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ScienceNews

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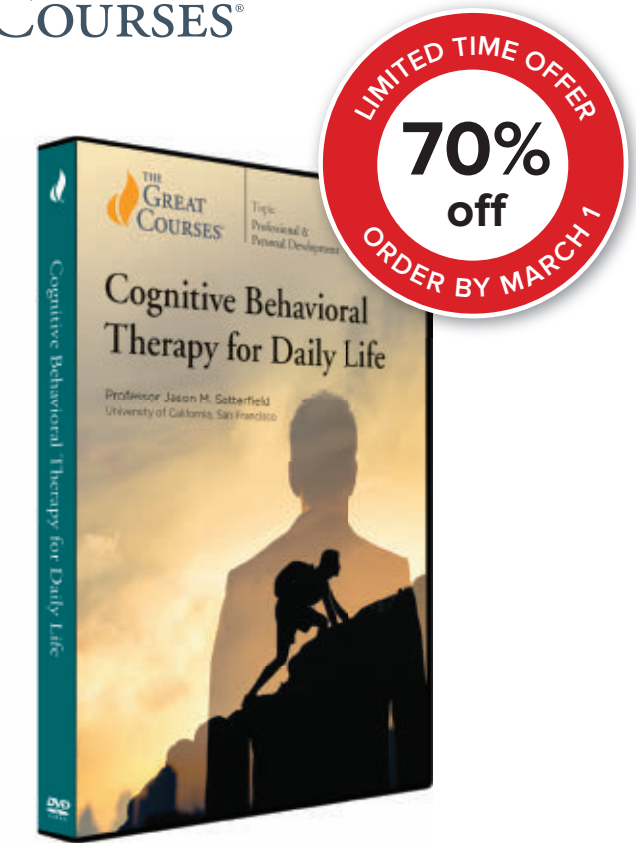

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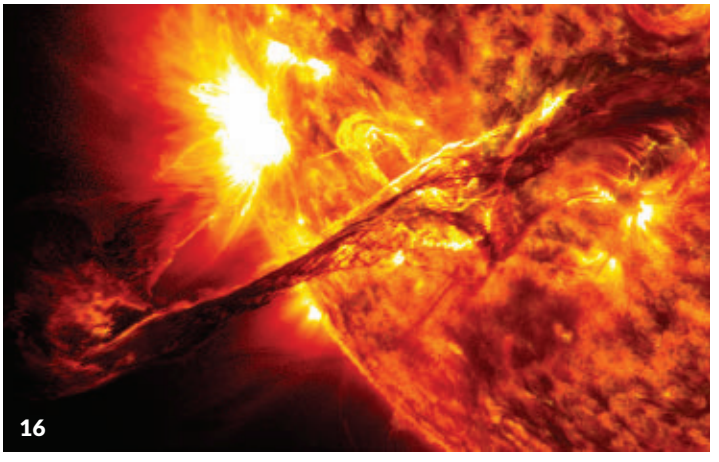
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COVER STORY There's got to be a better way to predict when the sun is going to send a burst of charged particles our way. Communication and transportation systems and the power grid depend on it. *By Ramin Skibba*

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Many U.S. colleges opened for fall semester last year, throwing a mixed bag of testing, surveillance and social distancing at students and staff. Did it keep the coronavirus at bay? *By Betsy Ladyzhets*

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Embroiderers stitch iconic images of brain cells

COVER A bright cloud of particles blew out from the sun in 2013. Activity in the current solar cycle is expected to peak in 2025. *SDO/Goddard/NASA/Flickr*

FROM TOP: NASA GODDARD SPACE FLIGHT CENTER; KATIE ASKEW/CAJAL EMBROIDERY PROJECT; BERNARD SPRAGG. NZ/FLICKR

When a naked mole-rat meets a sneaky sea worm

What do naked mole-rats and ancient sea worms have in common? Quite a bit, which is why they're sharing real estate on Page 8 of this issue.

One of my favorite parts of editing *Science News* is reading page proofs, one of the last steps in the long magazine production process. Even though I know what's going into the magazine and have read the articles before, it's still like opening up a surprise gift to see the pages come together. It's the work of dozens of people, a process that starts when writers pitch ideas for news and feature articles. News stories get published first on the *Science News* website, and there are many more than we can fit in a magazine. So it's up to managing editor Erin Wayman to choose the ones that will go into print. She looks for the most important or intriguing science of the previous two weeks, and aims for reporting across the fields of science, from artificial intelligence to zoology.

Articles that make the cut often either help answer a question that scientists have worked to solve for a long time, or alert us to something that's surprising and counterintuitive.

For Page 8, Wayman picked a report on how naked mole-rats use distinctive dialects to communicate with mole-rats within their social group. "It may seem surprising, but they're highly social animals, so they would need a way to communicate," she says. I was surprised and charmed by the notion of these mostly blind critters chirping away in their burrows.

Wayman then paired the chatty naked mole-rats with a story of fossils that suggest giant worms may have dug tunnels in the seafloor millions of years ago, springing forth from them to nab unsuspecting prey. While present-day hairless rodents and ancient predatory worms may not seem to have much in common, Wayman says she sees a pattern. "You're looking at behavior today and in the past, which gives insights into animal behavior."

And for more connections between present and past, Page 9 features a story suggesting that hominids may have developed a specialized thumb muscle quite early on, one that helps give humans today our firm grip and uniquely adaptable hands. "It's amazing that the manual dexterity that we rely on has been around for almost 2 million years, even before we were human," Wayman says. Perhaps we have that muscle to blame for humankind's newly acquired talent for texting.

Whether it's clueing our readers into gossipy naked mammals or ancient thumb muscles, we put a great deal of care into choosing articles that not only tell you something interesting or fun about the world, but also something that's relevant to life today. That includes our continuing in-depth coverage of the coronavirus pandemic: Page 7 has a fascinating article explaining how a common antidepressant may help fend off serious illness from COVID-19.

I hope you enjoy reading the magazine as much as we love creating it for you. And if you need more great science journalism while awaiting the next issue, we've got plenty more for you at www.sciencenews.org.

— Nancy Shute, Editor in Chief

CTK Bio Canada Develops Bioplastic Resin Designed to Break Down in Soil and Seawater

CTK Bio Canada has developed a new bioplastic resin designed to biodegrade by both industrial and home composting, as well as in unmanaged environments like soil and seawater. The Company is now undertaking detailed experimental trials with academic partners to validate its technology ahead of anticipated commercial rollout in 2022.

Park and Shum developed their technology in partnership with Profs. Zachary Hudson and Emily Cranston, experts in plant-based materials technology at the University of British Columbia. Hudson holds the Canada Research Chair in Sustainable Chemistry, and Cranston is currently the President's Excellence Chair in Forest Bio-Products. Once the formulation had been developed, prototyping began with the Polymer Materials and Manufacturing group at McMaster University; Heera Marway, Vladimir Gritsichine, Profs. Michael Thompson and Li Xi.

The Company's materials are designed to overcome a critical barrier in the bioplastics space—the ability to degrade in water. While increased use of bioplastics are a positive sign for the environment, Shum and Park knew that too much of it was still ending up in rivers and oceans where they couldn't easily biodegrade. CTK Bio Canada's materials are designed to break down not only if disposed of in the green bin, but also if they end up discarded to the environment. The materials should degrade only to nontoxic byproducts, while also remaining compatible with equipment for manufacturing traditional plastics.

Most importantly, the team believes they can achieve these milestones in materials science while keeping costs competitive with petroleum-based plastics. Initial prototyping has already been completed on a series of plastic parts and films, with detailed testing planned in 2021 to validate the material's degradability. The Company has also released a white paper on its website describing the formulation and design in more detail.

CTK BIO CANADA

WANT TO LEARN MORE?

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Excerpt from the March 6, 1971 issue of *Science News*

50 YEARS AGO

Whale protection

Whaling by the single remaining United States whaling firm, the Del Monte Fishing Co. of San Francisco, will probably end as the result of a proposal ... to terminate licensing for hunting the finback, sei and sperm whales. The three were placed on the endangered species list last year.

UPDATE: During the 20th century, humans killed an estimated 2.9 million large whales. In response to those losses, countries eventually took action. Legislation passed in the 1970s effectively put a stop to commercial whaling in the United States. A worldwide ban followed in 1986, though some countries including Japan, Norway and Iceland continue to hunt the animals. The bans have helped whale populations recover, but not enough to move these three species off the U.S. endangered species list. Sperm whales have rebounded to an estimated 450,000 individuals, sei whales number around 50,000 and finback whales have reached about 100,000. Ship collisions now pose a bigger threat to the mammals than commercial whaling (*SN Online: 7/29/14*).

THE SCIENCE LIFE

A physicist is unraveling knitting's math secrets

Physicist Elisabetta Matsumoto is an avid knitter and has been since taking up the hobby as a child. During graduate school at the University of Pennsylvania in 2009, Matsumoto came across an unusually knotty stitch while knitting a pattern for a red dragon. "I have books with thousands of different stitch patterns, but the one in the red dragon wall hanging was one I had never seen," she says. That got her thinking about the geometry of stitches and, eventually, led her to study the mathematics of knitting.

There are two types of stitches — knit and purl — and they can be combined into 100 or so basic patterns, Matsumoto says. By varying stitch combinations within patterns, a knitter can alter the elasticity, mechanical strength and 3-D structure of the resulting fabric. Yarn on its own isn't very elastic. But when knitted, the yarn gives rise to fabric that can stretch by more than twice its length while the yarn itself barely stretches.

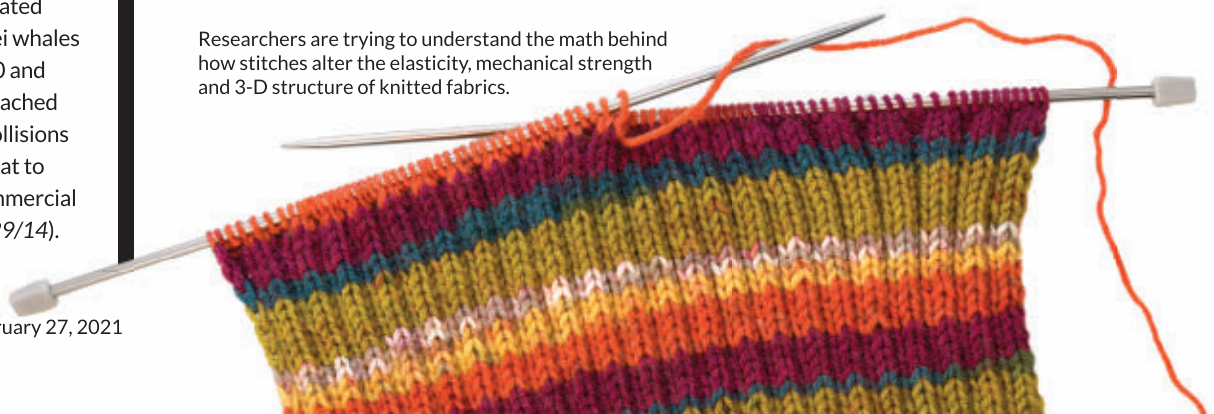
Physicist Elisabetta Matsumoto hopes to create a dictionary of stitches that could be used to manipulate material properties.

Matsumoto, now at Georgia Tech in Atlanta, is teasing out the mathematical rules that dictate how stitches impart such properties to fabrics. She hopes to develop a catalog of stitch types, their combinations and the resulting fabric properties. Knitters, scientists and manufacturers could all benefit from a dictionary of knits, she says.

Matsumoto's research builds on knot theory, a set of mathematical principles that define how knots form. These principles have helped explain how DNA folds and unfolds and how a molecule's makeup and distribution in space impart it with physical and chemical characteristics (*SN: 9/15/18, p. 32*). Matsumoto is using knot theory to understand how each stitch entangles with its neighbors. "The types of stitches, the differences in their geometries as well as the order in which you put those stitches together into a textile may determine [the fabric's] properties," she says.

Making tiny changes, such as altering a couple of crossings in a knot, could have a huge impact on the mechanics of the textile. For instance, a fabric made of solely knits or purls tends to curl at the edges. But combine the two stitch types together in alternating rows or columns, and the fabric lays flat. And despite looking nearly identical, these knitted fabrics have varying degrees of stretchiness, Matsumoto and grad student Shashank Markande reported in July in the *Bridges 2020 Conference Proceedings*.

Matsumoto's team is now training a computer program to predict the mechanical properties of fabrics, based on yarn properties, mathematical stitch details and final knitted structures. These predictions could someday help tailor materials for specific applications — from scaffolds for growing human tissue to wearable smart clothing (*SN: 6/9/18, p. 18*) — and perhaps solve knotty problems of everyday life.
— Lakshmi Chandrasekaran



Researchers are trying to understand the math behind how stitches alter the elasticity, mechanical strength and 3-D structure of knitted fabrics.

FROM TOP: COURTESY OF E. MATSUMOTO; ROMIRI//ISTOCK/GETTY IMAGES PLUS

A newly discovered bat species from Guinea's Nimba Mountains is a great reminder that there's flashy coloring in the bat world.

INTRODUCING

A new bat species is always ready for Halloween

Bats, better known for their mousy looks, can have a colorful side. A new species, discovered when two bats were caught at an abandoned mining tunnel in western Africa, sports showy orange and black swaths of fur.

The species, dubbed *Myotis nimbaensis*, is "just gorgeous," says mammalogist Nancy Simmons of the American Museum of Natural History in New York City. Orange fur on the bat's back contrasts with black patches of wing membranes. But bright fluff is not what sets this species apart: Three other *Myotis* species in Africa are similarly flashy. Rather less visible traits, from details of its echolocation calls to hidden striping in its fur, peg *M. nimbaensis* as unusual, Simmons and colleagues report online January 13 in *American Museum Novitates*.

Researchers discovered the new species the old-fashioned way — in a remote forest at night with keen eyes studying real animals. When Simmons' team collected the first bat, near the mouth of an abandoned tunnel for mineral exploration in Guinea's section of the Nimba Mountains, the dramatic beast wasn't obviously a new species. While most kinds of bats are various shades of brown and black, bats here and there around the world can be yellow, fluffball white or coppery red. And there was the matter of Africa's other orange *Myotis* species.

M. nimbaensis, named for its mountainous habitat, differs genetically from near kin about as much as humans differ from gorillas, Simmons says. Differences also show up in teeth and other anatomy. One way to tell the new species apart, for instance, is from the proportions of secret stripes on the hairs in orange fur patches. The bottom third of each hair is black. Then comes a creamy white middle third before the hair turns pumpkin at the tip. — *Susan Milius*

SCIENCE STATS

COVID-19 worsened students' mental health

The coronavirus pandemic has caused the mental health of U.S. college students to plummet, researchers report January 7 in *PLOS ONE*. Environmental psychologist Matthew Browning of Clemson University in South Carolina and colleagues surveyed more than 2,500 students from seven public universities across the United States last spring. About 85 percent of those surveyed experienced high to moderate levels of emotional distress arising from the pandemic, the team found. Students most at risk of mental health challenges included women, Asian people, students under age 25, students in poor health, those who knew somebody with COVID-19 and lower-income students. Spending eight or more hours in front of computer, smartphone or TV screens also increased the risk. — *Sujata Gupta*

~85
percent

Proportion of U.S. college students surveyed who experienced moderate to high levels of emotional distress early in the pandemic

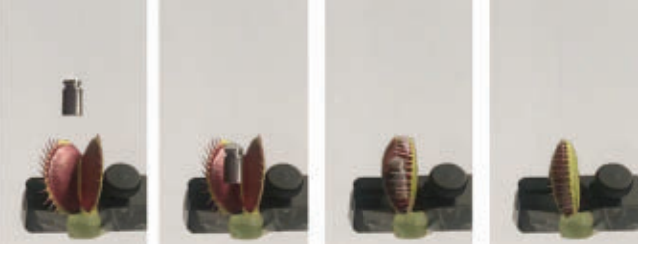
HOW BIZARRE

A robot arm toting a Venus flytrap has a gentle but firm grasp

A new robotic grabber is ripped straight from the plant world. The device, made with a severed piece of a Venus flytrap, can grasp tiny, delicate objects, researchers report January 25 in *Nature Electronics*.

Normally, the carnivorous *Dionaea muscipula* scores a meal when an unsuspecting prey touches delicate hairs on one of the plant's jawlike leaves, triggering the trap to snap shut. By sticking electrodes to the leaves and applying a small electric voltage, researchers designed a method to force Venus flytraps to close. Even when cut from the plant, the leaves retained the ability to shut upon command for up to a day, say materials scientist Wenlong Li and colleagues at Nanyang Technological University in Singapore.

Integrating soft, flexible plant material into robotics could aid in picking up fragile objects that would otherwise be damaged by clunky, rigid graspers (*SN: 4/13/19, p. 5*), the researchers say. So, Li's team attached a piece of a flytrap to a robotic arm and used a smartphone app to control the trap. In experiments, the grabber clutched a piece of wire half a millimeter in diameter. The dismembered plant also caught a slowly moving one-gram weight. One drawback: The traps take hours to reopen, so this bot had better make the catch on the first try. — *Emily Conover*



In laboratory experiments, a robotic grabber made with part of a Venus flytrap grasped a slowly moving one-gram weight.

