A New Black Hole Portrait | Teen Brains Tune Out Mom

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE ■ JUNE 4, 2022

Beyond the BRAIN

Glial cells may have big jobs in unexpected parts of the body

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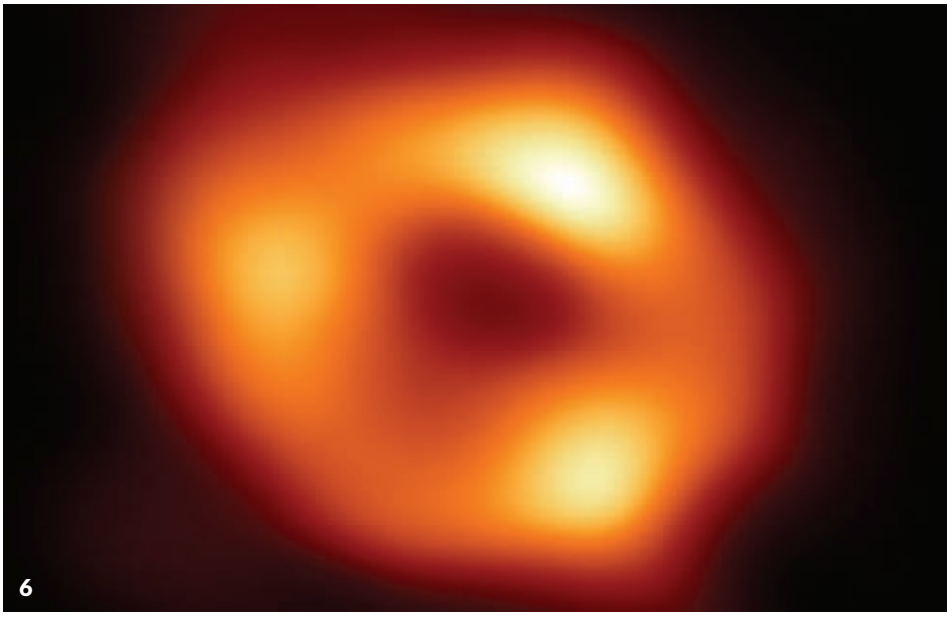
Features

News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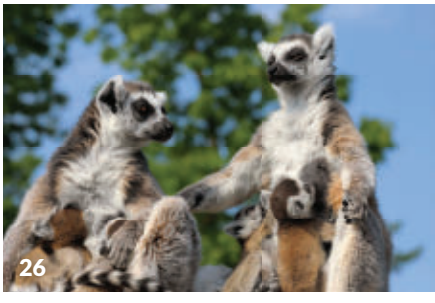
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Departments

COVER In the brain, glial cells called astrocytes (blue) protect nerve cells (orange) and strengthen their connections. *Dennis Kunkel Microscopy/ Science Source*

FROM TOP: TARGET MALARIA; RAIMUND LINKE/THE IMAGE BANK/GETTY IMAGES PLUS; EHT COLLABORATION

A new *Science News* for the young people in your life

Learning amazing new things about science is a delight—and sharing those amazing things with others is even better. That's a big reason why we've been publishing *Science News* for more than 100 years. And that's why we've launched a new print magazine for young people called *Science News Explores*.

Maya Ajmera, our publisher, president and CEO, is a parent herself. She envisions the magazine as a way for kids to connect with science that doesn't feel like homework, and that doesn't involve staring at a screen. "*Science News Explores* is written in a way that middle school children can fully understand," she says, "while still being a great read for adults."

We know a thing or two about kids and science, having reported for young people since 2003 with our award-winning *Science News for Students* website. "They ask really great questions," says Sarah Zielinski, editor of *Science News Explores* and managing editor of *Science News for Students*. "I want to feed that curiosity and help them hold onto it as they grow into adults."

And you'll find reporting by your favorite *Science News* journalists in *Science News Explores* too. Our writers and editors are masters at making complex science accessible to younger readers, while not dumbing it down. It may surprise you to learn that the articles, many of which are adapted from *Science News* articles, are often longer, because technical terms need to be replaced by explanation. It's a reminder of how often fields of science, or any field of expertise, develop shorthand terminology that makes communication within the field easier, but can make it harder for others to understand.

The inaugural issue includes an introduction to what may be the world's tiniest reptile; a conversation with Tiera Fletcher, who designs spacecraft that may fly people to Mars; and a voyage to the ocean depths. By steering a remote-controlled camera along the seafloor, scientists have learned how a whale's carcass helps feed more than 100 species, including "snot-flowers." Readers can also use a map of Mount Everest to learn how tiny bits of plastic have made it to the world's highest peak. And you'll find out whether seeing a movie about Spider-Man may help tame fear of arachnids in real life.

We hope you'll share the joy of science with a young person in your life by giving them a subscription to *Science News Explores* at www.sciencenews.org/explores. I hope you'll enjoy the magazine as much as we've enjoyed creating it for the next generation of science fans. —*Nancy Shute, Editor in Chief*

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Tears From a Volcano

Uniquely American stone ignites romance

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

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Necklace enlarged to show luxurious color

Excerpt from the June 3, 1972 issue of *Science News*

50 YEARS AGO

A busy week in Moscow

U.S. and Soviet leaders ... signed agreements on space, science and technology, health and the environment.... The space agreement ... outlines plans for cooperation in fields such as meteorology, study of the natural environment, planetary exploration and space biology.

UPDATE: The 1972 space agreement led to the first international human spaceflight, the Apollo-Soyuz mission, during which Soviet and U.S. crews socialized in space (*SN: 7/26/75, p. 52*). Apollo-Soyuz encouraged decades of collaboration that continues today on the International Space Station. Now, Russia's war in Ukraine has prompted many countries to pull back on scientific endeavors with Russia, in space and on Earth (*SN: 3/26/22, p. 6*). While NASA remains committed to the space station, the head of Russia's space agency has threatened to end the cooperation in retaliation for sanctions imposed in response to the war. Russia has yet to make moves to abandon the station, though the country has ceased supplying rocket engines to the United States.

Jack-in-the-pulpit species *Arisaema angustatum* (left) and *A. peninsulae* (right) may attract male gnats by wafting sexy scents, but the plants are dangerous places for their tiny pollinators.

IT'S ALIVE

Flowers use sex to lure pollinators to their deaths

Fake, fatal invitations to romance could be the newest bit of trickery uncovered among some jack-in-the-pulpit wildflowers.

The fatal part isn't the surprise. Jack-in-the-pulpits are the only plants known to kill their own insect pollinators as a matter of routine, says evolutionary ecologist Kenji Suetsugu of Kobe University in Japan. The new twist, if confirmed, would be using sexual deception to woo pollinators into the death traps, Suetsugu reports in the May *Plants, People, Planet*.

Until now, biologists have found only three plant families with any species that pretend to offer sex to insects, Suetsugu says. But unlike the proposed jack-in-the-pulpit deceit, the other cases aren't fatal, just phony.

The orchid family has turned out multiple cheats, some so seductive that a male insect leaves wasted sperm as well as pollen on a flower. Similar scams show up among daisies: Dark bumps that a human in bad light might mistake for an insect can drive male flies to frenzies on fire-hued *Gorteria* petals (*SN: 3/8/14, p. 16*). Among irises, a species dangles velvety purple petals where deluded insects wallow.

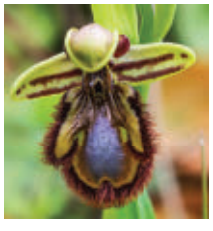
Two jack-in-the-pulpit species in Japan, *Arisaema angustatum* and *A. peninsulae*, have now raised suspicions that their family should be added to the list of sexual cheats. These oddball flowers, with floppy canopies bending over little cupped "pulpits," depend mostly on punctuation-sized fungus gnats for pollination. The plants have a strong scent to lure mate-seeking gnats. But for gnats that enter the pulpit, things will go terribly wrong.

An escape hatch deep in the pulpit stays open during the plant's first phase of flowering. That hole vanishes as the plant grows larger. Since a gnat can't overcome the pulpit's waxy inner wall to climb out, any gnat tricked once the hatch closes is doomed.

Biologists had assumed that jack-in-the-pulpits seeking fungus gnats were perfuming the air with mushroomy, nice-place-to-have-kids scents. But homey smells don't explain one of Suetsugu's odd observations: Almost all the gnats found in *A. angustatum* and *A. peninsulae* traps were males.

An odor lure for males might mimic a come-hither scent of female gnats, Suetsugu proposes. That would be outright fraud. And even if males found a mate in the waxy dungeon, they and their offspring would starve. Whatever the ruinous scent, a human can barely detect it, Suetsugu says.

To confirm that the plants are up to something odd, scientists need to identify the lure. Then maybe we'll also understand the valentine scent of a female fungus gnat. —*Susan Milius*



The bee orchid, *Gorteria* daisy and velvet iris (from top) are known to bait insects with sexual trickery.

TOP BOTH: K. SUETSUGU/*PLANTS, PEOPLE, PLANET* 2022; BOTTOM THREE: JORUN THARALDSEN (ORCHID AND IRIS), STEVEN JOHNSON (DAISY)

MYSTERY SOLVED

Why pipe organs are acoustic rule breakers

Dancing gold has helped solve a long-standing mystery: why pipe organs violate a mathematical formula that should describe their sound.

In 1860, physicist Hermann von Helmholtz published an equation relating the wavelength of a pipe's fundamental tone to pipe length. Generally, the longer a pipe is, the lower its fundamental tone will be. But the equation doesn't work in practice. A pipe's fundamental tone always sounds lower than the pipe's length suggests it should according to the formula. Fixing this problem requires adding an "end correction" to the equation. Why this was, nobody could figure out.

Then in 2010, Bernhardt Edskes of Wohlen, Switzerland, was tuning an organ when he spotted a piece of gold hovering just above a gilded pipe's upper rim, seemingly trapped in a vortex. Edskes told physicist Leo van Hemmen of the Technical University of Munich about the observation. Using cigarette smoke, they and colleagues found that a vortex indeed forms over a playing organ pipe. And this vortex is capped by a hemisphere of resonating air, explaining the "end correction," the team reported March 14 at a meeting in Chicago of the American Physical Society. The cap lengthens the pipe by the exact amount that must be tacked on to the formula to get the pipe's fundamental tone. —*Bas den Hond*

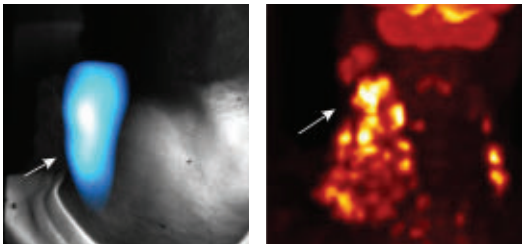
TEASER

New imaging device detects tumors' faint glow

A type of light commonly observed in astrophysics experiments and nuclear reactors can help detect cancer. In a clinical trial, a prototype of an imaging machine that relies on this usually bluish light, called Cerenkov radiation, successfully captured the presence and location of cancer patients' tumors, researchers report April 11 in *Nature Biomedical Engineering*.

In Cerenkov luminescence imaging, or CLI, particles released by radiotracers injected into the body cause the target tissue to vibrate and relax in a way that emits the light, which is then captured by a camera. When compared with standard scans of the tumors, Cerenkov light images were classified as "acceptable" or better for 90 percent of patients, says cancer researcher Magdalena Skubal of Memorial Sloan Kettering Cancer Center in New York City.

Between May 2018 and March 2020, 96 people underwent both CLI and standard imaging, such as PET-CT. Participants with a variety of diagnoses, including lymphoma, thyroid cancer and prostate cancer, received one of five radiotracers and were then imaged by the prototype. Skubal and colleagues found that CLI detected all radiotracers, suggesting that the technology is more versatile than PET-CT scans, which work with only some tracers. CLI isn't as precise as PET-CT scans, but the technology could be used as an early diagnostic test, the team says.



The Cerenkov luminescence image (left) of the neck of a patient with Hodgkin's lymphoma reveals a tumor (arrow). Similar signs of disease show up in a PET-CT scan (right).

IMAGES AT LEFT: E.C. PRATT *ET AL*/*NATURE BIOMEDICAL ENGINEERING* 2022; ILLUSTRATION: T. TIBBITTS

The findings strengthen the case for CLI as a low-cost option that could expand medical imaging access in hospitals, says Antonello Spinelli, a preclinical imaging scientist at the Experimental Imaging Centre in Milan. —*Anna Gibbs*

FOR DAILY USE

Science points to safer ways to wash chicken

Health experts recommend against washing raw chicken because that can spread harmful bacteria. But if you do, you're not alone. Nearly 70 percent of U.S. grocery shoppers do too. But there are ways to make it safer, researchers report in the March *Physics of Fluids*.

The team placed raw chicken under running faucets and monitored the spray of water and bacteria to nearby surfaces. Water that fell 40 centimeters from a faucet to chicken caused bacteria to travel farther than water that fell just 15 centimeters. The initial burst of water from flicking on a faucet also sent contaminated spray flying. Gradually turning on the faucet and keeping water pressure low reduced spray.

Reducing splashing plus kitchen cleaning and handwashing can prevent foodborne illnesses, says food safety scientist Ellen Shumaker of North Carolina State University in Raleigh, who wasn't part of the study. —*James R. Riordon*

Tips to minimize contamination from washing raw chicken

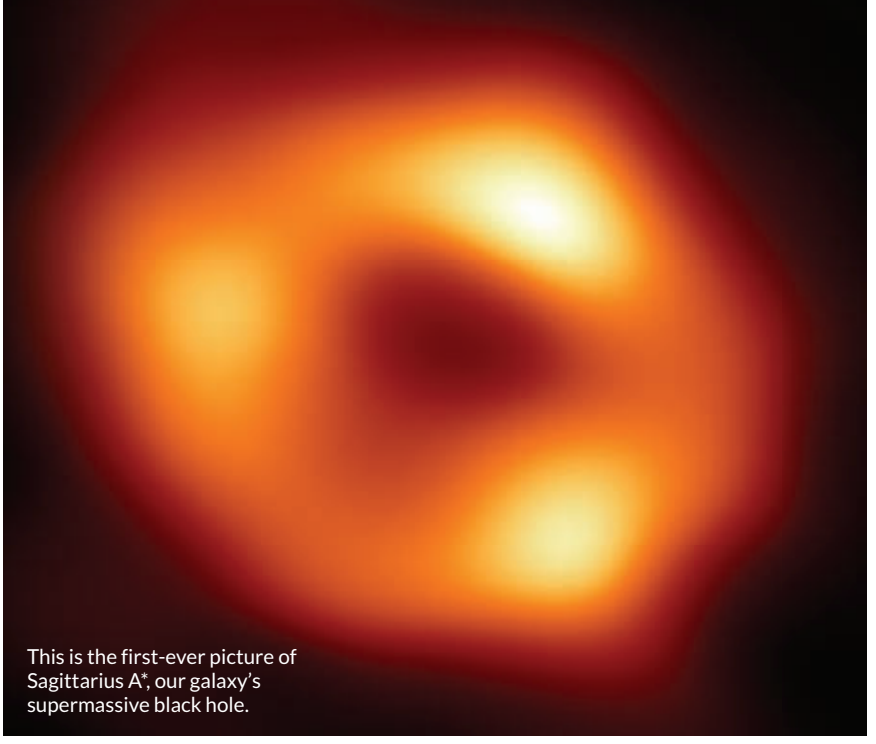
Health experts recommend not washing chicken before cooking it. But if you do, follow U.S. Department of Agriculture guidelines for cleaning and sanitizing your kitchen as well as these other safety tips from a new study:

- Minimize the distance between the faucet and the surface of the chicken.
- Turn on the faucet gradually to avoid water splashing off the chicken and across your counters.
- Keep washing times brief.

