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JUNE 2026

ScienceNews

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Illustration by Matthew Kam

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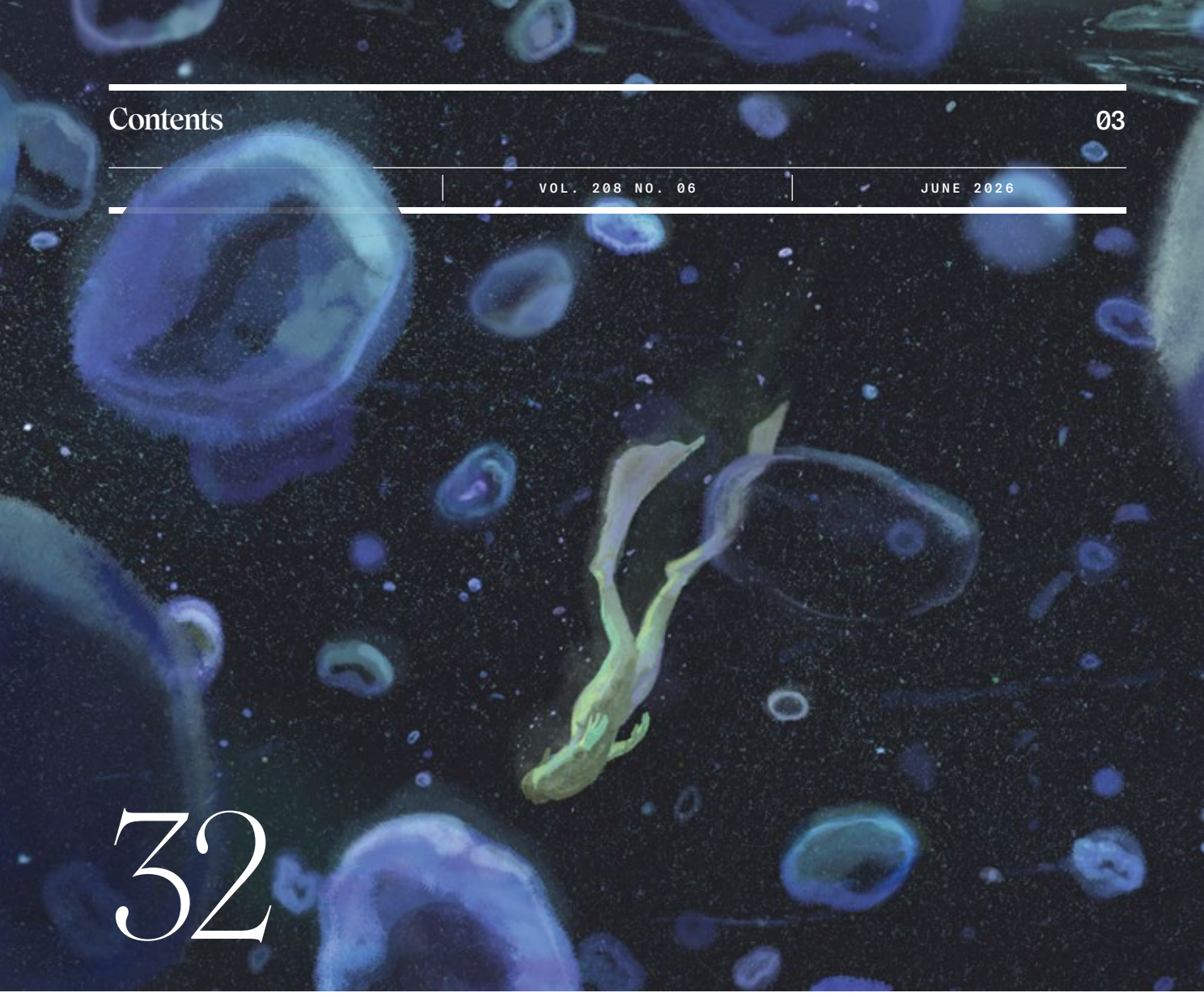

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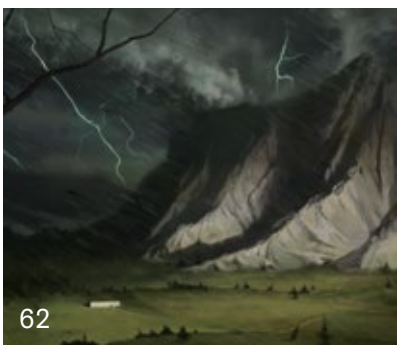

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FROM TOP: XIAO HUA YANG; GRACE ALDRICH

The science of us

Humans are complicated creatures; studying them is complicated, too. The social sciences contain as many as 12 core disciplines, depending on who's counting. And they range widely, from anthropology, psychology and sociology to more quantitative fields like economics and demographics. Being able to grasp the vast variations in human activity, from one person's mental state to the movements of nations, is essential for navigating the chaotic times we live in.

To keep you current on the science behind hot button issues in the news, we're expanding our coverage of the social sciences with a new column, Being Human, in this issue (Page 60). First up: whether trying to encourage people to have more babies, an idea being put forth by pronatalist movements in the United States and elsewhere, will help reverse falling birth rates, and whether that should be a goal.

Our social sciences writer Sujata Gupta dug into the research and found that government incentives aimed at encouraging individuals to have more children have rarely succeeded. That's especially likely now, when young people are struggling to find jobs and affordable housing, and when the headlines get scarier by the day.

"Whether you are liberal or conservative, the way we think about the family is the nuclear family," Gupta told me. But, she notes, the notion of a family being just parents and kids is a surprisingly recent invention, and one that puts a lot of pressure on parents. As a married working parent whose own parents are far away, Gupta has been feeling that pinch herself.

Evolutionary history shows that humans have long relied on cooperative child-rearing approaches that included extended kin, older siblings and community members. Some current hunter-gatherer societies continue in that mode, Gupta reports, but it would be hard to emulate in Western societies.

A better focus for encouraging parenthood, experts say, may be on improving well-being in a community overall. Policies that support all inhabitants may make it more likely that young adults will feel secure enough to take the big leap into parenthood, and that their children will feel secure too, Gupta says. That's a much larger undertaking than, say, sending new parents a check in the mail. But it might make society work a little better for all.

Nancy E. Shute

Nancy Shute
Editor in Chief
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ELIZABETH PENNISI

FREELANCE SCIENCE JOURNALIST

● ELIZABETH PENNISI DUNKED HER HEAD into a tank of cold water, holding her breath while pedaling a stationary bike. After 30 seconds, she popped up for air for one minute before plunging her head into the water again. And again. And again. This wasn't self-torture: She was participating in an experiment run by integrative physiologist Erika Schagatay to identify the signs of an impending blackout in divers. Pennisi traveled from Washington, D.C., to Mid Sweden University in Östersund to meet Schagatay and learn about the science of freediving (Page 32). An avid swimmer, Pennisi thought she would be able to repeat the process for a long time. She was disappointed when, after the seventh round, she needed to rest for longer to hold her breath again. "It drove home to me how we make assumptions about things," Pennisi says. "We really don't know unless we test them."

Sujata Gupta
Our new social sciences column, Being Human, debuts with a look at the pronatalist movement (Page 60). Some pronatalists advocate for increasing birth rates by targeting the nuclear family. But that family structure is at odds with how humans evolved, social sciences writer Sujata Gupta reports. The best way to boost populations, many scientists argue, is to build and support communities. But Gupta knows that's easier said than done. "I live pretty far away from my family. Building a community, especially when my two kids were young, was very, very challenging because my husband and I worked long hours," she says. "It takes a village to raise children, but it's hard to make that village."

Haley Weiss
Associate news editor Haley Weiss grew up watching her physician parents share useful health information with patients, friends and family. Now, as the editor of the column The Health Checkup (Page 28), Weiss is helping reporters do the same for *Science News* readers. "The wellness industry is so large and aggressive today, and there are a lot of agents out there who want people's money, attention, time and energy," Weiss says. "I want to help people manage their decisions and examine the forces that are coming at them."

Abby Wallace
When an issue goes to press, Abby Wallace's work kicks into high gear. The digital engagement producer directs the print-to-digital process and makes the magazine shine online. Many considerations go into what she does. For instance, Wallace prefers to schedule book reviews for Tuesdays because that's when new books typically come out. And puzzles are reserved for Fridays so that people can have something fun going into the weekend. "I want everyone's work to have the best chance at catching people's attention because I know how hard they worked," Wallace says.

CLOCKWISE FROM TOP LEFT: COURTESY OF E. PENNISI; SOCIETY FOR SCIENCE; COURTESY OF H. WEISS; COURTESY OF A. WALLACE

PALEONTOLOGY

ANCIENT SPIDER KIN HAD CLAWS OUT

By Tom Metcalfe

● **A well-preserved** fossil shows that early relatives of spiders and scorpions already had hallmark front claws about 500 million years ago. Described in *Nature*, the animal (*Megachelicerax cousteaui*) offers the oldest clear evidence yet of these specialized appendages, helping resolve a debate over how they evolved.

The fossil (right, inset) preserves views of both the top and underside of the body, allowing researchers to reconstruct the hand-sized animal in unusual detail (illustrated). Its clawed mouthparts suggest that chelicerae — which became spiders' fangs and scorpions' feeding tools — evolved from some early arthropods' grasping appendages rather than insects' sensory antennae. The seafloor-dwelling creature probably used the claws to prey on primitive worms.

ILLUSTRATION BY MASATO HATTORI; PHOTO BY RUDY LEROSEY-AUBRIL

This view of the fossilized animal's insides shows clawed appendages (arrows) beside the mouth, plus other body structures that helped researchers reconstruct the creature's anatomy.

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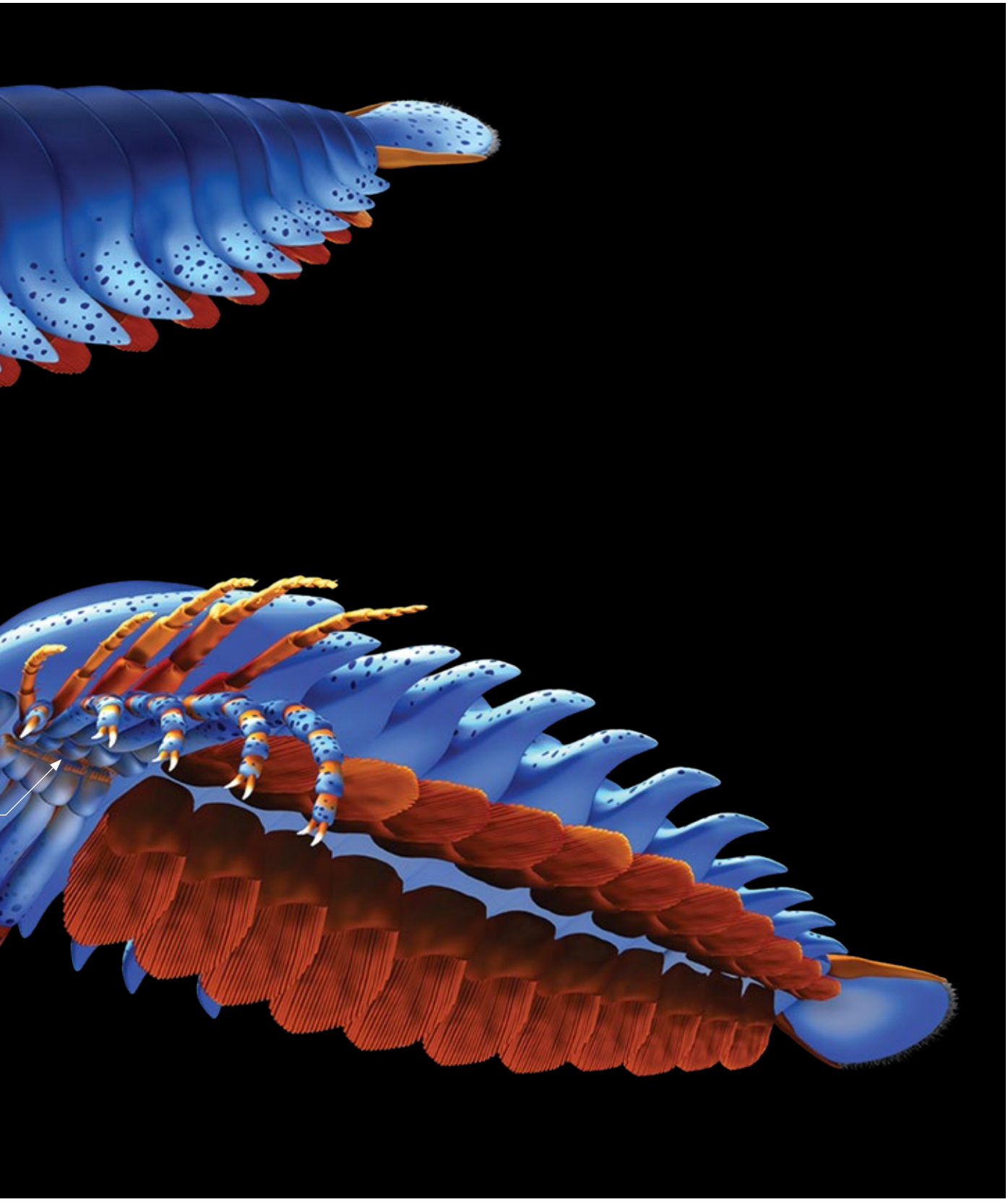

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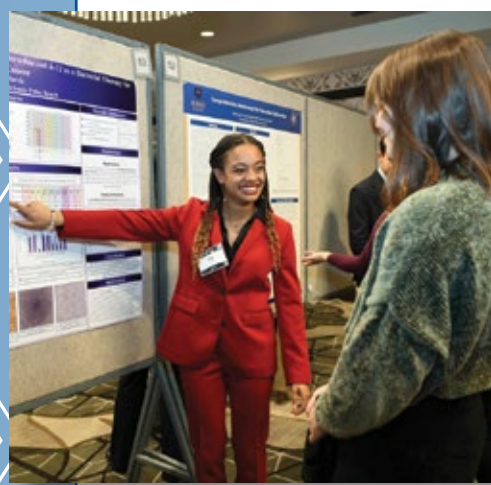

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News

NASA

PLANETARY SCIENCE

TOTAL ECLIPSE OF THE SUN, FROM SPACE

● "We just went sci-fi," astronaut Victor Glover said as he and his crewmates observed a total solar eclipse from space. Glover piloted NASA's Artemis II mission, which swung around the farside of the moon on April 6. For almost an hour, the moon blocked the sun from the spacecraft's point of view (shown in the photo above). The astronauts saw lunar features illuminated by light reflected off Earth, a glow that might be the solar corona, and planets including Saturn and Mars (bright dots bottom right of the moon). —*Lisa Grossman*

CLIMATE

Extreme heat is upending more of daily life

By Nikk Ogasa

● **During hot weather,** daily activities such as walking and gardening can become dangerous. Such obstructive heat has become much more common around the world, researchers report in *Environmental Research: Health*.

Using global heat, humidity and demographic data, the scientists found that sweltry conditions can make it dangerous for adults ages 18 to 40 to do moderately strenuous physical activities for an average of about 50 hours per year. That's double what young adults faced from 1950 to 1979. Meanwhile, adults over 65 now experience an average of about 900 hours of activity-limiting conditions each year. That's over 10 percent of the year and 300 more hours than half a century ago.

"We see substantial declines in the number of hours that older adults can safely do general tasks," says human biometeorologist Jennifer Vanos of Arizona State University in Tempe.

↑ **Hot, humid conditions now sharply limit everyday activity, especially for older adults.**

Vanos and colleagues combined heat and humidity data from 1950 to 2024 with simulations of healthy adults' ability to regulate body temperature in the shade, plus population and development information for nearly 200 countries. That let the team identify when and where heat and humidity have made it unsafe for adults to do moderate physical activities — those more strenuous than walking to the store or sweeping a doorstep. "That's not any way to live," she says.

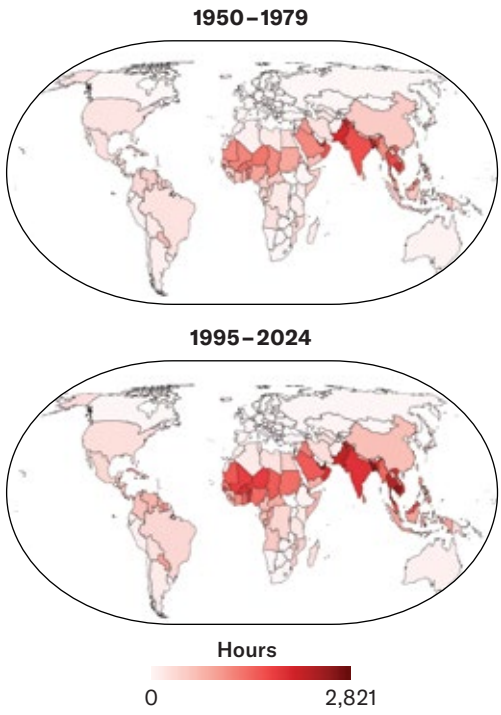
Almost 80 percent of the human population lives in places where heat and humidity severely limit activity for older adults during part of the year, the team found. People in South and Southeast Asia and the Middle East face the greatest potential annual exposure. Older adults in Thailand, for example, can face nearly 2,200 hours of obstructive

SARAH HANSON

heat on average. That's 600 more hours than that demographic group faced a half-century ago. In Qatar, older adults may face more than 2,820 hours per year, an increase of about 550 hours. Meanwhile older U.S. adults face about 270 hours each year, a 70-hour increase.