FROM TOP: © BAT CONSERVATION INTERNATIONAL; W. LI *ET AL*/*NATURE ELECTRONICS* 2021

Watch the robotic Venus flytrap grabber in action at **bit.ly/SN_RoboFlytrap**

LIFE & EVOLUTION

Many early fossils may be impostors

Abiotic objects that resemble microbes preserve more easily

Crystalline objects known as biomorphs, such as these sphere-shaped structures, are made nonbiologically through chemical reactions and can closely resemble microfossils.

C. NIMS

BY CAROLYN GRAMLING

When it comes to finding fossils of very ancient microbial life — whether on Earth or on other worlds, such as Mars — the odds are just not in our favor.

Microbial life-forms are much less likely to become safely fossilized in rocks compared with nonbiological structures that happen to mimic their shapes. That finding suggests that Earth's earliest rocks may contain abundant fakers — minuscule objects masquerading as fossilized evidence of life, researchers report online January 28 in *Geology*.

The finding is "at the very least a cautionary tale," says geomicrobiologist Julie Cosmidis of the University of Oxford.

Tiny, often enigmatic structures found in rocks dating back more than 2.5 billion years can offer hints of the planet's earliest life. The hunt for ever-more-ancient signs of life has sparked intense debate — in part because the farther back in time you go, the harder it is to interpret tiny squiggles, filaments and spheres in the rock (*SN: 1/18/20, p. 5*). One reason is that the movements of Earth's tectonic plates over time can squeeze and cook the rocks, deforming and chemically altering tiny fossils, perhaps beyond recognition.

But an even more pernicious problem is that such filaments or spheres may not be biological in origin at all. Increasingly, scientists have found that nonbiological chemical processes can create similar shapes, suggesting the possibility of "false positives" in the fossil record.

One such discovery led to the new study, Cosmidis says. A few years ago, she and others were trying to grow bacteria and make them produce sulfur. "We were mixing sulfides with organic matter, and we started forming these objects," she says. "We thought they were formed by the bacteria, because they looked so biological. But then we realized they were forming in laboratory tubes that happened to have no bacteria in them at all."

That led her to wonder about such processes happening in the rocks themselves. So she and others examined what would happen if they tried to re-create the early formation stages of chert, a compact, silica-rich rock common on the early Earth. "Microfossils are often found in chert formations," says study coauthor Christine Nims, a geobiologist now at the University of Michigan in Ann Arbor.

Chert forms when silica precipitates out of water and accumulates, eventually hardening into rock. Cosmidis, Nims and colleagues added sulfur-containing bacteria called *Thiothrix* to solidifying chert to see what might happen during actual fossilization. To other chert samples, they added sulfur-containing "biomorphs," bacteria-shaped spheres and filaments made of tiny crystals.

Nanoparticles of silica encrusted the bacteria and the biomorphs, Nims says. But after a week or so, the bacteria started to deform, their cells deflating from cylinders into flattened, unrecognizable ribbons as the sulfur inside the cells diffused out and reacted with the silica outside the cells, forming new minerals.

The biomorphs, on the other hand, "had this impressive resiliency," she says. They also lost sulfur to the surrounding solution but kept their silica crust. That endurance suggests that enigmatic structures found in the early rock record have a better chance of being pseudofossils, rather than actual fossils, the team says.

The idea that living creatures are harder to preserve makes sense, says Sean McMahon, an astrobiologist at the University of Edinburgh. "Biomass does tend to break down quite quickly." In fact, scientists have known for centuries that certain chemical reactions can act as "gardens" that "grow" mineral objects that twist into tubes, sprout branches or otherwise mimic life. "There's a complacency about it, a misconception that we kind of know all this and it's already been dealt with," McMahon says.

Strategies to deal with this conundrum have included looking for certain chemical compounds in a potential fossil or for structures, such as mound-shaped stromatolites, that are thought to be uniquely formed or modified by the presence of life (*SN: 11/10/18, p. 12*). Those criteria are the product of decades of field studies, through which scientists have amassed a reference dataset of fossil structures to compare new finds against.

What's lacking is a similarly rich dataset for how such structures might form in the absence of life, McMahon says. This study highlights that attempts "to define criteria for recognizing true fossils in very ancient rocks are premature, because we don't yet know enough about how nonbiological processes mimic true fossils."

It's an increasingly urgent problem with rising stakes, as NASA's Perseverance rover will search for traces of life in ancient rocks on Mars, McMahon adds. "Paleontologists and Mars exploration scientists should take [this study] very seriously." ■

Antidepressant could treat COVID-19

Fluvoxamine prevents mild cases from worsening, data suggest

BY ESTHER LANDHUIS

The antidepressant fluvoxamine could prevent people from getting seriously ill with COVID-19, curbing hospitalizations, new data show.

The results come from real-world use of the drug to treat workers at the Golden Gate Fields horse racing track in Berkeley, Calif. Of those who opted to take fluvoxamine, none got sicker, and within two weeks, symptoms cleared. In comparison, 12.5 percent of those who turned down the drug wound up hospitalized. Two people got so sick they were put on ventilators to assist with breathing, and one of them died, researchers report online February 1 in *Open Forum Infectious Diseases*.

The data need verification from ongoing larger clinical trials. Still, some experts say that the new findings, along with cell, animal and human observational data, suggest that a two-week course of fluvoxamine, which costs about $10 and is already approved by the U.S. Food and Drug Administration, could be considered for patients at high risk of suffering severe COVID-19 symptoms.

Racetrack physician David Seftel and David Boulware, an infectious disease physician-scientist at the University of Minnesota Medical School in Minneapolis, led the real-world test after hundreds of track workers became infected with the coronavirus in November. That month, Seftel had heard about fluvoxamine during a presentation by tech entrepreneur Steve Kirsch, whose COVID-19 Early Treatment Fund supports research on existing drugs that could be repurposed to treat coronavirus infections (*SN: 9/26/20, p. 8*).

Kirsch shared results from a fund-supported randomized trial in which none of 80 newly diagnosed COVID-19 patients assigned to a two-week course of fluvoxamine became seriously ill. By comparison, six of 72 patients, or 8.3 percent, who took a placebo worsened, and four needed hospitalization, researchers reported in November in *JAMA*.

It wasn't just the trial results that intrigued Seftel, however. "I immediately dove into the biochemistry," he says.

The drug's biochemistry implied it might be able to regulate cellular responses to stress and infection. Fluvoxamine is a selective serotonin reuptake inhibitor, or SSRI, typically prescribed for obsessive-compulsive disorder. SSRIs prolong signaling of the chemical messenger serotonin in the brain. The drugs, most notably fluvoxamine, also activate a protein called sigma-1 receptor that prevents production of chemical messengers that exacerbate inflammatory reactions.

0
percent
Proportion of COVID-19 patients in a new study who took fluvoxamine and were hospitalized

12.5
percent
Proportion of patients who did not take the drug and were hospitalized

In a 2019 study, mice that lacked sigma-1 receptor died from systemic inflammation known as sepsis; fluvoxamine treatment protected animals from deterioration and death. Lab dish experiments described in the Dec. 4 *Science* showed that knocking down levels of sigma-1 receptor in cultured cells lowered infection rates with SARS-CoV-2, the virus that causes COVID-19. Fluvoxamine also blocks activation of platelets, blood components important for clotting. This anti-platelet activity, together with the mouse and cell data, explain how fluvoxamine might squelch out-of-control immune activity and prevent blood clots — both key features of severe COVID-19.

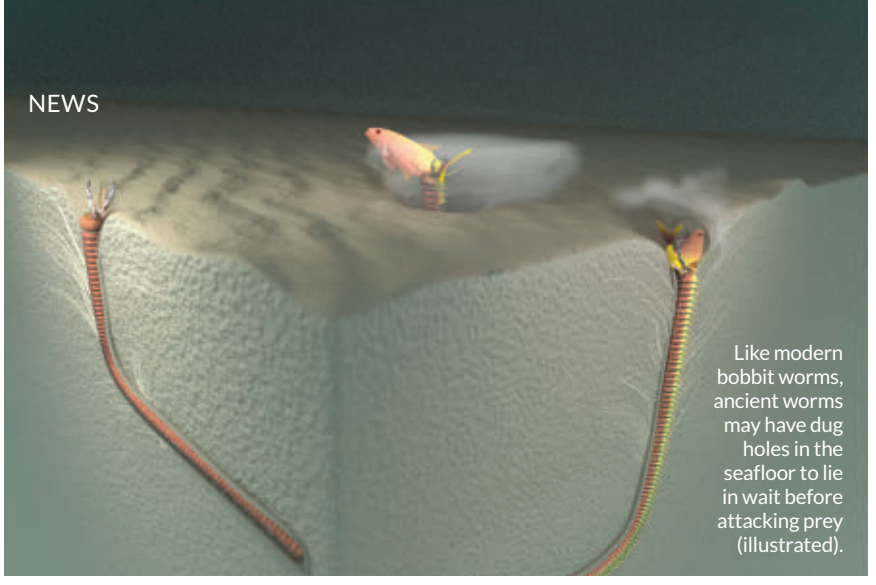
Seftel shared the emerging data on fluvoxamine with 113 infected racetrack workers and offered a 14-day course of the drug at no cost to those who could safely take it. The group was predominantly male and Latino, and 30 percent had chronic medical problems such as diabetes or high blood pressure.

Sixty-five people chose to take the drug, and 48 declined. The treatment group had a higher proportion of Latinos and tended to be sicker — 62 percent entered the study with COVID-19 symptoms compared with 42 percent of the group that declined treatment. No one who took the drug suffered serious complications, and after 14 days, none reported lingering symptoms. But six of 48 people who declined fluvoxamine were hospitalized, and one died. What's more, 60 percent still reported experiencing a variety of symptoms including shortness of breath and muscle and joint pain two weeks after their diagnosis.

Even though it wasn't a randomized, controlled trial, the racetrack study adds to evidence that there may be a benefit to giving fluvoxamine to patients with COVID-19. "It wasn't blinded. Overt and unconscious bias can occur when you know who's getting treatment or not," says Jeffrey Klausner, an infectious disease physician at the University of Southern California in Los Angeles who was not involved with the research. But "it definitely reduces the likelihood that the [*JAMA*] study was just by chance."

Researchers at Washington University School of Medicine in St. Louis are testing fluvoxamine in a larger, randomized nationwide trial financed by Kirsch's fund and other philanthropic sources. Participants get pills, either fluvoxamine or placebo, shipped to their homes, along with a thermometer, pulse oximeter and blood pressure monitor. Participants take the pills for 15 days and log symptoms on a web-based platform. As of February 4, the trial had enrolled 200 people, says coinvestigator Angela Reiersen, a child psychiatrist. The team hopes to collect data from 880 people.

Randomized trials in Korea, Brazil and Hungary are also investigating fluvoxamine as a possible treatment in patients with mild to moderate COVID-19. ■



Like modern bobbit worms, ancient worms may have dug holes in the seafloor to lie in wait before attacking prey (illustrated).

LIFE & EVOLUTION

Fossil lairs hint at ambush attacks

Ancient worms may have hid in the seafloor before striking

BY HELEN THOMPSON

About 20 million years ago, giant ocean worms may have burrowed into the seafloor and burst forth like the space slug in *Star Wars* to ambush unsuspecting prey.

Underground lairs left behind by these animals appear in rocks from coastal Taiwan, researchers report January 21 in *Scientific Reports*. The diggers may have been analogs of today's bobbit worms (*Eunice aphroditois*), which bury themselves in sand to surprise and strike fish.

Paleontologist Masakazu Nara of Kochi University in Japan first spotted the fossilized burrows in 2013. Eventually, Nara and colleagues found 319 specimens. The team determined the burrows were up to 2 meters long and 2 to 3 centimeters wide. To make these tunnels, the animals drilled L-shaped paths into the seafloor. The paths had a funnel structure at the top that looks like a feather in vertical cross sections.

Some kind of giant worm likely dug the burrows, the researchers conclude, because the burrows lack the hallmark pellets lining shrimp tunnels and had smoother linings than bivalve tunnels. Iron deposits along the inside suggest the digger must have been long and slender and used mucus to reinforce the walls. Funneling at the top of burrows also points to the worm emerging from its hideout, retreating and then rebuilding the top sections over and over again.

"These [funnels] suggest that the worm repeatedly dragged its prey down into the sediment," says study coauthor Ludvig Löwemark, a geoscientist at National Taiwan University in Taipei.

These hunting tactics are consistent with those of bobbit worms, which conceal their 3-meter-long bodies in sand and surge forth to grab unsuspecting fish with scissorlike jaws. While the oldest evidence of bobbit worms dates to around 400 million years ago, how or if the burrow diggers relate to bobbit worms is unknown.

Because the animals that lived in these ancient tunnels were invertebrates, they didn't have skeletons to leave behind in the fossil record. "It is almost always a challenge to link fossil traces to specific trace makers," says David Rudkin, an invertebrate paleontologist at the Royal Ontario Museum in Toronto, who was not involved with this study. Still, Rudkin thinks that the case for ancient bobbit worms hiding in these burrows is convincing.

If ancient bobbit worms did terrorize the seafloor back then, the burrows are a rare example of invertebrates hunting vertebrates — usually it's the other way around. Bobbit worms' presence would also make the local ecosystem more complex than previously thought, Löwemark says. "There was obviously a whole lot more going on at the seafloor 20 million years ago than one would imagine when seeing these sandstones," he says. ■

LIFE & EVOLUTION

Naked mole-rats squeak in dialects

Unique 'chirps' may help group members recognize each other

BY JONATHAN LAMBERT

When one naked mole-rat encounters another, their chirps might reveal whether they're friends or foes.

These rodents are famous for their wrinkly, hairless appearance. But hang around one of their colonies for a while, and you'll notice something else — naked mole-rats are a chatty bunch. Their burrows resound with near-constant chirps, grunts, squeaks and squeals.

A computer algorithm has uncovered a hidden order within this cacophony, researchers report in the Jan. 29 *Science*. Distinctive chirps that pups learn help the mostly blind, xenophobic rodents discern who belongs, strengthening the bonds that maintain cohesion in these highly cooperative groups.

"Language is really important for extreme social behavior, in humans, dolphins, elephants or birds," says Thomas Park, a biologist at the University of Illinois at Chicago who wasn't involved in the study. This work shows naked mole-rats (*Heterocephalus glaber*) belong in those ranks as well, Park says.

Naked mole-rat groups resemble ant or termite colonies. Every colony has one breeding queen who suppresses the reproduction of tens to hundreds of workers that dig elaborate subterranean tunnels in search of tubers in eastern Africa. Food is scarce, and the rodents attack intruders from other colonies.

While researchers have long noted the raucous chatter, few have studied it. "Naked mole-rats are incredibly cooperative and incredibly vocal, and no one has really looked into how these two features influence one another," says neuroscientist Alison Barker of the Max Delbrück Center for Molecular Medicine in Berlin.

She and colleagues used machine learning to analyze over 30,000 "soft chirps" — a common vocalization — from

Y.-Y. PAN ET AL/SCIENTIFIC REPORTS 2021

Watch a bobbit worm's sneak attack at **bit.ly/SN_BobbitWorm**

seven lab colonies over two years. Each colony had a unique sound, varying primarily in frequency and how much that frequency changes within a single chirp.

Naked mole-rats pick up on these differences too, replying to the sounds of their own colony with frequent chirping but largely ignoring foreign dialects, the researchers found. The animals aren't just responding to voices they've heard before either, as artificially concocted calls matched to a specific dialect also elicited a response.

A bit of luck allowed Barker's team to test whether dialects are learned or genetically encoded. Most colonies reject outsiders, but sometimes pups from other groups can get adopted. Multiple lab populations produced new litters around the same time, allowing the team to switch three youngsters to new colonies. If dialect stems from genetics, these outsiders should still sound like outsiders as they grow up. But if dialects are learned, transplanted pups should sound like their new brethren. The latter was true.

"A sample size of three is small, but these are really difficult experiments to do," says Chris Faulkes, an evolutionary ecologist at Queen Mary University of London. Still, he says the results strongly suggest that dialects of naked mole-rats are learned, similar to those of humans, cetaceans and some birds.

Naked mole-rats from different colonies have distinctive dialects, which help maintain colony cohesion, a new study suggests.

While a colony's sound is distinctive, it's not fixed. In periods of anarchy — when a queen dies and is not yet replaced — dialects start to dissolve, becoming much more variable, the researchers found. Once a new queen emerges, the colony coheres again, suggesting that in addition to suppressing reproduction, queens also somehow control a colony's voice.

"We tend to think of this communication and cooperation as positive aspects of naked mole-rat culture, but individuals are rigidly controlled in their behavior by the queen," Barker says. "It gives them a huge survival advantage, but it's a bit like living in an oppressive regime." ■

HUMANS & SOCIETY

Humanlike grips go back 2 million years

Thumb dexterity gave some hominids an edge in toolmaking

BY BRUCE BOWER

Thumb dexterity similar to that of people today already existed around 2 million years ago, possibly in some of the earliest members of our own genus *Homo*, a new study indicates. That finding is the earliest evidence to date of an evolutionary transition to hands with powerful grips comparable to those of human toolmakers, who didn't appear for roughly another 1.7 million years.

Thumbs that enabled a forceful grip and improved the ability to manipulate objects gave ancient *Homo* or a closely related hominid line an advantage over hominid contemporaries, says a team led by Fotios Alexandros Karakostis and Katerina Harvati. *Australopithecus* made and used stone tools but lacked humanlike thumb dexterity, thus limiting its toolmaking capacity, the paleoanthropologists, both from the University of Tübingen in Germany, found.

