Polar Bears Hunt With Weapons | Ice Gets Bent Out of Shape

Science News

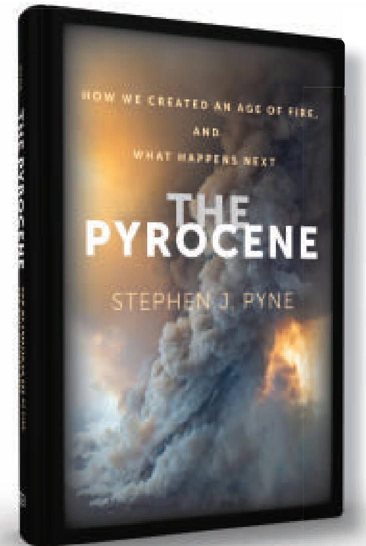
MAGAZINE OF THE SOCIETY FOR SCIENCE ■ AUGUST 28, 2021

What Is a Planet?

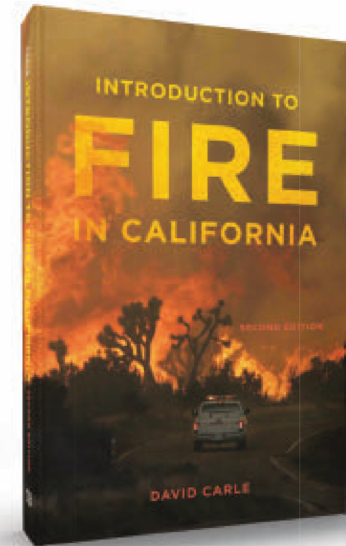
Fifteen years after Pluto lost its title, scientists still don’t agree

ON FIRE AND UNDER WATER

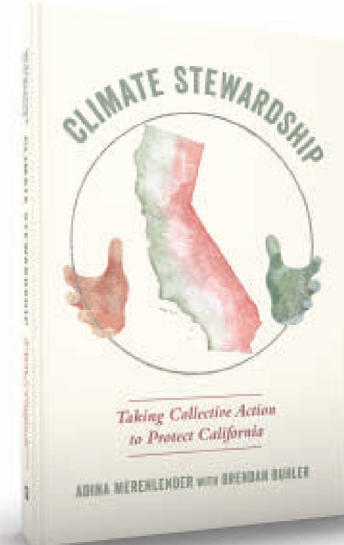
SOLUTIONS FOR OUR BURNING PLANET AND ITS RISING OCEANS



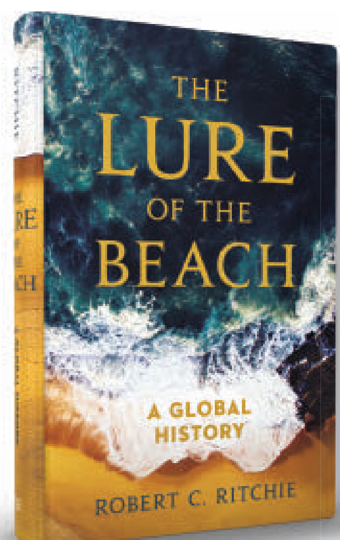
"The world is on fire, and no one sees that—or writes about it—better than Stephen Pyne. This is a brilliant guidebook to that future."
—David Wallace-Wells, author of *The Uninhabitable Earth*



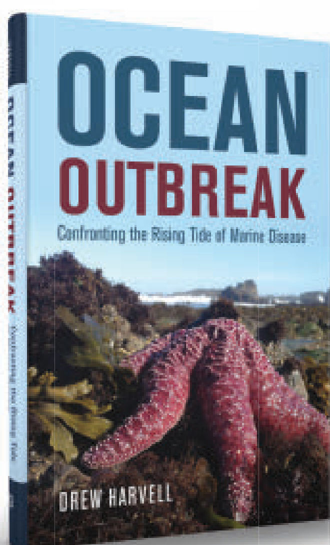
The essential guide to California's long relationship with fire, updated for the climate-change generation.



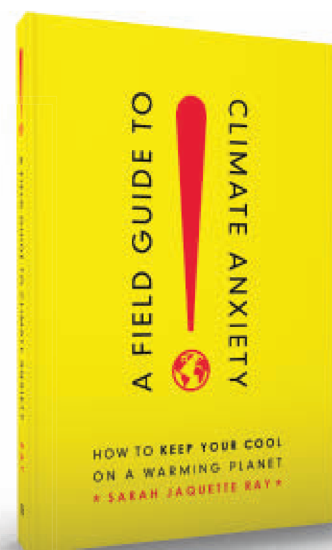
"This wonderful book reminds us of what we are capable of as individuals to improve the future of our planet and people."
—Kirkus Reviews



A history of our relationship—and responsibilities—to our beaches and their ecosystems.



"Manages to inspire both pragmatism and optimism, which likely stems from the immense number of people working . . . to better understand these issues."
—Forbes



"The book is carefully and clearly written, demonstrating the author's commitment to climate work . . . as well as the depth of her own knowledge as an environmentalist. Highly recommended."
—CHOICE

UNIVERSITY of CALIFORNIA PRESS

www.ucpress.edu

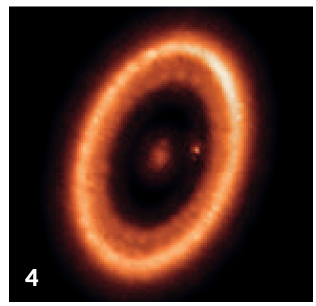
VOL. 200 | NO. 4

Science News

24

Features

News



4

Departments

12

COVER Pluto rises above the horizon of its largest moon, Charon, in this illustration. *Mark Garlick/Science Photo Library/Getty Images Plus*

FROM TOP: DREW ANGERER/GETTY IMAGES; ALMA/ESO, NAOJ AND NRAO, M. BENISTY *ET AL*; JOHN CAPINERA/UNIV. OF FLORIDA, BUGWOOD.ORG (CC BY-NC 3.0 US)

Debate over Pluto's planet status still carries on

Fifteen years ago, Pluto was kicked out of the planet club. On August 24, 2006, members of the International Astronomical Union voted in favor of a new definition of what constitutes a planet. What was once considered the solar system's ninth planet no longer qualified.

The public outcry was immediate. "In changing the definition of *planet*, the International Astronomical Union is messing with something much bigger than it is," one *Science News* reader complained in a letter to the editor. "Think of all the dictionaries, encyclopedias, textbooks and websites that will need revision."

Many planetary scientists were upset too, though mostly for other reasons. As astronomy writer Lisa Grossman explains in this issue (Page 20), some researchers thought the new definition — that a planet is a spherical body that orbits the sun (which Pluto is) and has cleared other objects out of its orbit (which Pluto hasn't) — was too restrictive. Some scientists still lobby for a broader definition.

The debate over classifying solar system objects reminds me of another classification challenge: categorizing the diversity of life on Earth. As a child, I remember learning about the five kingdoms of life: animals, plants, fungi, protists (things like algae) and monerans (bacteria). Though there was never a vote (that I'm aware of), that system was superceded. In the 1990s, biologists proposed new groups such as domains — bacteria, archaea (unicellular organisms that had once been considered bacteria) and eukaryotes. More recently, scientists have debated how to organize eukaryotes, organisms that store DNA within a cell nucleus. For example, did you know you're an opisthokont? According to some biologists, all animals, fungi and some single-celled eukaryotes fall into that "supergroup" (*SN: 8/8/15, p. 22*). The name, roughly meaning "rear pole," references the fact that many opisthokonts have at least some cells powered by a whiplike tail. Animals, for instance, have sperm. But I doubt many schoolchildren would cry if we lost our membership in this group, as they did over Pluto's "demotion."

Categorizing life is an ongoing process, and even the definition of life itself is uncertain, with questions about whether viruses should be considered alive. Still, classification is more than just semantics. These groupings serve a purpose; they reveal our place in nature and help us understand how life has evolved. As new information, particularly genetic information, has come in, scientists have realized that some groupings had been based on superficial similarities and have revised the taxonomy accordingly.

Classification holds a similar purpose in planetary science and is also subject to new information. As Grossman shows, the 2006 vote didn't end debate over what defines a planet. Some scientists now argue that interesting geology is the true hallmark, which would make many solar system objects eligible for a status upgrade. Though this broader definition of a planet may never be put to a vote, we'd love to know whether you think it's a plausible alternative. Let us know at feedback@sciencenews.org.

— Erin Wayman, Managing Editor

In the next few months, various *Science News* editors will share their thoughts in the Editor's Note.

PUBLISHER Maya Ajmera
EDITOR IN CHIEF Nancy Shute

EDITORIAL
EDITOR, SPECIAL PROJECTS Elizabeth Quill
NEWS DIRECTOR Macon Morehouse
DIGITAL DIRECTOR Kate Travis
FEATURES EDITOR Cori Vanchieri
MANAGING EDITOR, MAGAZINE Erin Wayman
DEPUTY NEWS EDITOR Emily DeMarco
ASSOCIATE NEWS EDITOR Ashley Yeager
ASSOCIATE EDITOR Cassie Martin
ASSOCIATE DIGITAL EDITOR Helen Thompson
AUDIENCE ENGAGEMENT EDITOR Mike Denison
ASTRONOMY Lisa Grossman
BEHAVIORAL SCIENCES Bruce Bower
BIOMEDICAL Aimee Cunningham
EARTH AND CLIMATE Carolyn Gramling
LIFE SCIENCES Susan Milius
MOLECULAR BIOLOGY, SENIOR WRITER Tina Hesman Saey
NEUROSCIENCE, SENIOR WRITER Laura Sanders
PHYSICS, SENIOR WRITER Emily Conover
SOCIAL SCIENCES Sujata Gupta
STAFF WRITERS Erin Garcia de Jesús, Jonathan Lambert
EDITORIAL ASSISTANT Aina Abell
SCIENCE WRITER INTERNS Jaime Chambers, Nikk Ogasa
CONTRIBUTING CORRESPONDENTS
Laura Beil, Tom Siegfried, Alexandra Witze

DESIGN
CHIEF DESIGN OFFICER Stephen Egts
DESIGN DIRECTOR Erin Otwell
ART DIRECTOR Tracee Tibbitts
ASSISTANT ART DIRECTOR Chang Won Chang

SCIENCE NEWS FOR STUDENTS
EDITOR Janet Raloff
MANAGING EDITOR Sarah Zielinski
ASSISTANT EDITOR Maria Temming
WEB PRODUCER Lillian Steenblik Hwang

SOCIETY FOR SCIENCE
PRESIDENT AND CEO Maya Ajmera
CHIEF OF STAFF Rachel Goldman Alper
CHIEF MARKETING OFFICER Kathlene Collins
CHIEF PROGRAM OFFICER Michele Glidden
CHIEF, EVENTS AND OPERATIONS Cait Goldberg
CHIEF COMMUNICATIONS OFFICER Gayle Kansagor
CHIEF ADVANCEMENT OFFICER Bruce B. Makous
CHIEF TECHNOLOGY OFFICER James C. Moore
CHIEF FINANCIAL OFFICER Dan Reznikov

ADVERTISING AND SUBSCRIBER SERVICES
ADVERTISING Daryl Anderson
SCIENCE NEWS IN HIGH SCHOOLS Anna Rhymes
PERMISSIONS Maxine Baydush

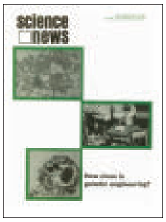
Science News
1719 N Street NW, Washington, DC 20036
(202) 785-2255

Subscriber services:
E-mail subscriptions@sciencenews.org
Phone (800) 552-4412 in the U.S. or (937) 610-0240 outside of the U.S.
Web www.sciencenews.org/join
For renewals, www.sciencenews.org/renew
Mail *Science News*, PO Box 292255, Kettering, OH 45429-0255

Alliance for Audited Media

Editorial/Letters: feedback@sciencenews.org
***Science News* in High Schools:** snhs@societyforscience.org
Advertising/Sponsor content: ads@societyforscience.org
Science News (ISSN 0036-8423) is published 22 times per year, bi-weekly except the first week only in May and October and the first and last weeks only in July by the Society for Science & the Public, 1719 N Street, NW, Washington, DC 20036.
Subscribe to *Science News*: Subscriptions include 22 issues of *Science News* and full access to www.sciencenews.org and cost $50 for one year (international rate of $68 includes extra shipping charge).
Subscribe www.sciencenews.org/subscription
Single copies are $3.99 (plus $1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.
Postmaster: Send address changes to *Science News*, PO Box 292255, Kettering, OH 45429-0255. Two to six weeks' notice is required. Old and new addresses, including zip codes, must be provided.

SOCIETY FOR SCIENCE



Excerpt from the August 28, 1971 issue of *Science News*

50 YEARS AGO

The shrinking mass of Pluto

Pluto was the last of the planets to be discovered (in 1930). If astronomers continue to make it lighter, it may be the first to disappear.... [The latest measurement] brings Pluto down to 0.11 of Earth's mass, less than an eighth of its former self.... The wide discrepancies among the figures presented for the mass of Pluto illustrate the particular difficulties of measuring its mass.... If a planet has satellites, its mass can be determined from studying their motions.... But Pluto has no known satellites.

UPDATE: The discovery of Pluto's moon Charon in 1978 (*SN: 7/15/78, p. 36*) finally allowed astronomers to accurately calculate the planet's mass: about 0.2 percent of Earth's mass. Decades after scientists resolved Pluto's heft, the planet received arguably the greatest demotion of all — a downgrade to dwarf planet (*SN: 9/2/06, p. 149*). Some astronomers have since proposed alternate definitions for the term "planet" that, if widely adopted, would restore Pluto to its former rank (see Page 20).

Some soil samples collected near Shackleton Glacier in Antarctica (shown) were seemingly devoid of microbial life, an unexpected finding.

THE SCIENCE LIFE

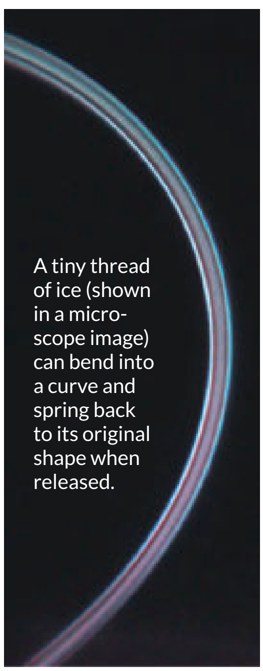
Missing microbes hint at limits on the search for E.T.

Even in the harshest environments, microbes always seem to get by. They thrive everywhere from boiling-hot seafloor hydrothermal vents to high on Mount Everest. Clumps of microbial cells have even survived for years in outer space (*SN: 9/26/20, p. 10*).

There was no reason for microbial ecologist Noah Fierer to expect that any of the 204 soil samples he and colleagues had collected near Antarctica's Shackleton Glacier would be different. A spoonful of typical soil could easily contain billions of microbes, and Antarctic soils from other regions host at least a few thousand per gram. Fierer assumed that all of his samples would host at least some life, even though the air around Shackleton Glacier is so cold and so arid that he often left his damp laundry outside to freeze-dry.

Surprisingly, some of the coldest, driest soils didn't seem to be inhabited by microbes at all, Fierer and colleagues report in the June *Journal of Geophysical Research: Biogeosciences*. To Fierer's knowledge, this is the first time that scientists have found soils that don't appear to support any kind of microbial life.

The findings suggest that exceedingly cold and arid conditions might place a hard limit on microbial habitability and raise questions about how negative scientific results should be interpreted, especially in the search for life on other planets. "The



A tiny thread of ice (shown in a microscope image) can bend into a curve and spring back to its original shape when released.

HOW BIZARRE

Ice gets flexible in lab experiments

Ice's well-established reputation for being stiff and brittle may be ruined. Thin, pristine threads of ice are bendy and elastic, scientists report in the July 9 *Science*.

To create the flexible ice, nanoscientist Peizhen Xu of Zhejiang University in Hangzhou, China, and colleagues used a needle with an electric voltage applied to it, which attracted water vapor within a chilled chamber. The resulting ice whiskers were a few micrometers in diameter or less. Ice usually contains defects: tiny cracks, pores or misaligned sections of crystal. But the ice threads consisted of near-perfect crystals, giving the threads atypical properties. Between –70° and –150° Celsius, scientists could curve the ice into a partial circle with a radius of tens of micrometers. When the team released the bending force, the fibers sprang back to their original shape. Bending the fibers compresses the ice on its inside edge, inducing the ice to take on a different structure. That discovery could give researchers a new way to study ice's properties when squeezed. *— Emily Conover*

FROM TOP: N. FIERER; P. XU ET AL/*SCIENCE* 2021

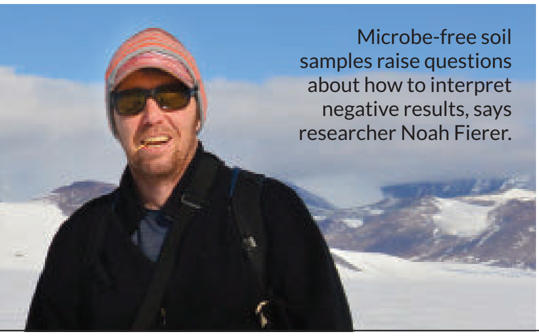
Watch a video of ice bending at **bit.ly/SN_IceSpring** challenge comes back to this sort of philosophical [question]: How do you prove a negative?" says Fierer, of the University of Colorado Boulder.

