ScienceNews

AFTER THE FIRES

The long road to recovery in LA

SCIENCENEWS.ORG | VOL. 207 NO. 3 | MARCH 2025

REGENERON SCIENCE TALENT SEARCH

A program of SOCIETY FOR SCIENCE Since 1942

CONGRATULATIONS

REGENERON SCIENCE TALENT SEARCH FINALISTS

Regeneron and Society for Science salute the amazing young scientists selected as finalists from nearly 2,500 entrants in the 2025 Regeneron Science Talent Search.

Laasya Acharya
Mason, OH

Vidya Ambati
Charlottesville, VA

Prisha Prakash Bhat
Plano, TX

Jolene Cao
Saint James, NY

Ishana Chadha
Commack, NY

Ava Grace Cummings
Durham, NC

Lena Zewdu Feleke
Nashville, TN

Finán Gammell
East Greenwich, RI

Yurai Gutierrez Morales
Princeton, NJ

Melody Heeju Hong
Levittown, NY

Jiwu Jang
Lexington, MA

Vishwum Kapadia
Hunting Valley, OH

Hrithik Ketineni
Portland, OR

Rania Sophia Lateef
Manassas, VA

Allison Lee
East Brunswick, NJ

Chloe Yehwon Lee
Plano, TX

Logan Lee
Honolulu, HI

Benjamin Li
Millburn, NJ

Rivka Lipkovitz
San Francisco, CA

Vivek Malik
Tarrytown, NY

Atreya Manaswi
Orlando, FL

Siddharth Nirgudkar
Acton, MA

Thanush Patlolla
Raleigh, NC

Matteo Paz
Pasadena, CA

Yash Ranjith
Campbell, CA

Sophia Rong
Gainesville, FL

Charlotte Ava Rosario
San Mateo, CA

Akilan Sankaran
Albuquerque, NM

Aiden Rubin Sanxhaku
Philadelphia, PA

Sandeep Sawhney
New Hyde Park, NY

Addison Grace Shea
Bradenton, FL

Kevin Shen
Olympia, WA

Emma Lee Wen
Great Neck, NY

Amy Xiao
Garden City, NY

Elisa Zhang
San Ramon, CA

Owen Jianwen Zhang
Bellevue, WA

Ray Zhang
Alexandria, VA

Angeline Zhao
Andover, MA

Ashley Zhu
New York, NY

Minghao Zou
San Jose, CA

About the Regeneron Science Talent Search

The Regeneron Science Talent Search is America's oldest and most prestigious science and math competition for high school seniors. The competition is designed to engage and inspire the next generation of scientific leaders.

www.regeneron.com/sts | https://www.societyforscience.org/regeneron-sts/

VOL. 207 NO. 03 | MARCH 2025

12

News

On the Cover

Photograph by Agustin Paullier/AFP via Getty Images

SARA GIRONI CARNEVALE

Circle keeping ... has been an effective approach to fostering connectivity and learning about each other through shared stories, instead of plunging headlong into accomplishing goals. It has also been important for flattening established hierarchies by holding an equal space for every voice regardless of whether it is from a rookie or an established investigator."

–Ruma Banerjee, Vincent Massey Collegiate Professor of Biological Chemistry, University of Michigan Medical School, Co-Director, ASBMB MOSAIC program

Learn about the Circle process in these books and many more!

20% DISCOUNT with coupon code 3SCIENCE25

We accept purchase orders.

LIVING JUSTICE PRESS

Living Justice Press

https://livingjusticepress.org

651.695.1008 • ljp@livingjusticepress.org

Quantity discounts available

VOL. 207 NO. 03 | MARCH 2025

48

Features

Curiosities

FROM TOP: BORCHEE/E+/GETTY IMAGES PLUS; LAURIE GREASLEY

After the fires, LA's long, hard road to recovery

When the first fire sparked in Los Angeles on January 7, people knew it could be bad. The city hadn't felt rain in months, and Santa Ana winds were predicted to blow from the east at near-hurricane strength. They just didn't know how bad it would get. "It was a devil wind," Los Angeles County Fire Chief Anthony Marrone told 60 Minutes. "The conditions that night were unbearable."

The resulting infernos killed at least 29 people and burned more than 200 square kilometers, wiping entire neighborhoods away. It would be reassuring to think that the blazes were a bizarre anomaly. But they're not. In January, 2,128 fires burned across the country, from California to Virginia. It's the highest number for January in the last 10 years.

With the LA fires finally receding, new threats are emerging. In this issue, we focus on the challenges that increasing numbers of people worldwide face after a wildfire. For one, staff writer Nikk Ogasa reports, deadly debris flows present an immediate threat. When rain finally arrives, it can cause scorched slopes to peel away, bulldozing neighborhoods (Page 36). Even while the flames were still raging in LA, scientists were hard at work identifying areas most at risk so that people could be warned to stay clear.

Heavy metals and toxic chemicals also threaten the health of anyone working or living in the city, senior writer Tina Hesman Saey reports (Page 38). They're in the air, the water, even coating the insides of houses that didn't burn. By every estimate, cleaning up and rebuilding will take years.

But the toughest challenge may be helping people regain their equilibrium. Mental health problems can persist for years after a natural disaster, social sciences writer Sujata Gupta reports, and people who didn't suffer the loss of a house or loved ones are still vulnerable to long-term distress (Page 34). We'll continue to cover the aftermath of the LA fires and other natural disasters fueled by a warming world.

In this our third issue of the redesigned magazine, I want to thank all the readers who took the time to share their thoughts about our new look. "SN just jumped about 50 points to me," one caller said. "It is a nearly perfect magazine." Please keep your thoughts coming. We value your opinion, and we will continue to refine and improve the magazine to make it the best possible reading experience.

Nancy Shute
Editor in Chief
nshute@sciencenews.org

Making road trips more interesting for more than 50 years!

ROADSIDE GEOLOGY

NEW

Fans of the *Roadside Geology* series never go on a trip without at least one of these books. Loaded with photos, maps, and informative text, they have answered travelers' geology questions since 1972.

ROADSIDE GEOLOGY OF ARIZONA, SECOND EDITION
Stephen J. Reynolds & Julia K. Johnson
430 pages, 6"x9" paper
$32.00

NOW PUBLISHED BY

GSA
THE GEOLOGICAL SOCIETY OF AMERICA

1-800-234-5308
gsaservice@geosociety.org

USE CODE
2025GEOSAVE15
TO SAVE 15% OFF
THESE TITLES ONLINE

Science News

Society for Science, publisher of *Science News*, is a nonprofit organization best known for our award-winning journalism, world-class science competitions and STEM outreach programming aimed at increasing opportunities for all young people. For more than a century, *Science News* journalists have provided accurate, editorially independent coverage of science that gives people the information and context they need to evaluate the news and the world around them.

Science News
1719 N St. NW
Washington, DC 20036
(202) 785-2255

Alliance for Audited Media

Subscriber services:

Email	subscriptions@sciencenews.org
Phone	(800) 552-4412 in the U.S. or (937) 610-0240 outside of the U.S.
Web	www.sciencenews.org/subscribe For renewals, www.sciencenews.org/renew
Mail	Science News, PO Box 292255, Kettering, OH, 45429-0255
Editorial and Letters	feedback@sciencenews.org
Science News Learning	snlearning@societyforscience.org
Advertising and Sponsor Content	ads@societyforscience.org

Science News (USPS 484680, ISSN 0036-8423) is published 12 times per year, monthly by the Society for Science & the Public, 1719 N St. NW, Washington, DC 20036.

Subscribe to *Science News* Subscriptions include 12 issues of *Science News* and full access to www.sciencenews.org and cost $59 per one year (international rate of $77 includes extra shipping charges).

Subscribe www.sciencenews.org/subscription

Single copies are $9.99 plus shipping and handling ($1.01 domestic, $5.01 international). Periodicals Postage Paid at Washington, D.C., and additional mailing offices.

Postmaster Send address changes to *Science News*, PO Box 292255, Kettering, OH 45429-0255. Two to six weeks' notice is required. Old and new addresses, including zip codes, must be provided.

VOL. 207 NO. 03 | MARCH 2025

NIKK OGASA

STAFF WRITER

● NIKK OGASA IS NO STRANGER to covering wildfires. It all started in 2020, when he was a graduate student at the University of California, Santa Cruz. The CZU Lightning Complex fires had spread across the mountains near campus, and Ogasa wrote about the calamity. It was then that he learned about the dangers of massive waves of debris-laced mud that can occur after wildfires. "That's a problem because debris flows can strike suddenly," Ogasa says. So when devastating infernos erupted in the Los Angeles area in January, he got to reporting on researchers' efforts to assess the debris flow risk (Page 36). The process was emotionally challenging for Ogasa, who is from Southern California and has family there. But, he says, "writing about the fires helped me by making me feel like I was contributing somehow, and that made me feel a little less helpless."

Kathryn Hulick
Brains are often compared with artificial intelligence, but "the two systems are actually very, very different," says freelance journalist Kathryn Hulick. Researchers are exploring ways to make AIs more brainlike, which may improve the technology's energy efficiency, Hulick reports (Page 40). She is keeping a close eye on AI's rapid advancements. "I'm watching for any innovation that actually makes AI smarter—more adaptable and more capable of understanding the world."

Jenny Krumrine
Freelance writer Jenny Krumrine's kids are obsessed with puffins. So when her brother mentioned a puffling rescue operation in Iceland, she was all in. For her photo essay about the Puffling Patrol (Page 48), she traveled to Heimaey. Krumrine was impressed by the people's devotion. "Some nights, near-freezing wind scoured the island, making it hard to walk, yet lots of people were out searching for pufflings for hours," she says.

Lisa Grossman
Before the 2025 American Astronomical Society meeting, astronomy writer Lisa Grossman read as many talk abstracts as she could, looking for results that sounded new or simply neat. "Exoplanet guts was both," she says, referring to astronomers' first direct look at an exoplanet's insides (Page 12). Grossman finds attending in-person conferences valuable. "I can read all the journal articles I want, but there's no substitute for listening to conversations in a hallway."

Aaron Tremper
Aaron Tremper loves solarpunk, a sci-fi subgenre that envisions sustainable futures that merge technology and nature. This has led the editorial assistant for *Science News Explores* to write about living machines for this issue's Technically Fiction (Page 62). "Many tropes that make for great Technically Fiction stories seem truly outlandish," says Tremper, who often pens them for *Explores*. "Finding expert sources willing to explore these hypothetical scenarios is a big part of making these stories work."

CLOCKWISE FROM TOP LEFT: LISA STRONG; K. HULICK; JOHN LEHMANN; LEISE JONES PHOTOGRAPHY; ANDRE CHEN

VOL. 207 NO. 03 | MARCH 2025

ARCHAEOLOGY

STONE AGE STONES TO SUMMON THE SUN

By Richard Kemeny

● **Over 600 engraved stones** unearthed from Stone Age ritual gathering sites in Denmark display motifs that commonly represent the sun (one shown) and croplike plants. What's more, ice cores point to a volcanic eruption around the time the stones were intentionally buried about 4,900 years ago. Taken together, the evidence suggests the stones' burial was linked to the potentially cataclysmic event, researchers report in *Antiquity*. "These stones are seen as a kind of prayer or invocation for the sun to return," says Alison Sheridan, an archaeologist at National Museums Scotland in Edinburgh who was not involved in the research. PHOTO BY JOHN LEE/NATIONAL MUSEUM OF DENMARK, R. IVERSEN *ET AL/ANTIQUITY* 2025

1920s Style for a 1920s Price

It was a warm summer afternoon and my wife and I were mingling with the best of them. The occasion was a 1920s-themed party, and everyone was dressed to the nines. Parked on the manse's circular driveway was a beautiful classic convertible. It was here that I got the idea for our new 1920s Retrograde Watch.

Never ones to miss an opportunity, we carefully steadied our glasses of bubbly and climbed into the car's long front seat. Among the many opulent features on display was a series of dashboard dials that accentuated the car's lavish aura. One of those dials inspired our 1920s Retrograde Watch, a genuinely unique timepiece that marries timeless style with modern technology.

With its remarkable retrograde hour and minute indicators, sunburst guilloche face and precision movement, this design is truly one of a kind. What does retrograde mean? Instead of displaying the hands rotating on an axis like most watches, the hands sweep in a semicircle, then return to their starting point and begin all over again.

Retrograde watches by the big brands can set you back thousands; one recent offering from a big French fashion house is selling for more than $150,000! But because we've designed the 1920s Retrograde Watch in-house, we can offer it to you for just $99!

This watch is so wildly popular with our customers that we're actually concerned about running out; we only have ~~937~~ 729 left for this ad!

JOIN MORE THAN 1 **MILLION** SMART PEOPLE WHO LOVE STAUER WATCHES

Watch Specifications:
- Precision movement
- Stainless steel case, caseback and crown
- Retrograde hour and minute indicators
- Water-resistant to 5 ATM
- Brown genuine leather band
- Fits wrists up to 8"

1920s Retrograde Watch
~~$399~~ $99* + S&P *Save $300*

**Special price only for customers using the offer code.*

1-800-333-2045
Your Insider Offer Code: RGW327-01

Stauer Impossible Price ONLY $99

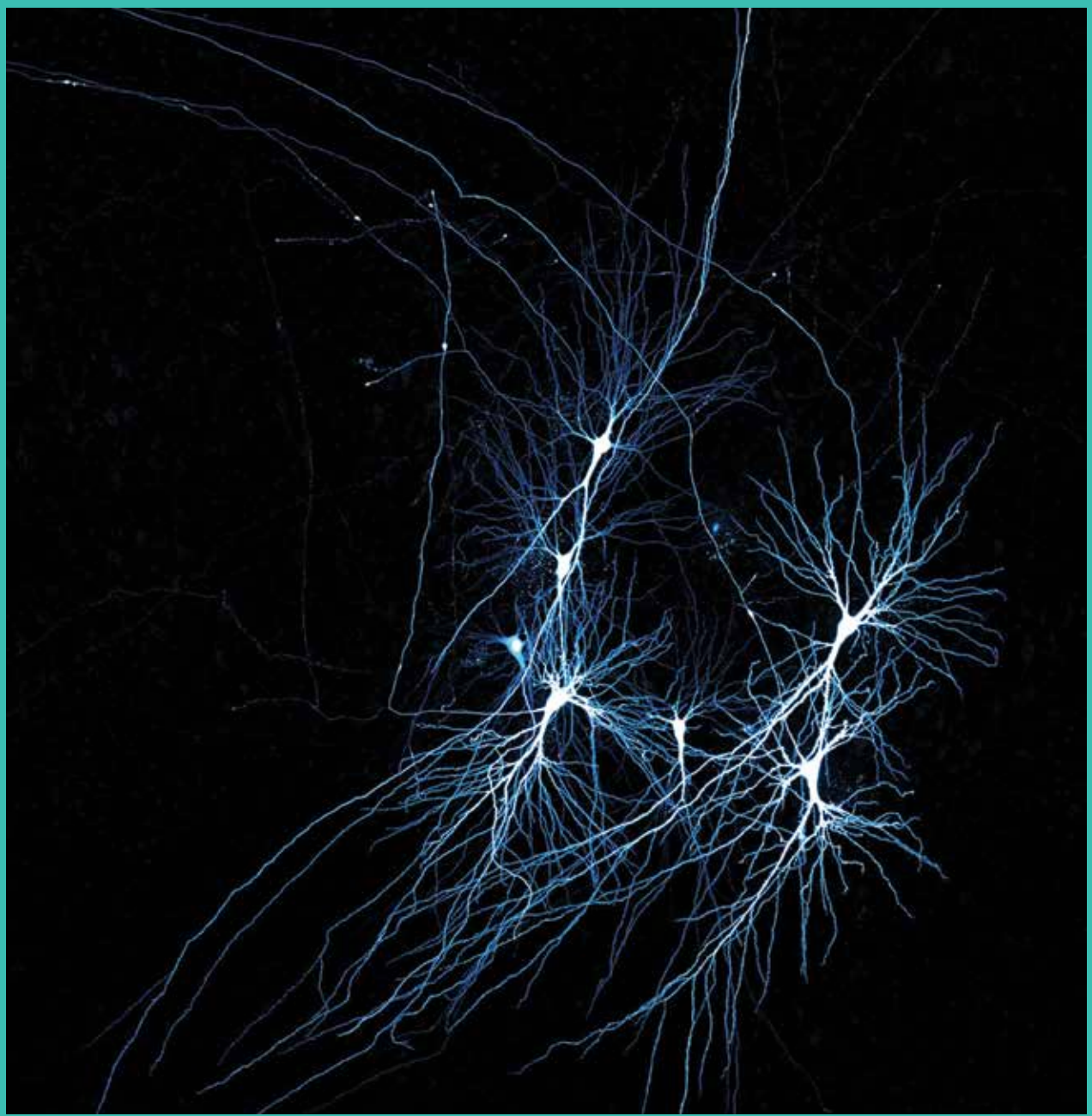
"An elegant and exciting timepiece that every collector will love."
— George Thomas, internationally renowned watch expert

"[A] unique and beautiful timepiece."
— Carlos C., Los Banos, CA

Stauer, 14091 Southcross Drive W., Dept. RGW327-01, Burnsville, MN 55337 **www.stauer.com**

Stauer® | AFFORD THE EXTRAORDINARY®

News



JAKE WATSON

NEUROSCIENCE

THE HUMAN BRAIN'S MEMORY LANES

● Our brain's memory center bears a sleek design. Analyses of living tissue from the human hippocampus have revealed relatively few cell-to-cell connections, or synapses, for a vast number of nerve cells. Scientists recorded electrical activity from pyramidal cells (reconstruction shown) in a circuit crucial for memory. Only about 10 synapses exist for every 800 cell pairs tested, yet signals sent via those synapses are extremely reliable and precise, the team reports in *Cell*. Abundant cells and sparse, strong synapses may maximize memory. —*McKenzie Prillaman*

PLANETARY SCIENCE

A CRUMBLING EXOPLANET SPILLS ITS GUTS

BY LISA GROSSMAN

For the first time, astronomers have taken a direct look at an exoplanet's insides.

An exoplanet about 800 light-years from Earth is spilling its guts into space, and new observations with the James Webb Space Telescope, or JWST, have let astronomers read the entrails, scientists reported at a meeting of the American Astronomical Society held in National Harbor, Md.

"If this is true, it's super cool," says astronomer Mercedes López-Morales of the Space Telescope Science Institute in Baltimore. "For the first time, you can study directly what the interior of an exoplanet is made of. That's exciting."

The planet, a Neptune-sized world called K2 22b, was discovered in 2015. The planet sits scorchingly close to its star, completing an orbit in just nine hours. It is too small to be detected itself, but it periodically emits clouds of opaque dust that form a cometlike tail, blocking up to 1.3 percent of the host star's light.

Astronomers soon realized that the dust was probably cooled magma from the planet's interior. That trail of planet viscera offered a unique opportunity to figure out the chemical composition of an exoplanet's mantle.

Getting insight into any planet's mantle, even Earth's, is challenging, says astronomer Jason Wright of Penn State. "When nature gives you a gift like that, you have to take it."

Wright's team observed K2 22b with JWST's mid-infrared spectrograph in April 2024. Different minerals in the dust emit specific wavelengths of light, letting the team figure out what the planet is made of.

SARA GIRONI CARNEVALE

The dust doesn't seem to be pure iron, which is what scientists would expect if the planet was a core with no mantle or crust surrounding it. "There is still meat left on the bones, so to speak," Penn State astronomer Nick Tusay said at the meeting.

But something in the dust emitted light that was hard to link to any specific material, Tusay said. The researchers first checked to see if the dust grains were magnesium oxide and silicon monoxide, which are expected in mantle material. But those minerals didn't fit the data.

Surprisingly, some of the dust's contents look most like nitric oxide and carbon dioxide from vaporized ices, Tusay says. "If that's true, what we're looking at is a snowball disintegrating."