The team digitally simulated how a key muscle influenced thumb movement in 12 fossil hominids, five 19th century humans and five chimpanzees. Surprisingly, Harvati says, a pair of roughly 2-million-year-old thumb fossils from South Africa display agility and power on par with modern human thumbs.

Scientists disagree about whether the South African finds come from early *Homo* or *Paranthropus robustus*, a species on a dead-end branch of hominid evolution. But the thumb dexterity in those ancient fossils is comparable to that found in members of *Homo* species that appeared after around 335,000 years ago, the researchers report online January 28 in *Current Biology*. That includes Neandertals from Europe and the Middle East, as well as a South African hominid dubbed *Homo naledi*.

By comparison, the researchers conclude, *Homo* or *P. robustus* possessed thumbs that were more forceful than those of three several-million-year-old *Australopithecus* species, two of which have previously been proposed to have had humanlike hands (*SN: 2/21/15, p. 9*).

"*Australopithecus* would probably be able to perform most [tool-related] hand movements, but not as efficiently as humans or other *Homo* species we studied," Harvati says. The tool-wielding repertoire of *Australopithecus* fell closer to that of modern chimpanzees, which use twigs to collect termites and wield rocks to crack nuts, she suggests.

The new study goes beyond past efforts that focused only on the size and shape of ancient hominid hand bones. Using data from humans and chimpanzees on how hand muscles and bones interact while moving, the team constructed a digital 3-D model to re-create how a key thumb muscle — musculus opponens pollicis — attached to a bone at the base of the thumb and operated to bend the digit's joint toward the palm and fingers.

The new findings on how ancient thumbs worked underscore the slowness of hominid hand evolution, says paleoanthropologist Matthew Tocheri of Lakehead University in Thunder Bay, Canada. *Australopithecus* made stone tools as early as about 3.4 million years ago (*SN: 6/13/15, p. 6*). "But we don't see major changes to the thumb until around 2 million years ago," he says, "soon after which stone artifacts become far more common across the African landscape." ■

FELIX PETERMANN/MAX DELBRÜCK CENTER

Having two distinct mitochondrial genomes may help explain how the tuatara, a reptile native to New Zealand, tolerates the cold.

BERNARD SPRAGG. NZ/FLICKR

GENES & CELLS

The tuatara hides an extra set of genes

It's the only known vertebrate with two mitochondrial genomes

BY DEVIN A. REESE

New Zealand's lizardlike tuatara already was an oddball. Its superpowers include a nearly century-long life span, resistance to many diseases and a high tolerance (for a reptile) to the cold. Now, it turns out, a part of the tuatara's genetic instruction book is as weird as the animal's life history — and may help explain the tuatara's ability to be active at temperatures as low as about 6° Celsius.

Tuatara have two distinct copies of the genetic instruction manual for making mitochondria, researchers report January 29 in *Communications Biology*.

"It's the first evidence of a full additional copy of the mitochondrial genome in a vertebrate," says Chris Schneider, a herpetologist at Boston University who was not involved in the study. Some mollusks are the only other animals ever found to have two copies.

Mitochondria are tiny energy factories found in cells, and their genetic material is important in building the enzymes that keep the mitochondria running. Recent studies show that mitochondrial DNA plays major roles in aging and various human cancers, as well as metabolic, muscular and neurodegenerative diseases (*SN: 11/17/12, p. 5*). Studying the mitochondrial genomes of other animals could offer clues to the inner workings of human disease, the researchers say.

"The mitochondrial genome is much more important than people realize, given its association with aging and disease," says Robert Macey, a genomicist at the Peralta Genomics Institute in Oakland, Calif. "How that operates in an animal that ages slowly in a cool environment might tell us something significant about how mitochondria work."

Efforts to decode the tuatara's genetic makeup began in 2012, with the launch of the Tuatara Genome Project led by Neil Gemmell, an evolutionary biologist at the University of Otago in Dunedin, New Zealand. After getting the blessing of the Maori people to sample the reptile's blood (tuatara are a *taonga*, special treasure, to the Maori), the team found the genome to be 50 percent larger than the human genome.

This discovery led to deeper exploration of the mitochondrial part of the genome. Most techniques that decipher, or sequence, DNA chop it into small pieces, "read" the DNA and then reassemble the pieces. That provides a high-resolution look at individual puzzle pieces. Piloting a new technique that reads long DNA segments, Macey's lab sequenced the tuatara's mitochondrial genome in one fell swoop, showing its overall structure. The technique, called long-read sequencing, "is undoubtedly the future of gene sequencing, that we can sequence whole molecules in one pop," Macey says.

Dan Mulcahy, a molecular biologist at the Smithsonian's Global Genome Initiative in Washington, D.C., and Macey were mulling over the data when Mulcahy recalls saying, "I think there may be two [mitochondrial] genomes!"

The revelation came from comparing both the chopped puzzle pieces and the overall structure, and noticing that sections from the same part of the mitochondrial DNA had striking differences in their gene sequences — like the way the notes of a song might be arranged differently by two different composers. The variation raised eyebrows; mitochondrial DNA is usually inherited only from a mother's egg, so the scientists expected to see a single copy of the mitochondrial genome, not two copies like they would see with nuclear DNA, which is inherited from both the mother and father.

Together, the scientists painstakingly assembled two fully functional mitochondrial genomes. The genomes differed by 10.4 percent. In comparison, human and chimpanzee mitochondrial genomes differ by 8.9 percent. "The tuatara's arrangement of genes is unlike any other vertebrate," Mulcahy says.

When Lara Urban, a genomicist at the University of Otago, analyzed the two genomes, she noticed differences between genes related to metabolism. Cell metabolism adjusts to help an animal cope with environmental extremes. The double mitochondrial genome might give the tuatara flexibility in how its metabolism responds to the cold, the scientists say.

"The tuatara has the most complicated mitochondrial genome I've ever seen," Macey says. Finding the genetic basis for the animal's metabolic feats could clarify the mitochondrial genome's function, helping to find treatments for human metabolic diseases. ■

EARTH & ENVIRONMENT

Upwellings may push continents apart

Mid-ocean ridges may play an unexpected role in plate tectonics

BY MARIA TEMMING

An upsurge of hot rock from deep beneath the Atlantic Ocean may be driving the continents on either side apart.

The Americas are moving away from Europe and Africa by a few centimeters each year, as the tectonic plates underlying those continents drift apart. Scientists typically think tectonic plates separate as the distant edges of those plates sink down into Earth's mantle, creating a gap (*SN: 1/16/21, p. 16*). Material from the upper mantle seeps up through the rift between the plates to fill in the seafloor.

But new seismic data show that hot rock is welling up beneath a seafloor rift called the Mid-Atlantic Ridge from hundreds of kilometers deep in Earth's mantle. This suggests that material rising up under the ridge is not just a passive response to tectonic plates sliding apart. Rather, deep rock pushing toward the surface may be driving a wedge between the plates, researchers report in the Jan. 28 *Nature*.

A better understanding of plate tectonics, which causes earthquakes and volcanic eruptions, could help people better prepare for these natural disasters.

Matthew Agius, a seismologist at Roma Tre University in Rome, and colleagues glimpsed what's happening beneath the Mid-Atlantic Ridge using 39 seismometers on the seafloor near a spot along the ridge between South America and Africa. Those sensors monitored rumbles from quakes around the world for about a year. Because the seismic waves from those quakes traveled deep through Earth's mantle on their way to the seismometers, the recorded tremors contained clues about the location and movement of material far below the seafloor.

In those signals, Agius' team saw hints of material from Earth's lower mantle, more than 600 kilometers below the seafloor, welling up toward the Mid-Atlantic Ridge. "This was completely unexpected," Agius says, and it could be a powerful force for pushing apart the tectonic plates on either side of the rift.

"It's certainly an interesting observation," says Jeroen Ritsema, a seismologist at the University of Michigan in Ann Arbor. But it's hard to tell how much deep mantle upwelling contributes to Atlantic seafloor spreading based on observations from only one group of seismometers near the equator, he says. It's like "you're looking through a keyhole, and you're trying to see what's in the living room and the bedroom and the kitchen."

Observations at other locations along the Mid-Atlantic Ridge, as well as at other mid-ocean ridges, could help determine whether deep mantle material surging up beneath these rifts really plays a major role in seafloor spreading. ■

ATOM & COSMOS

Milky Way's glow is highly energetic

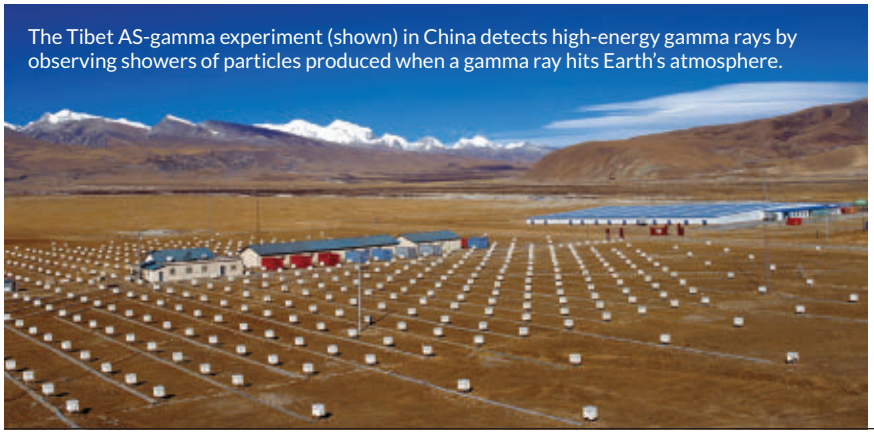
New find points to the existence of powerful cosmic accelerators

BY EMILY CONOVER

The Milky Way glows with a gamma ray haze, with energies vastly exceeding anything physicists can produce on Earth, according to a new paper. Gamma rays reported in the study, to be published in *Physical Review Letters*, came from throughout the galaxy's disk, and reached nearly a quadrillion (10^{15}) electron volts, known as a petaelectron volt or PeV.

These diffuse gamma rays hint at the existence of powerful cosmic particle accelerators in the Milky Way. Physicists believe such accelerators are a source of mysterious, highly energetic cosmic rays, charged particles that careen through the galaxy, sometimes crashing into Earth's atmosphere. When cosmic rays, which mainly consist of protons, slam into interstellar debris, they can produce gamma rays, a form of high-energy light.

Certain galactic environments could rev up cosmic ray particles to more than a PeV, scientists suspect. In comparison, the Large Hadron Collider, the premier particle accelerator crafted by humans, accelerates protons to 6.5 trillion electron volts. But physicists haven't definitively identified any natural cosmic accelerators capable of reaching a PeV, dubbed PeVatrons. One possibility is that supernova remnants, the remains of exploded stars, host shock waves that can accelerate cosmic rays to such energies.



The Tibet AS-gamma experiment (shown) in China detects high-energy gamma rays by observing showers of particles produced when a gamma ray hits Earth's atmosphere.

If PeVatrons exist, the cosmic rays they emit would permeate the galaxy, producing a diffuse glow of gamma rays of extreme energies. That's just what researchers with the Tibet AS-gamma experiment found. "It's nice to see things fitting together," says physicist David Hanna of McGill University in Montreal, who was not involved with the study.

After cosmic rays are spewed from their birthplaces, scientists believe they roam the galaxy, twisted about by its magnetic fields. "We live in a bubble of cosmic rays," says astrophysicist Paolo Lipari of the National Institute for Nuclear Physics in Rome, who was not involved with the research. Because they are not deflected by magnetic fields, gamma rays point back to their sources, revealing the whereabouts of the itinerant cosmic rays. The new study "gives you information about how these particles fill the galaxy," Lipari says.

Lower-energy gamma rays also permeate the galaxy. But it takes higher-energy gamma rays to understand the highest-

ATOM & COSMOS

Meteorites hint at early atmospheres

Water-rich steam may envelop young rocky exoplanets

BY LISA GROSSMAN

By burning bits of meteorites, scientists may learn what the atmospheres of some young exoplanets are made of.

Experiments baking pulverized space rocks suggest that rocky planets initially have atmospheres full of water, Maggie Thompson, an astrophysicist at the University of California, Santa Cruz, reported January 15 at the virtual meeting of the American Astronomical Society.

Astronomers have discovered thousands of planets orbiting other stars. Like the terrestrial planets in the solar system, many could have rocky surfaces beneath thin atmospheres. Some space telescopes can peek at starlight filtering through exoplanet atmospheres to figure out what chemicals they contain, and if the worlds could be hospitable to life.

Instead of looking at the atmospheres themselves, Thompson and colleagues are working from the ground up, examining rocky planets' building blocks to see what kind of atmospheres are possible.

The team studied three carbonaceous chondrite meteorites. These rocks represent the first solids that condensed out of the disk of dust and gas that surrounded the young sun and ultimately formed the planets in the solar system. Exoplanets probably formed from similar stuff.

Thompson's group ground samples of the meteorites to powder, and then heated the powder in a furnace hooked up to a mass spectrometer to measure trace amounts of different gases that escaped as the powder warmed.

That setup is analogous to how rocky planets form their initial atmospheres after solidifying. A young planet heats its rock with the decay of radioactive elements, collisions with asteroids or other planets, and with the leftover heat from planetary formation. The warmed rock lets off gas. "Measuring the outgassing composition from meteorites can provide a range of atmospheric compositions for rocky exoplanets," Thompson said.

All three meteorites mostly let off water vapor, accounting for 62 percent of the gas emitted on average. The next most

INSTITUTE OF HIGH ENERGY PHYSICS OF THE CHINESE ACADEMY OF SCIENCES/XINHUA/ALAMY STOCK PHOTO

energy cosmic rays. "In general, the higher the energy of the gamma rays, the higher the energy of the cosmic rays," says astrophysicist Elena Orlando of Stanford University, who was not involved with the research. "Hence, the detection ... tells us that PeV cosmic rays originate and propagate in the galactic disk."

Scientists with the Tibet AS-gamma experiment in China observed gamma rays with energies between about 100 trillion and a quadrillion electron volts coming from the region of the sky covered by the disk of the Milky Way. A search for possible sources of the 38 highest-energy gamma rays, above 398 trillion electron volts, came up empty, supporting the idea that the gamma rays came from cosmic rays that had wandered about the galaxy. The highest-energy gamma ray carried about 957 trillion electron volts.

Tibet AS-gamma researchers declined to comment on the study.

Scientists have previously seen extremely energetic gamma rays from individual sources within the Milky Way, such as the Crab Nebula, a supernova remnant (*SN: 8/3/19, p. 11*). Those gamma rays are probably produced in a different manner, by electrons radiating gamma rays while circulating within a cosmic accelerator. ■

common gases were carbon monoxide and carbon dioxide, followed by hydrogen, hydrogen sulfide and some more complex gases that weren't identified.

The results indicate that astronomers should expect water-rich steam atmospheres around young rocky planets, at least as a first approximation. "In reality, the situation will be far more complicated," Thompson said. A planet can be made of other kinds of rocks that would contribute other gases. Over time, geologic activity changes the atmosphere.

But this sort of basic research is useful because it "has put a quantitative compositional framework on what those planets might have looked like as they evolved," says planetary scientist Kat Gardner-Vandy of Oklahoma State University in Stillwater. ■

A small spider used its own version of a pulleylike system to haul a lizard upward bit by bit.

EMANUELE OLIVETTI

LIFE & EVOLUTION

Tiny spiders hoist heavy prey with silk

Dropping the right lines can haul a big meal off the ground

BY SUSAN MILIUS

Some spiders catch prey many times their own weight by hitching silk lines to their quarry and hoisting the meaty prize up into the air.

Tangle web spiders, in the Theridiidae family, are masters of using silk to amplify muscle power. Their webs are "a messy tangle," says Gabriele Greco, who studies biological materials at the University of Trento in Italy. Silk strands slant and crisscross in a cobwebby scribble.

Filming how spiders hunt from such snarls, Greco and Trento colleague Nicola Pugno focused on attacks on insects that weighed up to 50 times as much as the spiders themselves. The web makers won their battles thanks to adroit fighting, venom and lots of prey-wrapping silk. Victorious spiders attached multiple silk threads to their prey bundle to haul the feast up to the web, Greco and Pugno report in the February *Journal of the Royal Society Interface*.

To analyze the spiders' weight-hauling moves, the researchers set up lab boxes to observe triangulate cobweb spiders (*Steatoda triangulosa*) and false black widows (*S. paykulliana*).

In the wild, both species stretch some strands from the tangle down to the ground, anchoring each strand's sticky end. When some small, edible creature such as an ant bumbles against the strand, it breaks loose from the ground and yanks the prey upward to flail helplessly in the air. Lunch!

What really interested Greco and Pugno were occasional reports of these strands catching "giant" prey, including a snake and a mouse. To give the food-catching silk an extreme workout, the researchers used cockroaches.

A single sticky-end strand can't jerk a big roach into the air, so when prey bumps the silk, the resident spider adds extra strands to its catch. In the lab tests, spiders had to add strand after strand before researchers saw the first upward lurch. During the raising process, the hauling threads maintained some give instead of being stretched very tight. That makes sense, Greco concluded, because these strands get tugged by struggling prey. Supertight strands might break.

The study strikes Symone Alexander, a chemical engineer at Auburn University in Alabama who has studied spider webs, as "very cool." The rounded, spoked webs on Halloween décor may be the popular notion of spider silk, but the animals have expanded the places and ways they can live with a wide range of silky innovations. Spiders have evolved silky trap doors, nets, lassos and ultrafast slingshots (*SN: 4/13/19, p. 5*).

