's religion or ethnicity.

I. B., who is Muslim, went on to play for professional teams in Belgium and Turkey, and with the Crisis erupting, he chose to move back home. "I couldn't hear about what was happening and not do something," he told me.

He returned to Bangui to find his fellow Muslims had been chased from his neighborhood. But when he encountered Anti-Balaka fighters, they welcomed him. "I asked them why they didn't attack me. They said, 'We can never kill you, I. B. We love you.'" He shakes his head at the absurdity.

He set about trying to find ways to help heal his country and one day noticed some boys playing soccer with a ball made of rags. He learned they all had Christian parents who had been killed or had fled. In the evenings they would line up by the bakeries downtown and ask for day-old bread and then go sleep under the mango trees on the road to the presidential palace.

I. B. teamed up with So.Sui.Ben, a Swiss charity, and rented a compound to house a dozen of the youngest boys. Twice a week, after the boys finish their school lessons, he leads them in practice. He's outfitted them in bright yellow uniforms, including socks and cleats, precious luxuries in a country where nearly all kids play barefoot.

But the orphanage isn't I. B.'s most ambitious project. He's been organizing "peace matches," soccer games between teams he assembles by mixing former Christian and Muslim fighters in some of Bangui's tensest neighborhoods.

"We have to focus on the young men," I. B. tells me, noting that part of the problem is that so many have no jobs and their heads are filled with films and music that celebrate violence. "When someone tells them to join a rebel group, they think they can live out this fantasy."



The matches require weeks of preparation and delicate diplomacy—persuading religious authorities to endorse them, recruiting participants, arranging security with UN peacekeepers, and soliciting donations from businesses. "It's not just about the game," I. B. says. "It's also about showing the community a picture of Muslims and Christians getting along and working together."

Some in Bangui are skeptical. "A soccer match can't bring back the dead," one imam said. "It won't create jobs. It won't change people's hearts."

Before leaving the country, I attend a peace match at a primary school in PK5, the Muslim neighborhood where Paul Koli-Miki had his teeth



After a year in a camp, Richard Dohou celebrated his return home by decorating with gold paper. His Bangui neighborhood, once a vibrant mix of Muslims and Christians, was emptied by brutal killings. Christians like Dohou are returning, but Muslims are not. “We can forgive each other someday,” says a resident, “but not yet.”

ripped out. A crowd of Christians and Muslims gathers in the stands. The atmosphere is festive. Young women in colorful sundresses hand out sodas. A jovial announcer describes the action and cracks jokes, substituting the players’ names with those of European superstars. “Messi takes the ball from Ronaldo and passes to Zidane,” he barks into the microphone. People are laughing, the sun is shining, and the young men race and jostle and sweat. It’s not the beautiful teamwork

that I. B. teaches, but I see him on the sidelines, smiling and cheering. Everyone is cheering.

It is a beautiful, if fragile moment, like a picture made out of butterfly wings. □

Peter Gwin is a senior editor for the magazine. **Marcus Bleasdale** photographed conflict minerals in the Democratic Republic of the Congo for the October 2013 issue.

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United in Protest

The fight against an oil pipeline inspired new activism among indigenous nations.

A signpost at Oceti Sakowin, one of the Standing Rock camps, showed distances to tribes around the world. "We're building foundations for things that are going to come," says Krystal Two Bulls (above), a Northern Cheyenne and Oglala Lakota.

When the demonstrations against the Dakota Access Pipeline (DAPL) kicked into high gear this past August, Lewis Grassrope, of the Lower Brule Sioux, joined the Standing Rock movement and put up a tepee on the North Dakota plain near Cannon Ball. “There was nothing but tall grass and wide-open green,” Grassrope said. “And spiders galore—I’d pray with them and make them my protectors.”

Every day during the summer, processions of people in traditional dress came to the camps around Cannon Ball, pledging to support a movement that had turned into something bigger than a pipeline protest. It had become an international call to protect indigenous people’s rights and their land.

The season’s first blizzard came and went on the heels of a tentative victory: The U.S. Army Corps of Engineers denied Dakota Access’s permit to drill under Lake Oahe. The camp cleared out, dropping almost overnight from some 10,000 people to about a thousand.

Then came January 20. Within days of his inauguration, President Donald Trump signed executive actions to advance approval of the Dakota Access Pipeline as well as the Keystone XL pipeline, part of a system that would carry oil from Canada to the Gulf of Mexico. By early February the Army had granted an easement to run the pipeline under the Missouri, at Lake Oahe.

But Grassrope, like many other protesters, vows to fight on in the campaign for native lands and tribal solidarity. At press time the Standing Rock Sioux had announced a gathering in Washington, D.C., in March.

As activists continue to raise awareness and the fight moves to the courts, Grassrope sees in last year’s rising at Standing Rock the beginning of a committed community of believers mobilized to resist the expansion of America’s fossil fuel economy.

“Standing Rock reached across the world, and everyone saw the power of what took place here,” Grassrope said. “Now, for most of us who have been in this camp, we must get back to our own reservations to take what we’ve learned back to them, because the fight is going to come to each nation. Each of the 500 nations that came here, the fight is going to come to them.” □



The \$3.8 billion Dakota Access Pipeline would add nearly 1,200 miles to the United States’ oil-distribution network. It could eventually carry about half of American-produced Bakken crude oil to market.

NGM MAPS
SOURCES: USGS, NORTH DAKOTA PIPELINE AUTHORITY; ENERGY TRANSFER PARTNERS

Standing Rock pediatrician Sara Jumping Eagle, with daughter Azilya Iron Eyes (left) and son, Zaniyan Iron Eyes, says we are experimenting on our children with the unknown effects of crude-oil pipeline spills and radioactive fracking waste and associated chemicals that can pollute our water supplies.



Top row from left: At camp a painting shows a black snake – a symbol of the pipeline – dismembered by a “water protector.” Indigenous people “have the same struggle everywhere,” says Eirik Larsen, a Sami from Norway. Two Bulls raises her fist at a protest in Bismarck.



Bottom row from left: “We’re uniting nations here,” says Susana Sandoval, a Purépecha from Chicago. Demonstrator Lewis Grassrope kneels before his tepee. George Pletnikoff, Jr., an Unangaġ from Alaska, says protesters face similar fights back home: “I want something like Standing Rock. We can become antibodies to the sickness of greed.”





Whose Moors Are They?

The future of Scotland's signature landscape is murky amid debates over class, culture, and nature.

A moor – like the scene visible from Sgòrr Tuath, a peak in the northwest of Scotland – is a minimalist, melancholy sweep of close-cropped, open terrain. Contention – over ownership, conservation, and land management – underlies the surface of these tended spaces.







Dougie Langlands (second from left) oversees deer stalking at the 44,000-acre Ardverikie Estate, owned by the same family for 150 years. Scotland has an estimated 400,000 red deer; both that figure and the merits of stalking are subject to heated dispute.

COMPOSITE OF SIX IMAGES; PRECEDING PAGES: COMPOSITE OF SEVEN IMAGES





The trademark of moorland is heather, a perennial that blooms in shades of pink and white as well as purple. This expanse unfurls down to the Dee River at Mar Lodge Estate in Aberdeenshire. Now owned by the National Trust for Scotland, Mar Lodge is pursuing a program of forest restoration.



Grouse shooting is considered the epitome of game-bird sport. Advocates tout the sport's cultural heritage and economic value to communities. Detractors call it cruel and extractive. A shooter and his "loader" (at left) wait for birds to be flushed into range at Urlar Estate, near Aberfeldy.



By Cathy Newman
Photographs by Jim Richardson

At exactly 6 p.m. on July 30, 2015, in Kingussie, Scotland, George Pirie, the agent acting on behalf of Eric Heerema, a Dutch entrepreneur, took possession of Balavil Estate from Allan Macpherson-Fletcher, its former owner. The sale, worth about five million pounds (\$6.3 million U.S.), meant that the 7,000-acre property—with its gray stone 18th-century manor designed by Robert Adam, rolling moors, three-mile beat of the River Spey, and Sarah the resident ghost—would no longer be part of a family legacy spanning 225 years.

“It was a great way of life, but it was time,” Macpherson-Fletcher said later, sipping a whisky in the sunroom of a renovated crofter’s cottage in a corner of the estate he’d held back for himself and his wife, Marjorie. Macpherson-Fletcher, a warm, genial, white-haired man with round tortoiseshell glasses, dressed in madder-hued trousers and a dark blue cardigan, sounded relieved.

He was 65, ready to retire. His children, “wisely,” Macpherson-Fletcher said, had no interest in taking over. The expense of upkeep was depleting of heart and wallet. “The fastest way to lose money is to own a Highland estate,” he quipped. Finally, the Scottish Parliament was about to push through a land reform bill that threatened

Scotland has lost more than 25 percent of its heathland since World War II—but whether that loss is cause for concern depends on your point of view.

to make ownership of such estates more costly and difficult—a plan shaped in part by long-held tensions over class and debates about the future of the moors, Scotland’s signature landscape.

For Macpherson-Fletcher, it was time to ring down the curtain.

In preparation for the new owners, the house had been stripped down to its hardwood floors and wainscoted walls. Down came ancestral portraits; closets were emptied of coats, breeks, caps, and waistcoats in the blue, tan, and brown estate tweed. Into storage went the glass-eyed trophy heads that hung on walls (stags, gazelles, two Cape buffalo, game birds), the mahogany dining table, silver meat domes and branched candelabras, Oriental carpets, the sterling service for 30 engraved with the Macpherson crest and motto, “Touch not the cat bot a glove” (translation: Don’t mess with me).

Instead of a sporting estate—a quintessentially British institution where clients pay dearly to roam the moors to stalk red deer, shoot grouse, and fish for salmon—Balavil would become a family residence. The manor, said the buyer’s wife, Hannah Heerema, would be a place “for the children to spend time.” (Last May the owners filed an application, pending as of this writing, to turn the farm buildings into a visitors center with a café, events facilities, and a parking lot with about 140 spaces for cars and buses.

Communities nearby, unpleasantly surprised about the turn toward the commercial and concerned about the detrimental impact on their villages, objected.)

After the closing, as if to underscore the end of a chapter, agent Pirie, who had been doggedly trailing Macpherson-Fletcher to ensure the deadline was met, drilled the garage door shut to secure the premises. What a shame that there were swallows nesting inside the garage, trapped as an unintended consequence of the sale.

“Poor birds,” thought Allan Macpherson-Fletcher, the former Laird of Balavil.

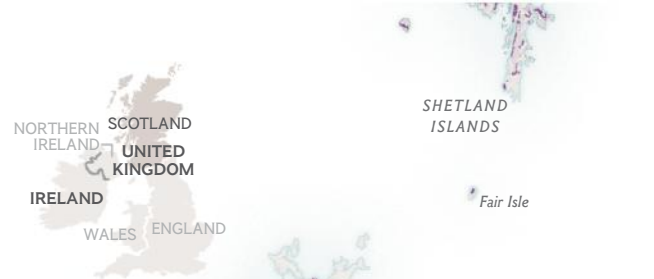
BALAVIL SITS in the Scottish Highlands, bracketed between the Spey and the Monadhliath Mountains. Six thousand of the estate’s 7,000 acres are moorland—a unique landscape whipped by the same gale-force gusts of economic, social, and political change that helped sweep the estate into the arms of a foreign buyer. (With the drop in the value of the pound after the United Kingdom’s vote to leave the European Union, acquisition of Scottish estates by foreign money is likely to accelerate. International buyers snapped up half of the 16 estates sold in 2015 and 2016.)

A moor is a close-shaven landscape of shrubs and grasses clawed at by wind, minimalist in feel. Think abstract art: blocklike swaths of color in a muted palette of ocher, sienna, and charcoal, with accents—depending on season and terrain—of sulfuric yellow (bog asphodel), maroon (lichen), and in late summer, a royal cloak of purple heather. The term incorporates the drier heath of the Highlands, as well as the wetter landscapes of blanket bogs in the more poorly drained regions of the country. Seventy-five percent of the world’s heather moorland is in the United Kingdom, most of it in Scotland.