Proving a negative result is notoriously difficult. No measurement is perfectly sensitive, so there's always a possibility that a well-executed experiment will fail to detect something that is actually there. It took nearly two years of experiments based on multiple methods before Fierer and his University of Colorado colleague Nick Dragone finally felt confident enough to announce that they'd found seemingly microbe-free soils. And the scientists intentionally stated only that they were unable to detect life in their samples, not that the soils were naturally devoid of life. "We can't say the soils are sterile. Nobody can say that," Fierer says. There's always another method to try, he says.

Polar microbiologist Jeff Bowman sees the findings as an indication that current technology can't detect very low levels of life, which can lead to false-negative results. "Certainly, there were things there," says Bowman, of the Scripps Institution of Oceanography in La Jolla, Calif. "This is Earth. This is an environment that is massively contaminated with life."

Even if there were a few microbes in the soil, that wouldn't undermine the team's evidence that cold and aridity pose a serious challenge to life, Dragone says. "It's the combination of multiple very challenging environmental conditions that restricts life more than just one acting by itself."

As scientists search for evidence of life beyond Earth, they will be forced to walk the line between evidence of absence and absence of evidence. "What we're trying to do on Mars is kind of the reverse of what we've tried to do on Earth," says polar microbiologist Lyle Whyte of McGill University in Montreal. On Earth, claiming that an environment is lifeless is a tough scientific sell. On Mars, it will be the other way around. *— Elise Cutts*



Microbe-free soil samples raise questions about how to interpret negative results, says researcher Noah Fierer.

FROM TOP: ALMA/ESO, NAOJ AND NRAO, M. BENISTY *ET AL*; COURTESY OF N. FIERER

THE –EST

A skeleton unearthed in Peru vies for the title of oldest known shark attack victim

When news broke in June that the oldest known case of a person killed by a shark involved a member of Japan's Jōmon culture around 3,000 years ago (*SN Online: 7/23/21*), two researchers took special notice.

Back in 1976, bioarchaeologist Robert Benfer of the University of Missouri in Columbia and anthropological archaeologist Jeffrey Quilter of Harvard University helped excavate a roughly 17-year-old boy's skeleton at a Peruvian village site called Paloma. The remains bore signs of a fatal shark encounter: One of the boy's legs was missing, and his hip and forearm bones displayed deep bite marks characteristic of those made by sharks. Radiocarbon dating indicated that the teen died around 6,000 years ago, Benfer says. That could make the teen the real oldest known shark attack victim.

Quilter described the youth's shark-related injuries in two paragraphs in the 1989 book *Life and Death at Paloma*. But the results were never published in an academic journal. Quilter and Benfer e-mailed the excerpt to the Jōmon researchers on July 26. "We were unaware of their claim until now but are keen to speak to them about it in more detail," says archaeologist J. Alyssa White of the University of Oxford, who led the Jōmon team. *— Bruce Bower*

PICTURE THIS

A forming exoplanet could make moons

New telescope images may provide the first view of moons forming outside the solar system.

The Atacama Large Millimeter/submillimeter Array, or ALMA, in Chile glimpsed a dusty disk of potentially moon-forming material around a baby exoplanet about 370 light-years from Earth. The Jupiter-like world is surrounded by enough material to make up to 2.5 Earth moons, researchers report in the July 20 *Astrophysical Journal Letters*.

ALMA observed a planet dubbed PDS 70c circling the star PDS 70 (center, above) in July 2019. Unlike most known exoplanets, this world is still forming, gobbling up material from the disk of gas and dust swirling around its star. During this formation process, planets are expected to wrap themselves in their own debris disks, which control how planets pack on material and form moons.

Around PDS 70c, ALMA spotted a disk of dust (small dot, right of the star) about as wide as Earth's orbit around the sun. With previously reported exomoon sightings still controversial (*SN Online: 4/30/19*), the new observations offer some of the best evidence yet that planets orbiting other stars have moons. *— Maria Temming*

News

LIFE & EVOLUTION

Oldest animal fossil claim stirs debate

Squiggly alleged sponge hints at a much earlier start for animals

BY JAKE BUEHLER

Pale, wormlike tubes in 890-million-year-old rock may be ancient sea sponges, a new study concludes. If confirmed, that controversial claim would push back the origin of the earliest sponges by about 350 million years and make the microscopic squiggles the oldest known fossils of animals.

Crucially, these fossils would imply that animals emerged in environmental conditions previously thought unworkable for animal life, geologist Elizabeth Turner reports July 28 in *Nature*.

Early in Earth's history, the ocean mostly lacked oxygen. It wasn't until about 800 million to 540 million years ago that a large pulse of the gas to the atmosphere, known as the Neoproterozoic Oxidation Event, brought atmospheric oxygen levels to within 10 to 50 percent of modern levels. That event boosted the amount of oxygen in surface ocean waters (*SN: 1/18/20, p. 7*). Until that point, oxygen levels were thought to be too low to sustain animal life. "But sponges are different from other animals," says Turner, of Laurentian University in Sudbury, Canada. "Some sponges in the modern world and in the rock record are known to be tolerant of comparatively low oxygen relative to modern ocean levels."

Until now, the earliest, unambiguous fossilized sponges date to about 540 million years ago to the beginning of the Cambrian Period, when an extreme burst in the evolution of animal diversity began (*SN: 9/7/13, p. 12*). Some other animals are known from nearly 20 million years earlier, but go too much further back in time and the fossils' classification as animals becomes less certain (*SN: 4/4/15, p. 12*). Based on genetic data and sponges' relative simplicity, the creatures are generally thought to have been the earliest form of animal life.

But some scientists aren't convinced that the newly described tubes are sponge fossils. "Organisms from anywhere on the tree of life can make wiggly, little [branching and rejoining] structures," says paleobiologist Jonathan Antcliffe of the University of Lausanne in Switzerland. The fossils lack features such as mineralized skeletal parts called spicules that would identify the creatures as sponges, he says.

What's more, the finding doesn't fit with what scientists know about the availability of nutrients, biominerals and oxygen in the whole ocean ecosystem before the Cambrian Period, Antcliffe says. "Everything we know about the Earth's oceans in this interval of time tells us that animals originated around 540 [million to] 550 million years ago. It's a legion of evidence, and to overturn such an enormously strong paradigm, you need more than 'might be a sponge.' "

Turner first found the network of tubes in 1992 in rocks from Little Dal, an ancient reef system formed by cyanobacteria, in northwestern Canada's Mackenzie Mountains. "I found this thing that was totally out of place," she says. "It was much more complex in terms of its structure than anything that could be made by cyanobacteria."

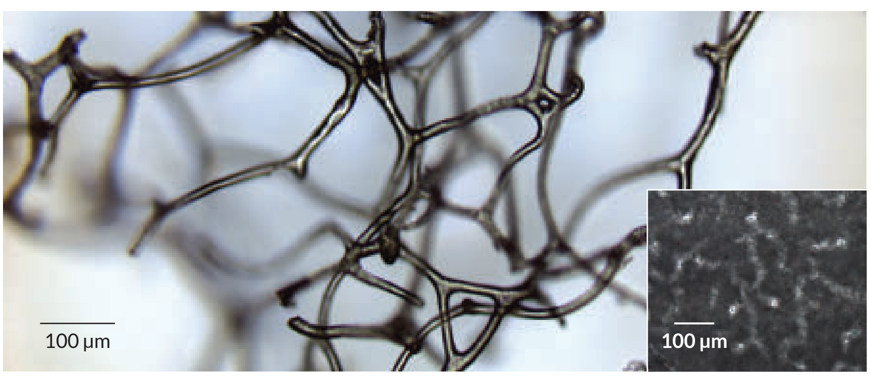
She would have reported the curious squiggles then, but without much else to tie the fossils to sponges besides a general resemblance, Turner moved on. More than a decade later, other scientists published research showing that sponges preserved in rock could appear similar to the pallid wiggles at Little Dal, so she returned to her find.

Turner argues that many modern sponges don't have spicules. If ancient creatures were similar, the newly described fossils could be sponges. And she suggests that sponges predating the Neoproterozoic Oxidation Event may have scraped out an existence in "oxygen oases" along microbial reefs, living in holes and reef flanks.

It's possible that early sponges emerged much earlier than the rest of animal life and remained in a kind of evolutionary stasis in low-oxygen conditions, Turner says. The evolution of more complex animals would have had to wait until oxygen became more abundant.

Scientists have known about odd types of fossils in the Little Dal reef for a while, says paleobiologist James Schiffbauer of the University of Missouri in Columbia. And previous genetic analyses have suggested that sponges evolved well before the Cambrian Period. "It has just been a matter of finding them if they were indeed preserved," Schiffbauer says.

Future research could help confirm the fossils' identity. Turner says she plans to continue studying the ancient tubes, adding that more answers may come from looking in the right places. "We need to be looking for similar material with a really open mind in rocks of similar age." ■



A skeletal fragment of a modern bath sponge (*Spongia officinalis*) has a characteristic branched structure. What's claimed to be an ancient sponge fossil (inset) sports a similar structure.

E.C. TURNER/*NATURE* 2021

Lunar rocks hint at fleeting magnetism

The moon's magnetic field lasted 500 million years at most

BY CAROLYN GRAMLING

A lunar magnetic field may have persisted for only a blip in geologic time, a new study suggests.

Shortly after the moon formed about 4.5 billion years ago, it may have begun generating a magnetic field, a protective sheath that can deflect charged particles from the sun. Now, analyses of moon rocks suggest that any lunar magnetic field was gone by at least 4 billion years ago, researchers report August 4 in *Science Advances*.

Magnetized lunar rocks brought back by Apollo astronauts decades ago were the first indication that the moon may have once had an internal dynamo — in which molten, iron-rich rock swirls inside the core of a celestial body, giving rise to a magnetic field (*SN: 12/17/11, p. 17*). But how long such a lunar dynamo may have lasted has been unclear.

The moon's core is "really small," says geophysicist John Tarduno of the University of Rochester in New York. It's not clear how that core could have sustained a dynamo for long before cooling, he says.

Tarduno and colleagues examined the magnetization of a handful of the Apollo rock samples. Analyzing the magnetism of tiny shards of metal trapped in crystals in rock dating from 3.9 billion to 3.2 billion years ago showed that those rocks were barely magnetized at all.

But a piece of lunar glass that formed during a meteorite impact about 2 million years ago had a strong magnetic field, "just a little weaker than Earth's today," Tarduno says. That's odd, because "everyone agrees there isn't a magnetic field on the moon now, and there wasn't one 2 million years ago," he says. "How does this happen?"

Taken together, these findings point to one conclusion, the team says: The moon hasn't generated a magnetic field for at least 4 billion years. The magnetization of the bit of glass happened due to the meteorite impact that also formed the glass itself, Tarduno and colleagues suggest.

The idea that a meteorite impact can produce strong magnetization in rocks has been discussed in previous scientific studies, Tarduno says. As a meteorite punches into the lunar surface at superfast speeds, the impact can partially ionize particles on the surface, creating thick, magnetized plasma. "The glass, as it was moving through this plasma, acquired that strong magnetization," he says.

The moon has been repeatedly battered by meteorites over time (*SN: 6/6/20, p. 32*). Relatively young and highly magnetized lunar samples that researchers have puzzled over may have gotten their magnetization in the same way the glass did, Tarduno says.

If so, that may also help explain results from recent studies, based on analyses of the magnetization of a moon rock dating to between 2.5 billion and 1 billion years ago, that have suggested the moon's magnetic field might have lingered until as recently as 1 billion years ago (*SN: 9/16/17, p. 10*).

Earth's moon has lacked a magnetic field, leaving it unprotected from the solar wind, for at least 4 billion years, a study suggests.

Lunar glass that formed in a meteorite strike about 2 million years ago (example shown) probably was magnetized by the impact rather than a magnetic field from the moon's core.

Geodynamicists have wrangled over how the moon's small core could have sustained a magnetic field for billions of years or even if the moon ever had a magnetic field at all, says paleomagnetist Lisa Tauxe of the Scripps Institution of Oceanography in La Jolla, Calif. Modeling studies of the moon's core "just have a great deal of trouble generating enough oomph to make a magnetic field, whereas you can do that pretty easily for the Earth." The new study, she says, "presents a well-argued case against a long-lived field."

If any lunar magnetic field disappeared about 4 billion years ago, the lengthy bombardment of the moon's surface by the solar wind since then may have left a hidden wealth of helium-3 and water buried in the lunar soils (*SN: 5/11/19 & 5/25/19, p. 8*). Those are products that future moon expeditions may be able to mine for energy, as well as life support.

Drilling into those soils may also give scientists an unprecedented glimpse at past physical properties of the sun, Tarduno says, which could also help scientists better understand conditions on the early Earth (*SN: 6/25/16, p. 12*). "[We] have the potential now to learn both about the ancient sun and early Earth's atmosphere, which you're not going to get in any other way," he says. "That's really exciting stuff." ■

FROM TOP: RORY COTTRELL; T. PESQUET/ESA, NASA

EARTH & ENVIRONMENT

Sea level dips spur volcanic eruptions

Santorini flare-ups are linked to periods of low sea level

BY MARIA TEMMING

When sea level drops far below the present-day level, the island volcano Santorini in Greece gets ready to rumble. A comparison of the activity of the volcano with sea levels over the last 360,000 years suggests that when the sea level dips more than 40 meters, it triggers a fit of eruptions. During times of higher sea level, the volcano is quiet, researchers report in the August *Nature Geoscience*.

Since more than half of the world's volcanic systems are in or near oceans, sea levels probably similarly influence other volcanoes, the researchers say.

Santorini is a ring of islands surrounding the central tip of a volcano poking out of the Aegean Sea. The entire volcano used to be above water, but a violent eruption around 1600 B.C. caused part of the volcano to cave in, forming a lagoon (*SN: 3/10/12, p. 12*).

To investigate how sea level might influence the volcano, physical geographer Christopher Satow and colleagues created a computer simulation of Santorini's magma chamber, which sits about four kilometers beneath the volcano's surface. When the sea level dropped at least 40 meters below the present-day level, the crust above the magma chamber splintered, the simulation showed. That allows magma stored under the volcano to "move up through these fractures and make its way to the surface," says Satow, of Oxford Brookes University in England.

Those magma-filled cracks should take about 13,000 years to reach the surface and awaken the volcano, the team found. After the water rises again, the cracks should take about 11,000 years to close, stopping eruptions.

It may seem counterintuitive that lowering the amount of water atop the magma chamber would cause the crust to splinter. Satow compares the scenario to wrapping your hands around an inflated balloon, where the rubber is Earth's crust and your hands' inward pressure is the weight of the ocean. As someone else pumps air into the balloon — like magma building up under Earth's crust — the pressure of your hands helps prevent the balloon from popping. "As soon as you start to release the pressure with your hands, [like] taking the sea level down, the balloon starts to expand," Satow says, and ultimately the balloon breaks.

The team tested the simulation's predictions by comparing Santorini's

Sea level seems to influence eruptions from the partially submerged volcano of Santorini (shown from above) in Greece. Lower sea levels are historically linked to more eruptions.

MATTER & ENERGY

Light is caught making matter

But the result depends on whether the photons are 'real'

BY EMILY CONOVER

Collide light with light, and poof, you get matter and antimatter. It sounds like a simple idea, but it turns out to be surprisingly hard to prove.

A team of physicists is now claiming the first direct observation of the long-sought Breit-Wheeler process, in which two particles of light, or photons, crash into one another and produce an electron and its antimatter counterpart, a positron. But the detection's significance hinges on whether the light is "real." Some physicists argue the photons don't qualify as real, raising questions about the observation's implications.

Predicted more than 80 years ago, the Breit-Wheeler process had never been directly observed. New measurements from the STAR experiment at Brookhaven National Laboratory in New York match predictions for the elusive transformation, physicist Daniel Brandenburg and colleagues report in the July 30 *Physical Review Letters*.

"The idea that you can create matter from light smashing together is an interesting concept," says Brandenburg, of Brookhaven. It's a striking demonstration of the physics immortalized in Einstein's equation $E=mc^2$, which revealed that energy and mass are two sides of the same coin.

