Introducing 2024's SN 10: Scientists to Watch

Science News

MAGAZINE OF THE SOCIETY FOR SCIENCE ■ OCTOBER 5, 2024

Scientists' Little Helpers

Fruit flies are boosting research across Africa

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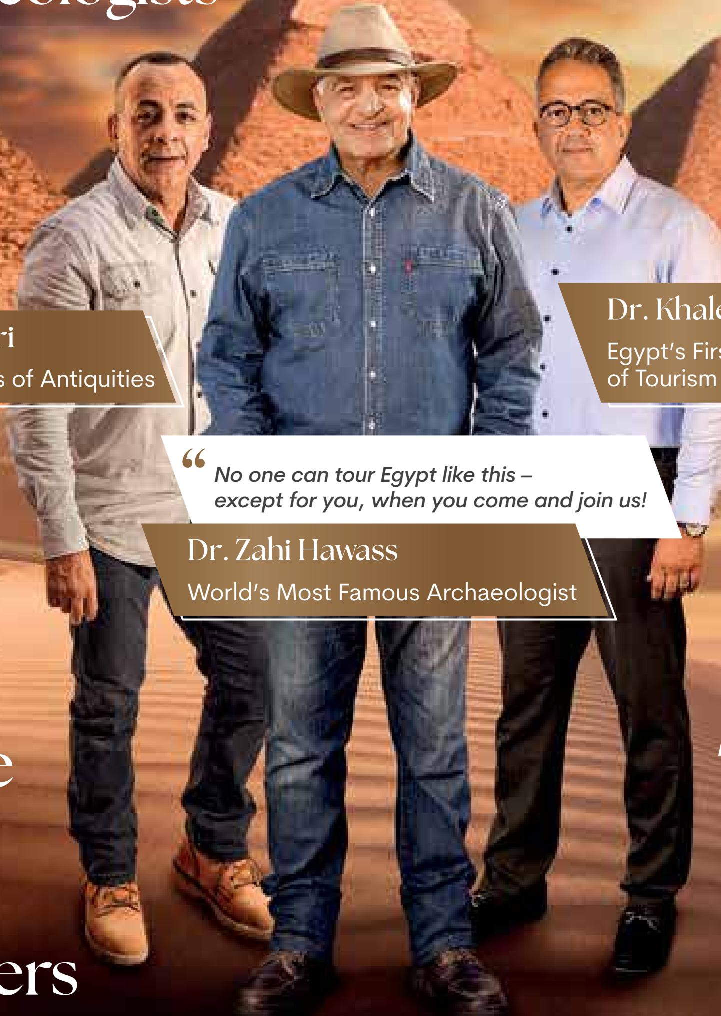

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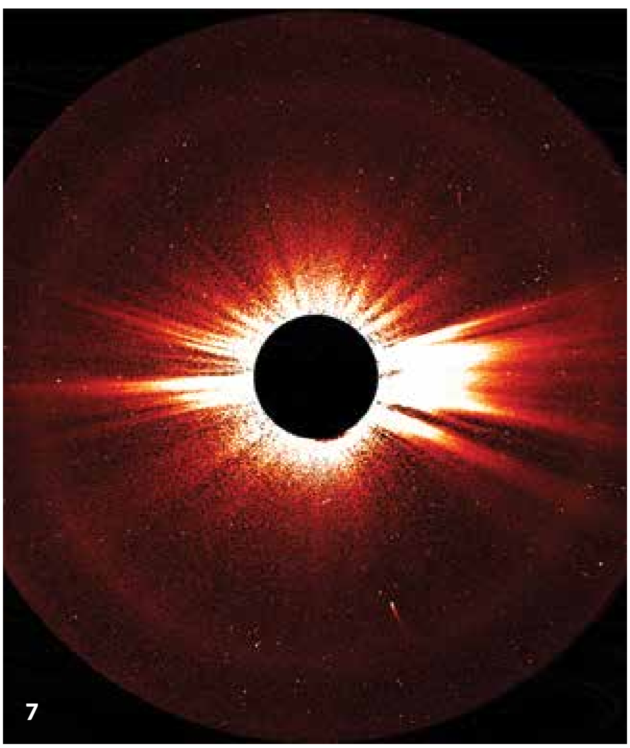

Departments

COVER Fruit flies, like this mutant one shown in a colorized micrograph, are longtime lab darlings of biology. *Eye of Science/ Science Source*

SN 10, CLOCKWISE FROM TOP LEFT: JACK KEARSE; BRANDON SANCHEZ MEJIA, UC BERKELEY; PROVIDED BY QUEEN'S UNIV.; SAM WILSON; JOHN T. CONSOLI/UNIV. OF MARYLAND; BRYCE VICKMARK PHOTOGRAPHY; COURTESY OF THE UCHICAGO PRITZKER SCHOOL OF MOLECULAR ENGINEERING, JOHN ZICH; DOUGLAS LEVERE; COURTESY OF F. VAN EDE; MICHAELA GO; ARTHROPOD: A. SMITH; SUN: JOY NG, BILL THOMPSON/STEREO/NASA GODDARD SPACE FLIGHT CENTER

Embracing the collective nature of science

He brings people together. She is good at recruiting other people to her vision. She has crossed boundaries between nations, scientific fields and languages. She is invaluable to the physics community.

These phrases are used to describe four of the remarkable early- and mid-career scientists profiled in our SN 10: Scientists to Watch (Page 15). And the gist of those observations — that collaborating and communicating with others is essential to science — is true of all 10 of the scientists on our list. They get that science depends on more than being smart and hardworking; it also requires building connections with others, to make one's own work possible and to amplify the work of all.

And they're already reaching out to help the next generation of science superstars. Jacqueline Gerson, an SN 10 honoree who's a biogeochemist at Cornell University, is working to demystify what she calls the "hidden curricula" for getting into science so that more people can find their way into the profession.

Science has long been a team sport, despite the lingering presence of the "great man" trope. Einstein was a noted collaborator and mentor, and a savvy Nobelist takes care to note the legions of grad students, postdocs, colleagues and researchers around the world that made a breakthrough possible.

In the early months of the COVID-19 pandemic, scientific collaboration rose to the next level, with tens of thousands of researchers worldwide racing to learn about the coronavirus. In one notable case from 2021, 15,025 researchers from 116 countries were named authors on a peer-reviewed academic paper from the COVIDSurg and GlobalSurg collaboratives — a feat noted by the Guinness World Records. The groups collected data from 1,667 hospitals on more than 140,000 patients globally to evaluate the benefits of vaccination for patients undergoing elective surgery. Another 2021 analysis determined that the surge in pandemic research, with 245,222 researchers publishing papers on COVID-19 in 2020 alone, far eclipsed the number of new authors for earlier epidemics including Zika, Ebola and HIV/AIDS. All told, more than 700,000 scientists had published work related to COVID-19 by 2021. Though that rush to join the cause resulted in some flawed work, the success of the mobilization is indisputable. The FDA approved the first COVID-19 vaccine for emergency use on December 11, 2020, just nine months after the World Health Organization declared the outbreak a pandemic.

And speaking of collaborators, some of them have wings. In this issue, we explore how efforts by researchers in Africa to use fruit flies as model organisms is paying off in making biological research more efficient and cost-effective (Page 22). The multinational effort is not only accelerating research on the continent, but it is also connecting African scientists with the global research community and making it easier for junior scientists to do research.

I especially loved learning about Rashidatu Abdulazeez, a Nigerian researcher whose first fruit fly collaboration started with setting out a bowl of rotten fruit to lure her study subjects. She has since founded Droso4Nigeria, which brings fly-based lessons to secondary schools. Abdulazeez also uses the flies to address urgent public health issues, such as lead poisoning. — *Nancy Shute, Editor in Chief*

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Excerpt from the October 5, 1974 issue of *Science News*

50 YEARS AGO

Satellites hinder radio astronomy

In the past, the satellites and probes launched by NASA and others successfully avoided conflict with the radio frequency bands reserved for radio astronomy. But now there is trouble. The trespassers are two major U.S. satellites.... When either of the satellites is on or near the line between an observer and what he wants to study, the work is rendered difficult or impossible.... Radio astronomers may be able to live with one or two such interlopers. Twenty or a hundred would be a catastrophe for radio astronomy.

UPDATE: The conflict between astronomers and satellites has only worsened. As of September, there are over 10,000 active satellites in Earth's orbit, and private companies continue to launch more (*SN: 4/8/23, p. 5*). Astronomers are worried that catastrophe is imminent, in part because optical telescopes now are affected. Satellites leave streaks across images of the night sky, making the images difficult to analyze. Efforts to mitigate the problem by modifying the satellites or their orbits have had mixed results.

The globular springtail can backflip so fast that scientists had to use a high-speed camera to unravel the mechanics of the arthropod's acrobatics.

A. SMITH

THE –EST

How an arthropod does the world's fastest backflip

Move over, Simone Biles. Nature's gold medalist for backflips is a millimeter-tall arthropod that can barely straddle the tip of a pencil.

Despite its size, the globular springtail (*Dicyrtomina minuta*) can vault itself more than 60 millimeters in the air, spinning at a rate as fast as 368 times per second, researchers report August 29 in *Integrative Organismal Biology*. Blink and you'll miss this superflipper, though, as its jump lasts just 161 milliseconds, on average.

"Nothing on Earth does a backflip faster than a globular springtail," says biologist Adrian Smith of North Carolina State University in Raleigh. "They're extraordinary, but also ordinary." The arthropods that Smith used in the study "are literally from my backyard," he says.

Globular springtails jump so fast that they often seem to simply vanish, Smith says, a useful trick for evading predators. To reveal the secrets of the arthropods' escape acrobatics, he and biomechanist Jacob Harrison of Georgia Tech in Atlanta analyzed high-speed footage of more than a dozen springtails from liftoff to landing.

Liftoff starts with a thump, as the springtail lets loose a springlike appendage called the furca from its underbelly. That thump propels the arthropod backward as fast as 1.5 meters per second, on average, the researchers found. While airborne, the glob spins anywhere from 14 to 29 times.

Some flights end less than gracefully, with springtails crashing back to Earth and bouncing about until they come to a stop. More often, the arthropods stick the landing by deploying a sticky tube typically used for grooming, the team found. "It's a sort of anchor that pulls them to their feet so they can get on with their day," Smith says.

"We sometimes get told that the only exciting parts of nature are fossilized in the ground or hidden in a tropical rainforest somewhere," Smith says. To him, these springtails show that everyday organisms are pulling off incredible feats all around us — we just have to look. *— Jonathan Lambert*

Watch springtails do backflips in slow motion at **bit.ly/SN_FlippingBugs**

INTRODUCING

JWST spots a planetary sextuplet

The James Webb Space Telescope looked at star cluster NGC1333 and spotted six newborn planets. Three of the worlds are circled in green in this composite image.

A distant stellar nursery holds a clutch of newborn Jupiter-sized worlds, the tiniest of which is surrounded by a dusty disk that might someday give rise to moons.

The detailed discovery, made thanks to the unparalleled sensitivity of the James Webb Space Telescope, could provide new insights into star and planetary formation, researchers report in a study to appear in the *Astronomical Journal*.

Stars arise from enormous clouds of gas and dust when pockets of material collapse under the influence of gravity. The same process can also create smaller nonstellar objects, such as giant planets and brown dwarfs, which lack the internal pressure to fuse hydrogen into helium.

In the star cluster NGC1333, located about 1,000 light-years from Earth, astronomers found six infant worlds with masses between five and 15 times that of Jupiter.

The dusty disk around the smallest world is exactly like the kind that circles baby stars and gives rise to planetary systems. This dusty disk might one day turn into a pack of orbiting moons, says astrophysicist Adam Langeveld of Johns Hopkins University.

It's possible that Langeveld and colleagues have found the lightest celestial object that can form with a disk. And given the parallels between how stars and planets can form, "we're really probing the limit of the star formation process," he says. Future work will use JWST to look at the chemical composition of the newborn worlds and the surrounding material. *— Adam Mann*

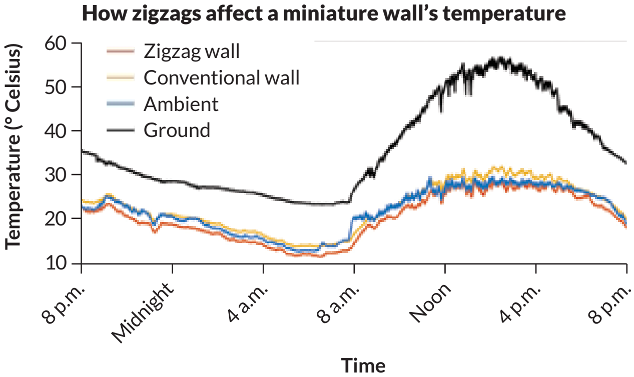
TEASER

Zigzag buildings could beat the heat

Adding zigzags to walls could help cool buildings by reflecting more of the sun's energy. A new corrugated design can reduce daily average exterior wall temperatures by a couple degrees Celsius, materials scientist Yuan Yang of Columbia University and colleagues report in the Sept. 17 *Nexus*.

Downward facets coated with reflective materials and upward facets coated with emissive ones help the wall absorb less heat than straight walls. In a test of small-scale walls, the zigzag version was 2.3 degrees cooler on average than a conventional wall. The difference grew to 3.1 degrees during the hottest part of the day (see graph below). *— Carolyn Gramling*

How zigzags affect a miniature wall's temperature



HOW BIZARRE

Mayonnaise may shed light on nuclear fusion experiments

Mayonnaise's texture inspires love and loathing. Either way, it's perfect for physics experiments.

The condiment's behavior sits on the border between elastic and plastic. If jiggled, mayo returns to its original shape. That's elastic behavior. But fling the condiment forcefully and it goes plastic, meaning the mayo changes shape permanently or breaks apart. This elastic-to-plastic transition can also occur in experiments that use lasers to kick off nuclear fusion. The lasers blast a fuel-filled capsule, raising pressures and temperatures so high that atomic nuclei in the fuel fuse and release energy. The molten capsule has some properties of a solid — like gloopy mayo, it doesn't flow on its own — but it can break apart under enough force.