"Even in a single web, there are different types of silk and glue used to make frame lines, capture lines and anchor lines," she says. "Spiders are ingenious." ■

BODY & BRAIN

Why Lyme disease is rare in the South

Which animals ticks bite may impact the disease's U.S. spread

BY AIMEE CUNNINGHAM

The paucity of Lyme disease cases in the southern United States may be partly due to what black-legged ticks in southern locales bite.

Although *Ixodes scapularis* ticks claim much of the eastern half of the country as home, the Lyme disease they spread is largely concentrated in the Northeast and increasingly in the Upper Midwest.

It's well known that ticks in the Northeast commonly latch onto white-footed mice. This relationship turns out to be a boon for Lyme disease: When infected with the bacterium *Borrelia burgdorferi*, which causes Lyme disease, these mice efficiently spread it to the ticks, which can then pass it on to people.

But ticks residing in the South are different. They are more likely to bite lizards called skinks, which are poor transmitters of the bacteria, researchers report January 28 in *PLOS Biology*.

This study "shows that there's this really interesting switch" from the North to South in the predominant tick host, says disease ecologist Shannon LaDeau of the Cary Institute of Ecosystem Studies in Millbrook, N.Y., who was not part of the research team. "It looks like that is reducing the transmission" in the South of the bacteria that causes Lyme disease.

An estimated 476,000 people are diagnosed with Lyme disease each year in the United States, according to insurance data from 2010 to 2018. Most people recover with early antibiotic treatment. But if the diagnosis is missed, the infection can spread in the body and cause arthritis and nerve pain.

Scanning for and removing ticks after a hike is one part of Lyme disease control. Understanding the ticks' behavior and their relationship to the environment can inform other prevention methods.

Black-legged ticks need blood meals to progress through several developmental stages. The larvae that emerge from eggs seek out a host for blood; this is when ticks can first become infected with Lyme bacteria. The next blood meal is at the nymph stage. Nymphs infected as larvae can spread the bacteria to other hosts, including people.

There's been a long debate about the difference in Lyme disease cases between the North and the South, says Howard Ginsberg, an ecologist at the Patuxent Coastal Field Station at the University of Rhode Island in Kingston. The ticks are in the South, so "why isn't there much Lyme disease?"

One possible reason is that nymphal ticks in the North seek hosts on top of or above leaf litter, which puts them in the path of passing hikers. Nymphal ticks in the South are more likely to stay under leaf litter, reducing the chance of such encounters, researchers reported in *Ticks and Tick-borne Diseases* in 2019. Ticks may remain below the leaf litter in the hotter South to avoid drying out.

This host-seeking behavior and the results of the new study help to explain the North-South difference, Ginsberg says. In 2011 and 2012, he and colleagues captured host animals and collected and tested ticks at eight sites in the eastern United States. "We tried to catch everything that crawled on the ground that the tick might attach to," he says.

In the North, the most common hosts were mice, while in the South, the ticks selectively attached to skinks, says Ginsberg. At a site in Massachusetts, for example, 75 percent of tick larvae and 93 percent of the nymphs were removed from mice, which accounted for 79 percent of the captured host animals. The team caught no skinks.

But at a site in Florida, although about 40 percent of the captured animals were mice, they had only 3 percent of the larvae and less than 1 percent of the nymphs. Meanwhile, skinks — which made up 28 percent of the captured host animals — had 92 percent of the larvae and 98 percent of the nymphs. The team also found that ticks in the North were more likely to be infected with Lyme bacteria than ticks in the South.

Understanding the ecological context of Lyme disease can help identify targets to try to reduce human risk, LaDeau says. For example, the possibility of vaccinating mice against Lyme bacteria may be more useful in the North.

The observed differences also influence predictions of how climate change may impact Lyme disease. Black-legged ticks have moved farther north, bringing Lyme disease to Canada, in part due to warming. Perhaps the behavior and biting patterns in the South will expand to Maryland, Delaware and Virginia, reducing Lyme disease cases there, Ginsberg says. It will take more research to learn how climate change will affect skink populations and how warming might change tick behavior, he says. ■

In the northern United States, the ticks that spread Lyme disease bacteria tend to latch onto white-footed mice (left). But in the South, the ticks typically target skinks (right), a new study finds.

BOTH: D. GORDON E. ROBERTSON/WIKIMEDIA COMMONS (CC BY-SA 3.0)

Beneath the linen wrappings, this Egyptian mummy's body is encased in a layer of mud. The mud may have been used to repair damage to the body or to emulate royal burial customs.

HUMANS & SOCIETY

An ancient Egyptian mummy was wrapped in mud

A mud-wrapped mummy is leading archaeologists to rethink how nonroyal Egyptians preserved their dead.

CT scans of a mummy from about 1200 B.C. reveal that the body is sheathed in a mud shell between its layers of linen wrappings. Ancient Egyptians may have used this preservation technique, never before seen in Egyptian archaeology, to repair damage to the mummified body and mimic royal burial customs, researchers report February 3 in *PLOS ONE*.

While parts of the mummy's legs are caked with mud about 2.5 centimeters thick, the mud over the face is spread as thin as 1.5 millimeters. Chemical analyses of mud flakes from around the head indicate that the mud layer is covered in a white, possibly limestone-based pigment, topped with a red mineral paint.

Leg fractures and other damage to the mummy's body hint that the mud wrap may have been used to restore the body after it was desecrated, potentially by tomb robbers. Repairing the body would have ensured that the deceased could continue existing in the afterlife.

The mud shell may also have been a poor man's version of the expensive resin coatings seen on royal mummies of this era, the researchers suggest. "Status in Egyptian society was in large part measured by proximity to the king," says Karin Sowada, an archaeologist at Macquarie University in Sydney. So imitating royal funerary practices may have been a display of social status.

The identity and social standing of the mud-wrapped individual remains a mystery. Analyzing other nonroyal mummies from ancient Egypt may reveal how common mud shells were, who used them and why. — *Maria Temming*

MATTER & ENERGY

Diamond holds up under pressure

Diamond's structure persists even when compressed to 2 trillion pascals, more than five times the pressure in Earth's core.

That finding, reported in the Jan. 28 *Nature*, suggests that diamond is metastable at high pressures: It retains its structure despite the fact that other, more stable structures are expected to dominate under such conditions. Studying diamond's quirks at extreme pressures could help reveal the inner workings of carbon-rich exoplanets (*SN: 8/9/14, p. 20*).

Diamond is one of several varieties of carbon, each composed of a different arrangement of atoms. At everyday pressures on Earth's surface, carbon's most stable state is graphite. But given a forceful squeeze, diamond wins out. That's why diamonds form after carbon takes a plunge inside Earth.

But at higher pressures than those found inside Earth, scientists had predicted that new crystal structures would be more stable. So physicist Amy Lazicki of Lawrence Livermore National Laboratory in California and colleagues pummeled diamond with powerful lasers. X-ray measurements revealed that diamond persisted, suggesting it is metastable under extreme pressure.

Diamond was already known to be metastable at low pressures; your grandma's diamond ring hasn't morphed into graphite. Once formed, diamond's structure can persist even if the pressure drops, thanks to the strong chemical bonds that hold carbon atoms together in diamond. Now, Lazicki says, "it looks like the same is true when you go to much higher pressure." — *Emily Conover*

BODY & BRAIN

Diabetes during pregnancy is tied to heart trouble later in life

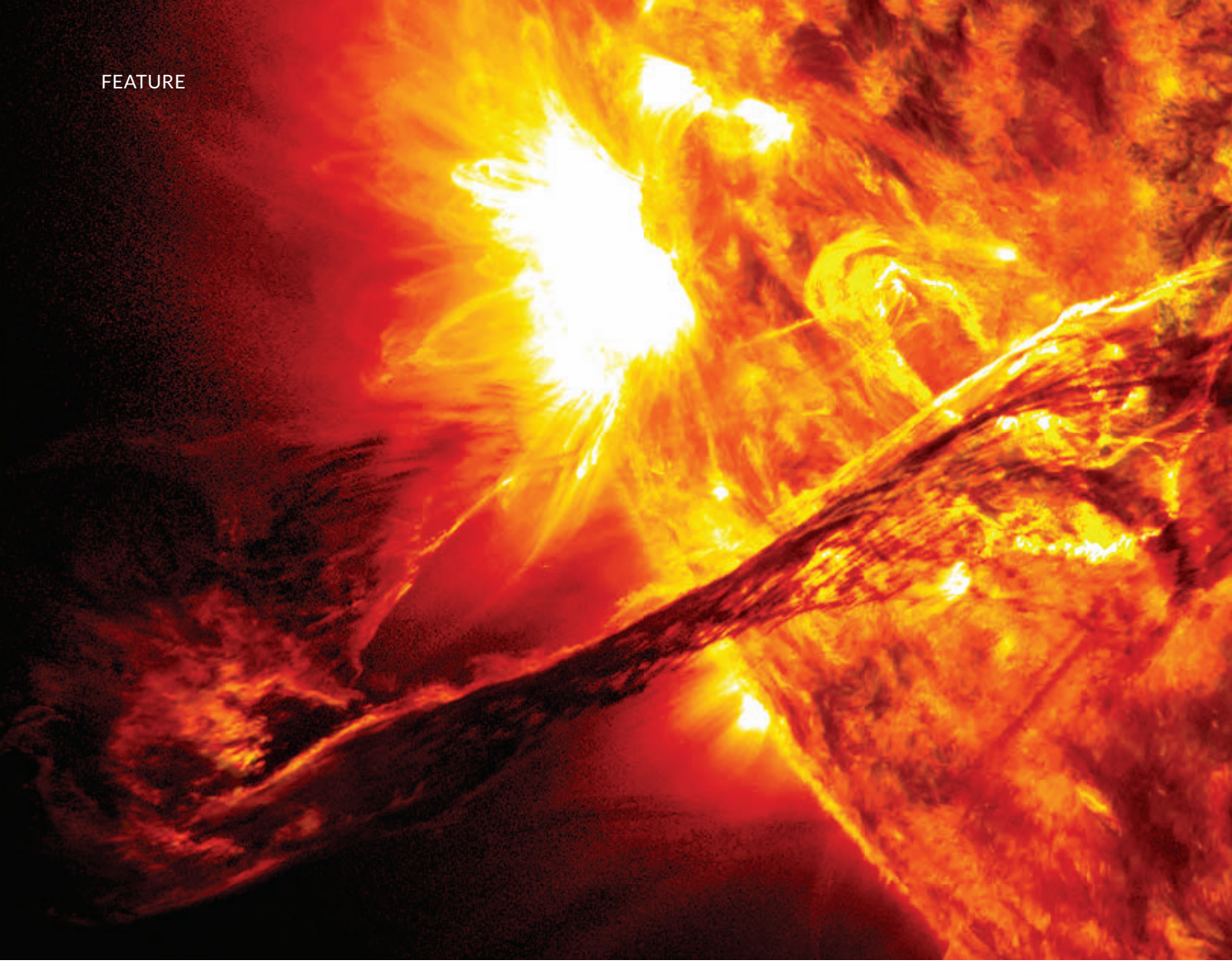
Diabetes brought on by pregnancy might set a woman up for heart problems later on, even if her blood sugar levels snap back to normal. That finding, reported online February 1 in *Circulation*, suggests that doctors should pay careful attention to the hearts of people who previously had gestational diabetes.

The results come from data collected by the CARDIA Study, a project designed to track heart health in young adults. Starting in 1985, CARDIA enrolled equal numbers of Black and white people, ages 18 to 30, from four U.S. cities. Following these people for 25 years, researchers looked for coronary artery calcification, or CAC, a hardening of blood vessels that can signal future heart disease.

More than 1,000 participants gave birth during the study. Of these women, 139 had gestational diabetes, an often-temporary condition in which blood sugar levels spike. About a quarter of these women, or 34, went on to have CAC, even when postpregnancy blood sugar levels normalized. A smaller proportion of women who hadn't had gestational diabetes — 149 of 994, or about 15 percent — went on to have CAC.

The study doesn't indicate whether some aspect of gestational diabetes causes CAC, only that the two are associated. But it's possible that changes in blood vessels that can accompany gestational diabetes may play a role in heart health later, the researchers say.

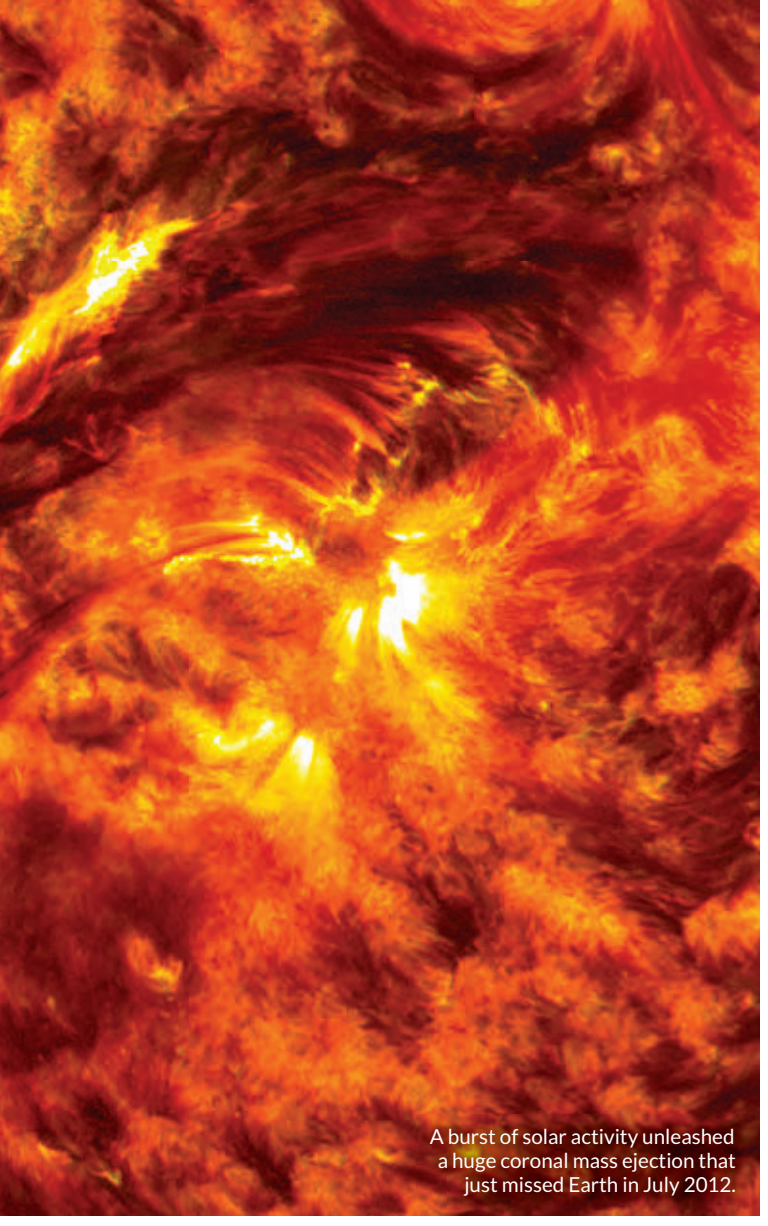
"The majority of women with gestational diabetes do not develop coronary artery calcification," says Khadijah Breathett, a cardiologist at the University of Arizona College of Medicine in Tucson who was not involved with the study. Still, the results highlight the importance of keeping blood sugar under control, she says. — *Laura Sanders*



Solar storm preparedness

The sun's outbursts can have destructive consequences on Earth

By Ramin Skibba



A burst of solar activity unleashed a huge coronal mass ejection that just missed Earth in July 2012.

NASA GODDARD SPACE FLIGHT CENTER

Since December 2019, the sun has been moving into a busier part of its cycle, when increasingly intense pulses of energy can shoot out in all directions. Some of these large bursts of charged particles head right toward Earth. Without a good way to anticipate these solar storms, we're vulnerable. A big one could take out a swath of our communication systems and power grids before we even knew what hit us.

A recent near miss occurred in the summer of 2012. A giant solar storm hurled a radiation-packed blob in Earth's direction at more than 9 million kilometers per hour. The potentially debilitating burst quickly traversed the nearly 150 million kilometers toward our planet, and would have hit Earth had it come just a week earlier. Scientists learned about it after the fact, only because it struck a NASA satellite designed to watch for this kind of space weather.

That 2012 storm was the most intense researchers have measured since 1859. When a powerful storm hit the Northern Hemisphere in September of that year, people were not so lucky. Many telegraph systems throughout Europe and North America failed, and the electrified lines shocked some telegraph operators. It came to be known as the Carrington Event, named after British astronomer Richard Carrington, who witnessed intensely bright patches of light in the sky and recorded what he saw.

The world has moved way beyond telegraph systems. A Carrington-level impact today would knock out satellites, disrupting GPS, mobile phone networks and internet connections. Banking systems, aviation, trains and traffic signals would take a hit as well. Damaged power grids would take months or more to repair.

Especially now, during a pandemic that has many of us relying on Zoom and other video-communications programs to work and attend school, it's hard to imagine the widespread upheaval such an event would create. In a worst-case scenario conceived before the pandemic, researchers estimated the economic toll in the United States could reach trillions of dollars, according to a 2017 review in *Risk Analysis*.