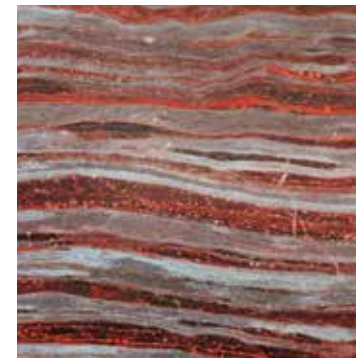
That's hard to explain for a planet so close to its star. "It's just so weird and unexpected," Tusay says. He has requested more JWST observing time to find out more.

López-Morales agrees that more observations are needed to confirm the planet's composition. "It's very preliminary, very promising, definitely needs more data," she says. Observing the handful of other known disintegrating exoplanets would be interesting, too.

A newly discovered disintegrating planet might be the best place to start. A planet found by the space-based TESS telescope in October is emitting a dust cloud so big, it extends halfway around its host star in a 9-million-kilometer-long horseshoe, MIT astronomer Marc Hon reported at the meeting. At 142 light-years from Earth, this crumbling exoplanet is the closest yet discovered, so its contents will be even more clear to JWST.

"We've proved we can do it with K2 22b," Tusay says. "This one will be better." ✖

CHANGLE WANG



EARTH

Ancient chemical clues hint continents got an early start

By Lucas Van Wyk Joel

● **Rivers may have operated on a global scale** by 3.5 billion years ago. The finding, reported in *Geology*, comes courtesy of ancient rocks in China and South Africa. A change in rock chemistry around that time provides the earliest known chemical evidence for continental weathering and the subsequent delivery of nutrients from land to ocean, scientists say.

"As soon as you get weathering, you've got a nutrient influx to the oceans, which can lead to … life thriving in coastal waters," says geobiologist Kurt Konhauser of the University of Alberta in Edmonton, Canada.

His team analyzed banded iron formations (shown above) that store snapshots of ocean chemistry through time. The rocks record a drastic change in the relative amounts of germanium and silicon about 3.5 billion years ago — a change that could have happened only if rivers were carrying weathered material out to sea, the researchers say.

Earth formed about 4.54 billion years ago. The emergence of weathering a billion years later suggests continents arose much earlier than previous estimates indicate, the team says. Other studies have placed the event at around 3 billion years ago.

The new work doesn't mean rivers weren't active before 3.5 billion years ago, says Eva Stüeken, a geochemist at the University of St. Andrews in Scotland. But at this point, "rivers are starting to majorly impact the chemistry of the ocean."

The team wants to see if the data say anything about the size of ancient continents, including the amount of continental crust, Konhauser says. "That's the next thing." ✖

ENVIRONMENT

MEGADROUGHTS ARE ON THE RISE WORLDWIDE

BY CAROLYN GRAMLING

Megadroughts are increasing worldwide — and they're becoming hotter and drier.

Since 1980, Earth has experienced an uptick in both frequency and intensity of these punishing, persistent droughts that last years to decades, researchers report in *Science*. Such lengthy precipitation deficits not only shrink the drinking water supply but also can lead to massive crop failures, food insecurity, increased tree mortality and increased incidence of wildfire.

The analysis logs the rising global toll of megadroughts from 1980 to 2018. Each year, multiyear droughts affected an additional 5 million hectares of land, physical geographer Liangzhi Chen of the Swiss Federal Institute for Forest, Snow and Landscape Research in Birmensdorf and colleagues found.

Using data on precipitation, evapotranspiration and regional vegetation changes, the team also assessed how the droughts impacted ecosystems and humans.

Nearly every continent has experienced megadrought during this period. The worst was southwestern North America's long-running dry period, ongoing since 2000 and particularly severe from 2008 to 2014. That drought was the region's most extreme in 1,200 years and has helped fuel California's recent bouts with fire, including January's unusual wintertime wildfires in Los Angeles County (see Page 32).

Megadroughts have the biggest impact on grasslands, the study revealed. However, these types of ecosystems appear to be more resilient than others, such as tropical and subtropical forests. And other biomes, such as northern boreal forests, are — despite bouts with dryness — still getting greener overall as the planet warms and their growing seasons extend.

That may change in the future, the team notes. The growing severity and frequency in Earth's megadroughts might push even the most resilient ecosystems past their limits. ✖

TOP MEGADROUGHTS FROM 1980 TO 2018

Megadroughts are becoming more common around the world. The following multiyear events are among the most severe in recent decades, according to a new study. Years of greatest impact are listed.

1.	Southwestern North America	2008–2014
2.	Sahel	1981–1987
3.	Central Asia	1998–2005
4.	Congo Basin	2010–2018
5.	Southern Africa	1992–1996
6.	Russia	1987–1991
7.	Southwestern Amazon	2010–2018
8.	Russia	2007–2012
9.	Eastern Brazil	2014–2017
10.	Central United States	1987–1990

↓ The U.S. Southwest's ongoing megadrought dried out much of California's Nicasio Reservoir (shown in 2021).

JUSTIN SULLIVAN/GETTY IMAGES

UNIV. OF CALGARY

EARTH

Ghostly white northern lights present an auroral mystery

By Maria Temming

● **Mysterious ribbons of grayish** white have been spotted woven through the northern lights.

New images reveal that these ghostly glows can appear tucked within or curled up beside red and green auroras. But the pale lights are not auroras themselves, researchers report in *Nature Communications*. Instead, the specters may arise through a similar process to the one underlying the mauve skyglow known as STEVE.

"These observations remind us just how much we still have to learn about the fundamental processes that shape the aurora," says Claire Gasque, a space physicist at the University of California, Berkeley who was not involved in the study.

Scientists at the University of Calgary in Canada first noticed something odd in auroral pictures taken by the Transition Region Explorer, or TREx mission. This Canada-based network of low-light cameras and other equipment is dedicated to sensing the near-Earth space environment. While other auroral imagers collect only certain wavelengths of red or green light, TREx cameras capture full-color images.

In 2023, space physicist Emma Spanswick CONT. ON PAGE 16

↖ Whitish light sometimes weaves through Earth's northern auroras, shown in this all-sky image. The ghostly glow may arise from heating, but the heat source is unknown.

ASTRONOMY

A 'PLATYPUS' MAY LINK TWO COSMIC PHENOMENA

By Lisa Grossman

● A bright blip in a distant galaxy may link two mysterious categories of cosmic flares. The event, dubbed the Platypus, could also offer a new way to understand the origins of supermassive black holes at the centers of most galaxies.

The brilliant burst, spotted in a dwarf galaxy about 6.5 billion light-years from Earth, has many of the hallmarks of a tidal disruption event—the final flash of a star being ripped apart by a black hole. But it also resembles a Luminous Fast Blue Optical Transient, or LFBOT, which astronomers think might be a class of exploding star.

The Platypus could connect the two, astronomer Vikram Ravi of Caltech reported at a meeting of the American Astronomical Society held in National Harbor, Md.

Using the Palomar Observatory near San Diego, Ravi and colleagues found a flare that looked like it could be a tidal disruption event around an intermediate-mass black hole. This type of black hole can be a few thousand times the mass of the sun. Understanding the elusive black holes can illuminate how supermassive ones form.

The Hubble Space Telescope tracked the blast to the outskirts of a tiny galaxy. The blast's brightness was 100 times that of all the stars in that galaxy.

The burst might come from an extremely massive star "doing some crazy explosion," says Caltech astrophysicist Jean Somalwar. Or it might come from a supermassive black hole shredding a star. But such a small galaxy probably lacks both, making an intermediate-mass black hole a good candidate.

The Platypus also resembled an LFBOT: It shone intensely in blue light and its brightness rose quickly. But whereas the brightness of most LFBOTs evolves over a few days, the Platypus glowed for weeks—like a tidal disruption event. The team hopes to get simultaneous observations with Hubble and the James Webb Space Telescope, which could clarify the Platypus's origins. ✖

CONT. FROM PAGE 15 and a colleague were reviewing some of these pictures. "We see this really, really weird thing. It was this kind of gray, white patch," she says. "We were both like, 'What *is* that?' "

After glimpsing similar tufts of grayish white in other images, the scientists decided to make a sweeping search of past TREx data. They found 30 white-laced auroras over Rabbit Lake and Lucky Lake in Saskatchewan from 2019 to 2023.

All-sky images showed these tendrils of white could span tens to hundreds of kilometers. They sometimes appeared alongside red or green auroras. Other times, white light bloomed in places where colorful auroras had just faded away.

Spectral data confirmed that the whitish light is made up of continuum emission. "When you see a continuum emission, you've got a little bit of light at all wavelengths," Spanswick says. This is different from normal auroras, where particles raining into the atmosphere excite atoms to throw off only specific wavelengths of red, green or blue.

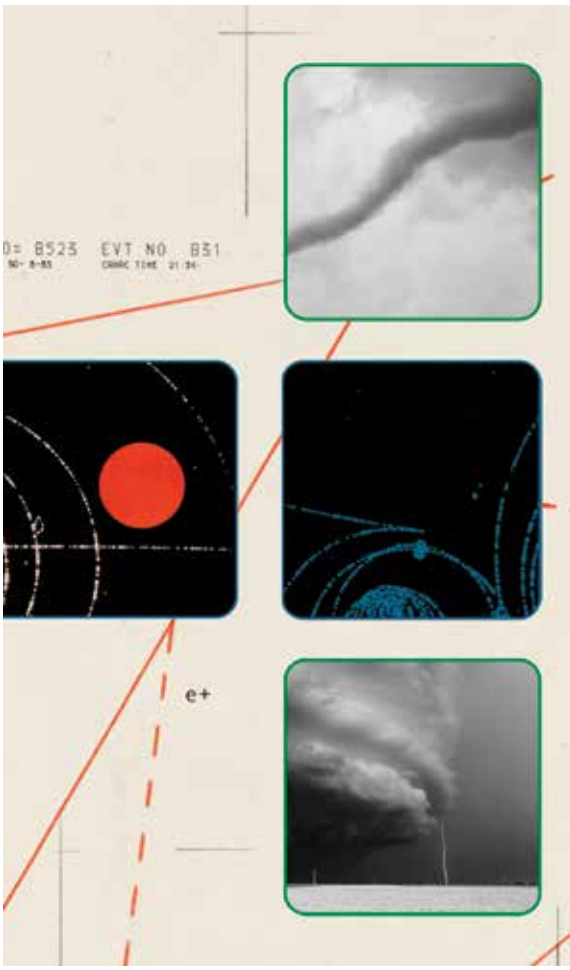
The continuum emission of the whitish northern lights looks a lot like that of STEVE, short for Strong Thermal Emission Velocity Enhancement. STEVE is a band of purplish white that runs east to west across the sky, closer to the equator than typical auroras. It's thought to arise from a river of extremely fast plasma rushing through the atmosphere, heating particles up to glow.

The newly identified whirls of white among the northern lights might also arise from atmospheric heating. "But what's doing the heating? And why in this patch, and not the region next to it?" Spanswick says. "We have no idea."

As someone studying STEVE, Gasque says that "observations of similar emissions in the aurora are fascinating." The patchiness of the white northern lights, compared with the neat arc of STEVE, suggests the two phenomena are not quite the same, she says. But there may be similar chemistry behind both, which could help solve a longtime mystery about STEVE.

Namely, it's not yet clear just how the torrent of plasma changes atmospheric chemistry to create STEVE's light. Investigating similar emissions lurking among auroras, Gasque says, "could provide valuable clues." ✖

Editor's note: Claire Gasque is the daughter of News Director Macon Morehouse, who was not involved with this article.



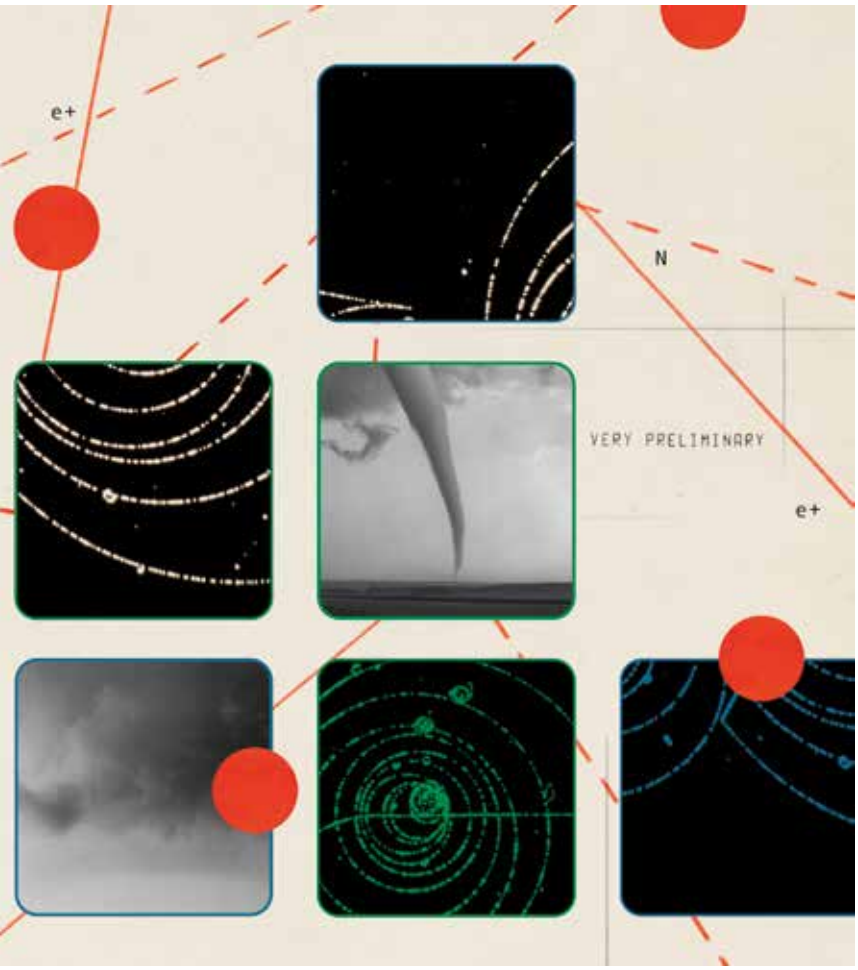
PARTICLE PHYSICS

Cosmic rays could reveal tornado secrets

By Emily Conover

● **Supercell thunderstorms are known** for their devastatingly gnarly tornadoes, but exactly how the twisters form is poorly understood. A new study suggests that scientists could glean hints with a little help from the cosmos.

Muons, subatomic particles that are like heavy versions of electrons, could reveal the atmospheric pressure within a thunderstorm



VALERIE CHIANG (SOURCES: GETTY IMAGES; CERN)

and resulting tornado, researchers report in *Physical Review D*. The particles are produced by cosmic rays, which are an assortment of high-energy particles from space, including protons. When cosmic rays careen into the atmosphere, they produce muons that rain down on Earth — including through tornadoes.

Computer simulations of supercell thunderstorms suggest that a low-pressure region within a storm contributes to tornado formation. But scientists have understandably struggled to take measurements inside the destructive tempests. Muons could probe pressure from a distance, solving that problem.

"You could actually use this technique to do pressure measurements remotely," says physicist William Luszczak of Ohio State University. "So instead of having to put a pressure sensor inside a tornado, you could measure the pressure from five kilometers away."

Muons are sensitive to the density of the air they pass through. Lower air pressure, which corresponds to a lower density, means more muons make it all the way to the ground. That muon excess could be identified with a detector on the ground.

Based on simulations of tornadoes and cosmic rays, the team proposes using a large detector spread across an area of 1,000 square meters. That might sound like a lot, but cosmic ray physicists are used to building enormous detectors. The GRAPES-3 experiment in India, which detects muons over an area of 25,000 square meters, previously used the particles to reveal enormous voltages within a thunderstorm.

That large-scale approach would mean waiting and hoping for a storm to pass close enough to observe. Alternatively, a smaller, portable detector (of about 100 square meters) could be transported to the location of predicted storms.

Muons have previously been used to study cyclones. But, says physicist Hiroyuki Tanaka of the University of Tokyo, "supercells are much smaller than cyclones.... For this reason, we need a much larger detection area." Tanaka questions whether the detectors needed could really be made portable, and whether the measurement will be successful in a realistic setting.

He might not have to wait long. Luszczak's team is planning a first test of the concept this summer. ✖

1,000

The area in square meters of a proposed ground-based detector that would leverage subatomic particles called muons to gauge the pressure inside severe storms and tornadoes from afar.

TECHNOLOGY

ROBOTS HELP SOLVE A HULA-HOOP PUZZLE

By Emily Conover

● To keep a Hula-Hoop aloft, it helps to be in shape — literally.

Experiments with hoop-slinging robots reveal how the spinning rings stay up despite the pull of gravity. The shape of the robot's body is a crucial factor, applied mathematician Leif Ristroph of New York University and colleagues report in the *Proceedings of the National Academy of Sciences*.

The shape needs to have hips — a slope that provides upward force to counteract gravity. And a waist — an hourglass-like curve that keeps the hoop from drifting up or down and sliding off.

A gyrating cylindrical robot couldn't keep a hoop from sliding down. It was missing the essential upward force, generated when a hoop swings over a sloped shape. But a cone-shaped robot, with a slope and no curve, also failed. If a hoop began near the cone's top, the upward force overpowered gravity, and the hoop migrated up. If a hoop began near the bottom, the upward force wasn't enough to keep it aloft, and it migrated down. But an hourglass-shaped robot kept a hoop steady (example illustrated, above).

People should be able to hula-hoop regardless of body shape, by adapting their gyrations based on the hoop's position. Indeed, the team got a cone-shaped robot to hula-hoop by adjusting the gyration rate based on how high the hoop slid. ✖

ANIMALS

Mole or marsupial? This critter is both

By Susan Milius

● **Evolving a dig-in-the-dark mole lifestyle** comes with radical anatomical changes, making it hard even to guess the animal's closest relatives. That's why the identity of Australia's most cryptic mammal, the marsupial mole, has been questioned for decades.

The two fit-in-your-hand *Notoryctes* species are elusive. "I've never handled, or even seen, a marsupial mole in my life, and I almost certainly never will," says evolutionary geneticist Stephen Frankenberg of the University of Melbourne in Australia.

The first people living around the iconic great red rock domes in what is now Australia's Northern Territory certainly knew of the local mole, which features in their cultural lore. But European settlers and their correspondents oceans away were fascinated in 1888 by reports of "a new Australian mammal." Opinions varied about whether it was a marsupial.

Now Frankenberg and colleagues have used a frozen museum sample to see where *Notoryctes* fits in the

↑ This Australian mole, shown eating a centipede, is more closely related to kangaroos than to other moles.

FROM LEFT: PETER CROWTHER; MIKE GILLAM/AUSCAPE/MINDEN PICTURES

animal evolutionary tree. It's not anywhere near other animals we call moles or even mole-rats.

Notoryctes are true marsupials instead of some not-quites, the team confirms in *Science Advances*. Their pouch faces backward, probably helpful when mom is almost swimming forward in sandy soil. These moles don't dig lasting tunnels but live in dunes or other soils that permit pushing through. Researchers also found an extra hemoglobin gene that might help keep young from suffocating in soil.

What kind of marsupial they evolved from is a trickier question to answer because life underground strongly favors certain body changes. The two species of *Notoryctes* have tapered beanbag bodies with specialized dig-tool limbs and testes that stay in the abdomen instead of descending into a draggy scrotum.

What the moles don't have are external ears or working eyes. Instead, their fur-covered face just has a raised pink fleshy "shield" structure like a big button nose on a stuffed animal.

The relatives they left behind in daylight have become today's bilbies, which are "very rabbitlike," Frankenberg says, and bandicoots, which are "more like giant shrews with their pointy snouts."

Bilbies and bandicoots do not resemble their mole cousins. Yet the study is the second big genetic analysis that has found that the moles, bilbies and bandicoots are a group of close relatives.

This group is also a sister to the Tasmanian devil and some other not very molelike creatures, says David Duchêne, an evolutionary geneticist at the University of Copenhagen. It just goes to show how going underground full-time can involve an extreme makeover. ✖

ANIMALS

VELVET ANTS HAVE THE SWISS ARMY KNIFE OF VENOMS

BY AMANDA HEIDT

Few creatures can tangle with a velvet ant and walk away unscathed. These ground-dwelling insects are not ants, but parasitoid wasps known for their excruciating stings.