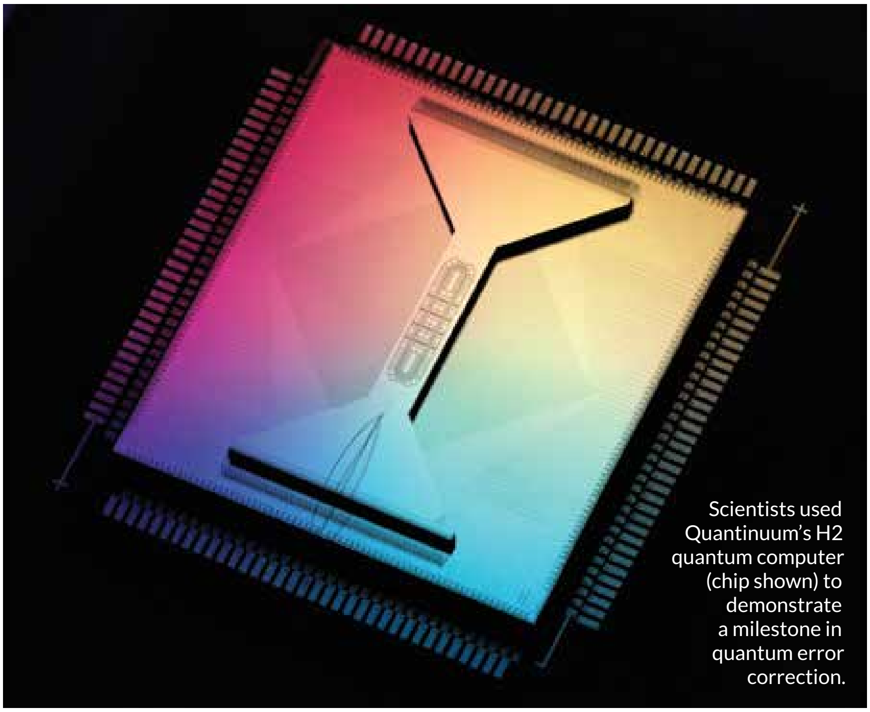
Because it's difficult to study how materials behave under the extreme conditions required for fusion, engineers Arindam Banerjee and Aren Boyaci of Lehigh University in Bethlehem, Pa., turned to mayo. Accelerating the condiment into air using a rotating wheel revealed where the border between elastic and plastic is, the team reports in the May *Physical Review E*. The mayo and air are akin to the molten fuel capsule and the gas it contains. If the capsule material becomes plastic before fusion occurs, the gas could escape, spoiling the fusion attempt. *— Emily Conover*

News

QUANTUM PHYSICS

A quantum computer fixes its errors

The feat brings reliable quantum computing closer to reality


Scientists used Quantinuum's H2 quantum computer (chip shown) to demonstrate a milestone in quantum error correction.

QUANTINUUM

BY EMILY CONOVER

For the first time, a quantum computer has improved its results by repeatedly fixing its own mistakes midcalculation, with a technique called quantum error correction.

Scientists have long known that quantum computers need error correction to meet their potential to solve problems that stump standard, "classical" computers. Quantum computers calculate with quantum bits, or qubits, which are subject to quantum physics but suffer from jitters that result in mistakes.

In quantum error correction, multiple faulty qubits are combined to make reliable qubits, called logical qubits, which are then used to perform the calculation. In previous efforts, error correction made calculations worse, rather than better, or detected errors but didn't actually fix them (SN: 11/6/21, *p.* 8).

Now, scientists have performed repeated rounds of operations and error correction on eight logical qubits, researchers from Microsoft and the quantum computing company Quantinuum reported September 10 at the Quantum World Congress in Tysons, Va. The operations performed in the calculation imbued the qubits with correlations called quantum entanglement. The corrected calculation had an error rate about a tenth that of one performed with the original, error-prone qubits, which are called physical qubits.

The researchers also entangled 12 logical qubits, the largest number of logical qubits ever entangled. The error rate for this entangled state was less than one-twentieth that of the equivalent state achieved using the computer's initial physical qubits.

"Error correction is working; this is huge," says Krysta Svore, a computer scientist at Microsoft in Redmond, Wash. "This is the direction we need to go for reliable quantum computing."

The researchers used a quantum computer developed by Quantinuum that has 56 qubits made from electrically charged atoms, or ions. Those qubits were combined to make the logical qubits.

A variety of schemes exist for correcting errors, and each one can fix a certain number of mistakes. The device in the study used an error correction scheme that could fix only one error. If the computer made two errors, the researchers were unable to fix the mistake, and they instead detected the mistakes and threw the result away to avoid inaccurate results.

In another recent milestone, reported in a paper posted August 24 at arXiv.org, researchers from Google found that error correction increases the length of time a qubit can store information in memory, though the team didn't perform calculations with the qubit. Taken together, the Microsoft and Google results show that "error correction works like we expect," says quantum engineer Ken Brown of Duke University and a scientific adviser for the quantum computing company IonQ. "That's really promising."

But more improvements are needed. The Microsoft result falls short of demonstrating a universal quantum computer, one that can perform all the operations that a quantum computer is capable of. "The next big challenge is getting enough resources … that you can actually do full universal quantum computing on many logical qubits," Brown says.

In another study, researchers at Microsoft combined high-performance classical computing, artificial intelligence and quantum computing to perform a chemistry calculation. The calculation can be done without a quantum computer, but the study was a proof of concept. The calculation used two logical qubits, and the results were improved compared with a calculation performed with the error-prone physical qubits.

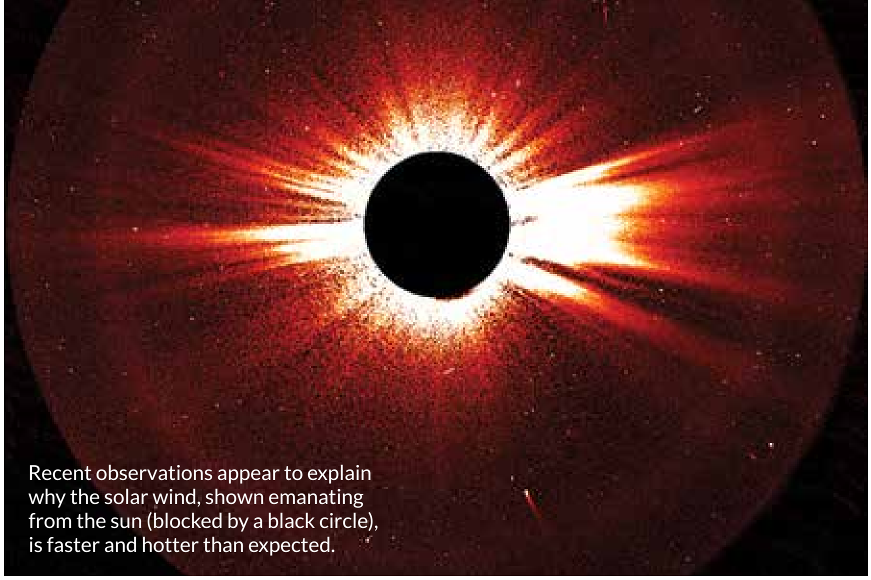
Future quantum computers with more logical qubits could unlock secrets that classical computers can't access. Scientists hope the machines might reveal how to more efficiently make fertilizer or extract carbon out of the atmosphere to combat global warming. "At the core, we want to save and feed our planet," Svore says. ■

ASTRONOMY

Plasma waves may rev up solar wind

Probes gather data that could answer a riddle about the sun

BY ADAM MANN



Recent observations appear to explain why the solar wind, shown emanating from the sun (blocked by a black circle), is faster and hotter than expected.

A lucky alignment of two spacecraft may have finally solved a solar mystery.

Data from NASA's Parker Solar Probe and the European Space Agency's Solar Orbiter suggest that plasma waves known as Alfvén waves energize the solar wind as it leaves the sun's outer atmosphere. The finding could explain why the stream of charged particles is hotter and faster than heliophysicists expect, researchers report in the Aug. 30 *Science*.

Scientists knew the solar wind accelerates as it blows out into the solar system. And data show that the temperature drops as the wind travels, but at a slower rate than predicted. Earth-based observations have spotted Alfvén waves emerging from the sun with enough energy to account for the wind's high speed and temperature. But researchers lacked direct evidence.

Then in 2022, Parker passed through a plasma stream containing Alfvén waves between the sun and Mercury. Less than two days later, Solar Orbiter flew through the same stream near Venus. The coincidence let heliophysicist Yeimy Rivera of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., and colleagues quantify the waves' energy.

The plasma traveled by Parker at about 1.4 million kilometers per hour and by Solar Orbiter at 1.8 million km/h. At Solar Orbiter, the plasma was 200,000° Celsius, three times as hot as expected. The waves had dissipated in the interim, which the team calculates would have injected enough energy into the solar wind to rev it up.

The study provides "a very strong indication that Alfvén waves can heat and accelerate the solar wind," says plasma physicist Jean Perez of the Florida Institute of Technology in Melbourne. But not everyone is convinced. Some critics suggest that the spacecraft could have intercepted different plasma streams.

But the probes measured helium in the plasma and found the exact same levels, suggesting it's the same stream, Rivera says. How exactly Alfvén waves transfer energy to the solar wind is an open question. ■

PHYSICS

Nuclear clock prototype makes debut

A new era of ultraprecise timekeeping may be on the horizon

BY EMILY CONOVER

Scientific clockmakers have crafted a prototype of a nuclear clock, hinting at future possibilities for using atomic nuclei to perform precise time measurements and make new tests of fundamental physics theories.

While the definition of a "clock" is scientifically hazy, the prototype is not yet used to measure time. So it technically should be called a "frequency standard," says physicist Jun Ye of JILA in Boulder, Colo. But the work, described in the Sept. 5 *Nature*, brings scientists closer to a nuclear clock than ever before.

"For the first time, all essential ingredients for a working nuclear clock are contained in this work," Ye says.

Whereas atomic clocks measure time based on electrons jumping between energy levels in atoms, nuclear clocks' timekeeping would depend on the energy levels of atomic nuclei. A certain frequency of laser light is needed for an atom or an atomic nucleus to make such a jump. The wiggling of that light's electromagnetic waves can be used to mark time.

Most atomic nuclei make energy leaps that are too large to be triggered by a tabletop laser. But a variety of the element thorium, thorium-229, has two energy levels that are close enough to each other that the transition between the levels could serve as a clock.

Now, Ye and colleagues have precisely determined the light frequency needed to set off the jump: 2,020,407,384,335 kilohertz. The measurement is more than a million times as precise as the best previous measurement. And it's more than a billion times the precision to which that frequency was known just over a year ago.

The improvement hinged on a component called a frequency comb. A crucial component of many atomic clocks, a frequency comb creates an array of discrete frequencies of light. The team compared the nuclear clock transition with that of an atomic clock with a known frequency.

"This is something that will be important as a scientific application for tests of fundamental physics," says physicist Ekkehard Peik of the National Metrology Institute in Braunschweig, Germany. In the future, such comparisons could be used to search for strange physics effects, such as drifting values of fundamental constants — numbers that are believed to be eternally unwavering. ■

JOY NG, BILL THOMPSON/STEREO/NASA GODDARD SPACE FLIGHT CENTER

ANIMALS

Data uncover a shark 'murder mystery'

Unfortunately for the victim, it's a shark-eat-shark world

BY JASON BITTEL

Scientists used to think that once a porbeagle shark reached adulthood, it was safe from predation. That is, until 2021, when tracking data for a porbeagle longer than Shaquille O'Neal is tall revealed that the sizeable predator had gone missing.

So, what happened to the poor shark? Data recovered from tracking devices placed on the porbeagle nearly six months prior suggest it was devoured by an even larger great white shark, marine biologist Brooke Anderson and colleagues report in the Sept. 2 *Frontiers in Marine Science*. It's the first documented predation of an adult porbeagle, the team says.

Porbeagles (*Lamna nasus*) look like a cross between a great white (*Carcharodon carcharias*) and a shortfin mako (*Isurus oxyrinchus*). Some individuals have been known to reach lengths exceeding three meters, which is partly why it's so surprising that a formidable predator in its own right should find itself on the wrong end of the food chain.

Anderson, of the North Carolina Division of Marine Fisheries in Raleigh, and colleagues pieced together the missing shark's presumed demise using location, temperature and depth data received from tags that had been attached to the shark during a routine survey off Cape Cod, Mass.

"All of a sudden," Anderson says, the "temperature increases even at 300 meters depth. And it stays high, even at 600 meters depth." That very clearly indicates "this tag is … in the stomach of a larger predator." Figuring out the predator's identity hinged on data that became available only after a tag floated to the surface, presumably after being excreted.

The temperature readings weren't warm enough to indicate the tag had been inside a large, warm-blooded marine mammal, such as an orca. That left two fish large enough and with the right internal body temperatures to have gobbled up the porbeagle: a shortfin mako or a great white. Diving patterns from previous studies suggest that the culprit likely is a great white. "It really was like a shark murder mystery," Anderson says.

But that's not the only plausible scenario, says shark scientist Megan Winton of the Atlantic White Shark Conservancy in Chatham, Mass. A predator could have eaten just the tag. It's also possible that the predator was another porbeagle, she says. ■

Marine biologist Brooke Anderson (in red) and colleagues affix trackers to a porbeagle shark off Cape Cod, Mass. One of their tagged sharks may have become a meal for a great white.

ANIMALS

Spiders might lure prey with fireflies

Orb weavers seem to use the bugs' own flashes against them

BY ERIN GARCIA DE JESÚS

Sometimes fireflies shouldn't follow the light.