ATOM & COSMOS

Milky Way's beast comes into view

Telescope images the shadow of our supermassive black hole



This is the first-ever picture of Sagittarius A*, our galaxy's supermassive black hole.

EHT COLLABORATION

BY LIZ KRUESI AND EMILY CONOVER

There's a new addition to the portrait gallery of black holes.

Astronomers announced that they have finally assembled an image of the supermassive black hole at the center of our galaxy. "This image shows a bright ring surrounding the darkness, the telltale sign of the shadow of the black hole," astrophysicist Feryal Özel of the University of Arizona in Tucson said at a May 12 news conference announcing the result.

The black hole, Sagittarius A*, appears as a faint silhouette within the glowing material surrounding it. The image reveals the turbulent, twisting region around the black hole in new detail. The findings also were published May 12 in six studies in the *Astrophysical Journal Letters*.

A global network of radio telescopes, known as the Event Horizon Telescope, created this much-anticipated look at the Milky Way's giant. Three years ago, the same team released the first-ever image of a supermassive black hole (*SN: 4/27/19, p. 6*), at the center of the galaxy M87, about 55 million light-years from Earth.

But Sagittarius A*, or Sgr A* for short, is "humanity's black hole," says astrophysicist Sera Markoff of the University of Amsterdam, a member of the EHT collaboration. At about 27,000 light-years away, it's the closest supermassive black hole to Earth. That makes it the most-studied black hole of its kind in the universe.

Yet Sgr A* and others like it remain among the most mysterious objects ever detected. That's because black holes are so dense that their gravitational pull won't let light escape. They are "natural keepers of their own secrets," says Lena Murchikova, a physicist at the Institute for Advanced Study in Princeton, N.J., who is not part of the EHT team. Their gravity traps light that falls within a border called the event horizon. EHT's images skirt up to that inescapable edge.

Sgr A* feeds on hot material pushed off of massive stars at the galactic center. That gas, drawn in by the pull of Sgr A*, flows into a surrounding accretion disk of glowing material. The accretion disk is where the action is, so astronomers want to know more about how the disk works.

The disk, the stars and an outer bubble of X-ray light "are like an ecosystem," says astrophysicist Daryl Haggard of McGill University in Montreal and a member of the EHT collaboration. "They're completely tied together."

M87's black hole is a gorging monster, shooting out huge, powerful jets. But Sgr A*, like most supermassive black holes, is relatively quiet and faint, eating only a few morsels fed to it by its accretion disk. Still, the area around Sgr A* is producing light. Astrophysicists have seen the vicinity feebly glowing in radio waves, jittering in infrared and burping in X-rays.

In fact, the accretion disk around Sgr A* seems to constantly flicker and simmer. This variability is like a froth on top of ocean waves, Markoff says. "And so we're seeing this froth that is coming up from all this activity, and we're trying to understand the waves underneath the froth."

By combining about 3.5 petabytes of data captured in April 2017, the team could begin to piece together the picture. It took years of work, complex computer simulations and observations in various types of light from other telescopes. Sgr A*'s variability — it changes on timescales of just a few minutes compared with weeks for M87's black hole — complicated the analysis. "It was like trying to take a clear picture of a running child at night," astronomer José L. Gómez of Instituto de Astrofísica de Andalucía in Granada, Spain, said at a news conference.

The new observations confirm the mass of Sgr A* at 4 million times that of the sun. And the image has turned up no hidden weaknesses in Einstein's steadfast theory of gravity, general relativity. Scientists have previously tested general relativity by following the motions of stars that orbit very close to Sgr A* (*SN: 8/18/18 & 9/1/18, p. 12*) — work that also helped confirm that the object truly is a black hole.

There's also more to come. Additional observations from the EHT, made in 2018, 2021 and 2022, are waiting to be analyzed.

"It's really exciting to have the first image of a black hole that is in our own Milky Way," says physicist Nicolas Yunes of the University of Illinois Urbana-Champaign, who is not part of the EHT team. It sparks the imagination, like early pictures astronauts took of Earth from the moon, he says. "It's fantastic." ■

All genetic bases appear in meteorites

The find bolsters the idea that life's precursors came from space

BY LIZ KRUESI

More of the ingredients for life have been found in meteorites.

Space rocks that fell to Earth within the last century contain the five bases that store information in DNA and RNA, scientists report April 26 in *Nature Communications*.

These "nucleobases" — adenine, guanine, cytosine, thymine and uracil — combine with sugars and phosphates to make up the genetic instructions for all life on Earth. Whether these basic ingredients for life first came from space or instead formed in a warm soup of earthly chemistry is still not known (*SN*: 9/26/20, *p.* 22). But the discovery adds to evidence that suggests life's precursors originally came from space, the researchers say.

Scientists have detected bits of adenine, guanine and other organic compounds in meteorites since the 1960s. Researchers have seen hints of uracil as well, but cytosine and thymine remained elusive, until now.

"We've completed the set of all the bases found in DNA and RNA and life on Earth, and they're present in meteorites," says Daniel Glavin, an astrochemist at NASA's Goddard Space Flight Center in Greenbelt, Md.

A few years ago, geochemist Yoshihiro Furukawa of Tohoku University in Sendai, Japan, and colleagues began using a technique to gently extract and separate chemical compounds in liquefied meteorite dust and then analyze them.

"Our detection method has orders of magnitude higher sensitivity than that applied in previous studies," says Furukawa's colleague Yasuhiro Oba, a geochemist at Hokkaido University in Sapporo, Japan. In 2019, the researchers combined forces with astrochemists at NASA to use this same technique to discover ribose, a sugar needed for life, in three meteorites (*SN Online*: 11/22/19).

In the new study, the group analyzed one of those three meteorites and three additional ones, looking for another type of crucial ingredient for life: nucleobases.

The researchers think their milder extraction technique, which uses cool water instead of the usual acid, keeps the compounds intact. "This extraction approach is very amenable for these fragile nucleobases," Glavin says. "It's more like a cold brew, rather than making hot tea."

With this technique, Glavin, Oba, Furukawa and colleagues measured the abundances of the bases and other compounds related to life in four samples from meteorites that fell decades ago in Australia and North America. In all four, the team detected and measured some combination of adenine, guanine, cytosine, uracil, thymine, several compounds related to the bases and a few amino acids.

Using the same technique, the team also measured chemical abundances within soil collected from the Australian site and then compared the measured meteorite values with that of the soil. For some detected compounds, the meteorite values were greater than the surrounding soil, which suggests that the compounds came to Earth in these rocks.

But for other detected compounds, including cytosine and uracil, the soil abundances were as much as 20 times as high as in the meteorites. That could point to earthly contamination, says cosmochemist Michael Callahan of Boise State University in Idaho.

"I think [the researchers] positively identified these compounds," Callahan says. But "they didn't present enough compelling data to convince me that they're truly extraterrestrial." Callahan previously worked at NASA and collaborated with Glavin and others to measure organic materials in meteorites.

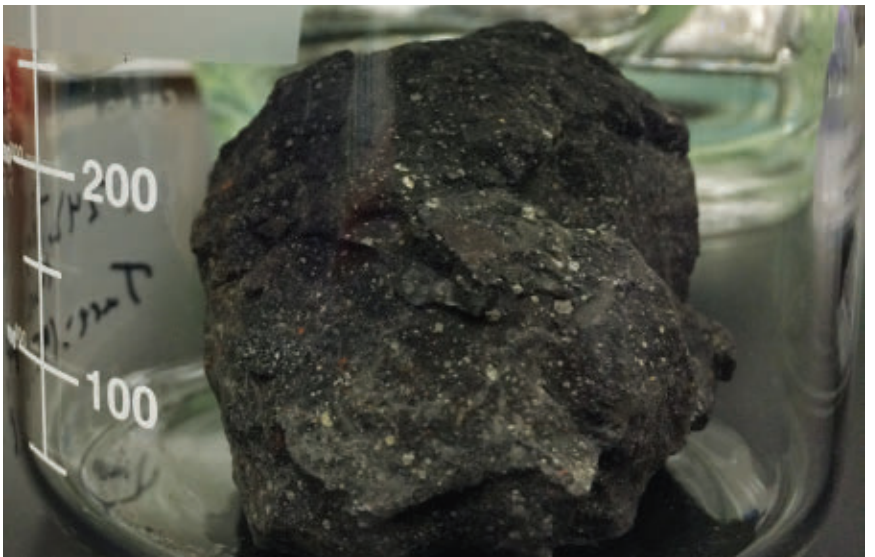
But Glavin and colleagues point to a few specific detected chemicals to support the hypothesis of an interplanetary origin. In the new analysis, the team measured more than a dozen other life-related compounds, including isomers of the nucleobases, Glavin says.

Isomers have the same chemical formulas as their associated bases, but their ingredients are organized differently. The team found some of those isomers in the meteorites but not in the soil. "If there had been contamination from the soil, we should have seen those isomers in the soil as well," Glavin says. "And we didn't."

Going directly to the source of such meteorites — pristine asteroids — could clear up the matter. The team is using the extraction technique on pieces from the surface of the asteroid Ryugu, which Japan's Hayabusa2 mission brought to Earth in 2020. NASA's OSIRIS-REx mission is expected to return in September 2023 with similar samples from the asteroid Bennu (*SN*: 1/19/19, *p.* 20).

"We're really excited about what stories those materials have to tell," Glavin says. ■

A two-gram chunk from this rock — part of a meteorite that fell in Australia in 1969 — contains key components of DNA and RNA that hadn't been found in space rocks before, researchers say.



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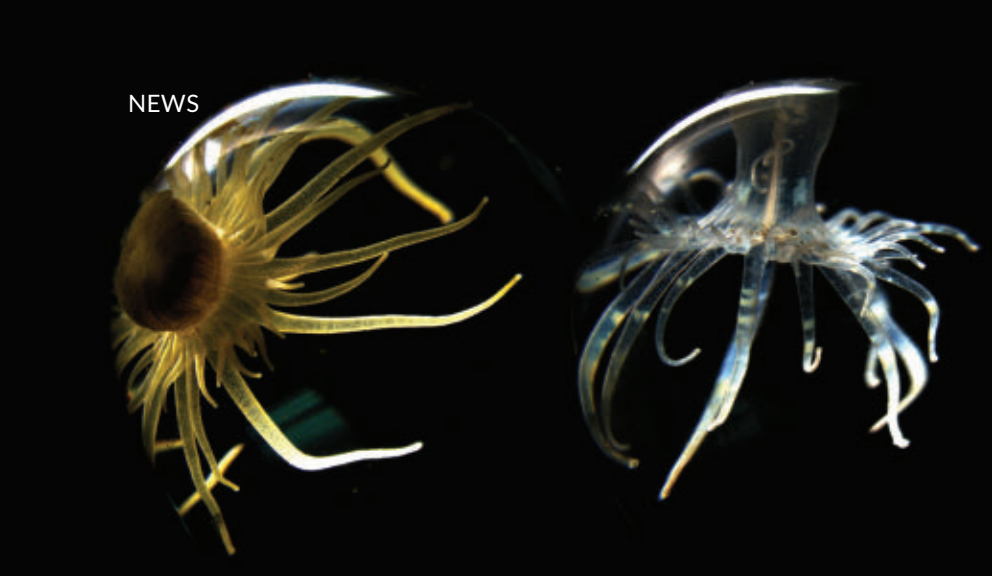


When exposed to oxybenzone and light in the lab, sea anemones with algal partners (brown) survive longer than those without algae (white).

EARTH & ENVIRONMENT

Corals turn a sunscreen chemical toxic

Lab experiments reveal how oxybenzone can damage reefs

BY ERIN GARCIA DE JESÚS

A common chemical in sunscreen can have devastating effects on coral reefs. Now, scientists know why.

Mushroom coral and sea anemones, a coral relative, can turn the chemical, oxybenzone, into a light-activated toxin that's deadly to them, researchers report in the May 6 *Science*.

The good news is that algae coexisting with coral can soak up the toxin and blunt its damage. The bad news is that bleached coral reefs, where helpful algae have been ejected, may be more vulnerable to death.

So combined, sunscreen pollution and climate change, which is making bleaching more common, could be a greater threat to reefs than either would be separately, says forensic ecotoxicologist Craig Downs of the nonprofit Haereticus Environmental Laboratory in Amherst, Va.

Because studies have suggested that oxybenzone can kill young corals and prevent adult corals from recovering after tissue damage, some places have banned oxybenzone-containing sunscreens.

Environmental chemist Djordje Vuckovic of Stanford University and colleagues found that glass anemones (*Exaiptasia pallida*) add sugars to oxybenzone. Such add-ons typically help detoxify chemicals and clear them from the body. But the oxybenzone-sugar compound becomes toxic when activated by ultraviolet light.

Anemones exposed to either simulated sunlight or oxybenzone alone survived the length of the experiment, 21 days. But anemones submersed in water with the chemical and exposed to fake sunlight died within 17 days. What's more, anemones with algae survived days longer than those without. The algal friends absorbed much of the oxybenzone and the toxin.

Experiments with mushroom coral (*Discosoma* sp.) had similar results.

Whether sunscreen components similar to oxybenzone have the same effects is unknown, Downs says. The answer could lead to better reef-safe sunscreens. ■

BODY & BRAIN

Specific brain cells tied to Parkinson's

Discovery might lead to better treatments for the disease

BY LAURA SANDERS

Deep in the brain, a very specific kind of cell dies in Parkinson's disease.

For the first time, researchers have sorted large numbers of cells in the affected region, called the substantia nigra, into 10 distinct types. Just one is especially vulnerable in Parkinson's, the team reports May 5 in *Nature Neuroscience*. The result could lead to a clearer view of how the disease takes hold and perhaps how to stop it.