Whether the observation truly qualifies depends on whether the photons are considered "real," as demanded by the Breit-Wheeler process, or "virtual." In particle physics, virtual particles are ones that appear for only instants and don't carry their normal masses.

Photons from a common source of light, such as a lightbulb or a laser, are considered real. But the bona fides of Brandenburg and colleagues' photons are up for debate because the light the team collided came from an unusual source: the electromagnetic fields of two atomic nuclei that race around Brookhaven's Relativistic Heavy Ion Collider.

Normally, photons from such electromagnetic fields are virtual. But in the experiment, the photons act as if they are real due to the high speeds at which the two nuclei are zipping along. In cases where the nuclei barely miss one another, their electromagnetic fields overlap and two photons from those fields can collide. So the team looked for near-misses that spit out one electron and one positron.

Measurements of angles between those particles, which depend on whether real or virtual photons collided, matched expectations for real photons, suggesting that the team had seen the

NASA EARTH OBSERVATORY

eruption history with geologic evidence of past sea levels. All but three of the volcano's 211 well-dated eruptions in the last 360,000 years happened during periods of low sea level, as predicted. Such periods of low sea level occurred when more of Earth's water was locked up in glaciers during ice ages.

"It's really intriguing and interesting, and perhaps not surprising, given that other studies have shown that volcanoes are sensitive to changes in their stress state," says geophysicist Emilie Hooft of the University of Oregon in Eugene. Icelandic volcanoes, for instance, have shown an uptick in eruptions after overlying glaciers have melted, relieving the volcanic systems of the weight of the ice.

As for Santorini, the last time sea level was 40 meters below the present-day level was near the end of the last ice age — and sea level is rising due to climate change — so Satow's team expects the volcano to enter a period of relative quiet. But two major eruptions in the volcano's history did happen amid high sea levels, the team says, so future violent eruptions aren't off the table. ■

Breit-Wheeler process.

Strictly speaking, the experiment is one step removed from the true Breit-Wheeler process, says particle physicist Lucian Harland-Lang of the University of Oxford. While the photons behave almost as if real, they are technically virtual.

Brandenburg and colleagues take a different view, in which the reality of the photon is based on how it behaves.

The scientists' measurements back that up, says laser plasma physicist Stuart Mangles of Imperial College London. "Everything they're measuring about it makes it look like a real photon." However, Mangles says, the photons are still virtual by some definitions.

Mangles and others are working toward detecting the Breit-Wheeler process with lasers, which produce light that's as real as the light allowing you to read this article. That, physicists are hoping, will clinch the case for colliding light making matter. ■

LIFE & EVOLUTION

Newly hatched pterosaurs took flight

A strong wing bone suggests the baby reptiles were agile fliers

BY CAROLYN GRAMLING

Pterosaur hatchlings may have been able to fly right out of the shell. A new analysis of the fossilized wing bones of embryonic, newly hatched and adult pterosaurs suggests the baby creatures were strong and nimble fliers from the start, researchers report July 22 in *Scientific Reports*.

Pterosaurs were a diverse group of flying reptiles that lived alongside dinosaurs from 228 million to 66 million years ago during the Triassic and Cretaceous periods. The group includes *Quetzalcoatlus northropi*, the largest creature known to take wing, and *Kunpengopterus antipollicatus*, which had opposable thumbs that enabled it to climb trees (*SN: 5/8/21 & 5/22/21, p. 16*).

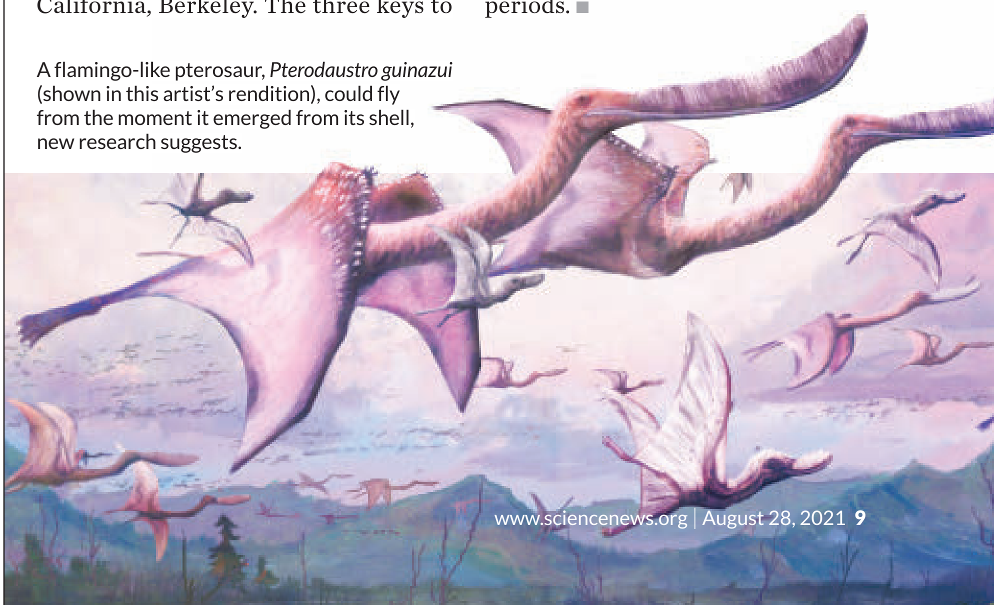
Scientists know relatively little about whether young pterosaurs could actively flap their wings or only glide — which might mean they stayed under parental care until they were flight-ready. But relatively recent revelations increasingly point toward early independence, or precociality, for the reptiles. For instance, researchers have found flight membranes on the wings of an embryonic pterosaur and the remains of a juvenile that was capable of long-distance flying long before it had grown to adult size.

"Baby pterosaurs almost certainly didn't glide," they flew, says paleontologist Kevin Padian of the University of California, Berkeley. The three keys to flight are strong bones, sufficient muscle mass to stay in the air for a long time and sturdy keratin fibers in the skin of the wings, analogous to bird feathers, Padian says. "We know little about the last two."

Paleontologist Darren Naish of the University of Southampton in England and colleagues turned to bones, comparing fossilized embryo and hatchling wing measurements with those of adults from two species: *Pterodaustro guinazui* and *Sinopterus dongi*. The team zeroed in on one wing bone, the humerus, that offers key information on whether a pterosaur was capable of getting off the ground.

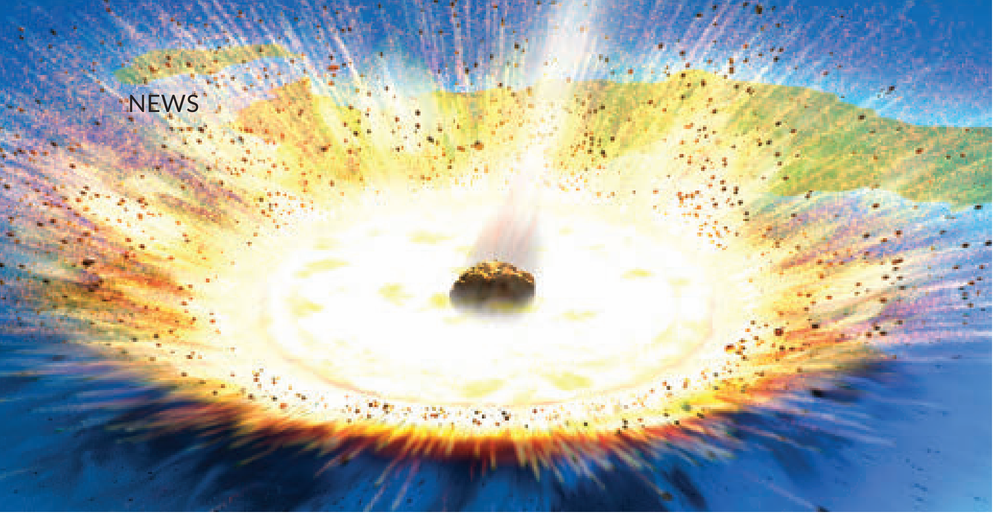
Relative to hatchlings' size, their humerus bones were stronger than those of many of the adults, and hatchlings also had shorter, broader wings, suggesting that youngsters might have been capable of nimbly changing direction and speed, and possibly flying long distances. Agile flying may have helped the hatchlings escape predators and chase tricky prey such as insects, all while navigating dense vegetation, the team suggests.

It isn't unusual in the animal world for young to fend for themselves, Padian says. "Precociality is the rule, not the exception, in vertebrates," he says. Only animals with extended parental care, such as songbirds and primates, can afford to be helpless for prolonged periods. ■



A flamingo-like pterosaur, *Pterodaustro guinazui* (shown in this artist's rendition), could fly from the moment it emerged from its shell, new research suggests.

MARK WITTON



When the Chicxulub asteroid (illustrated) slammed into Earth millions of years ago, the impact formed a tsunami that may have left ripples in rock under present-day Louisiana.

EARTH & ENVIRONMENT

Dino-killing asteroid had a ripple effect

An impact-induced tsunami may have left behind giant ridges

BY NIKK OGASA

The asteroid impact that slew the dinosaurs may have also indirectly sculpted the largest ripple marks ever found on Earth.

A series of ridgelike structures more than three stories high and spaced nearly two Eiffel Towers apart appear to be buried about 1.5 kilometers beneath central Louisiana. The oversized features are megaripples shaped by a massive tsunami generated by the Chicxulub asteroid impact, researchers argue in the Sept. 15 *Earth and Planetary Science Letters*.

"It's just interesting that something that happened 66 million years ago could be so well preserved, buried 5,000 feet down in the sediments of Louisiana," says geologist Gary Kinsland of the University of Louisiana at Lafayette.

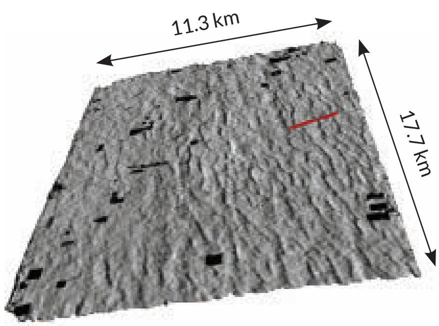
Ripple marks are repeating sequences of ridges typically found on sandy beaches or stream bottoms and form as wind or water flows over and moves loose sediment. But ripple marks on the beach are often centimeters in height, while the structures found by Kinsland's team have an average height of 16 meters and are spaced about 600 meters apart.

The structures' shape, size, orientation and location suggest that they formed after the Chicxulub asteroid crashed into the Yucatán Peninsula in Mexico, generating a tsunami that washed across the Gulf of Mexico and what is now Louisiana, which was underwater at the time (*SN: 11/25/17, p. 14*). But no one had ever before found ripple marks formed by the sprawling wave.

Geologist Kaare Egedahl discovered the ripples while searching for coal deposits. Studying at the University of Louisiana at Lafayette at the time, Egedahl had been combing through seismic reflection data — 3-D images of buried rock and soil that were generated by underground sound waves — provided by the Devon Energy company. Egedahl, now at the oil and gas company Cantium in Covington, La., found the ripples atop a layer of rock thought to have formed from debris shaken up by the Chicxulub asteroid impact. He then shared his finding with Kinsland.

"I knew where that layer was from in geologic time, and I knew what happened there," Kinsland says. "I knew there should be a tsunami."

These are the ripples (most pronounced near the red line in this reconstruction) beneath Louisiana that a group of geologists say were created by an asteroid-induced tsunami.



The ripple marks were preserved all this time thanks to the depth at which they formed underwater, Kinsland says. Other studies suggest that this region was 60 meters below the sea surface at the time. At that depth, the ripples would have been beyond the reach of tumultuous storms that could have erased them. Then, over millions of years, other sediments slowly buried the marks.

A smaller, analogous set of structures may exist off the east coast of Japan. There, a repeating sequence of underwater dunes was reported to have appeared after the 2011 Tohoku earthquake and tsunami (*SN: 2/25/12, p. 22*). Except for the dunes' size, they look nearly identical to the ripple marks buried beneath Louisiana, Kinsland says. That supports the idea that the taller structures were also produced by a tsunami, though one of a much larger magnitude.

Still, there is contention over whether the features beneath Louisiana really are megaripples formed by the Chicxulub-induced tsunami.

"It's hard to see how such a high-energy event could form ripple marks because they are usually associated with much calmer environments," says sedimentologist Pedro J.M. Costa of the University of Coimbra in Portugal. And ripple marks typically form from frequent and recurring wave motion, while tsunamis don't have many waves, he explains. Costa, who studies tsunami deposits, says that reconstructing the lay of the seafloor at the time of the impact and conducting experiments in water-filled wave tanks could help unravel the origins of the structures found by Kinsland's team.

This new work is important because it opens a discussion, Costa says. Maybe the Chicxulub impact "was such a high-magnitude event that what we see in normal tsunami events don't apply to this one." ■

FROM TOP: MARK GARLICK/SCIENCE PHOTO LIBRARY/GETTY IMAGES; MARTELL STRONG

STEM AT EMORY IS

WHERE STUDENTS LIKE YOU BEGIN TO CHANGE THE WORLD.

Emory pairs the academic rigor of its STEM fields with its designation as a leading research university. Choose from any one of our STEM majors or minors to gain a well-rounded, liberal arts degree that prepares you to take on whatever your next challenge might be. Not only will you develop skills such as writing and thinking critically about your field of interest, but you will be challenged to create new knowledge in your field with the help of Emory's outstanding faculty. It's a foundation for you, but also for humanity, preparing you to serve, lead, and—yes—change the world.

APPLY.EMORY.EDU/ACADEMICS/MAJORS-MINORS.HTML

EMORY

ADVERTISEMENT

LIFE & EVOLUTION

Sick caterpillars keep wasps at bay

Viruses stop young moths from becoming wasp nurseries

BY ERIN GARCIA DE JESÚS

When parasitic wasps come calling, some caterpillars have a surprising ally: a viral infection.

Insects called parasitoid wasps lay their eggs inside young moth larvae, turning the caterpillars into unwitting, destined-to-die incubators for possibly hundreds of wasp offspring. That's bad news for viruses trying to use the caterpillars as replication factories. Viral infections can be lethal for the caterpillars, but their chances of surviving with a virus are probably higher than if wasps use them as a living nursery.

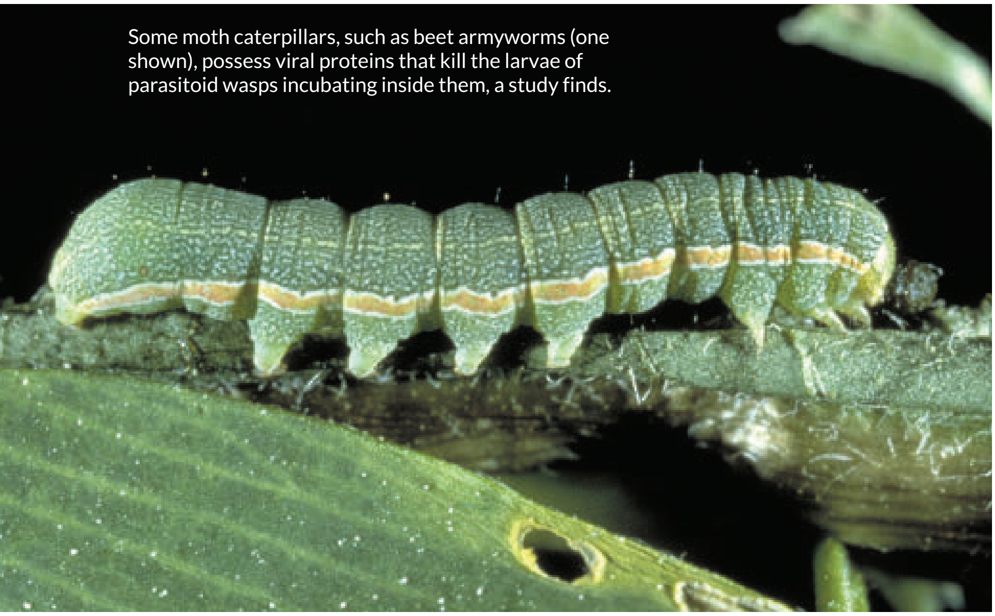
Now, a study shows how certain viruses can help caterpillars stymie parasitoid wasps. A group of proteins dubbed parasitoid killing factor, or PKF, that is found in some insect viruses are incredibly toxic to young parasitoid wasps, researchers report in the July 30 *Science*.

The finding shows that viruses and caterpillars can come together to fight off a common wasp enemy, says insect virologist Madoka Nakai of Tokyo University of Agriculture and Technology. A parasitoid wasp would kill a host that the virus needs to survive, so the virus fights for its home. "It's very clever," Nakai says.