A single flash from a female *Abscondita terminalis* firefly usually helps males find her among tall grasses at dusk. Males are showier, giving off multiple light pulses to attract a mate. If ensnared in an orb weaver spider's web, however, flashy males can become deadly decoys.

Orb weaver spiders seem to trick male fireflies into blinking in a pattern more like that of a female, researchers report in the Aug. 19 *Current Biology*. The femalelike lights lure other males into the web, allowing the arachnids to stock up on food.

"What a cool behavior," says Ximena Nelson, an animal behaviorist at the University of Canterbury in Christchurch, New Zealand, who was not involved in the study. The observations add a unique hunting tactic to spiders' repertoires (*SN: 10/7/23 & 10/21/23, p. 11*).

Behavioral ecologist Daiqin Li of Hubei University in Wuhan, China, and colleagues set up cameras on spider webs in nearby farmland to watch what happened to fireflies caught in them. The team placed a firefly directly into a spider web and either left the spider or removed it from its web. After each trial started, the researchers counted how many additional fireflies became caught in webs every few minutes.

In the webs of *Araneus ventricosus* spiders, the fireflies changed their flashes. But in the webs of other spider species, they did not, Li says.

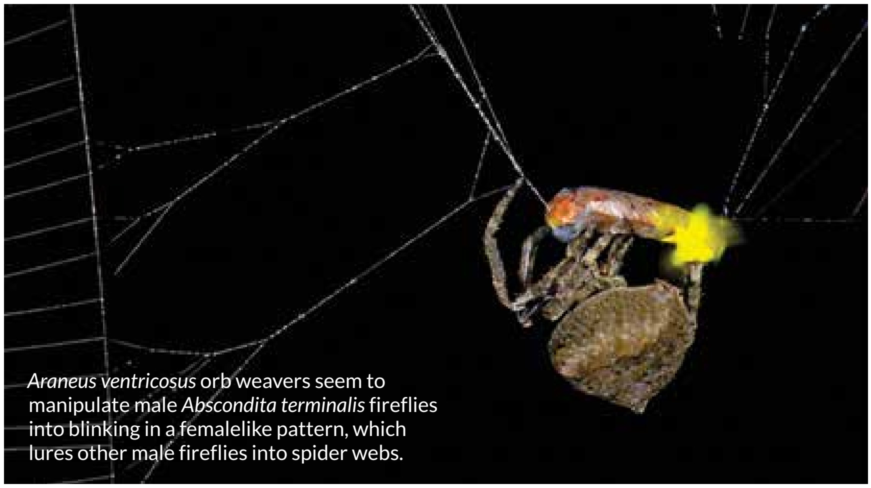
Male fireflies were more likely to get caught in webs and change their flashing pattern when an *A. ventricosus* orb weaver spider was around compared with when it was absent. Those spiders were also less likely to capture more fireflies when the team painted over the insects'

JAMES SULIKOWSKI

flashing lanterns with black ink.

Trapped males that had been bitten and wrapped in a spider's silk flashed just one of their two lanterns to pulse light. The weaker pulses appeared much closer to the flashing pattern of females, who have a single lantern.

The orb weavers also handled fireflies differently than nonflashing beetle species, Li says. While spiders wrapped other beetles in a thick layer of silk and began to feed almost immediately, fireflies got a light wrapping so their lanterns were still visible and then were stocked away in the web.



Araneus ventricosus orb weavers seem to manipulate male *Abscondita terminalis* fireflies into blinking in a femalelike pattern, which lures other male fireflies into spider webs.

As more fireflies get caught, the spiders "repeat the sequence for each of them and leave them there, just flashing," Li says.

Nelson says the jury is still out on how exactly the signals change. But Li suspects the spider's bite or venom has something to do with it. He's now planning to test those ideas and look for orb weavers outside of Southeast Asia that use this tactic. ■

ANIMALS

Heat may hamper bees' sense of smell

Antennae struggle to detect flowers' scents after a heat wave

BY GENNARO TOMMA

Heat waves don't just make bumblebees hot. The high temperatures also seem to drastically reduce the insects' sense of smell — which might threaten the survival of colonies.

For bumblebees, the ability to smell flowers is a matter of life or death. Olfactory cues help lead them to the best flowers to harvest nectar and pollen. But exposure to simulated heat waves reduced the ability of bumblebee antennae to detect flower scents by up to 80 percent, insect ecologist Sabine Nooten and colleagues report in the August *Proceedings of the Royal Society B*.

With climate change expected to increase the severity and frequency of heat waves, "the animals need to find a way to adapt somehow to cope with this," says Nooten, of the University of Würzburg in Germany.

Bumblebees are already suffering from climate change (*SN: 8/8/15, p. 9*). A thick, furry body makes bumblebees well adapted to thrive in cold regions. But cold-resistance in a warming world can turn fatal. Nooten and colleagues wanted to understand whether heat waves could also impact the ability of bumblebees to smell flowers.

The researchers exposed about 140 bees of two common species (*Bombus terrestris* and *B. pascuorum*) to simulated heat waves, placing the bees in tubes for almost three hours at temperatures up to 40° Celsius. A subset of bees were placed in a dry environment, some had access to sugary resources and some were given time to recover at ambient temperatures for 24 hours after the heat treatment.

Afterward, the researchers cut off the bees' antennae, which the insects use to smell, and measured whether olfactory sensory neurons in the antennae could detect chemical compounds that give many flowers their scent.

The common carder bee (*Bombus pascuorum*) and other bumblebee species partly rely on smell to find flowers. Heat waves dampen the ability, lab tests suggest.

Heat waves reduced the strength of the neurons' electrical signals by up to 80 percent. Female worker bees were more affected than males. Even worse, the antennae of the bees that had 24 hours to cool off still hadn't fully recovered their sense of smell.

"That was surprising," Nooten says. The team had expected those antennae to recover. The fact that they didn't suggests the bees don't recover swiftly, which spells trouble for getting food for the colony, she says.

The negative effect of heat waves on worker bumblebees' sense of smell could have a cascading effect on the survival of the whole colony, Nooten hypothesizes. Together with other factors such as habitat loss, "it could be one explanation for why we see so many [population] declines," she says.

Bumblebee ecologist Dave Goulson of the University of Sussex in England notes that antennae morphology is quite similar across bee species. "If bumblebees suffer in this way, I think it's probable that other bees would too," Goulson says. But until someone looks, we won't know for sure." ■

ANTHROPOLOGY

Neandertals in Europe split up

The continent had at least two distinct populations, DNA hints

BY BRUCE BOWER

Analyses of DNA from this roughly 50,000-year-old jaw points to a previously unknown Neandertal lineage in Europe. The group seems to have avoided mating with other Neandertals in the region.

L. SLIMAK

Neandertals traveled at least two evolutionary paths on their way to extinction around 40,000 years ago, a new study suggests.

Whether classified as a separate species or a variant of *Homo sapiens*, Neandertals have typically been viewed as a genetically consistent population. But an adult male's partial skeleton discovered in France contains genetic clues to a Neandertal line that evolved apart from other European Neandertals for around 50,000 years, nearly up to the time these close relatives of *H. sapiens* died out, researchers say.

The possibility of a long-lasting, isolated Neandertal population in southwestern Europe supports the idea that these hominids "very likely had their own, complex evolutionary history, with local extinctions and migrations, just like us," says paleogeneticist Carles Lalueza-Fox of the Institute of Evolutionary Biology in Barcelona.

A team led by archaeologist Ludovic Slimak of Université Toulouse III–Paul Sabatier in France and population geneticist Martin Sikora of the University of Copenhagen nicknamed the French Neandertal skeleton Thorin, after a character in J.R.R. Tolkien's *The Hobbit*. Thorin's remains, discovered at the entrance of Grotte Mandrin rock-shelter in 2015, are still being excavated.

Several dating methods applied to teeth from Thorin and animals buried near his body, as well as Thorin's position in Grotte Mandrin sediment, indicate that this Neandertal lived between around 50,000 and 42,000 years ago, Slimak, Sikora and colleagues report in the Sept. 11 *Cell Genomics*.

Analyses of carbon and other diet-related chemical elements in Thorin's bones and teeth suggest that he lived during an ice age, which did not develop in Europe until about 50,000 years ago.

Molecular segments representing about 65 percent of Thorin's genome were recovered from a molar, Sikora says. Thorin's DNA was then compared with DNA from other Neandertals, ancient *H. sapiens* and present-day people.

Arrays of gene variants in Thorin's DNA more closely align with the previously reported DNA structure of Neandertals that lived around 105,000 years ago than with Neandertals dating to around 50,000 to 40,000 years ago.

Previous evidence suggests that *H. sapiens* and Neandertals alternated occupations of Grotte Mandrin a few times between about 56,800 and 40,000 years ago (SN: 3/12/22, p. 9). But Thorin's DNA shows no signs of having acquired genes via mating either with Neandertals outside his lineage or with *H. sapiens*.

Thorin also inherited from his parents an unusually high percentage of DNA segments containing consecutive pairs of identical gene variants. Reduced genetic variation of that kind, previously found in Siberian Neandertals, reflects mating among close relatives in a small population.

Taken together, the genetic evidence fits a scenario in which Thorin belonged to a Neandertal lineage that split from other European Neandertals around 105,000 years ago, the researchers say. For roughly the next 50,000 years, the team suspects, Thorin's lineage consisted of small networks of closely related communities that exchanged mates.

Reasons why those ancient groups avoided mating with other Neandertals in the region, such as language or cultural differences, are unclear, Sikora says.

It is hard to say whether the population size of Thorin's lineage stayed constant or declined over time, perhaps as communities became more isolated, Sikora says. Thorin currently represents the only source of DNA from his lineage.

Similarities of Thorin's DNA to that of a Neandertal individual from Gibraltar, on Spain's southern tip, suggest that the newly reported lineage extended across parts of southwestern Europe, the investigators say. No consensus exists on an age for the Gibraltar fossil, a partial braincase found at a quarry in 1848.

"If Thorin is really 50,000 years old, this would be an amazing finding showing a strong genetic structure in late Neandertals," says paleogeneticist Cosimo Posth of the University of Tübingen in Germany. But, he says, further excavation and research at Grotte Mandrin will need to confirm when Thorin lived.

Thorin's remains were found in a small, natural depression on the rock-shelter floor. Slimak and Sikora's team cannot yet say how the body got there or whether it originated in older sediment. An older date for the partial skeleton would indicate that Thorin belonged to an isolated population that petered out quickly.

Long-term isolation would have resulted in Thorin inheriting a greater number of short DNA segments containing identical gene pairs than the team reported, Lalueza-Fox says. Isolating more of Thorin's DNA or collecting genetic remnants from other members of his lineage will clarify the evolutionary story of these close-knit Neandertals, he says. ■

Tears From a Volcano

Uniquely American stone ignites romance

On May 18, 1980, the once-slumbering Mount St. Helens erupted in the Pacific Northwest. It was the most impressive display of nature's power in North America's recorded history. But even more impressive is what emerged from the chaos... a spectacular new creation born of ancient minerals named Helenite. Its lush, vivid color and amazing story instantly captured the attention of jewelry connoisseurs worldwide. You can now have four carats of the world's newest stone for an absolutely unbelievable price.

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HEALTH & MEDICINE

Experimental drug eases hot flashes

In clinical trials, elinzanetant improved menopause symptoms

BY AIMEE CUNNINGHAM

A potential treatment for hot flashes brought relief and a better night's rest for women experiencing these disruptive symptoms of menopause.

Two clinical trials compared the drug elinzanetant with a placebo at two time points. The drug subdued hot flashes quickly: By the fourth week, a majority of those taking the drug reported at least a 50 percent reduction in frequency.

By week 12, more than 70 percent taking elinzanetant, compared with more than 40 percent on placebo, experienced that drop in hot flash frequency, researchers reported August 22 in *JAMA*. Participants on elinzanetant also reported significantly improved sleep compared with those on placebo at the 12-week mark.

Elinzanetant is made by Bayer, an international pharmaceutical company. The drug is "a promising new nonhormonal treatment," says Talia Sobel, a women's health internist specializing in menopause at Mayo Clinic in Scottsdale, Ariz., who was not involved in the trials.

After the first 12 weeks, the trials switched placebo users to the drug. Studies of treatments for hot flashes often show a placebo effect, says JoAnn Pinkerton, a gynecologist specializing in menopause at the University of Virginia Health System in Charlottesville. This could be due in part to the therapeutic rituals of the trials, scientists have proposed.

"We wanted to see if there was an additional effect beyond the placebo," Pinkerton says. "And indeed, there was." By 26 weeks, 82 percent of the participants who took elinzanetant the entire time, and more than 84 percent of those switched from the placebo, reported at least a 50 percent reduction in hot flash frequency. The finding that more than 80 percent of all participants benefited, regardless of whether they began on or switched to the drug partway through the trials, "is pretty dramatic," Pinkerton says.

In the transition to menopause, which signals the end of ovulation and menstrual periods, the ovaries' production of the sex hormones estrogen and progesterone fluctuates and eventually stops. During the lead-up to menopause and for years after, people can experience a range of burdensome symptoms, including hot flashes, night sweats, disturbed sleep, changes in mood, loss of concentration, vaginal dryness and urgency with urination.

Up to 80 percent of women experience hot flashes at some point during the menopausal transition, and the symptoms can continue for many women for more than seven years. Hot flashes are thought to be due to a narrowing of the body's range of temperature sensitivity, such that a small increase in body temperature can feel like a blast of heat. The body's exaggerated cooling response can trigger excessive sweating and a flushed appearance from dilated blood vessels.

80 percent
Estimated number of women who experience menopause-related hot flashes

>80 percent
Proportion of trial participants who experienced a substantial reduction in hot flash frequency

Hormone therapy (estrogen with progesterone or estrogen alone) is the most effective treatment for hot flashes and menopausal symptoms that affect the vagina and the urinary tract. The North American Menopause Society reaffirmed in 2022 that, absent certain health conditions, hormone therapy is a safe choice for women who are younger than 60 or who begin therapy within 10 years of the start of menopause. Hormone therapy also protects against bone loss, which occurs with the drop in estrogen with menopause.