Vulnerable groups such as outdoor workers and people with certain health issues may lack the resources to cope, Vanos says. "Their livability, their ability to work and play and just be even productive members of the population during very hot days is extremely compromised." ✖

THE AVERAGE TIME PER YEAR LOST TO HEAT



For older adults around the world, exposure to activity-limiting heat has increased by 50 percent over the last half a century. From 1950 to 1979 (top map), they experienced an average of about 600 hours per year. From 1995 to 2024 (bottom), the average rose to about 900 hours per year. People in South and Southeast Asia and the Middle East face the greatest annual exposure (dark red).

L. A. PARSONS *ET AL*/*ENVIRONMENTAL RESEARCH: HEALTH* 2026

NEUROSCIENCE

HUMAN ECHOLOCATION WORKS STEP BY STEP

BY NORA BRADFORD

Navigating the world as a blind person sometimes involves using a cane, guide dog or portable GPS. For some, this toolkit includes echolocation. Producing tongue clicks and listening for echoes can be enough to gain information about nearby objects.

But even for expert echolocators, a single click is rarely enough to perceive an object. Echo after echo incrementally improves understanding, especially for seasoned echolocators, researchers report in *eNeuro*. The finding helps explain how the brain processes sound more generally.

Many studies have shown that echolocation recruits visual areas of the brain and that performance improves with practice. "What remained unexamined here was how this happens, how the information builds in real time, over individual echo signals," says cognitive neuroscientist Santani Teng of the Smith-Kettlewell Eye Research Institute in San Francisco.

Teng and colleagues attached electrode caps to record brain activity in four blind expert echolocators and 21 sighted novices as they listened to prerecorded clicks and echoes. The sounds were played in sets of two, five, eight or 11. After each set, participants decided whether an object was to their right or left.

In line with previous research, the expert echolocators were far better at determining the direction of an object than people who could see. One consistently needed to hear just two sets of clicks and echoes to determine an object's direction. Using brain wave data, the team showed that each click-echo pair added to the evidence that the brain accumulated to make the perceptual decision.

The team's work suggests that in human echolocation, "spatial representations are constructed by progressively accumulating acoustic evidence over time, rather than through a single 'optimal snapshot,'" says neuroscientist Monica Gori of the Italian Institute of Technology in Genoa.

Teng and colleagues want to understand what makes some echolocators better than others. The team is interested in how experts learn to ignore the click itself and attune only to the echo. "Echolocators have a truly remarkable skill, with real-life benefits," Teng says. "But it is not magic." ✖

PARTICLE PHYSICS

ANTIMATTER TRAVELS BY TRUCK FOR THE FIRST TIME

By Emily Conover

● Special delivery: antimatter.

Scientists have completed the first-ever transport of antimatter by truck. In late March, researchers carried antiprotons, the negatively charged counterparts of protons, inside a magnetic trap on a truck. The particles, created at the particle physics laboratory CERN in Geneva, traveled about eight kilometers to another site at the lab before the trap was delivered, contents intact.

That's quite a feat because antimatter annihilates when it comes into contact with matter. So the antiprotons were corralled with electromagnetic fields to prevent them from banging into the walls of their container along the way.

The demonstration, which followed a test with protons in 2024, is part of an effort called BASE-STEP. Eventually, scientists hope to use BASE-STEP's technology to bring antiprotons from CERN to facilities around Europe. There, scientists will build carefully controlled experiments, free from the stray magnetic fields pervading the accelerator facility at CERN that produced the antimatter.

Those experiments could help scientists better understand why matter dominates the universe even though the Big Bang is thought to have produced matter and antimatter in equal parts. Scrutinizing antimatter particles' properties, such as their charge-to-mass ratios, atomic energy levels and responses to gravity, could offer clues to why antimatter is so rare.

The new demonstration is the first step toward antimatter experiments of a new level of quality, physicist Stefan Ulmer of RIKEN in Wako, Japan, said at a news conference announcing the achievement. "This is a starting point of a really exciting journey." ✖

PALEONTOLOGY

Modern apes may not have evolved in East Africa

By Jake Buehler

● **Modern apes may have** swung into existence in North Africa or the Middle East.

New fossil findings reported in *Science* unveil *Masripithecus*, a roughly 17-million-year-old early ape that lived in what is now Egypt. The discovery expands the earliest ancestry of gibbons, chimpanzees and humans beyond East Africa. That's where the vast majority of the fossil evidence for early modern apes came from until now, says paleontologist Shorouq Al-Ashqar at Mansoura University in Egypt.

"The entire story [of modern ape evolution] was told by only a small corner of the continent," Al-Ashqar says. Fossil monkeys from North Africa and the Middle East have been dated to this time period, the Early Miocene, up to about 20 million years ago. But no apes, she says.

In 2021, Al-Ashqar and her colleagues started a project looking for ape fossils at Wadi Moghra, a fossil hot spot in northern Egypt. There, in 2024, Al-Ashqar uncovered

↑ Paleontologist Shorouq Al-Ashqar discovered a fossilized jaw fragment and molar (shown) of a previously unknown ape genus, now called *Masripithecus*, at a site in northern Egypt.

HESHAM SALLAM

something unusual underfoot. "I found a piece of [lower jaw] with a wisdom tooth," she says. "I immediately realized that it was an ape."

Apes' teeth differ from those of monkeys, Al-Ashqar says. They're quite flat, comparatively. The second and third molars are also of similar size, unlike in monkeys.

After the researchers found more jaw pieces, they sent images of the pieces to a colleague in California, who was just as excited, Al-Ashqar says. The team compared the jaw with those of known fossil species and determined it belonged to a new genus and species of ape that lived 17 to 18 million years ago, naming it *Masripithecus moghraensis* (Egyptian ape from Moghra).

"Anytime anybody has a new ape fossil, it's exciting," says paleontologist Susanne Cote of the University of Calgary in Canada, who wasn't part of the study. Moghra has been known as a fossil site for a century, she says, yet these primates are apparently rare enough in the fossil record that it's taken this long to turn up evidence of them.

Based on the thickness of its tooth enamel, Al-Ashqar says, *Masripithecus* probably had a mixed diet of fruits, nuts and seeds. These would have been plentiful in the subtropical and tropical forests that covered Egypt when the ape lived.

The team combined genetic data from modern apes with information on physical characteristics of living and extinct ape species to generate an ape family tree. Apes are united by a relatively large body size compared with monkeys and lack the tails that most monkeys possess. *Masripithecus* was very closely related to the last common ancestor of modern apes. This raises the possibility that modern apes evolved in the north of the continent.

The team used a statistical analysis to reconstruct the predicted movement of early modern apes out of Africa over millions of years given the new fossil findings. The findings suggest that modern apes may have evolved in North Africa or the Middle East and moved into Eurasia, with some populations migrating back into Africa.

Cote suspects that apes would have been more widespread in Africa than what can be seen in the fossil record. Many regions outside of East Africa are very poorly sampled, she says, so the area is just a small window into that early period of ape evolution.

For James Rossie, a paleontologist at Stony Brook University in New York, *Masripithecus* shows that when fossil sampling does happen outside of East Africa, new and fascinating species tend to show up. "This [discovery] verifies that our view of ape evolution in Afro-Arabia still has huge blind spots," says Rossie, who was not involved in the work.

There's a lot left to learn about this mysterious Egyptian ape and more paleontological work to be done across the whole region. Other countries in North Africa, including Morocco, Tunisia and Libya, may contain early apes yet to be unearthed, Al-Ashqar says. "We're just getting started." ✖

HESHAM SALLAM, RECONSTRUCTION BY MAURICIO ANTÓN

Masripithecus moghraensis **(illustrated here) lived in Egypt about 17 million years ago. The discovery of the ancient primate adds a wrinkle in the story of ape evolution.** ↓

ANIMALS

EMPEROR PENGUINS AND FUR SEALS ADDED TO ENDANGERED LIST

By Carolyn Gramling

● Climate change might defeat two of Antarctica's iconic species.

The International Union for the Conservation of Nature has officially declared emperor penguins and fur seals endangered. The IUCN is a network of more than 17,000 scientists and experts that maintains the IUCN Red List, a running tally of how threatened different species are in the wild. Endangered status means the birds and seals are now considered to be facing a very high risk of extinction in the wild.

The breakup and loss of sea ice around Antarctica is driving the animals toward the brink, scientists say. For emperor penguins, shrinking, less stable sea ice puts chicks in danger of drowning or freezing to death. The penguins currently number around 595,000 adults, a decrease of 10 percent to 22 percent relative to 2009. The current population is expected to halve by 2080, according to the IUCN.

For Antarctic fur seals, the loss of sea ice is pushing their primary food source, krill, to deeper ocean depths. As a result, seal pups are far less likely to survive their first year. From 1999 to 2025, the adult population plunged from about 2.2 million seals to 944,000 seals. ✖

JOHNNY JOHNSON/THE IMAGE BANK/GETTY IMAGES

HEALTH & MEDICINE

'DIGITAL TWINS' MAY IMPROVE A LIFESAVING HEART PROCEDURE

BY ELIE DOLGIN

Virtual replicas of patients' hearts have allowed doctors to refine and personalize a lifesaving medical procedure for dangerous rhythm disturbances.

Like flight simulators for physicians, these "digital twins" give doctors a way to preview different intervention options on computer models of a patient's anatomy before ever entering the treatment room. And early results suggest the approach could lead to better outcomes than standard practices, researchers report in the *New England Journal of Medicine*.

Heart models may be just the leading edge. Similar virtual replicas could soon help guide planning and treatment decisions across many areas of medicine, such as microbiome therapies and orthopedic surgery.

"We've come to the age where we can start using digital twins to mimic actual physiology within the body," says Jonathan Chrispin, a cardiac electrophysiologist at Johns Hopkins University School of Medicine. "That ability could help move forward research as well as improve clinical outcomes."

One common treatment for dangerously fast heartbeats involves threading energy-delivering catheters through blood vessels in the groin and into the heart. Once there, doctors search for the source of the faulty electrical activity and ablate, or destroy, the responsible tissue. Tiny scars then stop the errant signal from spreading. This minimally invasive procedure restores a steady heartbeat in about two-thirds of patients.

Chrispin saw an opportunity to improve those odds. Working with Johns Hopkins biomedical engineer Natalia Trayanova and colleagues, he helped build digital doppelgängers of the heart that could pinpoint likely targets in advance.

The process begins with MRI scans that capture the heart's structure and highlight patches of damaged tissue left by prior injury. Software converts these images into a 3-D digital reconstruction of the heart muscle, assigning different electrical properties to healthy and deteriorated regions.

Computer simulations then model how electrical signals travel through the heart — where they may slow, split or loop back on themselves in ways that can trigger dangerous rhythms. Researchers can then test virtual ablations on CONT. ON PAGE 18

The Curse of the Perfect Gift.

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It happened on our last trip to South America. After visiting the "Lost City" of Machu Picchu in Peru, we ventured through the mountains and down the Amazon into Brazil. In an old village we met a merchant with an impressive collection of spectacular, iridescent emeralds. Each gem was tumbled smooth and glistened like a perfect rainforest dewdrop. But the price was so unbelievable, I was sure our interpreter had made a mistake.

But there was no mistake. And after returning home, I had **49 carats of these exquisite emeralds strung up with 14K-gold clad beads** and wrapped as a gift for my wife's birthday. That's when my trouble began. She loved it. Absolutely adored it. In fact, she rarely goes anywhere without the necklace and has basked in compliments from total strangers for months now.

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To make matters worse, my wife's become obsessed with emeralds. She can't stop sharing stories about how **Cleopatra cherished the green gem** above all others and how emeralds were **worshiped by the Incas and Mayans** and prized by **Spanish conquistadors and Indian maharajahs.** She's even buying into ancient beliefs that emeralds bring intelligence and good luck to anyone who wears them. I don't have the heart to tell her that I'm never going to be lucky enough to find another deal like this.

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CONT. FROM PAGE 16 the model to identify the most effective way to shut down those faulty signals before performing the real procedure.

"It's a very powerful tool for pre-procedural planning," Trayanova says. "You treat the digital twin before you treat the patient."

The team executed the strategy in 10 people with ventricular tachycardia, a potentially fatal rhythm disorder that originates in the heart's lower chambers. The condition contributes to tens of thousands of sudden cardiac deaths in the United States each year.

With the virtual heart model to guide them, Chrispin and his colleagues showed that they could quickly direct their catheters at problem areas, shaving the hours-long procedure down to about 30 minutes and reducing risks associated with prolonged sedation.

At the end of the procedure, doctors could no longer trigger the abnormal rhythm — a standard way to evaluate whether the faulty circuits have been shut down.

Two participants did experience brief recurrences of abnormal rhythms within a few weeks of the procedure. But in both cases, implanted defibrillators delivered corrective electrical pulses that restored a normal heartbeat. And after months to years of additional follow-up, all 10 participants remained free of sustained dangerous rhythms.

The approach is innovative, but larger trials are needed to determine whether the technology consistently leads to meaningful improvements in patient care, says Babak Nazer, a cardiac electrophysiologist at the University of Washington in Seattle. "That'll tell me if it's a game changer or a physiologically elegant widget." ✖

PLANTS

Treetops sparkle during thunderstorms

By Lily Burton

● **Thunderstorms may bring** more than rain and gloom. The same forces that cause thunder and lightning also make treetops sparkle in ultraviolet light, like a Christmas tree topper invisible to the human eye.

For over a century, scientists have discussed a phenomenon called Saint Elmo's fire, in which electrical discharges during thunderstorms elicit a bluish glow from pointy objects such as ship masts. More recently, researchers have wondered if thunderstorms might draw weak electrical discharges from the treetops. Lab experiments suggested they did. Now, scientists have confirmed it happens in nature. The tips of wild trees shed electrical charge along with a blue and ultraviolet glow during thunderstorms, meteorologist Patrick McFarland and colleagues report in *Geophysical Research Letters*.

The question of whether these discharges might form at the tops of trees came up a few years ago at

↑ **In the lab, electrical plates induced these spruce needles to glow. Similar discharges have now been spotted in trees in the wild.**

W. BRUNE

lunch, says McFarland, of Penn State. McFarland's advisor, William Brune, "leaned back from the picnic table that we were sitting at, and he looked up at the top of the tree right above us and just kind of postulated, you know, 'Hmm, I wonder if those trees glow under thunderstorms,'" McFarland says.

That afternoon, the researchers grabbed a branch off a spruce tree and took it to their lab. The team attached the branch to a positively charged electrical plate to simulate the ground, then placed a high-voltage plate above the branch to negatively charge the air around it. "Sure enough, we saw it glow," McFarland says.

The glow, called a corona, was just barely visible — radiating faint blue as well as invisible UV light. Detecting the corona in the lab made the researchers even more curious: "Do we see these glows under thunderstorms as well?" McFarland says.

The researchers outfitted a 2013 Toyota Sienna minivan with the instruments needed to find a thunderstorm plus a camera that could spot the distinct UV light emitted by a corona. In the summer of 2024, it was time to hit the road.

"We drove it down to Florida for about a month," McFarland says. Florida experiences the most thunderstorms of any state in the United States due to sea breezes from both the Atlantic Ocean and the Gulf of Mexico. During the summer, "you get thunderstorms almost every single day," he says.

But finding a storm is just one factor when searching for coronae, McFarland says. "Then you have to find a public place to set up with trees that seem relatively tall. And then you have to get all set up and, you know, get the instrument turned on and pointed at the tree," he says. "It's really, really challenging."

Serendipity led McFarland and colleagues to their best thunderstorm — and it wasn't in Florida. "This storm in North Carolina actually just so happened to form when we were driving back to Pennsylvania," McFarland says. The team found a spot in the coastal plains town of Pembroke, N.C., and recorded footage of a sweetgum tree and a loblolly pine for over two hours.

The video captured almost 50 coronae, none lasting more than four seconds. And the flashes didn't stick to one spot. They danced and darted like twinkle lights, jumping between leaves and along branches swaying in the wind, the researchers found.

While the study focused mainly on data collected during the North Carolina storm, coronae appeared in thunderstorms in Florida and Pennsylvania and had that same transient sparkling appearance, the team notes.

"These glows seem to be really, really widespread," McFarland says. "There may be many, many more coronae that are occurring that we just don't have the sensitivity to see." ✖

ASTRONOMY

TELESCOPES SPOT A COMET'S DEATH SPIRAL

By Nikk Ogasa

● For the first time, a comet may have been caught flipping its spin.