What's more, some moth caterpillars make the wasp-killing proteins themselves, the team found. It's possible that in the distant past, a few moths survived a viral infection and "got some presents" in the form of genetic instructions for how to make the proteins, says insect pathologist and geneticist Salvador Herrero of the University of Valencia in Spain. Those insects could have then passed the ability on to offspring. In this case, "what doesn't kill you makes you stronger," Herrero says.

Previous studies had shown that viruses and insects, including moths, can swap genes with each other. The new finding is one of the latest examples of this activity, says entomologist Michael Strand of the University of Georgia in Athens who was not involved in the research.

"Parasite-host relationships are very specialized," Strand says. "Factors like [PKF] are probably important in defining which hosts can be used by which parasites." But whether caterpillars stole the genetic instructions for the proteins from viruses or viruses originally stole the instructions from another host remains unclear, he says.



Some moth caterpillars, such as beet armyworms (one shown), possess viral proteins that kill the larvae of parasitoid wasps incubating inside them, a study finds.

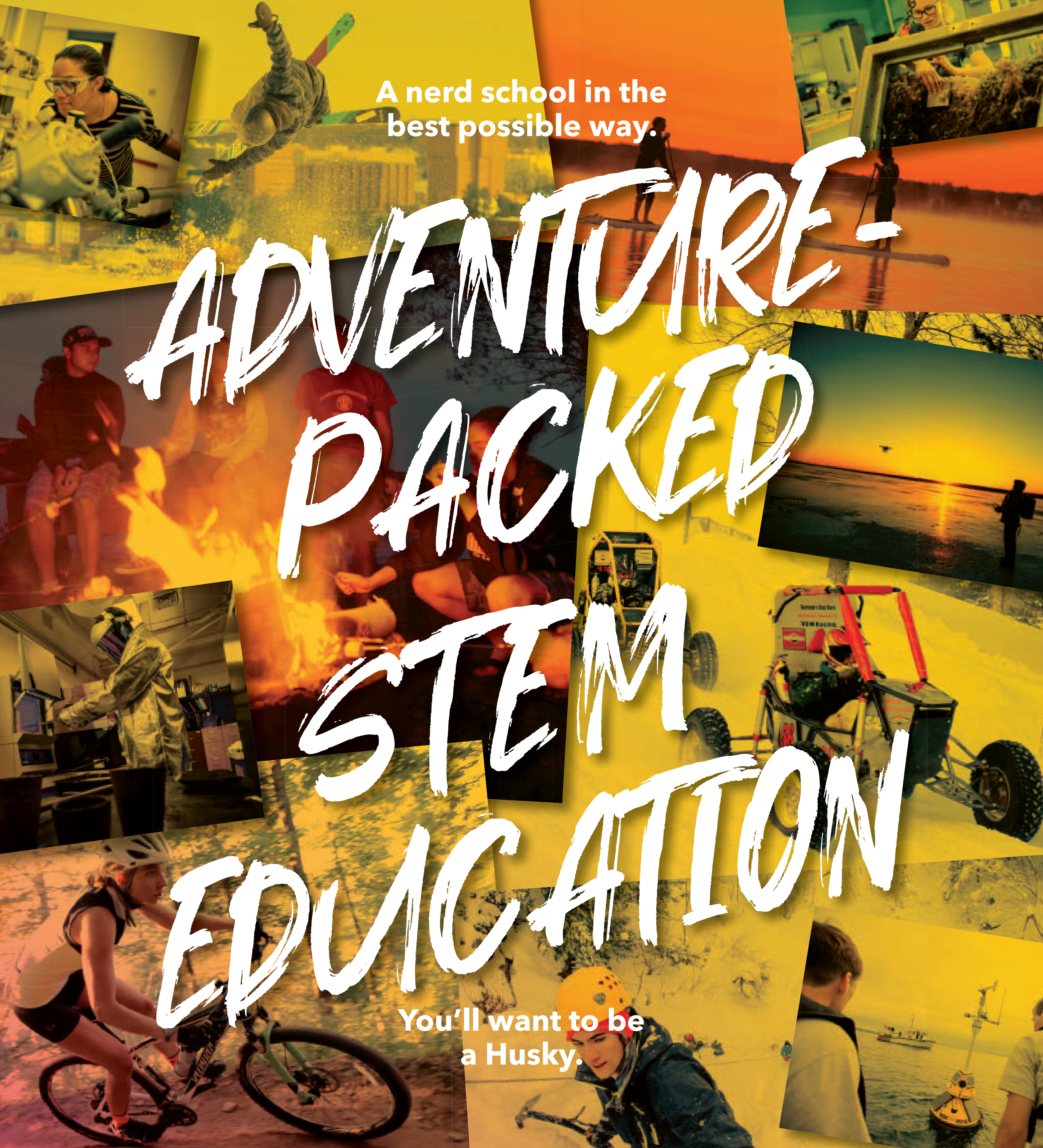
Researchers discovered in the 1970s that virus-infected caterpillars could kill parasitoid wasp larvae using an unknown viral protein. In the new study, Herrero, Nakai and colleagues identified PKF as wasp-killing proteins. The team infected moth caterpillars with one of three insect viruses that carry the genetic blueprints to make the proteins. Then the researchers either allowed wasps to lay their eggs in the caterpillars or exposed wasp larvae to hemolymph — the insect equivalent of blood — from infected caterpillars.

Virus-infected caterpillars were poor hosts of the parasitoid wasp *Cotesia kariyai*. Most young wasps died before they had the chance to emerge from the caterpillars into the world. Hemolymph from infected caterpillars was also an efficient killer of wasp larvae, typically destroying more than 90 percent of offspring.

C. kariyai wasp larvae also didn't survive in caterpillars, including the beet armyworm (*Spodoptera exigua*), that make their own PKF. When the researchers blocked the genes for the proteins in these caterpillars, the wasps lived, a sign that the proteins are key for the caterpillars' defenses.

Some parasitoid wasps, including *Meteorus pulchricornis*, weren't affected by PKF from the viruses or the beet armyworms, allowing the wasp offspring to thrive inside caterpillars. That finding suggests that the wasp-fighting ability is species specific, says Elisabeth Herniou, an insect virologist at CNRS and the University of Tours in France who was not involved in the work. Pinpointing why some wasps aren't susceptible could reveal the details of a long-held evolutionary battle between all three types of organisms.

The study highlights that "single genes can interfere with the outcome of [these] interactions," Herniou says. "One virus may have this gene and the other virus doesn't have it," and that can change what happens when virus, caterpillar and parasitoid all collide. ■


A nerd school in the best possible way.
ADVENTURE-PACKED STEM EDUCATION
You'll want to be a Husky.

As they jump, fox squirrels make quick calculations to balance trade-offs between tree limb flexibility and distance between limbs.

JUDY JINN/UC BERKELEY

LIFE & EVOLUTION

Leaping squirrels use parkour tricks

Obstacle course reveals how the animals navigate jumps

BY JONATHAN LAMBERT

Parkour enthusiasts need look no further than up in the trees for inspiration. Squirrels' aerial acrobatics make the rodents masters of the form.

A detailed look at how squirrels navigate narrow branches that bend and sway with the wind — where the smallest error could spell death — shows that the rodents make split-second calculations to balance trade-offs between branch bendiness and the distance between tree limbs. And for particularly tricky jumps, squirrels improvise parkour-style moves to stick the landing, researchers report in the Aug. 6 *Science*.

This research is "a great example of how cool 'normal' animals can be in their biomechanics," says Michelle Graham, a biomechanist at Virginia Tech in Blacksburg who was not involved with the work. "We've all seen squirrels do crazy stuff in nature, but no one ever pays any attention to it."

That is unless you're like Nathaniel Hunt, who has been mesmerized by watching squirrels flash through the overstory since graduate school. "Tree canopies are incredibly challenging environments to navigate," says Hunt, an integrative biologist at the University of Nebraska Omaha.

When jumping between bendy branches, a squirrel must assess how far it has to jump and know when to leap as it moves along a branch. Jump too early and the squirrel will fall short. Too late, and the squirrel will find itself out on a part of the branch too flimsy from which to launch. Hunt wondered, "How are they sensitive to that trade-off, managing to make accurate leaps?"

To find out, he and colleagues designed an artificial forest obstacle course on the outskirts of the University of California, Berkeley campus. Then the team used peanuts to coax free-ranging fox squirrels (*Sciurus niger*) into running and jumping through a series of acrobatic tests.

First, the unwitting subjects learned to leap from artificial branches of high, medium or low stiffness across a gap to reach a prize: a peanut at the end of a landing peg. High-speed video captured details of the jumps, from launch point to landing accuracy, for 12 squirrels spanning 96 leaping trials.

Unsurprisingly, the squirrels leaped from more bendy branches earlier — presumably to maximize jumping force — even though that increased the distance that the animals must clear, Hunt says. By comparing what the squirrels actually did with statistical models that simulated optimal jumping decisions, the researchers found something interesting: Branch flexibility had about six times as great an influence on when squirrels decided to jump as did the length of the gap. If squirrels had cared more about distance, they would have jumped from about the same spot on the rod, regardless of its give.

"We were surprised to see squirrels weighing both of these things simultaneously, but in different amounts," Hunt says.

The researchers upped the ante for five squirrels by increasing the flexibility of branches as well as gap distance. Initial leaps were less than graceful. No squirrels fell, but most had clunky landings at first, grasping the peg they leaped to with their front paws and swinging around to pull themselves up instead of landing neatly on all fours. But within five trials, "squirrels learned to compensate for their initial error," Hunt says, which they did by modifying their initial velocity.

If squirrels regularly encounter the same branches, such quick learning "might explain how they move so fluidly and rapidly" across particular branches, Hunt explains. The rodents might be such quick navigators, he says, because "they've already learned what they need to know about that branch."

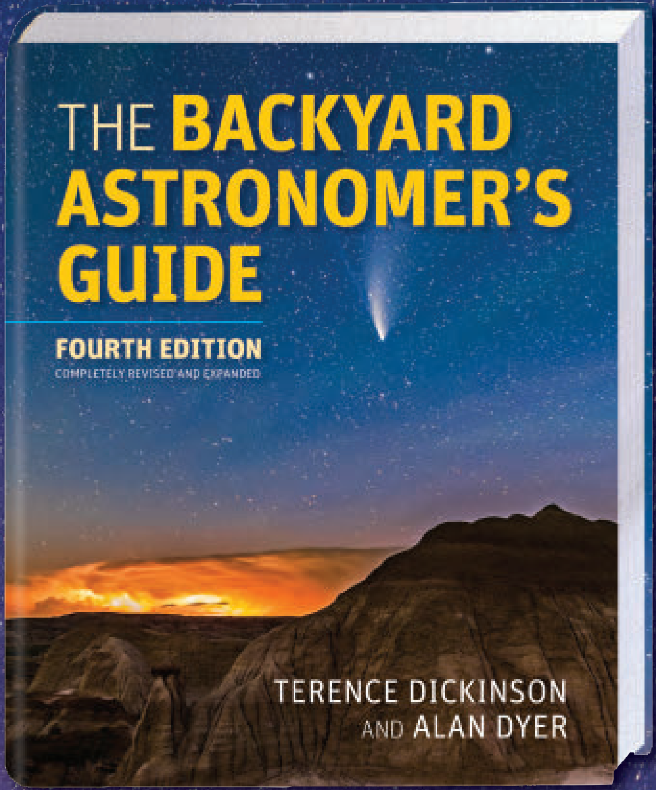
The squirrels surprised the researchers in other ways too. For longer jumps, or those that necessitated landing higher or lower than the starting point, many squirrels rotated midair, using their legs to "jump" off an adjacent vertical wall in a parkour-style maneuver. More often than not, squirrels employed parkour to slow down if they were coming in too hot to a landing. "It's an additional point of control," Hunt says.

For many arboreal animals, "jumping between limbs is such a common thing, and yet we so frequently only study it in pieces," Graham says, such as looking just at the launch but not the landing. This study's holistic look reveals "something really interesting about squirrels, that they take greater account of [branch bendiness] than the gap distance," she notes. "I don't know that I would've guessed that." ■

Watch squirrels leap through an obstacle course at bit.ly/SN_Squirrels

At last! A new, expanded and updated edition of

THE BACKYARD ASTRONOMER'S GUIDE



This fourth edition, by Terence Dickinson and Alan Dyer, expands the go-to guide for experienced amateur astronomers. It sets a new standard for astronomy guides.

The book is completely revised to describe the latest technology, observing techniques and equipment.

Illustrated with all-new photos and star charts, there are 5 new chapters including binocular, telescope and Moon tours by Ken Hewitt-White.

THE BACKYARD ASTRONOMER'S GUIDE will reward you every day of your observing life.

416 pages in full color · hardcover $49.95

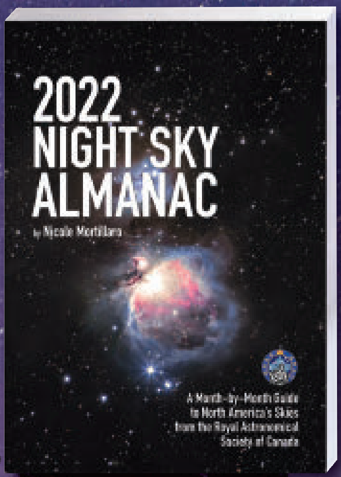
And also available in October:

2022 NIGHT SKY ALMANAC

by the Royal Astronomical Society of Canada

A portable guide to the night sky objects and events.

120 pages in color · paperback $14.95



Published by

FIREFLY BOOKS

www.fireflybooks.com

WHEREVER ASTRONOMY BOOKS ARE SOLD

LIFE & EVOLUTION

Polar bears kill prey with ice and stone

A study supports Inuit accounts of bears clobbering walruses

BY GLORIA DICKIE

Walruses, weighing more than 1,300 kilograms with huge tusks and nearly impenetrable skulls, are almost impossible for a hungry polar bear to kill. But some polar bears have invented a work-around — bashing walruses on the head with a block of stone or ice.

For more than 200 years, Inuit in Greenland and the eastern Canadian Arctic have told stories of polar bears (*Ursus maritimus*) using such tools to aid in killing walruses. Yet explorers, naturalists and writers often dismissed such accounts, relegating them to myth along with tales about shape-shifting bears.

The persistence of these reports, including one from an Inuit hunter in the late 1990s, coupled with photos of a male polar bear named GoGo at a Japanese zoo using tools to obtain suspended meat, compelled polar bear biologist Ian Stirling and colleagues to investigate further.

"It's been my general observation that if an experienced Inuit hunter tells you that he's seen something, it's worth listening to and very likely to be correct," Stirling says.

The researchers reviewed historical observations of tool use in polar bears reported by Inuit hunters to explorers and naturalists; relatively recent observations by Inuit hunters and non-Inuit researchers; and documented observations of GoGo and polar bear relatives in captivity using tools to access food. Taken together, the evidence suggests that tool use in wild polar bears, though infrequent, does occur in the case of hunting walruses because of the walruses' large size, the team reports in the June *Arctic*.

"Really, the only species you would want to bonk on the head with a piece of ice would be a walrus," says Andrew Derocher, director of the Polar Bear Science Lab at the University of Alberta in Edmonton, Canada, who wasn't involved with the research. He suspects that it might be just a few polar bears that behave this way. For example, if a mother bear figured out how to use ice or stone to bludgeon prey, "it's something her offspring would pick up on," but not necessarily a skill polar bears across the Arctic would acquire, Derocher says.

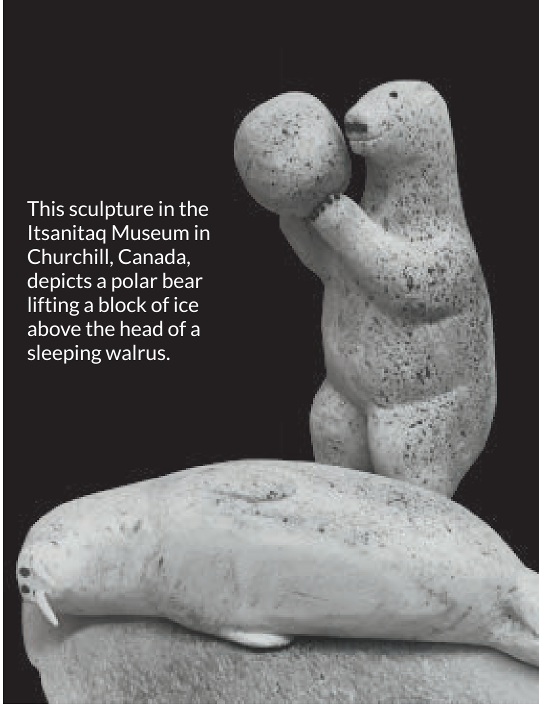
Among animals, using tools to solve problems has long been regarded by scientists as a marker of a higher level of intelligence. Chimpanzees, for example, craft spears to hunt smaller mammals (*SN: 3/3/07, p. 131*). Dolphins carry marine sponges on their beaks to stir sand and uncover prey (*SN: 6/11/05, p. 371*). And elephants have been known to drop logs or large rocks onto electric fences to cut off the power supply.