Now researchers have discovered that the wasps don't dole out pain the same way to all species. Different ingredients in their venom cocktail do the dirty work depending on who's at the business end of a wasp's stinger, researchers report in *Current Biology*.

Velvet ants wield not just venom, but also warning coloration and odor, an extremely tough exoskeleton and long stinger, and the ability to "scream" when provoked. In 2016, entomologist Justin Schmidt wrote that getting stung by a velvet ant felt akin to "hot oil from the deep fryer spilling over your entire hand." Scientists have found that other vertebrates react to the wasp's sting too, including mammals, reptiles, amphibians and birds.

Other species also possess such broad-spectrum venom. One study identified a centipede with a venom cocktail that changes depending on whether the arthropod is acting as predator or prey. But it remains rare for one organism to be able to deter animals from so many different groups, says Lydia Borjon, a sensory neurobiologist at Indiana University Bloomington. In some cases, scientists have identified generalized venoms that zero in on molecular targets shared by different groups of creatures, passed down from a common ancestor.

When Borjon and colleagues began experimenting with velvet ants, the team suspected that might be the case for their venom too. "If you're trying to defend against many predators, then it would make sense for the venom to be generally effective by targeting something pretty ancient," Borjon says. "Ultimately, what we found was different and surprising."

After collecting venom from *Dasymutilla occidentalis* velvet ants, the team created synthetic versions of its 24 peptides, the main chemical components of the venom that wreak cellular havoc. Testing the full cocktail and the individual peptides on fruit fly neurons revealed an insect-specific response to the most abundant peptide, called Do6a. It appears to target a type of neuron that reacts to noxious stimuli. CONT. ON PAGE 20

CONT. FROM PAGE 19 In mice, the synthetic venom still induced a painful response — but it wasn't driven by Do6a. Instead, the pain appeared to be caused by two peptides less abundant in the venom, Do10a and Do13a. These peptides prompt a broad and diffuse reaction across several types of sensory neurons.

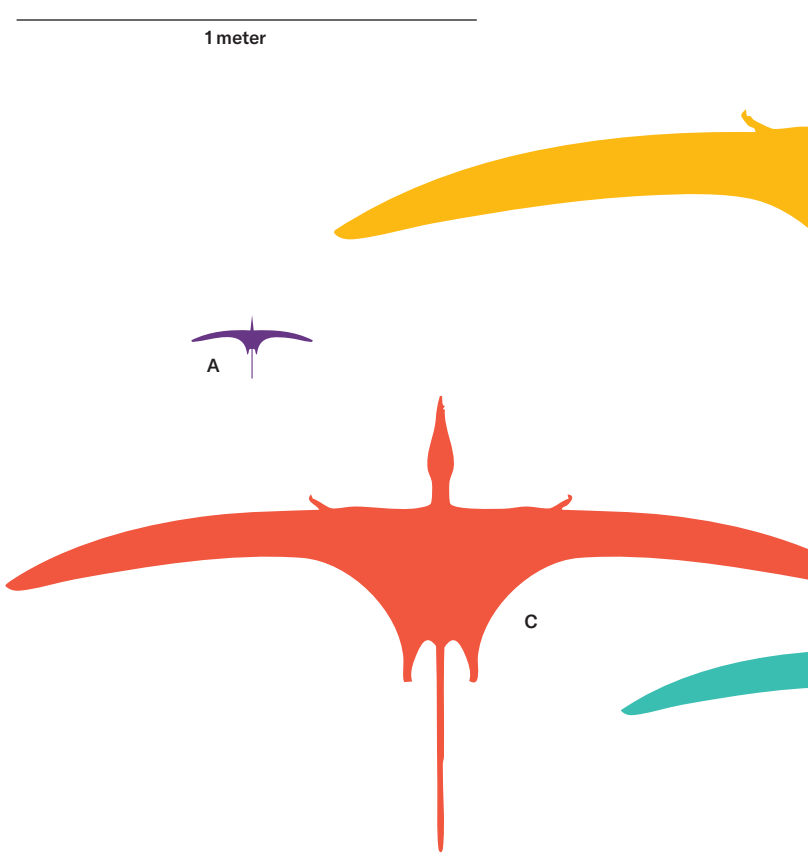
Taken together, Borjon says, the findings show that velvet ant venom induces pain in mammals via a generalized mechanism, while the venom's effect on insects is more tailored to a particular target.

The study is among the first to demonstrate multiple modes of action within a single venom and is "an important first pass, using some innovative techniques to explore an interesting question," says toxicologist Sam Robinson of the University of Queensland in Australia.

But the findings may be more common than they seem. There's little scientific incentive to test most venoms' effects in different creatures, particularly if a species is a prey specialist. "So while it seems like this is something unique, it's hard to say with certainty," he says.

The research also adds to another enduring mystery about the velvet ant: Why it seems to have so many weapons at its disposal. Despite their extensive defensive arsenal, nothing seems to consistently eat them, nor are velvet ants aggressive predators themselves, says Joseph Wilson, an evolutionary ecologist at Utah State University Tooele.

The fact that velvet ant venom packs a punch against other insects suggests that interactions with some unknown insect predator, either in the past or the present, may be driving the evolution of these features, Wilson says. Or it could just be a happy accident. "Sometimes, evolution works in mysterious ways." ✖



D. W. E. HONE AND S. N. MCDAVID/*PEERJ* 2025

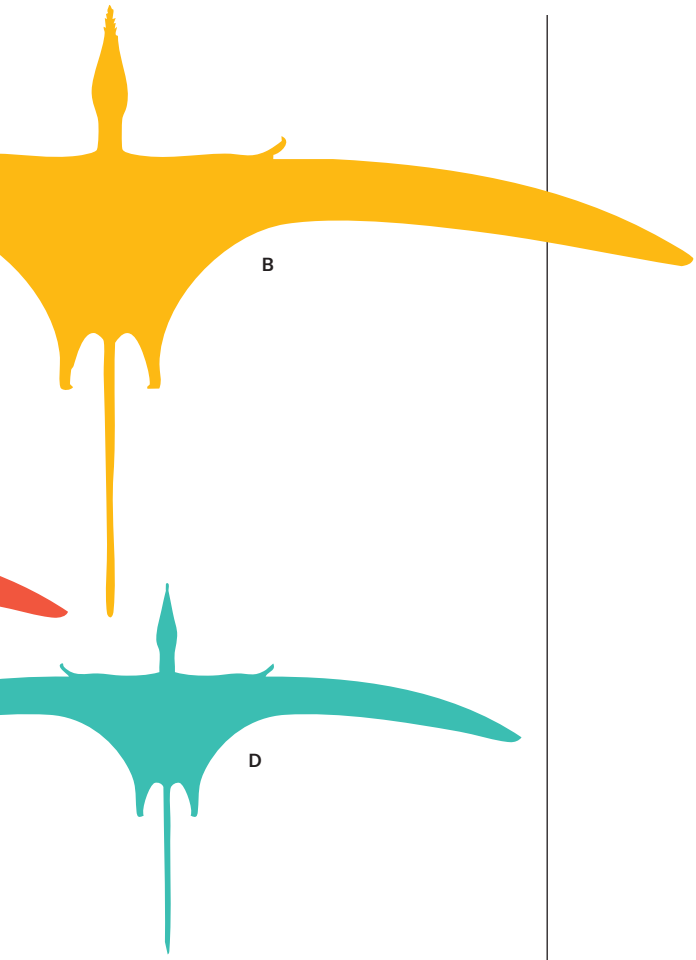
PALEONTOLOGY

A goliath pterosaur finally has an identity

By Jake Buehler

● **One pterosaur species** gave itself quite the makeover as it grew older and larger.

Researchers have spent more than a century wondering if a large, anatomically quirky flying reptile fossil represented a distinct species from its much smaller peers. Not so, scientists report in *PeerJ*. The Jurassic giant, they argue, is a superlative for this species. The finding helps reveal how some extinct fliers may have developed over their lives.



These silhouettes depict the estimated sizes of fossilized *Rhamphorhynchus* specimens. A is the smallest known individual, B is the largest known, C is the second largest individual yet known and D is a "typical" adult.

Rhamphorhynchus was a snaggle-toothed pterosaur that lived in Europe and Africa about 150 million years ago. It's one of the best-known pterosaurs, with over 100 known fossilized remains.

But one nearly complete fossil skeleton unearthed in Germany in the 19th century stood out from the rest. Most adults had a wingspan in the 1-meter range, comparable to that of a crow. But this special fossil was far larger, with an eaglelike wingspan. The fossil had initially been treated as a distinct species, but in 1995, one scientist proposed that all known *Rhamphorhynchus* instead belonged to a single species, *R. muensteri*. Yet the conspicuously king-sized example left lingering doubts, says David Hone, a paleontologist at Queen Mary University of London.

"This thing is big and weird," he says. "Maybe this is a different species, and we've not really looked at it properly."

So Hone and independent paleontologist Skye McDavid evaluated the mysterious skeleton's eccentricities, making detailed measurements of the skull and body and comparing them with other *Rhamphorhynchus* specimens.

In life, the animal would have had a 1.8-meter wingspan, making it over 60 percent larger than all but one of the largest known *Rhamphorhynchus*. The eye sockets were also proportionally smaller, and the skull openings behind the eyes were bigger. These and other features are in line with the stepwise shifts in proportions that pterosaurs went through as they grew larger, the pair argues. The giant appears to be what *R. muensteri* eventually grew into.

One of the most fascinating features of the fossil are its teeth. Other, smaller *R. muensteri* had interlocking, needlelike teeth with round cross sections, Hone says. The supersized specimen had curiously broad, flattened teeth. Hone thinks the compressed shape, coupled with the animal's overall large size, means it was eating something other than the shrimp and fish that its smaller cousins ate. For the colossal adult, such snacks "just fall between its teeth," he says. Instead, its diet may have included more terrestrial prey, like lizards or small mammals.

Paleontologist Dave Unwin agrees that the giant belongs to *R. muensteri*, but he questions the idea that older, larger individuals changed their dining habits. The anatomy of the pterosaur is "wholly unsuited" for foraging in terrestrial environments, says Ulwin, of the University of Leicester in England. And tooth differences in the big pterosaur are better explained as the consequence of having a heavier build.

Still, such work can help scientists better understand how pterosaurs grew throughout their lives, says paleontologist Rudah Duque of the Federal University of Pernambuco in Recife, Brazil. Recent finds across life stages have shed light on pterosaur biology more generally, he says. "But we still have much to discover." ✖

ANTHROPOLOGY

Women dominated Celtic society in Iron Age England

By Bruce Bower

● **Celtic women's social and political standing** in Iron Age England has received a genetic lift.

DNA clues indicate that around 2,000 years ago, women belonging to the Durotriges tribe — a Celtic society on the coast of south-central England — stayed in their home communities while their spouses came from outside the area, scientists report in *Nature*. This female-centered marriage pattern, called matrilocality, in ancient and modern societies tends to accompany greater opportunities for women to wield household and community power.

DNA extracted from skeletal remains of 57 people buried in Iron Age cemeteries near Durotrigian sites showed signs of matrilocality, paleogeneticist Lara Cassidy of Trinity College Dublin and colleagues found.

Analyses of mitochondrial DNA, typically inherited from the mother, revealed that most individuals of both sexes shared maternal ancestry. But a subset of individuals, mostly men, shared no genetic relationships. That's why the scientists think that those men migrated into a female-dominated society.

Matrilocal practices characterized many British Celtic communities, the team says. Comparisons of mitochondrial DNA from people buried at 156 British and European archaeological sites spanning about 6,000 years revealed shared maternal ancestries at six British Iron Age locations in addition to the Durotrigian sites. Most of those sites date to between 400 B.C. and 50 B.C.

Previous archaeological finds and historical accounts had suggested Celtic women held considerable status. Greek and Roman writers described powerful female political leaders in Iron Age England, including two Celtic queens. Prestigious ornaments and other items placed in the graves of western European Celtic women hinted at societies in which property was inherited through maternal lines.

"That said, we were not expecting such a strong and widespread signature of matrilocality across Iron Age Britain," Cassidy says.

Celts consisted of societies that spoke related Indo-European languages and spread across Europe between 3,000 and 2,000 years ago.

Cassidy's team found that Iron Age Celts in southern England, including Durotrigians, show genetic signs of substantial mating with continental Europeans who must

↖ Genetic analyses of skeletons (one shown) from Iron Age sites in southern England suggest a Celtic society embraced marriage practices that enhanced women's power.

have crossed the English Channel. An infusion of European ancestry in England and Wales first occurred before the Iron Age, as early as around 1000 B.C., a previous study estimated. Those population movements may have brought Celtic languages to the British Isles.

Social structures vary in modern matrilocal societies, Cassidy says. Men sometimes dominate formal positions of authority while women collaborate with local maternal relatives and other allies to control property, direct food production and make major buying and selling decisions. Unlike more common patrilocal systems, in which women marry into men's families, matrilocal arrangements give women more access to education and divorce.

The team's work confirms the existence of female-centered Celtic societies suggested by archaeological evidence in Iron Age Britain and France, says Rachel Pope, an archaeologist at the University of Liverpool in England. Those excavations suggest that matrilocal societies distributed power and resources in subtly different ways from one part of Europe to another, she says. "There was no one-size-fits-all social structure for prehistory."

The study also raises questions about how Iron Age Celtic cultures worked, says Bettina Arnold, an archaeologist at the University of Wisconsin–Milwaukee.

Genetic studies at Iron Age European sites have found weak evidence of matrilocal practices, yet female graves on the continent contain more sumptuous goods than those at British Durotrigian sites where matrilocality reigned, Arnold says. And the origins of men who married Durotrigian women are unknown, as are the ways in which the men integrated into the society. ✖

ECOSYSTEMS

MAPS OF 'SWIMWAYS' COULD HELP SAVE FISH

BY STEFAN LOVGREN

Flyways are to birds as swimways are to fish. And knowing where these underwater migratory routes are could redefine how river systems are managed, scientists say, if only they had detailed maps.

"Fish are the most heavily impacted of all migratory species globally," says Twan Stoffers, a fish ecologist at the Leibniz Institute of Freshwater Ecology and Inland Fisheries in Berlin. Migratory freshwater fish populations have dropped by over 80 percent since 1970 due to fragmented habitats, overfishing and pollution. Because their migratory paths are underwater, "we often don't know where these routes are, or even if all species can still use them," Stoffers says.

Now, thanks to the Global Swimways Initiative, paths are emerging and poised to become a conservation tool. Stoffers and others are creating maps of species-specific migration routes in rivers worldwide. The maps are intended to guide infrastructure development and habitat restoration by highlighting crucial corridors and bottlenecks.

Swimways' greatest obstacle? Dams. They disrupt migration routes by blocking breeding and feeding habitats. Globally, a third of major rivers remain free-flowing. Most are located in the Amazon and other remote regions. In Europe, rivers are so fragmented that identifying historical swimways is nearly impossible. But restoration efforts elsewhere show what's possible. The recent removal of four dams on the Klamath River in the northwestern United States allowed salmon to return to spawning grounds that they hadn't accessed in over a century.

The swimways initiative is now analyzing data for all known migratory freshwater fish species, about 2,400. "I'm happy with the amount of information we could find, but I'm also shocked at how many species we still have little information for," Stoffers says. Technology for tracking fish migrations isn't as robust as that used to study birds, he notes.

Fish migrations should be afforded the same nuance and attention given to bird migrations, says fish biologist Zeb Hogan of the University of Nevada, Reno. Mapping these underwater highways is essential for "the survival of freshwater fish and the ecosystems and communities that depend on them." ✖

THE HEALTH CHECKUP

PROBIOTICS CAN CURB A SWEET TOOTH — IN MICE

BY TINA HESMAN SAEY

Sugar is a siren song to many people. But some friendly gut bacteria might help you resist its lure. At least that's what ads for some probiotics claim. For years consumers have been bombarded with supposed health benefits of taking probiotics: improve gut health, get more energy and "feel lighter." Some also claim to reduce sugar cravings. But can a daily dose of bacteria really calm cravings for candy and cookies?

The idea is not totally out there. Studies with mice have found that missing some bacteria, *Lactobacillus salivarius*, *L. gasseri*, *L. johnsonii* and *Muribaculaceae*, can send the animals on sugar benders. And it's not just sweets; mice missing *L. johnsonii* and *Muribaculaceae* will also gorge on high-fat foods. "Anything that's pleasurable, the mice will eat more if they're missing these organisms," says microbiologist Sarkis Mazmanian of Caltech. Returning the microbes to mice reduces bingeing.

Other evidence points to how microbes might affect mice's food preferences. In a recent study in *Nature Microbiology,* researchers in China discovered how the gut bacterium *Bacteroides vulgatus* and a molecule it produces — pantothenate, aka vitamin B5 — can reduce rodents' preference for sugar.

The researchers studied mice genetically engineered to lack FFAR4, a sensor for some fatty acids, in their guts. For unknown reasons, lacking this sensor causes levels of *B. vulgatus* and pantothenate to go down, and these mice gorge on sugar. Giving the bacteria and vitamin to these mice lowered sugar consumption — all thanks to a chain reaction involving GLP-1, a protein that has become famous because semaglutide drugs such as Ozempic mimic its action in controlling blood sugar and weight.

Pantothenate stimulates GLP-1 production. In turn, GLP-1 spurs production of a protein called FGF21. That protein does something — scientists aren't yet sure what — in the hypothalamus, an appetite-control center in the brain, to reduce the desire for sugar.

B. vulgatus reduced sugar cravings only in mice lacking FFAR4. That suggests the bacterium or vitamin B5 may do nothing to stop sugar cravings in most people because they have intact FFAR4, Mazmanian says.

And in some cases, it may even be harmful. "There's some evidence that *B. vulgatus* has a dark side," he says. The organism can cause intestinal inflammation in rats with certain genetic alterations. While most people don't share the rats' mutations, an excess of *B. vulgatus* could cause tummy troubles for some.

Even if the animal data are suggestive, the reality is, no one knows whether any bacteria that reduce sugar cravings in mice will do the same for people. It just hasn't been tested yet in people, and what works in lab mice sometimes fails to hold up in human studies.

Companies aren't even required to test probiotics in people or prove that they work, says Pieter Cohen, an internal medicine doctor at Harvard Medical School who studies supplement safety. Because probiotics are sold as dietary supplements, they aren't subject to regulation by the U.S. Food and Drug Administration.

As long as they don't claim to treat diseases, Cohen says, companies can market their products as they choose, though they do need some evidence to back up their claims. That evidence? Mostly animal data.

"It is disconnected from any actual evidence in humans that they work," Cohen says.

Even Mazmanian, who studies beneficial bacteria, has reservations about commercial probiotics. "In 2025, I'm still skeptical of these claims," he says. Products that claim to reduce sugar cravings don't even contain the organisms that seem to satisfy mice's sweet tooth. Even if a benefit were found in humans, each person's unique biology, genetics and microbiomes could cause individual results to vary widely, he says. "Any biology that we discover ... is not going to apply to everybody." ✖

FALL 2025

UNDERGRAD ADMISSIONS

西湖大學 WESTLAKE UNIVERSITY

Apply through Common App

Scholarship Opportunities:

- We offer exceptionally generous scholarships, up to full tuition.
- 100% of admitted international students received scholarships/financial aid.

School of Science

- Chemistry
- Physics
- Mathematics & Applied Mathematics

School of Engineering

- Materials Science & Engineering
- Electronic & Information Engineering
- Artificial Intelligence

School of Life Sciences

- Biological Sciences

School of Medicine

（Upcoming）

Established in 2018, Westlake University is a leading research university with a strong emphasis on fundamental scientific research and cutting-edge technological innovation.

YUNGU CAMPUS

600 Dunyu Road, Xihu District, Hangzhou, Zhejiang, 310030, P.R. China

ugadmissions.westlake.edu.cn

intladmissions@westlake.edu.cn

SCIENCE & SOCIETY

A push to redefine obesity gathers momentum

By McKenzie Prillaman

● **Obesity needs a new definition**, health experts argue.