To avoid such destruction, in October then-President Donald Trump signed a bill that will support research to produce better space weather forecasts and assess possible impacts, and enable better coordination among agencies like NASA and the National Oceanic and Atmospheric Administration.

"We understand a little bit about how these solar storms form, but we can't predict [them] well," says atmospheric and space scientist Aaron Ridley of the University of Michigan in Ann Arbor. Just as scientists know how to map the likely path of tornadoes and hurricanes, Ridley hopes to see the same capabilities for predicting space weather.

The ideal scenario is to get warnings well before a storm disables satellites or makes landfall, and possibly even before the sun sends charged particles in our direction. With advance warning, utilities and governments could power down the grids and move satellites out of harm's way.

Ridley is part of a U.S. collaboration creating simulations of solar storms to help scientists quickly and accurately forecast where the storms will go, how intense they will be and when they might affect important satellites and power grids on Earth. Considering the havoc an extreme solar storm could wreak, many scientists and governments want to develop better forecasts as soon as possible.

Ebbs and flows

When scientists talk about space weather, they're usually referring to two things: the solar wind, a constant stream of charged particles flowing away from the sun, and coronal mass ejections, huge outbursts of charged particles, or plasma, blown out from the sun's outer layers (*SN Online: 3/7/19*). Some other phenomena, like high-energy particles called cosmic rays, also count as space weather, but they don't cause much concern.

Coronal mass ejections, or CMEs, the most threatening kind of solar storms, aren't always harmful — they generate dazzling auroras near the poles, after all. But considering the risks of a storm shutting down key military and commercial

satellites or harming the health of astronauts in orbit, it's understandable that scientists and governments are concerned.

Astronomers have been peering at our solar companion for centuries. In the 17th century, Galileo was among the first to spy sunspots, slightly cooler areas on the sun's surface with strong magnetic fields that are often a precursor to more intense solar activity. His successors later noticed that sunspots often produce bursts of radiation called solar flares. The complex, shifting magnetic field of the sun also sometimes makes filaments or loops of plasma thousands of kilometers across erupt from the sun's outer layers. These kinds of solar eruptions can generate CMEs.

"The sun's magnetic field lines can get complicated and twisted up like taffy in certain regions," says Mary Hudson, a physicist at Dartmouth College. Those lines can break like a rubber band and launch a big chunk of corona into interplanetary space.

It was 19th century German astronomer Samuel Heinrich Schwabe who realized that such solar activity ebbs and flows during 11-year cycles. This happens because the sun's magnetic field completely flips every 11 years. The most recent sun cycle ended in December 2019, and we're emerging from the nadir of sun activity while heading toward the maximum of cycle 25 (astronomers started numbering solar cycles in the 19th century). Solar storms, particularly the dangerous CMEs, are now becoming more frequent and intense, and should peak between 2024 and 2026.

Solar storms develop from the sun's complex magnetic field. The sun rotates faster at its equator than at its poles, and since it's not a solid sphere, its magnetic field constantly roils and swirls around. At the same time, heat from the sun's interior rises to the surface, with charged particles bringing new magnetic fields with them. The most intense CMEs usually come from the most vigorous period in a particularly active solar cycle, but there's a lot of variation. The 1859 CME originated from a fairly modest solar cycle, Hudson points out.

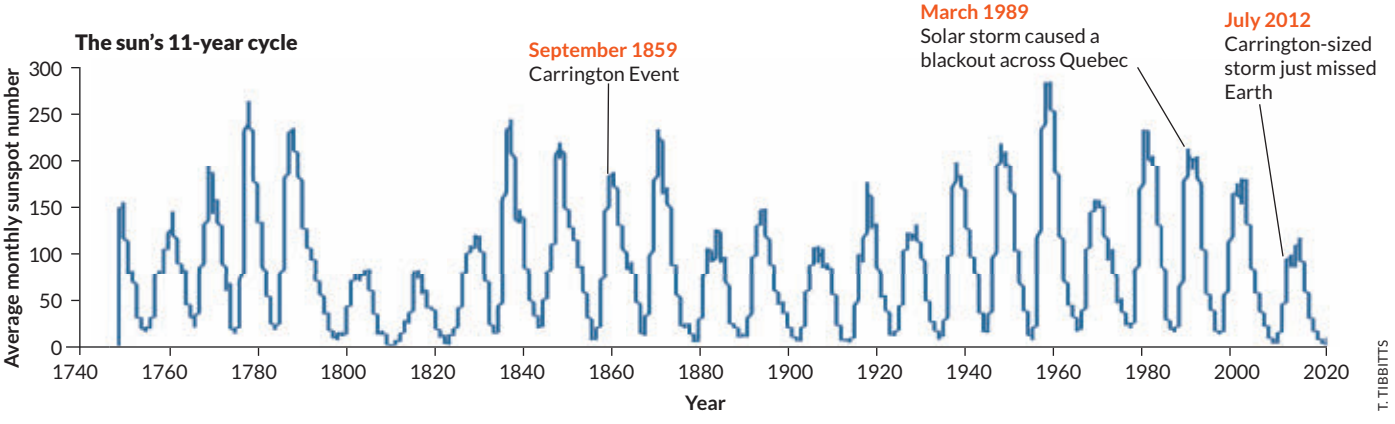
A CME has multiple components. If the CME is on a trajectory toward Earth, the first thing to arrive — just eight minutes after it leaves the sun — is the electromagnetic radiation, which moves at the speed of light. CMEs often produce a shock wave that accelerates electrons to extremely fast speeds, and those arrive within 20 minutes of the light. Such energetic particles can damage the electronics or solar cells of satellites in high orbits. Those particles could also harm any astronauts outside of Earth's protective magnetic field, including any on the moon. A crew on board the International Space Station, inside Earth's magnetic field, however, would most likely be safe.

But a CME's biggest threat — its giant cloud of plasma, which can be millions of kilometers wide — typically takes between one and three days to reach our planet, depending on how fast the sun propelled the shotgun blast of particles toward us. Earth's magnetic field, our first defense against space weather and space radiation, can protect us from only so much. Satellites and ground-based observations have shown that a CME's charged particles interact with and distort the magnetic field. Those interactions can have two important effects: producing more intense electric currents in the upper atmosphere and shifting these stronger currents away from the poles to places with more people and more infrastructure, Ridley says. With an extremely powerful storm, it's these potentially massive currents that put satellites and power grids at risk.

Earth's magnetic field, our first defense against space weather and space radiation, can protect us from only so much.

Anyone who depends on long-distance radio signals or telecommunications might have to do without them until the storm blows over and damaged satellites are repaired or replaced. A powerful storm can disturb airplanes in flight, too, as pilots lose contact with air traffic controllers. While these are temporary effects, typically lasting up to a day, impacts on the electrical grids could be worse.

A massive CME could suddenly and unexpectedly drive currents of kiloamps rather than the usual amps through power grid wires on Earth, overwhelming transformers and



Up and down The number of sunspots, and other solar activity that generates solar storms, rises and falls in an 11-year cycle. Solar cycle 25 began in December 2019 and is expected to peak in 2025.
SOURCE: SILSO DATA/ROYAL OBSERVATORY OF BELGIUM 2021

making them melt or explode. The entire province of Quebec, with nearly 7 million people, suffered a power blackout that lasted more than nine hours on March 13, 1989, thanks to such a CME during a particularly active solar cycle. The CME affected New England and New York, too. Had electricity grid operators known what was coming, they could have reduced power flow on lines and interconnections in the power grid and set up backup generators where needed.

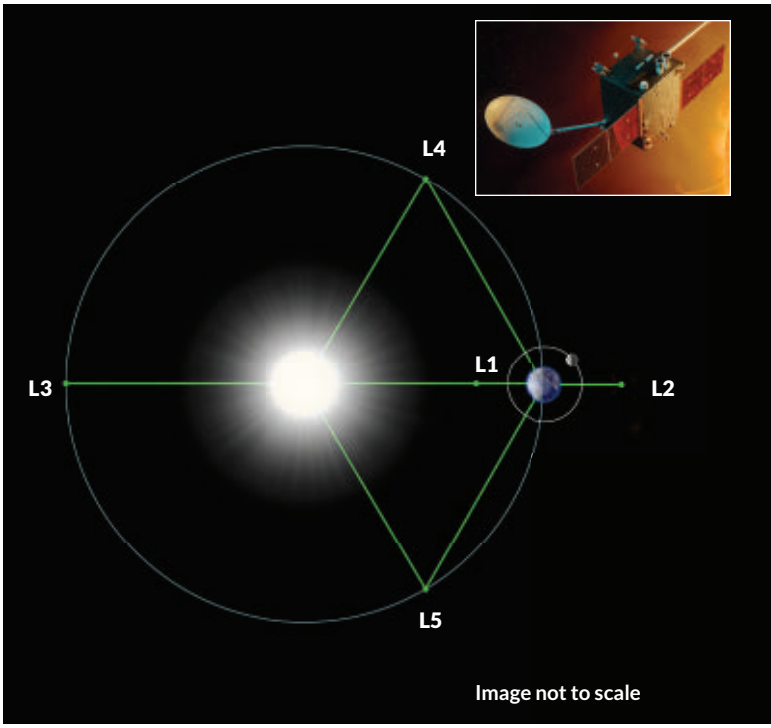
Early warning

But planners need more of a heads-up than they get today. Perhaps within the next decade, improved computer modeling and new space weather monitoring capabilities will enable scientists to predict solar storms and their likely impacts more accurately and earlier, says physicist Thomas Berger, executive director of the Space Weather Technology, Research and Education Center at the University of Colorado Boulder.

Space meteorologists classify solar storms, based on disturbances to the Earth's magnetic field, on a five-level scale, like hurricanes. But unlike those tropical storms, the likely arrival of a solar storm isn't known with any precision using available satellites. For storms brewing on Earth, the National Weather Service has access to constantly updated data. But space weather data are too sparse to be very useful, with few storms to monitor and provide data.

Two U.S. satellites that monitor space weather are NASA's ACE spacecraft, which dates from the 1990s and should continue to collect data for a few more years, and NOAA's DSCOVR, which was designed at a similar time but not launched until 2015. Both orbit about 1.5 million kilometers above Earth — which seems far but is barely upstream of our planet from a solar storm's perspective. The two satellites can detect and measure a solar storm only when its impact is imminent: 15 to 45 minutes away. That's more akin to "nowcasting" than forecasting, offering little more than a warning to brace for impact.

"That's one of the grand challenges of space weather: to predict the magnetic field of a CME long before it gets [here] so that you can prepare for the incoming storm," Berger says. But aging satellites like SOHO, a satellite launched by NASA and the European Space Agency in 1995, plus ACE and DSCOVR monitor only a limited range of directions that don't include the sun's poles, leaving a big gap in observations, he says.



Sneak peek The European Space Agency's upcoming Lagrange mission will monitor the sun with spacecraft at "Lagrange points" L1 and L5, two locations in orbit where the combined gravitational pull of the Earth and sun helps objects in space stay in position. Lagrange will be the first mission with a satellite (illustrated) at L5, to monitor the sun from the side to try and spot Earth-bound coronal mass ejections much earlier.

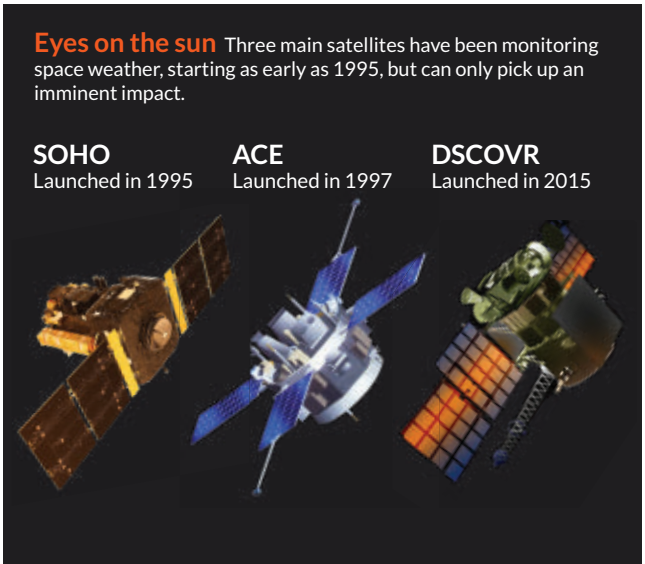
Ideally, scientists want to be able to forecast a solar storm before it's blown out into space. That would give enough lead time — more than a day — for power grid operators to protect transformers from power surges, and satellites and astronauts could move out of harm's way if possible.

That requires gathering more data, particularly from the sun's outer layers, plus better estimating when a CME will burst forth and whether to expect it to arrive with a bang or a whimper. To aid such research, NOAA scientists will outfit their next space weather satellite, scheduled to launch in early 2025, with a coronagraph, an instrument used for studying the outermost part of the sun's atmosphere, the corona, while blocking most of the sun's light, which would otherwise blind its view.

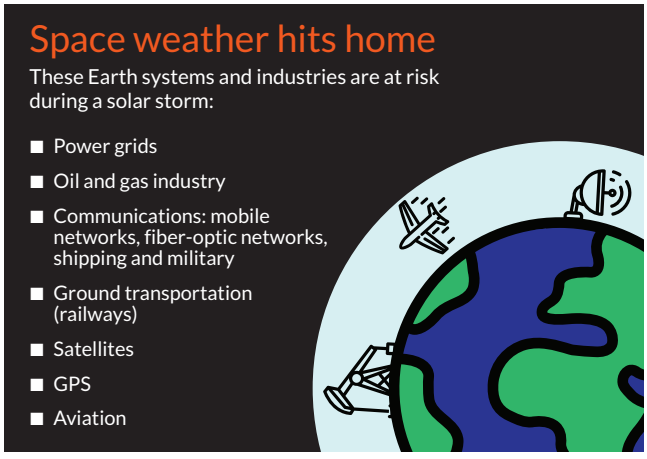
A second major improvement could come just two years later, in 2027, with the launch of ESA's Lagrange mission. It will be the first space weather mission to launch one of its spacecraft to a unique spot: 60 degrees behind Earth in its orbit around the sun. Once in position, the spacecraft will be able to see the surface of the sun from the side before the face of the sun has rotated and pointed in Earth's direction, says Juha-Pekka Luntama, head of ESA's Space Weather Office.

That way, Lagrange will be able to monitor an active, flaring

Eyes on the sun Three main satellites have been monitoring space weather, starting as early as 1995, but can only pick up an imminent impact.



TOP: WMAP SCIENCE TEAM/NASA; BOTTOM FROM LEFT: ATG MEDIALAB/ESA; NASA; NOAA



area of the sun days earlier than other spacecraft, getting a fix on a new solar storm's speed and direction sooner to allow scientists to make a more precise forecast. With these new satellites, there will be more spacecraft watching for incoming space weather from different spots, giving scientists more data to make forecasts.

Meanwhile, Berger, Ridley and colleagues are focused on developing better computer simulations and models of the behavior of the sun's corona and the ramifications of CMEs on Earth. Ridley and his team are creating a new software platform that allows researchers anywhere to quickly update models of the upper atmosphere affected by space weather. Ridley's group is also modeling how a CME shakes our planet's magnetic field and releases charged particles toward the land below.

Berger also collaborates with other researchers on modeling and simulating Earth's upper atmosphere to better predict how solar storms affect its density. When a storm hits, it compresses the magnetic field, which can change the density of the outer layers of Earth's atmosphere and affect how much drag satellites have to battle to stay in orbit.

Satellite safety

There have been a few cases of satellites damaged by solar storms. The Japanese ADEOS-II satellite stopped functioning in 2003, following a period of intense outbursts of energy from the sun. And the Solar Maximum Mission satellite appeared to have been dragged into lower orbit — and eventually burned up in the atmosphere — following the same 1989 solar storm that left Quebec in the dark.

Satellites affected by solar storms could be at risk of crashing into each other or space debris, too. With mega-constellations of satellites like SpaceX's being launched by the hundreds (*SN: 3/28/20, p. 24*), and with tens of thousands of satellites and bits of space flotsam already in crowded orbits, the risks are real of something drifting into the path of something else. Any space crash will surely create more space junk, too, tossing out debris that also puts spacecraft at risk.

These are all strong motivators for Ridley, Berger and colleagues to study how storm-driven drag works. The U.S. military tracks satellites and debris and predicts where they'll likely be in the future, but all those calculations are worthless without knowing the effects of solar storms, says Boris Krämer, an aerospace engineer at the University of California, San Diego who collaborates with Ridley. "To put satellites on trajectories so that they avoid collisions, you have to know space weather," Krämer says.

It takes time to create simulations estimating the drag on a single satellite. Current models run on powerful supercomputers. But if a satellite needs to use its onboard computer to make those computations on the fly, researchers need to develop sufficiently accurate models that run much more quickly and with less energy.

New data and new models probably won't be online in time for the upcoming solar storm season, but they should be in place for solar cycle 26 in the 2030s. Perhaps by then, scientists will be able to give earlier red alerts to warn of an incoming storm, giving more time to move satellites, buttress transformers and stave off the worst.

The goal of improving space weather forecasts has drawn broad federal government support and interest from industry, including Lockheed Martin, because of the threats to important satellites, including the 31 that constitute the U.S. GPS network.

The growing interest in space weather led to the 2020 law, known as the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act, or PROSWIFT. And the National Science Foundation and NASA have thrown support behind space weather research programs like Berger's and Ridley's. For instance, Ridley, Krämer and their collaborators recently received $3.1 million in NSF grants to develop new space weather computer simulations and software, among other things.