> "We have a great deal of observational information that tends to suggest polar bears are really smart."
> IAN STIRLING

Studies on the cognitive abilities of polar bears are lacking. "However, we have a great deal of observational information that tends to suggest polar bears are really smart," Stirling says.

Members of the bear family, Ursidae, are typically assumed to have strong cognitive skills as a result of their large brains and evidenced by their sophisticated hunting strategies. Studies on captive American black bears (*Ursus americanus*) have even revealed some mental capabilities that appear to exceed those of nonhuman primates.

Gabriel Nirlungayuk, an Inuit hunter of Rankin Inlet in Nunavut, Canada, says he has heard such stories of polar bears using tools to hunt walruses. "I've seen polar bears since I was probably 7 years old. I've been around them, I've hunted alongside them, and I have seen their behaviors. The smartest hunters are usually the female bears." Sometimes, Nirlungayuk says, polar bears will lure young seals closer to them by pretending to be asleep in open water. Other times, he's observed a polar bear sniff out a seal's breathing hole in sea ice, even when the hole was obscured by snow.



This sculpture in the Itsanitaq Museum in Churchill, Canada, depicts a polar bear lifting a block of ice above the head of a sleeping walrus.

G. DICKIE

"I have worked with the Inuit on traditional knowledge for a very long time and one of my favorite subjects is polar bears, because science often suggests one thing and the Inuit say another thing," Nirlungayuk says.

There are about 26,000 wild polar bears living in 19 subpopulations across the Arctic and sub-Arctic. The bears primarily eat seals, hunting the marine mammals by staking out above their breathing holes. Because of climate change, Arctic sea ice is fast disappearing, and scientists predict that many polar bear populations will be extinct by the century's end. Desperate polar bears may increasingly attack walruses, but "there are limitations to how many walruses an adult bear can take down," says study coauthor Kristin Laidre, an Arctic ecologist at the University of Washington in Seattle. It takes a lot of energy.

After the study was published, Anthony Pagano, a U.S. Geological Survey scientist who is based in Anchorage, Alaska, sent Stirling a video. Pagano had previously attached a GoPro camera to a wild polar bear for a separate project. That footage, Stirling says, shows a female polar bear sliding a large block of ice around before throwing it into the water at a seal. ■

ATOM & COSMOS

A super-short cosmic burst defies astronomers' expectations

A surprisingly short gamma-ray burst has astronomers rethinking what triggers such especially brief celestial cataclysms.

The Fermi Gamma-ray Space Telescope detected a one-second-long blast of gamma rays, dubbed GRB 200826A, in August 2020. Such fleeting gamma-ray bursts, or GRBs, are usually thought to originate from neutron star smashups (*SN: 11/11/17, p. 6*). But a closer look at the burst revealed that it came from the collapse of a massive star's core before the star exploded. That process is typically thought to produce GRBs that last longer than two seconds.

Discovering such a brief gamma-ray burst from a stellar explosion suggests that some bursts previously classified as originating from stellar mergers may actually be from the deaths of massive stars, researchers report July 26 in two studies in *Nature Astronomy*.

Clues about the GRB's origin came from the burst itself. The wavelengths of light and amount of energy released in the burst were more similar to collapse-related GRBs than collision-produced bursts, astrophysicist Bing Zhang of the University of Nevada, Las Vegas and colleagues say. And the burst hailed from the middle of a star-forming galaxy, where astronomers expect to find dying massive stars but not neutron star mergers.

Another group, led by astronomer Tomás Ahumada-Mena of the University of Maryland in College Park, used the Gemini North Telescope in Hawaii to find the stellar explosion that followed the GRB. The burst may have been so brief because jets that radiate gamma rays from a star's collapsing core had barely breached the surface before the star blew up. *— Maria Temming*

GENES & CELLS

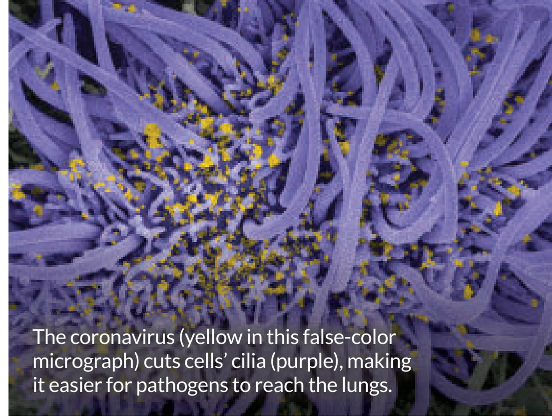
How COVID-19 sabotages cells

A coronavirus infection can mow down forests of hairlike cilia that coat a person's airway, destroying a crucial barrier to keeping the virus from lodging deep in the lungs.

Cilia normally move in waves to push mucus out of the airway and into the throat. To protect the lungs, objects that don't belong — including viral invaders like the coronavirus (*SN: 10/10/20 & 10/24/20, p. 7*) — get stuck in mucus, which is then swallowed.

But the coronavirus appears to throw that system out of whack by clearing tracts of cilia. Cells without the hairlike structures stop moving mucus, which could help the virus invade the lungs and cause severe COVID-19, researchers report July 16 in *Nature Communications*.

Scientists at the Pasteur Institute in Paris infected lab-grown human cells that mimic the lining of the respiratory tract with the coronavirus. Infected cells' cilia were stubby compared with cilia on healthy cells. When the team added microscopic beads to the surface of infected cells to measure mucus movement, those beads largely stayed still — a sign that the cells wouldn't move mucus through the respiratory tract. *— Erin Garcia de Jesús*


The coronavirus (yellow in this false-color micrograph) cuts cells' cilia (purple), making it easier for pathogens to reach the lungs.

VINCENT MICHEL, RÉMY ROBINOT, MATHIEU HUBERT, OLIVIER SCHWARTZ AND LISA CHAKRABARTI/INSTITUT PASTEUR

ATOM & COSMOS

Magnetized black holes go bald

Like a shaggy dog in springtime, some black holes have to shed. New computer simulations reveal how black holes might discard their magnetic fields.

Unlike dogs with their varied fur coats, isolated black holes are mostly identical. They are characterized only by their mass, spin and electric charge. According to a rule known as the no-hair theorem, any other features, or "hair," are quickly cast off. That includes magnetic fields.

The rule applies to black holes in a vacuum, where magnetic fields can simply slip away. But a magnetized black hole would typically be surrounded by electrically charged matter called plasma, and scientists didn't know whether such black holes would lose their hair.

In simulating the plasma surrounding a magnetized black hole, astrophysicist Ashley Bransgrove of Columbia University and colleagues found that a process called magnetic reconnection allows the black hole's magnetic field to escape. The magnetic field lines that map out the field's direction break apart and reconnect. Loops of magnetic field form around blobs of plasma, some of which blast outward while others fall into the black hole. That process eliminates the black hole's magnetic field, the team reports in the July 30 *Physical Review Letters*.

The phenomenon could spew X-rays that astronomers could detect. So scientists may one day glimpse a black hole losing its hair. *— Emily Conover*

LIFE & EVOLUTION

Yak scat helps pikas survive winter

Instead of hibernating or subsisting on stores of grass in burrows during winter on the Qinghai-Tibetan Plateau, pikas (*Ochotona curzoniae*) continue foraging but reduce their metabolism to conserve energy, researchers report in the July 27 *Proceedings of the National Academy of Sciences*. Some pikas even resort to unusual rations: yak poop.

Cameras at four sites confirmed that pikas regularly brave the cold to forage. And data on pikas' energy expenditure and body temperature revealed that in winter months, the animals slowed their metabolism by an average of 29.7 percent, in part by cooling their bodies a couple degrees overnight.

At sites with yaks, pikas were more abundant but foraged less. That puzzled the researchers "until we found a sort of half-eaten yak turd in one of the burrows," says ecophysiologist John Speakman of the University of Aberdeen in Scotland. Yak poop could be a plentiful food source, reducing pikas' time spent on the surface, he says. DNA evidence from stomach contents confirmed that pikas commonly dine on dung. Whether such meals have downsides remains to be seen, but clearly, not being too picky pays off for pikas. *— Jonathan Lambert*

Pluto's Place

The definition of planet is still a sore point

By Lisa Grossman

For 76 years, Pluto was the beloved ninth planet. No one cared that it was the runt of the solar system, with a moon, Charon, half its size. No one minded that it had a tilted, eccentric orbit. Pluto was a weirdo, but it was our weirdo.

"Children identify with its smallness," wrote science writer Dava Sobel in her 2005 book *The Planets*. "Adults relate to its inadequacy, its marginal existence as a misfit."

When Pluto was excluded from the planetary display in 2000 at the American Museum of Natural History in New York City, children sent hate mail to Neil deGrasse Tyson, director of the museum's planetarium. Likewise, there was a popular uproar when 15 years ago, in August 2006, the International Astronomical Union, or IAU, wrote a new definition of "planet" that left Pluto out. The new definition required that a body 1) orbit the sun, 2) have enough mass to be spherical (or close) and 3) have cleared the neighborhood around its orbit of other bodies. Objects that meet the first two criteria but not the third, like Pluto, were designated "dwarf planets."

Science is not sentimental. It doesn't care what you're fond of, or what mnemonic you learned in elementary school. Science appeared to have won the day. Scientists learned more about the solar system and revised their views accordingly.

"I believe that the decision taken was the correct one," says astronomer Catherine Cesarsky of CEA Saclay in France, who was president of the IAU in 2006. "Pluto is very different from the eight solar system planets, and it would have been very difficult to keep changing the number of solar system planets as more massive [objects beyond Neptune] were being discovered. The intention was not at all to demote Pluto, but on the contrary to promote it as [a] prototype of a new class of solar system objects, of great importance and interest."

For a long time, I shared this view. I've been writing about Pluto since my very first newspaper

Some scientists maintain that fascinating geology should re-earn Pluto planetary status, 15 years after it was reclassified as a dwarf planet.

JHU-APL, NASA, SWRI

gig at the *Cornell Daily Sun*, when I was a junior in college in 2006. I interviewed some of my professors about the IAU's decision. One, planetary scientist Jean-Luc Margot, who is now at UCLA, called it "a triumph of science over emotion. Science is all about recognizing that earlier ideas may have been wrong," he said at the time. "Pluto is finally where it belongs."

But another, planetary scientist Jim Bell, now at Arizona State University in Tempe, thought the decision was a travesty. He still does. The idea that planets have to clear their orbits is particularly irksome, he says. The ability to collect or cast out all that debris doesn't just depend on the body itself.

Everything with interesting geology should be a planet, Bell told me recently. "I'm a lumper, not a splitter," he says. "It doesn't matter where you are, it matters what you are."

Not everyone agrees with him. "Fifteen years ago we finally got it right," says planetary scientist Mike Brown of Caltech, who uses the Twitter handle @plutokiller because his research helped knock Pluto out of the planetary pantheon. "Pluto had been wrong all along."

But since 2006, we've learned that Pluto has an atmosphere and maybe even clouds. It has mountains made of water ice, fields of frozen nitrogen, methane snow–capped peaks, and dunes and volcanoes. "It's a dynamic, complex world unlike any other orbiting the sun," journalist Christopher Crockett wrote in *Science News* in 2015 when NASA's New Horizons spacecraft flew by Pluto.

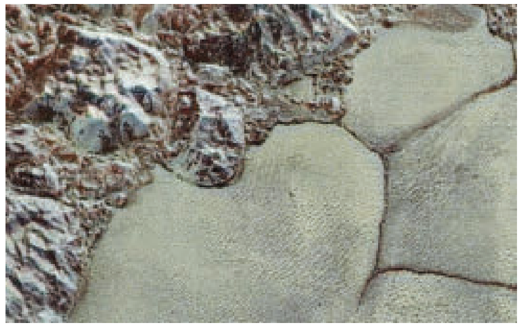
The New Horizons mission showed that Pluto has fascinating and active geology to rival that of any rocky world in the inner solar system. And that solidified planetary scientist Philip Metzger's view that the IAU definition missed the mark.

"There was an immediate reaction against the dumb definition" when it was proposed, says Metzger, of the University of Central Florida in Orlando. Since then, he and colleagues have been refining their views: "Why do we have this intuition that says that it's dumb?"

Retelling the tale

It turns out that the "we just learned more" narrative isn't really true, Metzger says. Though the official story is that Pluto was reclassified because new data came in, it's not that simple. Teaching that narrative is bad for science, and for science education, he says.

The truth is, there's no single definition of a planet — and I'm beginning to believe that's a good thing.



Observations from NASA's New Horizons mission showed that the surface of Pluto's Sputnik Planitia region is covered in churning nitrogen ice "cells" (white polygonal blocks, top) that constantly bring fresh material up to the surface from below. Closer views highlight the rugged water-ice mountains that border some of these cells (bottom).

For centuries, the word "planet" was a much more inclusive term. When Galileo turned his telescope at Jupiter, any largish moving body in the sky was considered a planet — including moons. When astronomers discovered the rocky bodies we now call asteroids in the 1800s, those too were called planets, at least at first.

Pluto was considered a planet from the very beginning. When Clyde Tombaugh, an amateur astronomer from Kansas newly recruited to the Lowell Observatory in Flagstaff, Ariz., spotted it in photos taken in January 1930, he rushed to the observatory director and declared: "I have found your Planet X."

The discovery was no accident. In 1903, U.S. astronomer Percival Lowell hypothesized that a hidden planet seven times the mass of Earth orbited 45 times farther from the sun. Lowell had searched for what he called Planet X until he died in 1916. The search continued without him.

The new planet was thought to be "black as coal, nearly as dense as iron, twice as dense as the heaviest earthly surface rocks," *Science News Letter*, the predecessor of *Science News*, reported in 1930.

Further research showed Lowell had grossly overestimated Pluto's mass: It's more like one five-hundredth the mass of Earth. Things got even weirder when scientists realized Pluto wasn't alone out there. In 1992, an object about a tenth the diameter of Pluto was found orbiting the sun "in the deep freeze of space well beyond the orbits of Pluto and Neptune," as *Science News* described it.

"I have found your Planet X."

CLYDE TOMBAUGH

Clyde Tombaugh, shown here with a homemade telescope, discovered Pluto in 1930 when he was 24 years old.

PLUTO: JHU-APL, NASA, SWRI; TOMBAUGH: GL ARCHIVE/ALAMY STOCK PHOTO

Since then, more than 2,000 icy bodies have been found hiding in that frigid zone dubbed the Kuiper Belt, and there are many more out there. Awareness of Pluto's neighbors brought new questions: What characteristics could unite these strange new worlds with the more familiar ones? And what sets them apart? With so many new objects coming into focus, there was a growing desire for a formal definition of "planet."

In 2005, Brown spotted the first of the Kuiper Belt bodies that seemed to be larger than Pluto. If Pluto was the ninth planet, then surely the new discovery, nicknamed Xena (in honor of the TV show *Xena: Warrior Princess*), should be the 10th. But if Xena was an icy leftover from the formation of the solar system undeserving of the "planet" title, so too was Pluto.

Tensions over how to categorize Pluto and Xena came to a head in 2006 at a meeting in Prague of the IAU. On the final day, August 24, after much acrimonious debate, a new definition of "planet" was put to a vote. Pluto and Xena got the boot. Xena was aptly renamed Eris, the Greek goddess of discord.

Textbooks were revised, posters were reprinted, but many planetary scientists, especially those who study Pluto, never bothered to change. "Planetary scientists don't use the IAU's definition in publishing papers," Metzger says. "We pretty much just ignore it."

In part that might be cheek, or spite. But Metzger and colleagues think there's good reason to reject the definition. Metzger, Bell and others — including Alan Stern of the Southwest Research Institute, the planetary scientist who led the New Horizons mission and has argued since before the discovery of the Kuiper Belt that the solar system contains hundreds of "planets" — make their case in a pair of recent papers, one published in 2019 in *Icarus* and one forthcoming.

After examining hundreds of scientific papers, textbooks and letters dating back centuries, the researchers show that the way scientists and the public have used the word "planet" has changed over time, but not in the way most people think.

On August 24, 2006, in Prague, members of the International Astronomical Union voted for a new definition of planet that redesignated Pluto and its neighbor Eris as dwarf planets, shrinking the total number of planets in the solar system to eight.