For over 75 years, obesity has been called a disease by the World Health Organization. But the label is hotly debated. Some say it helps legitimize obesity's seriousness; others point out that people living with obesity are not always ill.

So a commission of nearly 60 health experts has proposed a definition and diagnostic criteria for clinical obesity: a disease in which excess body fat harms a person's tissues, organs or ability to do daily tasks. The report, published in the *Lancet Diabetes & Endocrinology*, also describes preclinical obesity, when surplus body fat does not affect tissues or organs but may increase the risk for developing clinical obesity, type 2 diabetes, certain cancers and other diseases.

"We are calling for a change — a radical change," obesity researcher Francesco Rubino of King's College London said at a news briefing. With 1 billion people classified as having obesity in the world today, "no country is rich enough to be able to afford inaccuracy in the diagnosis of obesity," he said.

Doctors have primarily relied on BMI to diagnose obesity. A BMI of 30 or above generally classifies adults as having obesity, according to the WHO.

But the metric represents weight divided by height squared rather than an actual measurement of body fat. BMI, if used, should be a screening tool used with another metric, like waist circumference, waist-to-hip ratio or waist-to-height ratio, to confirm excess fat, the commission argues. A larger waistline can hint at too much fat around organs, which is especially dangerous. Two of those body metrics or a scan that measures fat could be used instead of BMI, the report suggests.

A person should show signs of organ, tissue or whole-body dysfunction to qualify for a clinical obesity diagnosis. The commission specifies 18 symptoms in adults and 13 in children, including sleep apnea, high blood pressure, knee pain and difficulty with tasks like bathing.

The proposed definition and diagnostic criteria for clinical obesity would help clinicians ID who would benefit most from treatment, says Francisco Lopez-Jimenez, a cardiologist at the Mayo Clinic in Rochester, Minn. Interventions like GLP-1 drugs, bariatric surgery and lifestyle counseling can be costly for patients, health systems and insurers.

Lopez-Jimenez worries whether preclinical obesity — in which patients may need anything from simple monitoring to weight-loss drugs — would be taken seriously. "We have to be careful when we call a condition preclinical," he says. "If that would lead to less treatments for those individuals, I would have a problem with that."

Commission member Fatima Cody Stanford admits that may be a challenge. "Preclinical obesity will struggle, I think, in terms of coverage by insurers. But before, it wasn't even being acknowledged," says Stanford, an obesity medicine physician scientist at Massachusetts General Hospital and Harvard Medical School in Boston.

It's up to doctors and health care systems to decide whether to put the guidelines into practice. But the global perspectives that went into the report and a growing movement to better diagnose obesity should help with adoption, Stanford says. ✖

"No country is rich enough to be able to afford inaccuracy in the diagnosis of obesity."

—Francesco Rubino

NEUROSCIENCE

SILENCING MEMORIES COULD BE KEY TO PTSD RECOVERY

BY LAURA SANDERS

Recovery from post-traumatic stress disorder comes with key changes in the brain's memory system, a study of people who survived the 2015 terrorist attacks in Paris reveals. The finding points to ways that the brain can reshape itself after trauma, researchers report in *Science Advances*.

"It's not written in stone," says Pierre Gagnepain, a cognitive neuroscientist at the research institutes Inserm and Cyceron in Caen, France.

In November 2015, terrorists attacked a crowded stadium, a theater and restaurants in Paris. In the years after, Gagnepain's team studied 100 survivors. Fifty-three had PTSD. While undergoing functional MRI scans, volunteers were sometimes asked to conjure a picture in their mind when they saw a specific word. Other times, they were asked to look at the word and will their minds to stay blank.

Eighteen months after the attacks, all 53 people with PTSD showed differences in how their brains handled intrusive memories compared with people without. Three years after, 19 people had recovered. Their brain activity during the memory suppression task was like that of people who never had PTSD.

Regaining memory control was linked with the hippocampus, a key memory center in the brain. People with PTSD had smaller hippocampi. But as some recovered, this shrinking stopped. The team plans to study the circuitry that may aid recovery. ✖

CHRISTOPHER FURLONG/GETTY IMAGES

↖ Mourners observe a minute of silence at a memorial for the victims of the 2015 terrorist attacks in Paris that killed 130 people and injured hundreds more.

HEALTH & MEDICINE

U.S. DEMENTIA CASES MAY SOAR OVER THE NEXT 3 DECADES

By Meghan Rosen

● One million adults per year in the United States will develop dementia by 2060, scientists predict in *Nature Medicine*. Dementia encompasses many symptoms, including memory, reasoning and language difficulties that interfere with daily life. Over 6 million people in the United States are currently affected by dementia.

"This is a huge problem," says epidemiologist Josef Coresh of New York University's Grossman School of Medicine. A rise in the projection isn't surprising given the aging population, but the extent of the rise is, he says.

Forty-two percent of people who are over age 55 will develop dementia within their lifetime, Coresh's team predicts. That's about double the percentage of a previous estimate by other researchers.

The new finding is based on a larger, more diverse study population than earlier work. Coresh and colleagues followed more than 15,000 people for years using several methods to identify dementia cases. They pored over hospital and death records, evaluated participants in person and screened them by phone. For the last decade, the team has been calling participants twice a year. That revealed dementia cases that might otherwise have gone unreported.

Though the team focused on dementia in people over age 55, risk doesn't typically start ticking up for decades. And some populations are at greater risk than others, including women, Black people and those with a gene variant linked to Alzheimer's disease.

But there's reason for hope. A high risk isn't a certainty. And "a lot of dementia risk is modifiable," Coresh says. Improving cardiovascular health, exercising and even preserving hearing can reduce risk.

In a 2023 study of older adults with hearing loss, people who used hearing aids had a lower rate of cognitive decline than those who didn't. Hearing aids could help people engage socially, which may boost brain health. ✖

Q&A

HAVE 5 YEARS OF COVID-19 READIED US FOR WHAT'S NEXT?

BY MCKENZIE PRILLAMAN

Five years ago, on March 11, 2020, the World Health Organization declared COVID-19 a pandemic. Whether it still is depends on who you ask. There are no clear criteria to mark the end of the pandemic. And the virus SARS-CoV-2, which causes COVID-19, continues evolving and infecting people worldwide. "Whether the pandemic ended or not is an intellectual debate," says Ziyad Al-Aly, a long COVID researcher at Washington University in St. Louis. "For the family that lost a loved one a week ago in the ICU, that threat is real. That pain is real. That loss is real."

According to recent WHO data, 521 people in the United States died of COVID-19 in the last week of 2024. That's drastically lower than at the height of the pandemic in 2020. Nearly 17,000 people in the United States of COVID-19 the last week of that year.

Dropping death and hospitalization rates, largely due to vaccinations and high levels of immunity, prompted the WHO and the United States to end their public health emergencies in 2023. The U.S. government has since reduced reporting of infections and access to free vaccines, tests and treatments. Health professionals, scientists and policy makers now view COVID-19 as an endemic disease, one that's always present and may surge at certain times of year.

In the last five years, scientists have learned heaps about the virus and how to thwart it. The pandemic also highlighted health inequities, flaws in health care systems and the power of collaboration. But it's hard to predict how the United States and other countries will manage COVID-19 going forward, let alone future pandemics.

To understand what's at stake, *Science News* spoke with Al-Aly, epidemiologist Bill Hanage of Harvard University and infectious diseases doctor Peter Chin-Hong of the University of California, San Francisco. The conversations have been edited for length and clarity.

Q What have scientists learned about COVID-19 since the pandemic began?

Al-Aly We learned it's an airborne virus. We learned that, unfortunately, it was [and still can be] fatal. More than 1 million Americans lost their lives. We also learned that it resulted in a wave of chronic disease and disability. There are now more than 20 million Americans living with long COVID.

Chin-Hong We learned the genetic sequence of the virus. We've developed vaccines, including mRNA vaccines that hadn't been used on a wide scale before. We've developed tests, particularly tests at home, which hadn't been favored by the U.S. Food and Drug Administration before this pandemic.

Hanage We learned that a virus can transform itself, such that you get waves of infections. We also learned that the folk evolutionary biology saying, "viruses don't want to kill you, they will evolve to become nicer over time," is false.

We suspected early on that, given many people could be shedding virus without severe symptoms, this was likely to spread like wildfire before anybody knew they were sick.

Q How is COVID-19 monitored now?

Hanage There's still active genomic surveillance, trying to figure out whether the virus [has changed] and which [change will] herald an unusually large surge of infections.

Chin-Hong [Infections are monitored through] wastewater. We can't tell what number of individuals. We just know what variants are circulating. Deaths and hospitalizations are still monitored, although hospitals are not obligated to report data centrally anymore.

Q What do we know about long COVID?

Al-Aly It affects at least 400 million lives across the globe. We recently estimated the economic losses to be about $1 trillion per year. That's about 1 percent of global productivity.

Long COVID can affect nearly every organ system. In some individuals, it can be mild and not disabling. But in others it can be severely disabling, to the point of people being bedridden and losing their jobs. Unfortunately, we have not cracked the code for treating long COVID.

Q How has COVID-19 management changed now that the virus is considered endemic?

Chin-Hong The biggest shift has been in thinking about respiratory viruses as a pack. Many appear in similar ways and at similar times of year. They are also prevented in similar ways, for example, by wearing a mask or getting a vaccine.

There's some danger in forgetting about COVID. It's still causing a significant number of deaths.

↓ A U.S. Army soldier immunizes a woman with the Pfizer COVID-19 vaccine in Miami on March 9, 2021. The Army deployed service members to assist federally supported community vaccination centers across the country.

JOE RAEDLE/GETTY IMAGES

Hanage Researchers are looking at longer-term questions. We still have a lot to learn about how SARS-CoV-2 interacts with the immune system. They matter for devising treatments for long COVID or antivirals.

Q The United States is withdrawing from the WHO. How might that affect COVID-19 management?

Chin-Hong Number one is resources. The United States provides the lion's share [of funding], so the withdrawal will limit the management of world health in general. Number two is siloing. You can't see the whole picture [of global health].

Q Are we ready for future pandemics?

Al-Aly We're even more ill-prepared and in a worse situation because we politicized every single pandemic response. If a pandemic breaks out, I predict that vaccine uptake would be way less than it was for COVID-19, and there would be less enthusiasm for masking and a lot of the public health measures that protected millions of people in the U.S.

Q What if anything from this pandemic gives you hope for the future?

Al-Aly Operation Warp Speed was a human feat. We as a community of scientists, under the leadership of President Trump, realized vaccine development at record speed.

Then, scientists across the globe dropped everything and said, "OK, we're going to focus on long COVID." The patient community ... helped us understand long COVID is happening, alerted the medical community and guided us.

Hanage The people who voluntarily limited their contacts, were caring enough to stay home if they felt sick [and did] not prioritize themselves over the risks to others. ✖

Stauer Impossible Price Was $299, Now $39

Classic Chic — the toast of France

Style and Sophistication for a Fraction of the Price!

I Lost a Fortune at the French Races, but Fortunately I Found This Bag

Ready! Set! Go!" The starting gate opened and 19 horses galloped off, each jockeying for the lead. While Apache, the horse I bet on, was the odds-on favorite, his rival Napoleon pulled ahead in the race's final seconds.

In less than a minute I lost a fortune at the Paris horseraces. After a brief moment of disbelief, something caught my eye. It seemed like every woman in Paris was carrying the same classic handbag! I had to have one for my own, so I had our handbag designers interpret this classic offer. Presenting the **Parisian Chic Claire Handbag**.

Inspired by the equestrian gear I encountered in the stables after the race. The **Claire Bag** is the color of saddle leather with metal adornments that recall horse bits and stirrups. Sturdy and chic, the Claire Bag is ideal for the woman on the go. See for yourself why the **Parisian Chic Claire Handbag** is the toast of France!

Backed by our **satisfaction guarantee**, you can revel in its sophistication risk-free for 30 days. Should it fail to dazzle, return it for a full refund of the item price.

Jewelry Specifications:

- Brown vegan leather.
- 8 1/2"x 4" D x 6 1/2" H, 9 1/2" H w/ handle.
- Two interior open pockets, two interior zipped pockets, one outside zipped

Parisian Chic Claire Handbag

~~$299~~ $39* + S&P *Save $260*

**You must use Insider Offer Code PCH150-01 to get this price.*

1-800-333-2045

Your Insider Offer Code: PCH150-01

ACCREDITED BUSINESS BBB Rating of A+

Stauer®

14091 Southcross Drive W.
Dept. PCH150-01, Burnsville, MN 55337

www.stauer.com

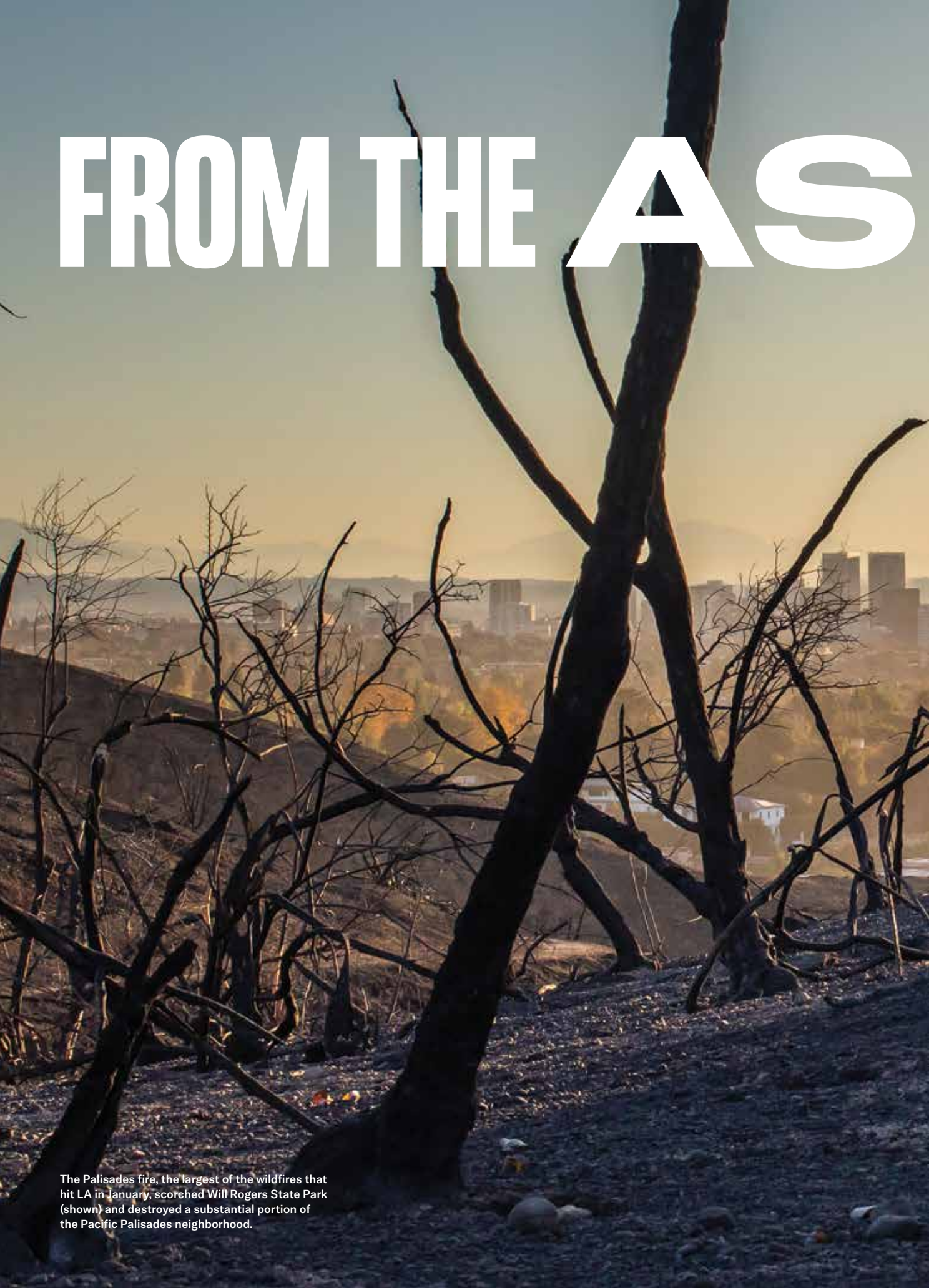
Stauer® | AFFORD THE EXTRAORDINARY.

Sand eel fish are a favorite food of Atlantic puffins, like this one off the coast of England. As North Atlantic waters warm, sand eel fishing is becoming a challenge for the seabirds (see Page 48).

Features

JOHN GRIFFITHS (GRIFF-OGRAPHY) YORK, UK/MOMENT/GETTY IMAGES PLUS

FROM THE AS



The Palisades fire, the largest of the wildfires that hit LA in January, scorched Will Rogers State Park (shown) and destroyed a substantial portion of the Pacific Palisades neighborhood.

HES

APU GOMES/GETTY IMAGES

The wildfires that erupted in the Los Angeles area in January were among the most destructive in California history. Flames incinerated over 20,000 hectares, an area larger than Washington, D.C. Climate change made the dry, windy conditions that drove the infernos 1.3 times more likely, researchers say. Though the fallout is staggering, science can inform efforts to keep people safe from the dangerous aftereffects and help survivors recover. — *Cassie Martin, Deputy Managing Editor*

Rebuilding Mental Health

BY SUJATA GUPTA

↑ A woman hugs her children among the charred remains of their home in Altadena, Calif. The community, not far from LA, was hit hard by the Eaton fire.

MARIO TAMA/GETTY IMAGES

Firefighters have contained the wildfires in Los Angeles County that left at least 29 people dead and destroyed more than 16,000 structures and homes. Now, residents there are starting to grapple with the emotional trauma of the disaster.

People returning to charred neighborhoods to see the extent of the damage face tremendous uncertainty around what the future holds. Helping survivors address their short- and long-term mental health needs after a disaster of this magnitude presents a formidable challenge, experts say.

Connecting survivors with mental health resources is key. But so is addressing other needs not often considered part of mental health care. Economic losses brought on by job loss and other stressors in the months and years following a disaster strongly link to ongoing psychological distress, says public health sociologist Alexis Merdjanoff of New York University. "It's really these longer-term needs that get overlooked."

And those needs are not evenly distributed. A quarter of the people at risk of displacement soon after the fires began, or 74,000 individuals, identified as Latino, UCLA's Latino Policy and Politics Institute reported. Latinos have been more likely to suffer job loss and economic instability in the disaster's wake. Across the county, 85 percent of household workers identify as Latino. In the Palisades fire zone, Latinos comprise just 7 percent of residents but hold 34 percent of jobs.

Science News spoke to social scientists studying disasters to understand how to identify wildfire survivors most at risk of developing mental health problems and how to best support them.

Provide longer-term support

Helping survivors access mental health services is crucial, experts say. Untreated PTSD, for instance, correlates with substance use disorder, chronic health conditions and self-harm. That cascade can in turn strain relationships.

Minimizing other stressors can also alleviate immediate psychological distress, research suggests. Interviews with survivors of Australia's 2003 wildfires in Canberra showed the immense value people placed on visiting charred homes and neighborhoods in the disaster's aftermath. That brief moment let neighbors come together and share their grief, says disaster geographer Christine Eriksen of the University of Bern in Switzerland. Yet officials often prioritize clearing the rubble as quickly as possible. "Removing

rubble before people have a chance to connect with their home is traumatizing," Eriksen says.

In an ideal world, federal and state agencies would extend aid beyond the typical few months to allow people to begin to rebuild mentally, emotionally and physically, Merdjanoff says.

People tend to ignore their mental health to address more pressing concerns in a disaster's immediate aftermath. Extending mental health services beyond a few months could rope in a lot more people in need, she says.

Mental health risks can persist

Direct exposure to the disaster, such as having to evacuate, amplifies the likelihood of receiving a formal mental health diagnosis, particularly for PTSD, depression or anxiety, research shows.