The research "goes right to the core of the matter," says Raj Awatramani, a neuroscientist at Northwestern University Feinberg School of Medicine in Chicago who was not involved in the study.

Parkinson's affects nearly 1 million people in the United States. It steals a person's ability to move smoothly, leaving them with balance problems, tremors and rigidity. These symptoms come with the death of nerve cells in the substantia nigra that churn out dopamine, a chemical signal involved in movement.

But, it turns out, those dopamine-making neurons are not all equally susceptible. Researchers in the lab of Evan Macosko, a neuroscientist at the Broad Institute of MIT and Harvard, analyzed more than 15,000 dopamine-making neurons in the substantia nigra from the postmortem brains of eight people without Parkinson's or other brain disorders. The team sorted the cells into 10 types, each defined by a specific location and certain combinations of active genes.

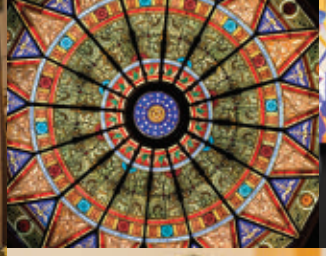
When looking at substantia nigra neurons in the brains of people who died with either Parkinson's or the related Lewy body dementia, the team noticed something curious: One of the 10 cell types was drastically diminished.

The missing neurons were defined by their location in the lower part of the substantia nigra and an active *AGTR1* gene, experiments led by lab member Tushar Kamath found. The researchers don't know if the gene has a role in the cells' fate.

Knowing the characteristics of the cells that go missing in Parkinson's could point to replacements, Awatramani says. "If a particular subtype is more vulnerable in Parkinson's disease, maybe that's the one we should be trying to replace."

In fact, Macosko says, stem cell scientists have already been in contact, eager to make these specific cells. "We hope this is a guidepost," he says. ■

D. VUCKOVIC, CHRISTIAN RENICKE



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HUMANS & SOCIETY

A calming brew for child sacrifices

Inca victims may have drunk a beverage containing harmine

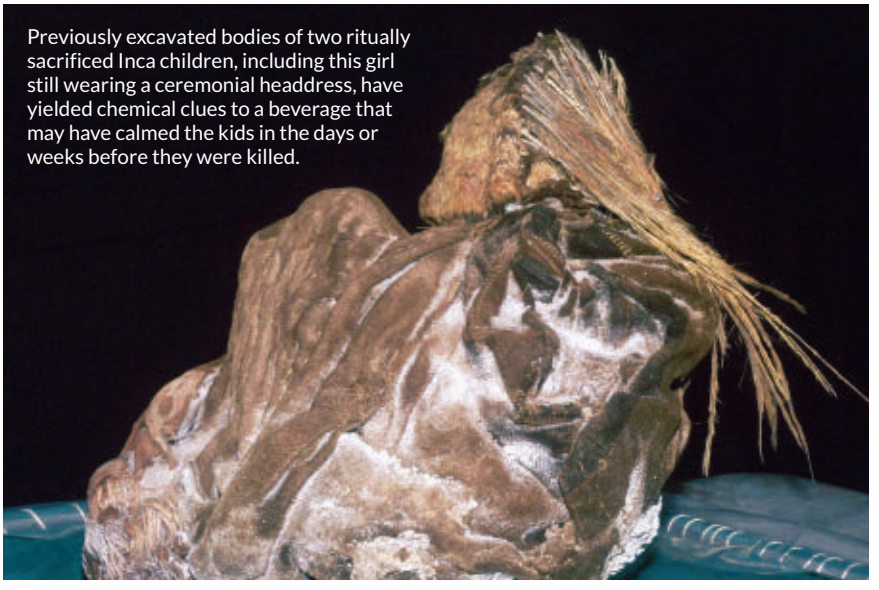
BY BRUCE BOWER

Two Inca children slated for ritual sacrifice more than 500 years ago quaffed a special soothing concoction that has gone undetected until now.

Those young victims, identified from their remains as a girl and a boy roughly 4 to 8 years old, drank a liquid that may have lightened their moods and calmed their nerves in the days or weeks before they were ceremonially killed and buried on Peru's Ampato Mountain, a new study suggests.

The youngsters' bodies contained chemical remnants from one of the primary ingredients of ayahuasca, a liquid concoction known for its hallucinogenic effects, say bioarchaeologist Dagmara Socha of the University of Warsaw in Poland and her colleagues (SN: 6/8/19, p. 9). Analyses focused on hair from the girl's naturally mummified body and fingernails from the boy's partially mummified remains.

While no molecular signs of ayahuasca's strong hallucinogens appeared in those remains, the team did find traces of harmine and harmaline, chemical products of *Banisteriopsis caapi* vines, Socha's group reports in the June *Journal of Archaeological Science: Reports*. In ayahuasca, *B. caapi* amplifies the strength of other more hallucinogenic ingredients.



Previously excavated bodies of two ritually sacrificed Inca children, including this girl still wearing a ceremonial headdress, have yielded chemical clues to a beverage that may have calmed the kids in the days or weeks before they were killed.

Recent investigations with rodents suggest that solutions containing harmine affect the brain much like some antidepressant drugs do. "This is the first [evidence] that *B. caapi* could have been used in the past for its antidepressant properties," Socha says.

While research on whether harmine can lessen depression or anxiety in people is in its infancy, archaeologist Christine VanPool of the University of Missouri in Columbia thinks it's possible that the ingredient was used on purpose. Spanish documents written after the fall of the Inca Empire say that alcohol was used to calm those about to be sacrificed, so other brews may have been used too, speculates VanPool, who was not part of Socha's team.

"I tentatively say, yes, the Inca understood that *B. caapi* reduced anxiety in sacrificial victims," she says.

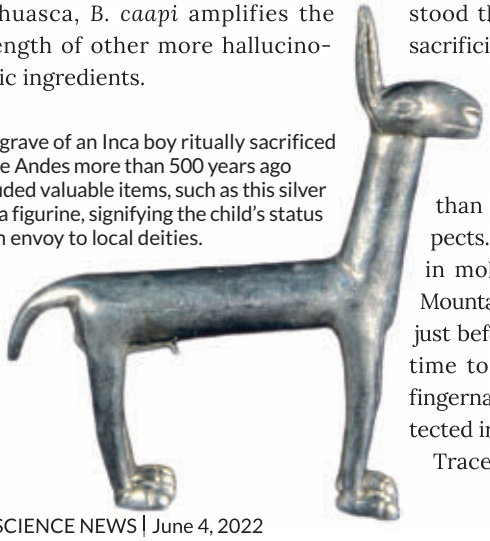
Spanish chroniclers may have mistakenly assumed that victims of Inca sacrifice drank a popular corn beer known as chicha rather than a *B. caapi* beverage, Socha suspects. No evidence of alcohol appeared in molecular analyses of the Ampato Mountain children. But alcohol consumed just before a sacrifice wouldn't have had time to be incorporated into hair and fingernails and so would have gone undetected in the researchers' tests.

Trace evidence did also indicate that both children had chewed coca leaves in the weeks leading up to their deaths. Spanish written accounts describe the widespread use of coca leaves during Inca rites of passage. Those events included ritual sacrifices of children and young women, who were believed to become envoys to various local gods after death.

The sacrificed children were found during a 1995 expedition near the summit of Ampato (SN: 11/11/95, p. 312). It would have taken at least two weeks and possibly several months for the children to complete a pilgrimage from wherever their homes were located to the capital city of Cuzco for official ceremonies and then to Ampato Mountain, Socha says.

Giving those kids a calming *B. caapi* drink as well as coca leaves to chew doesn't surprise archaeologist Lidio Valdez of the University of Calgary in Canada, who did not participate in the new study. Children may not have understood that they were going to die, but they had to endure the rigors and loneliness of a long trip while separated from their families, he says.

Valdez suspects Ampato Mountain was originally called Qampato, a word meaning toad in the Inca language. Andean societies such as the Inca associated toads with water or rain. "The mountain was also likely linked with water or rain and the children perhaps sacrificed to ask the mountain gods to send water," he says. ■



The grave of an Inca boy ritually sacrificed in the Andes more than 500 years ago included valuable items, such as this silver llama figurine, signifying the child's status as an envoy to local deities.

BOTH: JOHAN REINHARD

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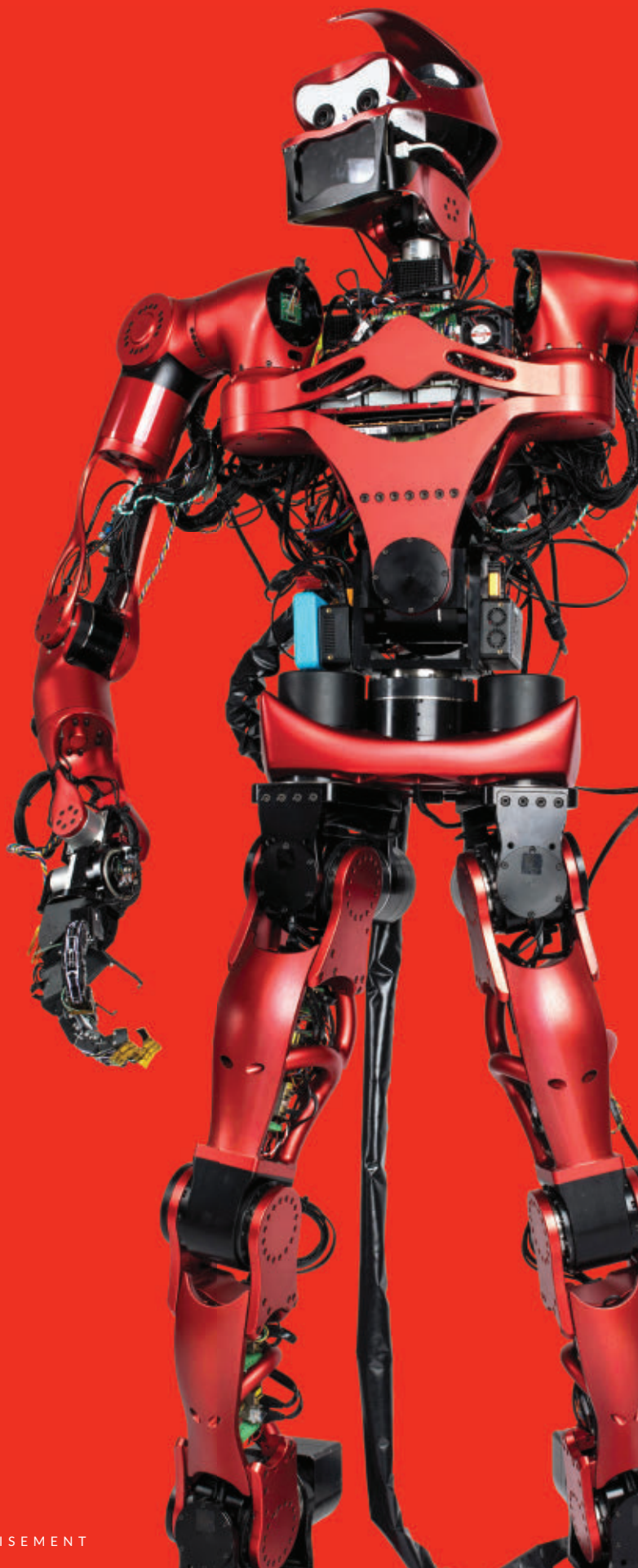

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MATH & TECHNOLOGY

Trilobite eye inspires a new camera

A specialized lens simultaneously focuses near and far

BY ANNA GIBBS

Ben Franklin had nothing on trilobites.

Roughly 400 million years before the founding father invented bifocals, the now-extinct trilobite *Dalmanitina socialis* already had a superior version (SN: 2/2/74, p. 72). Not only could the sea critter see things both near and far, it could also see both distances in focus at the same time — an ability that eludes most eyes and cameras.

Now, a new type of camera sees the world the way this trilobite did. Inspired by *D. socialis*' eyes, the camera can simultaneously focus on two points anywhere from three centimeters to nearly two kilometers away, researchers report April 19 in *Nature Communications*.

"In optics, there was a problem," says physicist Amit Agrawal of the National Institute of Standards and Technology in Gaithersburg, Md. Focusing a single lens on two different points just simply could not be done, he says.

If a camera could see like a trilobite, Agrawal figured, it could capture images with exceedingly large depths of field — the distance between the nearest and farthest points that a camera can bring into focus. Large depth of field is important for the relatively new technique of light-field photography, which uses many tiny lenses to produce 3-D photos.

To mimic the trilobite's ability, Agrawal and colleagues constructed a metalens. This flat lens is made up of millions of rectangular nanopillars arranged like a cityscape, if skyscrapers were one two-hundredth the width of a human hair. The nanopillars act as obstacles that bend light in different ways depending on their shape, size and arrangement. The researchers arranged the pillars so some light traveled through one part of the lens and some light through another, creating two focal points.

The team then built an array of identical metalenses into a light-field camera that could capture more than a thousand tiny images. Combining all the images results in a single image that's in focus close up and far away, but blurry in between. The blurry bits can then be sharpened with a machine learning computer program.

Dolls in this light-field image were placed 30 centimeters (foreground) to 3.3 meters (top) from a camera. All dolls are in focus thanks to a lens inspired by an extinct trilobite's eye.

Achieving a large depth of field can help the program recover depth information, says Ivo Ihrke, a computational imaging scientist at the University of Siegen in Germany who was not involved with the research. A standard image doesn't contain information about distance from the camera lens to objects in the photo, but a 3-D image does. So the more depth information that can be captured, the better.

The trilobite approach isn't the only way to boost the range of visual acuity. Other light-field cameras using a different method also can focus near and far at the same time, Ihrke says. One such camera contains an array of three types of glass lenses, each tailored to focus light from a particular distance, that work in concert. But in the trilobite array, all the lenses are the same, which helps achieve higher-resolution images.

Such advances in capturing depth with light-field cameras, Agrawal says, will improve imaging techniques that could help self-driving cars or Mars rovers gauge distances. ■

EARTH & ENVIRONMENT

Gravity shifts can reveal big quakes

Detecting temblors' earliest signs could speed up warnings

BY CAROLYN GRAMLING

Massive earthquakes don't just move the ground — they make speed-of-light adjustments to Earth's gravitational field. Now, researchers have trained computers to identify these tiny gravitational signals, demonstrating how the signals can be used to mark the location and size of a strong quake almost instantaneously.

It's a first step to creating a very early warning system for the planet's most powerful quakes, scientists report May 11 in *Nature*.

Such a system could help solve a thorny problem in seismology: how to quickly pin down the true magnitude of a massive quake immediately after it happens, says Andrea Licciardi, a geophysicist at the Université Côte d'Azur in Nice, France. Without that ability, it's much harder to swiftly and effectively issue hazard warnings that could save lives.