Nonhormonal treatments are needed too. For women older than 60 or those more than 10 years out from menopause, hormone therapy is tied to a higher risk of coronary heart disease, stroke and blood clots. People who have had estrogen-sensitive breast cancer, prior blood clots, a history of stroke, severe endometriosis and migraines with aura are among those who wouldn't be good candidates for hormone therapy, Pinkerton says.

Research focusing on KNDy neurons, nerve cells in the hypothalamus involved in temperature regulation, has led to the development of new nonhormonal treatments. As estrogen levels decline, these neurons grow and become overactive, which stimulates production of certain chemical messengers. One of the messengers binds to a receptor found on KNDy neurons and on nearby thermoregulatory neurons, which appears to spur hot flashes.

A drug called fezolinetant, which blocks that receptor, received approval from the U.S. Food and Drug Administration in 2023. The new drug, elinzanetant, targets that same receptor but also interferes with another receptor present on KNDy neurons that may have a role in insomnia.

The participants in the two clinical trials for elinzanetant were postmenopausal women 40 to 65 years old having 50 or more moderate to severe hot flashes during the course of a week. Headache and fatigue were the most commonly reported side effects by participants taking the drug compared with those on placebo. An ongoing 52-week trial of elinzanetant is assessing longer-term safety, while another trial is looking at how well the drug works for women receiving therapy for hormone-positive breast cancer (*SN: 6/3/23, p. 10*).

Many women experiencing hot flashes and other bothersome symptoms of menopause aren't getting sufficient or appropriate treatment, Sobel says. "There are safe and effective options, both hormonal and nonhormonal, that can help improve their symptoms and quality of life," she says. "I encourage women to find a trusted clinician who is trained in menopause management." ■

HEALTH & MEDICINE

Face transplant includes an eye

In May 2023, Aaron James, an electrical lineman, had the first partial face transplant to include an eye. Over a year later, there are no signs of rejection and there is blood flow to the donated eye. But James cannot see out of it, a medical team from New York University Langone Health reports September 9 in *JAMA*. The nerve connections from the eye have withered.

A test that assesses the eye's ability to react to light detected a small response, though this result does not mean sight will return, the medical team notes. James doesn't have sensation in the eye's surface and the lid remains closed.

Eye transplants have been proposed as a potential solution for blindness, but experts note there are many barriers to restoring sight this way. A big one is renewing nerve connections from retinal cells to visual processing centers in the brain. These connections do not regenerate after injury. *— Aimee Cunningham*

CLIMATE

Dry spells give valley fever a boost

California droughts can keep cases of valley fever low. But cases skyrocket when the rain returns.

Researchers analyzed cases of valley fever, a sometimes lethal illness caused by *Coccidioides* fungi that spreads through dust, in California from 2000 to 2021. Cases tended to peak between September and November, the end of the dry season, the team reports in the October *Lancet Regional Health — Americas*. Smaller peaks occurred during drought, but cases spiked a year or two after the dry spell ended.

Why is unclear. Fungal populations might crash during droughts, helping surviving fungi thrive with less competition in wet times. A lack of rain may also boost amounts of spore-spreading dust.

Knowing when the valley fever season starts can help doctors stay alert for cases, says Justin Remais, an environmental health researcher at the University of California, Berkeley. *— Erin Garcia de Jesús*

EARTH

How quakes forge gold nuggets

When strained by earthquakes, underground networks of quartz veins can generate enough voltage to snatch gold from passing fluids, researchers report in the September *Nature Geoscience*.

A lot of mined gold comes from branching mineral layers, or veins, made mostly of quartz. The deposits build up over time by earthquakes that open underground fractures. Incoming subterranean fluids deposit quartz and gold. Subsequent quakes create more fractures and reopen existing veins, swelling and ramifying the deposit over time. But how does gold concentrate in quartz, an unreactive medium?

The key is quartz's piezoelectricity, the ability to develop electric charge when strained. Scientists plunged quartz slabs into solutions of dissolved gold and struck the slabs at a frequency mimicking small quakes. The striking generated voltages up to 1.4 volts, causing gold grains to aggregate on the slabs.

The aggregates adopt the voltage of the charged quartz, attracting even more gold, says geologist Christopher Voisey of Monash University in Melbourne, Australia. *— Nikk Ogasa*

PARTICLE PHYSICS

New limits placed on dark matter

Scientists have slashed the potential hiding spaces for dark matter particles. The LUX-ZEPLIN, or LZ, experiment has ruled out the existence of dark matter particles with a wide swath of properties.

Dark matter has never been directly detected. LZ looks for a hypothetical dark matter particle called a weakly interacting massive particle, specifically WIMPs with masses above 9 billion electron volts. The LZ detector, filled with liquid xenon, monitors for atomic nuclei recoiling when WIMPs plow into the liquid.

The researchers characterize WIMPs by their cross section — the probability that a particle will interact. The result shrinks the maximum possible cross section to about a fifth of that allowed by previous results, LZ researchers reported at two physics meetings in August. *— Emily Conover*

SN 10

Dionna Williams
NEUROSCIENTIST
Emory University

JACK KEARSE

Scientists to Watch

Big challenges and mysteries inspire this year's honorees

Scientists are problem solvers. They devise ways to tap new resources for building electric vehicles and to track stealth movements of environmental contaminants. Scientists are also detectives. They investigate how physics governs the movements of cells and how dark matter could have shaped the early universe.

These are just some examples of how the researchers recognized by this year's SN 10: Scientists to Watch list are tackling some of the world's thorniest challenges and most puzzling mysteries. For the ninth year, *Science News* is highlighting 10 early- and mid-career scientists whose talent and curiosity know no bounds. If you want to nominate a researcher for next year's list, please send their name, affiliation and a few sentences about their work to sn10@sciencenews.org.
— Karen Kwon, Research and Special Projects Editor

Looking past prejudice reveals why HIV and illicit drugs are a bad combination

After meeting patients with HIV while a Ph.D. student, Dionna Williams realized the fundamental flaws in how medical science treats people who have HIV and also use illicit drugs or misuse prescription drugs. People in this group often have worse outcomes than people with HIV who don't use these drugs, including faster disease progression and worse symptoms.

For years, many scientists assumed the poor outcomes resulted from people not taking their medications that keep HIV in check, says Williams, a neuroscientist at Emory University. But the argument didn't make sense to Williams. "Every person with HIV that has a substance use disorder, they can't just all not be taking their meds." Perhaps biological reasons are at play, realized Williams, who uses both she and they pronouns. Their career has been dedicated to exploring those connections.

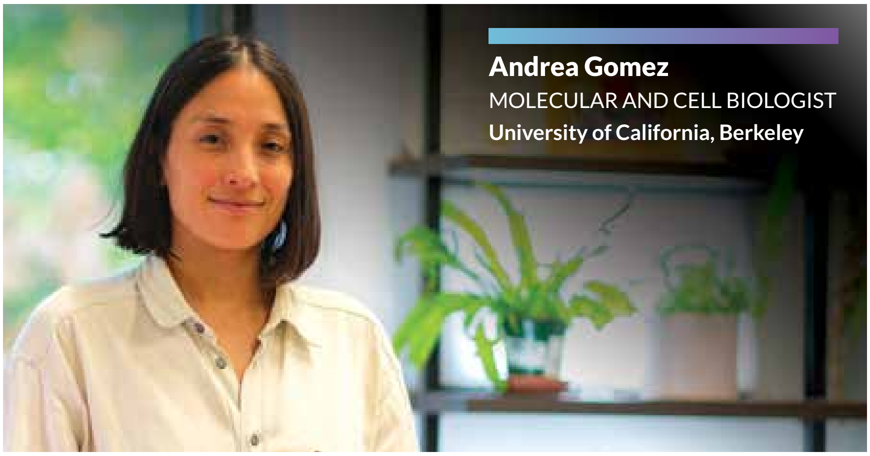
This year, Williams and colleagues reported that in human cells in the lab, cocaine made it easier for one anti-HIV medication to get past the brain's protective barrier while making it harder for another. Cocaine can also up the amounts of enzymes that are needed to convert medications to active forms. So people who use illicit drugs may need higher or lower doses, or a different treatment.

Williams' research embraces those who are marginalized, partly because Williams knows what it's like to be an outsider. "I own multiple marginalized identities," they say. "I'm a nonbinary Black woman. I am also queer. I am Autistic. I am [a] first-generation [college student]. I'm from a disadvantaged background."

Holding all those identities helps Williams understand people of all types and be a better scientist. "She is just an amazing young scholar," says neuroscientist Habibeh Khoshbouei of the University of Florida, noting that Williams' research intersects diverse fields — pharmacology, neuroscience and immunology.

One aim of Williams' research is to understand individual variation in human biology. A recent study highlights why that's important. Williams and colleagues discovered that different lab animals — rats, mice and rhesus macaques — each make proteins that detect cannabinoids, the active ingredients in marijuana, in different amounts in different organs of the body. There was even variation within a species.

Similarly, some people may make far more or fewer drug-sensing proteins in certain organs, Williams says. Many scientists would dismiss the variation as noise. "That's not noise," Williams says. "It's really important information about people's biology." *— Tina Hesman Saey*



'Splicing' makes the brain flexible and may help explain psychedelics' effects

One of the most remarkable things about the human brain is that it changes. A lot. This ability to reinvent itself, to morph, to strengthen some connections and let others fall away, captivates Andrea Gomez.

A molecular and cell biologist at the University of California, Berkeley, Gomez spends her time figuring out how the brain stays flexible, but not too flexible. The brain operates on a knife's edge, a just-right compromise between flexibility and rigidity. Too much plasticity would devolve into chaos. "We would never have a memory form," Gomez says. But too much rigid structure would also be calamitous. "Some of the most interesting questions, I find, is what mechanisms, what biological features, allow us to live at that edge."

Gomez's inquiries span from the tiny — minuscule conduits called synapses that sprout between nerve cells — to big shifts in behavior. This wide-ranging curiosity is one of her hallmarks as a scientist, says Peter Scheiffele, a neurobiologist at the University of Basel in Switzerland and Gomez's former postdoc adviser.

He remembers when Gomez became fascinated by the gut. She began experimenting with the idea that molecular instructions could help pattern the gut the same way they pattern the brain, but the work was stopped by COVID-19. Scheiffele sees this as "a story of genuine enthusiasm, motivation and, at some points, a certain randomness." Some scientists are linear thinkers who stick to a rigid plan. Gomez, he says, is more "blue sky, go out there and challenge yourself." She will say, "Let's see."

While in Scheiffele's group, Gomez and colleagues discovered that certain synapses are affected by a process called splicing. Cellular machinery doesn't just copy information faithfully from DNA. These messages can get cut and recombined, or spliced, and then used as templates for new versions of proteins. In the brains of mice, at least, a protein that depends on splicing dramatically affects synapses of certain nerve cells. When a version of the protein is missing, these synapses aren't as responsive as they should be, and mice flip from being curious about new objects to avoiding them.

Today, Gomez studies psychedelic drugs, among other things. Psychedelics are thought to open windows of plasticity in the brain. One way this may emerge is through splicing, Gomez suspects. A dose of psilocybin leads to thousands of splicing events in mice's brains that don't happen without the drug, Gomez has found.

Gomez is a member of the Laguna Pueblo tribe. "I heard about psychedelics before I started working on it, from Indigenous perspectives, all the way back to high school." Soon after she arrived at UC Berkeley, a colleague floated the idea of studying how psychedelics make the brain more flexible — another instance of Gomez saying, "Let's see." — *Laura Sanders*

The human brain inspires light-based computer

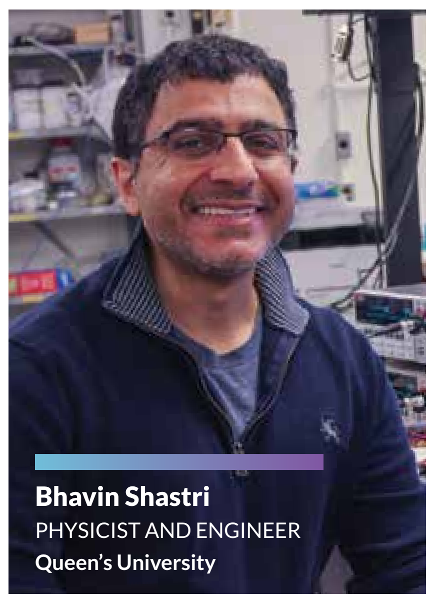
Bhavin Shastri wants to create light-based — or photonic — computers. And he wants them to mimic the human brain.

Standard computers rely on electricity, using wires to transmit data via electric currents. Photonic computers instead rely on light in the form of laser beams.

Though light has been used to transmit, store and process data in the lab, photonic computing is still in its infancy. Shastri, a physicist and engineer at Queen's University in Kingston, Canada, has set out to push those boundaries. His photonic computer chips pack together and connect photonic components that behave like the brain's nerve cells, creating a physical neural network on a chip. These types of chips are more powerful for certain applications and could be a big boon for AI.

When Shastri met optical physicist Paul Prucnal as a postdoc at Princeton University, Prucnal told Shastri about his research creating "a laser that behaves like a biological neuron," Shastri says. Prucnal's team was looking to use such a laser to compute with light. That idea caught Shastri's attention.

Shastri was "the first to connect the dots," Prucnal says, when he realized that



FROM TOP: BRANDON SANCHEZ MEJIA, UC BERKELEY; PROVIDED BY QUEEN'S UNIV.

photonics could push past some serious limitations of electronics.

Standard computers are "reaching their fundamental limits," Shastri says. When most modern computers compute, they cannot simultaneously access the bulk of their memory, and when they are retrieving information from memory, they cannot calculate. This makes the computers slow and unwieldy for computations with high processing demands. Computers with architectures that mimic the brain, or neuromorphic computers, promise to be faster and spend less energy.

