

A Psychedelic for Depression | The End of Arcibo

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 19, 2020 & JANUARY 2, 2021



2020 Year of the Virus

Scientists mobilize to combat a historic pandemic



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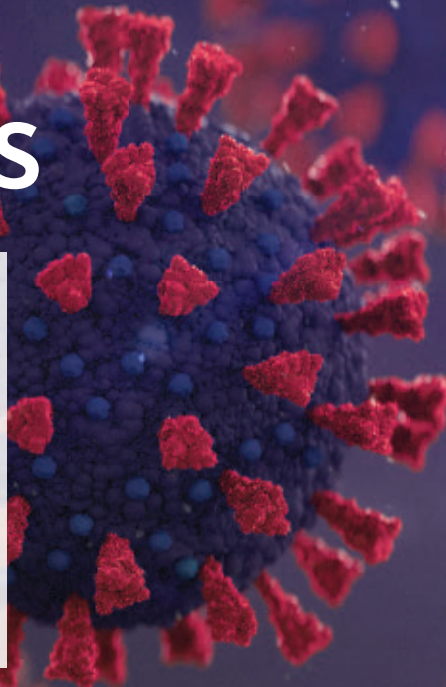
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2020 Year in Review

16 A Year Like No Other

Science News looks back over a year dominated by a life-changing, deadly pandemic and by urgent calls for equity, including greater inclusivity for Black scientists in all fields of research. Amid the tumult, researchers continued to elucidate the impacts of a warming climate, launch missions into space and discover wonders of the natural world.



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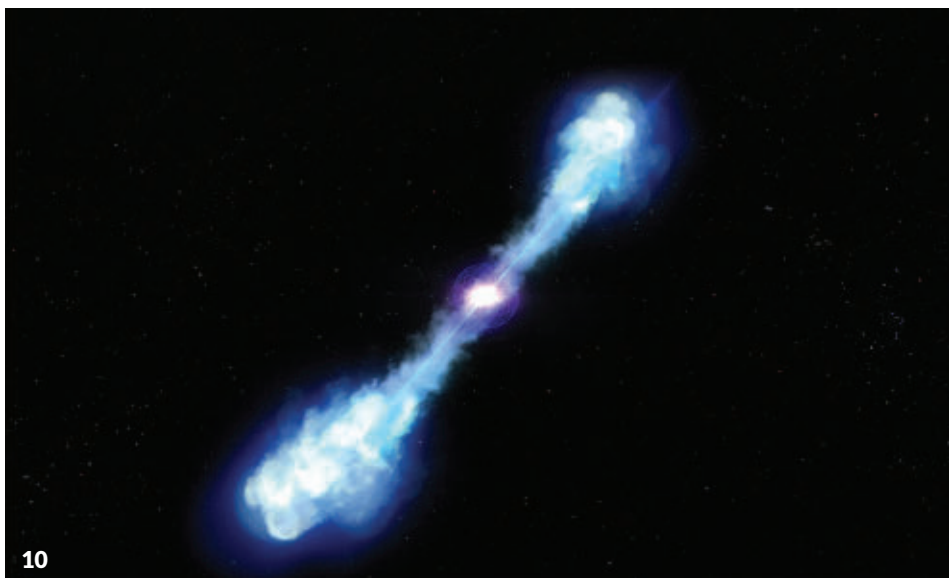


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COVER 2020 was the year of the face mask, one tool for protecting us — and those around us — from a deadly virus.
Pui Yan Fong



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After a year like no other, new challenges and hope

In these waning days of December, last January seems very far away. Our family calendar for that month still speaks of what was then normal — a work trip for me, theater rehearsals for our daughter, a concert by the neofolk band Heilung. My husband and I attended the show standing shoulder to shoulder with friends and strangers.

But even then, the virus was coming. The first confirmed case in the United States was reported January 21, right before that concert. Since then, the world has learned that in a pandemic year, a concert hall packed with thousands of people is the last place you want to be.