As large earthquakes rupture, the shaking and shuddering sends seismic waves through the ground that appear as large wiggles on seismometers. Current seismic wave–based detection methods notoriously have difficulty distinguishing between, say, a magnitude 7.5 quake and magnitude 9 quake in the seconds following such an event.

That's because the initial estimations of magnitude are based on the height of seismic waves that are the first to arrive at monitoring stations. Yet for the strongest quakes, those initial wave amplitudes max out, making quakes of different magnitudes hard to tell apart.

But seismic waves aren't the earliest signs of a quake. All of that mass moving around in a big earthquake also changes the density of the rocks at different locations. Those shifts in density translate to tiny changes in Earth's gravitational field, producing "elastogravity" waves that travel through the ground at the speed of light.

TING XU, A. AGRAWAL

Such signals were once thought to be too small to detect, says seismologist Martin Vallée of the Institut de Physique du Globe de Paris, who was not involved in the new work. Then in 2017, Vallée and colleagues reported seeing elastogravity signals in seismic station data. Those findings proved that "you have a window in between the start of the earthquake and the time at which you receive the [seismic] waves," Vallée says.

But researchers still pondered how to turn elastogravity signals into an effective early warning system. The tiny gravity wiggles are difficult to distinguish from background noise in seismic data. When scientists looked retroactively, they found that only six mega-earthquakes in the last 30 years have identifiable elastogravity signals, including the magnitude 9 Tohoku-Oki earthquake in 2011. That quake produced a devastating tsunami that flooded two nuclear power plants in Fukushima, Japan (SN: 4/9/11, *p.* 5).

So Licciardi and colleagues created PEGSNet, short for Prompt ElastoGravity Signals Network, a machine learning computer program designed to identify these tiny gravity shifts. The team trained the program on real seismic data collected in Japan and 500,000 simulated gravity signals for earthquakes in the same region.

PEGSNet was then given a test: Track the origin and evolution of the 2011 Tohoku earthquake as though it were happening in real time. The result was promising, Licciardi says. The program accurately identified the magnitude and location of the quake five to 10 seconds earlier than other methods.

This study is a proof of concept and hopefully the basis for an early warning system, Licciardi says. "It's tailored to work … in Japan. We want to build something that can work in other areas" known for powerful quakes, such as Chile and Alaska. The hope is to build a global system to work alongside other detection tools. ■

When grabbed, greater mouse-eared bats (one shown) make insectlike buzzing noises.

MARCO SCALISI

LIFE & EVOLUTION

These bats buzz like wasps and bees

Myotis bats may be the first known insect-mimicking mammals

BY JAKE BUEHLER

Some bats buzz like wasps and bees when grasped, and the sound seems to deter predatory owls.

The findings reveal what may be the first known case of a mammal mimicking an insect, researchers report in the May 9 *Current Biology*.

Animal ecologist Danilo Russo encountered the odd noise while studying greater mouse-eared bats (*Myotis myotis*) in Italy from 1998 to 2001. When he and colleagues removed bats caught in mist nets, the handheld animals made a buzzing noise that was reminiscent of wasps or bees. "When you hear them, that's what comes to your mind immediately," says Russo, of the University of Naples Federico II in Italy.

Years later, the researchers decided to test the idea that the uncanny buzzing was a defense mechanism called Batesian mimicry. Batesian mimics are themselves harmless but resemble — visually, acoustically or chemically — a different species that is distasteful or dangerous to predators. When wary predators can't tell harmless mimics from the noxious originals, the mimics are protected.

The team caught more of the bats and recorded the buzzing cries as the bats were handled in the laboratory. Researchers also recorded the buzzing sounds of four stinging insect species (two wasps and two bees) found in European forests.

The team compared audio profiles of insect and bat buzzing and revealed that most of the time, the analyses could distinguish between the two sound sources.

But audience matters. Tawny owls (*Strix aluco*) and barn owls (*Tyto alba*) commonly hunt bats, so Russo's team wondered if the birds could be the target for the buzzing performance. When the researchers limited their sound analyses to the frequencies that an owl hears, the buzzes became much harder to tell apart.

The team then played recordings of bat and insect buzzes — and bat social calls — to eight captive birds from each owl species. The owls reacted to the insect and bat buzzing the same way: by moving away from the speaker. In contrast, the owls approached the speaker when it played bat social calls, potentially associating those calls with prey.

Birds tend to avoid stinging insects, Russo says. The negative association might be evoked if an owl grasps a bat and hears an indignant buzz, he and colleagues suspect. If so, this scenario is the first known example of mimicry — acoustic or otherwise — where a mammal copies an insect, the team says.

Most examples of Batesian mimicry involve visual signals, so finding potential acoustic mimicry is exciting, says David Pfennig, an evolutionary biologist at the University of North Carolina at Chapel Hill who was not involved with the research. Pfennig points to a few examples of acoustic mimicry, such as burrowing owls imitating a rattlesnake rattle or Congolese giant toads hissing like Gaboon vipers.

But behavioral ecologist Matthew Bulbert isn't convinced the new finding is mimicry. Owls encounter bats and stinging insects in different contexts, so it's unlikely that bat buzzes fool the birds, says Bulbert, of Oxford Brookes University in England. Instead, the buzzing might startle an owl, increasing the chance it releases the bat. "That in itself is still pretty cool," he says. ■

ATOM & COSMOS

How dunes may form on Jupiter's Io

Gas let off when hot meets cold might explain the moon's lumps

BY NIKK OGASA

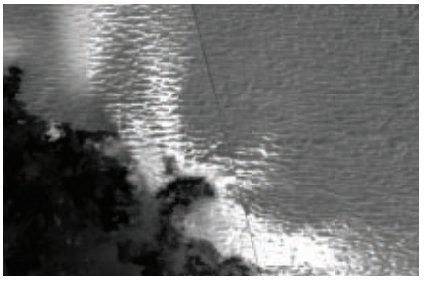
On Jupiter's moon Io, lava creeping beneath frost may give rise to fields of towering dunes.

That finding, described April 19 in *Nature Communications*, suggests that dunes may be more common on other worlds than previously thought, though the lumps may form in odd ways.

"In some sense, these [other worlds] are looking more familiar," says George McDonald, a planetary scientist at Rutgers University in Piscataway, N.J. "But the more you think about it, they feel more and more exotic."

Io is crowded with erupting volcanoes, created by the gravitational forces of Jupiter and some of its other moons pulling on Io and generating heat. Around 20 years ago, scientists reported another type of surface feature — hummocky ridges. They couldn't be dunes, scientists reasoned, because Io's atmosphere is too thin for winds to whip up a dunescape.

But in recent years, dunelike features have been discovered on comet 67P and Pluto (SN: 8/28/21, p. 20), planetary bodies that also lack thick atmospheres. So McDonald and colleagues revisited the matter of Io's mysterious mounds.



The dark area (lower left) in this composite image of Io's surface is a lava flow. The bright streaks may be evidence of material strewn by vapor jets created when the lava hits frost.

On Earth, powerful explosions of steam often occur when flows of molten rock encounter bodies of water. While water isn't found on Io, sulfur dioxide frost is pervasive. So the scientists hypothesize that when hot lava slowly flows into and under a frost layer, jets of sulfur dioxide gas could burst forth. That could provide the force needed to send grains of rock and other material flying, forming dunes.

The researchers calculate that an advancing lava flow, buried under at least 10 centimeters of frost, could turn some of the frost into pockets of hot vapor. When enough vapor accumulates and the pressure becomes high enough, the vapor could burst out at velocities over 70 kilometers per hour. These bursts could propel grains with diameters from 20 micrometers to 1 centimeter in size.

Images of Io's surface, collected by NASA's now-defunct Galileo probe, revealed highly reflective streaks of material radiating outward over dunes in front of lava flows — possibly material newly deposited by vapor jets. What's more, the dimensions of the hummocky features align with those of dunes on other planetary bodies. Some of the Ionian dunes are over 30 meters high, the team estimates.

A lot of scientists thought the lumps could be dunes, says planetary scientist Jani Radebaugh of Brigham Young University in Provo, Utah, who was not involved in the study. "What's exciting about it is that they've come up with a good physical mechanism to explain how it's possible." ■

BODY & BRAIN

Mom's voice loses its grip for teens

As kids grow up, unfamiliar voices get more interesting

BY LAURA SANDERS

Young kids' brains are especially tuned to their mothers' voices. Teenagers' brains, in their typical rebellious glory, are most decidedly not.

That conclusion, reported April 28 in the *Journal of Neuroscience*, may seem laughably obvious to parents of teens, including neuroscientist Daniel Abrams of Stanford University School of Medicine. "I have two teenaged boys myself, and it's a kind of funny result," he says.

But the finding may be deeper than a punch line. As kids grow up and expand their social connections beyond family, their brains need to be attuned to that growing world. "Just as an infant is tuned into a mom, adolescents have this whole other class of sounds and voices that they need to tune into," Abrams says.

He and colleagues scanned the brains of 7- to 16-year-olds as they heard the voices of either their mothers or unfamiliar women. To focus the experiment on just the sound of a voice, the words spoken were gibberish.

Abrams and colleagues have previously shown that in kids ages 7 to 12, certain regions of the brain — particularly those parts involved in detecting rewards and paying attention — respond more strongly to mom's voice than a voice of an unknown woman. But in these same brain regions in teens, the new study finds, unfamiliar voices elicited greater responses than mom's. The shift seems to happen between ages 13 and 14.

It's not that these brain areas stop responding to mom, Abrams says. Rather, the unfamiliar voices become more rewarding and worthy of attention. That's how it should be, Abrams says. Exploring new people and situations is a hallmark of adolescence.

Voices can carry powerful signals. Biological anthropologist Leslie Seltzer of the University of Wisconsin–Madison and colleagues have found that when stressed girls hear mom's voice on the phone, their stress hormones drop. The new results support the idea that the brain changes to reflect new needs, Seltzer says. Though, she notes, the results might change across varying mother-child relationships.

For now, teens and parents frustrated by missed messages can take heart, Abrams says. "This is the way the brain is wired, and there's a good reason for it." ■

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The Star Potential of GLIA

Outside the brain, these neglected cells step into the spotlight

By Laura Sanders

In a mouse spleen, glia (green) and nerves (white) mingle as they wrap around a small artery (pink). Such close connections in several organs have caught the attention of scientists.

T. LUCAS, L. ZHU AND M. BUCKWALTER/*GLIA* 2021

In the theater of the brain, nerve cells have long been cast as the stars, bringing mental scenes to life with their electrical and chemical performances. Yet many of the cellular actors in the human brain are glial cells, presumably the supporting cast and behind-the-scenes stagehands.

In recent decades, though, accumulating evidence has shown that glia are not just minor players that keep the show running. They actually play starring roles in many of the brain's most important acts, such as remembering, learning and thinking.

And the latest research points to a surprising new setting for the story of glia: outside the brain. Mysterious populations of glia reside in the heart, spleen, lungs and various other organs. But no one knows how they'll fit into the plot. Early hints suggest the story is going to be riveting.

Already, tantalizing clues are rolling in about what these cells are doing. Glia appear to help regulate the heart's beating, for instance. Glia in the spleen reside right between nerve cells and immune cells — a perfect spot to influence the connection between health and stress. Exactly what glia are up to in the lungs is unknown, but whatever it is seems important, early experiments suggest — mice with no lung glia die.

"The fact that now there are these new glial cell populations being discovered in unique organs will hopefully trigger a lot of lightbulbs," says

Sarah Ackerman, a neurobiologist at Washington University in St. Louis. Like most researchers who study glia, Ackerman focuses on glia inside the brain.

She sees big potential in the handful of new studies that look at far-flung glia. "There's going to be a revelation that across all of these organs, there are specialized glia that are supporting the function of the neurons there, but also overall organ health."

Understanding the roles of glia outside the brain could have big implications for human health, leading to better ways to treat heart disorders, immune system problems and even lung cancer, some scientists suspect.

"If we continue to ignore these cells, it's only going to slow us down," says Tawaun Lucas, a neuroimmunologist at Genentech in San Francisco. He recently uncovered details about glia in mouse spleens.

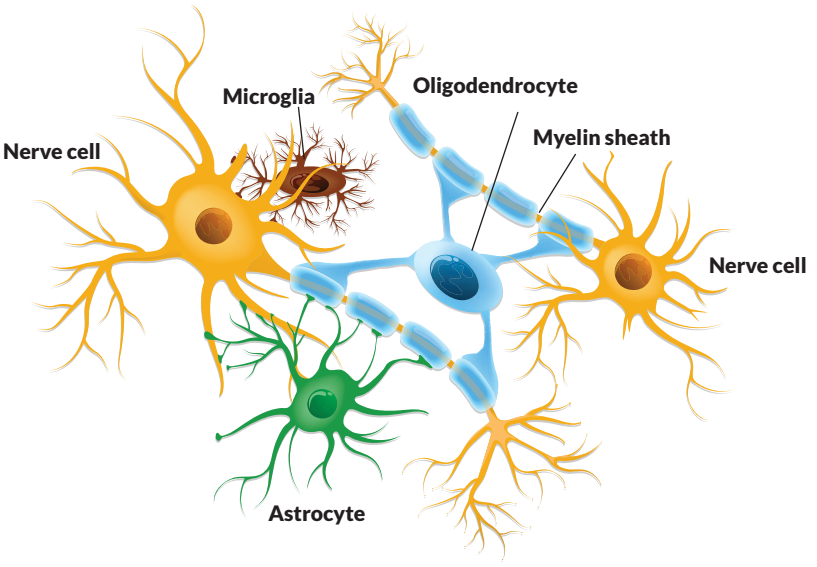
It's too early to know how important glia outside the brain will turn out to be. Maybe these studies on glia represent a burgeoning new field of research. Or maybe the mystery is never solved. "The connection it's going to have to the conventional world of glia as we know it remains to be seen," says Bruce Ransom, a neurologist and neuroscientist at the City University of Hong Kong who is also an editor in chief of the scientific journal *Glia*.

Still, the potential plotlines of these newly described groups of glia are worth following. "We're always looking for that little opening that you can enlarge and see something really important," Ransom says. "That's a possibility here."

Immune system meets nervous system

Glia are named for glue, the sticky substance that exists solely to hold other, more important things together. In the brain, various glia do lots of supporting. Glia called astrocytes keep nerve cells fed. Microglia combat invaders. And oligodendrocytes insulate nerve wires with a fatty substance called myelin. But glia are now known to have much fancier jobs too, including changing the signals that pass between nerve cells, guiding the growth of nerve cells and pruning neural connections called synapses (SN: 8/22/15, *p.* 18).