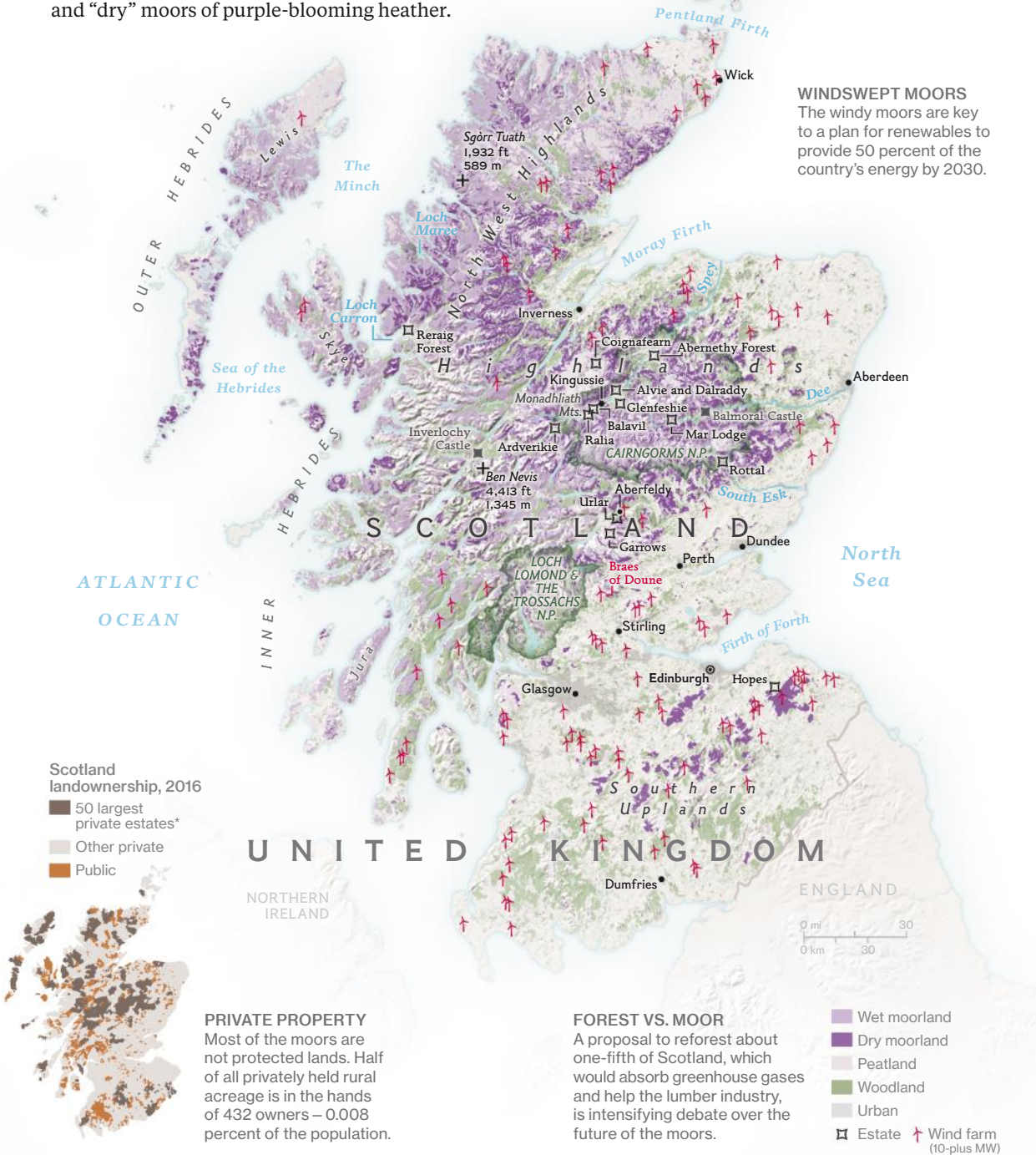
A moor is also the bleak backdrop of gothic literature and Hollywood epics: Emily Brontë’s *Wuthering Heights*, Arthur Conan Doyle’s *Hound of the Baskervilles*, Mel Gibson’s *Braveheart*. Above all, it is the iconic headliner of Visit Scotland tourist brochures. In a government survey, respondents identified a heather-carpeted moor, a loch, and an artfully placed red deer

Managing the Moors

Half of what is now Scotland was forest when humans settled there 10,000 years ago. After centuries of farming, grazing, and deforestation, about 40 percent is now moorland: the “wet” moors of carbon-absorbing bogs and “dry” moors of purple-blooming heather.



WINDSWEPT MOORS
The windy moors are key to a plan for renewables to provide 50 percent of the country's energy by 2030.



Scotland landownership, 2016

- 50 largest private estates*
- Other private
- Public

PRIVATE PROPERTY
Most of the moors are not protected lands. Half of all privately held rural acreage is in the hands of 432 owners – 0.008 percent of the population.

FOREST VS. MOOR
A proposal to reforest about one-fifth of Scotland, which would absorb greenhouse gases and help the lumber industry, is intensifying debate over the future of the moors.

- Wet moorland
- Dry moorland
- Peatland
- Woodland
- Urban
- Estate
- Wind farm (10-plus MW)

*Includes trusts, joint family ownership, and companies with members and stakeholders
LAUREN JAMES, NGM STAFF. SOURCES: SCOTTISH NATURAL HERITAGE; THE JAMES HUTTON INSTITUTE; SCOTTISH GOVERNMENT; CONTAINS ORDNANCE SURVEY DATA © CROWN COPYRIGHT AND DATABASE RIGHT (2017); ANDY WIGHTMAN, WHO OWNS SCOTLAND; U.K. DEPARTMENT FOR BUSINESS, ENERGY AND INDUSTRIAL STRATEGY; EUROPEAN NATURE INFORMATION SYSTEM





At Ralla Estate near Kingussie, gamekeepers Alastair Lyon (at left) and Richard Williams selectively burn patches of aging heather – a task known as muirburn, which takes place from October to April – to encourage new growth for red grouse to feed on.



The stag ballroom at Mar Lodge Estate, which is decorated with 2,435 sets of antlers, was built in the late 1890s by the Duke of Fife for social gatherings. These days it's used for weddings and, until recently, for the annual ghillies ball given for gamekeepers and their staff at the end of stalking season.







Colin Murdoch, who manages the deer population at Reraig Forest, near Loch Carron, feeds stags to spur antler growth. In addition to offering stalking, the property hosts wilderness tours. Many estates now feature holiday home rentals and outdoor pursuits such as zip lines to bolster the bottom line.

‘What would you rather see,’ says Mike Daniels, of the John Muir Trust, in tones that would strip paint off a wall, ‘a golden eagle in wilderness or toffs shooting grouse?’

as the country’s archetypal landscape. National identity balances on the tip of a landscape tradition. For Americans it’s the Wild West; for Australians, the outback. In Scotland the mist of myth envelops the moors. The landscape of a moor, which looks as if it has always been there but hasn’t, “is wild but not wilderness,” explains biologist Adam Smith, director of the Game and Wildlife Conservation Trust in Scotland. To remain heather moorland, it must be managed by selective, periodic burning to prevent forest from reclaiming the terrain.

Because of overgrazing by deer and sheep, invasion by bracken, and the setting aside of land for forest, Scotland has lost more than 25 percent of its heathland since World War II—but whether that loss is cause for concern depends on your point of view. To step onto a moor is to sink into a bog of contention, resentment, and righteousness. Not everyone agrees, but scientists such as Smith argue that moors are among the most biologically diverse habitats in Britain, populated by a multitude of birds: curlews, golden plovers, lapwings, and merlins. There are economic benefits—tourism, most of all. And environmental ones: Wet moors, those with peat bogs, are effective carbon sinks and thus mitigators of climate change.

A significant percentage of moorland is managed specifically for grouse shooting, but a

passionate contingent believes that such land could be put to better use. David Read, an emeritus professor of botany at the University of Sheffield, for one, thinks some of the land would be better off more thoughtfully planted with Sitka spruce for lumber. “Heather is unproductive,” he says. If there were more spruce, “at least Scotland wouldn’t have to depend on lumber imports.”

Others—such as Mike Daniels, head of land management at the John Muir Trust, a conservation group—would allow moorland to revert to its natural state, a process known as rewilding. “What would you rather see,” Daniels says, in tones that would strip paint off a wall, “a golden eagle in wilderness or toffs shooting grouse?”

The trip wire of ownership adds yet another layer to the debate. According to land reform specialist Andy Wightman—who has spent 20 years combing through deeds, records, and maps to research landownership—just 432 people own half the privately held rural land in Scotland.

“The super-rich have always been able to buy and manage Scottish land, no questions asked,” says Lesley Riddoch, a land reform activist who believes that large country estates are emblematic of inequities and an affront to Scottish democracy. “For centuries lairds have run sporting estates, sometimes the size of small countries, without local input—evicting tenants here, tolerating crofters there.” Riddoch would like to see the land broken up into affordable parcels and made available to young families.

The Scottish sporting estate is elite by tradition. In 1852 Prince Albert bought Balmoral Castle, in the Aberdeenshire Highlands, for Queen Victoria. The royal imprimatur made going to Scotland downright chic. Royals and men of means decamped to drafty manors in summer for sport and other diversions. Wealth from the industrial revolution and newly opened railway lines from London to Scotland made it possible to pop into Scotland for a few weeks of shooting. The upper class fell into a tartan swoon.

The Balmoral effect persists. In the early 1990s, Mar Lodge, a 72,000-acre estate near the queen’s property, now owned by the National Trust for Scotland, belonged to the billionaire

husband of a former nude model, who had hoped to be friends with the neighboring royals.

Fat chance.

ON JUNE 22, 2015, a Scottish government bill was introduced that, among other things, called for reinstating a tax on sporting estates and easing the way for the community purchase of estate land, thanks to a government fund.

"It's an antique structure that has to be changed," said Michael Russell, a member of the Scottish Parliament and the committee that evaluated the bill. He spoke of fat cats tone-deaf to public interest, like the Australian hedge fund owner who proposed building a golf course on the island of Jura—just for his buddies—before community pressure effected a change of heart. "We have to take some radical action. We should have done this long ago," Russell said.

Besieged estate owners acted like stags at bay. "A Mugabe-style land grab," Lord Astor wrote in the *Spectator*, deriding the bill. "Tartan Stalinists: Forced sales of country estates... Contempt for the wealthy," howled the *Daily Mail*. The political windstorm affected the sale of Balavil, which languished on the market for two years, its asking price ultimately cut by two million pounds. Buyers, said Robert McCulloch, a partner in real estate broker Strutt and Parker, were wary of the uncertainty surrounding land reform, Scottish independence, and the specter of higher taxes. The bill passed in March 2016.

NINE "GUNS"—as members of a shooting party are known—gathered in front of the manor house at Rottal Estate, in the Angus Glens, along the South Esk River, on a clear September day. The property, once owned by the Earl of Airlie, had been sold in 2005 to Hertfordshire businessman Dee Ward, who had invited his friends for a driven shoot: the sporting equivalent of Kabuki theater, a ritual with distinctive costumes and customs. One dresses for grouse. Ward wore his estate tweeds with a tattersall shirt and wool tie. It shows respect for the bird, he explained. "We are shooting red grouse," he reminded his guests. "Snipe are allowed, but please don't shoot black grouse or hares."

Rottal, a classic sporting estate, is managed for grouse shooting, a controversial pursuit often attached, fairly or not, to words such as "elite," "snob," and "toff." A "driven shoot" is the Rolls-Royce of a noble sport, if you are a devotee, and perhaps a ridiculous pastime if you are not. Those in the shooting party that day were friends of the owner, but for paying guests, a day on the moors can cost £750 (about \$935) or more per "gun." (The client may take home two birds, called a brace; the owner sells the rest to the game dealer.) Throw in accommodation—at Inverlochy Castle in the West Highlands, for example, you may book a suite for £695 (about \$870) a night—add meals, tips, a J. Purdey & Sons shotgun with a Circassian walnut stock and rose-and-scroll engraving (\$80,000 and up), and you see why the sport tilts in the affordability direction of hedge fund directors and other masters of the universe.

In a driven shoot, beaters—people waving flags—sweep through the moors in a line to flush birds toward the guns. Unlike a pheasant, which flies straight and high and presents a fat, complacent target, the red grouse—*Lagopus lagopus*—flies fast and low, like a feathered dart on an erratic trajectory. Afterward dogs retrieve the birds.

The dispute over driven shoots on the moors is more bare-knuckle boxing match than debate. "A practice pursued by the few to the detriment of the many," writes Mark Avery, whose petition to ban the sport in the United Kingdom attracted 123,000 signatories last year. "Maximizing the number of grouse means treating the moors as if they were giant chicken runs," columnist George Monbiot argued in the *Guardian*.

The other side argues, with equal vehemence, its own version of biodiversity and economic benefit. "We run a grouse shoot with strong conservation roots. Heather-clad moorlands are one of the rarest habitats in the world," says Robbie Douglas Miller, owner of the Hopes, an estate in the southern part of Scotland known as the Borders. "To protect and enhance, it takes a lot of time and money. Grouse moor management is the only use for upland that does this."

The economic argument is backed up by a survey sponsored by the Game and Wildlife



Landowners who lease their property as sites for turbines like these at Braes of Doune Wind Farm, near Stirling, are well compensated. But conservationist Mike Daniels considers wind farms the visual equivalent of industrial pollution. "You wouldn't put a car factory on top of a hill," he says.

COMPOSITE OF FOUR IMAGES







The quiet beauty of old Scots pines is doubled by the waters of Loch Maree, in the North West Highlands. Isolation excludes deer, which graze on young trees. Estates use fencing to keep out deer and aid forest regeneration, but it's expensive, unsightly, and hazardous to low-flying birds.