We know that now because scientists around the world devoted themselves to solving the mystery of SARS-CoV-2. There's so much we still don't know, as we enumerate on Page 17, but we've learned a tremendous amount.

Many of those lessons were painful, a chronicle of misery and loss. The pandemic timeline we built for this special year-end issue recalls what we have endured (Page 22) — vacationers trapped on a sick cruise ship, millions out of work as countries locked down, students out of class, hospital workers overwhelmed, people dying without the comfort of a loved one's hand.

The early missteps in public health advice are particularly painful to recall, including assertions that asymptomatic people couldn't spread the disease, and that masks weren't needed. Also painful: the refusal by many in public office to heed the advice of scientists, and antisense disinformation that accompanied it. How many lives could have been saved had science not been under attack?

Then came news from clinical trials showing that several vaccines can prevent illness. On December 2, the United Kingdom became the first Western country to approve a vaccine. The United States is poised to follow by year's end. As a journalist, I looked with skepticism at the promises of vaccines by New Year's. Now that it looks like scientists may have pulled off this astonishing feat, I couldn't be more delighted to be proved wrong.

That's not the end of the story, of course. Even if these vaccines prove to be as reliable as the clinical trials suggest, there will be big logistical challenges in distribution, and in overcoming mistrust in vaccines, especially among Black and Hispanic communities hit hardest by the coronavirus.

Considering how much the pandemic disrupted the year, it's remarkable to look back and see how much "regular" life went on. While going all-in on covering the pandemic, we also continued to cover all the sciences, as we have since 1921. Those articles about gravitational waves (Page 34) and space launches (Page 36) and flying snakes (Page 40), and many others, brought me the joy of discovery, day after day.

The pandemic still rages; we have so much more work to do. I am so proud of the extraordinary efforts of our *Science News* team to bring you accurate breaking news, as well as the deeper context, in the midst of a global crisis. We will continue that work. I am hopeful that a year from now we will look back at 2021 as another year of scientific discovery and achievement, and the year we tamed the virus. — *Nancy Shute, Editor in Chief*

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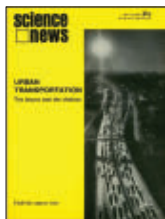


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Excerpt from the December 19, 1970 issue of *Science News*

50 YEARS AGO

Urea normalizes cells

Intravenous infusions of urea now appear to promise successful treatment of sickle-cell patients.... Urea causes sickled cells to revert to their normal, doughnut shape. Thus far, intravenous infusions of urea have relieved sickle-cell crises in 22 patients tested.

UPDATE: Sickle-cell disease causes painful clots that can lead to strokes and damage organs. Bone marrow transplants, which began in the 1980s for sickle-cell patients, are a cure, but finding a donor can be challenging. In 1998, a urea-based compound called hydroxyurea became the first drug approved by the U.S. Food and Drug Administration to treat sickle-cell disease. Until then, without a transplant, doctors could only ease symptoms with painkillers and blood transfusions. Hydroxyurea is still used today. Because the compound can be toxic at high doses, scientists have continued searching for better treatments. Clinical trials under way in the United States are using the gene-editing tool CRISPR/Cas9 to edit sickle-cell patients' DNA in an effort to beat the disease for good (SN: 8/31/19, p. 6).

Dirt recipes based on observations of Mars' surface (shown) are helping scientists figure out what it will take to grow food on the Red Planet.

FUTUROLOGY

Farming on Mars will be nothing like in *The Martian*

In the film *The Martian*, astronaut Mark Watney (played by Matt Damon) survives on the Red Planet by farming potatoes in regolith fertilized with his own feces. In real life, future astronauts might be able to grow crops on Mars, but new lab experiments suggest the process will be a lot more complicated than simply planting crops with poop.