Researchers have a good handle on the roles of some glia outside the brain. Enteric glia help the gut digest food, for instance, and a type of glia called Schwann cells, sisters to the brain's oligodendrocytes, spread myelin on peripheral nerves to help speed signals along. In the skin, specialized Schwann cells kick off pain sensations, scientists reported in *Science* in 2019. Less is known about glia in other organs, such as the spleen glia that intrigue Lucas. Naming these glia can be tricky, since the cells sometimes share similarities with multiple types of other glia. For now, these outsider glia are often lumped into one of two catchall categories, nonmyelinating Schwann cells or satellite glia.



A family affair In the brain, several types of glia keep things running. **Microglia** are immune cells that patrol for pathogens, help prune nerve cell connections and more. **Oligodendrocytes** coat nerve fibers in myelin, insulation that speeds messages. **Astrocytes** guide nerve cell growth, regulate blood flow and influence signals between neurons.

Lucas started out as a neuroscientist at Stanford University, focusing on the brain. Then a mouse under a microscope shifted his attention. The mouse was genetically engineered so that its glia glowed green. As Lucas looked throughout the body, he saw green cells all over, including in the spleen, lymph nodes, kidney, liver and lungs.

His adviser at Stanford, neurologist Marion Buckwalter, was quickly captivated by the spleen glia. "I started reading about the spleen, and I thought, 'This is really fascinating,'" she says. The spleen is packed with immune cells. Like many organs, the spleen also contains nerves that are part of the body's sympathetic nervous system. This control system can dilate pupils, quicken heart rates and get the body sweating. Often called the "fight-or-flight system," the sympathetic nervous system flies into action under threats, says Lucas, "whether you get kicked in the head, or are chased by a tiger or have stressful things going on at work."

The sympathetic nervous system and the immune system converge in the spleen, and glia may be particularly important in this connection. Experiments with the mice revealed big, complex glia in the spleen right alongside message-sending nerve cell axons. And "just microns away, there are immune cells," Buckwalter says. The spleen's glia are perfectly positioned to communicate between

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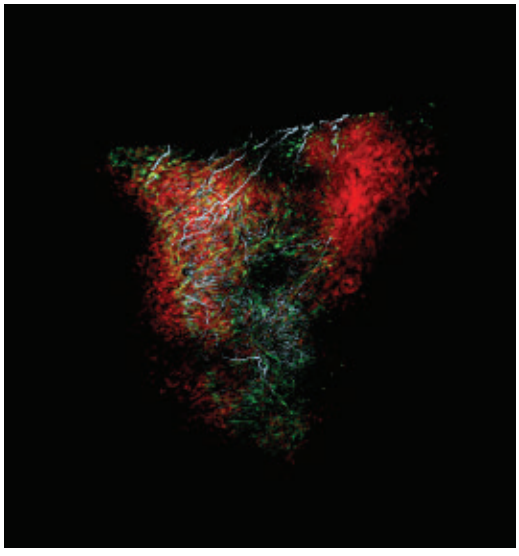


On a zebrafish heart (red), glia (green) form a netlike structure with nerve cells (blue) and their connections. These glia, named cardiac nexus glia, help regulate heart rhythm.

N. KIKEL-COURY (CC BY 4.0)

the nervous system and the immune system, the researchers reported in 2021 in *Glia*.

By looking at the genetic instructions inside those glia found in the spleen, Lucas and colleagues showed that the spleen's glia have the cellular equipment to speak the language of both immune cells and nerve cells: They can sense chemical signals made by immune cells *and* they can sense chemical signals sent by nerve cells. How these cells use this machinery is unknown, but the results position spleen glia to be important communicators. Until Lucas' experiments, no one had any clues about the glia's behavior, Buckwalter says.

The possibility of communication between glia, nerve cells and immune cells in the spleen "has potentially huge implications," Buckwalter says. Stress and brain injuries such as strokes can harm the immune system. After a stroke, for instance, the sympathetic nervous system instigates a die-off of immune cells called B lymphocytes in the spleen, which can lead to dangerous infections. Immune cells also play a role in autoimmune disorders such as multiple sclerosis and rheumatoid arthritis, which can flare up in people who are stressed. If glia influence the immune cells, perhaps their behavior can be tweaked to prevent such flare-ups.

Research so far is preliminary. It's not yet clear whether these spleen glia are in fact sending messages between the nervous system and the immune system, and if so, what the results of those conversations are. It's too soon to say with any certainty that glia in people's spleens are involved in autoimmune disorders, Buckwalter says. But the idea has piqued her interest.

Studying these mysterious cells in organs feels like a different sort of science, she says. It's harder than just trying to find a missing piece of a puzzle. "It's like we just got a puzzle, and the pieces aren't labeled and the box has no picture on it."

The beating heart

A similar puzzle can be found in the heart.

Cody Smith, who studies neural biology at the University of Notre Dame in Indiana, was well aware that the heart was packed with nerve cells. Most nerve cells are thought to have glia nearby, and Smith was eager to find the heart's glia. Along with graduate student Nina Kikel-Coury, Smith went searching for them. "We really had no idea what to expect," he says.

It turned out that a population of glia resides in the hearts of zebrafish. Named cardiac nexus glia, these cells appear early in zebrafish development and go on to spread out and form a gossamer-thin web around the heart, Smith and Kikel-Coury reported last year in *PLOS Biology*.

In zebrafish, at least, these glia do important work: They guide the development of the heart and regulate heartbeat. When the researchers messed with the cells, the fish's heart rates increased. That's an unusual effect, Smith says. Usually, disruptions to heart cells cause heart rates to slow.

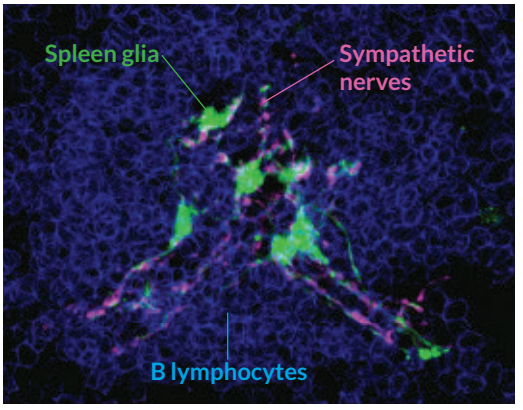
By looking at other datasets that catalog the genes active in mouse and human heart cells, the researchers found cells that had similar collections of active genes to the heart glia in the zebrafish. The shared genes suggest that these glia may be in many species' hearts. That data "support the idea that they're in humans," Smith says.

Some congenital heart disorders have defects in the outflow track of the heart, where blood exits to an artery. That's also the spot that these glia first appear early in zebrafish development. It's possible, Smith says, that these glia may be involved in human heart trouble. "We're at such an early phase of this work," he cautions. "I wish we had more answers."

The plot thickens

Investigations of glia in the spleen and brain are just the beginning. Organs throughout the body may rely on glia, other research hints. Glia have turned up in the lungs, for instance, found there in mice by Buckwalter and Gabriela Suarez-Mier, a graduate student when the work was done.

Lung glia may be involved in breathing and oxygen exchange in capillaries, Lucas says, but



In a mouse spleen, glia are nestled next to nerves that are part of the sympathetic nervous system, as well as immune cells called B lymphocytes. This close proximity positions glia as potential information brokers between the nervous system and the immune system.

details are slim. Those glia are crucial, Lucas' preliminary experiments suggest: When researchers use a toxin to kill the glia in the lungs, "all of the animals die."

In his current work, Lucas is studying glia's potential role in cancer. Tumors in lungs (and also in the liver and pancreas) have nerves that attach to them, and glia wrap themselves around those nerves, Lucas says. In a lab dish, other researchers have found, Schwann cells will grow toward cancer cells. So the behavior of glia that linger near a tumor is now an important question, Lucas says.

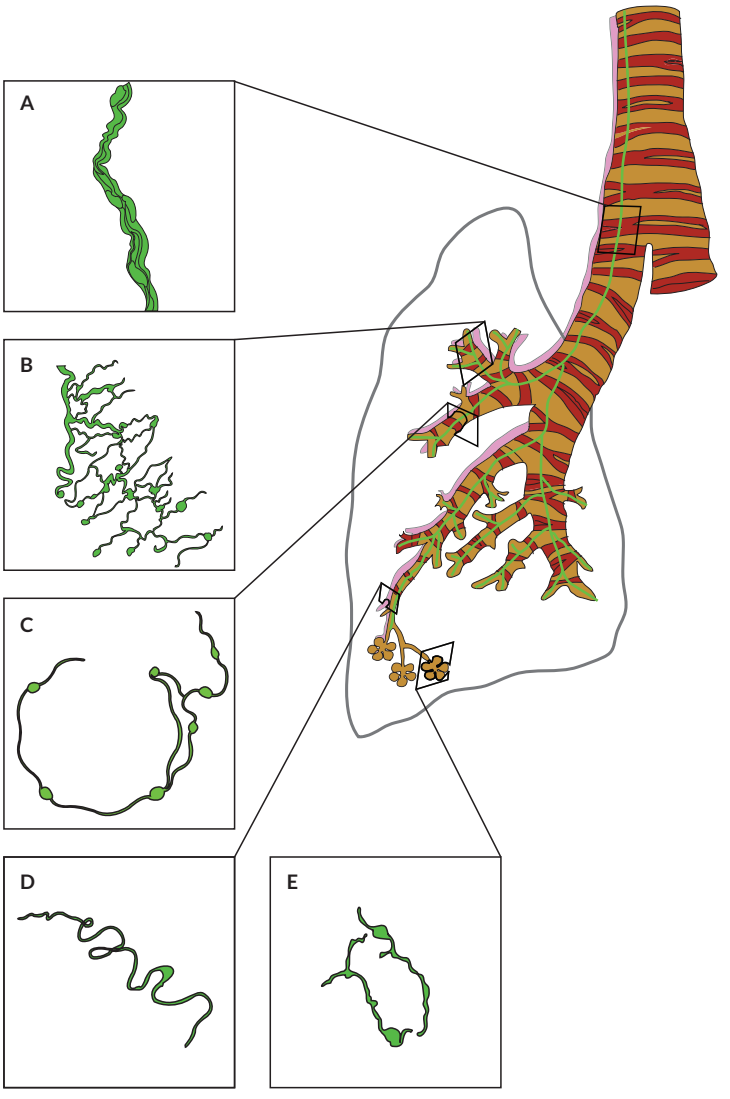
Understanding the body's glia and possibly enlisting them to fight disease will require more than a surface-level understanding. Techniques that reveal how individual cells use different collections of genes promise a deeper view of glia in the body. Other genetic labeling methods offer a way to monitor these mystifying glia in living animals. "The tools are going to allow us to go from, 'OK, they're there,' to 'What are they doing?'" says Ackerman, the neurobiologist at Washington University.

Glia biologists looking beyond the brain are still very much at the beginning of their script. "What cells are here and how do they work together?" Lucas asks. "We're starting from square one."

Being outside the brain puts these glia in a good position to be possible targets for therapies, Ackerman says. The brain is hard to reach with drugs, as it's ensconced in its protective blood-brain barrier. Brain cells are also less able to repair themselves than cells in the peripheral nervous system. "We might be able to affect positive change in a more efficient way than trying to direct repair in the brain or the spinal cord," she says.

It's too soon to say whether glia outside the brain are part of the same story as the brain's glia. The variety of glia residing outside the brain might all end up being individual bits of disparate biology, never coalescing into a plot that's relevant for the entire nervous system, says Ransom, of the City University of Hong Kong.

"I think it's exciting and interesting work, and I think it's completely justified to study it entirely," he says. For now, there's no telling where glia's story will take us. ■



Getting air In a mouse lung, glia (green) wrap around thick nerve bundles (A) that travel down the lung and meshlike nerves that surround large and small bronchi (B and C). Glia also wrap around blood vessel nerves (D) and small airways (E). This varied anatomy hints at some of the ways that lung glia might help with oxygen exchange.

FROM LEFT: T. LUCAS, L. ZHU AND M. BUCKWALTER/*GLIA* 2021; G. SUAREZ-MIER AND M. BUCKWALTER/*ASN NEURO* 2015

Explore more

- Emily Scott-Solomon, Erica Boehm and Rejji Kuruvilla. "The sympathetic nervous system in development and disease." *Nature Reviews Neuroscience*. November 2021.

A weapon against mosquitoes

As gene drives pass new tests, researchers in Africa are getting public input on whether to unleash them

By Tina Hesman Saey

In a large laboratory cage, a male mosquito carries a genetic weapon that could launch the destruction of his species. That loss could also mean the end of the parasite that causes malaria.

The weapon, a self-replicating bit of DNA known as a gene drive, is one of the most anticipated and controversial tools being developed to stop mosquitoes from spreading diseases like malaria to humans.

The gene drive interferes with the insects' ability to reproduce. It wiped out captive populations of mosquitoes in eight to 12 generations (SN: 10/27/18, *p.* 6) in a small lab study. In 2021, the technology worked in the large cages, in Terni, Italy, too. Within as little as five to 10 years, this gene drive could be ready to test in the wild.

The first experimental release could be rolled out in Burkina Faso, Mali, Ghana or Uganda. In those locations, researchers are working with a nonprofit research consortium called Target Malaria to develop the gene drive carriers along with other genetically engineered mosquitoes to fight malaria.

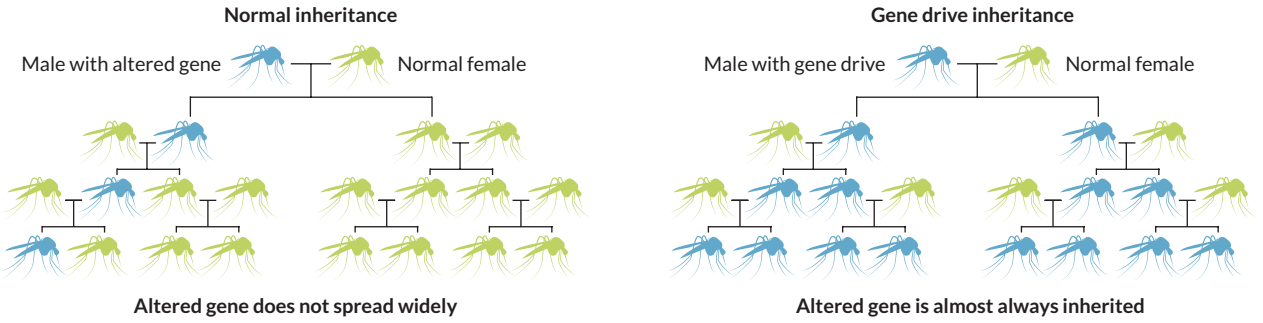
This research is driven by the idea that every tool available must be used to fight malaria, which sickened close to 241 million people in 2020 and killed 670,000 worldwide, mostly in Africa. Children 5 years old and younger accounted for about 80 percent of the continent's malaria deaths, the World Health Organization says.