But cramming enough wires on a chip to form a brainlike web of connections isn't easy. Electric currents in close proximity will exert unwanted magnetic forces on one another, resulting in overheating and erratic performance. Light, however, doesn't typically interact with other light. Thus, countless light beams of different wavelengths can pass along the same path simultaneously without any issues.

Prucnal notes that Shastri was the first to successfully create neuromorphic photonic computers on a chip. "Bhavin was pioneering a way of thinking," Prucnal says.

Shastri's team began by studying simpler devices akin to a single neuron. Years later, in a yet-to-be-published work, the researchers have demonstrated that a chip with 100,000 neuronlike components can perform 120 billion operations per second, says Shastri — about 40 times faster than the average electronic computer.

Shastri's brilliance goes beyond his "incredible energy" and "incredible capability," Prucnal says: Shastri brings people together. "It's not just being likable, but it's having a vision for how to [unite] these various fields."

Still, don't expect a photonic neuromorphic computer in your home anytime soon. These computers are more suited for specific research or industry applications.

Shastri may be set on transforming computing, but his work is motivated by a decades-old fascination with light and its properties. "I have been very lucky to be able to do something," he says, that "has always been my childhood dream."
— *Claire Yuan*

SAM WILSON

Illuminating the movements of mercury can help mitigate exposure

One of the world's richest biodiversity hot spots is Peru's Madre de Dios, a region of the Amazon. But when biogeochemist Jacqueline Gerson first traveled there in 2017, she witnessed deforestation resulting from artisanal and small-scale gold mining. These mining efforts are so prolific in Madre de Dios that they support at least half of the region's economy.

Jacqueline Gerson
BIOGEOCHEMIST
Cornell University

But deforestation isn't the only price of that gain. The process to isolate the gold from riverbank sediments releases fumes of mercury into the air.

For Gerson, now at Cornell University, illuminating how toxic contaminants flow through the environment is a calling. She studies how human activities contribute to these contaminants and alter their paths.

Globally, people unleash more than 2,000 metric tons of mercury into the air each year. More than 35 percent of those emissions are generated by small-scale and artisanal miners, making it the leading anthropogenic source.

In the environment, bacteria convert the element into the more toxic methylmercury, which bioaccumulates more readily in wildlife and people. Exposure to large amounts of mercury can wreak havoc on the central nervous system, digestive tract and kidneys, leading to seizures, blindness, sleep loss, memory loss, headaches, muscle weakness or even death.

Most of Gerson's work is centered on mercury, but she has studied other hazardous contaminants, such as selenium and sulfur. In most cases, Gerson already has a good idea of where the substances are coming from. It's the rest of the story — where they go, where they end up — that she's after. Before we can better manage and reduce the risks these contaminants pose to people, she says, "we need to first understand their fate."

In 2018, Gerson returned to Madre de Dios to investigate how communities far upriver of the mining areas become exposed to mercury. Unsurprisingly, areas closest to the mining had the highest mercury levels in the air. But water shed by leaves in the forest canopy, known as throughfall, offered a more complicated picture. The denser the canopy, the more concentrated the mercury in the throughfall. A conservation area called Los Amigos Biological Concession showed "the highest loads of any location in the globe," Gerson says.

What set Los Amigos apart was its pristine, old-growth forest. The large leaves in the mature forest canopy provide wide surfaces for airborne mercury to gather on, accumulate and later be washed to the ground by rain, Gerson says.

"It's important to get this information out," says biogeochemist Mae Gustin of the University of Nevada, Reno. Mercury's impact is more pervasive than people realize, she says. "The whole [eco]system is being contaminated."

The movements of contaminants aren't the only pathways to which Gerson is bringing attention: Back in the United States, she is committed to illuminating entryways into science. For instance, she coauthored a 2023 *Bulletin of the Ecological Society of America* article titled "Demystifying the graduate school application process."

"There's a lot of hidden curricula in getting into grad school and getting into the sciences in general," Gerson says. That information is not easily accessible to those who don't already know the process. "I'm really passionate about trying to make STEM a lot more inclusive." — *Nikk Ogasa*

Steampunk physics investigates thermodynamics in the quantum realm

Picture Victorian London, but its skies are filled with airships. Steam-powered robots crowd the streets, mingling with people in top hats and petticoats. That type of retro-futuristic mash-up is the fantasy realm of steampunk, a genre of literature, film and other art. Theoretical physicist Nicole Yunger Halpern sees her specialty as the real-world version of steampunk.

In steampunk, “there’s this strange juxtaposition of the old setting and futuristic technology,” she says. “That’s what we do in quantum thermodynamics.”

Thermodynamics describes concepts of heat, work and energy. The field was born in the 1800s from efforts to understand steam engines. Quantum physics describes phenomena on the scale of atoms, electrons and the like, and has driven the development of modern technologies such as quantum computers.

Quantum thermodynamicists aim to develop tools to describe heat, work, cooling and efficiency in quantum systems, and determine the limits of performance of quantum devices. Yunger Halpern, a National Institute of Standards and Technology physicist based at the Joint Center for Quantum Information and Computer Science in College Park, Md., is at the forefront of those efforts.

“She has a vision, and she follows it,” says quantum physicist Aram Harrow of MIT. “She is good, also, at recruiting other people to her vision.”

A major contribution has been her exploration of the concept behind Heisenberg’s uncertainty principle. Imagine a cup of tea. Thermodynamics describes how energy moves from the tea to the air or how evaporating water molecules escape. Both energy and water molecules are conserved. They move from one place to another, but the total amount is fixed.

Nicole Yunger Halpern
THEORETICAL PHYSICIST
National Institute of Standards and Technology

What if the tea wasn’t an entire cup but a bundle of a few atoms? Yunger Halpern wants to know how the exchange would differ. In quantum physics, conserved quantities can be incompatible; they can’t be measured simultaneously. Heisenberg’s uncertainty principle, which states that the better you know the position of a quantum object, the worse you know its momentum, and vice versa, is an example.

“For many decades, almost no one really thought about what happens when you have a system and environment that exchange quantities that are incompatible,” Yunger Halpern says. But that incompatibility can decrease the amount of entropy, or disorder, produced in such exchanges. Because entropy in an isolated system tends to increase over time, some scientists think entropy is related to an “arrow of time” that distinguishes future from past. So incompatible quantities might hinder a system’s ability to experience that arrow of time.

Yunger Halpern also aims to put quantum thermodynamics to practical use through autonomous quantum machines. Typical quantum devices, like the quantum bits that make up quantum computers, require constant prodding from experimenters to operate. Last year, she and colleagues developed a quantum refrigerator that automatically cools a quantum bit.

It’s not just her science that’s in the spotlight — her writing is too. Her 2022 book, *Quantum Steampunk*, drew public attention, and she blogs at the website Quantum Frontiers. Writing allows her to explore ideas without the constraints of peer review. “Thinking really broadly and wildly and as creatively as you feel like,” she says “is useful for keeping creative in physics.” — *Emily Conover*

How the rules of physics govern cell biology

The X’s and O’s scrawled on the whiteboard behind Hawa Racine Thiam look like drawings from a football playbook. But Thiam is no coach, and those doodles don’t depict players — they represent cells and their environment. Thiam, a Stanford biophysicist, has sketched out an idea of where immune cells might go to find microbes.

She’s fascinated by the physics of cells: how they move and deform, and the rules that shape their behavior. Demystifying the mechanics of cell movement could have implications for health, allowing scientists to send immune cells to the site of an infection or stop the spread of tumors.

This is “unquestionably an important area of research,” says Clifford Brangwynne, a bioengineer at Princeton University. People sometimes have the misconception that biology operates outside the laws of physics, he says. But the same rules apply.

It’s a topic that keeps Thiam’s curiosity whirring. Her Ph.D. work revolved around how the nucleus influences a cell’s ability to move. At the time, conventional wisdom on cell migration largely ignored the nucleus. Scientists thought crawling cells took three basic steps: extend a “foot,” attach it to a nearby surface, then retract the rear, pulling the cell forward. (Imagine Batman whisked up the side of a building by his retractable grappling hook.)

But what happens when cells need to cram through tight spots? From experiments that had cells moving through smaller and smaller pores, Thiam’s team reported in 2016 that the nucleus helps determine whether immune cells can migrate in confining environments. Compare cell movement to passing a plastic bag through a small hole. If the bag contains a kiwi, it probably won’t fit. Thiam and colleagues discovered that cells can deform their nuclei, up to a point. Cells rupture the membrane surrounding the nucleus and extrude some of its guts, making the whole thing more able to ooze through a constriction. It’s like crushing

JOHN T. CONSOLI/UNIV. OF MARYLAND

Hawa Racine Thiam
BIOPHYSICIST
Stanford University

that kiwi until the fuzzy skin breaks and the fruit is floppy rather than firm. Now it can squeeze through a smaller space.

In 2020, she and colleagues reported on an unusual cellular defense mechanism called NETosis, a way for white blood cells called neutrophils to trap microbial invaders. Pathogens creep into the body and — BOOM — they're ensnared, like dolphins caught in a fishing net. But this net is made of DNA blasted out of the neutrophil. Scientists first reported NETosis in 2004 but didn't really know how it worked. Using cutting-edge microscopy and gene-editing techniques, Thiam's team outlined the sequence of events.

"She has this fearlessness in coming at these really very challenging problems in cell biology," Brangwynne says. He thinks that fearlessness stems from her background. Thiam has crossed boundaries between nations (she grew up in Senegal and moved to France for her higher education), fields of science and languages (she speaks four).

But Thiam says she still asks herself if she's smart enough or works hard enough to be a good scientist and mentor. Whenever she has doubts, she tries to remember that she and others believe in her — and then she forges onward. "I just try to keep pushing." — *Meghan Rosen*

FROM TOP: MICHAELA GO; COURTESY OF F. VAN EDE

Tiny eye movements can signal how the brain organizes information

A cyclist pedals down the street. Signs, trees and fire hydrants whip by. The cyclist's brain takes in information from what the cyclist has perceived but can no longer see. The brain sorts through that information — the color, shape and text on signs, for example — and selects what is most important. Based on that, the cyclist takes the correct turn and continues on.

Freek van Ede uses a lot of bicycling metaphors. A cognitive neuroscientist at Vrije Universiteit Amsterdam, van Ede studies attention. His focus is not on external attention — what someone is looking at or attending to in the moment. Instead, van Ede is trying to understand internal attention — how the brain focuses on and grabs exactly what it needs from incoming information to guide future behavior.

When van Ede was in college, most cognitive neuroscientists were looking at attention in terms of space — putting blocks in different places on a screen, for example, and asking people to select among the blocks. But van Ede became interested in how time might play a role.

Getting a more real-world picture means measuring brain activity in real time, which is why van Ede uses electroencephalography, paired with eye tracking. In one study, participants watched objects briefly appear on a screen. Van Ede found that when a participant was asked to recall something about an object that had been on-screen, their gaze flicked toward where the object had been, even though it was no longer there.

That flicking was detectable as microsaccades — tiny unconscious movements that your eyes make. When study participants shifted their attention to focus on where an object had been, the microsaccades were systematically pulled in the direction of that attention shift. This discovery opened new opportunities for tracking "the mind's eye," van Ede says, and so deciphering what information the brain is using to plan future action.

Van Ede's lab has used the technique to show that when preparing for the future, the brain doesn't wait until all the information is in to make a plan. Instead, the brain plans possible actions as each piece of information comes in — even though the brain can select only one plan in the end.

Van Ede "seems to be very good at coming up with new twists on older designs" for a task, says Tobias Egner, a cognitive neuroscientist at Duke University.

The finding is emblematic of van Ede's curiosity-driven research. Knowing how the brain plans actions could someday help scientists understand memory disorders or attention problems, but that's not the primary driver. What he and his team choose to study is "a little bit based on our intuition, even what is interesting, or based on some intriguing findings that we want to chase down," he says. — *Bethany Brookshire*

Freek van Ede
COGNITIVE NEUROSCIENTIST
Vrije Universiteit Amsterdam

Yotam Ophir
COMMUNICATIONS RESEARCHER
University at Buffalo

Do not dismiss the disconnect between scientists and the public

TV stars and terrorists may appear to have little in common. But after watching YouTube videos by members of a violent terrorist organization, Yotam Ophir realized the two groups deploy similar tactics to connect with remote audiences — by dressing casually, staring straight at the camera when talking and narrating their pasts in gripping, plot-driven fashion.

Since the realization more than a decade ago, Ophir, a communications researcher at the University at Buffalo in New York, has remained intrigued by how various people communicate information and beliefs to broader audiences, especially in fields such as health, science and politics.

In 2013, Ophir started his Ph.D. at the University of Pennsylvania. In communications researcher Joseph Cappella's lab, Ophir initially investigated how cigarette companies lured people into buying products known to cause cancer and other health problems. But his focus changed the next year when an Ebola outbreak began. Ophir found a disconnect between the science of how Ebola spreads and how it was being portrayed in the media. "I wanted to study the way the media talks about epidemics," he says.

Ophir's early challenge was sorting out how to identify patterns in enormous troves of documents, Cappella recalls. "He took advantage of the computational techniques that were being developed and helped develop them himself."

Ophir automated his analysis of over 5,000 newspaper articles about the H1N1, Ebola and Zika epidemics and found that those articles were frequently at odds with the U.S. Centers for Disease Control and Prevention's recommendations for how to communicate information about infectious disease outbreaks. Few articles included practical information on what individuals could do to reduce the risk of catching and spreading the disease.

Based on his research, "I was warning that we're not ready for the next epidemic because we don't know how to talk about it," Ophir says. "Then COVID happened."

Ophir's latest research measured public perceptions of science and scientists by asking over 1,100 phone respondents in the United States about their political leaning and views on federal government's funding for science. When conservatives perceived scientists as biased, they were less likely to support funding, the team found. The same wasn't true for liberals.