In the weeks after floods devastated Alberta, Canada, in 2013, scientists administered surveys to 300 survivors that asked respondents to rate the material and psychological changes to their lives following a major life event. Six years later, the team zoomed in on 65 respondents from the hardest hit area. Those who scored above a certain threshold were more likely to have elevated levels of PTSD six years after the floods, mental health researcher Eamin Zahan Heanoy and colleagues reported in *Sustainability* in 2023. Some survivors whose homes and livelihoods remained largely intact but reported high psychological distress in the immediate aftermath had high levels of anxiety and depression six years later. The findings suggest that LA officials should closely monitor evacuees and those who are experiencing high distress for longer-term symptoms, says Heanoy, of the University of Alberta in Edmonton.

Merdjanoff's work similarly highlights the importance of paying attention to less impacted individuals and communities. Her team surveyed 1,000 New Jersey households in which at least one member had lived in the area hit by Hurricane Sandy in 2012. Respondents took surveys assessing PTSD and quality of life. The team studied people who were directly and indirectly affected by the storm, such as people whose houses remained intact while ones around them flooded.

About 16 percent of participants experienced psychological distress two years after the storm while 6 percent struggled with PTSD, the team reported in 2022 in the *Clinical Social Work Journal*.

Mental distress lasts longer and affects more people than PTSD, Merdjanoff says. That's probably because even survivors who didn't directly witness the event can endure related stressors.

For example, New Jersey families who lost income were five times as likely to report high levels of distress as those who did not. And families whose homes were structurally damaged reported lower levels of well-being than those whose homes were undamaged and those whose homes were destroyed. Such families were stuck in limbo, often facing costly home repairs.

Socioeconomics up the stakes

Lower-income individuals face more stressors after disaster, such as difficulty finding temporary housing, lack of insurance and more precarious jobs, than higher-income individuals. Those stressors can increase psychological distress and lead to worse access to mental health resources in the long run, says environmental health expert Kate Burrows of the University of Chicago.

Wildfires don't burn dwellings indiscriminately, sociologist Kathryn McConnell adds. About 17,500 residential structures burned in the 2018 Camp fire in northern California. Over 87 percent of mobile homes in the fire zone burned while roughly 78 percent of single-family houses did, McConnell reported in *Landscape & Urban Planning*.

That disparity arises from a variety of factors, says McConnell, of the University of British Columbia in Vancouver. For instance, larger homes tend to have more space between structures, which makes it harder for the radiant heat around a building to ignite the neighboring one.

Such disparities also persist due to post-disaster gentrification. Most of the 600 homes rebuilt 20 months after the Camp fire were owner-occupied and higher in value than they were before the fire, McConnell found. Absent housing support for renters and lower-income individuals, a similar process could play out in LA.

Getting people into more permanent housing, ideally within a few months of the disaster, is the single greatest way to support people's well-being, Merdjanoff says. Stable housing "is the most critical piece to ... self-reported recovery."

Find ways to maintain community

Communities fractured by disaster can lead to long-term isolation, Merdjanoff says. Yet she has seen people get creative to reach the displaced. After official Hurricane Sandy recovery efforts ended, community members set up offices where people could get help with insurance claims, finding contractors and more. Creating those sorts of one-stop shops in LA could go a long way toward helping people recover from the fires, she says. ✖

The Next Risk: Landslides

BY NIKK OGASA

The LA wildfires were still burning when scientists began scouting the freshly charred burn scars to search for signs of another potential danger: roaring torrents of rock and mud and water that can sweep downhill with deadly momentum.

Triggered by intense rainfall, these debris flows become more likely after an intense wildfire has scorched an area's slopes. At least half of their volume is sediment, and it's mixed with burned trees, cars and boulders. "It's like concrete moving downhill," says geologist Jaime Kostelnik of the U.S. Geological Survey in Golden, Colo. Debris flows can carry a lot of material and can swell to five times as high as a flash flood, she says. "Basically, a flood on steroids."

Debris flows can hit speeds of about 56 kilometers per hour as they careen through valleys, canyons and stream channels. Some gain so much momentum that they carve new paths.

Due to their quick and powerful nature, debris flows can be devastating. In January 2018, debris flows in Montecito, Calif., killed 23 people and damaged or destroyed over 400 homes just a month after the Thomas fire started.

The mountainous areas of Los Angeles County are known for debris flows after blazes like the 2009 Station fire and 2016 San Gabriel Complex fire, both of which were near the recent Eaton fire. The steep terrain and the fact that California is in its wet season "leads us to believe that the level of hazard is going to be quite high," Kostelnik says.

Spurred by the threat, she and other scientists began assessing the extent to which the LA wildfires primed the landscape for debris flows, even as new flames roared to life. The findings will inform decisions about when and where to warn people about the hazard. That's crucial, because avoiding debris flows is the only way to stay safe.

Researchers from federal and state agencies have been surveying the areas burned by the Palisades and Eaton fires, the two largest, as well as the smaller Kenneth and Hurst fires.

The field teams first study satellite imagery from before and after the areas burned for changes in vegetation cover. As flames devour leaf litter, the underlying soil loses a protective layer that shields it from erosion by rainfall. That loss is exacerbated if standing vegetation that hampers water flowing across the ground is also incinerated. And the destruction of root systems unbinds dirt and rocks, making them easier to move.

Then there's how the fires alter the dirt. Gases released by burning vegetation can seep into the ground and condense into a waxy substance. The wax prevents water from percolating into the soil, resulting in more runoff on the surface. And heat can disaggregate soil particles, promoting erosion.

Following a fire, it can take just a brief bout of rainfall to trigger a flash flood, and if the rushing water picks up enough sediment, it can evolve into a debris flow. "These things can happen within minutes of a rainstorm," Kostelnik says.

ANATOMY OF A DEBRIS FLOW

Sloped landscapes severely burned by wildfire are at high risk for debris flows after intense bouts of rain, shown in this illustration. The flames alter soil, making it prone to erosion.

SAYOSTUDIO

Guided by the satellite images, the teams enter the burned areas and sample the soils of those most severely burned, says Jeremy Lancaster, a geologist who scouted the Palisades and Eaton burn scars. In each scar, teams assess how deeply and intensely the fires had burned the soil.

"We're typically worried about moderate to high burn severity," says Lancaster, of the California Department of Conservation. In moderately burned areas, up to 80 percent of litter has been burned and surface roots may have been killed, while high severity areas have no litter or surface roots remaining. The Eaton and Palisades fires' burned areas had burned mostly at moderate severity and hydrophobic soil layers had formed.

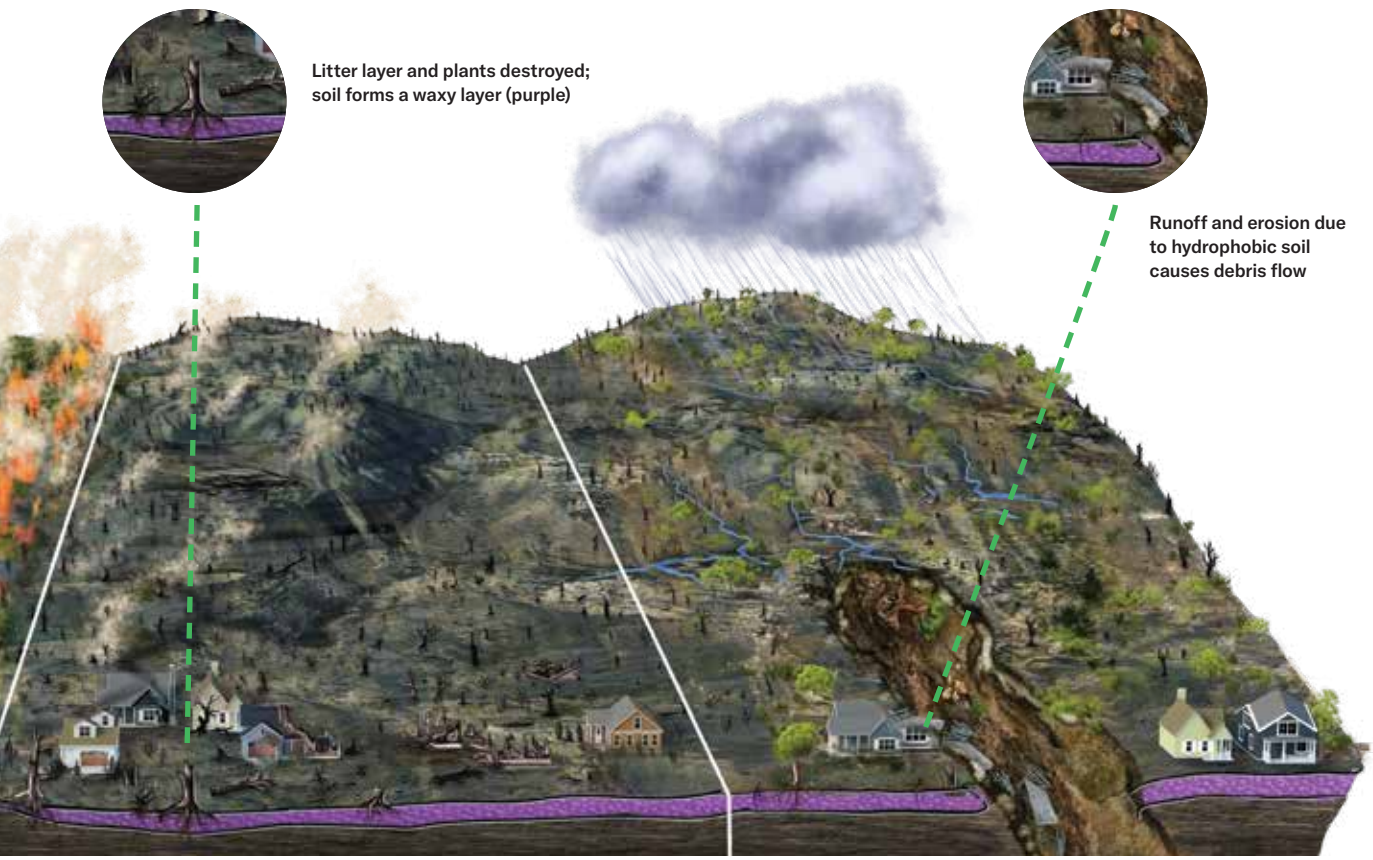
Between the two fire areas, the Eaton fire's burn scar appears to pose greater risk for debris flows. "The Eaton [fire area] has extremely steep watersheds sloping down into Altadena, Pasadena, all the way out to Monrovia," Lancaster says.

The team's observations have helped generate publicly available maps showing where debris flow hazard is greatest. Those maps will later inform decisions by officials to issue alerts and evacuation orders.

Emergency planners try to anticipate debris flows using the maps and weather forecasts. They watch for storms that could drop over a centimeter of rain in 30 minutes, or over a half-centimeter in 15 minutes, on severely burned slopes. Debris flows become much more likely at these rates, says hydrologist Jayme Laber of the National Weather Service in Oxnard, Calif.

About 12 to 36 hours before a storm, the NWS may issue a watch alert if the forecast rainfall could trigger debris flows. Once the storm has arrived, the NWS may warn that debris flows are imminent. "Don't wait for the warning because ... it could be zero minutes of lead time," Laber says. The watch alert is the best time to take action.

Evacuations can be exhausting, especially for people displaced by the fires. Complicating the anxiety is the fact that debris flow risk can stay heightened for two to five years after a fire, Laber says. "It's been really dry, so it might take a couple more years" before LA really starts to recover. ✖



Wildfire-induced changes in soil and vegetation cover

Rainfall-triggered debris flow in burned areas

Toxic Dangers Lurk in LA

BY TINA HESMAN SAEY

The LA wildfires may be extinguished, but an insidious danger remains: chemicals from burned homes, cars and pipes, and even fire retardants that may jeopardize the health of people near burn zones for months to come. Longer-term health effects are also possible.

"There's a general misperception that after the flames go out, the hazard has gone away," says Joseph Allen, director of the Healthy Buildings Program at Harvard University. Wildfires' aftermath may expose people to toxic chemicals and harmful particles in the air and water both outside and inside their homes, Allen warns.

Officials are still assessing the impact from the LA wildfires. But lessons learned from previous fires and from lab experiments can point to ways to return air and water back to prefire safety.

Outdoor hazards

The ash, soot and other pollutants that settle out of smoke can get stirred up by wind and as people move about. And those emissions are not necessarily captured by regional air quality monitors. Even if your city's air "looks good or healthy or green, that doesn't necessarily indicate that the air quality is good around your home," Allen says. That can be a problem for both people living near burned areas and those living kilometers away.

↓ Scorched urban debris such as this car that was burned in the Eaton fire near LA can produce pollutants that invade homes and cause health problems.

ALI MATIN/MIDDLE EAST IMAGES/AFP VIA GETTY IMAGES

What's in the air depends on the fuels that fed the fire. Smoke from burning vegetation is full of fine particles and chemicals, including ozone, sulfur dioxide and volatile compounds that can be hazardous to health. Increasingly, urban areas are burning too, especially as development snuggles up next to wild lands. Burning buildings and vehicles disperse heavy metals, such as lead and copper. Older homes may release asbestos. Plastics and electronics give off noxious chemicals and metals. All can contaminate air, soil and water.

The chemicals used to fight the fire may also pose a risk. Among the many iconic images of the LA fires were low-flying planes dumping fire retardants that painted neighborhoods red.

The main component of the retardant is ammonium phosphate, which is not too concerning for human health, says water quality scientist Daniel McCurry of the University of Southern California in LA. The red hue comes from iron oxide, or rust.

But some retardants, including an earlier version of the product used in LA, have high levels of the heavy metals chromium and cadmium, McCurry and colleagues reported in October in *Environmental Science & Technology Letters*.

Contact with large amounts of some forms of chromium can damage skin and irritate eyes and airways. Prolonged or repeated exposure may raise cancer risk. Short exposure to high levels of cadmium can cause flulike symptoms and may damage lungs. Low-level exposure over time can lead to kidney, bone and lung diseases.

The metals in the fire retardant McCurry tested may be contaminants from the mine where its maker, Perimeter Solutions, gets phosphate, he says. The U.S. Forest Service now uses a version of the retardant that is less toxic to fish. McCurry hasn't tested the new version for heavy metals.

People returning to survey homes should wear protective clothing and remove it before leaving the site to avoid spreading ash and chemicals, says environmental engineer Andrew Whelton of Purdue University in West Lafayette, Ind.

Allen recommends wearing a P100 respirator with filters that catch organic vapors. It also may protect against inhaling leftover retardant.

Water worries

Drinking water and water pipes and tanks may be unsafe after a fire, Whelton says. Chemicals may be introduced when plastic pipes or other

plumbing components burn or get too hot, or when smoke is sucked into the system. Low water pressure and breaks in pipes may also allow microbes to get in. Some cancer-causing chemicals such as benzene, released when plastics burn, can seep into plastic pipes and gaskets and leach out slowly, making water unsafe for a long time.

Levels of chemicals in the water determine whether it is safe for drinking, bathing, laundry or dishwashing. At low levels, "we can bathe in it, but we can't drink it," Whelton says. "But if it's highly polluted, then just having it touch our skin or [smelling it] can make us sick."

Local utilities often warn residents against drinking, bathing or using the water to do dishes. "Pay attention to what officials say, the testing data, and ask a lot of questions," Whelton says.

If water contains harmful levels of chemicals, boiling will not help and can even make things worse. Boiling helps release volatile organic compounds, or VOCs, that settled out of wildfire smoke. People can inhale them and get sick.

Once authorities lift water advisories, residents should contract reputable companies to test their water for contaminants, Whelton says.

Indoor contamination

Wildfire smoke pollutes indoor air and surfaces, too. Some still-standing homes near or within a burn zone may no longer be habitable due to the build-up of toxic chemicals. "Those homes have to be stripped down to their studs and then rebuilt," Whelton says.

That's because homes trap smoke, says atmospheric chemist Joost de Gouw of the University of Colorado Boulder. Take the Marshall fire in December 2021, in Boulder's suburbs. Strong winds whipped small grass fires into an inferno that destroyed 1,084 homes, forced the evacuation of some 50,000 residents and killed two people.

About 11 hours after the fire started, a snowstorm quenched it and scrubbed the outdoor air clean. That let de Gouw and colleagues study how smoke permeated homes without continued contamination from outside air.

In a survey six months after the fire, residents reported finding that ash had crept in through doors, windows and vents upon returning home. People who reported finding ash were more likely to have headaches than those who didn't. Respondents who said their homes smelled different a week after the fire experienced headaches, sore throat, dry cough, irritated eyes and a strange taste in their mouths, researchers reported in January in *ACS ES&T Air*. Those symptoms may have been due to VOCs, the scientists suspect.

> "There's a general misperception that after the flames go out, the hazard has gone away."
>
> **Joseph Allen**

In a companion study, researchers measured VOCs in homes for five weeks. In one heavily smoke-affected home, the VOCs benzene, toluene, naphthalene, furan, furfural and guaiacol were high 10 days after the fire, when the study began. Notably, benzene and toluene levels rivaled those in LA in the 1990s, a decade of bad air pollution when over half of the days on average had unhealthy or hazardous air quality. Concentrations dropped rapidly in the study's first five days and then declined steadily. Indoor levels matched outdoor levels by five weeks after the fire.

In places where fires burn longer and don't get snow or rain to wash ash and smoke out of the air, it may take longer for air quality to return to healthy levels. And not all chemicals dissipate at the same rate, says indoor and atmospheric chemist Delphine Farmer of Colorado State University in Fort Collins. For VOCs that take months, "waiting five weeks isn't going to be enough."

Air cleaners with activated carbon filters can help speed recovery — but only when running. VOC levels in fire-impacted houses can drop close to outdoor levels within an hour after turning a cleaner on, only to rebound when the device is turned off, research has shown. Opening windows can help too, but that's not likely to work in places where outdoor air quality is bad.

The best way to get rid of harmful smoke chemicals is cleaning. Vacuuming, mopping and wiping down horizontal surfaces in a test house reduced VOCs better than air cleaners and kept the air cleaner longer than opening windows, Farmer's team reported in 2023 in *Science Advances*.

But to be effective, cleaning probably needs to be more extensive. Chemicals from smoke attach to surfaces of all kinds, walls and ceilings included. "These gases don't care what room they're in," Farmer says. "And they don't care whether the surface is horizontal or vertical or upside down." ✖

MAKING AI THINK MORE LIKE YOUR BRAIN

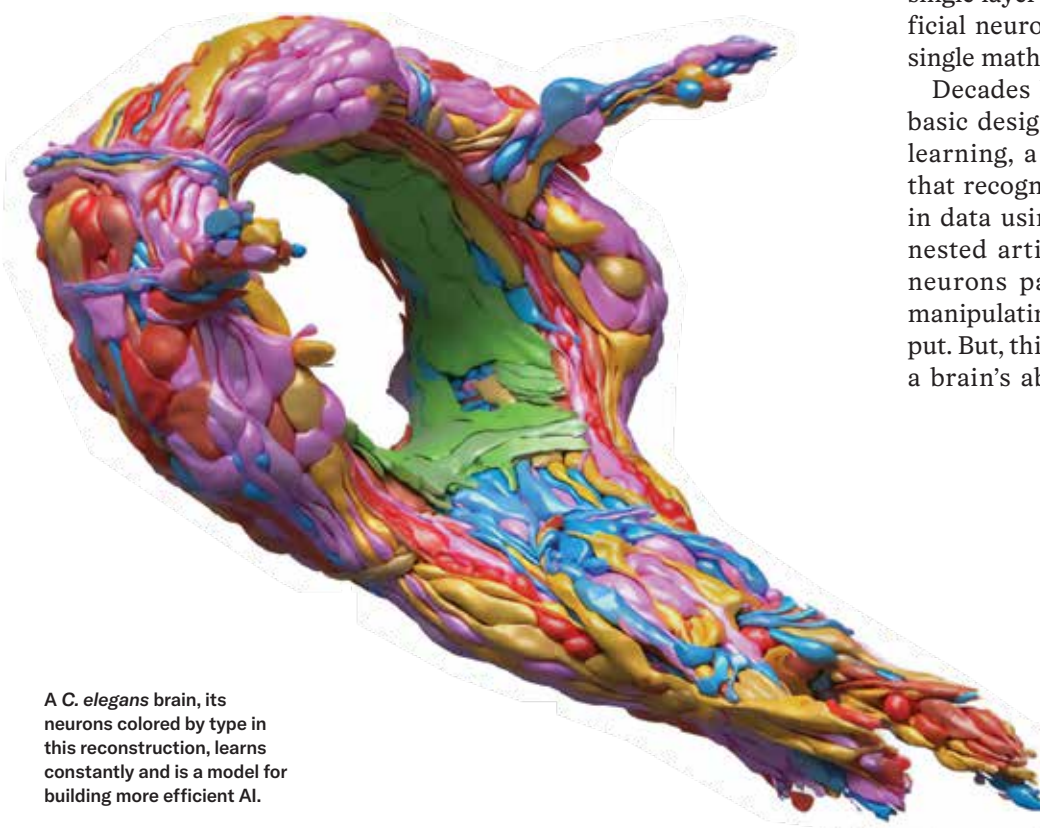
New brain-inspired hardware, architectures and algorithms could lead to more efficient, more capable forms of AI

BY KATHRYN HULICK

ILLUSTRATIONS BY MATT CHINWORTH

The tiny worm

Caenorhabditis elegans has a brain just about the width of a human hair. Yet this animal's itty-bitty organ coordinates and computes complex movements as the worm forages for food. "When I look at [*C. elegans*] and consider its brain, I'm really struck by the profound elegance and efficiency," says Daniela Rus, a computer scientist at MIT. Rus is so enamored with the worm's brain that she cofounded a company, Liquid AI, to build a new type of artificial intelligence inspired by it.