Because of malaria's huge toll, large investments have been made to fight the disease, yielding preventive drugs, insecticide-treated bed nets and even malaria vaccines—one was recently recommended for use in sub-Saharan Africa (SN: 12/18/21 & 1/1/22, *p.* 32). These efforts are helping. But mosquitoes

Scientists in Terni, Italy, used a gene-editing technique called a gene drive to stop mosquitoes from reproducing in a laboratory (shown).

COURTESY OF TARGET MALARIA

Gene drive impels inheritance



are developing resistance to insecticides, and some anti-malaria drugs may no longer work well.

"To go toward zero [cases], we need to have something that is transformational," says Fredros Okumu, a mosquito biologist and director of science at Ifakara Health Institute in Tanzania.

Gene drives might be the transformational answer people are looking for. Researchers are still refining and testing the technology, which was first devised in 2015 (SN: 12/12/15, p. 16). Though other types of genetically altered mosquitoes have been released in Brazil, the United States and elsewhere, those altered genes spread slowly among wild populations (SN *Online*: 3/9/22). Gene drives could potentially spread to nearly ever member of a species quickly, forever altering the species or wiping it out.

But whether gene drives ever play a role in combating malaria may depend as much on social considerations as on science.

"A technology doesn't work by technical strength alone. It works because it embeds into a social context," says Ramya Rajagopalan, a social scientist at the University of California, San Diego. In the past, scientists "developed a technology in the lab, got it all set up and ready to go, and then you go to the stakeholders and say, 'Hey, we have this great technology, do you want to use it?'"

If people reject that sort of offer, as has happened with some genetically modified crops, researchers often think, "If [the public] only knew enough about the technology, they'd be more accepting," Rajagopalan says. But more often the failure comes because the researchers "don't include community voices from the outset in the design and the implementation."

Because of the possibility of forever altering ecosystems, the European Union has already said "no" to using gene drives there. But Africa is where a gene drive might one day help defeat malaria. Researchers are hoping to eventually release gene drives on the continent, but must first get public consensus. To that end, scientists are looking for ways to involve members of the public in research, and learn about local priorities and how to talk about the technology.

Rattling the cage

No one is ready to let mosquitoes carrying gene drives out of the lab yet. For now, researchers are doing tests with mosquitoes in captivity to get an idea of whether the technology will work as planned. In the Terni cage trials, scientists used small rooms, setting humidity levels, lighting and other characteristics to mimic some of the conditions the mosquitoes might encounter in the wild.

In cages almost 5 cubic meters big—about the size of a small dressing room—containing hundreds of *Anopheles gambiae* mosquitoes, scientists added male members of the same species that carried the engineered change to their DNA.

The gene drive used for this experiment is built on the molecular scissors known as CRISPR/Cas9. Male mosquitoes are engineered to carry the gene drive, which consists of instructions for making the DNA-cutting enzyme Cas9 and an RNA that guides the enzyme to the gene to be cut. When an engineered male mates with an unaltered female, Cas9 snips a gene called *doublesex* inside the fertilized egg. As the

Upping the odds

With other forms of genetic engineering, the altered gene follows normal rules of inheritance (left) and is passed on to only 50 percent of offspring. Gene drives (right) can paste themselves into a gene inherited from an unaltered parent, ensuring the genetic change gets passed on more often.

In Uganda, Target Malaria staff member Victor Balyesima collects mosquitoes for experiments. Local residents often help with this effort.

FROM TOP: E. OTWELL, M. TELFER; TARGET MALARIA

egg tries to repair the cut, the gene drive from the father's *doublesex* gene is pasted over the copy of the gene inherited from the mother. So the offspring gets two copies of the gene drive, instead of one.

Normally, any particular version of a gene has a 50 percent chance of being passed from parent to offspring. But with the copy-and-paste CRISPR system, gene drive–carrying mosquitoes pass the drive to about 96 percent of male progeny and more than 99 percent of females. With that genetic cheat, the gene drive spreads rapidly through the population.

The *doublesex* gene is essential for the development of female mosquitoes. When the gene doesn't work, "the mosquito itself doesn't work," says Ruth Müller, chief ecologist and entomologist at the Institute of Tropical Medicine in Antwerp, Belgium. The gene drive breaks the gene.

Female offspring that inherit two copies of a broken *doublesex* gene develop mouthparts and genitalia that are closer to the male form. Those females are sterile, and they cannot bite people with their malformed mouthparts. Unable to bite, those mosquitoes can't transmit malaria-causing parasites from their bodies to humans.

In those naturelike cages in Terni, when gene drive–carrying mosquitoes were introduced, the populations died out in 245 to 311 days, researchers reported in July 2021 in *Nature Communications*. In two cages where no gene drive mosquitoes were added, mosquito populations lived normally to the end of the experiment.

This was the first proof that the gene drive might work under almost real-world conditions, says Müller, one of the study's leaders. But there is still a lot to learn about drives, she says, including how they will affect mosquito populations in the wild, whether they can slow malaria's spread and importantly, what the impact will be on other creatures in the environment.

Getting those answers will determine the feasibility of moving forward scientifically. They will also play a big role in whether the public agrees to releasing a tool that could intentionally drive a species toward extinction.

Considering all possibilities

While Müller's and other Target Malaria science teams based in Africa, Europe and North America refine gene drives, other affiliated and independent groups are mapping out what releasing a gene drive could do to the planet. "Right now there are a lot of theoretical discussions," Müller says. It's important to gather data to "fill the debate with more facts" about the real risks and benefits, she says.

At least 46 theoretical harms could arise from the use of gene drives on mosquitoes, researchers reported in March 2021 in *Malaria Journal*. Those potential downsides include reductions in pollinators and other species directly or indirectly related to the disappearance of the mosquitoes. It's possible that people could develop allergic reactions to the bite of mosquitoes carrying a single copy of the gene drive, or to fish that eat the altered mosquito larvae. There could be a decline in water quality caused by large numbers of mosquito larvae dying. There's even a set of scenarios in which malaria cases increase if, for instance, mosquito species that are better malaria spreaders take over in areas where a gene drive has thinned out less-troublesome mosquitoes.

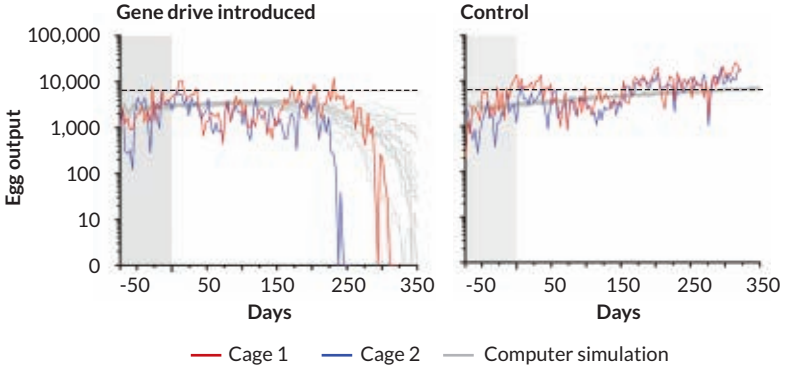
Dreaming up possible nightmare consequences was an exercise intended to tell researchers what they might need to plan for and test before releasing gene drive mosquitoes into the wild. At workshops held in 2016 through 2019 in Ghana, Kenya, Botswana, Gabon and the United States, researchers worked out a chain of events that might lead to each of those potential harms.

The list of 46 possibilities focused on four areas that African leaders said were most important to protect: biodiversity, human and animal health, and water quality. By identifying these hypothetical hazards, researchers can begin calculating the likelihood of a harm happening and how bad it could be, says report coauthor John Connolly, a senior regulatory scientist for Target Malaria who is based at Imperial College London.

"You probably never really finish a risk assessment, but you get a clearer understanding of the risks and uncertainties," Connolly says. Target Malaria and independent groups hope to answer some questions by examining data collected from the release of genetically altered mosquitoes that don't carry gene drives.

Population crash
In large cages with about 570 mosquitoes, researchers added about 70 gene drive–carrying males. As the gene drive spread, more females became sterile and egg production crashed. The gene drives worked faster than computer simulations suggested (gray). In control cages with no gene drive, egg production continued as usual (horizontal dotted black line).

Mosquito egg output differs with and without gene drive



A. HAMMOND *ET AL*/*NATURE COMMUNICATIONS* 2021

Studies of biological pest control mechanisms — such as releasing a predator to eradicate an invasive species (remember invasive cane toads in Australia [*SN Online*: 10/14/14]) — may also provide some clues about how gene drives may spread, says Keith Hayes, who leads a risk assessment team at the Commonwealth Science and Industrial Research Organization's Data61 in Hobart, Australia.

Some questions may never truly be answered unless gene drives are released. Scientists can experiment and simulate what might happen, but "at some point you have to say, 'We don't know everything. We can't know everything. There may be surprises,'" Hayes says. That's when a decision will need to be made about a release based on what is known about the risks and benefits.

High stakes

Even if those evaluations reveal downsides to gene drives, the potential benefits for human health and economics may far outweigh the risks, Müller argues.

"If you have a high burden of malaria, that costs a lot," Müller says. "Children cannot go to school. People cannot go to work. That should also be considered if you talk about costs."

Opponents of gene drives say it's unfair to paint rejection of the unproven, potentially dangerous, technology as dooming children to death from malaria. "We are already not saving those children with measures [that would help] such as improving sanitation and the medical system," says Mareike Imken, the European coordinator of the Stop Gene Drives campaign. Her organization is calling for a global moratorium on the release of gene drives until there is worldwide consensus on whether they are safe and necessary and how they should be regulated.

"We need the highest possible obstacle to using this high-risk … technology," Imken says. Allowing gene drives to be tried against malaria would essentially unleash them for use against a wide variety of organisms, with potentially devastating ecological consequences, she says. Instead, the world should invest more in already proven methods of controlling and eradicating malaria.

But there are potential upsides to gene drives that current approaches, such as insecticides, don't offer. "The stuff we have been doing for years has been intentionally designed to eradicate mosquitoes. It just didn't do it. We've been spraying the hell out of them for years, and in the process killing a lot of other nontarget organisms," Okumu says.

By replacing insecticides, gene drives might help

Vampire spiders might miss *Anopheles* mosquitoes … for a minute

If gene drives wiped out swaths of malaria-carrying mosquitoes, perhaps the only creature that would mourn the loss is a species of jumping spider found in the Lake Victoria region of Kenya and Uganda.

The spiders, *Evarcha culicivora*, share the mosquitoes' taste for human and animal blood. "This vampire spider is perhaps the only species we know is heavily dependent on these [mosquitoes]," says Fredros Okumu, a mosquito biologist and director of science at Ifakara Health Institute in Tanzania. He's referring to *Anopheles* mosquitoes, a main malaria spreader in Africa.

Blood is a unisex perfume for the spiders. Adults that have recently feasted on blood are more attractive to the opposite sex. Blood also provides nourishment for adult and baby spiders.

But the spiders' mouthparts are unable to pierce skin or hides, says Fiona Cross, an arachnologist at the University of Canterbury in Christchurch, New Zealand. Instead, the spiders wait for mosquitoes to siphon blood from a person or animal, then the spiders pounce on the flying blood bags (shown below). "We call them mosquito terminators," she says.

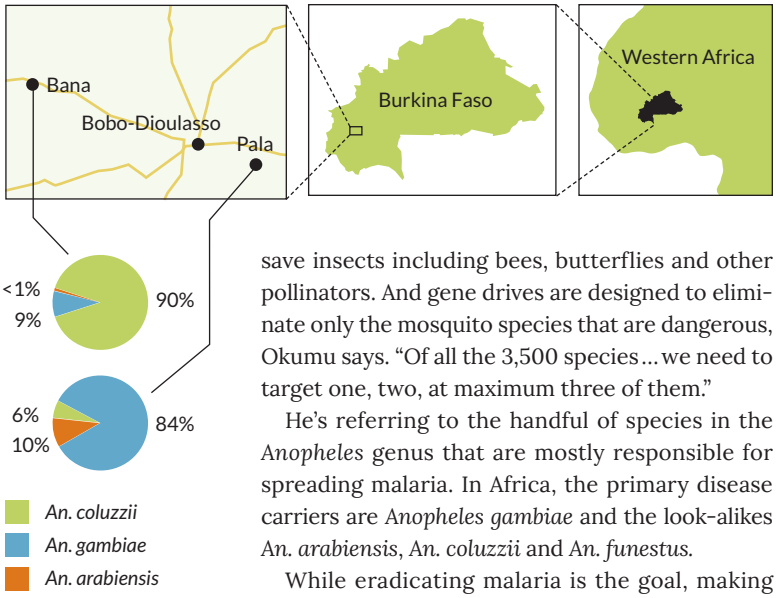
While any blood-laden mosquito will do, *Anopheles* mosquitoes are *Evarcha*'s favorite, partly because of the mosquito species' bottoms-up resting pose. While other mosquitoes rest with their abdomens parallel to a surface, *Anopheles* lift their rears into the air, especially helpful for baby spiders, which are able to creep under the tilted abdomen.

Baby spiders, which "basically resemble dots with eight legs," scuttle under the mosquito, "leap up, grab the mosquito from underneath, and as the mosquito flies away, the little spiderlings hang on with their little fangs and have just enough venom to bring the mosquito down," Cross says. "They have the feast of a lifetime."

But that doesn't mean gene drives would doom the spiders by eliminating large swaths of the mosquitoes, Cross says. "If *Anopheles* were wiped from the planet, I would say that the spiders could adapt." — *Tina Hesman Saey*

F. CROSS

Mosquito mixes in two villages in Burkina Faso



Malaria carriers

Though separated by only about 30 kilometers, the villages of Bana and Pala in western Africa's Burkina Faso each have a different mix of malaria-carrying *Anopheles* species. SOURCE: P.S. EPOPA *ET AL/MALARIA JOURNAL* 2019

Fact vs. fiction

Over five years, discussions with residents of Bana, Burkina Faso, cleared up some misconceptions about how malaria is transmitted. The talks were part of a Target Malaria effort to involve the community in plans to use genetically modified mosquitoes. SOURCE: L.P. TOE *ET AL/ MALARIA JOURNAL* 2021

save insects including bees, butterflies and other pollinators. And gene drives are designed to eliminate only the mosquito species that are dangerous, Okumu says. "Of all the 3,500 species … we need to target one, two, at maximum three of them."

He's referring to the handful of species in the *Anopheles* genus that are mostly responsible for spreading malaria. In Africa, the primary disease carriers are *Anopheles gambiae* and the look-alikes *An. arabiensis*, *An. coluzzii* and *An. funestus*.

While eradicating malaria is the goal, making mosquitoes extinct is mostly hyperbole, says Tony Nolan, a molecular biologist at the Liverpool School of Tropical Medicine in England.