Our reliance on technology in space comes with increasing vulnerabilities. Some space scientists speculate that we've failed to find alien civilizations because some of those civilizations were wiped out by the very active stars they orbit, which could strip a once-habitable world's atmosphere and expose life on the surface to harmful stellar radiation and space weather. Our sun is not as dangerous as many other stars that have more frequent and intense magnetic activity, but it has the potential to be perilous to our way of life.

"Globally, we have to take space weather seriously and prepare ourselves. We don't want to wake up one day, and all our infrastructure is down," ESA's Luntama says. With key satellites and power grids suddenly wrecked, we wouldn't even be able to use our phones to call for help. ■

Explore more

- Thomas E. Berger *et al.* "Flying through uncertainty." *Space Weather*. January 2020.

Ramin Skibba is a freelance writer and journalist based in San Diego.

T. TIBBITTS

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COVID-19 on Campus

Fall semester was the start of a big experiment

By Betsy Ladyzhets

At the University of Colorado Boulder, students pick up campus maps and pandemic protocols on August 18. Each school that opened for the fall semester had its own patchwork of safety measures in place to try to keep students and staff safe from COVID-19.

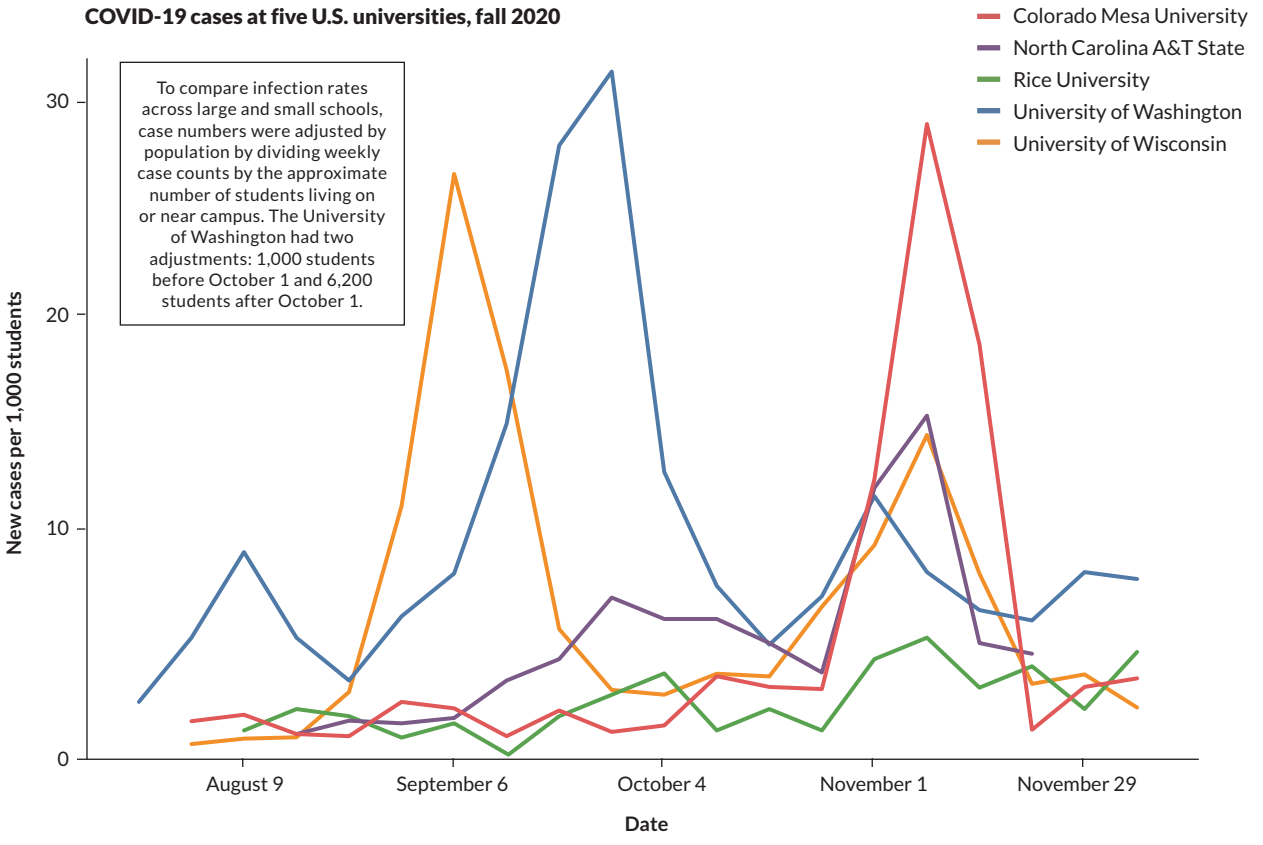
MARK MAKELA/GETTY IMAGES

One year into the COVID-19 pandemic, we know the SARS-CoV-2 virus spreads easily through large indoor gatherings and communal living spaces. A person can become infected, spread the virus to friends, family, teachers or coworkers, and *then* start exhibiting symptoms several days later — or never show any signs of infection.

With these kinds of risks, a college campus seems like one of the more dangerous places to spend time. In fact, U.S. counties with large colleges or universities that offered in-person instruction last fall saw a 56 percent rise in COVID-19 cases in the three weeks after classes began compared with the three weeks before. Counties with large schools that offered only remote learning saw a drop in cases of almost 18 percent, researchers from the U.S. Centers for Disease Control and Prevention reported on January 8 in *Morbidity and Mortality Weekly Report*.

Universities that opened their campuses in August and September faced an uncharted, months-long experiment in infection control. They had no manual, no surefire way to keep students and staff from getting sick.

Science News took a look at five universities that opened in the fall. Each school cobbled together some type of testing at various frequencies



coupled with uneven rules about wearing masks and public gatherings.

For testing, all five schools used polymerase chain reaction, or PCR, tests, which are the gold standard for diagnosing COVID-19. Results can take days, however, when demand for tests is high (*SN Online: 8/31/20*). One school also used a test called loop-mediated isothermal amplification, or LAMP, which, like PCR, measures viral DNA to identify infections. LAMP is less sensitive than PCR, but results come in much more quickly since there's no need to send samples to a laboratory.

Antigen tests, which detect proteins from the virus and also give rapid results, helped one school move students quickly into quarantine, even though those tests have a higher rate of false-negative results. One school additionally set up wastewater sampling at dorms to pick up early signs of outbreaks.

"Colleges are high risk, but also exactly where innovation can happen," says Pardis Sabeti, a computational geneticist at the Broad Institute of Harvard and MIT, which worked with more than 100 colleges and universities on their COVID-19 mitigation strategies.

One example of such innovation, she says, is universal student use of phone-based apps for symptom monitoring and contact tracing. Student engagement and leadership was also key to successful outbreak control, Sabeti says. Several universities recruited students as health ambassadors to promote safe behavior; at one school, a student panel meted out punishments to their peers who broke the rules.

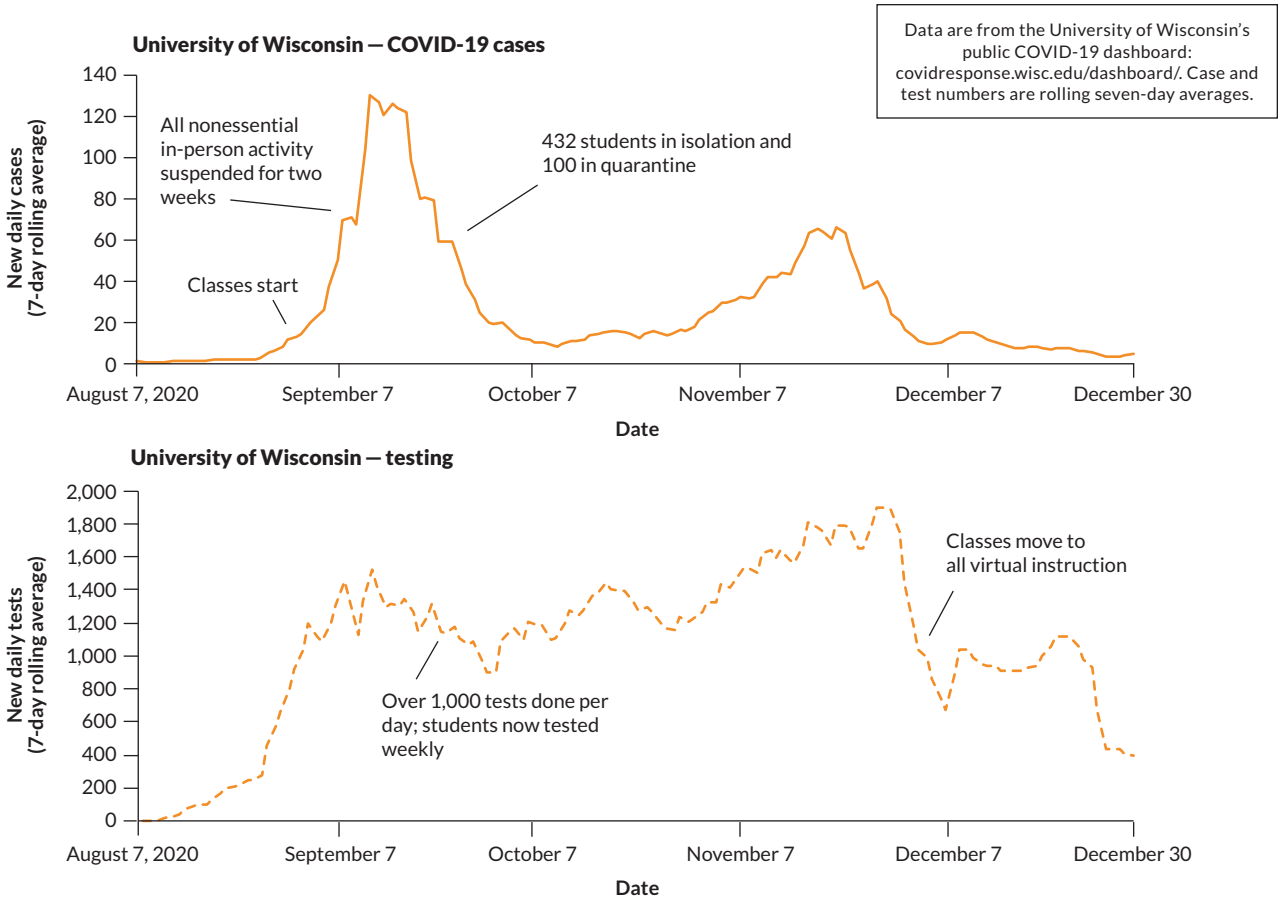
Four of the five schools profiled here faced at least one outbreak during the fall, but none sent students home before Thanksgiving break. As spring semester gets under way, and universities bring even more students back to campus, the experiment continues.

"Most schools have had very unsuccessful [fall] semesters," Sabeti says. To do a better job in the spring, she suggests that schools double down on public health measures and civic engagement with both students and broader communities. At the schools profiled here, student involvement seemed to be an important part of control efforts. Several of the schools are adding new strategies as case totals have been climbing around the country.

Pick a different handful of universities and you'll probably find a different mix of approaches and outcomes. Maybe by the end of spring semester, a book of best practices for keeping colleges safe during a pandemic can be written.

Five experiences
As students arrived on campuses for the fall semester, many universities experienced COVID-19 outbreaks, as did all but one of the five schools profiled here. Some experienced late-semester peaks from Halloween parties or from a surge in a nearby city. SOURCE: DATA PROVIDED BY EACH UNIVERSITY

C. CHANG



Students: 6,400 in dorms; 31,650 enrolled

Testing: Mandatory, weekly PCR testing for students and staff in university housing; random sampling of faculty, staff and students living off campus who opt in to testing

Safety measures: Masks required indoors and outdoors; contact tracing; event restrictions following CDC guidelines

Spring semester plans: Undergrads tested twice a week; faculty and staff need a negative test within eight days of coming to campus; mandatory symptom monitoring and contact tracing via a phone app for all students in the Madison area; up-to-date testing required for building access

University of Wisconsin–Madison

In September, Wisconsin had one of the highest per capita rates of COVID-19 in the country. The University of Wisconsin–Madison was at the center of concern: Hundreds of students tested positive when campus opened in late August. Some students on campus gathered in large groups without masks despite university restrictions, according to the *Badger Herald*, a student newspaper. At the peak of the outbreak in early September, 911 students and staff tested positive in a single week.

The university partnered with a local biotechnology company that had developed a PCR COVID-19 test. As a research university, UW–Madison had the infrastructure to quickly analyze test samples on campus.

The initial plan had been to test all students living in residence halls every other week, says Jake Baggott, associate vice chancellor and executive director of University Health Services. But when cases spiked in September, the school moved to weekly testing.

"We sampled each residence hall, and each floor of each residence hall, every day," Baggott says. A staggered schedule was set based on living arrangements: If one student was tested on a Monday, the roommate was tested Tuesday, the next-door neighbor tested Wednesday and so on. This staggering helped administrators identify outbreak sites more quickly, as new data were available each day at a hyperlocal level.

Students who tested positive were put into two-week isolation and anyone known to be exposed to an infected person or exhibiting symptoms went into quarantine. All nonessential in-person activity was suspended for undergraduates for two weeks, starting on September 7. On September 20, a record 432 students were in isolation and 100 were in quarantine.

By late September, new daily cases had dropped below 20, and test positivity — the share of tests returning positive results — remained below 5 percent, a threshold recommended by the World Health Organization before a community should think about reopening. The university used similar tactics to crack down on a smaller outbreak that began in late October.

C. CHANG

North Carolina Agricultural and Technical State University, Greensboro

When campus first reopened, North Carolina Agricultural and Technical State University, NC A&T for short, had the capacity to test only symptomatic students. And turnaround was slow: Results took five to six days, sometimes longer.

The COVID-19 strategy shifted in late September, when the school received antigen tests through a U.S. Department of Health and Human Services grant for testing at historically Black colleges and universities. The trade-off for the antigen test's quick results is a higher likelihood of false negatives (as many as 1 in 5 in asymptomatic people). But for administrators, the speed was worth it.

"We decided to test everywhere we could," says Robert Doolittle, medical director of the Student Health Center — at the health center and pop-up sites around campus.

When an outbreak started after a Halloween party, which violated campus rules, the university restricted in-person socializing and tested about 1,000 students in a week with both antigen and PCR tests. Health center staff educated students about how to interpret the results of each test type: antigen test results are preliminary and may give false negatives, while PCR test results are more definitive. The PCR testing identified 61 cases in students who had negative antigen results, but the rapid tests still allowed the school to send 160 students into immediate isolation.

Young people who worked at the Student Health Center were instrumental to the testing effort, says Yolanda Nicholson, director of health education and wellness. The students ran social media campaigns, created educational videos and stood outside the center to advertise testing hours. Nicholson and student staff encouraged those who came in for testing to tell their friends about the experience. Some students went live on Instagram while they got tested, showing their peers what the experience looked like.

While upperclassmen criticized some freshmen for gathering without masks in August, as noted in the student paper, the *A&T Register*, students, for the most part, Nicholson says, "took it seriously."

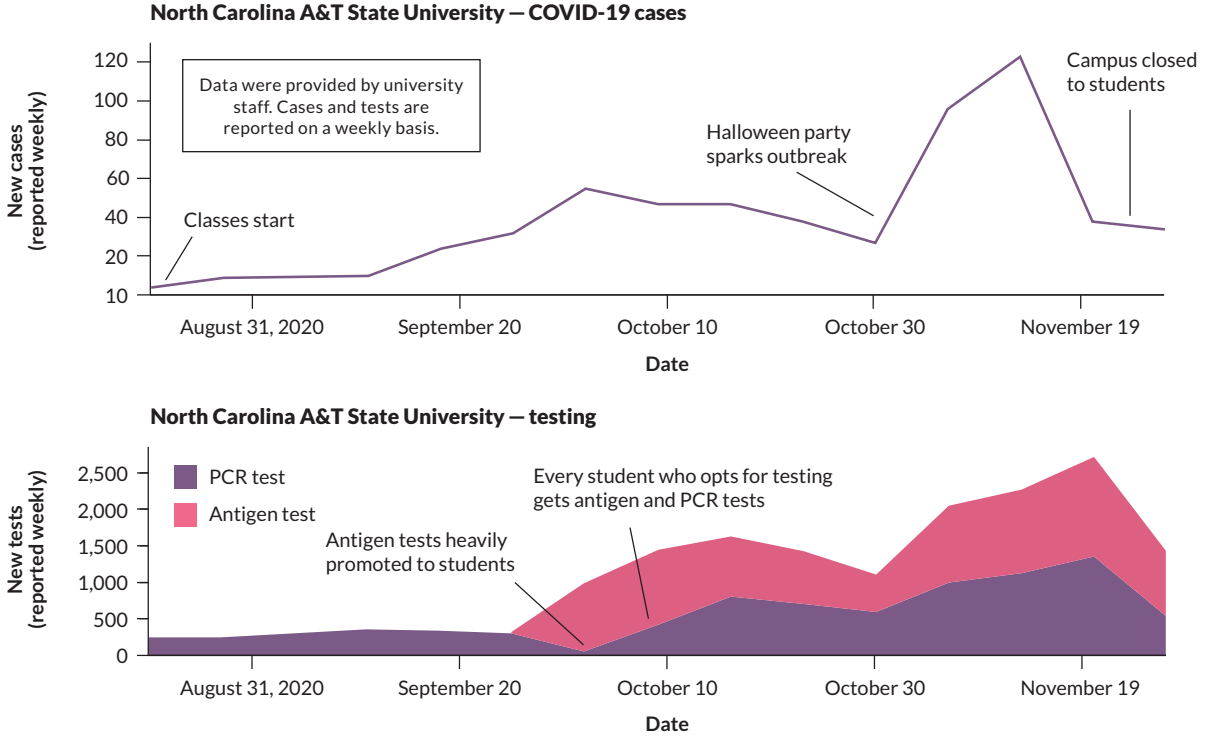
In an infomercial Nicholson shared with *Science News*, students expressed their reasons for getting tested: "for my family, for my loved ones, for us." NC A&T students understand that U.S. Black residents have been hit hard by the pandemic, Nicholson says. Demand for testing rose toward the end of the semester, as students were keen to avoid bringing the virus home to their families.