A *C. elegans* brain, its neurons colored by type in this reconstruction, learns constantly and is a model for building more efficient AI.

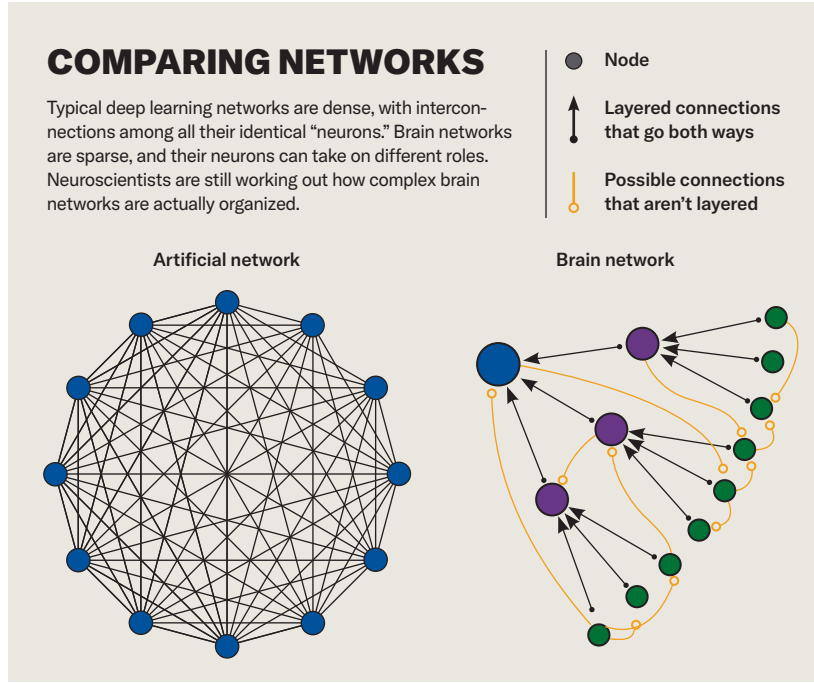
Rus is part of a wave of researchers who think that making traditional AI more brainlike could create leaner, nimbler and perhaps smarter technology. "To improve AI truly, we need to ... incorporate insights from neuroscience," says Kanaka Rajan, a computational neuroscientist at Harvard University.

Such "neuromorphic" technology probably won't completely replace regular computers or traditional AI models, says Mike Davies, who directs the Neuromorphic Computing Lab at Intel in Santa Clara, Calif. Rather, he sees a future in which many types of systems coexist.

Imitating brains isn't a new idea. In the 1950s, neurobiologist Frank Rosenblatt devised the perceptron. The machine was a highly simplified model of the way a brain's nerve cells communicate, with a single layer of interconnected artificial neurons, each performing a single mathematical function.

Decades later, the perceptron's basic design helped inspire deep learning, a computing technique that recognizes complex patterns in data using layer upon layer of nested artificial neurons. These neurons pass input data along, manipulating it to produce an output. But, this approach can't match a brain's ability to adapt nimbly

FROM TOP: HAKAN KVARNSTROM/SCIENCE SOURCE; D. WITVLIET *ET AL*/BIORXIV.ORG 2020



to new situations or learn from a single experience. Instead, most of today's AI models devour massive amounts of data and energy to learn to perform impressive tasks, such as guiding a self-driving car.

"It's just bigger, bigger, bigger," says Subutai Ahmad, chief technology officer of Numenta, a company looking to human brain networks for efficiency. Traditional AI models are "so brute force and inefficient."

In January, the Trump administration announced Stargate, a plan to funnel $500 billion into new data centers to support energy-hungry AI models. But a model released by the Chinese company DeepSeek is bucking that trend, duplicating chatbots' capabilities with less data and energy. Whether brute force or efficiency will win out is unclear.

Meanwhile, neuromorphic computing experts have been making hardware, architecture and algorithms ever more brainlike. "People are bringing out new concepts and new hardware implementations all the time," says computer scientist Catherine Schuman of the University of Tennessee, Knoxville. These advances mainly help with biological brain research and sensor development and haven't been a part of mainstream AI. At least, not yet.

Here are four neuromorphic systems that hold potential for improving AI ↓

1 Making artificial neurons more lifelike

Real neurons are complex living cells with many parts. They are constantly receiving signals from the environment, with their electric charge fluctuating until it crosses a specific threshold and fires. This activity sends an electrical impulse across the cell and to neighboring neurons. Neuromorphic computing engineers have managed to mimic this pattern in artificial neurons. These neurons, part of spiking neural networks, simulate the signals of an actual brain, creating discrete spikes that carry information through the network. Such a network may be modeled in software or built in hardware.

Spikes are not modeled in traditional AI's deep learning networks. Instead, in those models, each artificial neuron is "a little ball with one type of information processing," says Mihai Petrovici, a neuromorphic computing researcher at the University of Bern in Switzerland. Each of these "little balls" links to the others through connections called parameters. Usually, every input into the network triggers every parameter to activate at once, which is inefficient. DeepSeek divides traditional AI's deep learning network into smaller sections that can activate separately, which is more efficient.

But real brain and artificial spiking networks achieve efficiency a bit differently. Each neuron is not connected to every other one. Also, only if electrical signals reach a specific threshold does a neuron fire

J. D. MONACO, K. RAJAN AND G. M. HWANG

and send information to its connections. The network activates sparsely rather than all at once.

Importantly, brains and spiking networks combine memory and processing. The connections "that represent the memory are also the elements that do the computation," Petrovici says. Mainstream computer hardware — which runs most AI — separates memory and processing. AI processing usually happens in a graphical processing unit, or GPU. A different hardware component, such as random access memory, or RAM, handles storage. This makes for simpler computer architecture. But zipping data back and forth among these components eats up energy and slows down computation.

The neuromorphic computer chip BrainScaleS-2 combines these efficient features. It contains sparsely connected spiking neurons physically built into hardware, and the neural connections store memories and perform computation.

BrainScaleS-2 was developed as part of the Human Brain Project, a 10-year effort to understand the human brain by modeling it in a computer. But some researchers looked at how the tech developed from the project might make AI more efficient. For example, Petrovici trained different AIs to play the video game "Pong." A spiking network running on the BrainScaleS-2 hardware used a thousandth of the energy as a simulation of the same network running on a CPU. But the real test was to compare the neuromorphic setup with a deep learning network running on a GPU. Training the spiking system to recognize handwriting used a hundredth the energy of the typical system, the team found.

For spiking neural network hardware to be a real player in the AI realm, it has to be scaled up and distributed. Then, it could be "useful to computation more broadly," Schuman says.

2 Connecting billions of spiking neurons

The academic teams working on BrainScaleS-2 currently have no plans to scale up the chip, but some of the world's biggest tech companies, like Intel and IBM, do.

In 2023, IBM introduced its NorthPole neuromorphic chip, which combines memory and processing to save energy. And in 2024, Intel announced the launch of Hala Point, "the largest neuromorphic system in the world right now," says computer scientist Craig Vineyard of Sandia National Laboratories in New Mexico.

Despite that impressive superlative, there's nothing about the system that visually stands out, Vineyard says. Hala Point fits into a luggage-sized box. Yet it contains 1,152 of Intel's Loihi 2 neuromorphic chips for a record-setting total of 1.15 billion electronic neurons — roughly the same number of neurons as in an owl brain.

Like BrainScaleS-2, each Loihi 2 chip contains a hardware version of a spiking neural network. The physical spiking network also uses sparsity and combines memory and processing. This neuromorphic computer has "fundamentally different computational characteristics" than a regular digital machine, Schuman says.

These features improve Hala Point's efficiency compared with that of typical computer hardware.

"The realized efficiency we get is definitely significantly beyond what you can achieve with GPU technology," Davies says.

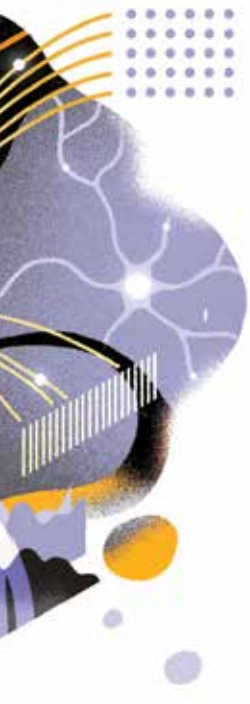
In 2024, Davies and a team of researchers showed that the Loihi 2 hardware can save energy even while running typical deep learning algorithms. The researchers took several audio and video processing tasks and modified their deep learning algorithms so they could run on the new spiking hardware. This process "introduces sparsity in the activity of the network," Davies says.

A deep learning network running on a regular digital computer processes every single frame of audio or video as something completely new. But spiking hardware maintains "some knowledge of what it saw before," Davies says. When part of the audio or video stream stays the same from one frame to the next, the system doesn't have to start over from scratch. It can "keep the network idle as much as possible when nothing interesting is changing." On one video task the team tested, a Loihi 2 chip running a "sparsified" version of a deep learning algorithm used 1/150th the energy of a GPU running the regular version of the algorithm.

The audio and video test showed that one type of architecture can do a good job running a deep learning algorithm. But developers can reconfigure the spiking neural networks within Loihi 2 and BrainScaleS-2 in numerous ways, coming up with new architectures that use the hardware differently. They can also implement different kinds of algorithms using these architectures.

It's not yet clear what algorithms and architectures would make the best use of this hardware or offer the highest energy savings. But researchers are making headway. A January 2025 paper introduced a new way to model neurons in a spiking network, including both the shape of a spike and its timing. This approach makes it possible for an energy-efficient spiking system to use one of the learning techniques that has made mainstream AI so successful.

Neuromorphic hardware may be best suited to algorithms that haven't even been invented yet. "That's actually the most exciting thing," says neuroscientist James Aimone, also of Sandia National Labs. The technology has a lot of potential, he says. It could make the future of computing "energy efficient and more capable."



"I'm excited about Liquid AI because I believe it could transform the future of AI and computing."

—DANIELA RUS

3 Designing an adaptable 'brain'

Neuroscientists agree that one of the most important features of a living brain is the ability to learn on the go. And it doesn't take a large brain to do this. *C. elegans*, one of the first animals to have its brain completely mapped, has 302 neurons and around 7,000 synapses that allow it to learn continuously and efficiently as it explores its world.

Ramin Hasani studied how *C. elegans* learns as part of his graduate work in 2017 and was working to model what scientists knew about the worms' brains in computer software. Rus found out about this work while out for a run with Hasani's adviser at an academic conference. At the time, she was training AI models with hundreds of thousands of artificial neurons and half a million parameters to operate self-driving cars.

If a worm doesn't need a huge network to learn, Rus realized, maybe AI models could make do with smaller ones, too.

She invited Hasani and one of his colleagues to move to MIT. Together, the researchers worked on a series of projects to give self-driving cars and drones more wormlike "brains" — ones that are small and adaptable. The end result was an AI algorithm that the team calls a liquid neural network.

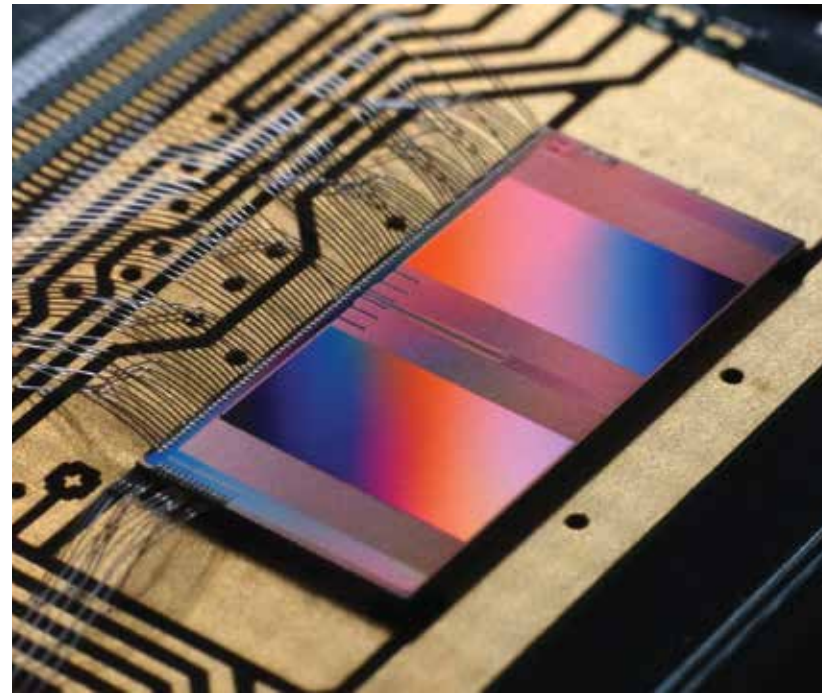
"You can think of this like a new flavor of AI," says Rajan, the Harvard neuroscientist.

Standard deep learning networks, despite their impressive size, learn only during a training phase of development. When training is complete, the network's parameters can't change. "The model stays frozen," Rus says. Liquid neural networks, as the name suggests, are more fluid. Though they incorporate many of the same techniques as standard deep learning, these new networks can shift and change their parameters over time. Rus says that they "learn and adapt ... based on the inputs they see, much like biological systems."

To design this new algorithm, Hasani and his team wrote mathematical equations that mimic how a worm's neurons activate in response to information that changes over time. These equations govern the liquid neural network's behavior.

Such equations are notoriously difficult to solve, but the team found a way to approximate a solution, making it possible to run the network in real time. This solution is "remarkable," Rajan says.

In 2023, Rus, Hasani and their colleagues showed that liquid neural networks could adapt to new situations better than much larger typical AI models. The team trained two types of liquid neural networks and four types of typical deep learning networks to pilot a drone toward different objects in the woods. When training was complete, they put one of the training objects — a red chair — into completely different environments, including a patio and a lawn beside a building. The smallest liquid network, containing just 34 artificial neurons and around 12,000 parameters, outperformed the largest standard AI network they tested, which contained around 250,000 parameters.



This BrainScaleS-2 computer chip was built to work like a brain. It contains 512 simulated neurons connected with up to 212,000 synapses.

The team started the company Liquid AI around the same time and has worked with the U.S. military's Defense Advanced Research Projects Agency to test their model flying an actual aircraft.

The company has also scaled up its models to compete directly with regular deep learning. In January, it announced LFM-7B, a 7-billion-parameter liquid neural network that generates answers to prompts. The team reports that the network outperforms typical language models of the same size.

"I'm excited about Liquid AI because I believe it could transform the future of AI and computing," Rus says.

This approach won't necessarily use less energy than mainstream AI. Its constant adaptation makes it "computationally intensive," Rajan says. But the approach "represents a significant step towards more realistic AI" that more closely mimics the brain.

4 Building on human brain structure

While Rus is working off the blueprint of the worm brain, others are taking inspiration from a very specific region of the human brain — the neocortex, a wrinkly sheet of tissue that covers the brain's surface.

HEIDELBERG UNIV.

"The neocortex is the brain's powerhouse for higher-order thinking," Rajan says. "It's where sensory information, decision-making and abstract reasoning converge."

This part of the brain contains six thin horizontal layers of cells, organized into tens of thousands of vertical structures called cortical columns. Each column contains around 50,000 to 100,000 neurons arranged in several hundred vertical minicolumns.

These minicolumns are the primary drivers of intelligence, neuroscientist and computer scientist Jeff Hawkins argues. In other parts of the brain, grid and place cells help an animal sense its position in space. Hawkins theorizes that these cells exist in minicolumns where they track and model all our sensations and ideas. For example, as a fingertip moves, he says, these columns make a model of what it's touching. It's the same with our eyes and what we see, Hawkins explains in his 2021 book *A Thousand Brains*.

"It's a bold idea," Rajan says. Current neuroscience holds that intelligence involves the interaction of many different brain systems, not just these mapping cells, she says.

Though Hawkins' theory hasn't reached widespread acceptance in the neuroscience community, "it's generating a lot of interest," she says. That includes excitement about its potential uses for neuromorphic computing.

Hawkins developed his theory at Numenta, a company he cofounded in 2005. The company's Thousand Brains Project, announced in 2024, is a plan for pairing computing architecture with new algorithms.

In some early testing for the project a few years ago, the team described an architecture that included seven cortical columns, hundreds of minicolumns but spanned just three layers rather than six in the human neocortex. The team also developed a new AI algorithm that uses the column structure to analyze input data. Simulations showed that each column could learn to recognize hundreds of complex objects.

The practical effectiveness of this system still needs to be tested. But the idea is that it will be capable of learning about the world in real time, similar to the algorithms of Liquid AI.

For now, Numenta, based in Redwood, Calif., is using regular digital computer hardware to test these ideas. But in the future, custom hardware could implement physical versions of spiking neurons organized into cortical columns, Ahmad says.

Using hardware designed for this architecture could make the whole system more efficient and effective. "How the hardware works is going to influence how your algorithm works," Schuman says. "It requires this codesign process."

A new idea in computing can take off only with the right combination of algorithm, architecture and hardware. For example, DeepSeek's engineers noted that they achieved their gains in efficiency by codesigning "algorithms, frameworks and hardware."

When one of these isn't ready or isn't available, a good idea could languish, notes Sara Hooker, a computer scientist at the research lab Cohere in San Francisco and author of an influential 2021 paper titled "The Hardware Lottery." This already happened with deep learning—the algorithms to do it were developed back in the 1980s, but the technology didn't find success until computer scientists began using GPU hardware for AI processing in the early 2010s.

Too often "success depends on luck," Hooker said in a 2021 Association for Computing Machinery video. But if researchers spend more time considering new combinations of neuromorphic hardware, architectures and algorithms, they could open up new and intriguing possibilities for both AI and computing. ✖

"The neocortex is the brain's powerhouse for higher-order thinking."

—KANAKA RAJAN

Kathryn Hulick is the author of *Welcome to the Future* and runs the substack Wow! Tech & Nature.

Patrolling for Puffins

A community in Iceland helps wayward birds find the sea—and helps scientists too

By Jenny Krumrine

A small, rocky island off Iceland is home to the world's largest breeding colony of Atlantic puffins.

When breeding season is in full swing, around 1.5 million adults pair up and nestle into burrows on the grassy seaside slopes above Heimaey island's rocky cliffs.

Once chicks hatch, puffin moms and dads devote about six weeks to caring for their babies, bringing meals of small fish and fending off predators such as seagulls. By late August or early September, the pufflings are mature enough to live on their own. Over four to five weeks, throngs of young birds head off to sea. Their instinct is to head for the open ocean, where they will spend most of their lives. They leave in the dark of night to hide from predators, guided by the moon.