Comet 41P/Tuttle-Giacobini-Kresák apparently began twirling in the opposite direction sometime between May and December 2017, astronomer David Jewitt reports in the *Astronomical Journal*. The roughly kilometer-wide space rock may keep spinning faster in the new direction until it tears itself apart.

In May 2017, NASA space telescopes caught 41P rotating once every 46 to 60 hours — taking more than double the amount of time that it had the previous March. The change, reported in 2018 in *Nature*, was the quickest shift in a comet's spin ever observed.

Jewitt, of UCLA, analyzed space telescope images from December 2017 and found that 41P rotated once every 14 hours. Heat from the sun probably sublimated some of the comet's ice, he says, generating gases that acted like thrusters (illustrated). The resulting torque probably slowed 41P to a halt and then led it to turn in nearly the opposite direction. As its spin accelerates, centrifugal forces will eventually cause the comet to break apart — perhaps in a few decades, Jewitt estimates. ✖

NASA, ESA, CSA, RALF CRAWFORD/STSCI

CHEMISTRY

THIS NAIL POLISH COULD FIX TOUCH SCREEN FRUSTRATIONS

BY SKYLER WARE

A newly formulated nail polish could one day let people activate touch screens with their fingernails.

When pressed to a screen, the polish disrupts the screen's electric field, which registers as touch. While the formula isn't commercially viable yet, it could allow people to use long nails like styluses.

"This is huge because it shows that functional behavior can be embedded invisibly into everyday cosmetic materials," says Shuyi Sun, a computer scientist who has studied cosmetic biosensors and now works at the Association of California Nurse Leaders in Sacramento.

Touch screens, such as on smartphones and tablets, are typically made of glass coated with a thin, transparent layer of electrically conductive material. That layer creates a small electric field across the screen. When another conductive object, such as a fingertip, contacts the screen, it disturbs the electric field. The device registers that disturbance as a touch and can detect the point on the screen where it occurred.

ESTUDIO PUM

But nonconductive materials — like a fingernail or a glove's wool fabric — don't distort the field, so they don't register. People with long nails must use the pads of their fingers to type instead, which can cause typing errors, at least until users adjust to the new angle.

"It's really hard to use your phone," says Manasi Desai, an undergraduate student who is studying chemistry and biology at Centenary College of Louisiana in Shreveport.

To remedy this common inconvenience, Desai and her research adviser, organometallic chemist Joshua Lawrence, mixed several different additives into commercially available clear nail polish. Two of the additives, ethanolamine and taurine, each resulted in a clear polish formulation that, as a blob held with tweezers, could activate the touch screen. While ethanolamine has some toxicity, taurine is a common dietary supplement that occurs naturally in the human body.

"One of our major goals was to make it clear and colorless, so that you could apply it over any manicure or even on your bare nails," says Desai, who shared the findings in Atlanta at a meeting of the American Chemical Society.

The modified nail polish uses acid-base chemistry to activate the touch screen, the team suspects, though more research is needed to confirm. When in contact with the screen's electric field, the added molecules probably shuffle protons between themselves, moving just enough charge to affect the field.

Painting a thin coat of polish on a fingernail doesn't currently leave enough additive behind to activate the screen, but the duo plans to focus on improving the formula's performance in future work. ✖

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Q & A

NEW GUIDELINES RECOMMEND EARLY CHOLESTEROL TESTING

BY ERIN GARCIA DE JESÚS

New heart health recommendations emphasize early testing and treatment to lower cholesterol levels as key to reducing the risk of cardiovascular disease. A group of 11 medical associations including the American College of Cardiology and the American Heart Association released new guidelines to help doctors and their patients manage cholesterol levels. They advise first testing cholesterol in childhood, around age 10. The aim: Help patients keep levels low to reduce the chances of heart attack or stroke decades in the future.

Also new is a cardiovascular risk calculator called PREVENT that assesses the risk of heart attack and stroke over the next 10 and 30 years in adults ages 30 to 79 who don't already have heart disease.

The previous recommendations, released in 2018, relied on another calculator that was based on clinical data from a cohort of around 25,000 adults who participated in U.S. National Institutes of Health-sponsored studies, says Roger Blumenthal, a cardiologist at Johns Hopkins School of Medicine. That calculator looked forward just 10 years. What's more, the guidelines did not have specific cholesterol benchmarks for people with different levels of risk based on family or medical history.

PREVENT, on the other hand, is based on studies that included a total of 6.6 million people, helping to better estimate short- and long-term risks on an individual basis, Blumenthal says. The new guidance also emphasizes additional tests that are not part of the standard cholesterol blood test, or lipid panel, including a one-time assessment of lipoprotein(a), or Lp(a). Levels of Lp(a) are determined by genetics and can increase long-term risk.

Roughly a quarter of U.S. adults have high levels of low-density lipoprotein, or LDL, cholesterol. Reducing these "bad" cholesterol levels with lifestyle changes such as healthy eating and exercise or with medications can lower the risk of cardiovascular disease, the leading cause of death globally.

Science News connected with Blumenthal, who chaired the guideline writing committee, to discuss the new recommendations and how they might impact treatment. This conversation has been edited for length and clarity.

Q What are the most important changes in the guidelines?

A I'll start with number one, which essentially is to assess and treat early. We recommended — especially if there's any family history of heart disease, or if there's another cardiovascular risk factor — that the clinician should screen with a lipid panel around age 10 and again around age 20 and then every five years after that.

We also made the point that, especially if you're age 30 and above and your LDL cholesterol is 160 or higher on successive occasions, it makes sense to consider starting a cholesterol-lowering medication if there's a family history of heart disease or other risk factors.

We now have a more robust and more accurate risk estimator that we call PREVENT. I think one of the best things about PREVENT is that we have a good way to estimate long-term risk. We can tell patients with certain risk factors that while their risk over the next 10 years is really low, their risk over the next 20 to 30 years is quite high.

If there's a family history of cardiovascular disease, even if your estimated risk in your 30s is quite low, clinicians should talk to their

patients about healthy lifestyle habits. Many young adults in their 30s and 40s have a very low 10-year risk because so much of the PREVENT score is based on chronological age rather than biologic age.

But we can now estimate 30-year risk. If you have a person whose 10-year risk is 1 or 2 or 3 percent, but the calculator can tell them that if you don't change your lifestyle habits, if you don't improve your weight, your cholesterol and your blood pressure, your 30-year risk may be 30 percent, that gets their attention.

Q What are the most important benchmarks to know about?

A The key numbers to remember are LDLs of 100, 70 and 55. We state that in all borderline risk individuals — and I would say for all adults — that we like them to strive to improve their lifestyle habits so that they can lower their LDL down to the range of 100 milligrams per deciliter or less. We know that individuals who may have some evidence of mild to moderate atherosclerotic disease or have multiple risk factors very well may want to try to get their LDLs down in the 70 mg/dL range. For those at high-risk, getting their LDLs closer to the 55 mg/dL range is preferable.

A one-time measurement of Lp(a) can be a helpful tiebreaker for risk assessment, even if other lipid levels are normal. We put in the guidelines that if your Lp(a) is above a certain threshold, your risk probably is twice as high as the PREVENT score estimates.

We also stated that there are certain high-risk groups for clinicians to remember: those who have diabetes, chronic kidney disease or HIV infection. We have really good data that if their LDLs are suboptimal, that treatment with statin therapy in addition to more aggressive lifestyle changes makes sense.

Q Why did the committee decide on these changes?

A One, we have a more accurate risk calculator. Two, we wanted to follow the same logic that the American Heart Association and the American College of Cardiology did with the recent blood pressure guidelines. They said that if, after six months of lifestyle improvement attempts, your blood pressure stays above 130/80, you should give strong consideration to going on a medication. We felt, with that same proactive approach, that if an individual is 30 years and older and has persistently higher LDL cholesterol, considering medication makes sense.

Q Is that why there is a focus on early treatment?

A It's really important to start health behavior counseling in youth. Pediatricians generally have that strong ethos in prevention. My late father was a pediatrician. A lot of my interest in preventative cardiology stems from my discussions with him about how the habits that one develops in youth or adolescence generally are the habits that one will follow later on. ✖

Cutting back on cholesterol-rich foods, such as eggs and bacon, and increasing fiber intake is one way to help lower the risk of cardiovascular disease. ↓

CAVAN IMAGES/DORENE HOOKEY/GETTY IMAGES PLUS

PHYSICS

A static electricity mystery comes to the surface

By Emily Conover

● **Static electricity is a touchy subject.**

Touch or rub two materials together, and they can exchange electric charge. But the details of that exchange are poorly understood. Now, scientists have identified a hidden factor. A veneer of carbon-rich molecules alters how identical materials exchange charge, scientists report in *Nature*. That suggests that surface contamination plays a major role.

"Static electricity is not child's play," physicist Scott Waitukaitis said in a talk at the American Physical Society's Global Physics Summit. "Quite literally, it could be the reason that we have ground to stand on." The charge created by colliding particles in protoplanetary disks is thought to help planets, including Earth, form. It also is the source of volcanic lightning, helps buoy sand lofted in dust storms and can cause industrial accidents such as fires in sawmills.

When two identical particles collide, one can gain a positive charge and the other goes negative. But scientists didn't know what determines which particle gets which charge. Waitukaitis and colleagues investigated this effect in silicon dioxide, or silica, a material found in sand, rock and glass.

The team used acoustic levitation, harnessing sound waves to suspend a tiny silica sphere in midair before bouncing it off a silica plate and measuring the charge the sphere gained. That technique avoided any unwanted effects from physically touching the object.

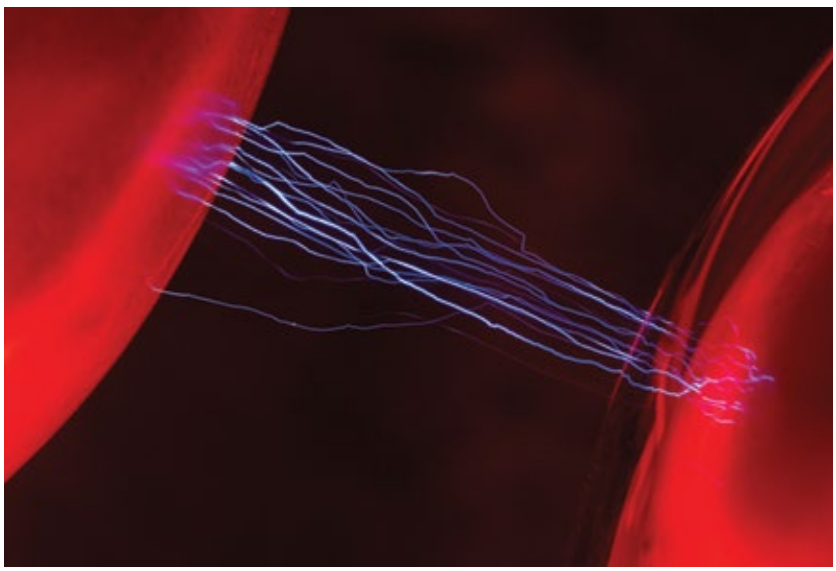
Some spheres charged positively while the plate charged negatively. But some interactions went the other way. However, if the researchers heated the sphere or the plate to 200° Celsius for two hours and then let it cool, they could manipulate the effect. The treated object almost always picked up a negative charge, and the unadulterated one became positively charged. The same thing happened to spheres treated with plasma, a mix of charged particles.

Close inspection revealed that the treatments stripped off a thin layer of carbon-rich molecules from the silica's surface. Most objects exposed to air pick up such molecules. "This carbon cake, it just grows on everything," says Waitukaitis, of the Institute of Science and Technology Austria in Klosterneuburg.

After a sphere was heat-treated, its carbon layer returned over several hours of exposure to air, and its charging behavior changed alongside the layer's growth. "That really nailed it down," says chemical engineer Daniel Lacks of Case Western Reserve University in Cleveland, who was not involved in the study.

Scientists had long suspected that surface contamination was important in static electricity. "This work nicely shows that one has to be very careful about the ... influence of contaminations," says physicist Rolf Möller of the University of Duisburg-Essen in Germany.

Although it's not the end of the story, as other studies have identified other relevant factors, the work could spark better understanding of an electrifying phenomenon. ✖



Static electricity, a charge buildup caused by rubbing or touching, is a poorly understood phenomenon, despite its prevalence. ↓

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ECOSYSTEMS

FOR CLOUD FOREST MAMMALS, ONE TREE MAKES A GREAT POTTY

BY BETHANY BROOKSHIRE

When a human has a sudden need to go number two, they might seek out a public bathroom. When mammals in Costa Rica's cloud forests need to defecate, they do something similar. But instead of searching for a convenient porta-potty, they zero in on a strangler fig tree.

A survey of more than 150 trees revealed nearly a dozen latrines in the major forks of the strangler fig tree (*Ficus tuerckheimii*). A camera trap at one arboreal potty recorded 17 species visiting the spot. The findings, published in *Ecology and Evolution*, suggest that treetop toilets might provide communication hubs across mammal species.

Many mammals set aside a place to poop, says mammalogist Mike Cove of the North Carolina Museum of Natural Sciences in Raleigh. "There's been a lot of observations of this type of behavior and multispecies latrine use in the tropics," Cove says. But those were all on the ground.

Jeremy Quirós-Navarro found his first canopy commode by accident. The plant taxonomist at the University of Connecticut in Storrs was documenting plant life in the cloud forest of Costa Rica. In a tree, at the junction of several large branches, was a pile of poo. Quirós-Navarro soon found more, he says, "but only in a specific tree."

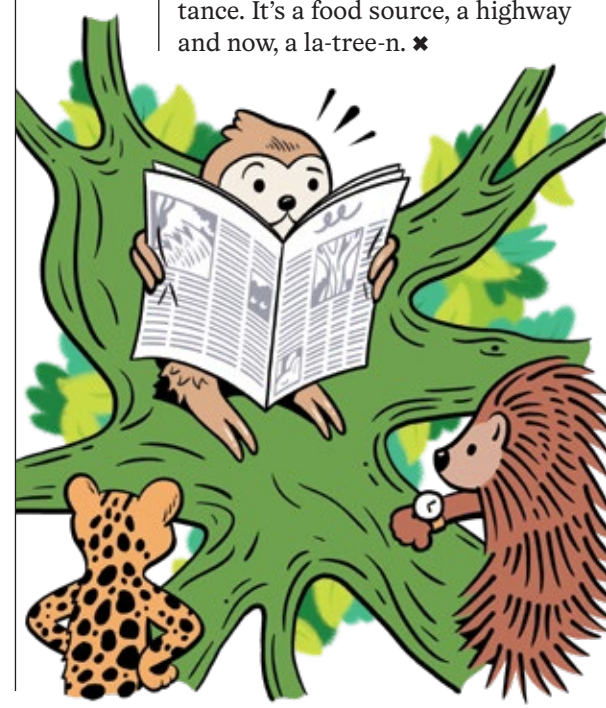
That tree, *F. tuerckheimii*, is a keystone species in the tropics. The strangler fig provides plenty of food and holes for shelter, and the wide-spreading branches provide travel routes within the forest canopy, making the tree a hub for many species. After finding the first four latrines in strangler figs, Quirós-Navarro and colleagues began to think "this is a pattern," he says. A survey of 169 trees from 29 species uncovered 11 total latrines. All were in strangler figs, and 73 percent of the fig trees surveyed had at least one latrine.

The team isn't sure why the latrines occur in just one tree species, but Quirós-Navarro suspects the strangler fig's structure has something to do with it. The point from which all the branches grow can be up to a meter across and potentially acts as a flat platform, he says. It is filled with soil, small plants and, in many cases, poop.

A camera trap at one latrine captured three visitors a day over two months. Mexican hairy dwarf porcupines visited most often, but kinkajous, opossums, pocket mice, coatis and capuchin monkeys all stopped by. Even margays, secretive arboreal cats, used it to spray urine.

Hoffmann's two-toed sloths, which are thought to ditch their treetop abodes for ground commodes, appeared twice. Both times the sloths were a female and her young. Perhaps pooping in a tree lowers the risk of encountering a predator. Or maybe it's just convenient, says biologist Erik Hom of the University of Mississippi in Oxford. A flat place covered in dirt might be groundlike enough, Hom says.

That so many animals do their business in the same spots and also sometimes roll in the waste suggests the toilets double as message boards, Quirós-Navarro says. Why the strangler fig is the toilet of choice remains a mystery. But the bathrooms add to the tree's importance. It's a food source, a highway and now, a la-tree-n. ✖



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THE HEALTH CHECKUP

SCOUT A SAFE SUMMER SWIMMING HOLE

BY NIKK OGASA

A sewer line collapse in Maryland earlier this year spilled more than 360 Olympic-sized swimming pools' worth of wastewater into the Potomac River just upstream of Washington, D.C. The incident may be the largest sewage spill in U.S. history, and it's a quintessential example of fecal pollution, the most common source of sickness from natural waterways. Anytime we swim in a lake, river or ocean, we risk encountering waterborne pathogens.