MICHAL CIZEK/AFP/GETTY IMAGES

In and out

Consider Ceres, the first of what are now known as dwarf planets to be discovered. Located in the asteroid belt between Mars and Jupiter, Ceres was considered a planet after its 1801 discovery, too. It's often said that Ceres was demoted after astronomers found the rest of the bodies in the asteroid belt. By the end of the 1800s, with hundreds of asteroids piling up, Ceres was stripped of its planetary title thanks to its neighbors. In that sense, the story goes, Ceres and Pluto suffered the same fate.

But that's not the real story, Metzger and colleagues found. Ceres and other asteroids were considered planets, sometimes dubbed "minor planets," well into the 20th century. A 1951 article in *Science News Letter* declared that "thousands of planets are known to circle our sun," although most are "small fry." These "baby planets" can be as small as a city block or as wide as Pennsylvania.

It wasn't until the 1960s, when spacecraft offered better observations of these bodies, that the term "minor planets" fell out of fashion. While the largest asteroids still looked planetlike, most small asteroids turned out to be lumpy and irregular in shape, suggesting a different origin or different geophysics than bigger, rounder planets. The fact that asteroids didn't "clear their orbits" had nothing to do with the name change, Metzger argues.

And what about moons? Scientists called them "planets" or "secondary planets" until the 1920s. Surprisingly, it was nonscientific publications, notably astrological almanacs that used the positions of celestial bodies for horoscope readings, that insisted on the simplicity of a limited number of planets moving through the fixed sphere of stars.

Metzger thinks that older definition of a planet that included moons was forgotten when planetary science went through a "Great Depression" between about 1910 and 1950. So many asteroids had been discovered that searching for new ones or refining their orbits was getting boring. Telescopes weren't good enough to start exploring asteroids' geology yet. Other parts of space science were way more exciting, so attention went there.

But new data that came with space travel brought moons back into the planetary fold. Starting in the 1960s, "planet" reappeared in the scientific literature as a description for satellites, at least the large, round ones.

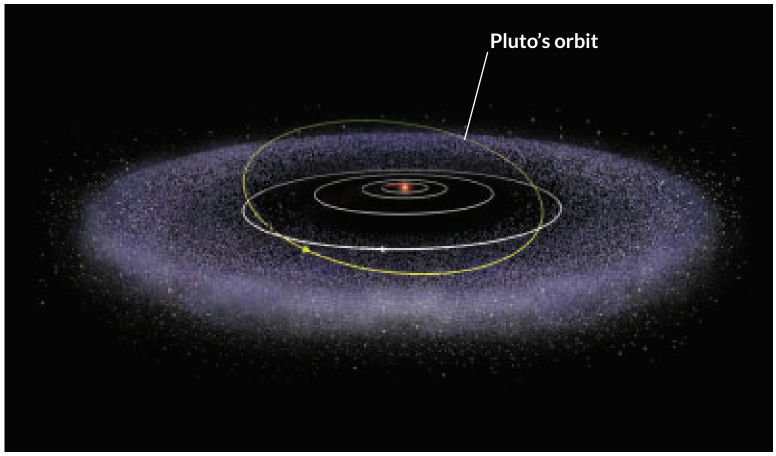
Real-world usage

The planet definition that includes certain moons, asteroids and Kuiper Belt objects has had staying power because it's useful, Metzger says. Planetary scientists' work includes comparing a place like Mars (a planet) to Titan (a moon) to Triton (a moon that was probably born in the Kuiper Belt and captured by Neptune long ago) to Pluto (a dwarf planet). It's scientifically useful to have a word to describe the cosmic bodies where interesting geophysics, including the conditions that enable life, occur, he says. There's all sorts of extra complexity, from mountains to atmospheres to oceans and rivers, when rocky worlds grow big enough for their own gravity to make them spherical.

"We're not claiming that we have the perfect definition of a planet and that all scientists ought to adopt our definition," he adds. That's the same mistake the IAU made. "We're saying this is something that ought to be debated."

A more inclusive definition of "planet" would also give a more accurate concept of what the solar system is. Emphasizing the eight major planets suggests that they dominate the solar system, when in fact the smaller stuff outnumbers those worlds tremendously. The major planets don't even stay put in their orbits over long timescales. The gas giants have shuffled around in the past. Teaching the view of the solar system that includes just eight static planets doesn't do that dynamism justice.

Caltech's Brown disagrees. Having the gravitational oomph to nudge other bodies in and out of line is an important feature of a world, he says. Plus, the eight planets clearly dominate our solar system, he says. "If you dropped me in the solar system for the first time, and I looked around and saw what was there, nobody would say anything other than, 'Wow, there are these eight — choose your word — and a lot of other little things.' "



Crowded space
Pluto and hundreds or thousands of other objects that rival Pluto in size and interest orbit in the icy back of the solar system's fridge, called the Kuiper Belt (white fuzzy ring).

NASA

Thinking of planets that way leads to big-picture questions about how the solar system put itself together.

One common argument in favor of the IAU's definition is that it keeps the number of planets manageable. Can you imagine if there were hundreds or thousands of planets? How would the average person keep track of them all? What would we print on lunch boxes? I'm not making fun of this idea; as an astronomy writer who has been obsessed with space since I was 8, I would be reluctant to turn people off to the planets.

But Metzger thinks teaching just eight planets risks turning people off to all the rest of space. "Back in the early 2000s, there was a lot of excitement when astronomers were discovering new planets in our solar system," he says. "All that excitement ended in 2006." But those objects are still out there and are still worthy of interest. By now, there are at least 150 of these dwarf planets, and most people have no clue, he says.

This is the argument I find most compelling. Why do we need to limit the number of planets? Kids can memorize the names and characteristics of hundreds of dinosaurs, or Pokémon, for that matter. Why not encourage that for planets? Why not inspire students to rediscover and explore the space objects that most appeal to them?

I've come to think that what makes a planet may just be in the eye of the beholders. I may be a lumper, not a splitter, too. ■

Explore more

- Philip T. Metzger *et al*. "The reclassification of asteroids from planets to non-planets." *Icarus*. February 2019.
- Philip T. Metzger *et al*. "Moons are planets: Scientific reductionism vs. cultural teleology in the taxonomy of planetary science." In prep.

The Debate Over Gender-Affirming Health Care

Researchers explore the benefits and risks for transgender youth

By Maria Temming

Daniel's birth certificate is marked "female," but Daniel is nonbinary — not exclusively male nor female. "I'm masculine leaning," says the 18-year-old.

The disconnect between Daniel's gender identity and physical appearance, which was apparent to them around age 4, became unbearable during puberty. "I hated showers because I didn't like looking at my body," Daniel says. "I just felt really uncomfortable with the idea of being female." At 13, Daniel came out to their mother as transgender, someone whose gender identity does not match the sex they were assigned at birth.

About a month after coming out, Daniel started seeing a therapist who specialized in gender identity. A year later they were referred to an endocrinologist, who prescribed the sex hormone testosterone. For Daniel, the most important effect was a deeper voice. "My biggest problem with getting misgendered was that my voice was really high," Daniel says.

Before starting hormone therapy, Daniel considered suicide. With masculinizing hormones, they say they're happier with life. "I definitely feel more like myself. Like I was just existing before, but now I'm living, now that I'm open to everyone about who I am, and most importantly I'm open to myself," says Daniel, whose last name is being withheld for medical privacy. "Starting testosterone, for me, saved my life."

Daniel's hormone therapy is just one method that doctors use to bring a person's body into alignment with their gender identity, an approach known as gender-affirming health care. This kind of care looks different for people of different ages. For young children, it is limited to allowing them to socially express their gender, with perhaps a name and pronoun change. Adolescents may take medications to delay puberty, followed by gender-affirming hormones and possibly surgery. While researchers are still investigating potential risks, existing evidence suggests that these treatments could have life-saving mental health benefits.

Over the last 20 years or so, gender-affirming treatment has become the standard of care for transgender people in the United States. That

Proposed restrictions on gender-affirming health care are part of a recent wave of legislation that some LGBTQ advocates say unjustly discriminates against transgender people.

DREW ANGERER/GETTY IMAGES

change has followed increasing recognition in the medical community that being transgender is a normal example of human diversity and not a mental disorder. About 1.8 percent of American high schoolers are transgender, according to the U.S. Centers for Disease Control and Prevention.

Despite findings from the United States and Europe that show the positive mental health effects of gender-affirming care, a recent groundswell of state legislation has sought to curb access to gender-affirming health care for those who want it. In April, Arkansas became the first state to ban gender-affirming treatments for minors. Similar bills have been proposed in more than a dozen other states. Although several of those proposals failed — and a federal judge blocked the Arkansas law in July — they may still exact a mental health toll on many transgender youth, experts say.

"Even if the bills don't pass, even if they die in committee, the damage is being done," says Jason Klein, a pediatric endocrinologist at NYU Langone Health in New York City. "Many people across this country are already going to be hurt just by the ideas being put out by these bills."

Proponents of health care restrictions for transgender youth say they want to protect children from life-altering procedures they may later regret, as well as medical risks, which may include impacts on fertility and bone health. But the American Academy of Pediatrics and the Endocrine Society have endorsed gender-affirming care, arguing that the restrictions would endanger a population already at severe risk of depression and self-harm.

Transgender youth are three to four times as likely as their peers to have depression or anxiety (*SN Online: 3/1/17*). Among 13,600 transgender and nonbinary youth who participated in a national survey in 2020, 52 percent had considered suicide in the previous year, and 21 percent had attempted it.

Gender-affirming health care could improve those alarming statistics across age groups, says Jack Turban, a child and adolescent psychiatry researcher at Stanford University School of Medicine. "All existing research suggests that gender-affirming medical interventions improve the mental health of transgender youth."

Transitioning in childhood

For children who haven't yet started puberty, gender-affirming health care involves no medical treatments. It entails parents and doctors supporting a child through a social transition. This may mean calling the child by a new name, using the pronouns that fit their gender identity and allowing the child to dress or wear their hair however feels most authentic to them.

Mental health care professionals can help families through this process. "Sometimes, the kids need more conversation and time to think about their gender identity and their goals for themselves," Klein says. "Sometimes, the parents need that — the kids are very solid and steady and know exactly who they are, and the parents might need some time to kind of adjust."

Being supported through a social transition appears to boost young people's mental health. Levels of depression and self-worth reported by more than 100 socially transitioned transgender children from across the United States and Canada were about the same as for their non-transgender, or cisgender, siblings and peers, researchers reported in 2017 in the *Journal of the American Academy of Child & Adolescent Psychiatry*. Transgender kids who have not socially transitioned, on the other hand, have historically shown high levels of depression.

Opponents of gender-affirming health care have cited studies suggesting that as many as 80 percent of people who identify as transgender in early childhood will not continue to do so when they grow up. But others have pointed out that those studies included many children who may have been considered transgender based on outdated and overly broad criteria, thus skewing the results. Researchers are still investigating how gender identity evolves with age.

"We have to be honest. We don't know so much about it," says Annelou de Vries, a child and adolescent psychiatrist at the Amsterdam University Medical Centers. Thus, nonpermanent gender-affirming treatment options may allow

52
percent
Proportion of transgender and nonbinary youth surveyed in 2020 who had considered suicide in the previous year

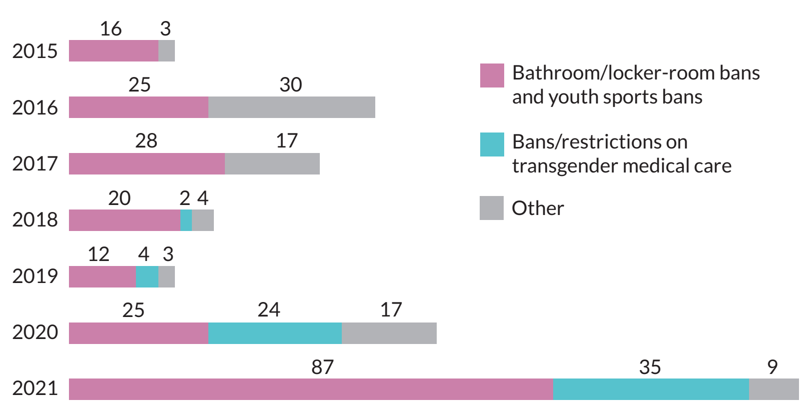
21
percent
Proportion who had attempted suicide

Limiting laws

A recent surge in U.S. state legislation seeks to bar transgender people from using bathrooms or competing on sports teams that match their gender identities. Other bills restrict access to gender-affirming health care for minors.

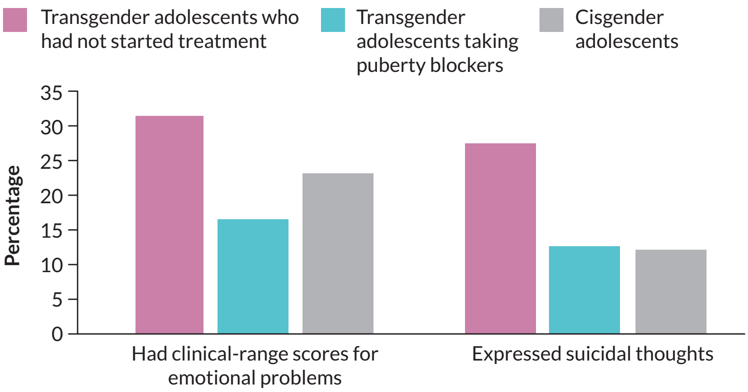
SOURCE: HUMAN RIGHTS CAMPAIGN, AS OF JULY 27, 2021

Number of anti-transgender bills introduced in state legislatures, 2015–2021



C. CHANG

Differences in mental health among Dutch adolescents



Closer to OK
Emotional problems, such as depression or anxiety, that would qualify for mental health care were much more common among transgender teens who had not been treated with puberty blockers than among those who had received those medications, in a study of Dutch youth. Similarly, a higher percentage of transgender teens who had not received puberty blockers expressed suicidal thoughts than trans peers who had received the medications and than cisgender, or nontransgender, teens.
SOURCE: A.I.R. VAN DER MIESEN *ET AL/J. ADOLESCENT HEALTH* 2020

children time to safely explore their identity as they approach adolescence, proponents say.

Pausing puberty

At the start of puberty, children who are transgender or questioning their gender identity may begin taking medications that suppress the natural release of estrogen and testosterone, sex hormones that cause the body to change. Such puberty blockers can be taken through an injection once a month or every few months, or through a small implant inserted in the upper arm and replaced annually.

"These medications are fully reversible," says Russell Toomey, a family studies and human development researcher at the University of Arizona in Tucson. When someone stops taking them, the body picks up where it left off and proceeds through puberty.

Delaying puberty allows transgender children to go through their early teenage years without experiencing potentially distressing body changes not aligned with their gender identity, Toomey says. For adolescents who later receive hormones, puberty blockers can limit the development of physical features such as breasts that would require surgery to change later.

Puberty blockers are among the gender-affirming treatments forbidden by the latest bills. But these medications are not new and are not just for transgender youth. They have been used for decades to treat children who start showing signs of puberty before age 8 or 9, a condition known as precocious puberty. For transgender youth, these time-tested medications can be a lifeline. Transgender adolescents who had access to puberty blockers were 70 percent less likely to consider suicide than those who could not get the medications, according to a 2020 study in *Pediatrics*. Of the more than 20,000 U.S. transgender adults surveyed, nearly 17 percent had wanted puberty blockers while growing up, but just 2.5 percent of them received the medications.

Youth who visited a gender identity clinic but hadn't started treatment had more emotional problems such as anxiety and depression, and suicidal tendencies than their cisgender peers, a study of 1,100 youth in the Netherlands found. In contrast, children receiving puberty blockers at that clinic showed similar or better psychological functioning than cisgender kids, the researchers reported in 2020 in the *Journal of Adolescent Health*.

Daniel wishes they'd had the opportunity to take the medications. "I really do believe if I'd been on [puberty] blockers, things would have been a lot easier for me," Daniel says. "I would have still struggled, but it would have been easier to handle."

One possible side effect of puberty blockers is delayed bone development. The medications interrupt the rapid buildup in bone density that generally occurs during puberty, potentially leading to weaker bones in adulthood. But long-term data from people treated for precocious puberty suggest that bone development catches up once people stop taking puberty blockers.

Likewise, early data on transgender youth indicate that hormone therapy helps bone growth catch up once teens stop taking puberty blockers, de Vries says. Long-term data don't yet exist to comprehensively assess the impacts in transgender adults.

To be safe, Johanna Olson-Kennedy, who practices pediatrics and adolescent medicine at Children's Hospital Los Angeles, gives special instructions to her patients starting puberty blockers. "We have them take vitamin D and calcium supplementation, and we stress the importance of weight-bearing exercise, which is critical for shoring up bone density."