PREVIOUS SPREAD: TCYUEN/MOMENT/GETTY IMAGES PLUS; THIS SPREAD, TOP: RACHEL BENNETT/ISTOCK/GETTY IMAGES PLUS; BOTTOM: J. KRUMRINE

↖ Nesting pairs raise chicks in burrows on the grassy slopes above cliffs on the Icelandic island of Heimaey (left). Parents care for immature pufflings until they can fly off on their own. The downy fluff around this puffling's neck (top) shows that it's not yet ready to fledge. Pufflings leave the burrow under the cover of night and head to the sea, but artificial lighting can disorient them. Heimaey's Puffling Patrol looks for lost birds in town, such as at this gas station (above).

But sometimes fledglings lose their way. Heimaey's only town got electricity about a century ago. Ever since, dazzled by night lights or swept along in stiff sea breezes, some young puffins have taken a wrong turn — toward town.

Light pollution affects wildlife in perilous ways, disrupting crucial activities from pollination to mating. Some creatures, like these Atlantic puffins (*Fratercula arctica*), lose their orientation and can't find their way to the ocean. Some could be attacked by predators; others might starve. Fortunately for these pufflings, the residents of Heimaey have taken a hands-on approach to addressing the problem.

The community-based Puffling Patrol searches for and rescues birds that have gone astray. These chicks — and colony adults — are helping scientists study puffins' largely mysterious lives at sea.

To the rescue

Equipped with flashlights, cardboard boxes and gloves, folks head out after dark searching for lost chicks. They scour backyards, parking lots and rooftops — wherever the bright glow of town competes with moonlight.

On any given night during puffling season, a dozen or more small groups and individuals may be patrolling the town. Rescuing stranded birds is a long-standing tradition on the island, though the catchy Puffling Patrol name has been around for only a decade or so. Typically teens or younger kids scour the night alongside parents or grandparents who pass down the tradition. (For the little ones, it's a great excuse to stay up late.)

Puffins dive from the sea surface to nab food. They zip through the water as if they're flying. But adaptations that enhance swimming, such as a stubby wingspan, come at the expense of take-off ability, which leaves them vulnerable to

cats and other predators on land.

On the upside: The birds are easy to catch. Usually it takes just a short chase to grab one. The bird is put in a cardboard box and taken home. People are asked to weigh their rescued pufflings and log them on the Puffling Patrol website. (The only thing to watch out for are the pufflings' tiny, kitten-like claws.)

The patrol often takes healthy rescues — those large enough to live at sea — to the cliffs. From this height, the birds can catch some air. They'll fly as far as they're able before landing in the water, perhaps 50 meters or more, the farther the better. Some pufflings need a helpful boost — a push — off the clifftop, while others take the initiative on their own.

Some rescues, however, need extra care. While wandering around town, pufflings sometimes fall into the harbor and end up slick with oil from the local passenger ferry, cargo ships and fishing boats. Dirtied feathers must be cleaned to become waterproof again. Otherwise, the birds would not survive in the frigid North Atlantic. Other pufflings may be injured or underfed. And some may have left home too early, before growing their adult plumage.

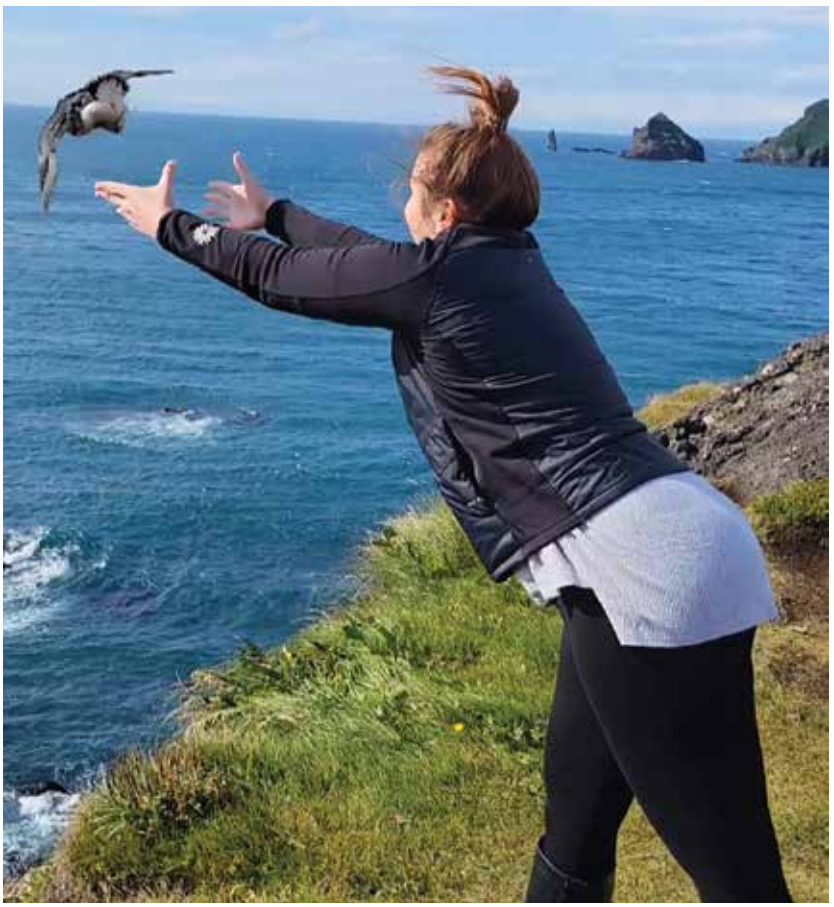
These birds are taken to the Puffin Rescue Centre in Heimaey, run by the global nonprofit Sea Life Trust. There's even a drop box for after-hours arrivals, where pufflings will remain safe through the night.

During the 2024 season, the Puffling Patrol rescued more than 4,200 pufflings — that's approximately one bird for every human on Heimaey.

Life at sea

For about 420 of the rescued birds, scientists put a ring on the puffins' legs. It's an ID band, allowing researchers to document a bird's location each time it's sighted and to monitor their population.

Adult puffins develop a brightly



ALL: J. KRUMRINE

← When members of the Puffling Patrol discover a wayward bird, they put it in a cardboard box to bring home and weigh (opposite page). Birds that are healthy enough will be brought back to Heimaey's seaside cliffs for release. Kim Cupples, a staff member at the Puffin Rescue Centre, gives one puffling a boost toward the sea (above). To help monitor the puffin population, research assistant Lucas Canas Hernandez puts an ID ring on a rescued puffling's leg (left). In the future, if scientists come across the bird again, they'll know how old it is.

colored striped beak and orange feet. This adult appearance does not change much, aside from the beak color getting brighter during breeding season. So the only way to know a puffin's exact age by sight is if it's been tagged. With the rings, scientists have learned puffins can live at least 40 years.

The birds spend most of their lives in the open ocean. Observing birds at sea is nearly impossible, so much about puffins remains a mystery. Ecologists like Erpur Snær Hansen, who leads a team at the South Iceland Nature Research Centre, are curious to know how far puffins roam and where they go.

Each June, Hansen and colleagues briefly capture adults at their burrows — while also checking on eggs — and fit them with battery-operated global location sensors. These geolocators detect changes in daylight, which can be analyzed to pinpoint a bird's location within about 180 kilometers.

On Heimaey, only adult birds are currently tagged with these GLS devices, but other researchers in Scandinavia have begun tracking juveniles as well to learn about their movements after fledging.

For about a decade, Hansen and other researchers have contributed GLS data to SEATRACK, a project that tracks seabirds. The data are revealing what seabirds do offshore, why there are fewer and fewer of them and what humans can do to help them survive.

In Europe, where more than 90 percent of Atlantic puffins reside, the species is listed as endangered. The European population of about 7.8 million birds is projected to decrease by 50 to 79 percent between 2000 and 2065, within three puffin generations.

Puffins face a variety of threats. One of their main food sources is sand eels, a group of slender fish with an eel-like appearance. Sand eel populations are shrinking due to climate change and industrial-scale overfishing. Puffins must compete with other sea life and trawlers for dwindling numbers of these and other forage fish. When sand eels become scarce, puffins must work harder to find them. Puffins stressed this way often produce fewer chicks. Another threat is pollution, including mercury, plastics and contaminants from shipping.

Bird migration studies using SEATRACK data have identified sites in the North Atlantic where restricting human activity and prioritizing pollution cleanup efforts could have a big impact.

For instance, there's a vital feeding ground for about 5 million seabirds, including puffins and 20 other species, in the middle of the Atlantic. Species from at least 56 colonies spanning 16 countries and regions come to this area during the vulnerable molting period, when birds shed worn-out feathers. In 2021, a European consortium called the OSPAR Convention declared this spot a marine protected area: the North Atlantic Current and Evlanov Seamount. It's the first such area identified by tracking data.

↑ The range of Atlantic puffins spans the North Atlantic from the coasts of Canada and the northeastern United States to Greenland and Russia. The birds spend most of their time at sea, returning to land only during breeding season.

BORCHEE/E+/GETTY IMAGES PLUS

Waiting for a homecoming

Once puffling season ends and burrows empty out, Heimaey's seaside cliffs go quiet. Members of the Puffling Patrol catch up on lost sleep and share their favorite pics.

At the end of the 2024 puffling season, three rescues couldn't be released and now live in an enclosure at the Puffin Rescue Centre, where visitors can watch their antics.

Meanwhile, Iceland's puffin researchers wait patiently for the birds' summer return. Adult puffins return to the same colony — even the same burrow — year after year. With the data collected from these birds, Hansen and other scientists will weave together the story of each wanderer's ocean journey. ✖

Jenny Krumrine is a science journalist in Pennsylvania.

Fundamentals First Fund

An ETF
Symbol KNOW

Your money
Carefully managed

Abstract

The Fundamentals First Fund, an ETF, is part owner of approximately 100 publicly traded worthy companies, and it owns publicly traded debt. These worldwide companies are vital, important, useful, or just plain nice to have around, and most have been pursuing their business course for decades. We individually select these companies with care and in a manner as to spread our risk so that no single company event can cause more than a bruise. Mason Capital has managed money this way for more than three decades. If you are more specifically interested in who we are, how we do it, and how you might participate, read on.

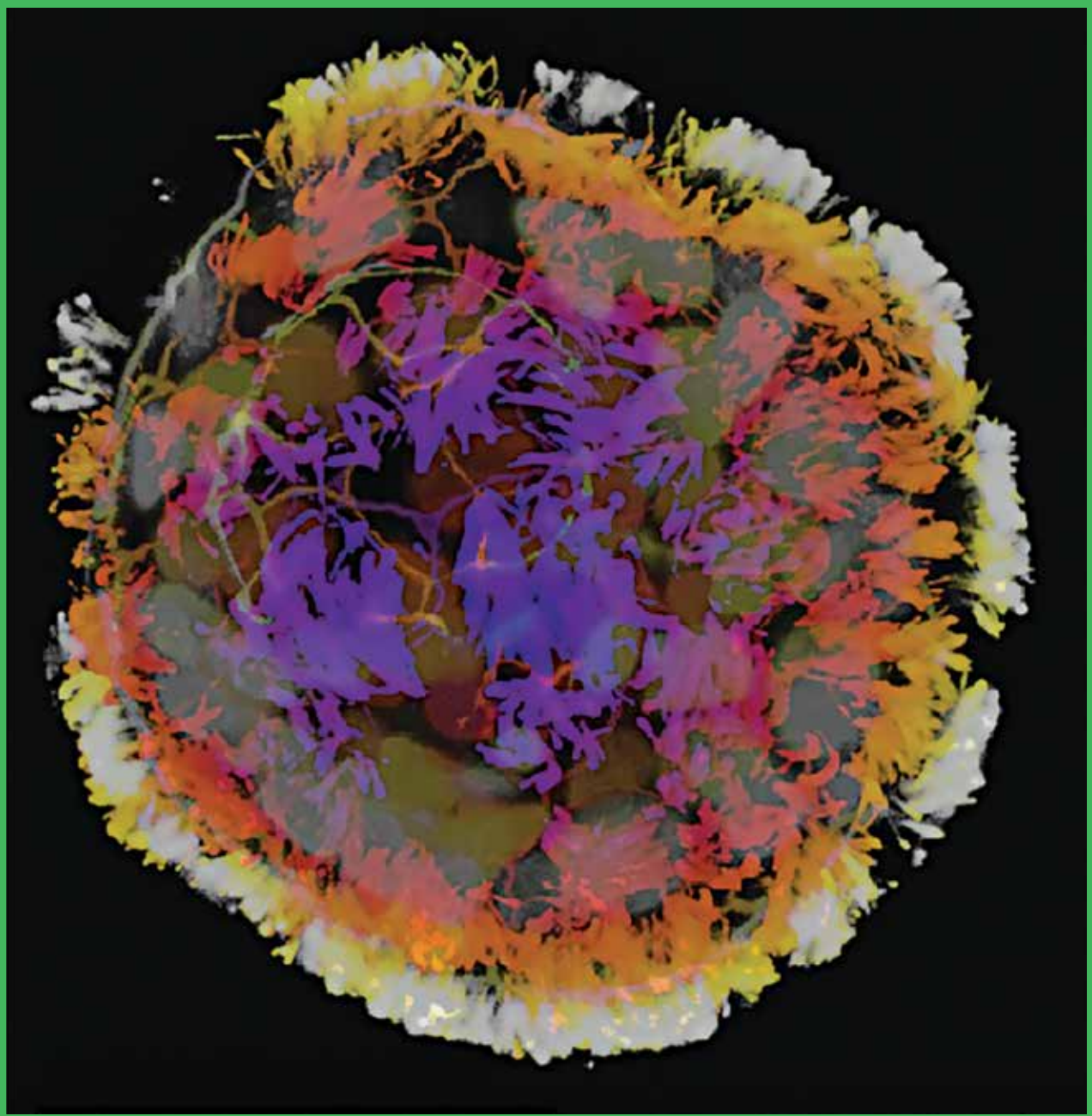
www.FundamentalsFirstFund.com

(Our Website Has a Lot About Us)

2/21/24 IPO Market Open:	**$10.00**
12/31/24 Market Close:	**$10.72**
Dividends Paid:	**$ 0.14**

Investors should consider the investment objectives, risks, charges and expenses carefully before investing. For a prospectus or summary prospectus with this and other information about the Fund, please call 617-228-5190 or visit our website at www.fundamentalsfirstfund.com
Investments involve risk. Principal loss is possible.
Quasar Distributors LLC.

Curiosities



G. GUMUSKAYA *ET AL*./*ADVANCED SCIENCE* 2023

HEALTH & MEDICINE

RISE OF THE ANTHROBOTS

● First there were xenobots, microscopic "living machines" made of frog cells that swim, move particles and heal themselves. Now meet another iteration: anthrobots. The devices, made of human bronchial cells, take healing to the next level (the one shown is about 100 micrometers wide, and colors indicate tissue depth). When applied to scratched nerve cells in a dish, anthrobots bridged the wound, helping it heal, researchers report in *Advanced Science*. The team envisions the bots could be used to deliver drugs, clear clogged arteries and more. —*Cassie Martin*

CHRONICLING THE SCIENCE OF LIFE IN THE SKY

By Andrea Tamayo

AIR-BORNE | *Carl Zimmer*
Dutton | $32

On March 10, 2020, 61 choir members rehearsed in a church hall in Skagit County, Wash. As they sang, a microscopic germ wafted through the air. Before the month's end, 58 members were infected and five fell gravely ill. Across the United States, the virus wreaked havoc. Within weeks, thousands of people died, schools and businesses shuttered and 700,000 people lost their jobs.

Many scientists determined in 2020 that the coronavirus spread through the air, but it would take public health agencies months longer to acknowledge that. The Skagit County superspreader event helped the World Health Organization and the U.S. Centers for Disease Control and Prevention to consider the airborne transmission of COVID-19. But to this day, some scientists believe the delay in calling the virus airborne was a mistake — one that stalled vital public health measures and allowed the disease to spread faster. In his new book, *Air-Borne*, science journalist Carl Zimmer roots the "mistake" in the past of a historically neglected field: aerobiology, or the science of airborne life.

Zimmer begins his chronicle in the 19th century with Louis Pasteur's summit up a towering glacier in the French Alps. As part of a grand experiment, the microbiologist tipped a glass chamber to the sky, snared life and proved that microscopic germs floated in the air. Pasteur's discovery inspired generations of scientists to look for airborne life themselves, including pathologist Fred Meier, who stuck Petri dishes out of various aircraft and ultimately named the field.

Through the stories of Pasteur, Meier and dozens of other scientists, Zimmer seamlessly weaves together centuries of aerobiology science. He richly humanizes the characters with honesty and complexity, simultaneously highlighting the publicly revered and the unsung. His pithy, punchy and accessible language gives life to glamorous experiments, like those conducted from hot-air balloons, as well as unassuming ones run in university basements.

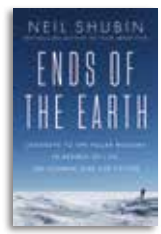
But aerobiology is more than science-laden joyrides through the sky. The field was mired in humankind's darkest moments, which Zimmer brings out of the shadows and into the light. Aerobiologists were central to debates on how life-threatening diseases like the Black Death, cholera and tuberculosis spread. And while some scientists worked to fight airborne infections, others committed to creating them,

Aerobiology is more than science-laden joyrides through the sky. The field was mired in humankind's darkest moments, which Zimmer brings out of the shadows and into the light.

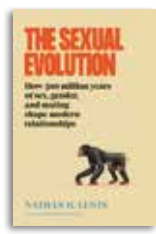
Zimmer writes. During World War II, the United States was one of several countries to create biological weapons. Some U.S. researchers helped build an arsenal of deadly germs and spores to potentially use against the nation's enemies. For years after the war, aerobiology remained shrouded in secrecy and was largely ignored by public health officials. It wasn't until COVID-19 that this began to change.

Readers will end the book with a better understanding of just how high life can fly and how far public knowledge of aerobiology has come. It's a reminder that the current decisions humans make regarding airborne life is informed by a deep history. Zimmer concludes his chronicle with a vision of harmonious coexistence with the life that teems in the atmosphere: "As long as there is life on Earth, it will fly, and as long as we are here, we will breathe." ✖

OTHER BOOKS ON THE SHELF

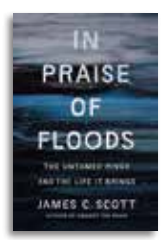


ENDS OF THE EARTH | *Neil Shubin*
Dutton | $32
A renowned evolutionary biologist takes readers on an expedition to the icy landscapes of the Arctic and Antarctica. In Earth's frigid polar regions lie clues that are helping scientists understand the past, present and future of our changing planet.



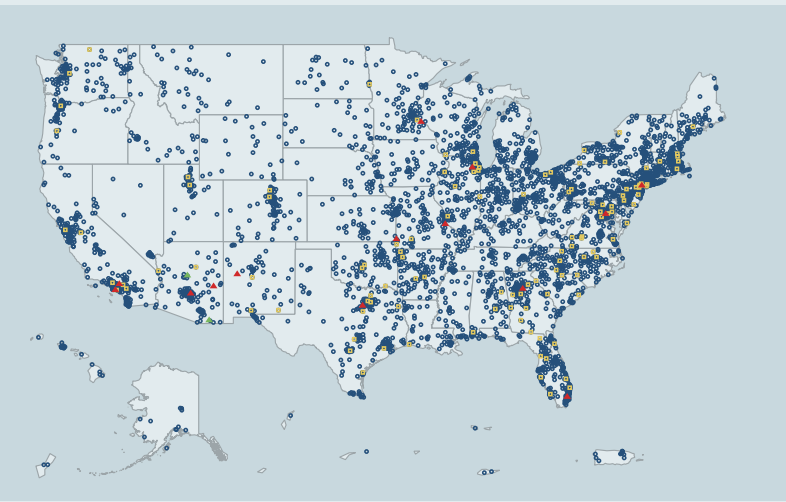
THE SEXUAL EVOLUTION | *Nathan H. Lents*
Mariner Books | $32
Journey through the animal kingdom to explore the richness of its sexual diversity. From whiptail lizards' same-sex interactions to bonobo's use of sex for conflict resolution, nature's vast array of sexual behaviors will help humans understand their own, an evolutionary biologist contends.