COMPOSITE OF SEVEN IMAGES

Graeme Macdonald knows which client is to be addressed as ‘Dave’ or ‘Sir,’ and when a client misses a shot, will console with exquisite tact: ‘Difficult bird, Sir.’

Conservation Trust that says grouse shooting supports 1,072 jobs, provides £14.5 million (\$18.3 million) in wages, and adds £23.3 million (\$29.5 million) to Scotland’s gross domestic product.

But rewilding advocate Mike Daniels counters that those numbers are relevant only to those who regard nature as a commodity. “You could say cheekily that if economics was the only criterion as the sole justification for a land use, then presumably you could make a strong economic case for slavery or bear baiting.”

“The truth of the matter is that if you think hunting is wrong, you will not be swayed by any argument,” says Tim Baynes, director of the Scottish Land and Estates Moorland Group, which represents owners.

The Game and Wildlife Conservation Trust’s Adam Smith quietly says this of the grouse-shoot dustup: “Moors are cultural landscapes where conflict and conservation sit side by side.”

The battle carries more than a whiff of class divide. “I wish,” sighed estate owner Robbie Douglas Miller, his frustration palpable, “that people paid more attention to how the land is managed rather than who owns it.”

SO LET’S CONSIDER management. Roy Dennis, an ornithologist and wildlife consultant, abhors moors managed for grouse. “Moors are as man-made as the olive groves in Italy,” he says. “Most

areas that now have moors were once forest.”

Dennis consults for Swedish-born philanthropist, publisher, and heiress Sigrid Rausing, owner of Coignafearn, a 40,000-acre estate in the Monadhliath Mountains, who hired him to restore the land to a natural state. He drove me out to see the restoration in progress: fences that kept deer from eating trees and shrubs and the resurgence of birch, Scots pine, wild cherry, willow, and rowan trees with their scarlet berries. A golden eagle circled in the sky.

“The problem,” he said, “isn’t with shooting grouse. It’s the intensification of land used to raise high numbers of grouse that isn’t sustainable.”

There are other estates with rewilding agendas, he said, naming Glenfeshie (owned by Danish billionaire Anders Povlsen), Mar Lodge (National Trust for Scotland), and Abernethy Forest (RSPB Scotland). Landownership is “not just about privilege. It’s about responsibility,” Dennis said.

Ronnie Kippen, head gamekeeper of the Garrows Estate, in Perthshire, disagrees. “I think that rewilding the land is neglect. Do [rewilding advocates] employ anyone?” he asked. In his opinion, managing for grouse is about conservation and jobs, related to the shoot—gamekeepers, beaters, estate staff—and to tourism. “Management of moors brings a livelihood,” Kippen insisted. He drove me around the estate and pointed out an uncommon black grouse, a kestrel, and a meadow pipit, a small songbird. “Who says there is no diversity on a moor?” he demanded.

Now meet Jamie Williamson, a man of unruly eyebrows and a mind that crackles like a Van de Graaff generator, skittering from thought to thought. He manages the Alvie and Dalraddy Estates, a combined 13,350 acres, but carries the title of laird lightly. He drives a truck, wears a plastic digital watch, and runs his property from a desk buried under an avalanche of paper. Williamson, a new breed of owner, acknowledges the past but monetizes the present.

Walk the moors with Graeme Macdonald, Alvie’s gamekeeper, and you will learn something about cultural tradition. Macdonald, a man with a bird’s-nest beard the color of winter, knows every furrow, rivulet, and rise. He knows where

stags may be found, which client is to be addressed as “Dave,” who is to be called “Sir,” and when a client misses a shot, will console with exquisite tact: “Difficult bird, Sir.”

Step into the manor library. Note the leather-bound volume with “Alvie Game Book” stamped in gold. Leaf through a diary of life and death in the tally of stag, snipe, and grouse eulogized in ink. “August 22, 1908—107 grouse shot by guns JB Barrington and JFM Lawrence...fine weather.”

The assumption of plenty was misguided, today’s owners admit. In 2015 Williamson canceled grouse shooting. Wet and cold weather in late spring killed insect and plant life; fledglings starved; bird numbers plummeted. The estate lost £50,000.

But grouse shooting represents only 4 percent of estate revenues these days. “The toffs still come,” he says, but “we farm tourists now.” The big money—more than £500,000 (\$632,000) a year—comes from renting holiday cabins and camping sites with Internet and TV hookups. Forestry, a zip line, a granite quarry, and a fish hatchery provide additional revenue.

“Being a laird doesn’t make me a villain,” Williamson said. “The criticism of being one of the too few with too much is a distortion.”

For Allan Macpherson-Fletcher, the former Laird of Balavil, all is moot. With the estate sold, there are no more awkward meetings with the bank manager. “In a good year the estate would break even; in a bad, we would lose money, so we had to borrow.” These days the crest on the Macpherson family silver would read: “It is not my problem.”

“As I left Balavil,” Macpherson-Fletcher told me, “I took a final look round, expecting a tear in my eye. And no, there was nothing, because it was just a tired old empty house. All the atmosphere and history had gone with us. What was left was just bricks and mortar.”

ON THE SUBJECT OF OWNERSHIP, the ancients leaned in on responsibility. Aristotle proposed that how one used one’s property was an indicator of virtue.

“We get greedy,” said Alison Hester, a professor

and biodiversity scientist at the James Hutton Institute, a research group based in Scotland focused on sustainable use of land and natural resources. The year had turned toward fall. Shadows had lengthened. Soon the soft hills would turn russet; the horizon would be smoke-smudged as gamekeepers on the great estates burned old heather to encourage new growth for grouse to eat.

As part of her dissertation, Hester studied and surveyed heather. She counted the number of shoots in an acre, then the number of flowers per shoot, then the number of seeds—each the size of a pencil dot—per flower. “Heather is absolutely beautiful,” she mused. “It hums with bees. It’s rich with the smell of fresh air and wind that blows your troubles away. As a child, we would go to the moors, fill our mouths with blueberries and listen to the curlews.”

That’s different from woodland, she continued. “In woodland you have the sheltering sensation of trees and the sweet honey smell of birch in spring.” The debate over which is better, she suggested, is an impossible one.

“I think it important to acknowledge up front that one reason for the love of moorland is because it’s a cultural landscape, and not to dress it up as something else. We protect other things for their cultural importance, so we shouldn’t belittle that aspect of it. Perhaps we need to step back and think about the bigger picture.”

Maybe instead of maximizing the population of grouse, you sacrifice some moorland to wildland, she offered. “What do we really want to preserve? Whatever the decision, something is won and something is lost.”

In the service of civilization, meadow yields to olive grove, prairie land becomes wheat field, moor replaces forest. How land is used depends on need, economics, and ownership. But also politics, power—and, Aristotle might say, virtue. □

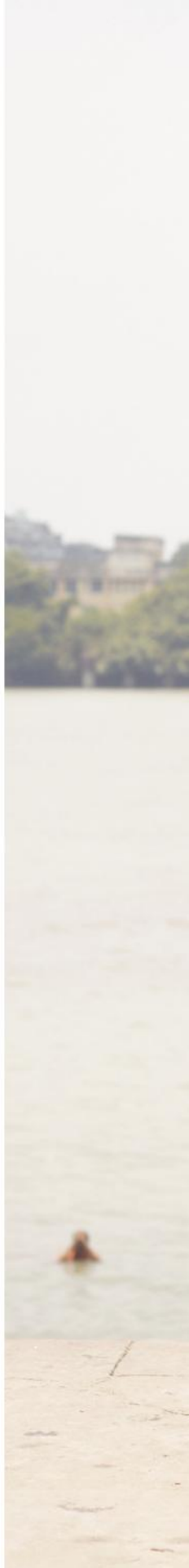
Former Editor-at-Large Cathy Newman has written more than 40 stories for the magazine. Photographer **Jim Richardson**, a no less prolific contributor who was once named Kansan of the Year, continues his photographic exploration of his beloved Scotland.

Flower Men

*Vendors at India's floral
markets wear their colorful wares
every day. In Kolkata the visual
contrast blurs the lines between
masculine and feminine.*

STORY AND PHOTOGRAPHS
BY KEN HERMANN

On the banks of the Hugli River, Angad Ray – a vendor
at Kolkata's giant Mullick Ghat flower market – sports
a crown of the false ashoka leaves he sells.





A few years ago I was on an assignment in India. I had a day off, so I went to the Mullick Ghat flower market in Kolkata. It's one of the largest floral wholesalers in Asia—a huge warren of stalls, more than a century old, with some 2,000 vendors setting up every day. Seasonal flowers arrive on trucks early each morning.

The crazy, hectic atmosphere fascinated me. But more than anything, I was drawn to the way the male sellers carried their flowers. They were macho men, but they held their petals in an almost ladylike way. One guy looked like he was wearing a floral dress. Intrigued by this masculine-feminine contrast, I went back two years later to shoot a series of portraits.

Flowers are used for everything in India, from festivals and parties to religious rituals. The variety is enormous: brightly hued hibiscuses, vivid crimson roses, jasmine bouquets, fragrant lotus and magnolia flowers. But I decided to photograph only the species that I saw the vendors carrying.

I originally thought about including both sexes in this series, but the women I asked told me they were reluctant to have their pictures taken. So I focused exclusively on the male vendors.

A lot of these guys speak only Bengali. Some are there illegally; gaining their trust was a challenge. But after a few days my assistant and I connected with one of them—a local guy who speaks Bengali and Hindi. His help made it easier for us to get permission and access.

The market was too congested to frame the kind of clean pictures I like, so I photographed the men along the Hugli River, a tributary of the Ganges. I took my pictures from 12 to 3 p.m., to capture the moody mixture of sunlight and smog. I also used a studio filter to soften the harsh midday light.

Over the course of eight days I photographed about 55 vendors. Most of the portraits took 10 or 15 minutes. That doesn't sound like much, but it was so hot it felt as if we were burning. At the end of each day's shoot, I had to go back to my hotel to change all my clothes. I was literally covered with sweat.

My work is an attempt to get beyond stereotypes. Some people think that everyone in India is poor and miserable. This project—a series of beautiful images made in a rough, unlikely environment—is my way of showing otherwise. □



A vendor named Kulwinder models what looks like a dress made of orange marigolds. To get these guys to take a break from their work and pose under the midday sun, I wound up paying for many of the bunches I photographed.







Meet the flower men: S. K. Baghat (above) wears a garland of Chinese hibiscuses; (opposite page, clockwise from upper left) Dev Kumar stands with a bouquet of lotuses; Dileep Hajra displays bunches of tuberoses; Ramdayal Yadav cradles bright red cockscombs; and Sikanto Pawani holds clusters of butterfly pea flowers.



Atul Dubey (above) shows off his yellow marigolds; Gorelal Dass holds up purple globe amaranths. These stoic, masculine men put on a macho face when they get their picture taken. But you can see that they carry their flowers – their livelihood – in a very gentle way.





Akhenaten

EGYPT'S FIRST REVOLUTIONARY

King Tut's father upended the religion, art, and politics of ancient Egypt, and then his legacy was buried amid a backlash. But today he endures as a symbol of change.



In Berlin's Neues Museum, Akhenaten's bust bears the scars of upheavals ancient and modern. Smashed by the king's successors in the 14th century B.C., it was also damaged as a result of being moved during World War II.

A Cairo vendor sells masks of Abdel Fattah el-Sisi during Egypt's 2014 presidential election. Having deposed his predecessor in a coup, the popular former general won 97 percent of the vote. After taking office, he announced the construction of a brand-new capital in the desert east of Cairo – a \$300 billion project reminiscent of Akhenaten's desert capital at Amarna. "It's the same back then; it's the same now," archaeologist Anna Stevens says. "Everybody is running after Sisi because he's a strong man."





By *Peter Hessler*
Photographs by *Rena Effendi*

SOMETIMES THE MOST POWERFUL COMMENTARY ON A KING IS MADE BY THOSE WHO ARE SILENT.

One morning in Amarna, a village in Upper Egypt about 200 miles south of Cairo, a set of delicate, sparrowlike bones were arranged atop a wooden table. “The clavicle is here, and the upper arm, the ribs, the lower legs,” said Ashley Shidner, an American bioarchaeologist. “This one is about a year and a half to two years old.”

The skeleton belonged to a child who lived at Amarna more than 3,300 years ago, when the site was Egypt’s capital. The city was founded by Akhenaten, a king who, along with his wife Nefertiti and his son, Tutankhamun, has captured the modern imagination as much as any other figure from ancient Egypt. This anonymous skeleton, in contrast, had been excavated from an unmarked grave. But the bones showed evidence of malnutrition, which Shidner and others have observed in the remains of dozens of Amarna children.

“The growth delay starts around seven and a half months,” Shidner said. “That’s when you start transition feeding from breast milk to solid food.” At Amarna this transition seems to have been delayed for many children. “Possibly the mother is making the decision that there’s not enough food.”