Reversible and not

Older transgender adolescents can start taking gender-affirming hormones, as Daniel did. A new law in Tennessee bans such hormones for prepubescent children. Yet current medical guidelines do not recommend hormone therapy earlier than about age 14 to 16.

Masculinizing hormone therapy involves taking testosterone to promote changes like voice deepening and facial hair growth, while suppressing menstruation and breast development. Daniel takes testosterone through injections, but the hormone can also be absorbed via skin ointment or a patch.

Feminizing hormone therapy involves taking estrogen through a pill, patch or injection, often with a separate drug to block the body's natural

C. CHANG

testosterone. This causes breast development, slows body hair growth and decreases muscle mass. Some effects of hormone therapy, such as facial hair growth, voice deepening and breast development, are permanent, whereas changes in muscle mass and fat distribution are reversible if treatment stops.

Twenty-one out of 47 transgender youth in a study at a Missouri children's hospital expressed suicidal tendencies before starting hormone therapy, while six did after treatment, researchers reported in 2019 in *Clinical Practice in Pediatric Psychology*. Another study at a Texas clinic found that 86 transgender teens on hormone therapy surveyed were happier with their bodies after about one year of treatment than they were before, researchers reported in 2020 in *Pediatrics*. On a body dissatisfaction scale from 0 (none) to 116 (highest dissatisfaction), teens' self-reported ratings fell 20 points on average, from about 71 before treatment to about 51 afterward.

While studies like these and many others on the mental health effects of gender-affirming health care are small, taken together they suggest the treatments have a positive impact, even as research efforts continue, says Lauren Beach, a sexual and gender minority health researcher at Northwestern University Feinberg School of Medicine in Chicago. "When we consider the incredibly heightened risk that trans youth face for suicide in general, those studies are incredibly compelling."

Hormone therapy is generally considered safe, but it's not risk-free. Testosterone and estrogen can both affect fertility, but the effects vary from person to person. People who want to preserve their fertility can freeze eggs or bank sperm before starting gender-affirming hormones — although adolescents who have taken puberty blockers may be less likely than those who have gone through uninterrupted puberty to produce viable eggs or sperm.

"In my experience, most people do not pursue fertility preservation techniques — whether that's because of their own wants or needs, or because of financial constraints, insurance constraints [or] time constraints," Klein says. Recent research echoes that observation. At one clinic, of 72 transgender adolescents counseled on fertility preservation options, just two used them, researchers reported in 2017 in the *Journal of Adolescent Health*.

Transgender individuals taking hormones may have a higher-than-before risk of common gender-associated diseases. For example, trans

BARCROFT MEDIA/GETTY IMAGES

Gender-affirming care helps transgender youth express their gender identities. Though labeled a boy at birth, Kyla Lechelt of Idaho, age 8 in this 2009 photo, says she's known she is a girl since age 2.

women who take estrogen may be at higher risk of breast cancer than cisgender men, but not higher risk than other women, says Joshua Safer, who directs the Mount Sinai Center for Transgender Medicine and Surgery in New York City. Trans women who take estrogen also have a slight risk of developing blood clots, but not higher than cisgender women's risk of developing blood clots from taking estrogen-containing birth control. Transgender men taking testosterone may, like other men, have a higher risk of high cholesterol, Safer says, but existing data cannot say for sure.

Beyond hormone therapy, gender-affirming treatment can involve surgery for some transgender people. Current medical guidelines do not recommend genital surgery for minors, but some adolescents may have masculinizing chest surgery if they experience severe distress or discomfort from unwanted breast development. "This is a major decision that requires careful coordination between a family and their physicians," Turban says.

Like other aspects of gender-affirming health care, surgery has been shown to improve mental health and quality of life for many. All but one of 58 individuals who had masculinizing chest surgery reported the procedure had an overall positive impact on their lives in a survey published in *Plastic and Reconstructive Surgery* in 2019.

Risk of regret

Medical guidelines recommend that every stage of gender affirmation, from social transition to surgery, involves extensive conversations among children and their parents, physicians and mental health care providers — and informed consent from both adolescents and their parents for any

Body changes

Transgender teens about 14 to 16 years old may start taking the masculinizing hormone testosterone or the feminizing hormone estrogen to promote body changes that align with their gender identity.

Effects of hormone therapies

Testosterone
Suppressed menstruation
Body fat redistribution
Voice deepening
Increased muscle mass
Facial and body hair growth
Estrogen
Decreased muscle mass
Body fat redistribution
Skin softening
Breast growth
Decreased body hair growth

Right timing For young children, gender-affirming health care is limited to providing support through a change in name and pronouns and clothing style, but no medication. Older adolescents may receive medical treatments, including puberty blockers, hormone therapy or surgery, if appropriate.

When health care support is considered

Age (years)	Options
<8	Social transition
8–14	Puberty blockers
>14	Hormone therapy
18 (with exceptions)	Surgery

medical procedures. "It's not that you decide on your 12th birthday where you are when you're 21," de Vries says.

Some lawmakers who have pushed bills to ban puberty blockers and hormone therapy for minors have argued that children who receive gender-affirming treatment may regret it when they grow up. Regret is a risk. But current research says that regret following gender-affirming medical and surgical care is rare, Turban says.

One team tracked the development of 55 transgender adults in the Netherlands who received puberty blockers and gender-affirming hormones in adolescence, followed by transition-related surgery in early adulthood. After surgery, participants had similar quality of life and happiness as their cisgender peers. All were satisfied with their appearance and none regretted treatment, according to a 2014 report in *Pediatrics*. A recent review of more than two dozen studies that include nearly 8,000 transgender patients who had gender-affirming surgeries similarly showed that only about 1 percent regretted treatment, researchers reported in March in *Plastic and Reconstructive Surgery-Global Open*.

A small percentage of people do choose to discontinue therapy. Among more than 800 adolescents who visited a gender identity clinic in the Netherlands over a 40-year period from 1972 to 2015, 1.9 percent of those who started taking puberty blockers did not proceed with hormone therapy, researchers reported in 2018 in the *Journal of Sexual Medicine*. And some adults who undergo gender-affirming treatments later decide to return to living as the gender assigned to them at birth, a process called detransitioning.

In a survey of nearly 28,000 transgender adults in the United States, about 2,200 had detransitioned. About 36 percent cited pressure from parents as a reason. Close to 33 percent reported pressure from community and 27 percent said they had trouble getting a job. Just under 11 percent said that fluctuations in their gender factored into their detransition, Turban and colleagues report in the June *LGBT Health*.

Legal ramifications

Legislation aiming to restrict gender-affirming health care may have more widespread consequences than preventing minors in some states from receiving treatment. Bills that portray gender-affirming health care as experimental or dangerous may make people who are questioning their gender reluctant to ask for help, Klein says. The bills may also make parents reluctant to seek help for their children even in places where treatment has not been made illegal.

These health care bills are just one aspect of a wave of legislation that some LGBTQ advocates say discriminates against the transgender community. A new law passed in Tennessee, but temporarily halted by a federal judge, requires businesses and government facilities to post signs if they allow transgender people to use bathrooms that match their gender identity. And several states, including Florida, Mississippi and Tennessee, now forbid transgender kids from playing on sports teams that match their gender identity. In late July, a federal judge prevented West Virginia from enforcing its sports ban.

61 percent

Fraction of transgender and nonbinary youth who reported being prevented or discouraged from using a bathroom corresponding with their gender identity

"We know that a major driver of mental health problems among transgender youth is rejection of their gender identity," Turban says. "Imagine that you heard powerful politicians pronouncing on the national stage that you're confused, invalid and dangerous to people in bathrooms and sports leagues. It's extraordinarily difficult for a child not to be negatively impacted by this rhetoric."

Research is just emerging on how recent anti-trans legislation may affect transgender youth and their families. Parents of transgender children expressed anxiety about the increased stigma their kids may face, and the potential health impacts of lack of access to gender-affirming care, according to a small online survey published on July 29 in *Psychology of Sexual Orientation and Gender Diversity*. "I am afraid for those kids who might find death preferable to being forced to go through the bodily changes of puberty for the wrong gender," says a Texas mother quoted in the study.

Daniel can relate. "It's frustrating. It angers me," they say. "But it's also so confusing, because what is the point of stopping people from being who they are, and doing things that could possibly save their life?" ■

Explore more

■ Caroline Salas-Humara *et al.* "Gender affirming medical care of transgender youth." *Current Problems in Pediatric and Adolescent Health Care.* September 2019.


UC San Diego
The Perfect Environment to Make a Big Impact
Set yourself up for success by embarking on a college adventure where you aren't just encouraged to study from a textbook, but to journey into the world and achieve exceptional things.
LEARN MORE AT ADMISSIONS.UCSD.EDU

On the Fringe
Michael D. Gordin
OXFORD UNIV., $18.95

BOOKSHELF

The real meaning of pseudoscience

There is no such thing as pseudoscience, and Michael Gordin has written a book about it.

In *On the Fringe*, Gordin, a historian at Princeton University, does not deny that there are endeavors afoot in the world that are labeled pseudoscience. Rather he shows that the term has no precise meaning, and that there is no unambiguous, universal test for delineating true science from the false versions on its fringe.

Many well-known examples of pseudoscience, he notes, were once mainstream scientific disciplines. Astrology, for instance, was for centuries respected or practiced by the most prominent scientific thinkers of their time.

Astrology's time is long past, of course. So Gordin refers to it, and alchemy, and eugenics, as vestigial sciences — once regarded as totally scientific, but cast aside into the pseudoscience realm by the advance of knowledge.

Other pseudosciences arise having never attained respectable scientific status. Some are ideologically driven "hyperpoliticized" sciences; some, like creationism, are "counterestablishment" ventures that feign scientific trappings; others are wishful thinking delusions like extrasensory perception.

Advocates for many such pseudosciences seek legitimacy by imitating the scientific process — holding conferences, publishing journals and claiming to cite evidence (though presented in ways riddled with logical fallacies).

The problem is, "real" science also sometimes suffers from errors of rigor and logic, as recent concerns about reproducing experimental results have demonstrated (*SN: 3/27/10, p. 26*). So drawing a sharp line between real and pseudo remains a difficult task.

Gordin provides neat, quick summaries of all these issues in his brief but thoughtful and enjoyable book. Most valuable of all is his first chapter, in which he demolishes the notion that philosopher Karl Popper's "falsifiability" criterion allows a clear demarcation between science and non- (or pseudo-) science. *Falsifiable*, Gordin points out, is undefinable. If nothing else, every working scientist (and science journalist) should read this chapter to learn that the refrain "if it's not falsifiable, it's not science" is philosophically unsound gibberish, a sign of a weak argument.

Still, some pseudoscience is clearly out of bounds. And some would say the scientific revolution of the 17th century established new rules that filtered bad science from the good. But it still took a while for modern science to do away with astrology and alchemy. Later, eugenics and even ESP were for a time taken seriously by some "modern" scientists. Sometimes it just takes time to identify bad science and discard it.

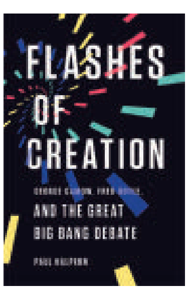
As Gordin writes, science is not a "fixed repository of information," but a dynamic enterprise focused to a large extent on "refuting or revising past knowledge." So in a sense the scientific revolution did not really render the science of the ancient Greeks or Middle Ages pseudoscience, but rather just revealed it to be primitive science, awaiting better methods, technologies and insights. As science historian Steven Shapin opened his 1996 book on that topic, "There was no such thing as the Scientific Revolution, and this is a book about it." — *Tom Siegfried*

BOOKSHELF

Two physicists star in the Big Bang's origin story

The Big Bang wasn't always a sure bet. For several decades in the 20th century, researchers wrestled with interpreting cosmic origins, or if there even was a beginning at all. At the forefront of that debate stood physicists George Gamow and Fred Hoyle: One advocated for an expanding universe that sprouted from a hot, dense state; the other for a cosmos that is eternal and unchanging. Both pioneered contemporary cosmology, laid the groundwork for our understanding of where atoms come from and brought science to the masses.

In *Flashes of Creation*, physicist Paul Halpern recounts Gamow's and Hoyle's interwoven stories. The book bills itself as a "joint biography," but that is a disservice. While Gamow and Hoyle are the central characters, the book is a meticulously researched history of the Big Bang as an idea: from theoretical predictions in the 1920s, to the discovery of its microwave afterglow in 1964, and beyond to the realization in the late 1990s that the expansion of the universe is accelerating.



Flashes of Creation
Paul Halpern
BASIC BOOKS, $30

Although the development of cosmology was the work of far more than just two scientists, Halpern would be hard-pressed to pick two better mascots. George Gamow was an aficionado of puns and pranks and had a keen sense of how to explain science with charm and whimsy. The fiercely stubborn Fred Hoyle had a darker, more cynical wit, with an artistic side that showed through in science fiction novels and even the libretto of an opera. Both wrote popular science books — Gamow's *Mr Tompkins* series, which explores modern physics through the titular character's dreams, are a milestone of the genre — and took to the airwaves to broadcast the latest scientific thinking into people's homes.

"Gamow and Hoyle were adventurous loners who cared far more about cosmic mysteries than social conventions," Halpern writes. “Each, in his own way, was a polymath, a rebel, and a master of science communication.”

While the Big Bang is now entrenched in the modern zeitgeist, it wasn’t always so. The idea can be traced to Georges Lemaître, a physicist and priest who proposed in 1927 that the universe is expanding. A few years later, he suggested that perhaps the cosmos began with all of its matter in a single point — the “primeval atom,” he called it. In the 1940s, Gamow latched on to the idea as way to explain how all the atomic elements came to be, forged in the “fireball” that would have filled the cosmos in its earliest moments. Hoyle balked at the notion of a moment of creation, convinced that the universe has always existed — and always will exist — in pretty much the same state we find it today. He even coined the term “Big Bang” as a put-down during a 1949 BBC radio broadcast. The elements, Hoyle argued, were forged in stars.

As far as the elements go, both were right. “One wrote the beginning of the story of element creation,” Halpern writes, “and the other wrote the ending.” We now know that hydrogen and helium nuclei emerged in overwhelming abundance during the first few minutes following the Big Bang. Stars took care of the rest.

Halpern treats Gamow and Hoyle with reverence and compassion. Recreated scenes provide insight into how both approached science and life. We learn how Gamow, ever the scientist, roped in physicist Niels Bohr to test ideas about why movie heroes always drew their gun faster than villains — a test that involved staging a mock attack with toy pistols. We sit in with Hoyle and colleagues while they discuss a horror film, *Dead of Night*, whose circular timeline inspired their ideas about an eternal universe.

And Halpern doesn’t shy away from darker moments, inviting readers to know these scientists as flawed human beings. Gamow’s devil-may-care attitude wore on his colleagues, and his excessive drinking took its toll. Hoyle, in his waning decades, embraced outlandish ideas, suggesting that epidemics come from space and that a dinosaur fossil had been tampered with to show an evolutionary link to birds. And he went to his grave in 2001 still railing against the Big Bang.

Capturing the history of the Big Bang theory is no easy task, but Halpern pulls it off. The biggest mark against the book, in fact, may be its scope. To pull in all the other characters and side plots that drove 20th century cosmology, Gamow and Hoyle sometimes get forgotten about for long stretches. A bit more editing could have sharpened the book’s focus.

But to anyone interested in how the idea of the Big Bang grew — or how any scientific paradigm changes — *Flashes of Creation* is a treat and a worthy tribute to two scientific mavericks.
— Christopher Crockett

CONVERSATIONS WITH MAYA

RODERIC PETTIGREW
CEO of Engineering Health & Executive Dean for Engineering Medicine at Texas A&M University

Maya Ajmera, President & CEO of the Society for Science and Publisher of *Science News*, chatted with Roderic Pettigrew, an alumnus of the 1967 International Science and Engineering Fair (ISEF). Pettigrew, who won the Vannevar Bush Award from the National Science Foundation and was the founding director of the National Institute of Biomedical Imaging and Bioengineering (NIBIB), currently serves as CEO of Engineering Health and Executive Dean for Engineering Medicine at Texas A&M University, in partnership with Houston Methodist Hospital. We are thrilled to share an edited summary of their conversation.

How did competing in ISEF in 1967 impact your life and are there moments that still stand out to you?

Going to ISEF was quite a memorable experience. Growing up in the segregated South in the '60s, this stands out as a significant event in my history. I appreciated it at the time, and I appreciate it even more in retrospect.

Even though I was born during the era of Jim Crow and racial segregation, I was fortunate in two ways. One, my immediate family was solid. My parents were people of impeccable character. They valued the dignity of others. They taught us to always consider the well-being of others. Second, as a young person, I was always interested in science. I often describe myself as having come out of the womb a scientist.