Researchers planted lettuce and the weed *Arabidopsis thaliana* in three kinds of simulated Mars dirt. Two were made from soils mined in Hawaii or California's Mojave Desert that resemble dirt on Mars. To mimic the makeup of the Martian surface more closely, the third was made using volcanic rock, clays, salts and other chemical ingredients that have been detected by NASA's Curiosity rover. Seeds were planted under controlled lighting and temperature indoors, just as astronauts would do on Mars. While both plant types survived in the Mars-like natural soils with the help of fertilizer, neither

In lab experiments, lettuce grew in Mars-like soil from the Mojave Desert if the soil was treated with nutrients such as nitrogen and potassium.



grew in the synthetic dirt, researchers report in the Jan. 15 *Icarus*.

Since neither plant could sprout in the synthetic dirt, biochemist Andrew Palmer and colleagues at the Florida Institute of Technology in Melbourne tried first starting plants hydroponically. But when transferred to the artificial dirt and given fertilizer, those seedlings died within a week. Lowering the dirt's pH from about 9.5 to 7.2, close to the pH of the natural soils, helped, though not by much. The seedlings survived an extra week but ultimately died.

The team also ran up against another problem: The original synthetic dirt recipe did not include calcium perchlorate, a toxic salt that recent observations suggest makes up to about 2 percent of the Martian surface. When the team added the salt at concentrations similar to those seen on Mars, neither lettuce nor *A. thaliana* grew at all post-transplant.

The exact treatment to make Martian dirt farmable may vary, depending on where astronauts make their homestead. Geochemist Laura Fackrell of the University of Georgia in Athens and colleagues made five different types of faux Mars dirt that represent a mix of materials that could be found or made on the planet. Fackrell is using those recipes, also reported in the Jan. 15 *Icarus*, to run plant growth experiments. So far, a drought-resistant legume has grown the best. Future studies could explore what nutrients will help plants survive. But this much is clear, Fackrell says: "It's not quite as easy as it looks in *The Martian*."

— Maria Temming

SAY WHAT?

Natech \nAY-tek\ n.

Natural hazard–induced technological disasters

In August, a dry lightning storm over California sparked an intense wildfire that raged through communities in the Santa Cruz Mountains. As firefighters worked to contain the blaze, local officials detected benzene in the water supply. The chemical, a known carcinogen, probably was released by melting plastic pipes.

Scientists call events like this “natech,” or natural hazard–induced technological disasters. Coined in the 1990s, the term initially applied to chemical or fuel spills after hurricanes, earthquakes and other natural hazards. But disaster researchers are expanding natech’s definition, says resilience scientist David Yu of Purdue University in West Lafayette, Ind. The term now includes damage to any kind of infrastructure that relies on technology, he says, such as electrical grids and water pipes.

That broadening definition partly explains why the frequency of natech is on the rise. More people are moving to coasts and the edges of wilderness areas, places vulnerable to natural hazards. It takes power plants, water supply facilities and networks of internet cables to support these growing population centers. As climate change fuels more frequent and intense hazards, they collide with vital infrastructure more often (*SN*: 2/15/20, p. 22). — *Megan Sever*

RETHINK

Fins help gobies get touchy-feely

Fish fins aren’t just for swimming. They’re feelers, too. The fins of round gobies can detect textures with a sensitivity similar to that of the pads on monkeys’ fingers, researchers report November 3 in the *Journal of Experimental Biology*.

Little is known about aquatic animals’ sense of touch. And for fish, “we used to only think of fins as motor structures,” says Adam Hardy, a neuroscientist at the University of Chicago. “But it’s really becoming increasingly clear that fins play important sensory roles.”

Hardy and colleague Melina Hale, also of the University of Chicago, measured the activity of nerves in the fins from six round gobies (*Neogobius melanostomus*). The duo logged spikes in nerves’ electrical activity as a bumpy plastic ring rolled lightly above each fin. Different spacings of bumps provided information on the range of roughness the fins could detect. Narrower spacings mimicked the texture of coarse sand, and larger gaps produced a roughness on the scale of pebbles.

The neural spike patterns corresponded with bump spacings. More closely spaced bumps produced more frequent sets of spikes while larger spaces produced less frequent sets. These signals also varied with the speed of the rotating ring. Together, the results suggest that goby fins respond to textures. What’s more, the spike patterns were similar to those recorded during tests on monkeys’ finger pads. That’s surprising given that these animals’ limbs and environments are a world apart, Hale says. Studying other fish species could reveal how common feeling fins are. — *Carolyn Wilke*

In addition to aiding swimming, the fins of round gobies (one shown) can sense differences in texture, a new study suggests.