Until recently Akhenaten’s subjects seemed to be the only people who hadn’t weighed in on his legacy. Others have had plenty to say about the king, who ruled from around 1353 B.C. until 1336 B.C. and tried to transform Egyptian religion, art, and governance. Akhenaten’s successors were mostly scathing about his reign. Even Tutankhamun—whose brief reign has been a subject of fascination since his tomb was discovered in 1922—issued a decree criticizing conditions under his father: “The land was in distress; the gods had abandoned this land.” During the next dynasty, Akhenaten was referred to as “the criminal” and “the rebel,” and pharaohs destroyed his statues and images, trying to remove him from history entirely.

Opinion swung to the opposite extreme during modern times, when archaeologists rediscovered Akhenaten. In 1905 Egyptologist James Henry Breasted described the king as “the first individual in human history.” To Breasted and many others, Akhenaten was a revolutionary whose ideas, especially the concept of monotheism, seemed far ahead of his time. And the archaeological record



An armed guard patrols near ancient grain silos at Amarna, where the intact ruins present a rare opportunity to study an ancient city at a moment in time. Amarna's royal palaces, temples, and main roadways were carefully laid out, but the majority of construction was haphazard. Bill Erickson, a professor of urban design at the University of Westminster in London, says that housing patterns in Amarna were strikingly similar to what he has observed in modern slums and unplanned neighborhoods. "These places may be 3,000 years old, but there are strong lessons about our cities today."

has always been thin enough to allow for excavations of the imagination. Dominic Montserrat, whose Akhenaten book is subtitled *History, Fantasy and Ancient Egypt*, noted that we often take scattered evidence from ancient times and organize it into narratives that make sense in our world. We do this, he wrote, “so that the past could be held up to the present, like a mirror.”

That modern mirror of Akhenaten has reflected almost every identity imaginable. The king has been portrayed as a proto-Christian, a peace-loving environmentalist, an out-and-proud homosexual, and a totalitarian dictator. His image was embraced with equal enthusiasm by both the Nazis and the Afrocentrist movement. Thomas Mann, Naguib Mahfouz, and Frida Kahlo all incorporated the pharaoh into their art. When Philip Glass wrote three operas about visionary thinkers, his trinity consisted of Albert Einstein, Mahatma Gandhi, and Akhenaten. Sigmund Freud once fainted during a heated argument with Swiss psychiatrist Carl Jung about whether the Egyptian king had suffered from excessive love of his mother. (Freud’s diagnosis: Akhenaten was oedipal, almost a thousand years before Oedipus.)

Archaeologists always tried to resist such interpretations, but key pieces of the puzzle were missing. Much study of Amarna has focused on elite culture: royal sculpture and architecture, and inscriptions from the tombs of high officials. For years scholars hoped for the opportunity to study the burial places of common people, knowing that Amarna’s brief window of existence—17 years—meant that a cemetery would provide a rare snapshot of everyday life. But it wasn’t until the early 2000s that a detailed survey of the surrounding desert finally located evidence of four separate cemeteries.

After the discovery, archaeologists and bioarchaeologists spent nearly a decade excavating and analyzing the largest of these cemeteries. They collected a sample of skeletons from at least 432 people, and their findings were grim. Of the burials where age at death was known, 70 percent of the individuals had died before reaching 35, and only nine appear to have lived beyond 50. More than one-third were dead before they

turned 15. The growth patterns of children were delayed by as much as two years. Many adults had suffered spinal damage, which bioarchaeologists believe is evidence that people were being overworked, perhaps in order to build the new capital.

In 2015 the team proceeded to another cemetery, to the north of Amarna, where they excavated 135 bodies. Anna Stevens, an Australian archaeologist who directs the cemetery fieldwork, told me that excavators soon noticed something different about these burials. Many of the bodies appear to have been buried hastily, in graves that contain almost no goods or objects. There isn’t evidence of violent death, but family groupings seem to have broken down; in many cases it looks as if two or three unrelated people were tossed together into a grave. They were young—92 percent of the individuals in this cemetery were no older than 25. More than half died between the ages of seven and 15.

“This is very clearly not a normal death curve,” Stevens said. “It may be no coincidence that this area had the king’s limestone quarries. Is this a group of workers who are being conscripted on the basis of their youth—and effectively being worked to death?” In her opinion, one thing is clear: “It absolutely dispels any lingering sense that Amarna was a nice place to live.”

FOR AKHENATEN, Amarna represented something pure and profoundly visionary. “No official has ever advised me concerning it,” the king wrote proudly of his founding of the brand-new capital city. He chose the site, a broad stretch of virgin desert above the east bank of the Nile, because it was uncontaminated by the worship of any god.

He also may have been motivated by the example of his father, Amenhotep III, who was one of the greatest builders of monuments, temples, and palaces in Egyptian history. Both kings were part of the 18th dynasty, which came to power after defeating the Hyksos, a group from the eastern Mediterranean that had invaded northern Egypt. The forefathers of the 18th dynasty were based in southern Egypt, and in order to drive out the Hyksos, they incorporated key innovations from their enemy, including the horse-drawn chariot and the

composite bow. The Egyptians professionalized their military, and unlike most previous dynasties, the 18th maintained a standing army.

They were also skilled at diplomacy, and the empire eventually stretched from current-day Sudan to Syria. Foreigners brought new wealth and skills to the Egyptian court, and the effects were profound. Under Amenhotep III, who ruled from around 1390 to 1353 B.C., the style of royal art shifted in ways that would be described today as more naturalistic.

EVEN AS Amenhotep III welcomed new ideas, he was also looking back to the distant past. He studied the pyramids of kings who had lived more than a thousand years earlier, and he incorporated traditional elements into festivals, temples, and royal palaces. He continued to worship Amun, who was the patron god of the city of Thebes. But Amenhotep III also began to emphasize Aten, a form of the sun god Re, portrayed as a solar disk, that recalled older patterns of worship.

The king's son took the throne as Amenhotep IV, but during the fifth year of his reign he made two momentous decisions. He changed his name to Akhenaten—Devoted to Aten—and he decided to move the capital to the site now known as Amarna. The king called his city Akhetaten, or Horizon of the Sun Disk, and soon this stretch of empty desert became home to an estimated 30,000 people. Palaces and temples were built quickly, at astonishing scale—the Great Aten Temple, the city's largest ritual complex, was nearly a half mile long.

Meanwhile Egyptian art was also being revolutionized. For centuries strict traditions had defined the correct subject matter, proportions, and poses of paintings and sculptures. Under Akhenaten, artisans were unleashed from these guidelines. They created lifelike, fluid scenes of the natural world, and they began to portray Akhenaten and his queen, Nefertiti, in unusually natural and intimate poses. Often the royal couple would be shown kissing and caressing their daughters; one scene even featured the king and queen about to get into bed together. The portrayal of Akhenaten's features seems designed to



AKHENATEN'S NEW CAPITAL

Egypt's two primary capitals in centuries past were the strategic and religious centers of Memphis and Thebes. But Akhenaten built a new capital, Amarna, on an isolated patch of desert, signaling a break from Egypt's religious and ideological past.

shock: massive jaw, drooping lips, and elongated, otherworldly eyes.

In the king's vision, religion became radically simplified. Egyptians worshipped as many as a thousand gods, but Akhenaten was loyal only to one. He and Nefertiti functioned as the sole intermediaries between the people and Aten, taking on the traditional role of the priesthood. Nefertiti was named co-regent, and while it's unclear whether she wielded political power, her religious and symbolic status was highly unusual for a queen.

All of this must have threatened priests of the old order who served Amun. After a few years at Amarna, the pharaoh ordered work crews to gouge out all images of Amun in state temples. It was an act of unbelievable boldness: the first time in history that a king had attacked a god. But revolutions have a way of turning against their greatest enthusiasts, and this violence eventually would consume Akhenaten's own creations.

I ARRIVED at the site of the Great Aten Temple one day just as Barry Kemp found a piece of a broken statue of Akhenaten. Kemp is a professor

A limestone stela at the Neues Museum (below) features Akhenaten and Nefertiti with three of their daughters beneath the sun god Aten. In Amarna stelae like this were erected as shrines in elite residences. No images of Akhenaten, Nefertiti, or Aten have been found in the commoners' cemeteries, suggesting that the new religion had yet to be embraced by the masses. Today, though, Egyptians at a Cairo theme park pose in ways that recall the natural, family-oriented style of Amarna art (right).



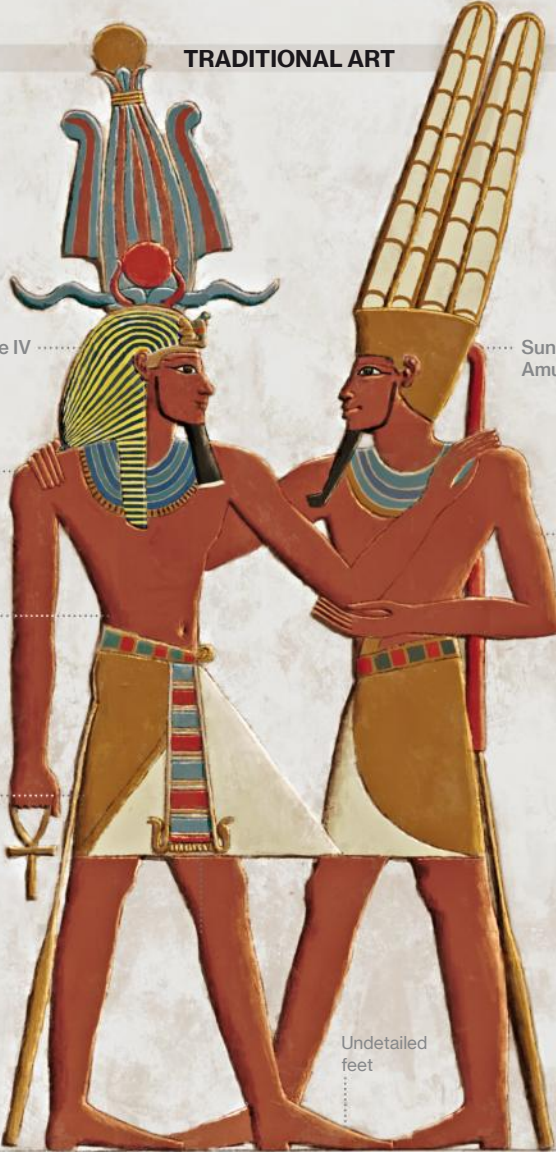


The Age of Akhenaten

The pharaoh Akhenaten, King Tut's controversial father, departed from centuries of tradition after taking power in 1353 B.C. Changes during his 17-year reign included new styles of art and architecture and mass celebrations of the sun god Aten that pushed the old gods aside.

TRADITIONAL ART

Egyptian art traditionally depicted figures in stiff, standard poses denoting formal roles and status. Common themes included military prowess and preparations for the afterlife.

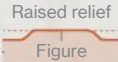


SCULPTURE



Facial features from past pharaohs added legitimacy to new ones.

RELIEF STYLES



GRID



Proportions fit into about 18 rows.



Fingers are symmetrical and lack detail.

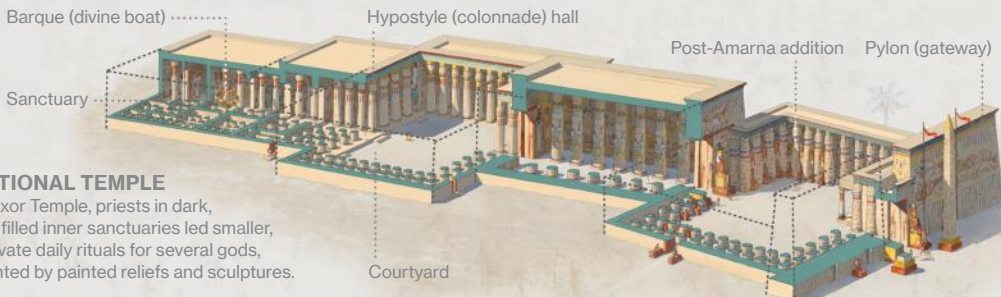
FERNANDO G. BAPTISTA, OSCAR SANTAMARINA, AND EVE CONANT, NGM STAFF; PATRICIA HEALY
 ART: ROCÍO ESPÍN; JOSE DANIEL CABRERA PEÑA
 SOURCES: PETER F. DORMAN, AMERICAN UNIVERSITY OF BEIRUT; BRETT MCCLAIN, UNIVERSITY OF CHICAGO; BARRY KEMP, AMARNA PROJECT

BUILDING A NEW BELIEF

Instead of enclosed shrines to local deities (below), Akhenaten ordered an open structure just for Aten and his earthly agents – the pharaoh and his queen, Nefertiti.