In 10th grade in Albany, Georgia, I had a highly impactful teacher, Robert Roquemore, who taught us that being a scientist means you are able to understand the laws of nature and the basic principles that govern how things work. Those principles can lead you to discovery.

At ISEF in San Francisco, Mr. Roquemore was so thrilled when my name was called as a fourth-place prize winner. I was just delighted to be participating. I recall that during the award ceremony, Mr. Roquemore was behind me and had to kick me under my seat when my name was called because my reaction was delayed. He was just ecstatic. He sent a telegram back to Monroe High School in Albany, and I won't forget it. His telegram said, "Pettigrew, takes fourth! Pettigrew takes fourth!" Given all of the obstacles we had to overcome, it was as if I had won a gold medal.

Your undergraduate education was in nuclear science and engineering. How did you find your way to the biological sciences?

I always had this basic interest in the welfare of man and a love of science. Those two come together in the biological sciences and medicine. When I was a graduate student at MIT, I had no medical school plans, but I did plan to work on problems that would improve people's lives.

While conducting my Ph.D. research, I spent a lot of time at Massachusetts General Hospital. Being in that environment was eye-opening. I began to think that not only did I want to work as a physical scientist, but I felt I could be more effective if I really understood those problems firsthand, which is what led me to medical school.

You were the founding director of NIBIB. What was your experience in building the institute from the ground up?

It was a marvelous experience to be named the founding director. I consider myself to be very privileged and a classic example of having the right blend of talents, experience and interest at the right time.

The experience was uniquely challenging because although Congress was responsive to the call to establish this new institute, the National Institutes of Health (NIH) itself, including NIH leadership, was not happy about the new institute and didn't see the need for it. From a practical standpoint, adding another institute meant that whatever funding the new institute received would not be available to the existing institutes. So for that reason, there was some resistance and hurdles that we had to overcome. In addition, there was a need to harmoniously blend the professional engineering and medical communities that had not operationally converged. The value of this, however, was inexorable.

What was your biggest medical accomplishment as part of the institute?

The institute became the home for what is now referred to as convergence research. It became the home for the integration of the physical sciences, life sciences and engineering. The power of convergence is indisputable and is in great evidence now. We even see it in this pandemic. It's through convergence that we arrived at these vaccines at unprecedented speed and the multiple widely available tests.

The technologies that emerged from NIBIB have been in development for some time, but they involve genetic engineering, they involve immune engineering, they involve bringing together the physical sciences and the life sciences. That's really what I'm proud of. Realizing this convergence and its impact—both now and in the future.

You have spoken about the Black Lives Matter movement. What are your thoughts about its impact?

My comments following the Central Park peaceful bird watcher incident and the George Floyd killing were about the need for everyone to recognize that humanity binds us all. In so doing, I sought to also illuminate the clear systemic nature of racism as a real social phenomenon with which we still wrestle. I have experienced this all of my life despite efforts to make meaningful contributions to society and interact with people as people.

Ultimately, it was a call to understand the commonality we share. It was also a call to appreciate the inherent value that experiential, racial and ethnic differences bring to the composite human community. It was a call to appreciate our common core as humans, to be humane and to embrace the flavor that comes from noncharacter-based differences, such as ethnicity, cultural variations, differential life experiences and perspectives.

It's been encouraging to see people from different walks of life come together and demand changes to eradicate systemic racism. Many sectors are starting to realize that humanity does indeed bind us, and the lost opportunity and self-injury our entire society will continue to endure if social injustice is not addressed.


Pettigrew is joined by his classmates at MIT. He received his Ph.D. in radiation physics at MIT in 1977.

Recruiting students of color into STEM fields has long been a challenge. As a dean, how are you expanding access?

Diverse teams are more effective at problem-solving. There is a national need to recruit more diverse students in order to properly respond to the growing challenges facing society. Having a diverse faculty base certainly helps when recruiting students, but expanding access to STEM starts long before they reach higher education, and this merits sustained attention as undergraduates.

Black students, like all students, need to be recognized and valued for their potential and the critical role they play in enhancing the effectiveness of the scientific enterprise through diversity. These students should be nurtured and mentored throughout the pipeline. Key elements include sufficient numbers to provide a supportive community, a culture that welcomes and provides a sense of belonging, mentors that offer guidance, sustained assistance and a plan for addressing financial impediments.

There are so many challenges in the world today. What keeps you up at night?

As someone who is driven by problem-solving, it is hard to sleep at all amidst so many challenges plaguing society. A more recent challenge that's been at the top of my mind is the racial and societal inequity in health care illuminated by COVID-19. This has been even more greatly compounded by inequities in vaccinations, consequent to both an understandable history-based hesitancy among minorities and systemic inequities in access and communication.

Data from the U.S. Centers for Disease Control and Prevention shows that minorities are inoculated at levels far below their share of the population. Black, brown and Indigenous Americans constitute a population that is more likely to suffer more severe consequences. This is an illustration of a broader problem in our society in which those with the greater need are often those who don't benefit from modern medicine.

I think the convergence of the sciences and engineering can accelerate the development of purposeful technologies to institute functional guardrails and ease of practical implementation into our health care delivery system. I also think we can engineer technological innovations to help overcome the social divide that works against health equity and more broadly address the composite social determinants of health. There is this opportunity, which science, inclusive of social science, can help answer.

JULY 3, 2021 & JULY 17, 2021

SOCIAL MEDIA

See the forest for the trees

Conserving big, old trees such as baobabs (one shown below) in Madagascar, can slow the devastation of climate change, **Susan Milius** reported in "First, protect today's forests" (*SN: 7/3/21 & 7/17/21, p. 24*).

The story reminded reader **@StephenChuaEOS** of the beloved children's book *The Little Prince*. On Twitter, he shared the little prince's simple philosophy: "It's a question of discipline.... When you've finished washing and dressing each morning, you must tend your planet."

GRAPHIC NODE/UNSPLASH

Join the conversation

E-MAIL feedback@sciencenews.org

MAIL Attn: Feedback
1719 N St., NW
Washington, DC 20036

Connect with us

Neuroscience mysteries

*A three-dimensional look at 50,000 brain cells taken from a woman with epilepsy uncovered some pairs with an astonishingly large number of connections, **Laura Sanders** reported in "An intricate brain map reveals quirks," (*SN: 7/3/21 & 7/17/21, p. 6*).*

Given that nerve cells usually touch once, reader **Leilani** wondered if the woman's epilepsy could be the reason for the cells' multiple connections.

The researchers don't think epilepsy is responsible for this cellular quirk, **Sanders** says, but for now, we can't be sure. "The tissue that scientists used to reconstruct the map was thought to be healthy, normal tissue that was removed to allow access to the spot in the woman's brain where seizures started. But it's possible that abnormal neural activity influenced the cells in that supposedly healthy tissue too," she says. "Until scientists have more maps that are made from a wider variety of brains, we won't know how common any of these 'rare' findings actually are."

Frankly, my deer, I don't give a slam

*Gray wolves in Wisconsin that use roads as travel corridors may scare deer away, reducing deer-vehicle collisions, **Jack J. Lee** reported in "Gray wolves clear deer from roadways" (*SN: 7/3/21 & 7/17/21, p. 8*).*

Reader **John Hosack** asked if this wolf behavior leads to increased wolf-vehicle collisions.

Wolf-vehicle collisions occur, **Lee** says, but less frequently than deer-vehicle collisions do. According to the Wisconsin Gray Wolf Monitoring Report, there were 21 wolf-vehicle collisions in the state from April 2019 to April 2020. That number is much lower than the nearly 20,000 deer-vehicle collisions that occur in the state each year. Gray wolves' small population size likely contributes to the low numbers, **Lee** says. But wolves may also tend to avoid roads with heavy traffic. A study in the April 2020 *Mammalian Biology* found that wolves in Poland prefer to travel along high-traffic forest roads when there was low human activity.

Bound by biology

*HIV's ability to create myriad variants in a single person partly explains why scientists haven't been able to find an effective vaccine, **Erin Garcia de Jesús** reported in "Why HIV vaccines remain elusive" (*SN: 7/3/21 & 7/17/21, p. 14*).*

Given this high rate of mutation, reader **Art Hager** wanted to know why HIV hasn't found ways to spread through the air or through mosquitoes.

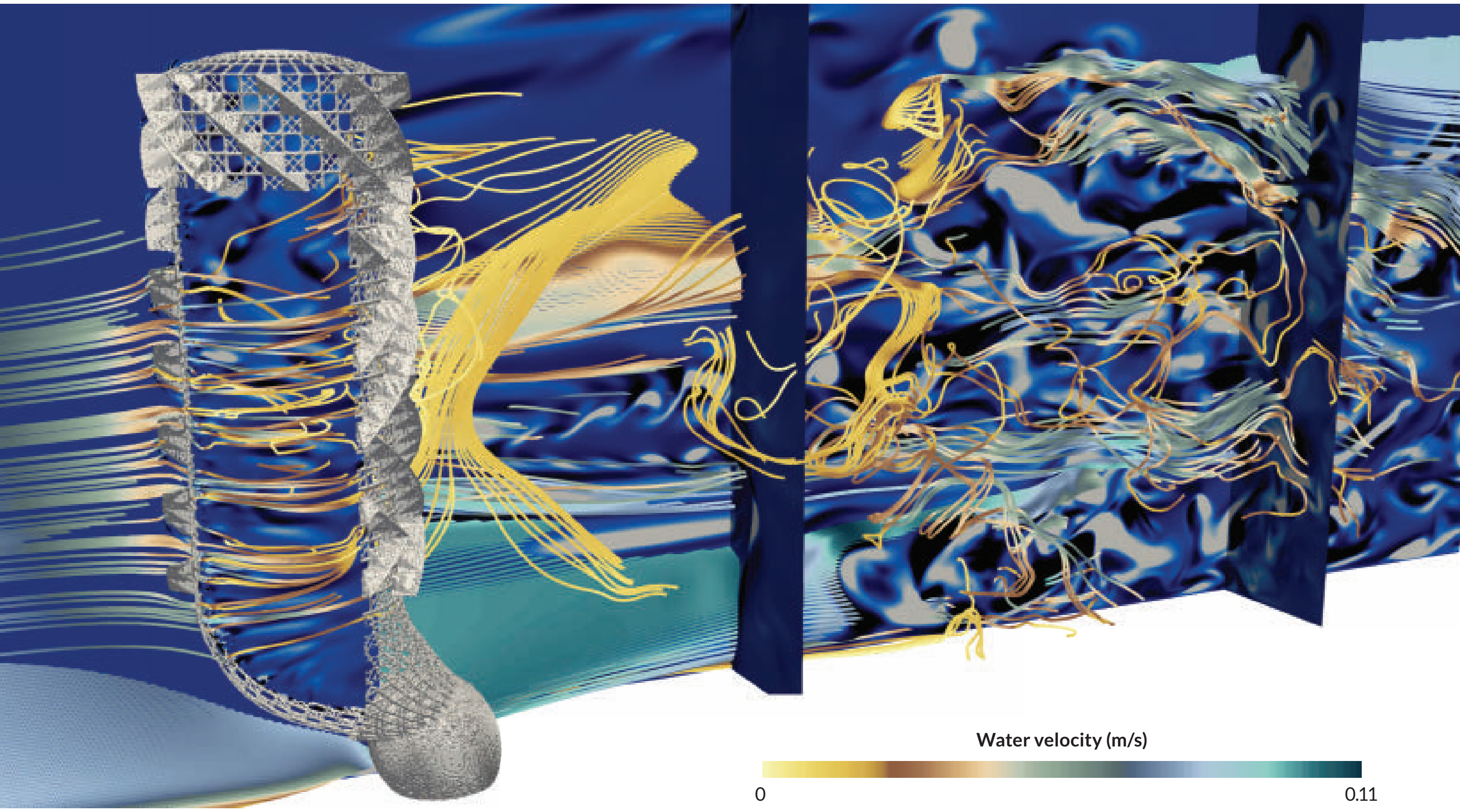
Even HIV has its limits, **Garcia de Jesús** says. The virus doesn't last long outside the body, and the changes it would have to undergo to spread in alternative ways would likely be more trouble than they're worth, she says. "Let's pretend that HIV is a small animal living on a mountain. This animal wants to get from peak A to peak B, but the valley in between is filled with wolves. The creature looks to peak C, but that valley has a lake that is impossible to cross. So it might as well stay on peak A where there's plenty of food and space, even if there are a few hawks flying around."

What gives, eggsactly?

*An experiment on the International Space Station suggests that space radiation doesn't affect the viability of sperm, **Maria Temming** reported in "After spending years in space, mouse sperm produce healthy pups" (*SN: 7/3/21 & 7/17/21, p. 16*).*

Reader **Suzan Chastain** wondered whether eggs are similarly unaffected by space radiation.

More research is needed to understand how eggs fare in space, says biologist **Teruhiko Wakayama** of the University of Yamanashi in Kōfu, Japan. Long-term experiments with mouse eggs are challenging because, unlike freeze-dried sperm, the eggs must be stored at temperatures of about –196° Celsius and the freezers on the International Space Station don't get that cold, **Wakayama** says. His team next plans to do a short-term experiment on the space station that will investigate microgravity's effects on developing mouse embryos. The embryos will be stored for one to two weeks in freezers at –95° C.



How a sea sponge manipulates ocean currents

The glassy skeleton of a Venus's-flower-basket is an eye-catching, lacelike chamber. But this glass sponge (top-down view at left) isn't all show. Simulations reveal how the sponge's intricate, porous structure alters the flow of water, helping the deep-sea animal endure unforgiving ocean currents and perhaps feed and reproduce, researchers report in the July 22 *Nature*.

Previous studies have found that the gridlike construction of a Venus's-flower-basket (*Euplectella aspergillum*) is strong and flexible. "But no one has ever tried to see if these beautiful structures have fluid-dynamic properties," says mechanical engineer Giacomo Falcucci of Tor Vergata University of Rome.

Using supercomputers, Falcucci and colleagues simulated how water flows past and through the sponge (gray at left in the simulation above). Its shape creates a gentle zone of slower water that flanks the sponge, the team found. As a result of this gentle-zone creation, the sponge's body endures less stress. If the sponge were a solid cylinder, the water would form a chaotic wake just past the animal that could jostle it, Falcucci says. Vertical cross sections (blue bars) divide the simulation into zones with different flow activity.

The team also found that ridges that spiral around the outside of the sponge cause water inside to slow and swirl, forming particle-trapping vortices. Food and reproductive cells that drift into the sponge would become trapped for up to twice as long as in the same sponge without ridges, simulations showed. That lingering could help the filter feeders catch more plankton. And because Venus's-flower-baskets can reproduce sexually, it could also enhance the chances that free-floating sperm encounter eggs.

It's amazing that such beauty could be so functional, Falcucci says. *— Nikk Ogasa*

FROM TOP: G. FALCUCCI *ET AL*/*NATURE* 2021; AGEFOTOSTOCK/ALAMY STOCK PHOTO

At Lehigh University, you'll find hands-on, creative and interdisciplinary experiences that will challenge you and prepare you to solve complex problems in real-world situations. Our world-class faculty and rigorous academic programs will have you ready for success in whatever STEM field you choose.

College of Arts and Sciences

Astronomy
Astrophysics
Behavioral Neuroscience
Biochemistry
Biology
Chemistry (B.S. and B.A.)
Cognitive Science
Computer Science (B.S. and B.A.)
Earth & Environmental Sciences
Mathematics
Molecular Biology
Pharmaceutical Chemistry
Physics
Statistics

P.C. Rossin College of Engineering and Applied Science

Applied Science
Bioengineering
Chemical Engineering
Civil Engineering
Computer Engineering
Computer Science (B.S.)
Electrical Engineering
Engineering Mechanics
Engineering Physics
Environmental Engineering
Industrial & Systems Engineering
Materials Science & Engineering
Mechanical Engineering

Intercollegiate Interdisciplinary Programs

Computer Science and Business (CSB)
Integrated Degree in Engineering, Arts and Sciences (IDEAS)
Integrated Business and Engineering (IBE)

Dual-Degree/Accelerated Programs

Arts & Engineering

College of Health

Population Health

LEHIGH UNIVERSITY

This is a partial list of Lehigh's majors and programs. For the full list, please visit **lehigh.edu/majors.**

lehigh.edu/admissions | admissions@lehigh.edu

6:1

student-to-faculty ratio

1,200+

science, math, and engineering labs on campus

24/7

hours the Center for Engineering Innovation and Design (CEID) is open for student use

200+

summer fellowships for undergraduate science and engineering students annually

2:1

student-to-faculty ratio in STEM majors

>40%

of Yale College students graduating with a STEM major are women

Yale

ADMISSIONS.YALE.EDU