The smartwatch app SoundWatch notifies people who are deaf or hard of hearing about birdsongs, sirens and other noises.

FOR DAILY USE

Smartwatch app vibes with noises of daily life

A new smartwatch app alerts users who are deaf or hard of hearing of nearby sounds, such as microwave beeps or car horns.

“The main motivation [for the app] came from my own experience, and conversations that my colleagues and I have had with deaf and hard of hearing people over several years,” says Dhruv Jain, a computer scientist at the University of Washington in Seattle who presented the system, called SoundWatch, at a virtual ASSETS conference on October 28.

Jain, who is hard of hearing, uses SoundWatch at home to avoid sleeping through a smoke alarm. “On a nature walk, it’ll tell me that there’s birds chirping, or there might be a waterfall nearby,” he says. “Those sounds make me feel more present and connected to the world.”

The SoundWatch app pairs an Android smartwatch and phone. The watch records ambient noises and sends that data to the phone for processing. When the phone detects a sound of interest, the smartwatch vibrates and displays a notification.

The app can identify 20 noises. In tests, SoundWatch correctly identified all 20 sounds 81.2 percent of the time. When set to listen only for urgent noises, the app was 97.6 percent accurate. Eight deaf and hard of hearing users gave the app broadly favorable reviews, but noted that it misclassified some sounds in noisy outdoor settings. Jain is working on a version of the app that users can train to recognize new sounds. — *Maria Temming*

Psilocybin may help treat depression

The psychedelic drug's benefits lasted a month in a small study

BY LAURA SANDERS

Hallucinogenic mushrooms' key ingredient, psilocybin, can swiftly and dramatically ease depression in the right therapeutic setting, a small study suggests.

A month after receiving two doses of the psychedelic drug, 13 people had big drops in depressive symptoms, researchers report online November 4 in *JAMA Psychiatry*.

Because the study was small and lacked participant diversity, it's unclear whether the positive results would extend to wider populations. Still, "the current results are clear," says Jay Olson, a psychology researcher at Harvard University who wasn't involved in the study. "At least for some people, psilocybin can reduce depression better than several common treatment options."

Existing antidepressant drugs don't work well for an estimated 30 to 50 percent of the people who try them. And when the drugs do work, the effects can be slow to appear. Psilocybin, a compound that can profoundly alter

consciousness and perceptions of reality, might be a powerful alternative, says neuropsychopharmacologist Roland Griffiths of Johns Hopkins School of Medicine, a coauthor of the new study.

Thirteen patients with moderate or severe depression received two doses of psilocybin pills spaced about a week and a half apart. Participants also received psychological support from researchers before, during and after taking psilocybin.

A comparison group of 11 people waited eight weeks and then received two doses of psilocybin and supportive therapy. This delay allowed the researchers to look for improvements in symptoms that were not related to the drug.

Clinicians used a common depression rating scale of 17 items to measure participants' symptoms. Scores can range from 0 to 52, with higher numbers indicating more severe depression. Before receiving psilocybin, participants who got the drug without delay scored an average of 22.9 points, signaling the high end of moderate depression. Four weeks after the second dose, average scores dropped to 8.5. A score of 7 or below indicates no depression. While the comparison participants waited their turn to get the drug, their scores hovered around 23.

Overall, 13 of 24 people — including some who got psilocybin immediately and some who got it later — met the definition of remission four weeks after their respective treatments. The drops in depression symptoms are substantial compared with those found by some analyses of standard antidepressants, Griffiths says.

As with clinical studies in general, positive effects might arise simply from participants' expectations, not the drug itself. But such effects are unlikely to account for the magnitude of the drop observed, Olson says.