That work resulted in a predictive model that can assess the gap between how science presents itself and public perception of that presentation. Identifying such communication gaps is a key step in facing today's challenges, Ophir says. "We could come up with a solution to climate change tomorrow and half the country would reject it.... We won't be able to survive if we don't learn to communicate better." — *Sujata Gupta*

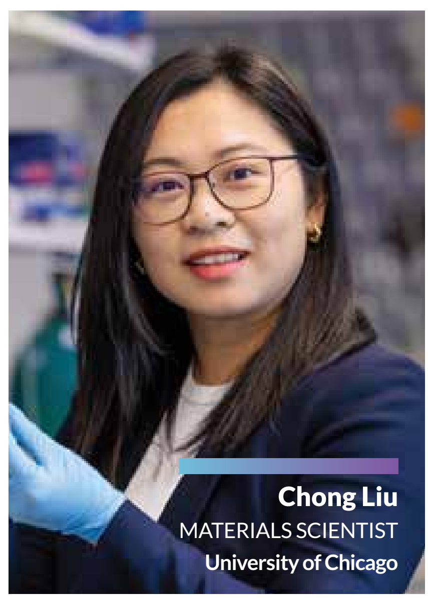
Unusual sources can help meet lithium demands

Electric vehicles promise to help wean us off fossil fuels, but they introduce a new problem: how to get enough of the lithium that EV batteries require.

Existing technology can extract lithium only from sources with highly concentrated ions, such as hard rocks or underground deposits of salty water called brines. Not only will those sources not be enough to meet demand, but mining them also comes with environmental consequences.

Materials scientist Chong Liu of the University of Chicago, though, has identified a material that could make extraction possible from unconventional sources. She's eyeing brines left over from geothermal and desalination processes, wastewater from fracking or even seawater, which could someday provide a huge supply of lithium — if it can be tapped. A big challenge here is that seawater has a sodium-to-lithium ratio of roughly 20,000-to-1, nowhere near the current sources that have ratios in the range of hundreds-to-1.

Pulling lithium ions from low-concentration solutions for commercial use will require a lot more research, Liu



Chong Liu
MATERIALS SCIENTIST
University of Chicago

FROM TOP: DOUGLAS LEVERE; COURTESY OF THE UCHICAGO PRITZKER SCHOOL OF MOLECULAR ENGINEERING, JOHN ZICH says. But her efforts have made huge strides toward more efficient extraction of resources, says University of Chicago molecular engineer Matthew Tirrell.

In the method that Liu works with, the researchers first dunk a material full of ion-sized passageways into briny water. The lithium ions in the water enter the material's lattice of channels and can be captured there. But briny water also contains sodium ions, which push their way into those channels, reducing the amount of lithium that can be taken up.

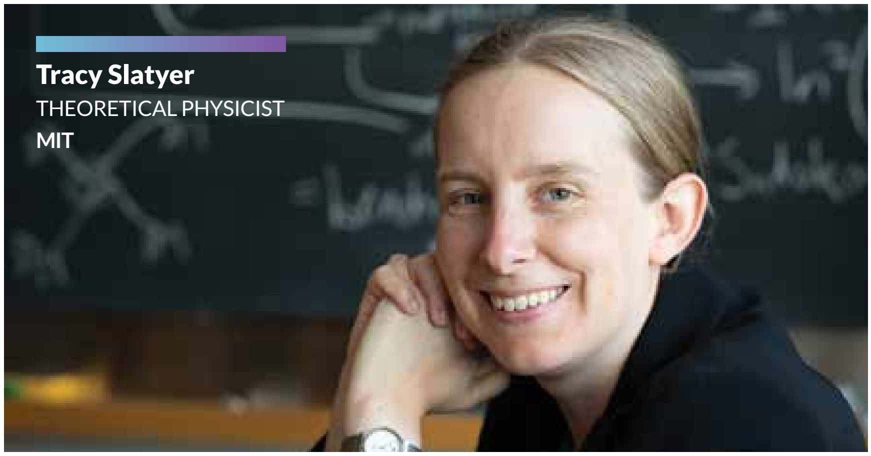
Liu started hunting for an ideal dunking material around 2016 during her postdoctoral work. She knew it was important to get it right: "This material's property will determine how much selectivity [for lithium] we can get, and what source water we can use," Liu says. The better the selectivity, the more lithium captured.

She eventually settled on iron phosphate. The oxygen in the iron phosphate bonds more easily with lithium than with the competing sodium ions. The larger sodium ions can expand the channels, but the lithium-oxygen bonds keep the channels small and receptive to more lithium. Once the material is full of ions, it is moved to freshwater where the researchers apply electric currents to expel the ions. Then they add a hydroxide, which combines with the lithium to form solid lithium hydroxide, the raw material used in EV batteries.

Besides extracting lithium and developing a new method for separating rare earth elements — another essential for modern technologies — much of the work at Liu's lab focuses on basic materials science. "We just accumulate more and more knowledge, so then we can start to predict things," she says. That's how the team landed on iron phosphate: After a lot of research, it was the first material that the team tried.

It's this deep understanding that makes Liu stand out, says physicist Steven Chu of Stanford University. Chu, a former U.S. Secretary of Energy, worked with Liu during her postdoctoral research. There is "a small number of people you want to pay attention to" because they frequently come up with clever, new approaches, he says, "and she's one of them." — *Anna Gibbs*

BRYCE VICKMARK PHOTOGRAPHY



There are many ways that we could discover dark matter in the universe

Tracy Slatyer, a theoretical physicist at MIT, dreams up new ideas about dark matter. The mysterious substance makes up around 85 percent of the matter in the universe. Yet it has consistently eluded scientists' attempts to pin it down. Slatyer tries to figure out what dark matter could be made from, how it might interact with itself or anything else and, most important, the consequences of those interactions.

Among scientists doing such work, "I don't think there's been anybody who's been more impactful," says physicist Dan Hooper of the University of Chicago. "She's as big a deal as I can make her out to be."

While in graduate school at Harvard University, Slatyer met physicist Douglas Finkbeiner, who was investigating odd excesses of positrons, the electron's antiparticle, and high-energy photons called gamma rays at the Milky Way's center that couldn't be explained with conventional theories. Together, Slatyer and Finkbeiner began looking more deeply at a type of self-annihilating dark matter that might address the mystery.

In 2008, NASA launched the Fermi Gamma-ray Space Telescope, which offered unprecedented views of high-energy photons emanating from the galactic plane. If dark matter was indeed self-annihilating, it would show up in Fermi's observations.

"We analyzed [Fermi's] data and saw this big fuzzy glow north and south of the galactic center," Slatyer recalls. "So we're like, 'Victory!' "

But the more they looked at the signals, the more they realized that this wasn't dark matter. Supermassive black holes feeding on gas and dust in the centers of other galaxies have been known to belch out material into hourglass figures. Eventually, Slatyer and her colleagues realized that this could be something similar. The glow came to be known as Fermi bubbles.

Slatyer hadn't found dark matter, but, she says, "I try not to complain when nature gives me exciting new things, whether or not they were what I was looking for in the first place."

Much of her work since then has focused on different dark matter scenarios. For instance, some of her research has looked at how the mysterious substance could have annihilated or decayed in the early universe, leaving behind fundamental particles that would cause small variations in the expected temperature of the overall cosmos.

By taking her theories to their logical conclusions, Slatyer has made herself invaluable to the community of physicists searching for dark matter. Given how little researchers know about dark matter, Slatyer thinks it's important to imagine a wide range of potential possibilities and then come up with experiments to test those options. She says, "We try to … make sure that we don't miss anything blindingly obvious." — *Adam Mann*

FRUIT FLIES HELP AFRICAN RESEARCH TAKE FLIGHT

The humble insects are boosting biology across the continent

By Darren Incorvaia

Fruit flies (shown in a tube) are a popular model organism in biology because the insects have a short life cycle, are easy to care for and share important genetic similarities with humans.

When Amos Abolaji returned to Nigeria from a year abroad, he brought home a strange souvenir — two jars full of fruit flies.

The biochemist had been conducting postdoctoral research at the Federal University of Santa Maria in Brazil on the health effects of certain pollutants. He had used laboratory rodents while working on his Ph.D. in Nigeria and wasn't previously exposed to the use of fruit flies. But when Abolaji joined toxicologist Joao Batista Teixeira da Rocha's lab in Brazil, "he told me he stopped the use of rodents for research." Rocha had switched to using the fruit fly *Drosophila melanogaster*.

After working with Rocha, Abolaji understood the power of fruit flies. "The fly has a high degree of advantages compared with rodents, especially in resource-limited regions," Abolaji says. They're cheap, easy to raise, require little lab space and can bring fast results — and they're poised to boost biomedical research across Africa.

When Abolaji returned to Nigeria in 2014 and became a professor at the University of Ibadan, he took his jars and converted his office into a miniature fly lab. He's now a key figure in a growing movement to establish fruit fly research across Africa, where rodents are still the go-to subject in studies of genetics, developmental biology, toxicology and other fields of biomedical research.

In Africa, fruit fly studies can help address urgent public health needs, connect local scientists with the global research community and build research capabilities across the world's second-largest continent.

"We use [the fruit fly] as a tool to be able to carry out not just research," Abolaji says, "but to raise [the] next generation of scientists."

Animal assistants

Studying animals to gain insights into human biology and medicine goes back millennia, at least as far back as the ancient Greeks. By the 12th century, Arab physician Ibn Zuhr was testing surgeries on animals before performing them on humans. In the mid-19th century, the Norway rat became a mainstay of lab research because the ubiquitous pest was easily acquired and survived well in captivity.

The fruit fly didn't enter the lab until 1900, when Harvard entomologist Charles Woodworth began breeding them en masse for reasons that are not entirely clear. He recommended them to researchers studying genetics — a field still in its infancy at the time — and from there the potential of the flies spread through word of mouth. The

Efforts to integrate fruit flies into research in Africa include the Drosophila Research and Training Centre (left), founded by Amos Abolaji (middle), which trains biomedical scientists. Rashidatu Abdulazeez (shown in her lab, right) started Droso4Nigeria to bring fruit fly–based lesson plans to secondary schools.

OPPOSITE PAGE: IRD/VECTOPOLE SUD/PATRICK LANDMANN/SCIENCE SOURCE; THIS PAGE (AND THROUGHOUT STORY), FRUIT FLY: ANTAGAIN/GETTY IMAGES; BOTTOM PHOTOS, FROM LEFT: A. ABOLAJI; DRTC; R. ABDULAZEEZ

Drosophila boom took off in earnest around 1910, after Thomas Hunt Morgan set up his famous Fly Room at Columbia University. Cluttered with flasks full of flies and bunches of bananas dangling from the ceiling, the Fly Room hardly compares to the sleek and sterile labs of today. But in that room, Morgan made the groundbreaking discovery that genes are passed down to the next generation on chromosomes.

The fruit fly's short life cycle allowed the field of genetics to take flight. Although rats reproduce fast for mammals — pregnancy is typically 21 days and females reach sexual maturity two to three months after birth — they have nothing on fruit flies. They can produce a whole new generation in just 10 days. This, plus their small genomes, makes the fruit fly a powerful tool for studying how genes and traits are passed down from one generation to the next. *Drosophila* are also used to study how embryos develop into adults and to test the biological effects of chemicals. (Because rodents are even more closely related to humans, they remain popular model organisms for studying mammal-specific traits and in clinical drug testing.) Over the last century, nine scientists have won Nobel Prizes based on work done with fruit flies.

Abolaji's *Drosophila* lab is in Ibadan, the third-most populous city in Nigeria and capital of the southwestern state of Oyo. When I reached him over Zoom, he presented a slide show of his history with *Drosophila*. "I thought it would be good if I just share it like a story," he told me.

Several years after bringing fruit flies back from Brazil in 2014, Abolaji was approached by DrosAfrica, an organization founded in 2013 to expand the use of *Drosophila* by African biologists. A trio of Spanish researchers started DrosAfrica after a workshop in Uganda on using insects in neuroscience research. Physiologist Sadiq Yusuf, who was then the deputy vice chancellor of Kampala International University and later went on to found a charity supporting research development in Africa called TReND, had organized the workshop.

The Spanish group had recognized that African researchers were primed to use fruit flies to accelerate the continent's research, which is what had happened in Spain a few decades earlier.

From Morgan's Fly Room, *D. melanogaster* spread quickly to other research labs in North America and Europe. But not every country caught fly fever. In Spain, virtually no one worked with the fly until Antonio García-Bellido returned to his native country after finishing a research fellowship at Caltech in the 1970s. Once home, the developmental biologist established a *Drosophila* lab. He made many significant contributions, including discovering that embryonic cells cluster together based on what anatomical structure they develop into, with their fate controlled by certain genes. García-Bellido, it's been said, "put Spain on the scientific map."

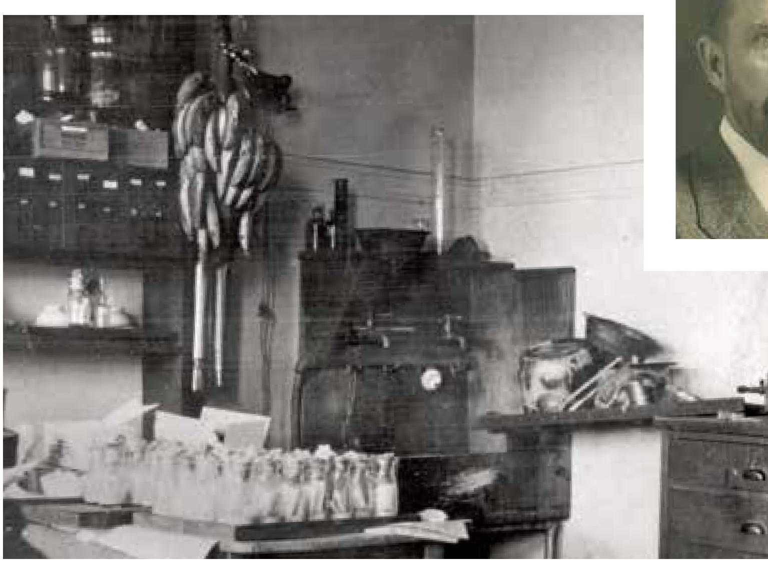
"Then he trained three people, and then these three people trained other people," says María (Lola) Martín-Bermudo, a geneticist at Pablo de Olavide University in Seville and a DrosAfrica cofounder. "Now there are lots of *Drosophila* labs in Spain."