Most often these bugs infect the digestive tract, causing symptoms like diarrhea and nausea, but they can also affect the eyes, ears, skin and more. With summer swimming season here in the United States, reports of public water quality can help you gauge the risk of getting sick.

In the United States, scientists typically collect water samples, culture them in the lab and then count how many of certain types of bacteria grow. They focus on one or two types of bacteria associated with fecal contamination, called indicator pathogens, because it would be too costly to test directly for all harmful microbes. The most common indicator pathogens are *Escherichia coli* for freshwater and *Enterococcus* for saltwater.

Unfortunately, "this indicator system ... has a whole host of problems associated with it," says environmental microbiologist Kelly Reynolds, of the University of Arizona in Tucson. *E. coli* can die off in the water before other harmful microbes from the same source, Reynolds says, so finding low levels of *E. coli* doesn't necessarily mean water is safe. *E. coli* and enterococci also show up in the feces of many warm-blooded animals, but conventional culture tests can't determine whether their source is human waste, which carries more diseases that can harm us.

Those limitations were highlighted in a 2024 study, which demonstrated an alternative testing method that identifies fecal matter using DNA markers unique to human gut microbes. Sandra McLellan, an environmental health researcher at the University of Wisconsin-Milwaukee, and colleagues filtered bacterial DNA from hundreds of samples gathered at 18 harbors worldwide, detecting fecal pollution in 46 percent of the samples. Meanwhile, only 18 percent exceeded indicator pathogen standards on conventional tests.

But that doesn't mean culture tests aren't useful. While they might miss short-lived periods of contamination, especially if samples aren't taken multiple times a week, these tests can help identify when there's persistent pollution.

Water quality checks and advisories are typically findable on government websites. States issue advisories when numbers of viable indicator pathogen cells counted in culture tests exceed their standard. Where McLellan lives in Wisconsin, for example, the state issues beach advisories when test counts of *E. coli* exceed 235 colony forming units per 100 milliliters of water. At that concentration, the EPA estimates that 36 out of 1,000 swimmers in an area will get sick. The Potomac River peaked at thousands of times that concentration after the spill, and shows signs of a slow recovery.

Wherever you dip, there are some guidelines you can follow to minimize the risk of infection. McLellan recommends avoiding entering the water for at least 24 hours after light rainfall, and 48 hours after a downpour of more than three centimeters. Runoff can flow past leaking pipes or faulty sanitary system plumbing and carry infectious microbes into public waterways.

Cloudy water and algae can also indicate potential pollution, McLellan says. And if you're unsure about the water quality, avoid submerging your head. One common way people pick up waterborne diseases is by swallowing water, and that's hard to prevent if your face goes under, Reynolds says.

"I always worry that I'm discouraging people from enjoying the water," McLellan says, but you can cover your bases. "I think that takes away 95 percent of the concern." ✖

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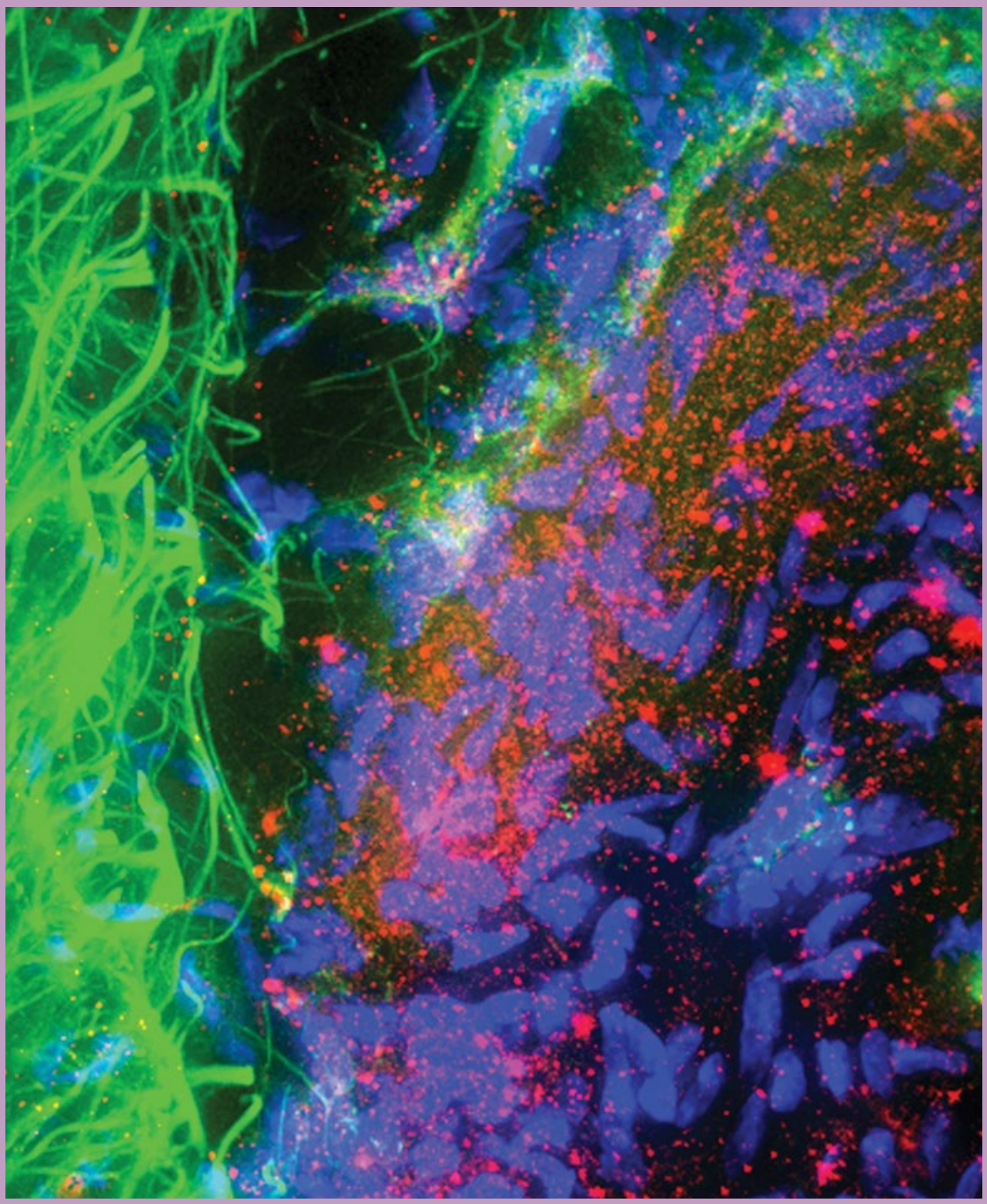
Some future treatments for Parkinson's disease will target a sticky protein (red in this micrograph) that kills nerve cells (blue) in the brain (see Page 40).

Features



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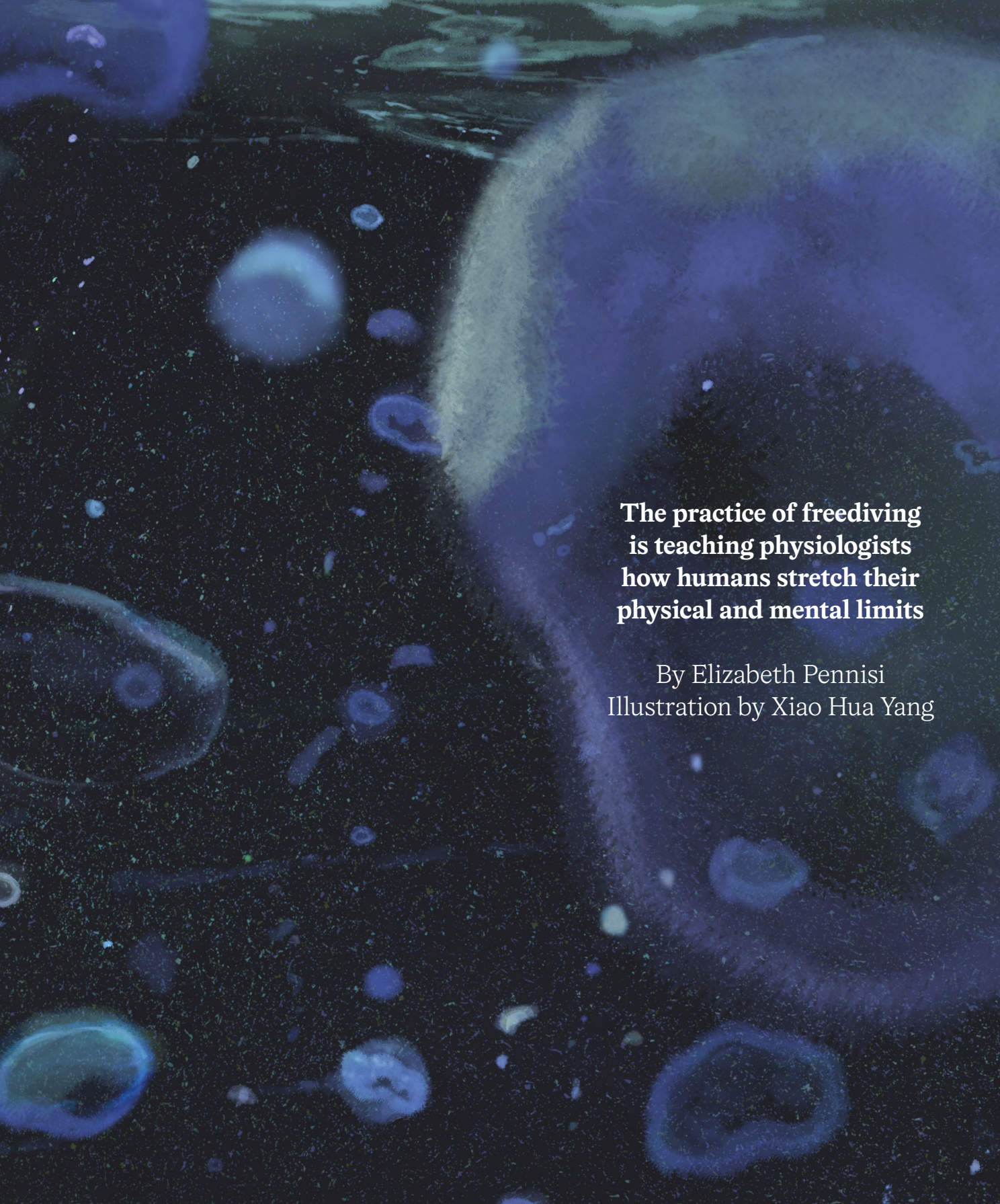


The practice of freediving is teaching physiologists how humans stretch their physical and mental limits

By Elizabeth Pennisi
Illustration by Xiao Hua Yang

EMES

At 19, Tucker Francis was living his dream.

About a decade earlier, he had sailed around the northwest Atlantic with his family, and his passion for the ocean and adventure blossomed. He loved snorkeling and recreational freediving, the loose term for diving deep underwater with no breathing gear. He would head down after the colorful creatures he spotted and stay underwater as long as possible to see as much as possible.

Then, while chaperoning a 2017 snorkel trip in the U.S. Virgin Islands, Francis did one last freedive and disappeared. The boat's captain found his body 10 meters down an hour later.

Investigators later determined that Francis had suffered from a hypoxic blackout, also often called a shallow water blackout: He passed out when his brain couldn't get enough oxygen — a problem that can come on without warning even among experienced swimmers. Once unconscious, the body sinks and the lungs can fill with water.

The grieving Francis family decided to try to do something to reduce the risk of such blackouts among other freedivers. So they turned to integrative physiologist Erika Schagatay of Mid Sweden University in Östersund. She studies people who risk blacking out every day as they dive deeper than the Statue of Liberty is tall: competitive freedivers, also known as breath-hold divers or apneists. With help, the best of these divers can hold their breath for nearly 30 minutes — about as long as it takes to sing "The 12 Days of Christmas" 10 times.

Indigenous peoples in Japan, Korea, the Philippines, Indonesia and elsewhere have been freediving to forage underwater for sea urchins, fish, seaweed and shellfish for thousands of years. Freediving competitions didn't get off the ground until the 1970s. In this increasingly popular competitive sport, athletes swim as far, dive as deep or hold their breath as long as possible, either in pools or in open water. Today, an estimated 4 million people around the world like to test how far they can go underwater in one breath.

These athletes combine mental, physical and social strategies that rival or even surpass what high-altitude climbers employ. As such, "freediving really does offer a unique window into human performance," Schagatay says.

Research into freedivers from all backgrounds is providing a better sense of how to treat and perhaps one day prevent serious health problems related to lung and heart function in the general population. The work may also help the Francis family realize their goal of providing a warning device for swimmers that will prevent deaths like their son's.

An extreme endeavor

Competitive freedivers push the body well beyond what was once thought humanly possible. At a depth of 70 meters, water pressure shrinks the lungs to about the size of a soda bottle. Blood oozes into the thorax, which caves in, leaving skin flapping around the rib cage. Go deeper, and blood leaving the brain resembles black sludge because it contains so little oxygen. Yet freedivers usually return to the surface, no harm done, and as such have been "rewriting the medical textbooks," says physiologist Damian Bailey of the University of South Wales in Pontypridd.

Freedivers "must balance the unpredictable, rapidly-changing, and interdependent physiological, psychological, and environmental demands with their own motivations for the dive," Suraiya Luecke, an anthropologist at UCLA and the University of Southern Denmark who studies Indigenous freedivers, wrote in 2022 in *Phenomenology and the Cognitive Sciences*.

In 1976, French diver Jacques Mayol set the competitive freediving record with a 101-meter descent. In 2023, the deepest descent with fins was 136 meters. Some competitors also see how far they can swim in a pool while staying submerged. In 2025, a swimmer using a fin reached 326.5 meters. Another diver surpassed a total time of 11 minutes underwater while not moving in 2009. And by breathing pure oxygen in advance of his attempt, a different stationary apneist reached 29 minutes in 2025, setting a controversial world record.

Such attempts to push the body's limits can be perilous, as a few high-profile deaths have shown. After reaching 72 meters in 2013, American freediver Nicholas Mevoli surfaced and soon began bleeding from the mouth. He died later that day.

And Russian freediver Andrey Matveenko died last November of complications after blacking out during a training dive at a world championship competition in Greece in September.

Elite athletes aren't the only ones succumbing: Shallow water blackout is an insidious risk for many other experienced swimmers, says Britt Jackson, executive director of Underwater Hypoxic Blackout Prevention, a nonprofit based in Norcross, Ga., that educates the public about the risks of breath-holding. For instance, it also affects synchronized swimmers, as well as underwater rugby and hockey players.

Coming up with hard numbers is difficult because there's usually no distinction made between blackouts and other forms of drowning. Nonetheless, by combing the internet and investigating drowning death reports, Jackson's group has documented 110 blackout deaths over the last two decades. Those may be just a drop in the bucket, she points out. More than 50 such deaths supposedly occurred in Hawaii alone in the last decade.

"We don't have reliable data," Jackson concludes. But the data they do have show that males ages 15 to 45 are at greatest risk, presumably because they try too hard to last underwater. Those who have survived a blackout say they felt as if they could hold their breath forever. "It's like a runners' high," Jackson says.

Schagatay herself began freediving for fun at age 13 off the coast of Portugal. "There were many more fish than in Sweden," she recalls. Over and over, she would dive down until she was blue and shivering.

Schagatay never dreamed that someone could stay submerged for multiple minutes until 1982, when she watched a Bedouin diver disappear in the Red Sea. The dive lasted longer than what had been considered the maximum time humans could go without a breath and not die or suffer brain damage. "I was afraid the person I saw was going to need my help, but then he came up with a moray eel in his spear," Schagatay says. She wondered how was that possible.

So in graduate school at Lund University in Sweden, Schagatay began focusing on marine mammal physiology. She eventually turned her attention to freedivers to see how much their bodies mimic a seal's or dolphin's as they dive.

Even before the Francis family approached Schagatay six years ago, she had been attending freediving competitions and outfitting athletes with monitors that tracked their oxygen consumption by measuring oxygen in the blood. She also tracked heart rate, lung volume and the rise of carbon dioxide levels in the body as measured in exhaled air. Her goal has been to understand what the body experiences and how it copes with the stresses of diminishing oxygen and increasing CO_2.

With new funding from the Francis family, Schagatay built a portable lab, which she sets up in places such as Dahab, Egypt. There, along the Red Sea, a 100-meter-deep sinkhole called the Blue Hole attracts freedivers of all skill levels. In some of her experiments, amateurs and skilled freedivers repeatedly held their breath for specified time periods on land; in others they swam successively greater lengths underwater in a pool. She compared the land-based results with the underwater swims to get a sense of how well dry-land tests reflected these swimmers' and divers' in-water abilities. If we know how long we can last underwater compared to how long we can hold our breath on land, "this could allow us to predict how long one can safely hold the breath," she says.

↘ Tucker Francis, 19, was on a recreational freedive when he experienced a shallow water blackout and died.