The new findings on psilocybin's antidepressant effects fit with earlier ones:

A dose of the drug eased depression and anxiety in a small group of patients with cancer, effects that lasted for years in some cases, researchers reported in the *Journal of Psychopharmacology* in January (*SN Online: 1/28/20*). Another study, published in *Lancet Psychiatry* in 2016, found that signs of depression dropped in 12 people who received two doses of psilocybin and psychological support.

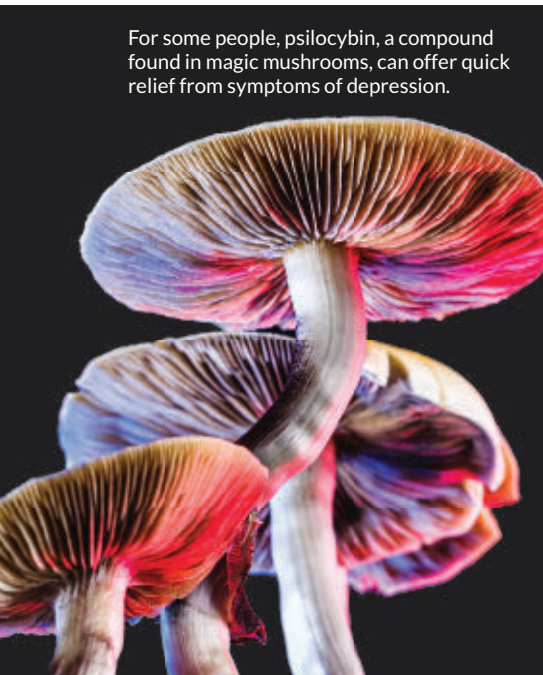
Overall, the approach is promising, Griffiths says, but questions remain. "We still need to collect more safety data, and we need to know conditions for optimal administration," he says.

Other questions relate to who might benefit from the drug, and who might not, and a diverse study population could help address that. In the new study, however, almost all participants were white; there was just one Asian participant and one Black participant. "We really need to think more about who we are including in these studies," says psychologist Monnica Williams of the University of Ottawa, who wasn't involved in the research.

Boosting participation rates among people of color calls for additional effort, particularly in the context of ongoing racial health disparities. A history of negative health care experiences might shape a psychedelic treatment experience, which is sensitive to the setting, Williams says. "A person of color might have a lot of reasons to feel very guarded and anxious in that situation, which is going to make it harder for that approach to be effective."

Of 282 people who participated in studies on psychedelics and mental health disorders from 1993 to 2017, the vast majority — 82 percent — were white, Williams and colleagues reported in a review article published in 2018 in *BMC Psychiatry*. "We're in the 21st century now," she says. "There's just no reason for this anymore." ■

For some people, psilocybin, a compound found in magic mushrooms, can offer quick relief from symptoms of depression.





A gray *Fritillaria delavayi* plant (right of center in this image) blends into its rocky background high in the mountains of southwestern China.

LIFE & EVOLUTION

A medicinal plant hides from people

A species prized by Chinese herbalists evolved camouflage

BY JONATHAN LAMBERT

Fritillaria delavayi plants should be simple to spot.

The usually bright green plants often stand alone amid the jumbled scree that tops the Himalayan and Hengduan mountains in southwestern China — easy pickings for traditional Chinese medicine herbalists, who have ground the bulbs of wild *Fritillaria* into a popular cough-treating powder for more than 2,000 years. The demand for bulbs is intense, since about 3,500 of them are needed to produce just one kilogram of the powder, worth about \$480.

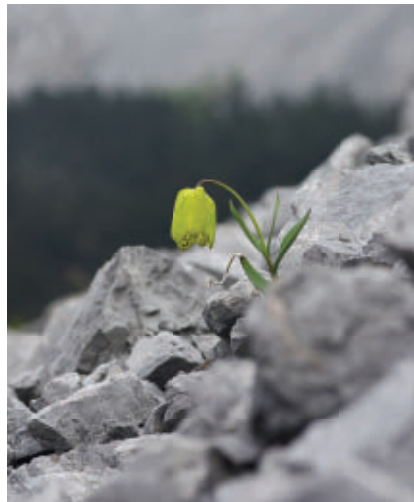
But some *Fritillaria* plants are remarkably difficult to find, with living leaves and stems that are barely distinguishable from the gray or brown rocky background. Surprisingly, this plant camouflage seems to have evolved in response to people. *F. delavayi* from regions that experience more harvesting are more camouflaged than those from less harvested areas, researchers report in a study published online November 20 in *Current Biology*.