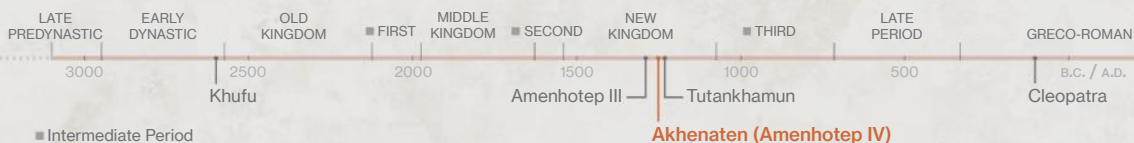


Multiple gods are worshipped.



TRADITIONAL TEMPLE

In the Luxor Temple, priests in dark, incense-filled inner sanctuaries led smaller, more private daily rituals for several gods, represented by painted reliefs and sculptures.



ART UNDER AKHENATEN

Akhenaten dramatically accelerated a shift toward intimate snapshots of family life and softer, less muscular poses in natural settings. Women assumed a more prominent role.



Features may have been elongated to make the pharaoh appear divine.

Sunk relief

Figure



Two more rows lengthen the torso and neck.



Fingers are slender, with nails.



Only the sun god Aten is celebrated.



At least 791 offering tables

Gilded-wood offering tables

Open colonnade

Pylon

Platform

Six courtyards

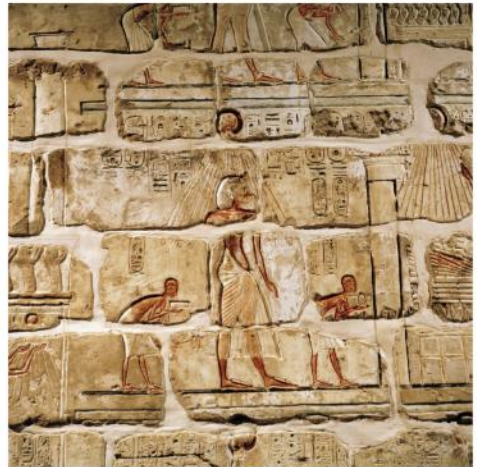
AKHENATEN'S LONG TEMPLE

In this part of the Great Aten Temple, sunshine illuminated courtyard tables piled with food and bowls of incense. Hastily built from small blocks, walls depicted the ritualized life of the royal family.





Wood is rare in Egypt, and the law restricts the use of precious alluvial soil for brick-making, so limestone blocks remain essential to inexpensive Egyptian construction. Akhenaten's temples and palaces were built with blocks now known as *talatat*, which could be lifted by a single worker. This allowed for rapid construction – but it also made it easy for Akhenaten's successors to dismantle his city. In the Luxor Museum a reconstructed wall of talatat (below) features sun-washed depictions of the king, deferential courtiers, and priests.



***‘THE DANGER
OF BEING AN
ABSOLUTE RULER
IS THAT NO ONE
DARES TELL YOU
THAT WHAT
YOU HAVE JUST
DECREED IS NOT
A GOOD IDEA.’***

Barry Kemp, Amarna Project

emeritus from Cambridge University who directs the Amarna Project, and he’s worked at the site since 1977. He’s spent more than three times as many years digging through the city’s ruins as Akhenaten spent building it.

“This is beautifully made,” he said, holding up the piece of carved stone statuary, on which only the king’s lower legs were visible. “This is not accidentally damaged.” Amarna archaeology has a forensic quality because so many artifacts were deliberately destroyed after the sudden death of the king around 1336 B.C. His only son and heir was Tutankhaten, no more than 10 years old, who soon replaced the “Aten” in his name with the title of the god that his father had hated: Tutankhamun. He abandoned Amarna and returned to the old traditions. Tutankhamun died unexpectedly, and soon the head of the army, Horemheb, declared himself pharaoh—possibly the first military coup in history.

Horemheb and his successors, including Ramses the Great, dismantled Amarna’s royal buildings and temples. They destroyed statues of Akhenaten and Nefertiti, and they omitted

the names of the heretic king and his successors from official lists of Egyptian rulers. This act of *damnatio memoriae* was so successful that it was one of the reasons Tutankhamun’s tomb escaped significant looting in the Valley of the Kings. Tut’s tomb may even contain further secrets—during the past year archaeologists have been investigating signs of possible hidden doorways in two walls of the burial chamber. In pharaonic times generations of looters usually combed through such tombs, but Tut’s was largely left intact. People simply forgot that it was there.

They also forgot most details of Amarna life. Kemp’s recent excavations have shown that the Great Aten Temple was destroyed and rebuilt sometime around Akhenaten’s 12th regnal year. The piece of statuary that he showed me dated to this event—it had been shattered at the command of the king himself, not his successors.

“It’s an odd thing for them to have done, from our perspective,” Kemp said, explaining that Akhenaten used such fragments as the foundation for a new, revised temple. “The statue is no longer needed, so they reduce it to hard core. We have no commentary on what’s going on.”

But other evidence is often remarkably intact. Ancient settlement sites were usually located in the Nile Valley, where millennia of floods and habitation destroyed original structures. In contrast, Amarna is situated in the desert above the river, where drinking water had to be hauled in. This was why the site was uninhabited before Akhenaten, and it’s why it was abandoned so completely. Even today you can still see the original brick walls of Amarna houses, and broken pottery is everywhere. It’s possible to visit the 3,300-year-old building where the famous painted bust of Nefertiti was excavated by a German archaeological team in 1912.

Kemp told me that he was originally attracted to Amarna by the intact city site, not the outsize figure of Akhenaten. He believes that too many modern characteristics have been ascribed to the king, and in Kemp’s opinion, even the word religion is “mischievous” when applied to ancient Egypt. Like most scholars nowadays, he does not describe Akhenaten as a monotheist. The word is

too charged by subsequent religious traditions, and during Akhenaten's reign most Egyptians continued to worship other gods.

Nevertheless, Kemp can't entirely resist speculating about the king's character. He's impressed by the changeability of Akhenaten's mind and by his ability to force workers to carry out his whims. At the Great Aten Temple, Kemp showed me traces of several large mud-brick offering tables that would have once been heaped with food and incense as part of rituals. The number of these tables is staggering—more than 1,700. "It's an insight into his mind, a man with a rather obsessive literalist mind," Kemp said. He once wrote: "The danger of being an absolute ruler is that no one dares tell you that what you have just decreed is not a good idea."

This lack of accountability probably also inspired artistic freedom. Ray Johnson, who directs the Chicago House, the University of Chicago's research center in Luxor, believes that Akhenaten must have been "wildly creative," despite his obsessive and despotic tendencies. "The later artistic representation at Amarna is so beautiful you could cry," Johnson said. "They have rejected the mannered, exaggerated style of traditional Egyptian art for a much softer style. The representations of women in particular are incredibly sensual."

Johnson has recently pieced together broken wall reliefs and statuary from collections scattered all around the world. Digitization makes work like this faster. Johnson showed me a virtual "join" in which he had matched a photograph of one fragment located in Copenhagen with another in the Metropolitan Museum of Art. "They're 4,000 miles apart, but I realized that they join," he said. The connection reveals a surprising scene: Akhenaten performs a ritual not with Nefertiti, but with Kiya, another wife, who didn't have the status of queen.

A small number of scholars are involved in such work, and the ones I met seemed to have a softer view of Akhenaten, perhaps because of intimate contact with the art. This proved to be the king's most lasting legacy, at least until his rediscovery in modern times. His city and his ritual practices

were quickly abandoned, but the Amarna artistic style influenced subsequent periods. Marsha Hill, a curator at the Metropolitan Museum of Art, told me that handling Amarna's sculpture fragments makes her feel more positive about Akhenaten.

"Everybody likes revolutionaries at some level," she said. "Someone who has a real good, strong idea that makes it seem like things are going to get better. I don't see him as destructive. Of course, it didn't work out. It usually doesn't. Steam builds up under the ground until it explodes, and then you have to put it all together again."

EGYPT'S MODERN REVOLUTION has made it even harder for archaeologists to study the scattered and shattered evidence of Akhenaten's reign. In February 2011 protests on Cairo's Tahrir Square forced the resignation of President Hosni Mubarak, who had ruled for nearly three decades. In 2012 Egypt held its first ever democratic presidential election, which was won by Mohamed Morsi, a leader of the Muslim Brotherhood. But after just a year in office he was removed by a military coup. In the aftermath of this event, security forces massacred hundreds of Morsi supporters in Cairo. Protests raged across the country, including in Mallawi, a city across the Nile from Amarna. In August 2013 a local mob of Morsi supporters attacked a Coptic Christian church, a government office building, and the Mallawi Museum. During the violence the museum's ticket taker was killed and every portable artifact was stolen—more than a thousand in all. Since then the police have recovered most of the pieces, but it took three years for the museum to reopen.

At Amarna agricultural encroachment is an even greater threat than looting. Now that diesel-powered pumps bring water up from the river, farmers are reclaiming desert land, including parts of the ancient city that have yet to be excavated. Officially the site is protected, but enforcement has been badly weakened by the revolution. Mohammed Khallaf, then the director of the office of antiquities in Minya, the regional capital, told me that villagers around Amarna are legally limited to about 300 acres of cultivated land. "But they've added another 300 through violations,"





At the Luxor Museum, Akhenaten's features appear on one of the few sculptures whose face was not smashed (below). Discovered beneath a temple at Karnak, this artifact appears to have been buried at the command of the king himself, who repeatedly changed the style of his portrayal, discarding previous versions. After three millennia, his visage remains iconic – in Minya a local artist decorates his home (left) with sculptures of Akhenaten and Nefertiti (modeled on a statuette of a noblewoman named Tuya).



Near the city of Minya, modern Egyptians still honor their dead by building permanent structures – such as a cemetery of domed roofs and limestone walls (right). At the ancient site of Amarna, the elite prepared elaborate tombs that were carved high into the cliffs east of the city. Commoners were buried on the desert floor, where few markers or grave goods have been found. Elaborate braids on a skull (below) reflect the care that residents took with their appearance, despite difficult conditions.



EXCAVATION BY AMARNA PROJECT, ANNA STEVENS





Mamdouh Abu Kelwa sails his felucca past the unfinished Aten Museum in Minya. Akhenaten needed only five years to build a new capital; the 25-acre museum complex has taken more than twice as long because of political and economic instability. Since the project began, Egypt has undergone a revolution and a coup, and two former presidents have been put on trial. Meanwhile the ancient king continues to be the subject of monumental art, including this sculpture at Minia University (below).





**AMARNA ART
PORTRAYED
AKHENATEN
GIVING PRIZES
TO SYCOPHANTS
AND PARADING
AROUND WITH
DEFERENTIAL
BODYGUARDS.**

he said. “Eighty percent of the encroachment has happened since the revolution.”

The revolution also halted construction of the Aten Museum, the most impressive building in Minya. Designed by German and Egyptian architects, the modernist structure rises nearly 200 feet beside the Nile, in a shape reminiscent of a pyramid. In all of Egypt, Akhenaten is the only pharaoh who is still being honored by the creation of monumental architecture. It’s a testament to the fact that the country’s Muslim leaders embrace Akhenaten’s popular identity as a monotheist, but nevertheless his legacy can’t seem to escape political upheaval. More than \$10 million was spent on the museum before the funding abruptly ended, a victim of the post-Tahrir economic collapse.

One day I visited the site and found 11 employees sitting in a darkened office with the air-conditioning off. Outside it was 109°F. Mohammed Shaben introduced himself as the museum’s IT manager and apologized for the heat—they had no electricity. I asked what an IT manager does without electricity.

“I don’t have anything to do,” Shaben said. “Everybody is waiting.”

He was 26, and most of the others were even younger. All were educated: curators, interior designers, restoration specialists. In Egypt about 60 percent of the population is under the age of 30, and young people dominated the Tahrir protests. They’ve also paid the highest price for the revolution’s failure. Since the coup there’s been a brutal crackdown on dissent, and Egyptian jails are home to tens of thousands of political prisoners, many of them young. Nearly a third of the country’s youth are unemployed. Shaben told me that he and other government employees were required to come and sit idly every day, despite the fact that construction on the facility had halted.

He gave me a tour of the museum, which featured five floors, 14 exhibition halls, and a theater, everything unfinished and open to the elements. A pack of stray dogs had taken up residence inside the museum; the site was strewn with tiles, rebar, and rusting air-conditioner ducts. “Look out for the bats,” Shaben said, when we entered the theater. He told me that someday it will seat 800.

A young antiquities inspector named Ahmed Gaafar accompanied us, complaining that the political upheaval had stymied his career as a curator. This pattern seems eternal, from the graves of Amarna to the frustration of Tahrir: In every time and in every place, revolutions eat the young. Gaafar mentioned Egypt’s recent presidential election, which had been won by Abdel Fattah el-Sisi, the general who had led the coup that ousted Morsi, the Islamist leader. Gaafar saw a connection between this coup and Akhenaten’s era.