COURTESY OF THE FRANCIS FAMILY

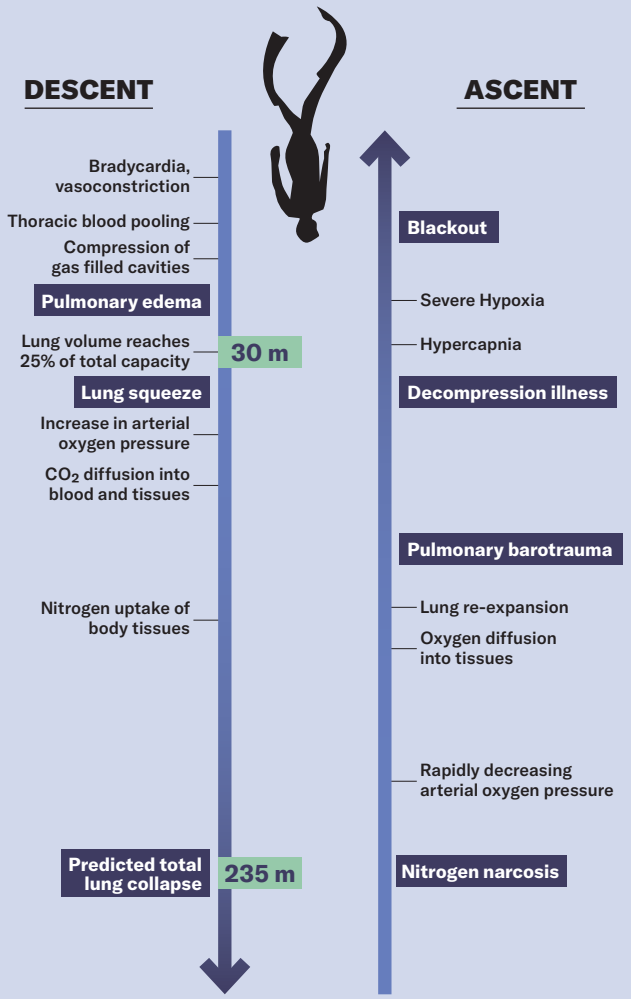
One problem Schagatay noticed with some freedivers, especially beginners, is that they involuntarily hyperventilate — taking a few quick breaths — right before they submerge. That increases the risk of blacking out because they expel CO_2 that would otherwise give the body an urgent "BREATHE NOW" command.

"Carbon dioxide is our best friend," says Juan Valdivia-Valdivia, a neurosurgeon at BayCare Medical Group in Tampa, Fla., who practices freediving.

When CO_2 levels in the body get high enough, the diaphragm begins to spasm to force inhalation. Freedivers learn to control this impulse. But, especially if they hyperventilate, novice divers can blow out so much CO_2 that the body doesn't start to spasm and they "extend the dive too long," Schagatay says. Then the divers are more likely to black out.

DEEP BREATH-HOLD DIVING

The body experiences several physiological changes during the descent and ascent of a deep breath-hold dive. Health risks (text in boxes) are not related to certain depths but rather to depth ranges during the descent or ascent. Trained freedivers can survive these extremes, but for some risks, like shallow water blackout, the signs can be difficult to sense until it's too late.



A stationary bike and a tub of water

Back in Östersund, Schagatay's university lab is just a few kilometers away from the Swedish national biathlon center. In the same building as her lab, Sweden's top Nordic skiers are studied on a custom treadmill, and there's a special chamber where oxygen content and temperature can be controlled to create near Everest-like conditions. In a room one floor above, Schagatay's postdoc Frank Pernett has set up a stationary bike with a basin of water strategically placed above the handlebars.

The goal is to test a common safety practice among swimmers or spearfishers who repeatedly submerge to explore coral reefs or attempt to catch fish. When these freedivers surface to take a breath, they tend to rest on the surface twice as long as they had just spent underwater to "catch their breath," so to speak, before diving again. But it was unclear whether this rest length offered adequate recovery time. If that time was too short, the body would become more susceptible over time to blacking out.

In the lab, volunteers pedal slowly — a substitute for swimming motion — as they place their face in the water and hold their breath for a fixed duration, then pull out and breathe normally for twice as long as they were underwater. They do this 10 times, and at the end of each submersion, they exhale into a tube attached to a machine that measures oxygen and CO_2. They have an oxygen meter on a finger and an electrocardiogram monitor around the chest. After a few submersions,

K. TETZLAFF ET AL./*FRONTIERS IN PHYSIOLOGY* 2021, ADAPTED BY J. HIRSHFELD

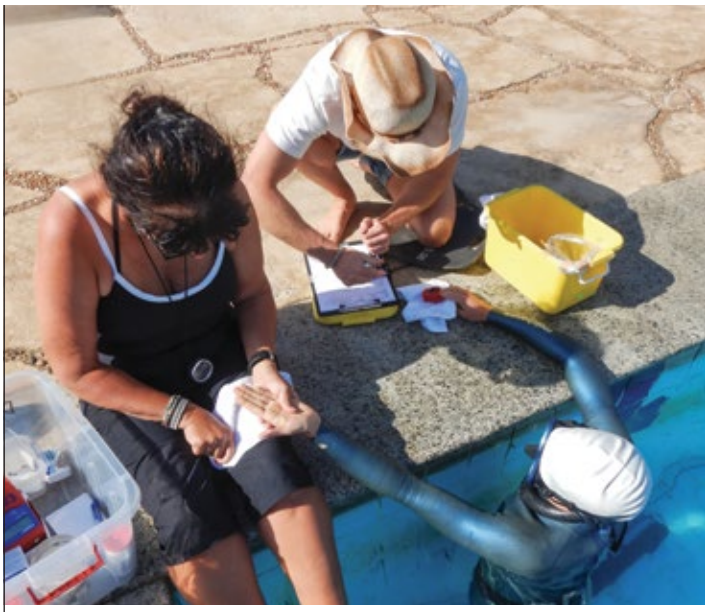
the researchers collect a finger prick blood sample to measure lactic acid accumulation, which indicates how oxygen-deprived the body has become.

The researchers found that the double rest time technique is sufficient in only about 70 percent of the study participants. That means almost a third of the divers do not replenish their oxygen adequately and could be at greater risk of blacking out, Schagatay and Pernett reported last year in Helsinki at the annual meeting of the European Underwater and Baromedical Society. They plan to publish those results later this year.

The team had assumed that the amount of oxygen in the body would be key to lasting the full time underwater during each attempt. Indeed, good freedivers tend to have large lungs. But how long the oxygen stored in lungs, blood and tissue lasts varies depending on metabolic rate and to some degree, heart rate. Experienced divers also tend to have low heart rates. But once the body runs low on oxygen, it begins to accumulate lactic acid, which means the body will need a much longer time to recover. So, Pernett says, beginner divers or those facing rough conditions need to pace out their dives even more, breathing on the surface three times as long as the time submerged.

A superpower of the spleen

Additional factors can influence the blood's oxygen supply, studies show. For instance, there's the spleen, which is a reservoir of red blood cells, which carry oxygen. Under stress, this organ contracts and floods the blood with these cells, providing an oxygen boost to the body. This contraction is part of what's known as the human dive reflex, says evolutionary genomicist



SVEN BJÖRKMAN

↗ **Erika Schagatay (left) and a student measure heart rate and arterial oxygen saturation in a freediver in Egypt.**

Melissa Ilardo of the University of Utah School of Medicine in Salt Lake City. When the mammalian body submerges in water, this reflex kicks in to maintain the brain's oxygen supply. The heart rate slows, blood pressure in the arteries increases and capillaries in the limbs constrict, shifting blood flow to the body's core, particularly the brain.

The spleen-provided boost during the dive reflex is so critical that the Bajau, an Indigenous freediving group in Indonesia, Malaysia, and the Philippines, have evolved bigger spleens, which helps them forage for fish and other seafood. They carry a genetic mutation that affects the spleen's growth, Ilardo and colleagues reported in 2018 in *Cell*.

Training still makes a big difference. Schagatay's team had previously shown that practice leads to a stronger dive response in the Bajau. Then, last year in *Cell Reports*, Ilardo and her team reported that the Haenyeo, a group of Korean women who freedive to depths of about 10 meters to harvest seafood, also have bigger spleens than their land-based peers. But that seems to be because diving is a way of life; they start as youngsters and continue through pregnancies and well into their ninth decade. So far, scientists have found no genetic component to their spleen size difference.

Practice can similarly help competitive freedivers enhance other aspects of the dive reflex so they can better cope with the strain of low oxygen and high CO_2.

A freediver's health also affects their success, especially those trying to reach record depths. Any active or recent respiratory infection seems to predispose the lungs' air sacs to clog with fluid as a diver swims back to the surface. That can impede normal breathing even after surfacing.

Other studies had concluded that divers with heart issues or problems compensating for changing pressure in their ears are more likely to black out, according to a review published

in 2009 in the *Journal of Applied Physiology* by environmental physiologists Peter Lindholm and Claes Lundgren of the Karolinska Institute in Stockholm. Fasting and too much exercise prior to diving can be detrimental too, as both can affect the amount of CO_2 in the body. In at least one case documented by Schagatay and colleagues, an erratically beating heart seemed to lead to the blackout.

Freediving teaches about disease

Data about freedivers have already provided clues about the health of nondivers.

"Freediving is the perfect model to understand what happens with low levels of oxygen in the blood," Pernett says. This deficit is a problem in many conditions — lung infections, chronic obstructive pulmonary disease, lung scarring or thickening and sleep apnea. He and others think applying the lessons learned from freediving research can improve the quality of life of patients with these conditions.

For example, freediver training exercises that help expand the lungs and take in more air for holding the breath longer could help asthmatics breathe better, Pernett suggests. Likewise, people with sleep apnea might benefit if they have a strong dive reflex.

Studies of freedivers can also inform clinicians about how the heart works. The low oxygen and high CO_2 and lactic acid levels associated with deep dives seem to predispose athletes to irregular heartbeats. If that's the case, similar changes may increase the risk of irregular heartbeats in nondivers.

Bradycardia, a slow heart rate, is another condition better understood through the lens of freedivers. During a dive, the heart slows down as part of the dive reflex and thereby conserves oxygen. "In the ambulance, they shouldn't try to cure this problem," Schagatay suggests. "The [low] heart rate is the body trying to cope."

Freediving research is also helping to improve our understanding of the blood-brain barrier. This cellular and molecular "wall" keeps toxins out of the brain. Bailey, the University of South Wales physiologist, finds freedivers useful for understanding how the barrier works — and why it fails. His subjects tend to be very healthy. So, the brain "is not contaminated by any form of disease, and we can decode" what happens when the barrier gets stressed.

During very long breath-holds, blood pressure and blood flow rise sharply to get precious oxygen into the brain, "which has one heck of an appetite for this gas," Bailey says. In his work with freedivers, Bailey discovered that low oxygen really stresses the brain, causing a temporary disruption of the blood brain

KATARZYNA STRZELSKA AND KOSTEK STRZELSKI

↓ This "bubble risk calculator," informed by research done in Egypt, helps divers adjust their activities to prevent decompression sickness.

"It's addicting to feel disconnected from normal thoughts."

—Juan Valdivia-Valdivia

barrier. "When it breaks down, harmful proteins can slip into brain tissue," Bailey says. Over time, the repeated stress of deep dives can lead to effects that resemble neurodegeneration, both his and Schagatay's teams have shown.

"Freediving may act as a kind of accelerated model of brain aging," Bailey says. "It's like stress-testing a machine to see where it cracks. That teaches us about vulnerability, and ultimately resilience."

The brain may have ways to cope with low oxygen to some extent, says physiologist Anthony Bain of the University of Windsor in Canada. He has done studies showing that high levels of CO_2 might help a stressed brain slow its energy use, temporarily lowering its needs for oxygen.

There's also an important psychological component to breath-holding that could be helpful for people with anxiety, panic disorders, PTSD or, for that matter, anyone feeling stressed. "These athletes have a phenomenal ability to cope with stress," Bailey says. While there is only scant anecdotal evidence, the breath control that comes out of freediver training may help these people, he adds.

Oleg G. Melikhov agrees. "The ability to control oneself, concentrate and relax are skills that are very helpful in everyday life," says the medical and science officer for the International Association for the Development of Apnea, an international organization that oversees freediving competitions.

Breath-holding, like meditation, seems to activate calming nerve circuits, a feeling that makes freediving appealing. "The deeper you go, the more relaxed you get if you really know how to do it," says Valdivia-Valdivia, who both competes and studies freedivers. He thinks his freediving has made him a better surgeon not just because of the discipline required to go deep but also because of what happens to his mind when he does.

At greater depths, self-awareness and a sense of detachment from the rest of the world soar. "It's addicting to feel disconnected from normal thoughts," he says. "Almost every time, I feel joy."

On the way to a warning device

Although the implications of freediving research can be broad reaching, the goal of the Francis family is quite narrow. They want to develop a watch or similarly sized device that will warn when blackout could be imminent. But they are also realistic. Schagatay "is doing terrific work," says Peter Francis, Tucker's dad. "But whether it will lead to a device, I don't know."

Schagatay's experiments and other work have provided much of the data needed to compute when a person's blood oxygen is approaching critically low levels, but turning these insights into a practical device is still a daunting task. "There are some 30 factors that affect these things," Schagatay says.

Divers in whom oxygen drops early in the dive are at greater risk of blacking out, Schagatay says, and that can happen even in moderately deep dives that freedivers don't feel are risky. People don't reach the surface in time.

Pernett has also been working on developing devices that detect if someone about to dive underwater is hyperventilating, though more testing is needed. Meanwhile, "there's a lot [that can be done] with education," Pernett says. "I don't think there's a chance that a device can be the only solution."

Tucker's parents agree. "We wouldn't suggest that people not freedive, but there's certain things you have to do to do it safely, not least of which is to make darn sure that you have somebody watching you who can pull you out," Peter Francis says.

Valdivia-Valdivia knows all too well the value of not diving alone. He's blacked out but was okay because safety divers nearby immediately pinched his nostrils shut and covered his mouth to close the airways and quickly brought him to the surface. "I didn't know it was happening until I was rescued."

"I wish more people would be aware [of blackouts]," Valdivia-Valdivia says. "Freediving can give you a very wholesome life, or it can take your life." ✖

Elizabeth Pennisi is a freelance science journalist based in Virginia.


Pushing
back against
Parkinson's


Emerging tests
and a cutting-
edge treatment
offer new hope
for patients and
their families

THE BIGGEST MEDICAL ISSUE OF SOMEONE'S LIFE MIGHT START WITH A QUIRK OF MOVEMENT.

MAYBE YOU NOTICE A TREMOR IN A LOVED ONE'S HAND. Or you sense something's off when you walk. Or perhaps you pick up on other oddities, like a loss of smell or disruptions in sleep.

These are some early symptoms of Parkinson's disease, a neurological disorder that progressively harms the brain. The damage impacts the rest of the body as well. Over time, Parkinson's can punch holes in memory and steal a person's movement.

"Until you spend time around Parkinson's patients, you don't know how profoundly it affects people," says Daniel Cleary, a neurosurgeon at Oregon Health and Science University in Portland.

It's a devastating disease that's all too common. More than 1 million people in the United States and 10 million globally are living with Parkinson's, making it the second most common neurodegenerative disease after Alzheimer's. Those numbers may underestimate the true count, which is expected to grow as the population over age 65 booms in the United States and globally. A recent estimate suggests that some 25 million people worldwide could be living with the disease by 2050. Diagnosing Parkinson's is not simple, and there's no easy way to catch it early. There's also no cure, which means patients and their families face a legion of medical challenges.

But hope is glinting on the horizon. New diagnostic tools and emerging treatments may improve the outlook for Parkinson's patients — one day even pushing back the disease's progression.

For this series, we spoke with patients who have undergone a first-of-its-kind treatment that uses high-intensity, focused ultrasound to ease symptoms. We also talked to scientists and physicians immersed in diagnostics and therapeutics. They sketch a picture of cautious optimism in a field desperate for solutions. That picture may foretell a future when people can fend off Parkinson's symptoms for years or even decades.
— Meghan Rosen

PREVIOUS SPREAD: ILLUSTRATION BY MATTHEW KAM

Dreaming up early diagnostics

Parkinson's disease is tricky to diagnose, but a plethora of new ideas are emerging

BY MEGHAN ROSEN

Neurologist David Standaert can often tell if someone has Parkinson's disease in a matter of minutes. Maybe their hand trembles and one of their arms doesn't swing as much as the other when they walk. Maybe their voice sounds softer than usual, and they have a stillness to their body and a masklike look on their face, with little expressivity or blinking. "I always tell patients, 'It's not any one thing that tells me you have Parkinson's. It's all of these things together,'" he says.

But Standaert's is a rare skill. A movement disorder specialist at the University of Alabama at Birmingham, he has been diagnosing people with the disease for decades. He's one of fewer than 1,000 doctors in the United States trained to spot and treat the sometimes-subtle signs of Parkinson's. That's a problem because more than 1 million people in the country have the disease, and the number is climbing as the population ages. "There are nowhere near enough movement disorder specialists to go diagnosing all these people," Standaert says.