"Extinction is not a likely outcome, nor even a desirable one. It's not necessary to make the mosquito extinct to eliminate malaria," says Nolan, one of the Target Malaria researchers developing gene drives. Geographic isolation may enable the gene drive to eliminate a local population of mosquitoes but nothing further afield. Mutations can arise in the Cas9 or guide RNA, causing the drive to stop working. Or other things might limit its spread.

But what would happen to the environment if a major mosquito species suddenly disappeared? Some researchers are trying to measure the ecological contributions of *An. gambiae*, including whether males pollinate plants visited for nectar. As of now, the mosquitoes' biggest known value is as food for predators. Birds, fish and other animals that eat mosquitoes or their larvae usually aren't picky about which species is for dinner. Only one species of spider is known to prefer *Anopheles* mosquitoes over other kinds (see Vampire spiders, Page 22).

Community agreement on false statements about mosquitoes and malaria in 2014 and 2019

Misconceptions about mosquitoes and malaria	2014 % agree (Respondents: 179)	2019 % agree (Respondents: 149)
All mosquitoes transmit malaria	76.3	16.1
Male mosquitoes transmit malaria	77.7	10.1
Seasonal fruits transmit malaria	13.9	0.9
Fatty foods transmit malaria	34.6	1.3

Okumu's experience leads him to think the malaria carriers wouldn't be missed much. In some parts of eastern Africa, including Okumu's home village in Tanzania, a combination of factors including prolonged dry seasons and insecticide and bed net use pushed *An. gambiae* out. "We have not seen — maybe because we didn't measure [well enough] — any ecological challenges associated with the disappearance of *Anopheles gambiae*," he says.

The mix of malaria carriers can vary considerably depending on local conditions. In Burkina Faso in western Africa, for instance, two villages had different mosquito populations: In Bana, to the northwest of the city Bobo-Dioulasso, about 90 percent of mosquitoes were *An. coluzzii* with *An. gambiae* making up 9 percent of the catch, researchers reported in 2019 in *Malaria Journal*. But on the southeastern side of the city, in the village of Pala, *An. gambiae* dominated, making up about 84 percent of mosquitoes caught. *An. arabiensis* accounted for about 10 percent, and *An. coluzzii* was about 6 percent of the catch in Pala.

If *An. gambiae* disappeared, one of the other species would fill the vacuum, Okumu says. That could be a good thing if the replacements don't bite people as much or are lousy at spreading malaria. It could also be worse if the balance shifts toward a more voracious people-biter that easily spreads the parasites.

Community input

Beyond the scientific hurdles, researchers must also get the public on board with releasing the technology. Without public support, even a gene drive that works perfectly could be a no-go.

Not everyone agrees on when and how to get input. Okumu worries that asking the public whether they want gene drives before scientists have answers to some of the most pressing questions could backfire. "I would rather we know the true benefits, the true risks and gain a consensus around it, and then start engaging the communities," he says.

Waiting until all the answers are in hand is a flawed approach, says Lea Pare Toe, a social scientist at the Institut de Recherche en Sciences de la Santé in Bobo-Dioulasso. "We should listen to [the community] and develop the science together," says Toe, who works with Target Malaria to engage local people in the research.

At Bana, researchers didn't start out talking about gene drives, or even genetic modifications, Toe says. First, the team had to clarify the connection between mosquitoes and malaria. They also

C. CHANG

had to dispel myths, such as eating fatty foods or sweet fruit can cause the disease. After an intensive engagement campaign from 2014 through 2019, researchers found that such false statements were far less accepted, the researchers reported in October 2021 in *Malaria Journal*.

Once people are clear on the causes of malaria, Toe and colleagues introduce the idea of genetics, and how researchers want to alter mosquitoes to combat malaria. People are generally OK with the uncertainty of research, she says. But they want to know more.

Residents pose specific questions about mosquito biology and ask how researchers can possibly work with such small creatures. They often ask whether the genetic alterations that make the mosquitoes sterile will transfer to humans. People "love the details," Toe says.

Sometimes, creative approaches are needed to get concepts across. For instance, Target Malaria planned a first stage — releasing genetically sterilized male mosquitoes that won't diminish mosquito populations — to help researchers collect data on how genetically altered mosquitoes stack up to normal ones in the wild.

Before those altered mosquitoes were set free, the organization wanted to ensure that Bana residents had a deep understanding of the project. Local leaders suggested a play. The scientists wrote a script, but the actors, a local storyteller and other community members revised it to improve storytelling. This helped forge an emotional connection with the audience, Toe and colleagues reported April 5 in *Humanities and Social Sciences Communications*.

Meanwhile in Tanzania, although reluctant to move too soon with the public, Okumu and colleagues talked with community leaders and surveyed residents of 10 villages in the southeastern part of the country, where very few people had heard about genetically modifying mosquitoes. The aim of this 2019 effort was to understand community perceptions, rather than ask permission. People were intrigued by the idea of gene drives, but they had concerns about whether the mosquitoes would look and behave differently from local mosquitoes, the team reported in March 2021 in *Malaria Journal*.

Community members were also skeptical that targeting just one type of mosquito would be enough to reduce malaria transmission or decrease mosquito bites enough to keep communities on board with the project. It would be better, they said, to get rid of all the biting mosquitoes.

In a separate study done in 2019, people in Uganda who were already familiar with gene drives expressed similar concerns. But those participants anticipated problems if the mosquitoes cross national borders into a country opposed to the release, researchers reported in March 2021 in *Malaria Journal*. Researchers may have to seek permission to release gene drive mosquitoes on a multinational scale, instead of just getting local and national consent.

TARGET MALARIA

Community leaders in Bana, Burkina Faso, suggested that researchers use theater to explain important concepts about genetically sterilized mosquitoes. Actors (shown during a performance) and community members helped develop the script.

Gene drives may win hearts and minds because they will first be tried against disease-carrying mosquitoes "that are very, very much not beloved or charismatic or anything," says developmental geneticist Kimberly Cooper of UC San Diego. "Do you know anyone who has sympathies for the mosquito? It's probably the most hated animal on the planet.

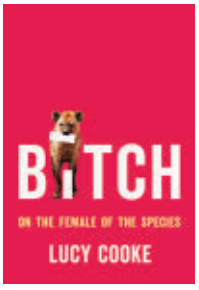
"But there will always be people who are very concerned about genetically modified organisms and their release into the environment," even if those organisms are mosquitoes, says Cooper, who is not involved with the malaria gene drive research but is developing a gene drive to use as a research tool in mice (*SN Online*: 1/23/19).

Still, the attraction of stamping out malaria is powerful. The benefits could be enormous. But whether they outweigh any environmental risks from the technology and whether the public will buy in to this radical approach remains to be seen.

"There are tons of unknowns," Okumu says. "The question is, should we pursue it? If you ask me, it would be unethical not to." ■

Explore more

- Lea Pare Toe *et al*. "Small-scale release of non–gene drive mosquitoes in Burkina Faso: from engagement implementation to assessment, a learning journey." *Malaria Journal*. October 9, 2021.



Bitch
Lucy Cooke
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BOOKSHELF

Sexism in biology has left female animals misunderstood

To Charles Darwin, nature had a certain order. And in that order, males always came out on top. They were the leaders, the innovators, the wooers and the doers.

"The males of almost all animals have stronger passions than the females," Darwin wrote in 1871. "The female, on the other hand, with the rarest of exceptions, is less eager." The founder of evolutionary theory posited that throughout the animal kingdom, males are active, females are passive, and that's pretty much that. Females, in sum, are boring.

That's poppycock, Lucy Cooke writes in her latest book, *Bitch*. This blinkered view of nature as a man's world was conceived and promulgated by Victorian men who imposed their values and world view on animals, she says. Cooke, a documentary filmmaker and the author of *The Truth About Animals* and two children's books (SN: 4/14/18, p. 26), has traveled the world and met scientists who are exposing the truth about the sexes. She takes readers on a wild ride as she observes the ridiculous mating rituals of sage grouse, searches for orca poop (to monitor sex hormones) and watches female lemurs boss around males.

Through such adventures, Cooke learns that females are anything but boring. "Female animals are just as promiscuous, competitive, aggressive, dominant and dynamic as males," she writes.

That may not sound radical to today's feminists, but in the field of evolutionary biology, such a pronouncement has long bordered on the heretical. Generations of biologists have focused on male behavior and physiology, on the assumption that females are little more than baby-making machines to be won over by the strongest, showiest males.

Female ring-tailed lemurs provide most territorial defense in their social groups, challenging stereotypes about male and female roles.

RAIMUND LINKE/THE IMAGE BANK/GETTY IMAGES PLUS

Historically, when females did something potentially interesting, like exercise leadership over their social groups, many scientists scratched their heads and chalked it up as an aberration. When behavior didn't fit the mold, like female-dominant spotted hyenas or peaceable male pinyon jays, it was either ignored or shoehorned into existing theory. For instance, ornithologists posited that aggressive female pinyon jays must suffer "the avian equivalent of PMS," Cooke writes. The reality is that pinyon jays have a complex social hierarchy that doesn't include the "alpha male" that scientists had expected. In recent years, scientists (many, but not all of them, female themselves) have begun to challenge Darwinian dogma about the sexes and submit it to rigorous testing.

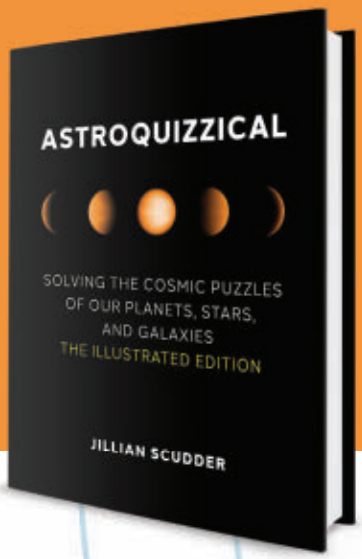
Cooke draws on this recent science to systematically take down myths about females. She begins by asking what biological sex actually is — what makes a male a male, and a female a female — and shows that it's far less black-and-white than we've been led to believe. Take the case of the European mole, in which the female sports gonads called ovotestes that produce eggs during the short breeding season, and testosterone the rest of the time. As a result, the female's genitalia look just like the male's, with a penislike clitoris and a vagina that vanishes after the breeding season.

The mole is just one example of sexual ambiguity among many that Cooke outlines. As the science of recent decades has revealed, even the genetics of sex is far more complicated than having either XX or XY chromosomes (which themselves are just one of many genetic systems for determining sex across the animal kingdom). In humans, males and females have the same set of about 60 sex-determining genes, which can create either testes or ovaries. Because of shared biology, the sexes are far more alike than they are different, and they exist in more of a continuum of bodies and behaviors than many people may be comfortable with.

Cooke also takes on many other ways scientists have misread sexual dynamics over the years, such as the myth that males benefit evolutionarily from promiscuity and females from monogamy. She addresses misconceptions about sexual cannibalism and animal genitals, complete with silicone replicas of animal vaginas. And she challenges ideas about the maternal instinct. As Cooke points out, males and females share the same neural circuitry, leading to fascinating experiments that stimulate certain nerve cells to flip male mice from infanticidal to doting dads.

In short, Cooke demolishes much of what you probably learned about the sexes in biology class. This may be disconcerting, even confronting for those who feel comfortable in the warm embrace of Darwinian order. But it's also exciting, and fascinating, and very well might change the way you see the world. — *Erika Engelhaupt*

Do all planets spin the same way?



In our solar system, all the major planets are spinning around their own internal axis. The diagram below shows each planet's direction of rotation, and the time it takes to make one complete rotation. If you think of the planets' orbits around the Sun as a flat surface, most planets spin as like a coin on its edge, flicked counterclockwise.

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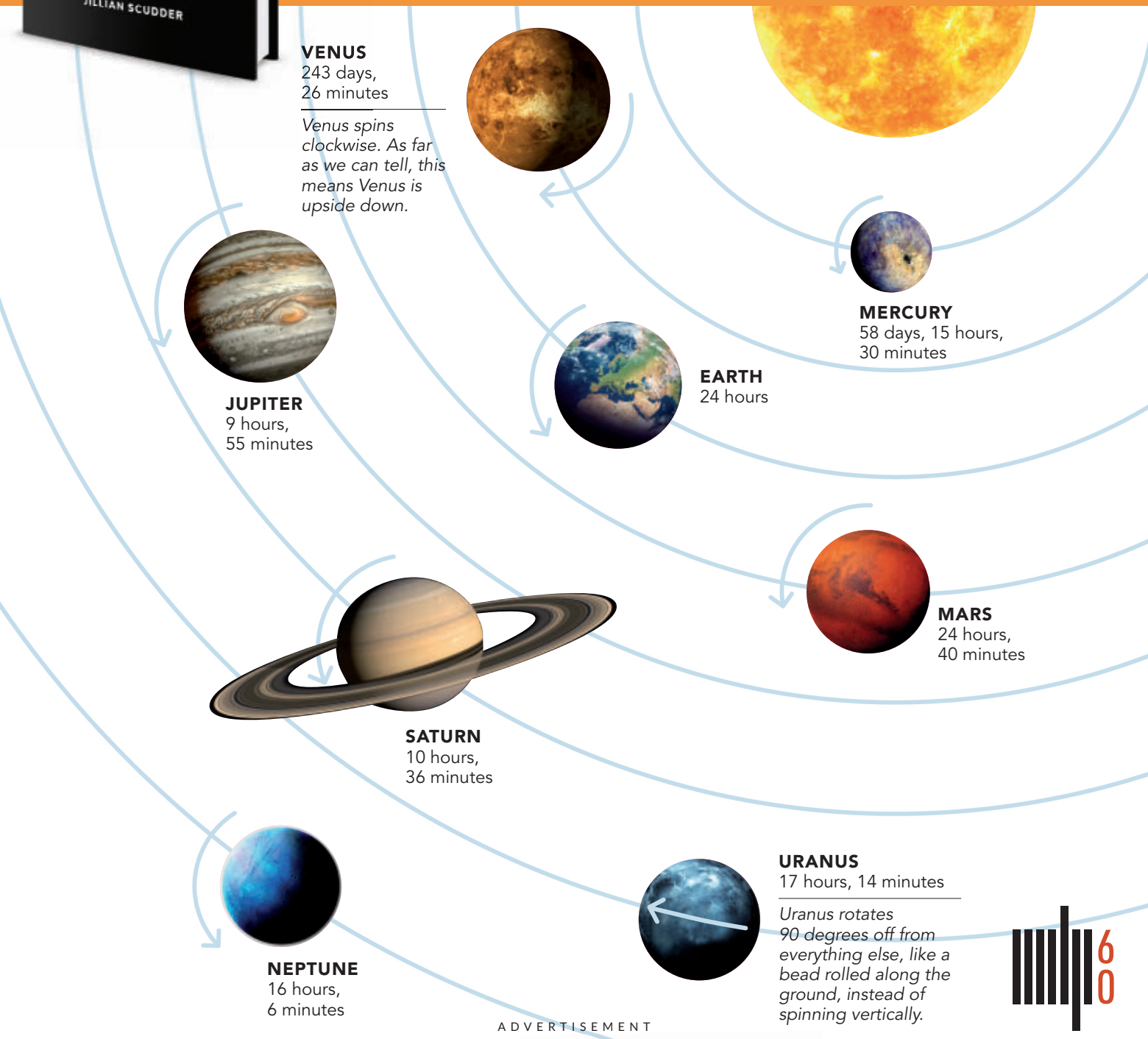

Science News for Students

Science News for Students is an award-winning, free online magazine that reports daily on research and new developments across scientific disciplines for inquiring minds of every age — from middle school on up.