“Some people say that Morsi is like Akhenaten, and Sisi is like Horemheb,” Gaafar said. “Horemheb liberated Egypt from a theocratic state that was growing weaker and weaker.” He continued, hopefully: “And he prepared the way for the Ramesside period, which was the greatest in Egyptian history. It’s the same with Sisi—he’s preparing Egypt to be great again.”

THAT SENTIMENT—preparing Egypt to be great again—is far older than Sisi or even Akhenaten.

In ancient Egypt, after periods of weakness or disunity, leaders often declared a *wehem mesut*, literally “repeating a birth”—a renaissance. They turned to ancient symbols as a way of using past glories to promise future success. Tutankhamun declared a *wehem mesut*, and it seems Horemheb may have as well. And the strategy continues today. Revolutions gain legitimacy if they’re connected to the past, which is why Tahrir slogans were often accompanied by images of Gamal Abdel Nasser and Anwar Sadat. It’s also why marginalized groups around the world, ranging from gay-rights activists to Afrocentrists, have gravitated to the figure of Akhenaten.

In 2012, after Morsi and the Muslim Brotherhood came to power, they passed a constitution that cited Akhenaten’s “monotheism,” and they named their policy program Nahda, Arabic for Renaissance. Three short years after Morsi was deposed, another charismatic leader on the other side of the world, Donald Trump, would rise under his own version of *wehem mesut*: “Make America Great Again.”

In Egypt there’s always a temptation to hold that modern mirror to the distant past, remaking the pharaonic world in our image. But it’s also true that ancient Egyptians developed sophisticated political tactics—their system, after all, lasted more than 3,000 years. They introduced us to the concept of divine kingship, as well as many universal symbols of power, including the crown and the scepter. Amarna art often functioned as propaganda, portraying Akhenaten giving prizes to sycophants and parading around the city with deferential bodyguards. Barry Kemp has written that those scenes provide “an unintended caricature of all modern leaders who indulge in the trappings of charismatic display.”

At the site of the Great Aten Temple, I asked Kemp whether such patterns of thought and behavior are universal across time. “We’re all the same species,” he said. “We’re wired up to some extent to think and behave the same way. But long-developed traditions moderate individual societies. That’s the responsibility—to find the balance between universal patterns and those that are distinctive culturally.”

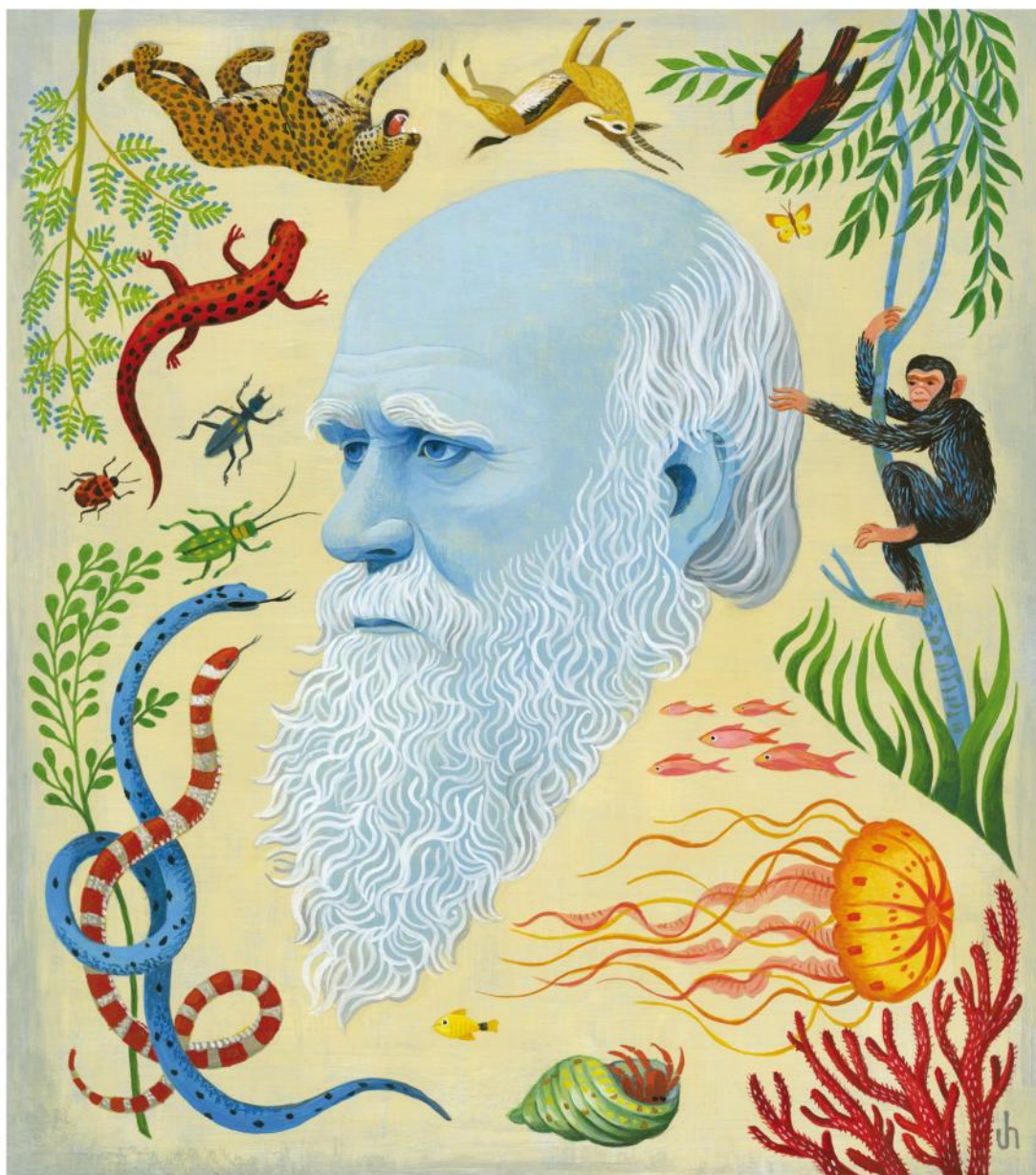
The Amarna Project, which organizes research at the site, keeps a Cairo office in a building next to Tahrir. Anna Stevens said that this environment has given her a new perspective on the past. “Living through this time has made me think much more about Akhenaten and the impact of revolutions,” she said, referring to the rise of Sisi. “I’m struck by this interest in a strong male leader.” She commented that at Amarna, the tombs of high officials feature Aten and the royal family, but thus far these images haven’t been found in the commoners’ cemeteries. “There’s no mention of Akhenaten or Nefertiti,” Stevens said. “It’s like it’s not their place.”

She observed a similar dynamic with the elitism of today’s politics. “You can have very radical changes at the top, but below that, nothing changes,” she said. “You can shift a whole city to another part of Egypt; you can shift a whole group of people to Tahrir Square—but nothing changes.”

In her view a revolution is an act of selective storytelling. “Akhenaten is creating a narrative,” Stevens said one day in her office. And then she pointed to an image of skeletons from a commoners’ cemetery. “But this narrative isn’t for these people, really.” Their stories will never be fully known, in the same way that the lives of most contemporary Egyptians are ignored when we focus on the dominant figures of national politics: Mubarak, Morsi, and Sisi. If we find it hard to capture the full range of revolutionary experiences during the past six years, what are the odds that we can truly understand the politics of the mid-14th century B.C.?

“That’s the way life is,” Stevens said. She sat six stories above Tahrir, surrounded by a mess of data from Amarna excavations. But she seemed comfortable with Akhenaten’s fundamental uncertainty: the mysteries of his faith, the messages of his people’s bones, and all the broken pieces that would never be put together again. She smiled and said, “There’s no clear narrative.” □

Peter Hessler lived in Cairo from 2011 to 2016 and is now working on a book about archaeology in Egypt. Rena Effendi shoots human-interest stories around the world. This is her third story for the magazine.



Icons, Analyzed

Howard Hughes turned doorknobs with Kleenex. Andy Warhol was a hoarder. Charles Darwin (above) had a nervous stomach. The famous, says author Claudia Kalb, are “no saner or zanier than the rest of us.”

Read on for excerpts from *Andy Warhol Was a Hoarder: Inside the Minds of History's Great Personalities*.

Interview starts in 15 minutes



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ALBERT EINSTEIN'S THEORY of relativity transformed our understanding of time and space. Abraham Lincoln's Emancipation Proclamation freed slaves. George Gershwin's "Summertime" intoxicated the soul. Betty Ford's advocacy and candor helped countless people struggling with substance abuse get treatment. Most of the 12 individuals I researched for my book were accomplished in science, business, politics, or the arts—but every one of them also exhibited behaviors associated with a mental health condition like autism, depression, anxiety, addiction, and obsessive-compulsive disorder.

While their public lives have been fodder for books, movies, and splashy headlines, their psyches reveal characteristics that many of us will recognize in our spouses, children, friends—even ourselves.

Our understanding of mental health has evolved dramatically from the days when our ancestors drilled holes in one another's skulls to allow evil spirits to

Scientists are trying to pinpoint the biological blueprints of mental health conditions. With each discovery comes the daunting reality: There's so much more to learn.

escape. Over the centuries, people with psychological ailments have endured a rash of treatments, from leeches to electroshock therapy. Today the brain and the mind are viewed as inextricably linked, and scientists are pushing to pinpoint the biological blueprints of mental health conditions.

With each new discovery, however, comes the daunting reality that there is so much more to learn. The human brain is infinitely complex and unpredictable—a breathtaking mass of tissue comprising some 100 billion neurons and immeasurable capacity. That a single organ can power our most basic needs (breathing, eating, walking), foster our intellect, and preside over random thoughts and amorphous feelings is as impossible to fathom as the breadth of the universe.

A mental health assessment is subjective, based largely on what a patient's symptoms look like and what he or she tells the doctor. For now, the best that clinicians can do is to compare this against descriptive information and a checklist of symptoms contained in the American Psychiatric Association's 947-page reference book called the *Diagnostic and Statistical Manual of Mental Disorders*, or *DSM*.

Although it serves a vital purpose in guiding mental health professionals toward diagnoses and treatment, the manual has long been controversial. Critics charge that the diagnostic criteria lack validation and are overly inclusive. Since it debuted in 1952, the number of distinct mental disorders has increased from 80 to 157 in the fifth and most recent edition of the *DSM* (known as the *DSM-5*), published in 2013.

Despite these valid concerns, the *DSM* is the standard reference guide relied on by most mental health professionals today, and I used it as a framework to understand the symptoms and behaviors of the figures I profiled: the seven aforementioned and also Fyodor Dostoevsky, Christine Jorgensen, Marilyn Monroe, Frank Lloyd Wright, and Princess Diana.

To unveil the details of their experiences and their struggles, I mined published medical reports, biographies, autobiographies, and, when available, letters and diaries. For historical and contemporary views about mental health, I consulted numerous books and journal articles and interviewed professionals with a range of expertise, including neuroscientists, psychiatrists, psychoanalysts, and clinical psychologists. In each case I explored a diagnosis proposed by a mental health expert or discussed openly by the individual profiled. My goal in presenting these portraits was not to assign labels but to contextualize mental health characteristics using both historical and contemporary psychiatry, and to explore the mysteries of the brain and human behavior.

Two of these figures exhibited early childhood behaviors that would have made them candidates for diagnostic assessments had they lived in the 21st century. Albert Einstein was socially awkward and had a habit of focusing intensively on solitary subjects. Several experts have suggested that he exhibited symptoms of high-functioning autism, a condition that until recently might have been diagnosed as Asperger's disorder.

George Gershwin, one of Einstein's younger contemporaries, was restless, unruly, and hyperactive as a boy, leading one psychiatrist to propose that today he would have almost certainly been hauled off to a child psychologist and tested for ADHD. Both Einstein's and Gershwin's stories are relevant to a critical question debated today: When is a diagnosis warranted in children, and what kind of impact will it have? Would Gershwin have written *Rhapsody in Blue* on Ritalin?

A number of the figures received valuable psychological counseling, including Princess Diana and Betty Ford. Others had ineffective therapy or none at all.

Ultimately, the book I wrote is about conflicts and connections—between the mind and the brain, between public images and internal struggles, between

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the way people are wired and the way they behave, between famous people and the rest of us. It's a journey into the wonder and anguish of the mind as told through the lives of 12 figures who reshaped the world.

What they shared, above all, was being human. My hope is that telling these stories will highlight the psychological challenges we all face—no matter how big or small—and maybe even eradicate some of the cultural stigma that can go along with them.

Frank Lloyd Wright

In June 1943, Frank Lloyd Wright received his first commission in New York City: a new museum for Solomon Guggenheim's collection of modern art. "I need a fighter, a lover of space, an originator, a tester and a wise man," Guggenheim's art advisor Hilla Rebay wrote to Wright. "I want a temple of spirit—a monument, and your help to make it possible."