A lack of specialists is just one of the problems that plagues Parkinson's diagnosis, which has proved difficult in part because the disease is so complicated. Over time, and for reasons scientists don't fully understand, particular nerve cells deep in the brain become damaged and die. For patients, this can manifest as tremors and a constellation of other symptoms that start mild

Living with Parkinson's

As the disease progresses, it can interrupt every aspect of daily life. In the following vignettes, patients and their families share what it's like to live with Parkinson's.

By Laura Sanders

MATT HUYNH

The challenge of simple tasks

Daily tasks that require a steady hand, such as getting dressed or putting on makeup, can be time-consuming, frustrating or even downright impossible. One of the first changes Robert Goings noticed was subtle. "I noticed that brushing my teeth wasn't quite right," he says. Gary Gilson, who also has Parkinson's, says he stopped driving much because he couldn't be sure he could control the accelerator and brake.

and progressively worsen. Eventually, as muscles stiffen and swallowing becomes difficult, people may become bedridden, in need of round-the-clock care.

But Parkinson's disease varies tremendously, Standaert says. Which symptoms arise, how severe they are and how quickly they progress differ from person to person. "I have seen tens of thousands of patients with Parkinson's disease, and no two are the same," he says.

This variability can make the disease tricky to spot. There's no simple screening test that offers a yes/no answer. But a confluence of factors now seems to be driving a deluge of diagnostic ideas. There's growing optimism about finding treatments to slow the disease, for one, Standaert says. While existing treatments can address people's symptoms, the possibility of delaying disease progression has ignited interest in early diagnosis. At the same time, technological advances are letting scientists capture signs of disease that were once undetectable. Preliminary concepts in the works aim to tap into signals that span the body, from our breath and bodily fluids to motions and more.

Although many of these approaches are still in their infancy, their development alongside treatments that seek to address the root causes of Parkinson's could one day be a major boon for people with the disease. Dozens of new drugs that attempt to stop Parkinson's in its tracks are now in clinical trials.

These therapeutics "are totally different than what we're currently using in the clinic," says Stanford movement disorder specialist Kathleen Poston. "We're testing things in people that have never been tried before."

Monitoring movements

For Robert Goings, an early sign of Parkinson's disease came from his handwriting. A former draftsman and civil engineering technician, his lines were straight and his lettering was precise. But around age 60, Goings noticed that his writing looked a bit off, he says.

The first inkling for Gary Gilson, a former surgical assistant, also had to do with his work. "I was in the operating room, and I was trying to shake a doctor's hand," he says. "My hand was shaking."

Linda Grant has a similar story. In her mid-60s, she noticed a tremble in her left hand. "I knew something was wrong and I had to get in to a doctor," she says.

Along with family history and other risk factors for the disease, Standaert and other specialists look for ways that the disease might be affecting movement. This includes symptoms like tremors and performance on physical tests, such as tapping the fingers together or screwing in an imaginary light bulb. On the light bulb test, people with Parkinson's usually make one good screwing motion before their hand movements start to shrink, Standaert says.

Standaert will at times use an imaging test called a DaTscan to look at the dopamine system in the brain. Healthy brains "light up" on the scan, indicating an abundance of dopamine-producing nerve cells. In Parkinson's, these cells tend to die, so a dimmer signal can indicate disease. But the test costs about $3,000 and requires multiple hours to perform. What's more, drops in dopamine can also occur in other neurodegenerative diseases. Because of those limitations, Standaert uses the scan only when there's a question about diagnosis.

Given that most diagnoses today rely heavily on symptoms related to movement, it's no surprise that ideas for new and simple diagnostics also focus on movement — aiming to pick up

Living with Parkinson's

Difficulty eating

One of Robert Goings' biggest challenges was eating. As his Parkinson's progressed, eating with his right hand became "an adventure." It was an effort, he says, to see "how much you can actually get in your mouth." Though Goings' right hand is dominant, he switched to using his left hand, which shook less. Sloshing liquids such as coffee and soup, or even a bottle of water, can be especially difficult to maneuver.

MATT HUYNH

subtle changes before they become obvious. Bioengineer Jun Chen's idea for an at-home Parkinson's test began brewing in his mind as he watched his grandfather develop the disease. Chen remembers his grandfather's hands shaking and frequent trips to the hospital to evaluate the disease's progression. Years later, that experience bubbled up into a project at the University of California, Los Angeles, that harnesses a phenomenon called magnetoelasticity in soft matter.

In February, Chen's team reported the creation of a squishy ball that can sense minute hand tremors. When a person holds or squeezes the ball, its soft, magnetic layer deforms in a way that produces measurable electrical signals. It's sensitive to the slightest of pressures, less than one kilopascal, like the touch of a very gentle fingertip, Chen's team reported in *Cell Biomaterials*. That could make the ball useful in detecting early-stage tremors, he says.

A similar idea is at play in two of Chen's other proof-of-concept devices. One is a pen that can detect tremors while a person is writing. The other is an intelligent keyboard that logs pressure-based signals when a person types. "You just type every day and record your typing patterns," he says. The keyboard could alert users when there's a change, potentially catching signs of Parkinson's disease early, his team reported in 2025 in *Science Advances*.

The researchers tested both devices in a few Parkinson's patients, but they will need to validate the findings in larger groups of people. Chen says that could take five years. If the results hold up, these or similar devices could one day make Parkinson's easier to spot — for specialists and nonspecialists alike.

With the shortage of specialists, the field needs a way for nonspecialists to identify the disease, Poston says. She's had patients who've bounced from doctor to doctor, waiting years before finally getting a diagnosis. Having a primary care doctor that can diagnose cases with the help of tools like these or even flag cases earlier could speed up the process, getting patients' symptoms treated sooner and saving them the emotional turmoil of not knowing.

Movement data collected by existing wearables like smartwatches could also help by picking up signs of Parkinson's in people who wouldn't otherwise be evaluated, Standaert says. In one study reported in 2023 in *Nature Medicine*, data collected from thousands of people wearing movement-tracking devices showed that, in the

In an ideal world, doctors would be able to diagnose Parkinson's disease and intervene at an early stage — when changes begin happening in the brain but before even the most subtle symptoms appear.

years before a Parkinson's diagnosis, people tend to be less physically active than those who don't develop the disease.

Other ideas include analyzing people's voices or even monitoring gait via radio signals pinging off the body. These tools are a type of passive monitoring. It's an approach that means people don't have to perform a specific task or undergo any test, which makes for an effective public health tool, Poston says. Imagine if your smartwatch said, "Hey your gait has changed. Maybe you should see your doctor," she says.

Chemical clues

In an ideal world, doctors would be able to diagnose Parkinson's disease and intervene at an early stage — when changes begin happening in the brain but before even the most subtle symptoms appear. The gap between the two could be five to 10 years, or maybe even longer. "It's a pretty big time window," Poston says.

One existing test can flag cases before symptoms appear by looking for clumps of alpha-synuclein, a protein that misfolds and accumulates in the brains of people with Parkinson's and is thought to play a role in the disease. "It's the closest we have to a definitive diagnosis," says Poston, who helped validate the test, called a seed amplification assay. But it's generally not covered by insurance, and it requires a sample of cerebrospinal fluid, the liquid cushioning the brain and spinal cord. That means patients must undergo a spinal tap, which is invasive and can be uncomfortable or even painful.

A truly transformative screening test would need to be simple and inexpensive. Perhaps it could even be incorporated into regular healthcare appointments, such as an annual exam or a dental cleaning, Poston and colleagues suggested in 2025 in the *Journal of Parkinson's Disease*.

Some researchers think chemical cues have potential. Detecting fatty molecules exhaled while breathing, for example, could be one approach. Chemical analysis of the breath of people with and without Parkinson's predicted which people had the disease, researchers reported in January in *npj Parkinson's Disease*. The team also spotted Parkinson's-linked molecules in the breath of people who appeared healthy but carried gene variants known to increase a person's risk of the disease. Whether the molecules can forecast who will go on to develop the disease, however, is not yet clear.

Potential early warning signs could also come from people's mix of gut microbes, or molecular markers present in their tears, earwax or stool, research suggests. These are just a smattering of the proof-of-concept diagnostics under investigation, Poston says. The field "has really exploded."

For her part, Poston is working with a National Institutes of Health consortium on a study that piggybacks on routine colonoscopies to look for abnormal alpha-synuclein protein in colon tissue. The clumping protein has been detected in the skin and gut of people with Parkinson's. But as with many potential markers, it's not yet clear at what point in disease progression clumps might appear.

In fact, whether the disease begins in the brain or elsewhere in the body is still one of many open questions, Poston says. Another is that scientists still don't fully understand the myriad elements that contribute to Parkinson's. Age and genetics factor in, and exposure to environmental toxicants like pesticides and herbicides can have a part, recent work suggests. That uncertainty adds to the challenge of identifying Parkinson's biomarkers, Standaert says.

If abnormal alpha-synuclein is consistently present in the colon of Parkinson's patients, it would be an appealing biomarker because doctors might be able to integrate screening into an

Living with Parkinson's

MATT HUYNH

Sleep troubles

Tremors, muscle cramps and pain can interrupt sleep, both for people with Parkinson's and their loved ones. Diana Goings sometimes slept apart from her husband Robert because of the nighttime jostling. But the drugs that treat Parkinson's symptoms can also disrupt sleep. Over 70 percent of people with Parkinson's experience sleep problems.

already established system. Poston plans to start recruiting participants this month; she's expecting to see results in the next two years.

Halting disease progression

As drugs to hold off the disease's progression advance, the demand for early testing will take on new urgency, Standaert says. Any speedup of the diagnosis journey will offer new opportunities to test therapeutics in people who are still at an early stage of the disease.

Diagnostics and therapeutics need to be developed in parallel, says Poston, who calls drugs that could stop progression "our biggest immediate need and my biggest hope."

Dozens of such drugs are in clinical trials, and a handful have advanced far enough that researchers may soon be able to gauge how well they work. One binds to alpha-synuclein clumps directly, attempting to slow their buildup and spread. Another seeks to surgically replace the nerve cells lost in Parkinson's, using cells derived from human embryonic stem cells. Yet another strategy ramps up cells' recycling machinery, so it can clear out alpha-synuclein and other protein garbage clogging the brain.

"There's a whole series of different strategies," Standaert says. "None of them is proven to work yet." Still, he's optimistic that, eventually, one of them will.

Whatever shape new diagnostics take, there's value in identifying people with early forms of the disease today, if possible, says neurosurgeon Emad Eskandar of the Albert Einstein College of Medicine in New York City. If doctors know about the disease earlier, they might test current treatments for their ability to curb its progression. Eskandar, for example, uses deep-brain stimulation to treat disabling movement symptoms. Perhaps early stimulation would be beneficial, he says.

Patients have varied feelings about earlier diagnosis. Goings says that getting an earlier diagnosis would make sense if there are treatment options that slow the disease. But for others, Eskandar points out, just knowing what's in store can be helpful. People can plan for what's next in their family life and career, try to prepare themselves mentally and physically, or start looking for specialists.

> The knowledge a diagnosis brings can be "a very powerful thing."
>
> – KATHLEEN POSTON

Gilson says an early diagnosis might have spurred some changes in his habits. He might have started eating better or trying to get more sleep, he says.

Standaert champions exercise, especially in people with sleep disorders that often precede other Parkinson's symptoms. "That has been shown time and time again to improve the outcome of Parkinson's," he says.

Grant also says she'd have been eager to find out, so she could have tapped into existing therapies sooner. "It would have been a blessing," she says.

Identifying the cause of their symptoms can help people feel more in control of what's happening, Poston says. The knowledge a diagnosis brings, she says, can be "a very powerful thing." ✖

Living with Parkinson's

Pain

Chronic pain can get overlooked, but it's extremely common in Parkinson's patients. "It's like your muscles are firing all the time," says Melissa Gilson of her husband Gary's experience. "It's like working out all the time." Neurosurgeon Daniel Cleary says musculoskeletal pain is an important symptom that is often neglected.

MATT HUYNH

The power of ultrasound

A new treatment can relieve the shaking, stiffness and pain that accompany Parkinson's — without invasive surgery

BY LAURA SANDERS

The night before he had brain surgery to treat his Parkinson's disease symptoms, Robert Goings couldn't sleep.

"He was pacing all night," says his wife, Diana. That's because it hurt to stop moving. Normally, Goings' restless movements, stiffness and muscle cramps were eased by medicine. But doctors wanted his symptoms unmasked for the procedure, which meant he was feeling them full blast. "My legs would cramp up, my arms, you know, everything would cramp up without the medication," Goings says.

The next morning, last November 5, Goings, who at age 68 had been living with increasingly disruptive symptoms for years, slid into an MRI machine at Oregon Health and Science University, or OHSU, in Portland. While Goings was inside the MRI tube, doctors aimed 1,024 ultrasound beams at several spots deep in his brain, burning the problematic tissue there.

Afterward, Goings was wheeled to a recovery room. "He held out his hand — dead still," Diana says. She remembers thinking, "Oh my God, I don't believe this. It's gone. Absolutely gone."

In opting for this treatment, called high-intensity focused ultrasound, Goings has joined a small but growing number of people choosing to control their Parkinson's symptoms with permanent lesions in their brain. Already, an estimated 50 to 60 people have undergone the surgery at OHSU, where the treatment calendar is booked up months in advance.

The U.S. Food and Drug Administration approved the earliest version of the treatment for certain Parkinson's patients in 2018, with several key clinical trials showing positive results. The latest version, which Goings received, was approved in 2025 and extends the treatment to include a new target in the brain that seems to ease not just tremors but also other movement symptoms, including slowness and stiffness. What's more, the treatment can now be done to both sides of the brain, thus providing relief to the entire body.

"People go into it not believing," says neurosurgeon Daniel Cleary, who has been helping to lead the focused ultrasound efforts at OHSU and who performed Goings' procedure. But the before-and-after experience can be profound.

Data generated in a yet-to-be published clinical trial of 40 people show that, when delivered to both sides of the brain, the treatment can improve people's movement disability symptoms by an average of about a third. That's compared with symptoms when patients are not taking medication. Three months out, 86 percent of study participants felt that overall, their Parkinson's symptoms had improved.

Many of the patients Cleary treats have had tremors for years, even decades. When they come out of the procedure and look at their hand, they are amazed that it's not shaking anymore. "Families get very emotional," Cleary says. "The patients get emotional. We get emotional. It's a big thing."

High-intensity focused ultrasound for Parkinson's is not yet widely available. In the United States, mainly large academic centers have the expertise to do it, Cleary says. And because the technique is relatively new, questions remain about the long-term effects. Like other Parkinson's treatments, the method relieves symptoms but it doesn't stop or even slow the brain destruction caused by the neurodegenerative disease.

Still, the procedure, which involves no cutting into the head, no anesthesia and no recovery in a hospital, holds promise as a way to ease severe

OPPOSITE PAGE: MATTHEW KAM

symptoms for millions of people with Parkinson's worldwide.

On their way north to OHSU from their house in Lebanon, Ore., Robert and Diana drove through a violent rainstorm, with poor visibility and lots of curves. Robert was driving, though they had taken Diana's car, expecting her to drive home. On the day after his procedure, Robert was feeling so good that he drove them both home.

Neuroscience at work

Parkinson's is marked by the death of a cluster of nerve cells deep in a part of the brain called the substantia nigra. These cells make the chemical signal dopamine, a neurotransmitter that's crucial for movement. One of the most common treatments is a medicine called levodopa, which adds back some of the missing dopamine. Other medications include carbidopa, which boosts levodopa's effects, and other drugs that influence the brain's dopamine system. While these medicines can help tremendously, Parkinson's is relentless. As the disease progresses, the drugs become less effective and increased dosages can cause debilitating side effects like uncontrolled movements.

Once Parkinson's progresses to later stages, some people opt for a treatment called deep brain stimulation, or DBS. Like a pacemaker for the brain, an implanted DBS system stimulates nerve cells in a way that can reduce symptoms. But some people aren't eligible for the surgery because they're not healthy enough, or they don't want permanent implants that require ongoing medical management.

Focused ultrasound gets around some of those issues by using a helmet that can dispense 1,024 ultrasound beams. The sound waves — the same sort that produce babies' sonograms — enter the head, pass through the skull and intersect at a precise spot deep in the brain. During the procedure, which lasts a little under an hour, doctors use the heat those waves create when they intersect to make a lesion.

"Ultrasounds are just mechanical waves — the same thing as if you drop a stone in a pond," says Pablo Villoslada, a clinical neurologist at Hospital del Mar in Barcelona who is exploring less intense ultrasound waves to treat dementia, multiple sclerosis and amyotrophic lateral sclerosis, or ALS. Because the waves can, in principle, reach anywhere in the brain, ultrasound methods hold promise for all sorts of neurological and mental health ailments, such as eating disorders, mood disorders and chronic pain, he says. "You need to select the right target, the right patient, the right circuit, the right stimulation," he says. "A lot of research must be done, but the potential is very high."

As a young man in his early career, Goings trained as a Navy diver, going deep underwater in Pearl Harbor, the bottom of which was a perpetual mud pit churned up by big ships. Some training exercises were done in the dark. He wore a blacked-out Mark V diving helmet, rendering him totally sightless. "You have to be able to feel," Goings says. Steady hands. No panicking.