Mosquitoes see red, which may be why they find us so appealing

Bzzz — a mosquito. A study has just identified another way these insects home in on us: They like the look of our skin. *Aedes aegypti* mosquitoes (shown) are attracted to reds, the same wavelengths given off by all human skin tones. They also like orange and light blue. Red hues attract three other mosquito species, too. But these bloodsuckers differ in what other colors they like. Researchers say this new intel could lead to better ways of luring mosquitoes into traps — and away from us. — *Laura Allen*

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Robots made of cells blur the line between creature and machine

Scientists recently assembled cells into living robots. "If you take a poppy seed and cut it in half twice, that's their size," says codeveloper Doug Blackiston, a biologist at Tufts University in Medford, Mass. These bots can move on their own, heal themselves and complete tasks, such as moving other objects. A growing number of researchers are exploring new ways to build things from cells — or from micromachines that mimic cells. Such bots — like the one illustrated, which can swim using muscle cells controlled by motor neurons — also raise ethical questions, including whether these creations are a new type of life. Some scientists warn that society needs to ponder these issues carefully as research on these technologies progress. — *Stephen Ornes*

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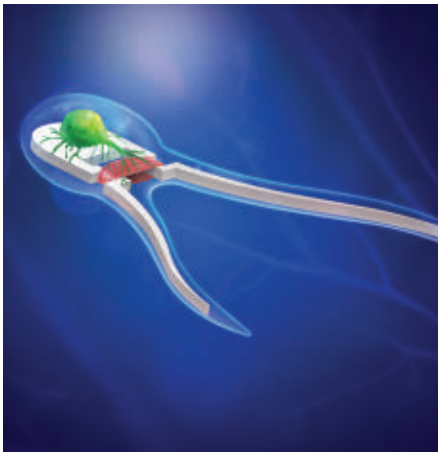

A bold plan to save the planet turns carbon dioxide into stone

The crumbling peaks of Oman's Al Hajar Mountains are slowly decomposing like a slab of rotten meat. But scientists believe these unusual rock formations may help tackle global warming. Their minerals are naturally petrifying 50,000 to 100,000 tons of carbon dioxide per year (seen here as whitish surface minerals). Researchers hope such rocks can one day help capture up to 20 billion tons of CO_2 from the air each year. "You're looking at something that could potentially have an impact on the human global carbon budget" — and slow climate change, says geologist Peter Kelemen of the Lamont-Doherty Earth Observatory in Palisades, N.Y. — *Douglas Fox*

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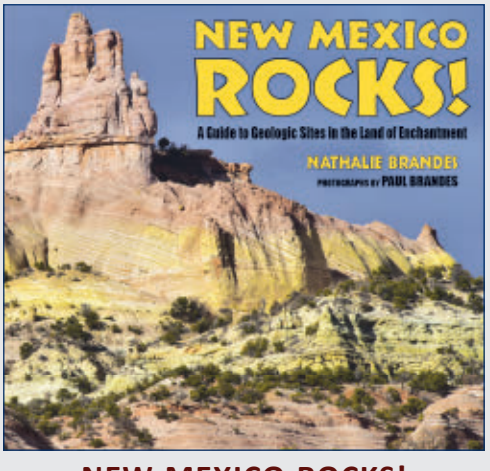

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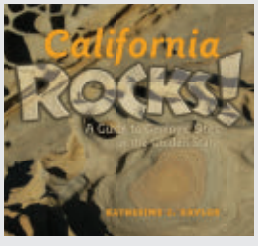

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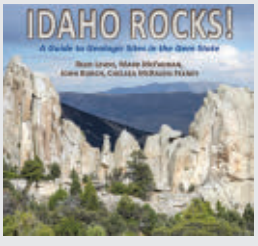

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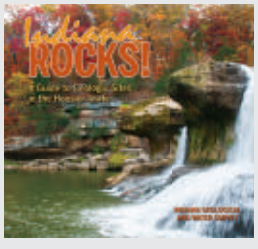

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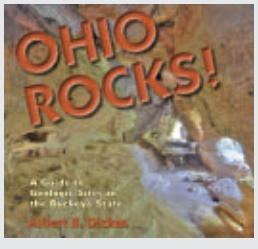

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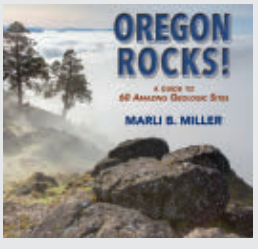

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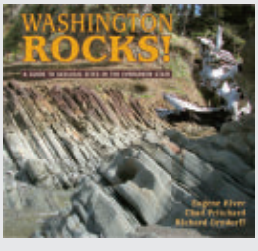

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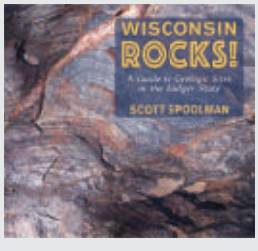

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Mirror, mirror

Clay models of dull and shiny beetles showed that Christmas beetles' mirrorlike exterior may not serve as a form of camouflage against predators, ***Susan Milius*** *reported in "Scientists scuff a theory about shiny disguises"* (SN: 4/9/22, p. 4).

Perhaps the clay models were simply not able to reproduce all the potential ways that the beetles' glittery bodies affect light and protect the insect, reader **Ron Kern** suggested.

It's true that the clay models didn't mimic all possible light effects generated by Christmas beetles, **Milius** says. But that wasn't the aim of the experiment. Think of the study as a sort of dissection, examining just one possible light trick at a time, she says. The results suggest that shine by itself isn't a deterrent against predators. Further testing could investigate whether other aspects of the beetle's mirror surface might offer benefits to these showy insects, **Milius** says.

Crater shapes

The impact that forged Hiawatha crater in Greenland happened about 58 million years ago, ***Carolyn Gramling*** *reported in "Greenland impact crater is surprisingly old"* (SN: 4/9/22, p. 5).

Reader **Barry Maletzky** asked why most impact craters are circular given that space rocks can strike at different angles.

Most craters are circular because of an impactor's explosive punch, says associate news editor **Christopher Crockett**. When space rocks crash into rocky planets and moons at high velocity, a tremendous amount of energy is transferred within a short period of time. At most angles of impact, such a process produces the typically round craters we see, scientists reported in 2013 in the *Journal of Geophysical Research: Planets*. "The effect is similar to planting explosives at the site and letting them blow," **Crockett** says.

Although they're rare, elliptical craters do occur in the solar system, and impact angle plays a role. The angle at which a crater becomes more likely to be elliptical than round depends on space rock size, impact velocity and type of material at the impact site, the study showed.

Resurrection roadblock

Scientists re-created the genome of the extinct Christmas Island rat by comparing it against the genome of a living relative. But some key DNA remains a mystery, ***Anna Gibbs*** *reported in "Rat reveals limits of de-extinction"* (SN: 4/9/22, p. 12).

Reader **Tim Cliffe** wondered if a complete genome could be reconstructed given enough DNA samples from different specimens of the extinct species.

The issue isn't that DNA is missing, but that scientists can't make sense of all the genetic sequences they have, says **Tom Gilbert**, an evolutionary biologist at the University of Copenhagen. Some genes in the Christmas Island rat's genome have diverged so much that they aren't remotely similar to the reference genome. If we can't identify the gene, we are unable to re-create it in a reference genome for the purpose of de-extinction, **Gilbert** says.

Deciphering brain waves

Researchers are studying the emotions of horses, octopuses and other creatures to understand how animals experience the world, ***Alla Katsnelson*** *reported in "What do animals feel?"* (SN: 4/9/22, p. 16).

In one study, horses that spent more time alone had more gamma brain wave activity than horses that grazed freely with a herd, **Katsnelson** reported. In people, high levels of such brain wave activity have been linked to anxiety and stress. Reader **Barbara Allan** thought that it was the opposite: Low levels of gamma brain wave activity are linked to stress and anxiety in humans.

Scientists are still working out how brain waves in people relate to various mental states, **Katsnelson** says. Studying brain waves and interpreting those studies is complicated, and the findings in this field vary. In their report, the researchers who studied horses point to evidence linking anxiety and stress to more gamma waves in people, she says. But other groups have found conflicting results, complicating the picture.

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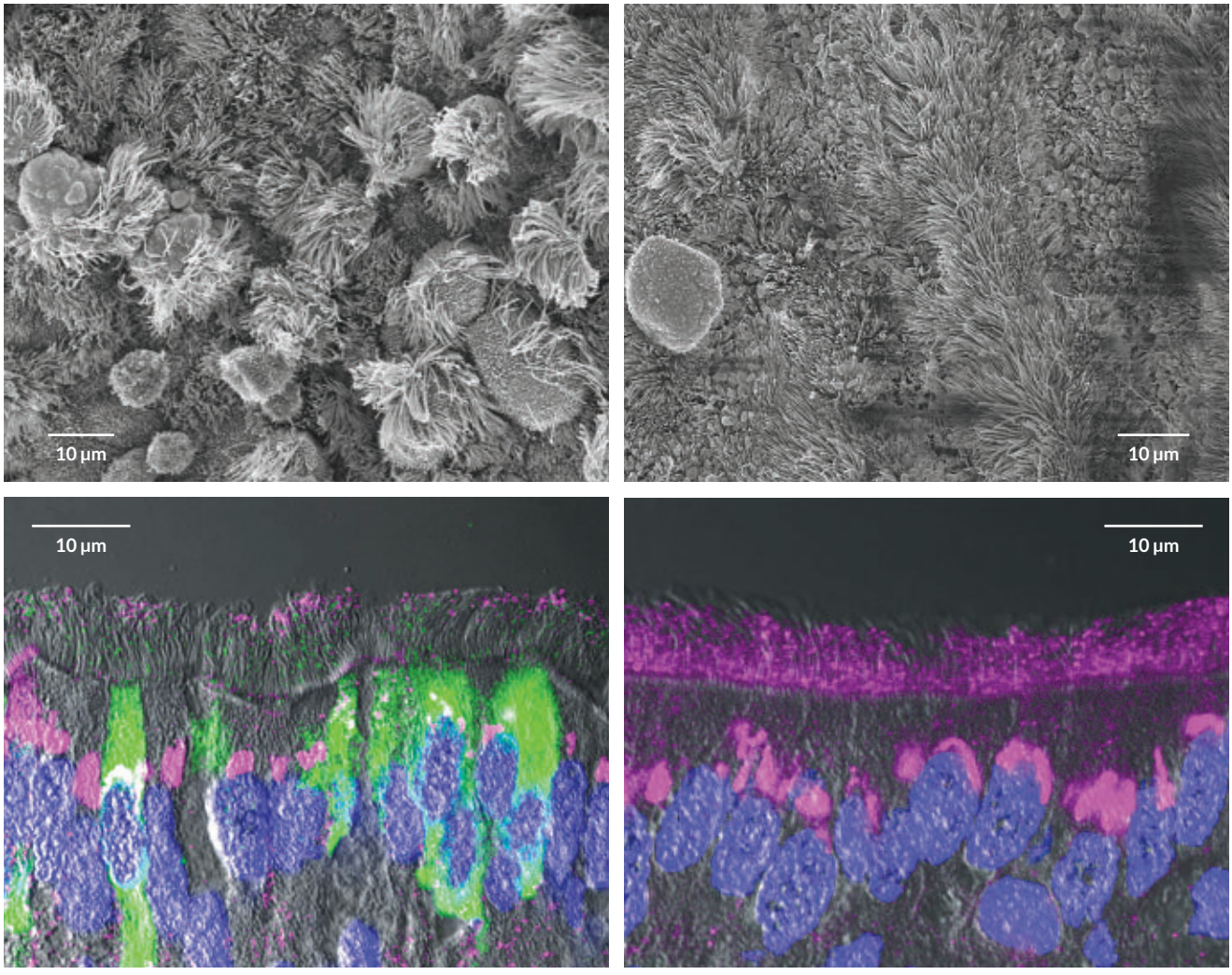

How allergic asthma helps protect against COVID-19

Allergic asthma may have a small bright spot: The immune system protein that triggers it may shield airway cells from infection with SARS-CoV-2, the virus that causes COVID-19. The finding helps explain why people with allergic asthma seem less prone to the coronavirus than those with other forms of asthma or related lung ailments.

Allergic asthma symptoms are triggered by allergens such as pollen or pet dander. These allergens prompt a protein called IL-13, which also helps the body fight off parasites, to signal the lungs to churn out sticky mucus and constrict airways. To see how IL-13 might help ward off SARS-CoV-2, pathophysiologist Camille Ehre of the University of North Carolina School of Medicine in Chapel Hill and colleagues grew airway cells in lab dishes. Some cells were treated with IL-13, and both treated and untreated cells were exposed to the coronavirus.

Healthy cells resemble grasslands, with protrusions called cilia sprouting from the cells' tops. But after four days, untreated cells exposed to the virus (top left) looked much different. Infected cells inflated like a balloon, with bald spots appearing as the cells died, the team reports in the April 19 *Proceedings of the National Academy of Sciences*. But cells doused with IL-13 (top right) got infected less often, leaving cilia lawns mostly intact, with far fewer balloons of dying cells.

IL-13 causes cells to churn out virus-trapping mucus. But it also protects cells by altering gene activity. For instance, it dials back production of the protein ACE2, which "makes it much harder for the virus to find its door to enter the cells," Ehre says.

IL-13 also ramped up production of a protective carbohydrate called keratan sulfate. Untreated cells (seen in cross section, bottom left) made little keratan sulfate (pink) and got infiltrated by the virus (green). Treated cells (bottom right) developed a thick layer of the carbohydrate, armoring the cells so they rarely got infected. In these images, cell nuclei are dark blue.

Which of these and other protective mechanisms is most important, or if it's a combination, is one of the many things left to explore, Ehre says. —*Tina Hesman Saey*

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