In many ways, Wright was the ideal man for the job. Then 76, the flamboyant architect had been rousing the design world with his bold and innovative buildings for more than 50 years. His artistic vision of "organic" architecture had produced breathtaking structures that melded with nature in a way never seen before. While others erected high-rises ambushing the sky, Wright built light-filled sanctuaries hugging the hills. Everything was novel.

But as Guggenheim and his staff would quickly discover, Wright's extraordinary talent was intertwined with a supreme narcissism that played out in myriad ways with his clients. Rooted in nonconformity, the maverick architect pursued his artistic convictions with little concern for the utilitarian matters of stability, practicality, and cost. Even Wright's most resolute admirers could not help but pay homage to the depths of what sociologist and architecture critic Lewis Mumford described as Wright's "colossal self-admiration."

Wright's ego did not wane as he aged—and indeed, took center stage throughout the planning and construction of the Guggenheim, exasperating everyone from Guggenheim himself to the contemporary artists whose works would be exhibited. Wright's conception of the museum required that the paintings be displayed at an angle to accommodate his dramatic spiral walkway. The project soon raised a fundamental question about what the museum would be showcasing: modern art or Wright's ego?

Impertinent and pioneering, Frank Lloyd Wright embraced his ego throughout his life, promoting it



to the world without an ounce of modesty. Plenty of people are narcissistic. Wright's behaviors line up with a more deeply entrenched mental health diagnosis: narcissistic personality disorder. Symptoms include a grandiose sense of self-importance, a need for excessive admiration, exploitive behavior in relationships, and a lack of empathy. Most people who exhibit characteristics of the disorder see nothing wrong with their behavior, nor do they recognize its impact on others. "Early in life I had to choose between honest arrogance and hypocritical humility," Wright famously said. "I chose the former and have seen no reason to change."

WRIGHT UNABASHEDLY FIDDLED with the truth—how he got his jobs, how much his buildings would cost, even the date of his birth. Records show that he was born on June 8, 1867, but Wright later declared the year to be 1869, presumably because he wanted to appear younger in his elder years.

The architect had a challenging relationship with his father, William, but his mother, Anna, doted on him. In his reminiscences, Wright depicts her in almost mythic proportions, both as loyal protector and overseer of his destiny. It was she, according to Wright, who determined that he would become an architect. "He was her protégé, her legacy," Wright's sister Maginel recalled.

■ Excerpted from *Andy Warhol Was a Hoarder*, by Claudia Kalb, © 2016. Available at shopng.com or wherever books are sold.



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Early interactions between parent and child are significant in the development of narcissistic personality disorder. Too much adulation can backfire. A spoiled or “golden” child may develop a sense of entitlement, believing that he is better than everyone else.

Wright’s feelings of entitlement and superiority infused every aspect of his behavior. Determined to pursue the architectural path he and his mother mapped out, he began taking classes at the University of Wisconsin–Madison but bridled at the rules of conventional schooling. In early 1887, the 19-year-old Wright moved to Chicago to look for a job. From the start, Wright showed contempt for other architects’ designs. The Palmer House looked like “an ugly old, old man whose wrinkles were all in the wrong place,” he wrote in his autobiography, and the Chicago Board of Trade, a “thin-chested, hard-faced, chamfered monstrosity.”

As he worked his way up from apprentice to virtuoso, Wright ingratiated himself with people who could help

Wright’s clients were expected to feel grateful to dwell in one of his rarefied structures. He lured in commissions with lowball estimates, then upped the price.

him, then moved on when they had nothing left to offer. He developed a close relationship with his boss Louis Sullivan—Wright later referred to him as his *lieber Meister*, or beloved master—yet soon betrayed Sullivan’s trust. His contract explicitly forbade moonlighting, but Wright started building his own “bootleg” houses anyway, enraging Sullivan. A few months before his contract expired, “I threw my pencil down and walked out,” Wright recalled, “never to return.”

Wright’s personal relationships were similarly fractured. Narcissists feed on admiration and expect it from those around them but often neglect to nurture close bonds. In fall of 1909, 42-year-old Wright abandoned his wife, Kitty, and his six children and set sail for Europe with Mamah Cheney, with whom he was having an affair. Wright left one night, his son John Lloyd Wright recalled in a memoir, and “didn’t even say goodbye.” He did, however, leave his family with something to remember him by: an unpaid \$900 grocery bill.

Throughout his professional career, Wright worshipped his aesthetic ideals above basic structural mishaps. Leaky roofs were practically an architectural insignia. The roof of the Johnson Wax building in

Racine, Wisconsin, held up by 21-foot-tall columns, dripped so frequently that workers kept five-gallon buckets on their desks.

Wright’s clients were expected to feel grateful to dwell in one of his rarefied structures, no matter the inconveniences—including the cost. Perpetually irresponsible with money, Wright lured in commissions with lowball estimates, then unabashedly upped the price. A church Wright promised for \$60,000 rang in at more than \$200,000. Fallingwater, the dramatic retreat perched on a 30-foot waterfall in Pennsylvania’s Allegheny Mountains, soared from \$35,000 to \$155,000.

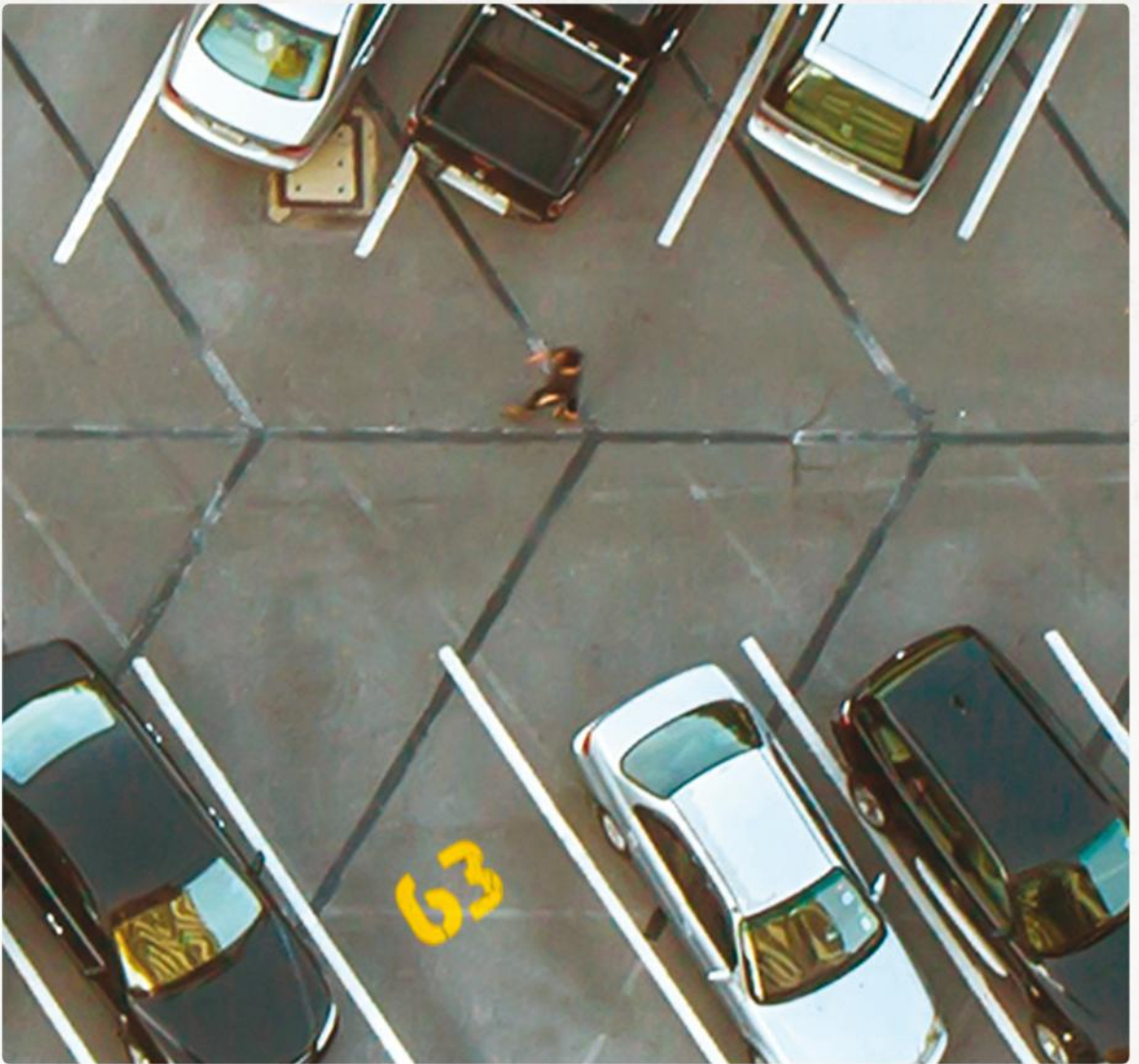
Although quick to spend, Wright was negligent about paying back. John, also an architect, signed on to work in Japan for his father with the promise of a paycheck, but it never materialized. When John raised the issue, his father looked at him reproachfully. “He then proceeded to figure what I had cost him all during my life, including obstetrics,” John wrote. After a client’s payment arrived, John deducted the amount he was owed. His father cabled him the next day: “You’re fired! Take the next ship home.”

WRIGHT SPENT THE FINAL years of his life overseeing construction of the Guggenheim. He lived at the Plaza Hotel, where he decorated his suite with velvet curtains and gold wallpaper. A *Saturday Review* writer who interviewed him there in 1953 described the architect pacing about in a gray robe, beaded green slippers, and a colorful scarf. In a booming voice, Wright grandstanded about his favorite subjects—the poetic beauty of Japanese art, the debacle of American design, and his efforts to “wake my people up” to the fact that without worthy architecture, there would be no culture. “They’d call that arrogance, wouldn’t they?” Wright quipped. “Well, I suppose it is.”

Wright died on April 9, 1959, after suffering an intestinal obstruction. He lived to be 91 but died just six months before the Guggenheim opened. The museum’s debut that fall was met with both acclamation and disdain. In a *New Yorker* review, Mumford extolled Wright as “one of the most richly endowed geniuses this country has produced” before skewering his design. “If the outside of the building says ‘Power,’” Mumford wrote, “the interior says ‘Ego’—an ego far deeper than the pool in which Narcissus too long gazed.”

Marilyn Monroe

“Mr. President, Marilyn Monroe.” With those words, the epic scene began. It was May 19, 1962, at Madison Square Garden. Actor Peter Lawford, John F. Kennedy’s brother-in-law, stood at a podium and extended his arm to welcome the actress, who had agreed to serenade the



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president at a fund-raiser celebrating his 45th birthday. Spotlights lit the dark stage. A drumroll sounded. But Monroe was nowhere to be seen. “A woman about whom it truly may be said she needs no introduction. Let me just say, here she is,” Lawford said. Again, nothing. Finally, as Lawford launched into yet another attempt, Monroe emerged, shimmying across the stage in a flesh-colored gown. As she cozied up to the podium, Lawford made his final introduction: “Mr. President, the *late* Marilyn Monroe.”

Monroe shielded her eyes from the glare of the spotlight, which electrified her platinum hair and the 2,500 rhinestones decorating her dress. It was a moment rich with anticipation and bawdy curiosity. Some 15,000 people sat expectantly in the audience, including Ella Fitzgerald, Jack Benny, Robert Kennedy, and, of course, the president. Monroe caressed the microphone, then crooned her tribute: “Happy birthday to you, happy birthday to you, happy birthday, Mr. Pres-i-dent, happy birthday to you.”

Lawford’s use of the word “late” was meant to be a ribbing of Monroe’s notorious tardiness in her personal and professional life. In retrospect, it haunts like the grim reaper. Underneath the glitz, Marilyn Monroe was a profoundly troubled woman who yearned for love and stability. The embodiment of life, beauty, and sensuality, she was also self-destructive and suicidal. Monroe’s symptoms included a feeling of emptiness, a split or confused identity, extreme emotional volatility, and impulsivity—all characteristics of a condition called borderline personality disorder.

Three months after her tribute to the president, Monroe would indeed become the late Marilyn Monroe. “Our angel, the sweet angel of sex,” as Norman Mailer famously referred to her, would be dead at the age of 36.

MARILYN MONROE WAS BORN as Norma Jeane Mortenson on June 1, 1926, in the charity ward of Los Angeles County Hospital. She never knew her father. Her mother, Gladys—later diagnosed with paranoid schizophrenia—was incapable of providing the affection and security her daughter needed. Monroe spent her early childhood in a foster family, and although she saw her mother, the encounters were stressful. “I used to be frightened when I visited her and spent most of my time in the closet of her bedroom hiding among her clothes,” Monroe recalled. “She seldom spoke to me except to say, ‘Don’t make so much noise, Norma.’”

People with borderline personality disorder often experience significant traumas early in life—separation from a parent, death of a parent, or neglect from caregivers. Monroe’s childhood experience stirred deep feelings of desolation and emptiness. “As



I grew older, I knew I was different from other children because there were no kisses or promises in my life. I often felt lonely and wanted to die,” she reflected.