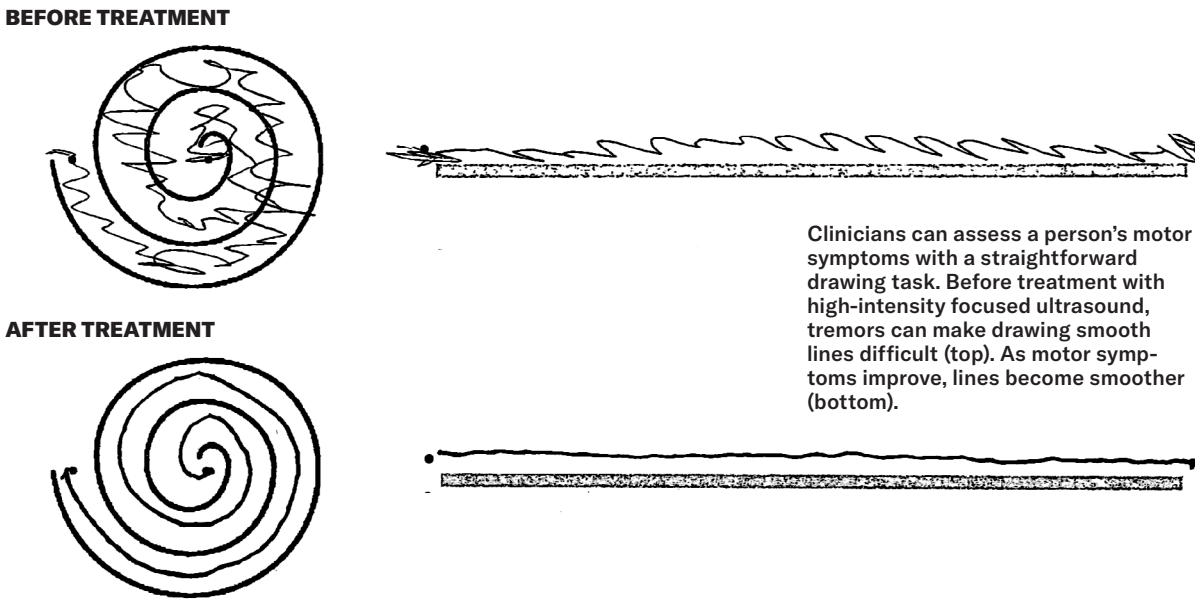
For his procedure, Goings was in a different sort of helmet, though water was still involved. Before getting started, medical staff shaved his head and mounted it in a tight-fitting brace. Screws that poked into his skin held everything steady. The procedure was done in an MRI so that Cleary and his colleagues could find the right spots to hit. And before Goings went into the machine, a flexible bladder sitting on the top of his head was pumped full of water. The liquid had two jobs: It helped conduct the sound waves into the head, and it helped keep his head from

Living with Parkinson's

Social withdrawal

It's easy to withdraw once Parkinson's symptoms set in, whether because of embarrassment or an inability to get around as easily. "You get so that you don't really like to be out in public when you shake a lot," Robert Goings says. "You know that other people are noticing. It's a dead giveaway." Isolation brought by Parkinson's can cause rippling harm that leads to poorer health overall, says neurologist Delaram Safarpour.

MATT HUYNH



Clinicians can assess a person's motor symptoms with a straightforward drawing task. Before treatment with high-intensity focused ultrasound, tremors can make drawing smooth lines difficult (top). As motor symptoms improve, lines become smoother (bottom).

heating up under the beams. Throughout the procedure, clinicians slid Goings in and out of the MRI tube several times to test his symptoms.

There's a lot of intricate neuroscience behind the focused ultrasound technique, says Delaram Safarpour, a neurologist and movement disorder specialist at OHSU. Movement results from a complex web of neural areas that span the brain. Some of these areas hit the gas pedal for movement, and some throw on the brakes.

"It's a big circuit that has to work in a balance," Safarpour says.

In Parkinson's, too much braking in one circuit can interfere with other parts of the network. "People will start having more movements than they should," Safarpour says. Taking out one of the brakes with ultrasound "is cutting a part of the circuit in order to bring the balance back."

Two such braking regions are ultrasound targets. The first, called the ventral intermediate nucleus of the thalamus, or VIM, is a good target for people who get tremors when they try to move. That issue can be present in Parkinson's, and it is a key symptom of a condition called essential tremor. The brain circuit that controls tremors involves signals moving from the cerebellum at the back base of the brain all the way up front to the motor cortex.

"We don't fully understand how the brain circuits work that affect tremor," Cleary says, but "we know that if we can knock out part of that pathway, the tremors get better."

A second target, the pallidothalamic tract, or PTT, is central to the latest FDA approval. A lesion there can ease slowness, stiffness and involuntary irregular movements called dyskinesia. It can also ease the pain caused by constant tensed-up, taut muscles that is almost universal among Parkinson's patients. "Because they're so rigid, so locked in, they get really severe pain," Cleary says.

Goings' tremors were worse on his right side, which is controlled by the left side of his brain, so that's where doctors aimed. Cleary generally targets both the VIM and the PTT. The procedure is done in stages, first with the ultrasound intensity high enough to temporarily disable the tissue but not permanently burn it. That lets doctors test the spot to see if the patient experiences relief before creating the permanent lesion.

"There was one point about three quarters of the way through, I came out of there smiling," Goings says. He was grinning because he felt his symptoms improve. "I said, you got the right spot," he says.

Diana remembers the doctor replying, "Oh no, we can do better than that." They did.

Goings' symptoms on the right side of his body have eased dramatically since his procedure, he says. "There are no ands, ifs or buts about it," he adds. "I am one hundred percent no regrets."

As with many other patients who get the procedure, Goings has remained on his medications, with the ultrasound treatment offering an added benefit. He's waiting now to have the other side done, which requires at least a six-month

During focused ultrasound treatment, clinicians scan a patient's brain using magnetic resonance imaging. This allows them to precisely target the right spot.

wait while doctors see how he's responding to the first procedure.

Still early days

Others have reported similar success. During his procedure, Gary Gilson, a 68-year-old former surgical assistant who lives in Hillsboro, Ore., was shaking so hard that technicians used weights and straps to keep him still. The shaking was expected, since he hadn't eaten much and hadn't had any medication. But what happened next surprised him. "All of a sudden, it just stopped … I was fighting it and then the next thing you know, it was gone."

In the three months since, Gilson's tremors have improved, but the biggest difference is that the pain that used to come from muscle rigidity on his right side has largely disappeared, he says. Because his left side wasn't as symptomatic as his right, he and his doctors are waiting to decide whether he will go back for treatment on the other side.

Linda Grant, from the small mountain town of Sisters in central Oregon, was similarly worn out from tremors. "My body fights every single tremor I have. My brain wants to stop it. So I think that's what tires me out so much. It's exhausting, actually."

Each time Grant came out of the MRI tube during her procedure, the clinicians would test her symptoms by asking her to use a stylus pen to trace a spiral and draw lines on a tablet. Throughout her procedure, her lines got more precise, steadier. Her tremors eased. Her right arm grew less rigid.

Afterward, as she settled into a recovery room, a nurse handed Grant a cup with no straw. Before her procedure, she wouldn't have been able to drink from it easily. But now she could. In the months since her treatment, Grant's tremors in her right hand have improved, though she still experiences tremors there when her left side shakes.

A common side effect of the procedure is temporary balance problems, lasting a few weeks to months, Cleary says. But those typically clear up and leave a person sturdier, he says. Grant has experienced some trouble walking, and has been working hard in physical therapy to keep herself as strong and mobile as possible. As for whether she'll have the other side treated, she doesn't hesitate: "I can't wait."

Nurse manager Christine Larsen, a coordinator of the focused ultrasound program at OHSU, checks in with patients after their procedure. She usually asks how their night went. She remembers one man answering that he had slept without waking for the first time in 20 years.

His wife said, "I woke up and I thought he was dead, because I'm used to sleeping with somebody who's in constant movement, constant tremor."

Data from patients treated for essential tremor, reported in 2022 in the *Journal of Neurosurgery*, show that improvements can last for at least five years — which is as long as patients have been followed so far. But how long relief might last for Parkinson's patients is not at all clear.

Parkinson's does not stop. Along with the death of nerve cells in the substantia nigra, other

changes unfold over time. A sticky protein called alpha-synuclein clumps up, and that clumping spreads elsewhere in the brain, interfering with brain activity. Systems that handle smell and digestion become disordered.

It's against this relentless body-wide backdrop that people are searching for relief, for as long as they can get it. While brain lesions created by focused ultrasound are not a cure for Parkinson's, the approach can help people get through their days. "It's a tough disease," Cleary says. "This makes a huge difference in their life."

These are early days, and there are a lot of questions to answer. Efforts include learning more about which patients might benefit the most, when to treat them and how to choose targets in the brain for each person. Plans are in the works to further study the PTT as a Parkinson's target. All the while, scientists are searching for ways to stop or slow the disease itself.

Cleary and other doctors at OHSU have busy schedules. They perform the procedures every Wednesday and every other Monday, usually treating about five people a day.

Living with Parkinson's

MATT HUYNH

Career changes

Both Robert Goings and Gary Gilson say their Parkinson's played a role in their retirement. Gilson, a former surgical assistant, eventually retired earlier than planned. Goings, who had worked as a draftsman and then a civil engineering technician, experienced changes in his lettering and was often tired and ill from his medication. "The symptoms kept getting worse, and I actually retired at 62," Goings says. "A portion of the decision in retiring was the Parkinson's."

"I was fighting it and then the next thing you know, it was gone."

– GARY GILSON

Cleary sees access as one of the biggest hurdles: Many people don't know that focused ultrasound is an option, there aren't enough surgeons and clinicians trained to do the procedure and the cost is not always covered by health insurance.

Making a compelling case to insurance companies requires more data, Safarpour says. "In big centers like ours, we constantly are gathering important data from patients that go through these procedures, and these will all become scientific papers that show improvement in quality of life and symptoms," she says. When it comes to insurers, "that's the way to fight back."

Though there's more work to do, the future for people with Parkinson's seems brighter than it did a decade ago, Cleary says. The first patient he treated with the new approach went from being unable to walk well to fluidly walking down the hall. "Seeing the profound effect on this single patient has really inspired a lot of people to say, 'OK, maybe we should go forward with this. Maybe this is something that's really powerful,'" he says.

When I ask Gilson, the former surgery technician, what's next for him, he answers immediately: "I'm going on vacation with my wife." They plan on visiting England, Germany and the Netherlands. The Gilsons have also bought a camper for future trips.

Goings is keeping busy closer to home, with firewood that needs chopping and rambling walks with his dog Scooter. Diana says that when faced with a challenge, Robert is the guy to say, "Give me some more." In this way, his Parkinson's is no different than any other challenge.

"There's no cure for it right now," Goings says. "But this is as close as I think you're going to get." ✖

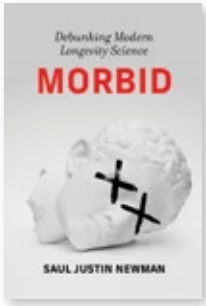
Curiosities

Above this Venezuelan lake, lightning flashes some 300 days per year. The phenomenon may be among the closest things Earth has to a perpetual storm (see Page 62).

XINHUA/TOURISM MINISTRY/ALAMY LIVE NEWS

MORBID DOESN'T WANT YOU TO FALL FOR ANTIAGING HYPE

By Meghan Rosen



MORBID
Saul Justin Newman
The MIT Press, $29.95

It's not often that a nonfiction science book exposes a story so scandalous it rivals something seen on reality TV. *Morbid*, by scientist and self-described "cheeky scamp" Saul Justin Newman, does just that, plunging readers into the mayhem and misdeeds of modern longevity science.

Newman, of the University of Oxford, writes about the world's (purported) oldest people and how to (allegedly) extend your life. Spoiler alert: There's no magic-bullet, fountain-of-youth wonder drug that's going to keep you young and spry. And take any stories you may have read about people living past 100 with a heaping spoonful of salt.

Consider the case of Irma Borgoglio: Neighbors thought the supposed centenarian was alive and well but she actually was quite dead. Borgoglio's son had been collecting her pension while keeping her body in the freezer.

Borgoglio was part of an extreme-age database that had been validated by researchers. And her case was no exception, Newman discovered. When he kicked the tires on such databases, which scientists use to gauge maximum human life span and pinpoint locations and diets tied to longevity, Newman uncovered a mountain of problems. Many examples of extreme longevity appeared to stem from errors in record keeping or — like Borgoglio — were straight-up scams. "Could most of the world's oldest people be just ... shonky data?" he writes.

It's a question Newman approaches with humor and locomotive force, hurtling readers on a journey to track down these superagers. It is a thrilling ride that exposes cracks in the case of a 122-year-old woman and deflates the hype around "blue zones," areas around the world where people supposedly live superlong, healthy lives. (For his work exposing flaws in record-keeping systems in blue zones, Newman won a 2024 Ig Nobel prize. The Ig Nobels honor achievements "that make people laugh, and then think.")

Newman is an expert debunker and he's not out to make friends. With logic, math and wit, he pokes holes in high-profile longevity research and undercuts a whole field of antiaging "medicine," including drugs for which Big Pharma shelled out big bucks. (Remember resveratrol, the red wine compound that shot to fame in the early 2000s with claims of antiaging powers? Turns out high doses mainly just cause diarrhea.)

Where *Morbid* starts off as a runaway train, it loses some steam when digging into the intricacies of aging biology. Newman seems to have done his homework and has enviable skill in statistics. But his musings on telomeres, cell recycling and evolutionary fitness might leave some readers — including this one — with more questions than answers. I imagine he'd be OK with that and any skepticism. After all, that's one of the book's underlying themes: You can't believe everything you read, even if it does appear in a prestigious scientific journal or a popular science book.

Though *Morbid* takes a mostly lighthearted approach to its takedown of longevity science, Newman makes clear that there is certainly something sinister afoot. There's money to be made in projects to "hack longevity," he writes. Scientists researching a seemingly promising antiaging compound can launch companies that market their product as supplements without proof that those products actually do any good. Instead of throwing money at the newest antiaging craze or leaping to laud the latest "oldest" individual, Newman advises a more cautious approach.

"Sack the charlatans, laugh out anyone who promises a 'cure' to aging or carries a trademark, and give space to reproducible basic research," Newman writes. That's advice everyone should be able to get behind — whether or not you agree with his stance on the longevity field. ✖

OUR UNDERSTANDING OF CHARLES DARWIN CONTINUES TO EVOLVE

By Aaron Tremper

DARWIN: A BIOGRAPHY

Janet Browne

Princeton University Press | $35.00

Charles Darwin had it out for the iguanas of the Galápagos Islands.

When the 26-year-old naturalist encountered marine iguanas on San Cristóbal Island in 1835, he repeatedly tossed these "most disgusting, clumsy lizards" into the ocean to test their preference for water. Later, he described yanking the tails of their land-based cousins on Isla Isabela. The landlubbers, he noted, were "ugly animals" that had a "singularly stupid appearance."

These antics, unbecoming for one of modern biology's founding fathers, are among many curveballs that historian of science Janet Browne pitches in *Darwin: A Biography*. The book, an abridged version of Browne's two longer Darwin biographies, distills the rich, complicated life of the beloved naturalist into 624 pages.

Readers first meet a young Darwin who is enthralled by beetle-collecting and grieving the death of his mother. While his hobby helped Darwin hone the techniques he relied on in his career, losing his mother inspired lifelong hypochondria, Browne suggests.

It doesn't take long to get to what is perhaps the most pivotal moment in Darwin's life: his voyage on the H.M.S. *Beagle*. This nearly five-year trip around the world supplied Darwin with the observations, specimens and worldly experience needed to pen his magnum opus, *On the Origin of Species*, decades later.

Browne makes it clear that Darwin's own origins were steeped in privilege. His affluent upbringing offered him access to people and services that made such a trip possible. The invitation from a Cambridge University professor to join the crew "subtly revealed the power of the old boys' network," Browne writes.

Meanwhile, an inheritance from Darwin's mother put the wind in his sails — paying for food, lodging and specimen preparation. The fact that Darwin could request money orders from his father while abroad, which has at times been overlooked by historians, "was only made possible through the great spread of the financial network of the British Empire," Browne writes.

In this sense, Darwin's role as a seafaring naturalist underscores how Victorian England's obsession with natural history fueled its imperial agenda. This Darwin shot, skinned and dissected his way through the Southern Hemisphere, often relying on hired and uncredited help. "Like other collectors of the time, he considered that he possessed the right to take material as he wished," Browne writes.

Though a watershed moment, the voyage was a mere blip in the naturalist's 73 years. Browne goes on to detail how Darwin grew a family and built a reputation in the natural sciences, courting controversy along the way. To prevent his theory of evolution from being scooped, Darwin "coauthored" a paper on the subject with rival naturalist Alfred Russel Wallace. Darwin added to and published an essay Wallace had written without Wallace's knowledge. It's one of the many controversies surrounding the eventual publication of *On the Origin of Species* in 1859.