The study “is quite convincing,” says Julien Renoult, an evolutionary biologist at the French National Center for

Scientific Research in Montpellier who wasn’t involved in the research. “It’s a nice first step toward demonstrating that humans seem to be driving the very rapid evolution of camouflage in this species.”

Camouflaged plants are rare, but not unheard of, says Yang Niu, a botanist at the Kunming Institute of Botany in China, who studies cryptic coloration in plants. In wide open areas with little cover, like mountaintops, blending in can help plants avoid hungry herbivores. But after five years of studying camouflage in *F. delavayi*, Niu found few bite marks on leaves, and he did not spot any animals munching on the plants.

“They don’t seem to have natural enemies,” he says.



In places where they aren’t heavily harvested, *Fritillaria delavayi* plants are bright green (like the one shown).

So Niu, his colleague Hang Sun and sensory ecologist Martin Stevens of the University of Exeter in England decided to see if humans might be driving the evolution of the plants’ camouflage. If so, the more heavily harvested a particular slope, the more camouflaged the plants that live there should be.

In an ideal world, to measure harvesting pressure “you’d have exact measures of exactly how many plants had been collected for hundreds of years” at multiple sites, Stevens says. “But that data is practically nonexistent.”

Luckily, at seven study sites, local herbalists had noted the total weight of bulbs harvested each year from 2014 to 2019. These records provided a measure of contemporary harvesting pressure. To estimate further back in time, the researchers assessed ease of harvesting by recording how long it took to dig up bulbs at six of those sites, plus an additional one. On some slopes, bulbs are easily dug up, but in others they can be buried under stacks of rocks. “Intuitively, areas where it’s easier to harvest should have experienced more harvesting pressure” over time, Stevens says.

Both measures revealed a striking pattern: The more harvested, or harvestable, a site, the better the color of a plant matched its background, as measured by a spectrometer. “The degree of correlation was really, really convincing for both metrics we used,” Stevens says.

Human eyes also had a harder time spotting camouflaged plants in an online experiment, suggesting that the camouflage actually works.

Hiding in plain sight may present some challenges for the plant. Pollinators might have a harder time finding camouflaged plants, and the gray and brown coloration could impair photosynthetic activity. Still, despite those potential costs, these *F. delavayi* show just how adaptable plants can be, Stevens says. “The appearance of plants is much more malleable than we might have expected.” ■



In August, a broken cable damaged the Arecibo Observatory's 305-meter-wide dish (shown). On December 1, the platform above the dish collapsed.

ATOM & COSMOS

Arecibo Observatory is closed for good

Broken cables and a collapsed platform shut down the telescope

BY LISA GROSSMAN

Arecibo's days are done. The platform suspended above the radio observatory's 305-meter-wide dish collapsed on December 1, ending the telescope's 57-year run. Arecibo was already damaged beyond repair after two support cables broke in recent months, the National Science Foundation announced on November 19.

"It's a death in the family," says astronomer Martha Haynes of Cornell University, who has used the telescope

in Puerto Rico to study hydrogen in the universe since 1973. "For those of us who use Arecibo and had hoped to use it in the future, it's a disaster."

The telescope, famous for appearances in movies such as *Contact*, consisted of a wide dish to collect radio waves from space and focus them into detectors housed in a dome that was part of the platform that collapsed. In August, one of the cables that supported the platform slipped out of a socket and punched a hole in the dish.

NSF and the University of Central Florida, which manages the telescope, had plans to repair the cable, Haynes says. But then a second cable unexpectedly broke on November 6.