To jump-start a similar spread of knowledge in Africa, Abolaji and DrosAfrica organized a workshop at the University of Ibadan in 2017, which brought in experienced fruit fly researchers from as far as Spain and the United Kingdom to teach attendees *Drosophila* biology and how the flies can be used to study neurodegeneration, cancer and toxicology, as well as help with drug discovery. "That workshop was one of the major turning points in my research," Abolaji says.

The workshop hosted participants from elsewhere in Africa, including Uganda, Rwanda and Ghana. One participant, a young woman from northern Nigeria named Rashidatu Abdulazeez, traveled 18 hours over two days to attend.

Meeting urgent needs

Long before arriving at that workshop, Abdulazeez had already become hooked on fruit flies. But she didn't have a jar of flies from another lab to start her work — she had to catch them herself.



Thomas Hunt Morgan (right) set up the famous Fly Room at Columbia University (shown below in 1918). As a model organism, fruit flies helped launch the field of genetics in the early 20th century.

BOTH: AMERICAN PHILOSOPHICAL SOCIETY

She'd read that the flies could be trapped outdoors, but nothing she tried had worked. While earning a master's degree in population genetics, Abdulazeez stayed with her auntie while trying to catch flies in the city of Kaduna in northwestern Nigeria. "[Perhaps] they don't want to stay far from humans," her auntie suggested. Thinking the flies might prefer human trash to other lures, Abdulazeez left out a bowl of rotten fruit overnight. "I had a dream that I caught lots of *Drosophila*," Abdulazeez recalls with a laugh. In the morning, her dream had come true.

In 2016, after solving the fly-catching problem, she published an analysis of the genetic variation of Nigeria's *D. melanogaster* populations.

Like Abolaji, Abdulazeez had to learn a lot about *Drosophila* on her own. But it was worth it. "I began to fall in love [with fruit flies] because I was just so amazed by the fact that we had so much in common," she says, referring to the 60 percent of our DNA that we share with fruit flies. And importantly, 75 percent of the genes that cause disease in humans are also found in the flies.

Abdulazeez is now a lecturer (akin to a professor) at her alma mater, Ahmadu Bello University in Zaria. Toward the end of our video call, she took me into the hallway as she headed to a meeting and pointed out the poster on her lab's door: a black-and-white image of a fruit fly peering through a microscope, with the words "Small Lab Big Science" blazoned across the top.

The "Big Science" benefits of *Drosophila* as a model organism stem from not only its similarities to us, but also its key differences, like being easy to care for. Starting a *Drosophila* lab can require as little as a jar of flies and a handful of microscopes, while a colony of lab rats can take up an entire room's worth of cages. The ease of using fruit flies is a huge boon for a continent with many local public health concerns but little local research funding.

"I desire to carry out research that will have beneficial effects on humans," Abolaji says. Some pollutants in the environment can predispose people to cancer, diabetes, Parkinson's disease and a whole host of other afflictions, he says, and he uses fruit flies to understand why.

One pollutant that Abolaji has studied is 4-vinylcyclohexene, a by-product of the manufacturing of pesticides, plastics and tires. Plastic manufacturing has been growing in Nigeria, from 120,000 tons in 2007 to an estimate of more than 500,000 tons in 2020, meaning more and more workers are potentially being exposed to VCH. In monkeys and rats, VCH is known to destroy follicles

Lab animal all-stars

Biologists have a menagerie of animals they turn to in experiments. Here are some of the species that are mainstays in the lab.

Roundworm (*Caenorhabditis elegans*)

Like the fruit fly, the 1-millimeter-long *C. elegans* is popular in studies of genetics and development. In addition to having a short life cycle and being cheap to maintain, the worm can be frozen and revived, unlike other lab animals, and its transparent body makes for easy observations of cells (unlike the false-color worm shown at left). But *C. elegans*' simple body — lacking blood, most internal organs and other features of more complex beings — limits it use as a model of human physiology and disease.

Similarity to humans: 65% of disease genes shared
Age at sexual maturity: 3 days
Birth rate: >140 eggs/day

Zebrafish (*Danio rerio*)

About as big as a safety pin, the zebrafish is a vertebrate and therefore more like humans than *C. elegans* or the fruit fly. Because it's easy to keep in the lab and transparent as an embryo, the zebrafish offers advantages over the mouse in studies of genetics and development. But since the fish lacks certain tissues and body parts, such as lungs, it isn't as versatile in physiology and disease research.

Similarity to humans: 80% of disease genes shared
Age at sexual maturity: 2–4 months
Birth rate: 200–300 eggs/week

Mouse (*Mus musculus*)

As far as mammals go, the mouse survives well in captivity. And it's similar enough to humans to be a viable choice for studies of disease and even behavior. Still, many health findings in mice don't end up translating to people.

Similarity to humans: >90% of disease genes shared
Age at sexual maturity: 1.5–2 months
Birth rate: 6–12 offspring/litter; up to 15 litters/year

Rhesus macaque (*Macaca mulatta*)

As a fellow primate, the rhesus macaque is extremely similar to humans as far as basic biology goes, making the monkey valuable in research into infectious diseases such as HIV/AIDS and chronic illnesses, reproduction, aging, drug development and more. But a long life span, slow reproductive cycle and complex social structure make the monkey difficult and expensive to keep in captivity. And the close kinship to humans has led to ethical questions about using rhesus macaques (and other primates) in lab experiments.

Similarity to humans: 97.5% of all genes shared
Age at sexual maturity: 3–4 years
Birth rate: 1 offspring/year

FROM TOP: STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY/GETTY IMAGES; MIRKO_ROSENAU/GETTY IMAGES; GLOBALP/GETTY IMAGES; EPHOTOCORP/GETTY IMAGES

in ovaries, so there's concern that exposure could cause early menopause in humans. "A woman that is working in an environment where such compounds are manufactured or produced or used as by-products, [who is] supposed to reach menopause at 56, may reach menopause at 30 or 35," Abolaji says.

But how VCH harms ovarian follicles was elusive. Abolaji got a hint by exposing *Drosophila* to VCH and analyzing the resulting changes in the fly's gene activity and physiology. The chemical causes the production of toxic types of oxygen-containing molecules known as free radicals, which damage cells.

In Tunisia, Hayet Sellami hopes to leverage the power of fruit flies to create a drug-screening factory, speeding up the process of identifying new medical treatments. Sellami, a medical doctor and researcher, says her journey with *Drosophila* began with a pair of workshops in 2018 and 2019 hosted by her institution, the University of Sfax, and organized by DrosAfrica and a professional network of scientists called Young Tunisian Researchers in Biology. Impressed by the workshops, university administrators approved creating a *Drosophila* research unit.

"Our research unit is the first [in Tunisia] to use *Drosophila* as a low-cost model for research," Sellami says. She hopes to begin fly research in earnest this year, and once the lab is fully up and running, researchers will be able to quickly screen prospective drugs by testing them on fruit flies. If a drug seems promising, the next step will be tests on rodents. Using *Drosophila* as a first pass for drugs will save valuable time and money that would otherwise be spent raising and caring for expensive rats and mice.

One of Sellami's interests is using the flies to test potential antifungal drugs. "This [is] a good opportunity to enhance our university and to have practical research," she says, and lead to "better health care for our people."

In a 2022 study, 63 percent of the fungus *Candida albicans* collected from pregnant Tunisian women's vaginas was resistant to the common antifungal drug fluconazole. *C. albicans* is often harmless, but it can cause yeast infections that can lead to rare pregnancy complications. So finding new antifungal drugs is a pressing concern.

Building research capacity

The University of Sfax is following in the footsteps of the University of Ibadan, where the small fly lab Abolaji founded in 2014 has blossomed into the separate Drosophila Research and Training Centre. It serves as a regional hub for scientists interested in working with fruit flies. Sellami hopes that Sfax becomes a hub for North Africa. By investing in fruit fly research, African institutions also now have the chance to join the iconic insect's global fan club.

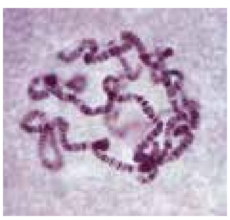
Biologist Ross Cagan of the University of Glasgow in Scotland was one of the *Drosophila* researchers recruited by DrosAfrica to run workshops. He now collaborates with both Abolaji and Sellami on medical research that not only has health implications for Africans but for people globally.

"My lab develops some technology we call 'fly avatar,'" Cagan says. Using gene editing, specific genetic mutations of individual cancer patients are introduced into fruit flies. The goal is to capture the complexity of a patient's cancer in a group of *Drosophila* flies to study how those mutated genes affect tumor progression and how the cancer responds to drugs.

"One of the questions on the table is, what's the difference between a European tumor and an

Nobel Prize–winning flies

As of 2023, nine scientists have earned a Nobel Prize in physiology or medicine for research done with fruit flies.



1933 Thomas Hunt Morgan
A pioneer of fruit fly research, Morgan discovered the role that chromosomes play in heredity. He was commended for "the ingenious choice of object for his experiments … [which] made it possible [for] Morgan to overtake other prominent genetical scientists, who had begun earlier but employed plants or less suitable animals as experimental objects."

1946 Hermann Joseph Muller
In heredity experiments, Muller ascertained that radiation, in the form of X-rays, can produce mutations in genes.

1995 Edward B. Lewis, Christiane Nüsslein-Volhard and Eric F. Wieschaus
The trio discovered genes that control early embryonic development. The fruit fly's fast maturation made it the perfect study subject — it takes a little more than a week for a fertilized egg to develop into a fully formed fly.

2011 Jules A. Hoffmann
Hoffmann shared the prize with two other scientists for work on the immune system. By studying the fruit fly, he discovered a gene that helps the body recognize invading microbes and activates innate immunity, the first line of defense against pathogens.

2017 Jeffrey C. Hall, Michael Rosbash and Michael W. Young
The three researchers discovered the genetic and molecular gears that control the body's inner clock, or circadian rhythm.

FROM TOP: ED RESCHKE/GETTY IMAGES; ANTAGAIN/GETTY IMAGES; JXFZSY/GETTY IMAGES; KATERYNA KON/SCIENCE PHOTO LIBRARY/GETTY IMAGES; MARLEI/GETTY IMAGES

African tumor?” Cagan says. Abolaji’s team is generating fly avatars that mimic the genetics of Nigerian patients with colorectal cancer.

Abolaji is “somebody that the more you get to know him, the more impressive he becomes,” Cagan says. “That collaboration is going beautifully. It is truly growing out of Nigeria.”

The biggest money for research still lies in Western institutions, and writing grants to get the funding for ambitious projects is difficult even for scientists in North America and Europe. Western collaborators can help African researchers navigate this path. Sellami recently submitted a proposal to Horizon Europe, a seven-year funding initiative of the European Union, in collaboration with Cagan to support Sfax’s research into personalized medicine with fly avatars. Sellami and Abolaji have also teamed up to submit a proposal to another EU funding initiative, Erasmus+.

One thing that makes these international collaborations stand out is that African scientists are guiding the research questions, says Marta Vicente-Crespo, cofounder of DrosAfrica and a program manager at the Nairobi-based Consortium for Advanced Research Training in Africa. Often in such collaborations, African researchers get what’s been dubbed “stuck in the middle.” They may collect data, but not analyze or interpret it, while Western scientists lead the project and claim the more prestigious first and last authorship spots on papers.

“There has been a lot of tokenization,” Vicente-Crespo says. “Things are changing, but very slowly.”

The legacy of colonization has left many areas of Africa with little capital, which means students looking to do research often have to fund the projects themselves. “We don’t have funding,” Abdulazeez says. “When you come for any of your degrees, you basically sponsor yourself.” Because rodents are expensive, students often can’t afford to use many, resulting in studies with low sample sizes and thus conclusions that aren’t reliable enough to publish.

“They get their degree, but the science doesn’t go anywhere,” Vicente-Crespo adds.

By using *Drosophila*, money that might have gone to feeding a few rodents for several weeks can instead turn into thousands of flies. Abdulazeez estimates that one mouse costs about 1,000 naira, the Nigerian currency; buying 80 of them would cost more than many Nigerians make in a month.

A fruit fly homecoming

There is a poetic side to *D. melanogaster*’s rise in African research — like humans, the fruit fly evolved in Africa before spreading around the world. Though they came to dominate the globe through an association with humans — living off our food waste — they once lived more pastoral lives. Researchers in 2018 found a population of *D. melanogaster* living in a forest in Zimbabwe, unaffiliated with humans. These flies fed and laid their eggs on the fruit of marula plants. The Indigenous San people of southern Africa historically collected marula fruit and stored them in caves, where the fruit fermented. Researchers speculate that this shared use of marula ultimately sparked the human-fly connection that persists to this day.

Three-quarters of the genes that cause disease in humans are also found in fruit flies.

Abdulazeez is most passionate about the ecology and evolution of fruit flies. For now, though, as the leader of a new research group, she’s focusing on more urgent health problems — like lead poisoning — and on inspiring the next generation of Nigerian biologists. “We still have people who are yet to accept the fact that we could use these flies for wonderful things,” she says. To combat this problem, she founded Droso4Nigeria, an organization that works to bring *Drosophila*-based biology lessons into Nigerian secondary schools and trains teachers to use fruit flies in the classroom.

Abolaji also stresses the importance of education and training. “The ultimate goal is to raise and develop the next generation of scientists in Africa,” he says.