By the end of Browne's biography, we recognize the Darwin most people know from textbooks: The heavy-browed, bearded scholar with an impressively long bibliography. Much of the book draws from Darwin's professional work, but the deepest insights come from his personal correspondence, diaries and notes. These documents reveal the man behind the theories. There's the agnostic lover at odds with his future wife over her belief in God. The grieving father wrestling with the deaths of three of his seven children. And the bitter author bristling at unfavorable book reviews.

Darwin: A Biography is neither a love letter nor a scathing critique. Instead, it offers glimpses of Darwin the Human, a figure often elbowed out of conversations by Darwin the Scientist. Browne paints a portrait of a man who laughed, wept and struggled his way through the Victorian era as much as he informed it. A dedicated reader will surely find getting acquainted with Browne's Darwin an enjoyable endeavor. That is, unless they're an iguana. ✖

Recognizing the Nation's Top Young Scientists

On March 10, Society for Science and Regeneron announced the top winners of the Regeneron Science Talent Search (STS), the U.S.'s oldest and most prestigious science and math competition for high school seniors. Since 1942, the competition has identified and supported the nation's most promising future leaders in science as they develop innovative solutions to solve significant global challenges through rigorous research.

This year marks the 85th anniversary of the STS and Regeneron's 10th year as the title sponsor. In February, Regeneron and the Society announced the company is renewing it's title sponsorship through 2036, pledging $150 million to fuel the next generation of science and technology leaders.

Connor Hill (shown above, center), 17, of State College, Pa., won first place and $250,000 for discovering a way to identify all the possible "noble polyhedra," highly symmetric shapes with flat sides and straight edges. He wrote a computer program to do the computations and proved there are two infinite families of noble polyhedra, as well as 146 isolated examples.

Edward Kang (left), 17, of Hackensack, N.J., took second place and $175,000 for using retinal images to train AI models on subtle patterns linked to autism and attention-deficit/hyperactivity disorder, which he used to create a screening tool.

Iris Shen (right), 17, of The Woodlands, Texas, won third place and $150,000 for testing a potential cancer drug in clams to see if they could serve as an animal model for blood cancer drug discovery.

These students and 37 other finalists spent a week competing in Washington, D.C., where they presented their research to the public and met top scientists and lawmakers.

The winning finalists were selected from over 2,600 entrants from 826 high schools across 46 states, Washington, D.C., Northern Mariana Islands, Puerto Rico and 16 additional countries. U.S. citizens living abroad are eligible to apply.

With projects spanning fields including quantum physics, medicine in microgravity and arctic conservation, the finalists represent some of the best young scientists the nation has to offer.

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EFFORTS TO BOOST BIRTH RATES AREN'T WORKING. EVOLUTIONARY HISTORY HINTS AT WHY

BY SUJATA GUPTA

With the announcement that U.S. Vice President J.D. Vance and his wife, Usha, are expecting their fourth child in July, Vance assumed the mantle for leading efforts to boost the nation's population. "Let the record show you have a vice president who practices what he preaches," he proclaimed in a speech at the 2026 March for Life rally in Washington, D.C.

Vance's views align with pronatalism, a political movement aimed at increasing birth rates. As rates plummet worldwide, that movement has become more popular, with policies spanning the political spectrum. To encourage childbearing, some countries have adopted left-leaning ones, including tax credits for new parents and paid parental leave. Right-leaning adherents tend to oppose state-funded support and advocate for the classic nuclear family, in which women stay home to raise the children while men bring home the bacon.

Yet both approaches have largely failed to increase birth rates. People's reasons for not having children in the modern era run deep. Some social scientists say that asking how to boost births is the wrong question; better to look at how to support communities. Evolutionary history, they say, is a guide.

"In ancient times, the nuclear family was not the system for taking care of children," says sociologist Philip Cohen of the University of Maryland in College Park. Cooperative childrearing was. Caregivers included older siblings, extended kin and community members.

The nuclear family is a modern invention, emerging just several hundred years ago. That and other demographic changes have weakened community ties. Nowadays, extended family members often live far apart. And smaller families mean few older siblings to watch younger ones. Yet people still need and yearn for deeply embedded systems of care, says anthropologist Heidi Colleran of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

To understand how people might have organized their family lives in the distant past, researchers often

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turn to contemporary hunter-gatherer societies. These communities still show immense diversity in family structure, but they share a universal trait: Parents rely on networks of caregivers, says anthropologist Karen Kramer of the University of Utah in Salt Lake City. "Human life history and the central dilemma of mothers — how to find enough hours in the day to support dependent offspring — is foundational to understand why cooperative relationships between mothers and children, spouses and others emerged," Kramer wrote in *Social Sciences*.

Cooperative childcare was especially useful when human life histories tended to favor larger families. High child mortality drove more births, as did the need for children to assist as laborers or caregivers for younger siblings. As societies shifted to market economies and child mortality declined, smaller families became the norm.

Arguably one of the biggest factors has been shifts in work, says demographer Rebecca Sear of Brunel University of London. Women in hunter-gatherer societies often concurrently work and care for children, such as by wearing their babies in slings while working in the field. These women are superproductive, Sear says. Studies of such communities have found that, on average, women's work produces almost half of the calories consumed in their communities.

In Western societies, work and family life began to diverge as societies shifted from farming to factory and office work. Lacking a network of caregivers, women tended to stay home to watch the children while men went to work, Sear says.

Worldwide, the average number of births per woman of childbearing age has fallen from 5.3 births in 1963 to 2.2 births in 2024, the World Bank Group reports. The United States and many other countries are now below a replacement level of about two births per woman. These declines feature heavily in pronatalists' rallying cry.

If the goal is simply to grow a given country's population, then, for the time being, immigration from countries with higher birth rates to those with lower ones could fill the gap, Sear says.

But pronatalism has long been bound up in discussions about who should have more children, Cohen says. When birth rates plummeted in the aftermath of World War I, Benito Mussolini and Adolf Hitler each established pronatalist policies.

5.3

The average number of births per woman worldwide in 1963

2.2

The average number of births per woman worldwide in 2024

People still need and yearn for deeply embedded systems of care.

—Heidi Colleran

In Nazi Germany, the government offered home loans to couples and forgave a portion of the loan for each child the couple had. The loans weren't available to people with "impure" lineages, ones that had nonwhite or disabled ancestors.

In some ways, the push today feels similar, Cohen says. Pronatalist leaders often encourage more people to have children while eschewing immigration. But a quarter of U.S. children have an immigrant parent. And immigrants make up a fifth of the childcare workforce.

At heart, the debate over how to address declining birth rates hinges on how one frames the problem, or if they see it as a problem at all.

Family policies such as paid parental leave and childcare support may boost birth rates by a tiny bit, by about one child for every 10 to 20 women, researchers reported in *Population and Development Review*. Does that mean such policies are failures? The researchers argue no.

Instead of using fertility as a metric of success, policy makers should focus on how well policies support individuals and families, the team says. Consider Nordic countries, which top the world happiness rankings. Their policies make caregiving, education, housing and health care affordable for all, and are centered on boosting the population's overall well-being rather than convincing people to have more children.

Data suggest that in the United States, people want more children than they are having. So let's help aspiring parents and improve quality of life across the board, Cohen says. Pronatalists often treat population decline as a harbinger of societal collapse. But for the foreseeable future, societies can adapt, he says. "The low birth rate gives us the opportunity to fix our other problems." ✖

EARTH HOSTS EXTREME STORMS, BUT AT LEAST THEY END

BY AARON TREMPER

Weather forecasts can get extreme in the land of Hyrule, in the Nintendo series *The Legend of Zelda*. A downpour in the coastal province of Faron, for instance, prevents Link, the game's hero, from reaching Calora Lake. And constant lightning and rain threaten the skybound Thunderhead Isles. These storms end only once Link completes a series of quests. The threat of never-ending storms makes for moody gameplay. But real storms "can't last forever," says Stephanie Spera, a physical geographer at the University of Richmond in Virginia.

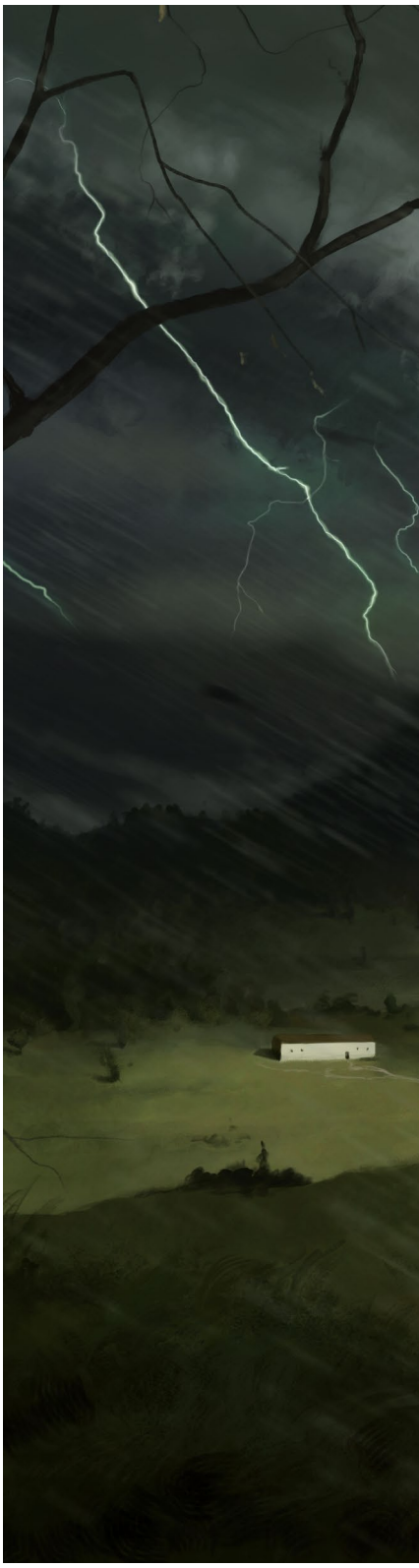
Storms result from imbalances between moisture and temperature. Though violent at times, thunderstorms help redistribute heat, moisture and electrical charges. "The whole purpose of anything in weather is to get the atmosphere back in balance," says meteorologist Chris Vagasky of the Wisconsin Environmental Mesonet, a statewide network of weather stations.

To fuel constant thunderstorms, such imbalances would have to persist. But Earth's atmospheric physics ensures that even the strongest storms eventually fade away.

Constant thunderstorms would need ongoing supplies of storm ingredients, Vagasky says. For one, you'd need a "persistent conveyor belt of warm, moist air." And heat, maybe 24-hour sunlight. As rising warm air condenses into cloud-forming droplets, then cooling rain and downward winds (which dissipate storms on Earth), the cycling would refuel the storm.

Even if a storm could sustain its internal energy, it couldn't stay stationary forever, because Earth's atmosphere is in constant motion. Like massive conveyor belts, jet streams move weather across continents. Wind patterns can also increase how long storms last and even force them to hang out in one place for a bit. In August 2017, Hurricane Harvey stalled over Houston for about four days. Fueled by warm coastal waters, some areas received nearly 130 centimeters of rain before the storm moved inland and broke up.

Like Houston, Faron, of *Zelda*, lies



GRACE ALDRICH

along a coast, perhaps in a cyclone-prone area where warm seas make storms last year-round. Earthly cyclones die when they make landfall, face windshear or reach colder water at higher latitudes. "They need to be refueled, which is why they die over land," Spera says. "There's no energy source."

While perpetual storms like those in Faron are impossible on Earth, certain scenarios come close.

The Thunderhead Isles storm looks similar to Earth's Intertropical Convergence Zone, Spera says. This solid band of clouds encircles the globe near the equator. Here, prevailing winds from the Northern and Southern hemispheres meet, lifting warm, humid air heated by the intense sunlight in the tropics. But it's home to a series of intense but short-lived events rather than single, massive ones, Spera says. And the zone doesn't stay still: It zigzags across the equator, leading to seasonal monsoon rains in places like the Indian subcontinent.

For flashier storms, head to Venezuela's Lake Maracaibo. Here, a phenomenon called Catatumbo lightning flashes up to 300 days a year and can last nine hours at a stretch. The region holds the world's record for the most concentrated lightning.

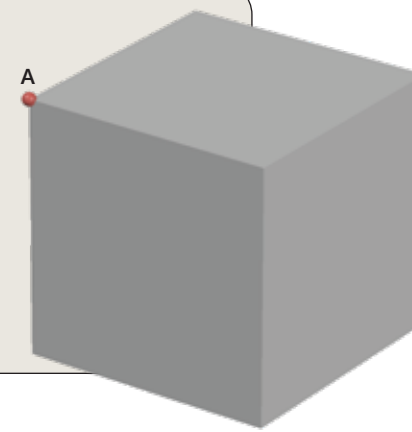
The key is its geography. Winds whisk moist air from the lake and nearby Caribbean Sea up the Andes Mountains. There, it meets colder air within the clouds. Water droplets collide with ice crystals, building up static charges. The bowl-shaped mountains hugging the lake prevent the cumulonimbus clouds from moving, leading to stagnant thunderstorms. "Catatumbo," Vagasky says, "is one of the closest things that we might see to [the Thunderhead Isles]." ✖

THE ANT GOES MARCHING

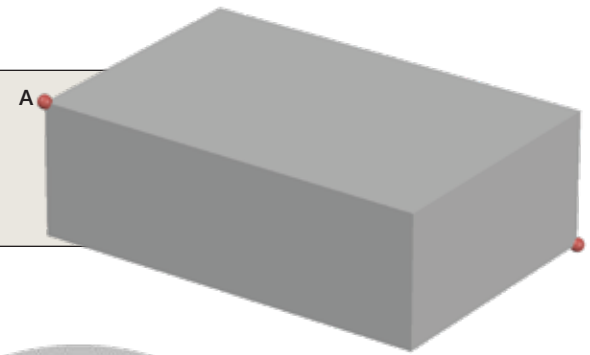
BY ZACH WISSNER-GROSS

June the ant has to crawl along the surface of four different 3-D objects to reach her dinner. Your job is to help her find the shortest path along the surface of each object, so that she can chow down as quickly as possible. June is one hungry ant!

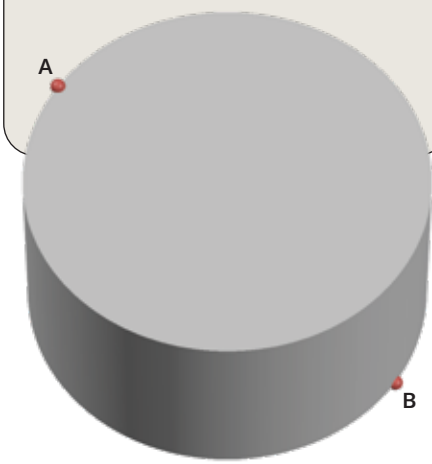
1 Suppose June starts at one corner (A) of a cube with a side length of 1 meter. Her dinner is at the opposite corner (B) of the cube. What's the shortest path she can take to reach her food, traveling along the surface of the cube? What's the length of this path?

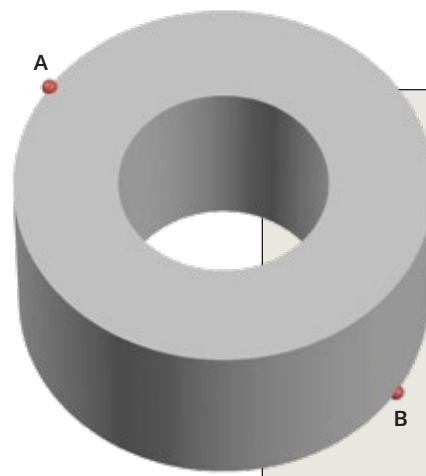


2 Instead of a cube, now suppose June is at one corner (A) of a rectangular prism that is 3 meters long, 2 meters wide and 1 meter tall. Her dinner is at the opposite corner (B). What's the shortest path to her food? What's the length of this path?



3 Now June is on a cylinder. More specifically, she is on the edge of one of the cylinder's two circular faces (A). Her dinner is on the edge of the opposite circular face, and all the way around on the other side of that face (B). The cylinder's radius is 2 meters and its height is 2 meters. What's the shortest path to her food? What's the length of this path?





4 Finally, June is on a hollowed-out cylinder, also known as a "cylindrical shell." The shell's outer radius is 2 meters and its inner radius is 1 meter. The shell is 2 meters tall. June is on the outer edge of one of the cylinder's two flat faces (A). Her dinner is on the edge of the opposite face, and all the way around on the other end of that face (B). What's the shortest path to her food? What's the length of this path?

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

Z. WISSNER-GROSS

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According to Bennet, in lieu of becoming a science teacher, donating to Society for Science is one of the best ways to help cultivate scientific thinking in future generations. Through science, we can understand the world and improve lives. That is why Bennet gives to the Society through his donor advised fund at Vanguard Charitable.

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