DOCTORED | *Charles Piller*
Atria/One Signal Publishers | $28.99
An investigative journalist uncovers a vast network of corrupt and self-interested researchers, regulators and corporate players that has hindered Alzheimer's disease treatment. Along the way, he reveals a group of renegades fighting back in service of science and patients living with the disease.



IN PRAISE OF FLOODS | *James C. Scott*
Yale Univ. | $28
In this posthumously published account, an esteemed anthropologist examines how human interventions such as dams, irrigation, dikes and levees can suppress rivers' annual flood pulses, threatening the life-forms and ecosystems that depend on them. ✖

Expanding Student Science Literacy



Serving as Science News Learning Ambassadors for the 2024–2025 school year, STEM educators Cara Hale-Hanes (above left), Rosalyn Parson (center) and Tandi Steffens (right) are teaching science literacy using current, real-life examples. Science News Learning, a sponsored program of Society for Science, helps educators incorporate science research into core curricula by providing access to Science News Media Group's journalism and a library of ready-to-use lesson plans.

Science News Learning Ambassadors also lead professional development sessions to share their strategies with fellow educators and develop new lesson plans using program materials.

HALE-HANES, a chemistry teacher at Ernest McBride High School in Long Beach, Calif., is developing lesson plans on sustainability and materials, which help students make meaningful connections between classroom content and global issues.

PARSON, a biology and environmental science teacher at Friendship Public Charter School in Washington, D.C., is expanding her students' science literacy by discussing content-specific articles, which supports her school's reading initiative.

STEFFENS, the science teacher at Grandview Middle School in Grandview, Mo., is developing "NewsDay Tuesday" activities that allow students to explore scientific concepts through the lens of current events. She is also creating lesson plan templates to help teachers incorporate current STEM research into their classrooms.

"I use Science News Learning lesson plans as a starting point when I find articles related to the unit's topics," Steffens says. "I love the leveled articles because they let my students cover the same material at their level, preventing the stigma of alternate assignments for students at lower reading levels."

Nearly 6,000 middle and high schools and more than 17,000 educators in all 50 states and five territories are expanding student science literacy with Science News Learning. In total, over 6 million students have access to program resources.

In the map above, blue circles are enrolled schools, yellow squares are enrolled districts or geographical cohorts, red triangles are program ambassadors and green triangles are rural STEM ambassadors or fellows.

SOCIETY FOR SCIENCE

LEARN MORE AND SIGN UP FOR THE SCIENCE NEWS LEARNING PROGRAM: WWW.SOCIETYFORSCIENCE.ORG/SCIENCE-NEWS-LEARNING

Society for Science is a nonprofit organization best known for our award-winning journalism, world-class STEM competitions and suite of Outreach & Equity programming activities. For more than a century, our mission has been to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, and inspire.

VOL. 207 NO. 03 | MARCH 2025

Location, location

● *Scientists launched a rocket from Svalbard, Norway, that measured Earth's ambipolar electric field for the first time. The weak field may control the shape and evolution of the upper atmosphere and may contribute to Earth's habitability, astronomy writer Lisa Grossman reported in "At long last, scientists detect Earth's hidden electric field."*

Reader Jayant Bhalerao, a college physics instructor, found the story useful in class: "We will share it with our students, so that they can appreciate how things they are learning in the textbook have real-life applications."

Bhalerao also wondered why scientists chose Svalbard as the rocket's launchpad. "Is there perhaps a scientific reason, or is it just infrastructure?"

To measure the ambipolar electric field, the rocket needed "to measure the escape of Earth's atmosphere at the poles, where some of the planet's magnetic field lines are open," Grossman says.

"Earth's magnetic field is kind of like a bar magnet, with field lines running from the North Pole to the South Pole in big closed loops. In these loops, charged particles are kept contained to Earth's vicinity," Grossman says. But at the poles, some field lines shoot out into space, allowing charged particles to escape. "The only launchpad that's far enough north to reach that open magnetic region is the one in Svalbard," she says.

Measuring mergers

● *Scientists are becoming increasingly optimistic about the possibility of detecting primordial black holes. If they exist, these ancient black holes born just after the Big Bang may shed light on the mysteries of dark matter, freelance writer Elizabeth Quill reported in "Black Hole Dawn."*

Cosmologists hope to spot signs of primordial black holes by studying black hole mergers, especially those with bizarre features, such as unexpected masses and spins.

Reader Michael Cross asked how scientists determine those black hole properties.

Scientists can observe black hole mergers through gravitational waves, which provide all sorts of information about the colliding bodies, says senior physics writer Emily Conover. As black holes spiral inward and merge with each other, scientists can detect "the patterns of waves, how strong the waves are and how frequently they oscillate. They also look at how those patterns compare between multiple detectors," Conover says. Black holes with different masses or spins "will give different patterns of waves."

"We will share it with our students, so that they can appreciate how things they are learning in the textbook have real-life applications."

January 2025

Tip of the hat

● Reader Philip Korb shared a note of appreciation for the January issue.

"Your new expanded and glossy magazine is dazzling. Beautiful ... and with even more in-depth reporting. The AI in Medicine article was comprehensive, the human navigation article confirmed what using GPS has demonstrated, and the role of guano in creating the American empire fascinating," Korb wrote. "*Science News* is an invaluable contributor to American life."

Korb's wife, Sandra Wolf, M.D., started reading *Science News* as a child, back during its newsletter years. Wolf has maintained the subscription for decades, sharing it with Korb when they married.

PLANTS AND FUNGI CAN HELP ROBOTS LEVEL UP

BY AARON TREMPER

In the TV series *Doctor Who*, treeborgs supply fresh air to spaceship passengers. Part tree, part robot, these devices convert starlight into oxygen. In Nnedi Okorafor's fantasy novel *Zahrah the Windseeker*, children receive their own "flora computers" made of leaves and vines, grown from CPU seeds and shaped into useful tech. Although these devices are fictional, flower-powered machines are getting real as a new generation of biohybrid technology blooms.

Engineers have long strived to make lifelike robots. But re-creating the complex functions of, say, a hand or leaf is impossible with synthetic materials, says Anand Mishra, an engineer at Cornell University. "There is a point where technology limits us."

Using life-forms to build machines can overcome some of these limits. Living tissue, for example, has evolved all sorts of ways to scope out the environment — seeing light, feeling warmth, smelling and tasting food. To make robots that are similarly sensitive to their surroundings, Mishra has turned to fungal tissue.

Fungi aren't plants, but Mishra is interested in one of fungi's most plantlike features, mycelia. These rootlike structures tunnel through soil for nutrients and can detect environmental cues such as light, heat and chemicals.

Mishra's team grew mycelia directly into electrodes attached to two robots. The fungi communicated with the robots through electrical signals called action potentials. These zaps are similar to those produced by heart and nerve cells.

Mycelia produce spontaneous action potentials, which triggered the biobots to walk and roll around. When flashed with ultraviolet light, the mycelia produced stronger zaps, which changed the robots' gait and showed that the bots could respond to the environment, Mishra's team reports in *Science Robotics*.

Using fungi in biohybrid robots is still "pretty new," Mishra says. His team now hopes to test how such tech responds to other cues, such as gases. One way their robots' sensory superpowers might help in the real world is in agriculture. Future "shroom" bots could walk through crop fields, testing soil health and

LAURIE GREASLEY

other conditions as they go.

While fungi may help robots better interact with the world, plant powers could help devices better survive it. "Many artificial [technologies] have a shelf life," says materials scientist Fabian Meder of the Sant'Anna School of Advanced Studies in Pisa, Italy. Electronics start to break down in a few years. Yet the oldest trees can stand tall for thousands of years. And while broken electronics require repairs, plants can recover from damage and adapt to new environments.

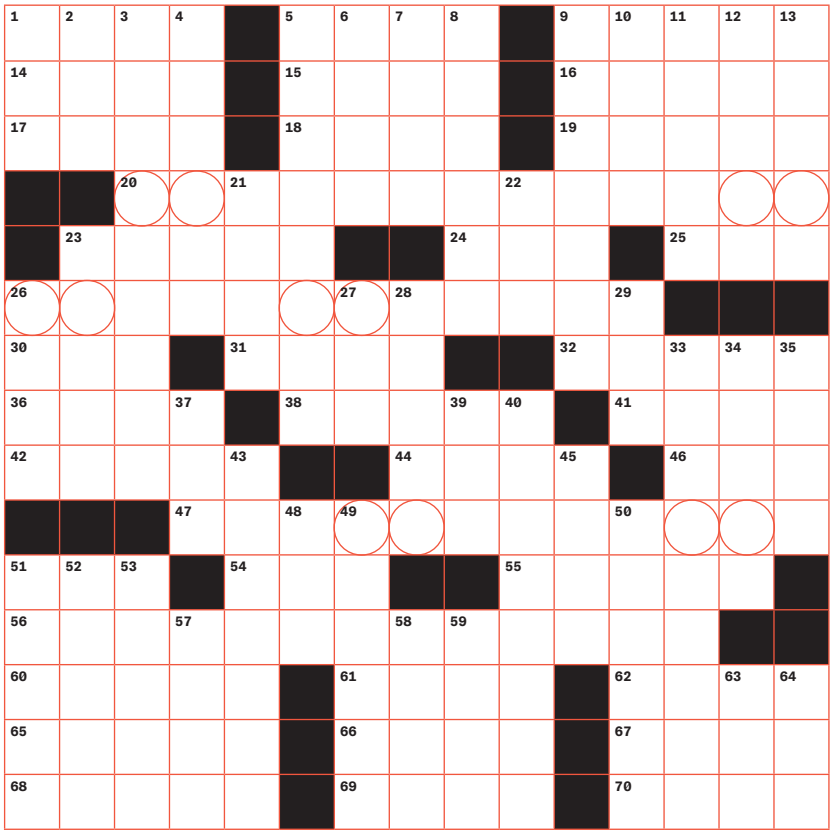
Meder has designed artificial leaves that tap an unlikely energy source: static electricity created by wind.

He places artificial leaves on plants. The fake leaves include a layer of rubber — a material good at building up static charge. When wind rustles one of these bionic plants, the artificial leaves bump into real leaves. This creates static charges that pass into the inner tissue of the real leaf, producing a current. This energy can be harvested through electrodes placed in the leaf. Meder's studies have shown that such devices can light up LEDs.

Working with living materials poses design challenges, such as keeping the living parts alive. Like fungi, plants need certain resources to stay healthy. "Photosynthesis is a big part of that," Meder says. So engineers might need to use transparent materials to make parts that would otherwise block out sunlight.

Meder is excited about this new way to tap a potential energy source: "It's always about harvesting [these] crumbs of energy which we otherwise would just lose."

Almost like those *Doctor Who* treeborgs surviving on the light of faraway stars. ✖



BURIED TREASURE

BY SHANNON RAPP AND REBECCA GOLDSTEIN

The hunt for treasure is often associated with pirates. But you don't have to be a freebooter to find these hidden answers. Inspect the clues and piece together words and phrases — and you just might uncover some shiny bits.

ACROSS

1 Mountain range from where the Rhine and Rhône begin flowing
5 Soy-based protein
9 Substance excreted through the skin
14 Hooves and paws, e.g.
15 State firmly
16 Yo-Yo Ma's instrument
17 ___ pool (seaside habitat)
18 ___ blocker (kind of drug)
19 What comes in waves?
20 *High fiber breakfast wrapped in aluminum?*
23 Bowling locale
24 Purpose
25 News feed letters
26 *Ropa vieja and a cortadito popular with copperheads?*
30 Big fuss
31 Darkens in the sun
32 Crabwalk
36 "You're making that up!"
38 Inclines
41 "Shoot!"
42 Adjacent over opposite, in a trig class
44 Nobel laureate Kandel
46 "The Pearl That Broke ___ Shell" (novel)
47 *Nursery rhyme character with platinum highlights?*
51 H.S. classes recognized for college credit
54 Hostile dog
55 Gradually wear away
56 *Beachcomber's device that could be set off by each pair of circled letters*
60 Braggy phrase
61 Sonic the Hedgehog game company
62 Small drinks
65 Knife brand
66 Drop produced by a lacrimal gland
67 Messy pile
68 Midrange singers
69 1, 3, 5, 7, 9, etc.
70 Govt. org. overseeing food safety

DOWN

1 Toward the rear, on a ship
2 Floral accessory
3 Rental that requires a little legwork?
4 Apt name for an astronomer
5 Striped feline friend
6 Rise ___ run (formula for the slope of a line)
7 Crumbly cheese
8 First planet discovered with the aid of a telescope
9 Smartphone interfaces
10 Don, as a lab coat and safety goggles
11 Community member who paved the way, say
12 Fake ID?
13 Implements chimpanzees use in the wild
21 Post-Mardi Gras observance
22 CBS series featuring forensic labs
23 A/V component?
26 Integral math course?
27 Sea urchin, at a sushi bar
28 Group of pancreatic cells that secrete hormones
29 "___ Mubarak" (holiday greeting)
33 Hangs out in the sun?
34 Drink that might have a foamy design
35 Website with DNA-shaped jewelry
37 Cheering cry
39 Make an attempt
40 Sour brandy cocktails
43 Cellular data center?
45 Rudely abrupt
48 Substance that can harden into sedimentary rock
49 Exclamation after a vanishing act
50 ___ pork (Chinese dish)
51 Commodore computer line with a friendly name
52 Danger
53 Move in an action scene
57 Too
58 Got ready to drive down the fairway
59 "Zounds!"
63 Protection for a goalie
64 Place to get a glycolic acid peel

Visit **sciencenews.org/puzzle-answers** for answers. We will publish science-themed crossword puzzles and math puzzles on alternating months. We'd love to hear your thoughts at **puzzles@sciencenews.org**.

COULD YOU BE AN ELLISON SCHOLAR?

Drive tech innovation while studying at the University of Oxford

- University studies complemented by an **innovation internship** at EIT Oxford
- Access to **state-of-the-art facilities** to develop and deploy world-benefitting technologies
- Generous financial package including full **scholarship** and living costs
- Receive mentorship from **world leaders** in your field

VISIT OUR WEBSITE

eit.org/scholars

EIT
Ellison Scholars

UNIVERSITY OF OXFORD

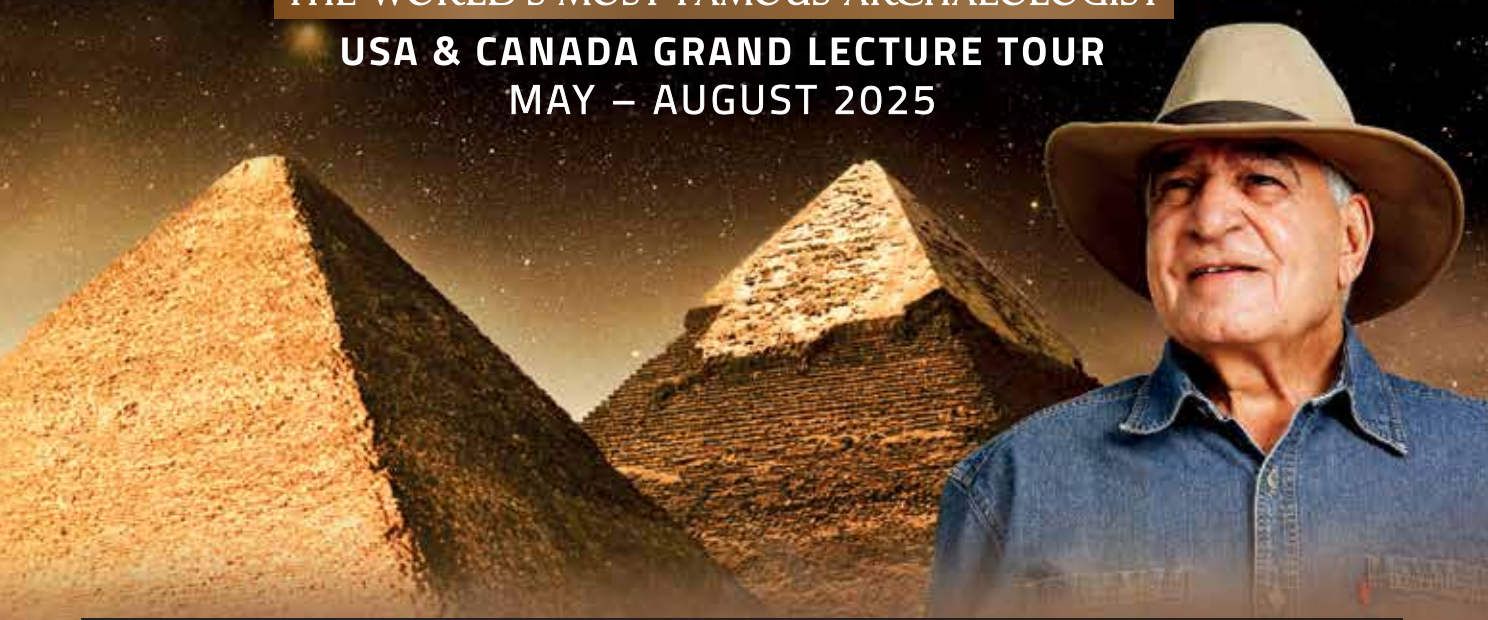
NEW SECRETS OF ANCIENT EGYPT – GROUNDBREAKING DISCOVERIES

A ROYAL EVENING WITH DR. ZAHI HAWASS

EVENT of the YEAR!

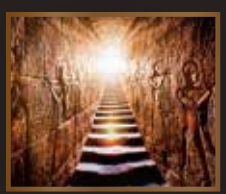
THE WORLD'S MOST FAMOUS ARCHAEOLOGIST

USA & CANADA GRAND LECTURE TOUR
MAY – AUGUST 2025



THE LOST PYRAMID • MISSING ROYAL TOMBS • NEW FINDS AT THE VALLEY OF THE KINGS • PROGRESS IN THE GOLDEN CITY




THE SEARCH FOR CLEOPATRA'S TOMB • SECRET ROOMS IN THE GREAT PYRAMID • KING TUT'S UNTOLD SECRETS • & MORE REVELATIONS!

Discover the greatest secrets of the Land of the Pharaohs! The time has come for the legendary Dr. Zahi Hawass to unveil ancient Egyptian mysteries that were lost for millennia.

The real-life Indiana Jones returns to North America to share the latest discoveries, reveal groundbreaking finds drawn from his most recent excavations and make the most thrilling announcements of his remarkable career. **This event will make history – live on stage – and you won't want to miss it!**

Join Dr. Hawass for a captivating all-new multimedia presentation prepared exclusively for this historic tour. Stay after the lecture for a Q&A session and a book signing.

May 1	Phoenix, AZ
May 3	Los Angeles, CA
May 6	San Diego, CA
May 9	Las Vegas, NV
May 11	Oakland, CA
May 14	Portland, OR
May 18	Seattle, WA
May 22	Denver, CO
May 25	Austin, TX
May 27	Oklahoma City, OK
May 29	Dallas, TX
June 1	New Orleans, LA
June 5	Tampa, FL
June 7	Orlando, FL
June 11	Nashville, TN
June 14	Atlanta, GA
June 16	St. Louis, MO
June 18	Charlotte, NC
June 21	Pittsburgh, PA
June 25	Columbus, OH
June 28	Chicago, IL
June 30	Minneapolis, MN
July 3	Cleveland, OH
July 6	Indianapolis, IN
July 9	Boston, MA
July 12	Baltimore, MD
July 16	Virginia Beach, VA
July 19	New York, NY
July 21	Philadelphia, PA
July 23	Washington, DC
July 26	Vancouver, BC – Canada
July 30	Toronto, ON – Canada
August 2	Montreal, QC – Canada

Seats are limited – Register now

www.ZahiLectures.com

contact@zahilectures.com

646-757-1717