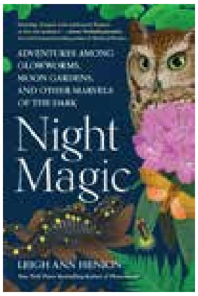
While international grants and collaborations are important, the ongoing success of Africa’s *Drosophila*-fueled research boom wouldn’t be possible without the passion, talent and resourcefulness of the African scientists leading the way. During our video call, Abolaji showed me the temperature-controlled incubator he uses to raise flies; a new one can cost upward of $10,000, but Abolaji fashioned his out of an old drink chiller (the kind you’d pull a bottle of soda from at the grocery store) for less than $500.

“Europe will not develop Africa for us. America will not develop Africa for us,” Abolaji says. “We are the ones to actually build Africa.” ■

Explore more

- Learn more about DrosAfrica at drosafrica.org

Darren Incorvaia is a journalist based in the western United States covering science, health and the environment.



Night Magic
Leigh Ann Henion
ALGONQUIN BOOKS, $30

BOOKSHELF

Life flourishes in the darkness of night

I feel like I've been out all night. In my mind, I've been walking the mountains and meadows of the Appalachian region after dark. I've encountered spotted salamanders, synchronous and blue ghost fireflies, glowworms and different kinds of moths and bats. My guide has been Leigh Ann Henion, who seeks to restore night to its rightful place as a wonderland of nature and renewal in her latest book, *Night Magic*.

Henion pursues nighttime journeys as a balm, searching for respite from the near-constant illumination due to artificial light. She wonders, what's life like in the dark? "Darkness is often presented as a void of doom rather than a force of nature that nourishes lives, including our own," Henion writes. "This is the story of how I set out to re-center darkness by spending time with some of the diverse and awe-inspiring life-forms that are nurtured by it."

Henion — an author who writes about the natural world, travel and other topics — takes readers to Tennessee, Ohio, Alabama and her home state of North Carolina. In the company of friends, her son, scientists and other night-curious strangers, she seeks the fauna, flora and fungi that thrive in darkness, sometimes searching in her own backyard.

The book moves through spring, summer and fall, each season focusing on a few different life-forms. In the spring, for example, she witnesses spotted salamanders, which live much of their lives in darkness. These black or dark-brown amphibians with cheery, yellow-orange spots spend most of their time below ground. The salamanders briefly emerge during spring nights to breed in ephemeral pools, areas fed by rain that dry out periodically.


Male synchronous fireflies in the Great Smoky Mountains of Tennessee perform a unified light show to attract females.

NAN ZHONG/MOMENT/GETTY IMAGES PLUS

Henion's night excursions continue with appearances from glowworms, which are luminous fly larvae that shine blue; colorful moths, major pollinators that are experiencing troubling population declines; and foxfire, the catchall term for bioluminescent fungi glowing on forest floors. Mixed in among these encounters, Henion laments the ever-growing theft of natural darkness by artificial light in her mountain neighborhood and around the world. "At this point in history," she writes, "a full third of human beings on this planet can no longer see the Milky Way from where they live."

Henion encourages readers to tune in to the darkness around them. This may require patience because it can take the eyes several hours to become adapted to low light. And she unpacks the fears people — including herself — can have about darkness and the animals associated with it.

For example, when Henion gets the opportunity to help survey bat populations in Alabama, she recounts feeling unnerved by an encounter with a bat that dove at her. A student of one of the bat researchers at the event reassured Henion that the bat wasn't ambushing her: "You've got to remember, bats are better fliers than Tom Cruise in *Top Gun*." The bat was just having dinner — the bugs around Henion's head, which were attracted to the carbon dioxide she exhaled.

Like bats, moths may be unfairly maligned in part for their connection to night, Henion writes. It's thought that moths orient themselves with help from the constant angle of the moon and are flummoxed by artificial lights that bombard them from all directions. As a moth enthusiast tells Henion, "in that state of artificial-light disorientation, it feels like a moth's attacking us," when instead, the creature doesn't know where to fly.

Though Henion refers to emerging research about artificial light's effects on human health, I found myself wishing for more details. For instance, she writes in the preface that light pollution "has been shown to cause increased rates" of certain health conditions. But the research she cites in the bibliography describes associations between artificial light and different health harms. Association does not mean causation. Excessive light exposure after it becomes dark does seem to be a health risk, but I was left wondering how big of a risk and where the science currently stands.

That criticism doesn't detract from the book's enthusiastic and meaningful argument to preserve natural darkness and the ecosystems that rely on it, for the sake of the creatures, the plants and ourselves. Henion closes with what feels like a blessing and a call to action: "May we find our way back to natural darkness, or at least hold fast to the wilderness that still exists, so that we'll be able to bear witness to night's living riches." — *Aimee Cunningham*

SOCIETY UPDATE

NEW DIRECTIONS

Society for Science is on a journey to invest in the future, pursuing fresh challenges while doubling down on our ongoing work. We are excited to share our latest Annual Report, New Directions. From expanding the reach of our programs to reporting on the latest scientific news and shaping a fresh vision to guide us in the coming years, the Society had a landmark year in 2023.

We hope you enjoy learning about the impressive young scientists and engineers who participated in our world-class science research competitions, the impact of our STEM outreach and equity programs, and our unbiased and independent journalism in Science News and Science News Explores. In 2024, we have continued to promote the understanding and appreciation of science.

View the 2023 Annual Report: www.societyforscience.org/2023annualreport

SOCIETY FOR SCIENCE

AUGUST 10, 2024

In control

A high dose of the psychedelic psilocybin temporarily dissolves brain networks, ***Laura Sanders*** *reported in "Psilocybin erases brain 'fingerprints'" (SN: 8/10/24, p. 12).*

In the study, a generic form of the stimulant Ritalin served as a control against psilocybin. Reader **Jason Patrick** asked why scientists chose that drug.

It can be hard to design studies of psychedelics because the drugs' effects are usually obvious to both researchers and participants, **Sanders** says. Though the control, called methylphenidate, and psilocybin produce very different experiences, the drugs have some similarities, **Sanders** says. Both affect levels of chemical messengers in the brain and can increase the body's arousal, elevating heart rate and blood pressure.

A ribbiting story

Some Sierra Nevada yellow-legged frogs are immune to the deadly chytrid fungus called Bd, hinting at ways to save frog species worldwide, ***Martin J. Kernan*** *reported in "Bouncing back" (SN: 8/10/24, p. 22).*

Enlightened by the story, reader **Devin J. Starlanyl** reflected on the frogs in his community. "I became more educated about the potential threat to frogs in our own ecosystems, and how easily they can be threatened," **Starlanyl** wrote. "Our evenings in spring are enhanced by the songs of our brook frogs. We have named the leaders Rosencrantz and Guildenstern. Our lives would be much dimmer without the songs of Guilde and Rozie the Ribbiter," he wrote. "I plan to contact our conservation commission about how to secure the health of our brook and our frogs."

Debunked displays

UFOs probably aren't aliens, so scientists are searching for the real origins of what are now called unidentified anomalous phenomena, or UAPs, ***Sid Perkins*** *reported in "UFOs get a rebrand" (SN: 8/10/24, p. 16).*

The story reminded reader **Don Wolman** of alleged UFO sightings in Utah in the 1960s. A 1978 paper in *Applied Optics* suggested that the mysterious light displays were probably caused by swarms of spruce budworm moths, not aliens. As the insects "flew through electrified air in the sky, their legs and antennae glowed with St. Elmo's fire," **Wolman** wrote. The atmospheric phenomenon produces glowing plasma around objects in an electrically charged field.

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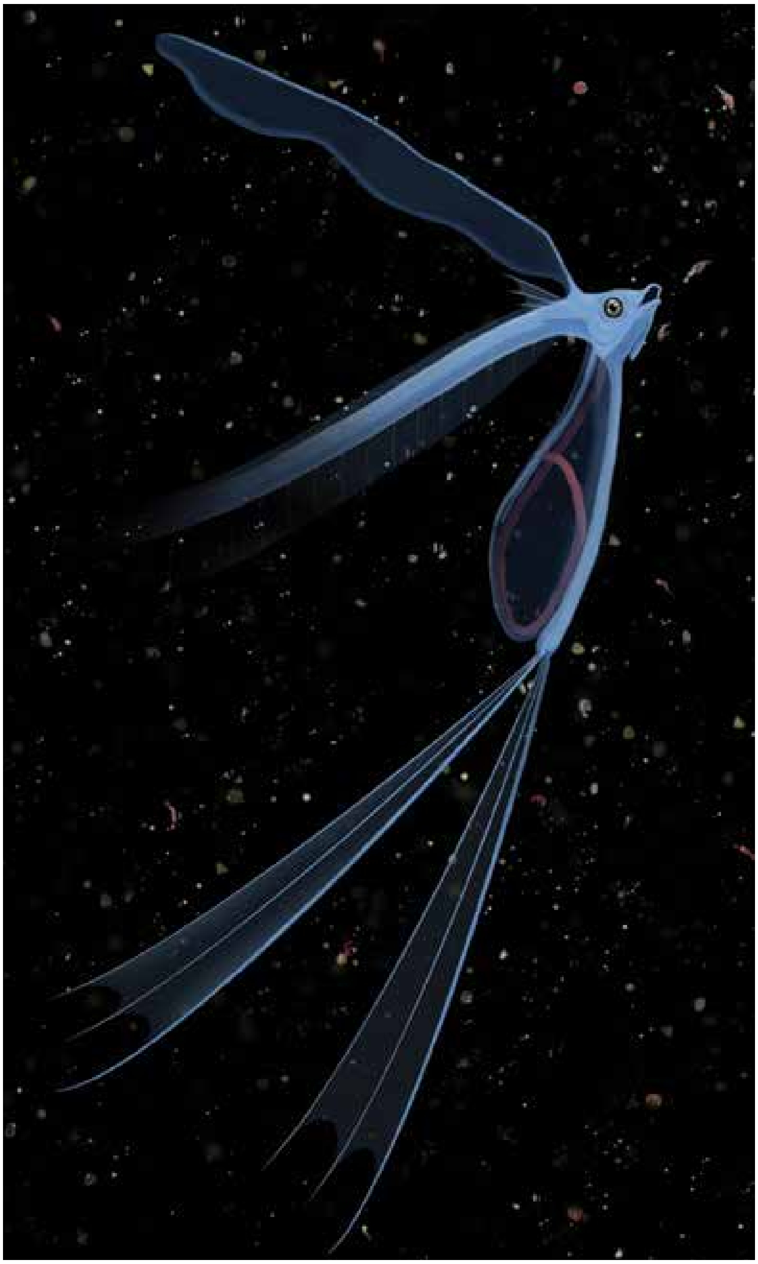

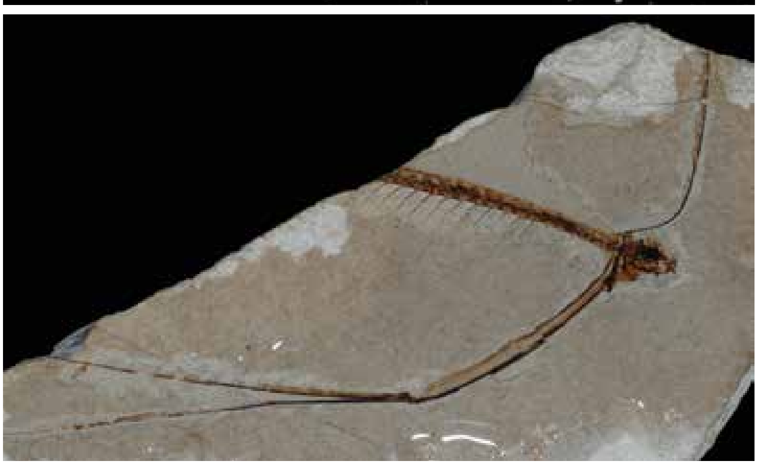

This ancient fish has stumped scientists for centuries

It wasn't an ancient boomerang. It was, in fact, a fish — albeit unlike any known today. Beyond that, nobody's quite sure what to make of *Pegasus volans*.

The fish's ribbonlike body, known from two fossils from a 50-million-year-old site in Italy, has thwarted efforts to pinpoint the animal's place on the tree of life for more than two centuries. Now, a pair of researchers says even the most prominent ideas are incorrect — enough so to rename the extinct animal.

"We know what it isn't," says Donald Davesne, a paleontologist at the National Museum of Natural History in Paris, "but it's unclear what it could be."

The creature has shared the genus name *Pegasus* with sea moths — flat, armored, snout-nosed fish — since Italian naturalist Giovanni Serafino Volta first described the fish in 1796. "They have nothing in common," Davesne says. "I don't know what this guy was thinking."

Using a stereomicroscope and photographs taken under ultraviolet light, Davesne and paleontologist Giorgio Carnevale of the University of Turin in Italy examined the fossils, each no longer than 6 centimeters. Based on the specimens' skeletal anatomy and fin size, reported August 23 at bioRxiv.org, the duo also ruled out a close kinship with oarfish, as some paleontologists have suggested.

Instead, Davesne and Carnevale note similarities to the larvae of modern cusk eels and other fishes in the group Teleostei, including a long dorsal fin ray that extended above the head (illustrated, top left). The fish's tiny abdomen suggests its guts dangled in a pouch, also like teleost larvae.

But the fossil fish don't appear to be larvae, due to their relatively large bodies and fully ossified skeletons, the researchers say. Still, the fossils (one, bottom left) could represent an early appearance of these larval traits, perhaps as part of an explosion of diversity roughly 66 million years ago among spiny-rayed fish, a group of teleosts that the researchers think *P. volans* belongs to, Davesne says.

He cautions that confirming any relationship would require more information — like the tail end of the fish, which is missing from both fossils.

With its family ties unclear, the fish needs a new genus name, the researchers say. Davesne has chosen a moniker in honor of a late musician he knew, following a naming habit practiced by Carnevale. The new name will be revealed once the paper is formally published. — *Sean Cummings*

FROM TOP: MARGAUX BOETSCH; D. DAVESNE

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