Students: 8,000 living on or near campus

Testing: PCR testing alone until September 28, when antigen testing was added; testing offered to symptomatic students, or during a spike in cases, or for those who request a test

Safety measures: Masks required indoors; contact tracing; limited capacity and social distancing in dining halls; size restrictions for nonclass gatherings; updated HVAC systems

Spring semester plans: Wastewater testing; students tested before returning to campus; testing incentives, such as free T-shirts



C. CHANG

Students: 1,000 living on or near campus during summer quarter; 6,200 during fall quarter (typical enrollment is 30,000)

Testing: Weekly targeted random sampling with PCR tests

Safety measures: Masks required indoors and outdoors; contact tracing; event restrictions varied

Spring semester plans: Students must get tested before returning to campus

University of Washington, Seattle

Fraternity and sorority houses — where students live and gather for parties — became sources of COVID-19 outbreaks at many schools. The University of Washington experienced a summer fraternity outbreak and applied lessons learned.

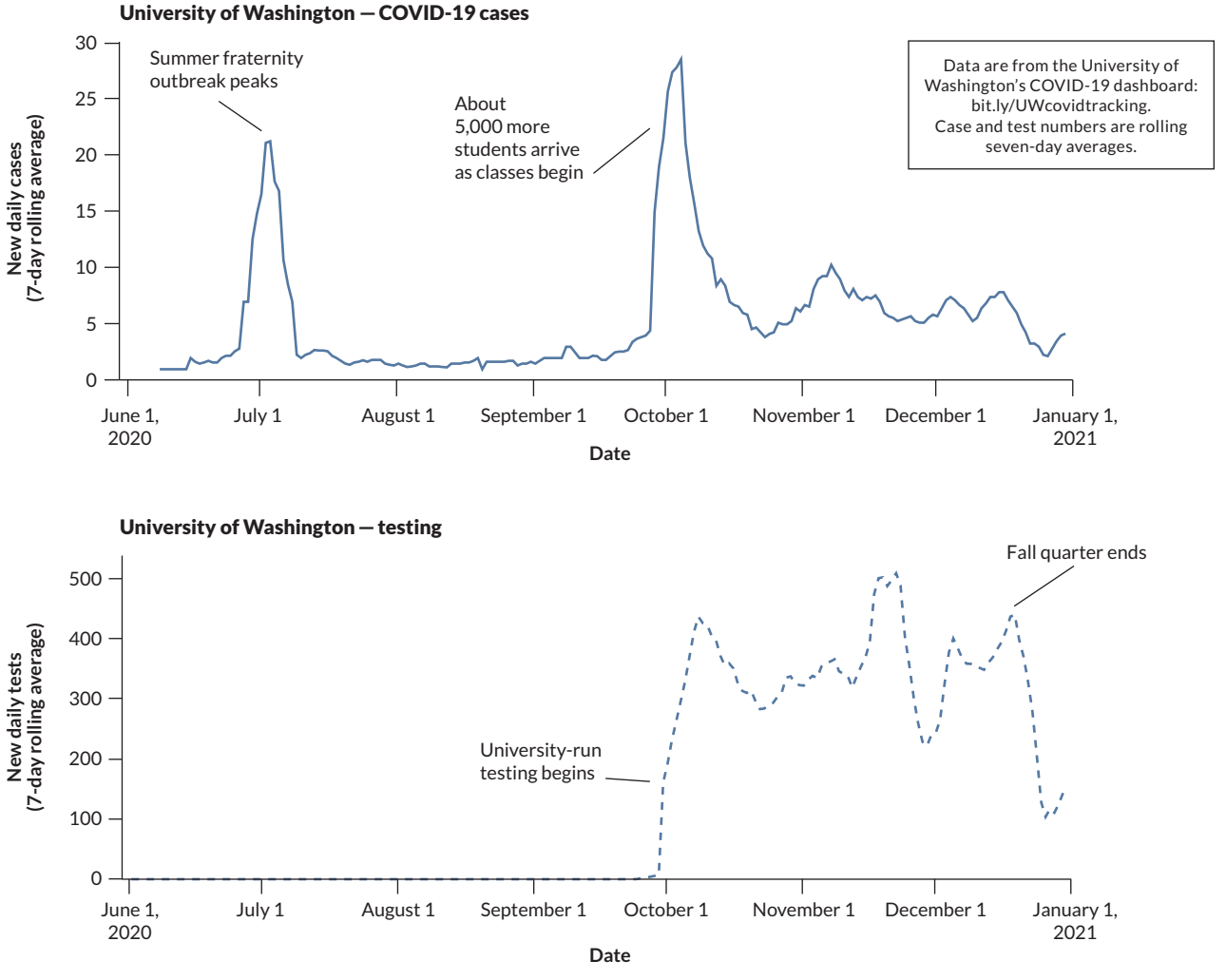
"It was late June, I was in the car, and I get a call from a [fraternity] chapter president that he has three members living in his facility that are symptomatic," says Erik Johnson, Interfraternity Council president at the time. "We went into emergency lockdown mode."

All 25 fraternity houses went into quarantine that same day. Within 48 hours, a testing site was set up to test every resident.

Johnson describes a major team effort: The university set up testing; the county public health department, which had responded to the first known U.S. COVID-19 outbreak, handled contact tracing; and fraternity leadership communicated the importance of quarantines and other safety guidelines. The summer outbreak was brought to heel in about two weeks, with the last case of the outbreak identified on August 8.

Both the university and student leaders used that summer experience to prepare for the fall. Genevieve Pritchard, 2020 president of the UW Panhellenic Association, which oversees sororities, joined weekly meetings with teams from the local public health department and the university's environmental health and safety office before sorority houses opened. Students could attend webinars to ask questions.

When an outbreak hit sororities at the start of fall quarter, infected students were quickly identified and isolated. The university reported 200 new cases the week ending October 4, 76 new cases the next week and 42 new cases the week after that. Only about a fifth of the usual student population had come to campus.



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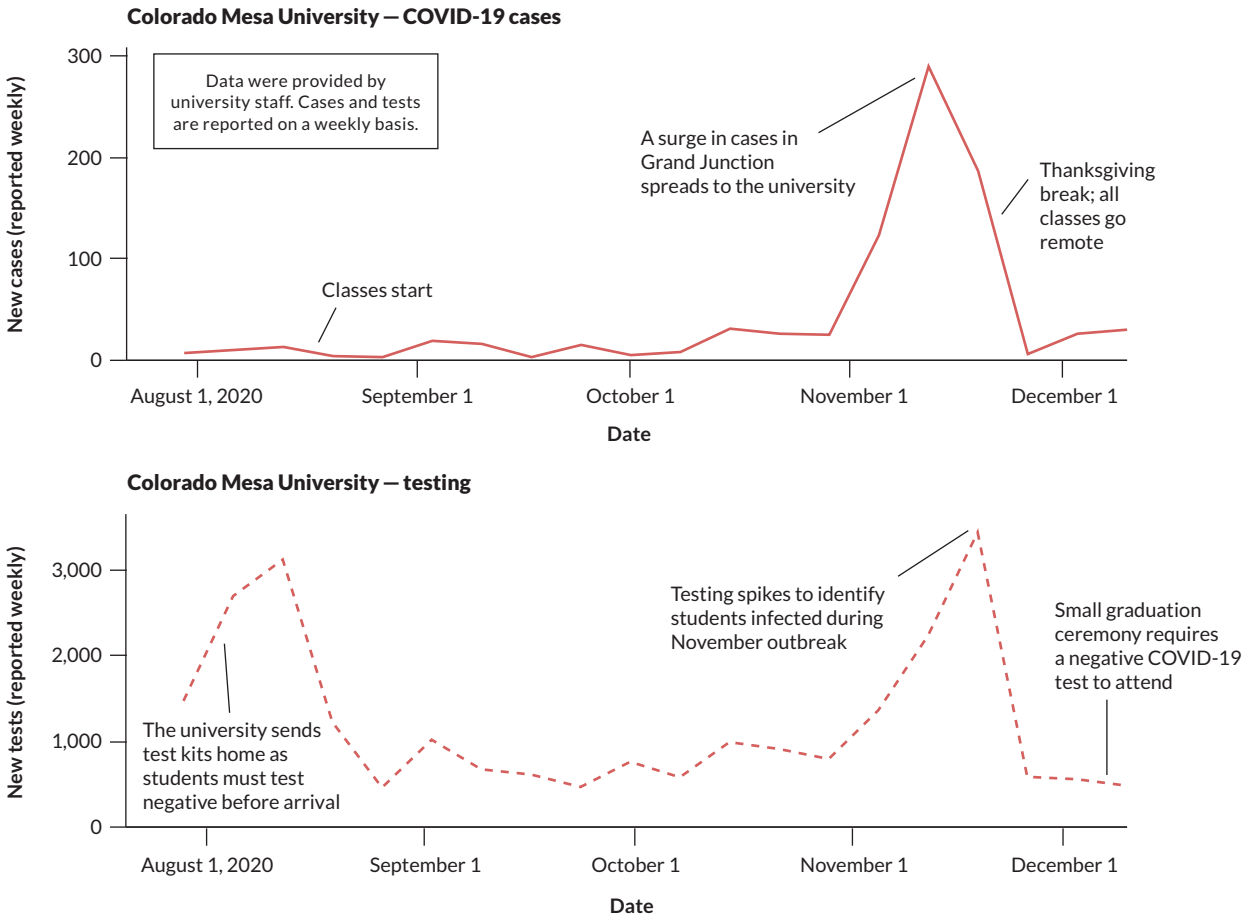


Colorado Mesa University, Grand Junction

As a school located far from large testing laboratories, Colorado Mesa University did not have access to 24-hour results for PCR tests. So the school relied on other screening methods and deliberate community building to bring its undergraduates — many of whom are first-generation, low-income students — back to campus.

The school used a "kitchen-sink approach" to COVID-19 surveillance, says Eric Parrie, CEO of COVIDCheck Colorado. Students had to test negative before returning to campus, and once they arrived, they participated in random testing with LAMP rapid tests, PCR tests for anyone known to have been exposed to the virus and wastewater sampling of residence halls.

John Marshall, vice president for Student Services, and Amy Bronson, program director of the university's Physician Assistant Program, held weekly COVID-19 virtual town halls starting in the spring. Student leaders encouraged safety among their peers through social media campaigns such as the school's "CMU is back" music video.

With a nod to the Maverick, the university mascot, students were grouped into small pods called "mavilies." Set up based on housing and activities, pods could be four students in an apartment or 20 students on a sports team. Mavilies were allowed to eat together, congregate closer than six feet in public spaces and remove masks in their communal living areas. The approach allowed sports teams to continue practicing, according to the student paper, the *Criterion*.

The university faced a November outbreak, which Marshall and Bronson attribute to community spread in Grand Junction, where many university students work. Campus testing and contact tracing ramped up during this time. Students were sent home for Thanksgiving, and the school finished its semester with two weeks of remote classes and exams — adhering to the school's original plan for the fall.

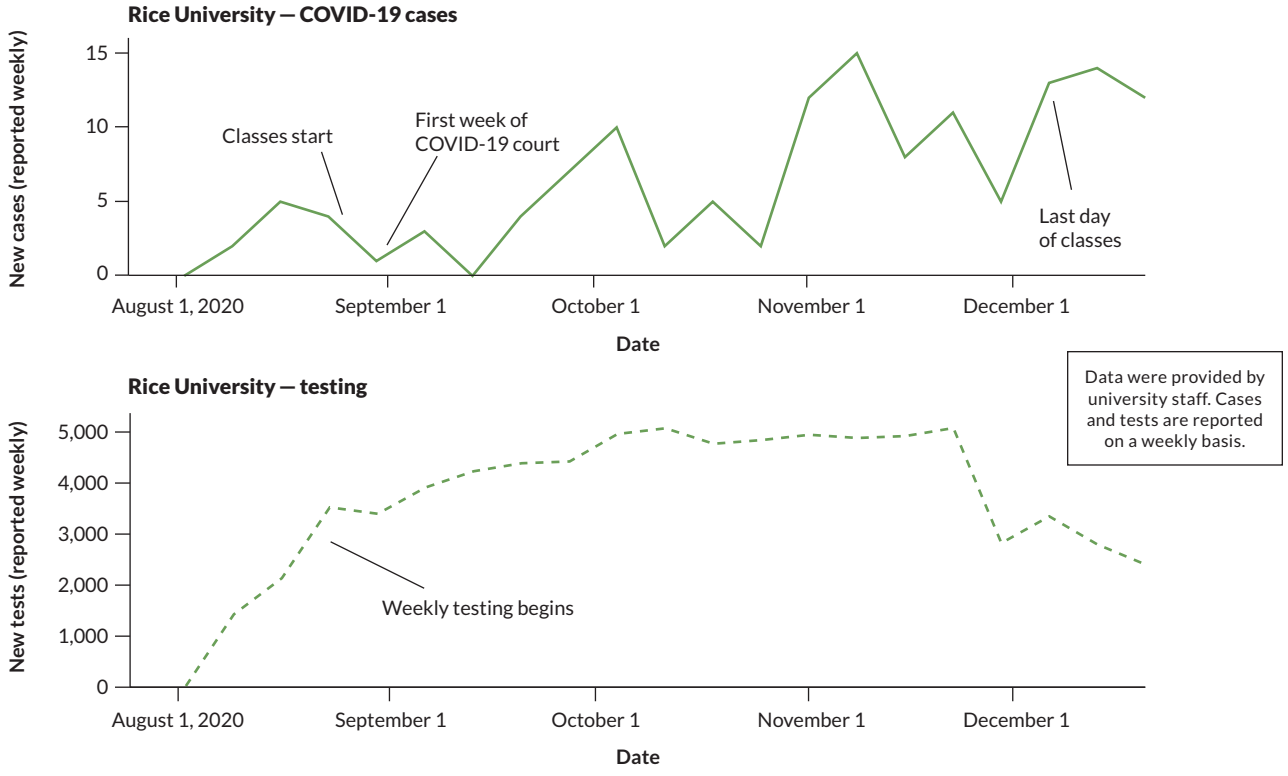
Students: 10,000 living on or near campus

Testing: Weekly random sampling LAMP tests; PCR tests confirm positive LAMP results

Safety measures: Students must complete five-module COVID-19 course before arriving; masks required indoors; wastewater testing of dorms; mandatory symptom monitoring, COVID-19 test tracking and international travel reporting; social distancing and enforced podding; dashboard shows occupancy of high-traffic campus areas; temperature checks at building entrances

Spring semester plans: Improved monitoring app with contact tracing

C. CHANG



Students: 3,000 living on or near campus

Testing: Weekly PCR testing for undergrads in dorms or who attend in-person classes; intermittent testing for staff, faculty and grad students every two to three weeks

Safety measures: Masks and social distancing required indoors and outdoors; contact tracing (priority is to first reach those exposed to more contagious students, based on viral load on PCR test); international travel logged in a Rice registry

Spring semester plans: Due to high case numbers in Houston, all classes online and campus closed to students until February 15; LAMP testing surveillance added to detect superspreader events

Rice University, Houston

A foundation of Rice University's reopening plan was weekly COVID-19 testing for undergraduates, says Yousif Shamoo, vice provost for research. After seeing Texas residents wait days for test results in the summer, the school lined up two Houston-based testing partners, Baylor Genetics and Houston Methodist Hospital, for 24-hour turnaround on test results.

Starting in the summer, student leaders helped the university prepare educational materials on COVID-19 and set up a system to discipline those who broke the rules and reward those who followed the rules, says Emily Garza, director of Student Judicial Programs.

Inspired by Rice's student-run Honor Council, the COVID-19 Community Court includes representatives from all 11 residential colleges who are selected by student leadership and trained by student Judicial Programs. Students on the court try their peers who break COVID-19 protocols on campus; students, staff and community members can report misconduct through an online portal.

The court has been criticized as an outlet for students to police each other. But Shamoo sees it as a means for education, reminding students that their actions have consequences.

As punishment for being caught without a mask, for example: "We're gonna make you write a three-page essay on whether you think masks are good ideas or not," he says. Students wrote their essays after watching videos and reading articles about public health and safety concerns around COVID-19. Another common penalty was community service hours, in which students created and posted flyers on campus buildings about COVID-19 precautions.

During the fall semester, about 130 student violations were reported, half on campus and half off campus. The university's staff judicial office investigated the off-campus violations.