One of the hallmark features of the condition is what psychiatrists call “identity disturbance.” Without a stable sense of self, people with borderline personality disorder are exceedingly sensitive to how they are perceived, and often find self-worth by pleasing others. As a child, Monroe was forced to adjust to new surroundings; on screen, she took on multiple identities; in the public spotlight, she played the seductress everyone wanted to see. “My work is the only ground I’ve ever had to stand on,” she said in an interview. “To put it bluntly, I seem to have a whole superstructure with no foundation.”

All of this played out in Monroe’s relationships, which were markedly intense and unstable. People with borderline personality disorder demand constant attention and reassurance, wearing out the people they turn to for support. None of Monroe’s three marriages lasted. She divorced her first husband, a merchant marine named James Dougherty, in 1946. Her marriage to Joe DiMaggio in 1954 was over in nine months. Monroe and playwright Arthur Miller, who married in 1956, stayed together for five years. But during that time, Miller wrote in his memoir, *Timebends: A Life*, he discovered “a troubled woman whose desperation was deepening no matter where she turned for a way out.” By the time filming started for Miller’s 1961 movie, *The Misfits*, which starred Monroe as a young



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divorcée, “it was no longer possible to deny to myself that if there was a key to Marilyn’s despair I did not possess it,” Miller wrote. “With all her radiance she was surrounded by a darkness that perplexed me.”

Borderline personality disorder often runs in families. Monroe connected her torment to her roots: In her autobiography, she pointed to “family ghosts”—her grandparents and an uncle—who she believed struggled with mental health issues as her mother did. Her grandmother was diagnosed with what’s now called bipolar disorder, her grandfather died in a mental hospital, and an uncle killed himself. “I wish I knew why I am so anguished,” she wrote in a letter. “I think maybe I’m crazy like all the other members of my family were.”

In June 1962, Monroe celebrated her 36th birthday on the set of the romantic comedy *Something’s Got to Give*. Photos show her smiling behind the dance of glittering cake candles. One week later, she was fired. Monroe had consistently arrived late for rehearsals or

Monroe’s third husband, playwright Arthur Miller, saw her as ‘a troubled woman whose desperation was deepening no matter where she turned for a way out.’

hadn’t shown up at all, claiming that she was sick. Her trip to serenade President Kennedy caused more delays and roiled the executives at Twentieth Century-Fox.

Over the next few weeks, Monroe sat for interviews, including her last, with *Life* magazine’s Richard Meryman. In a story published on August 3, Monroe shared her indignation at studio execs’ treatment, her desire to please her fans, and her thoughts on the capriciousness of fame. Meryman later described “anger, wistfulness, bravado, tenderness, ruefulness, high humor and deep sadness” flashing across her face as she talked.

On August 5, Monroe was found dead in her bedroom in Los Angeles, a telephone in one hand. Pill bottles were scattered nearby; sedatives were found in her blood. The coroner ruled her death a probable suicide. Onstage, Monroe lived; off it, she struggled to survive. “I was never used to being happy,” she told Meryman, “so that wasn’t something I ever took for granted.”

Charles Darwin

Trouble often comes in cascading torrents, and this was certainly true for Charles Darwin in the month of June 1858. Just as the great scientist and devoted

father, then 49 years old, was anguishing over the grave illnesses of two of his children, he received a correspondence from fellow scientist Alfred Russel Wallace that would change the course of scientific history. Wallace, traveling in the Dutch East Indies, had laid out an argument for evolution that was shockingly similar to the theory Darwin had been crafting—but not yet published—for almost two decades.

Wallace’s paper hit Darwin with volcanic force. There was no mistaking the similarities in the two men’s ideas about natural selection or the reality that Darwin, who had worked tirelessly to perfect his arguments, might be beaten to the punch on his life’s work. “I never saw a more striking coincidence,” Darwin wrote to his mentor, Charles Lyell.

These colliding events at home and at work would have been stressful for anyone. But the impact on Darwin was especially complicated, because he was a man of chronically bad health. For years the scientist struggled with a long list of afflictions, including fatigue, dizziness, muscle weakness, eczema, and headaches. His overwhelming issue was abdominal distress, with ongoing bouts of nausea, vomiting, and flatulence. And yet doctors could find nothing intrinsically wrong with him.

Since his death in 1882, biographers, historians, physicians, and mental health experts have weighed in with dozens of hypotheses. Is it possible that Charles Darwin was battling an infectious tropical bug, picked up on his travels aboard the *Beagle*? Was it irritable bowel syndrome or cyclic vomiting syndrome? Or were Darwin’s lifelong symptoms psychosomatic—physical manifestations of ongoing mental stress?

The proposed diagnoses on the list are so divergent you may as well be comparing a monarch butterfly to a great ape. But one key aspect stands out: Darwin was a worrier. He fretted about his children, about his work, about his deadlines, about his reputation, and, almost always, about what ailed him. Anxiety seemed to infuse his very being, entwining itself with whatever else may have been coursing through his brain and his body. The revered scientist, the man who boldly proposed that “man is descended from a hairy quadruped, furnished with a tail and pointed ears,” was altogether very human.

BORN IN SHREWSBURY, England, on February 12, 1809, Charles Robert Darwin was a perspicacious naturalist from his earliest days. As a child he recorded details about flowering plants and collected shells and birds’ eggs—hobbies that set the stage for his life’s work.

At the age of 22, Darwin was eager to set sail on the *Beagle*, a journey that would illuminate the diversity



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of life he sought to study. But in the weeks before the vessel's departure in December 1831, he began to worry—about the close quarters, about the possibility that he might drown, and about his health, an obsession that would persist throughout his life. “I look forward even to sea sickness with something like satisfaction,” he wrote in a letter to his friend John Henslow as the ship prepared to depart. “Anything must be better than this state of anxiety.”

Over the course of the journey, which spanned 40,000 miles, the young adventurer did well on land, riding hundreds of miles on horseback, climbing into the Andean foothills, and hunting animals for Christmas dinner. On the water, however, he struggled with intestinal distress, boils, headaches, and, above all, the seasickness he had anticipated. He spent much of his time nibbling on raisins (prescribed by his father, a physician), lying in his hammock, and retching.

Within several months of his return to England

Darwin fretted about his children, his work, his deadlines, his reputation, and, almost always, what ailed him. Anxiety seemed to infuse his very being.

in October 1836, Darwin began suffering from the symptoms that would debilitate him for decades. He referred to his ill health repeatedly in his correspondence and painstakingly recorded his symptoms in a health diary. Entries included specific complaints (“boil under arm,” “slight fit of flatulence”) as well as overall ratings (“goodish” and “poorish”).

Ultimately, it was Darwin's work—primarily his writing of *Origin of Species*—that occupied most of his time and his worry.

In 1844 Darwin completed a 189-page draft of his theory, with instructions for his wife, Emma, to publish it if he died. But 14 years later, when Wallace's correspondence arrived at his doorstep, Darwin still had not finalized his work. The cause for “Darwin's delay,” as it has been dubbed, has been scrutinized and debated for years. He was busy with his marriage, his children, and other major writing projects. And he needed time to analyze everything, from the breeding habits of pigeons to the variation among strawberries and pears. Well aware of half-baked speculations about evolution that had already been published, Darwin needed his account to be as tight as an anchor bend knot.

There is little doubt that Darwin struggled with feelings of anxiety about publishing his theory, especially early on. An affable man who avoided controversy and the public spotlight, he knew that his proposition that Earth's creatures were not uniquely designed by a higher power, but had instead evolved and adapted over time, would outrage the most pious members of society, upending centuries of religious belief about divine creation.

As he raced to the finish line in 1859, Darwin attributed his physical distress to the strain of completing his “abstract,” as he called it, and he longed for it all to be over. “I have been extra bad of late, with the old severe vomiting rather often & much distressing swimming of the head,” he wrote to a cousin. “My abstract is the cause, I believe of the main part of the ills to which my flesh is heir to.”

Over the years, Darwin tried an array of treatments, including mercury pills, antacids, lemons, codeine, and even electrical stimulation of his abdomen. At one point his favorite therapy was the Victorian “water cure,” which required sweating next to hot lamps, soaking his feet in cold baths, rising early, and avoiding sugar. He kept up as best he could, even cutting back on Emma's sweet puddings. Nothing worked for long.

Darwin's health problems persisted after publication of his celebrated dissertation. But during the last decade of his life—as he turned to far less contentious topics—his symptoms subsided, and he finally found relief. His last book, one of his most popular, was about earthworms.

On April 19, 1882, Darwin died at age 73 of what doctors called “angina pectoris syncope,” or heart disease. Despite his renown Darwin presumed he'd be buried in his hometown churchyard, next to two of his children. But in one of history's great ironies, the man who overturned religious doctrine with barnacles and apes found his final resting place in a velvet-draped coffin at the illustrious Westminster Abbey. For Darwin, nothing was ever simple.

SCIENCE IS DOING ITS BEST to unravel the mysteries that drive the interaction between our inner and outer selves: why we feel and act as we do, what happens when something goes wrong. This is a tough and valiant effort.

I hope the hypotheses I've explored and the questions I've raised will lead to a better appreciation of the tangled forces that make up our collective minds and the trials we all face. By learning more about these remarkable people, we may discover a greater appreciation for the depths of human experience and behavior—and gain a greater understanding of ourselves. □

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FURTHER

A GLIMPSE OF WHAT'S NEW AND NEXT

WHAT SEA RISE?

By Christopher Solomon

Climate change—the topic of my reporting trip to Ecuador's Galápagos Islands—never seemed so far away as in Puerto Villamil. In this backpacker's heaven at the ocean's edge, a stretch of marine rope laid across the road counts as a speed bump to slow cars at an iguana crossing.

One morning an expat American named James Hinkle poured me a local-bean coffee and told me how the ocean came over the low dunes a few years ago and swamped the main road. Hinkle's flowered surfer trunks exposed the tan legs of the semiretired. He and his wife, Marlene, own an eatery called Cafeteria Booby Trap. It and their home are on the same property, which sits just behind the

dunes and nearly as low as the beach. If climate change makes the ocean level here rise by 22 to 30 inches (55 to 76 cm) by 2100, as scientists predict, the Hinkles' risk of floods will rise too.

Do they worry about that? "I asked the guy who built the place to raise it higher than he did," Hinkle replied. "He said, 'Aah,'" with a dismissive wave that apparently meant, Don't waste my time. "When we came back later, it was built like this," said Hinkle, with his own resigned wave: What are you gonna do?

I followed the din of a concrete saw, incongruous in paradise. New guesthouses were rising yards from the waterline. Even the navy seemed unready for the future: Down the beach the Armada del Ecuador compound sat a few licks above the high-tide mark, separated from the patient sea by only a chain-link fence.

Snorkelers swim near a Galápagos sea lion. Such attractions draw some 200,000 tourists a year, which places heavy demands on water and other resources. Look FURTHER into the islands' future with Christopher Solomon's story in the June issue.

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Photo: Icy cliffs and an ice-scattered sea fill the view from the deck of the National Geographic Explorer in Antarctica.

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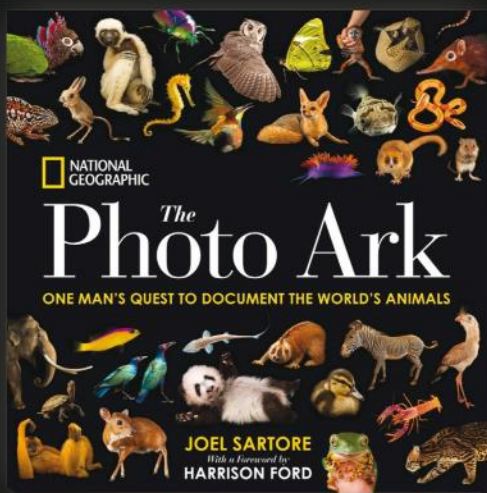


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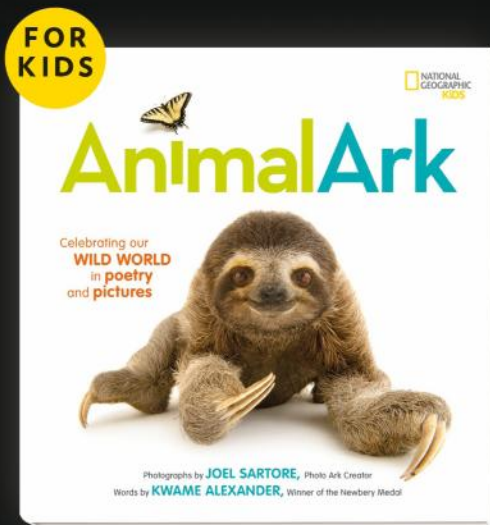


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—Joel Sartore



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WRITTEN BY NEWBERY MEDALIST AND POET **KWAME ALEXANDER**

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