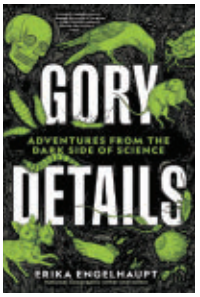
Rice also trained over 100 student health ambassadors to serve as resources for their peers who have questions about COVID-19 but don't want to ask administrators. Case numbers remained low at Rice, with no single day seeing more than six reported cases. Over 75,000 tests were conducted during the fall semester and only 135 cases were confirmed. ■

Explore more

- U.S. Centers for Disease Control and Prevention. "COVID-19. Colleges, universities and higher learning." December 29, 2020. bit.ly/CDC-COVIDcollege

Betsy Ladyzhets is a freelance science writer and data journalist based in Brooklyn, N.Y.

C. CHANG



Gory Details
Erika Engelhaupt
NATIONAL GEOGRAPHIC, $26

BOOKSHELF

Embrace the science of the taboo

We tend to turn away, physically or metaphorically, from things we find unsavory: leggy insects, bodily fluids, conversations about death. But just because something is disgusting, morbid or taboo shouldn't keep us from learning about it — and could even be a cue that we should, posits science journalist Erika Engelhaupt.

In *Gory Details*, Engelhaupt takes on a range of such topics, everything from which mammals are most likely to murder members of their own species and the spotty history of research on female genitalia to how fecal transplants work and the psychology of why we find clowns creepy. She often uses science, history or both to break down what gives a particular topic its taboo or ick status. How else are you going to stop chills from running up your spine while reading about a woman who pulled 14 tiny worms out of her eye other than by learning the story of parasitic survival that landed them there?

Regular *Science News* readers might recognize Engelhaupt's name: She was an editor at the magazine from 2009 to 2014. While here, *Gory Details* was born as a blog and later moved to *National Geographic*. The book includes updated and expanded versions of some blog posts, as well as plenty of new material.

Science News caught up with Engelhaupt to talk about the book. The following conversation has been edited for clarity and brevity. — *Kate Travis*

You've mentioned that when people learn your book title is *Gory Details*, they assume you write for kids.
Yes. At some point, people are expected to grow up and not be interested in gross things anymore, and I reject that. I think actually we all are interested in a wide variety of gross things. It's a matter of how you frame it. We may love watching murder mysteries and true crime and *CSI*-type shows. We don't necessarily think of ourselves as being morbid because of it. But when it comes to things like biology, anatomy and subjects that are taboo involving sex or death, we hold ourselves to a different standard. I want people to read this book and walk away feeling like, you know what? It's OK to be curious about things that we have considered off-limits for polite conversation.

You went to a conference on edible insects. This seemed like it was right at your limit of what you were willing to do in the name of *Gory Details*.
It was. I felt the need to go where all of the scientists would be and really learn why they think we're all going to be eating more insects in 20 years. It was a challenge for me. There's a little bit of a thrill in doing something like eating that first mealworm. You know it's not actually going to hurt you, but it's gross and it's new and it is exciting. The biggest challenge was the silkworm pupa, which was large and segmented and just looked so ... insecty.

You write about "delusions of infestation," where people believe their bodies are teeming with insects. I was struck by the stories of people with this condition, and that they seemed to have no other mental illness.
A delusion is just a fixed idea that's incorrect. When you hear that someone is delusional, you might think they're schizophrenic or psychotic. There can be cases where there's overlap with mental illness, but a lot of cases start off in a normal way. A person feels an itch, there's a real physical sensation. It's not too hard to imagine they'd think something is crawling on them and that it could be insects. It becomes extremely important to the person to convince people that they're right and not crazy. So the person gets deeper and deeper into [the delusion], and it becomes harder and harder to get them to accept treatment.

There are antipsychotic drugs that can help people let go of the idea and treatments that can solve underlying problems — skin problems, for example, or nerve problems that can cause the sensations. [Treatment with antipsychotics] makes it all sound very scary. That's one reason this problem goes so unrecognized and untreated — because of the stigma around mental illness and because it seems like people must be crazy. Our squeamishness and fear of people who are experiencing this, our deep discomfort with it, has really created a trap for people.

You write about a lot of new scientific research. Any standout papers where you thought, I have to write about this?
A study where scientists fed different human bodily fluids to blowflies to see which ones the flies found tastiest. [The scientists] were looking at how flies might transfer human DNA picked up from bodily fluids to different parts of a crime scene. [DNA analysis] techniques are now so sensitive that we're picking up DNA from fly poop. If the flies have previously eaten human blood or semen or saliva, there can be DNA from that person that gets pooped out by the fly. That [DNA] might get interpreted as blood spatter or get picked up incidentally at a crime scene and really confuse the situation. Who would have thought that you need to study fly poop to analyze DNA at a crime scene?

I was sure you were going to say the paper on the calorie count of a human, from the chapter on cannibalism.
That's one where it was a question I didn't know I had until I saw that a scientist had answered it. And those are some of the kinds of things that I wanted to fill this book with: You didn't know you wanted to know this, but I'm hoping that now you're glad you do. ■

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.

What the mummy's curse reveals about your brain

In late 1922, Lord Carnarvon financed and led a team in Egypt that found treasures associated with the tomb of Tutankhamun, the mummified boy king. But Carnarvon did not get to enjoy the riches for long. He died unexpectedly at age 56, just six weeks after entering King Tut's burial chamber. Sir Arthur Conan Doyle suggested an evil spirit might be to blame. Such rumors soon gave rise to the idea of the "mummy's curse." Now researchers are using statistics to debunk this and other suspicious coincidences. Our brains are primed to look for cause-and-effect patterns. That's why we often think we "see" compelling evidence of them — even when statistics show that actually we don't. — *Kathryn Hulick*

Read more: **www.sciencenewsforstudents.org/mummys-curse**

Our feverish universe is getting hotter every day

Global warming, meet cosmic warming. According to a new study, the universe is 10 times warmer today than it was 10 billion years ago. Back then, the average temperature of deep space was around 200,000° Celsius (360,000° Fahrenheit). Now it's roughly 2 million degrees C, which sounds pretty hot, but it wouldn't feel like it if you took off your space suit. (Pro tip: Don't disrobe in space. It's a bad idea.) People experience heat "by the transfer of thermal energy when we touch something," explains Martine Lokken, an astrophysicist at the University of Toronto. But in deep space, molecules tend to be very far apart. So it wouldn't feel hot, she says. It would feel like, well, nothing at all. — *Christopher Crockett*

Read more: **www.sciencenewsforstudents.org/cosmic-warning**

Honeybees fend off deadly hornets by decorating hives with poop

Giant hornets from Asia can quickly kill off an entire honeybee hive, wiping out thousands of bees in just a few hours. But Asian bees have found one stinky way to fend off these predators: smearing their hive entrances with animal dung. In tests, the hornets spent far less time at hives with moderate to heavy dung smears than at those with few dung spots. They also spent 94 percent less time chewing at filthy hive entrances. This suggests that a dirty doorway keeps hornets from trespassing on the hive. — *Asher Jones*

Read more: **www.sciencenewsforstudents.org/honeybees-defense**

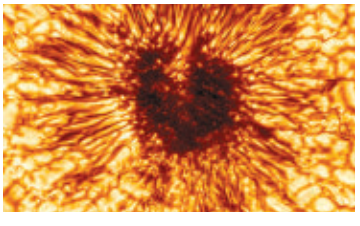
FROM TOP: FERGREGORY/ISTOCK/GETTY IMAGES PLUS; NASA, ESA, CFHT, CXO, M.J. JEE/UNIV. OF CALIFORNIA DAVIS, A. MAHDAVI/SAN FRANCISCO STATE UNIV.; H. MATTILA

JANUARY 16, 2021

SOCIAL MEDIA

Sun spotting

Earth's largest solar telescope has captured the sharpest image ever of a sunspot (below), **Christopher Crockett** reported in "A sunspot's moment in the spotlight" (*SN: 1/16/21, p. 32*). While many people on Facebook commented on the sunspot's resemblance to the Eye of Sauron from *The Lord of the Rings*, reader **DeWayne Williams** mused about connections between the macroscopic and microscopic worlds. "You ever think the universe looks like what you might see under a microscope," he wrote.



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Shaking up memories

*A post–World War II data boom clinched the unifying theory of plate tectonics after decades of debate over whether Earth's crust was static or mobile, **Carolyn Gramling** reported in "Shaking up Earth"* (SN: 1/16/21, p. 16).

The story reminded some readers about their experiences around the time of the theory's birth in the 1960s.

Reader **Jane Smiley** recounted her experience as a student at Harvard University when plate tectonics was being hotly debated. "My professor was Bernhard Kummel ... and we had to use his textbook. I was present at a great symposium on plate tectonics, which was attended by geologists from around the world," **Smiley** wrote. "There was a cacophony of vociferous arguments flying back and forth about the validity of plate tectonics. Everyone brought their papers using the overhead projector and some of the Europeans discussed Alfred Wegener's theory [of continental drift], and they got rebuffed by my professor as well as many others in the field," she wrote. "I was a 'drifter,' but I sat quietly while I listened attentively to the arguments. Professor Kummel was not a drifter and when I had to write papers in his class, I had to swallow my beliefs and write what he wanted to hear. It was a very exciting time to be a student there, and I learned to be an independent thinker in many disciplines."

Reader **Mark Wilson** recalled attending a lecture in the late 1960s by geophysicist J. Tuzo Wilson who, **Gramling** reported, compared the impact of the theory of plate tectonics to that of Einstein's general theory of relativity. The geophysicist shared "his ideas concerning oceanic hot spot island chains such as Hawaii, and what he called transform faults in the ocean floor," **Wilson** wrote. "I also worked for the summer of 1968 aboard a Canadian geophysical research ship on the Mid-Atlantic Ridge, surveying the ocean floor stripes of magnetism and gravity measurements, and conducting seismic tests. I ended up becoming a vertebrate paleontologist and biology professor, but always enjoy science writing that combines geology and biology."

Wilson wrote that he plans to incorporate Gramling's story in his teaching. "I have enjoyed [her] science writing for several years and have gathered a number of her articles as resources for my students. They are always clearly written, interesting and thought-provoking," he wrote. "When I next teach my course, the students will have several writing assignments, and one of them will be to produce a science news essay, hopefully interesting, like Gramling's work."

What stinks?

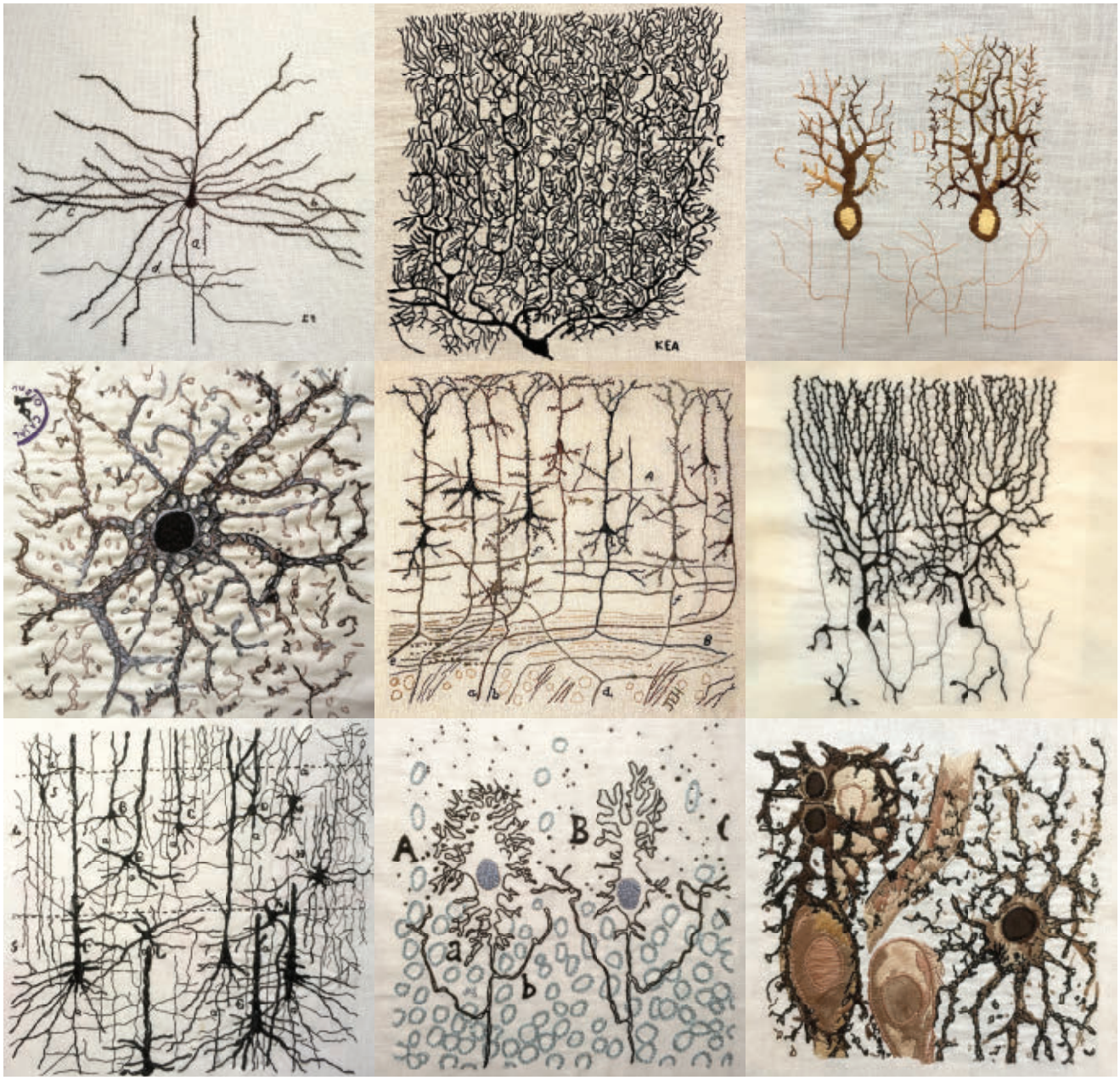
*Wild giant pandas that coat themselves in horse manure may be seeking out two chemical compounds in the poop that inhibit a cold-sensing protein, **Jonathan Lambert** reported in "Pandas may roll in poop to stay warm"* (SN: 1/16/21, p. 14).

"Fresh horse dung has a signature aroma to it, very tangy," reader **Pat Rapp** wrote. "Are those two volatiles ... responsible for that edge to the aroma?" he asked. **Rapp** also wondered if the compounds are present in the dung of other species such as donkeys and zebras. "If memory serves, donkey dung doesn't broadcast itself with anything like the strength of horse dung."

The compounds might contribute to horse manure's strong odor, says **Lambert**, but he doesn't think they are solely responsible for the stench. "The researchers are currently investigating whether these compounds are present in the dung of similar species," he says.

Correction

"Suspended education" (*SN: 1/16/21, p. 24*) reported that a study looking at a color-blind approach to reducing the discipline gap between white and Black students showed that the gap grew from a threefold difference to more than fivefold. This is incorrect. The gap grew to almost fivefold.



Iconic brain cell sketches, embroidered

In the late 1800s, Santiago Ramón y Cajal, a Spanish brain scientist, spent long hours in his attic drawing elaborate cells. His careful, solitary work helped reveal individual cells of the brain that together create wider networks. For those insights, Cajal received a Nobel Prize in physiology or medicine in 1906. Now, a group of embroiderers has traced those iconic cell images with thread, paying tribute to the pioneering drawings that helped us see the brain clearly.

The Cajal Embroidery Project was launched in March 2020 by scientists at the University of Edinburgh. More than 100 volunteers — scientists, artists and embroiderers — sewed panels (nine shown) that will ultimately be stitched into a tapestry, a project described in the December issue of *Lancet Neurology*.

The panels, each about 23 centimeters on a side, re-create a variety of brain cells. For instance, nerve cells called Purkinje cells (top row, middle) collect incoming signals with their lush tendrils before sending along their own quieting signals.

Cajal's drawings are still relevant, says neuroscientist and project cofounder Catherine Abbott. Even with powerful microscopes, our views of nerve cells look pretty much the same today. And that thread ties the embroiderers to Cajal's work, she says. "We are looking at the same thing and feeling the same sense of wonder." — *Laura Sanders*

CAJAL EMBROIDERY PROJECT. TOP ROW (LEFT TO RIGHT): LIZ RIBCHESTER, KATIE ASKEW, JANET PHILP; MIDDLE ROW: CAROL COLEMAN, JANE HALEY, EMMA PERKINS; BOTTOM ROW: NIKI STYPIDOU, MELANIE STEFAN, ALISON TODD

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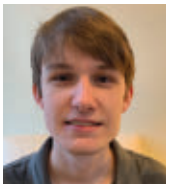
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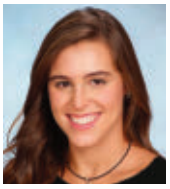
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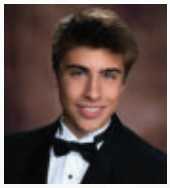
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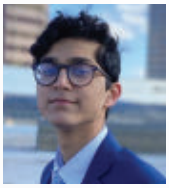
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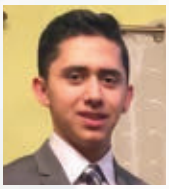
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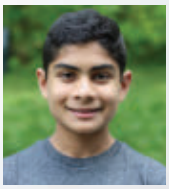
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