NSF determined that there was no safe way to repair Arecibo. "Until these assessments came in, our question was not if the observatory should be repaired but how," Ralph Gaume, director of NSF's Division of Astronomical Sciences, said in a statement. "But in the end, a preponderance of data showed that we simply could not do this safely." Those safety concerns proved valid with the collapse.

The closure is the last in a series of near disasters for Arecibo. A different cable was damaged in an earthquake in 2014. Repairs on that cable were delayed by Hurricane Maria in 2017, which temporarily shut down the observatory as Puerto Rico weathered widespread power outages and humanitarian crises.

Built in 1963, Arecibo was one of the best facilities in the world for observa-

MATTER & ENERGY

The dual nature of supercooled water

A new discovery could help explain some of water's quirks

BY EMILY CONOVER

Supercooled water is two of a kind.

Scientists have long suspected that water at subfreezing temperatures comes in two varieties: a high-density liquid that appears at very high pressures and a low-density liquid at lower pressures. Now, ultrafast measurements have caught water morphing from one type to the other, confirming that hunch. The discovery, reported in the Nov. 20 *Science*, could help explain some of water's quirks.

The work "adds more and more evidence to the idea that water really is two

components... and that that is the reason that underlies why water is so weird," says physicist Greg Kimmel of Pacific Northwest National Laboratory in Richland, Wash., who was not involved in the study.

When free from impurities, water can be liquid below its typical freezing point of zero degrees Celsius, forming what's called a supercooled liquid. The dual nature of supercooled water was expected to appear under conditions so difficult to study that they've been dubbed a "no-man's-land." Below about -40°C , water is liquid for mere instants before crystallizing into ice. And the high-density phase appears only at high pressures.

Physicist Anders Nilsson of Stockholm University and colleagues infiltrated that no-man's-land by monitoring water's properties on a scale of nanoseconds. The scientists first created a high-density ice. A pulse from an infrared laser then heated

the ice, forming liquid water under high pressure. That water expanded, and the pressure rapidly dropped. Meanwhile, the team used an X-ray laser to investigate how the water's structure changed, based on how the X-rays scattered. As the pressure decreased, the water transitioned from a high-density to low-density fluid before crystallizing into ice.

Previous studies have used ultrafast methods to find hints of water's two-faced demeanor, but those were done mainly at atmospheric pressure. The new work achieved conditions as extreme as about 3,000 times atmospheric pressure and -68°C .

The result could indicate that supercooled water has a "critical point" — a certain pressure and temperature at which two distinct phases merge into one.

Finding such a critical point could explain why water is so odd. Most liquids

tions ranging from mysterious blasts of radio waves from deep space called fast radio bursts to asteroids that could potentially crash into Earth. The telescope also was used in the search for extraterrestrial intelligence.

“Astronomers don’t have a lot of facilities,” Haynes says. Each new one is designed to have unique advantages over existing telescopes. “So when you lose one, it’s gone.”

The observatory’s end is also a symbolic and practical loss for Puerto Rico, says Kevin Ortiz Ceballos, a student at the University of Puerto Rico at Arecibo who used the observatory to study the first known interstellar comet and stars that host exoplanets.

“Arecibo is like an icon of Puerto Rican science,” Ortiz Ceballos says. He grew up watching Puerto Rican cartoons in which the characters went to Arecibo to use the telescope. He credits it with sparking his interest in astronomy, and he had hoped to return to Puerto Rico to work at Arecibo after completing a Ph.D. “Puerto Rico has a huge mass emigration problem,” he says. “It’s a huge brain drain. Being able to do what I love without having to leave, it was a huge dream for me.” ■

become denser and more difficult to compress as they cool. Water gets denser as it is cooled to 4° C, but becomes less dense as it is cooled further. Likewise, its compressibility increases as it’s cooled.

If supercooled water has a critical point, that could indicate that the water experienced in daily life is strange because, under typical pressures and temperatures, it is a supercritical fluid—a weird state that occurs beyond a critical point. Such a liquid would not be the high-density or low-density form, but would consist of some regions with a high-density arrangement of water molecules and other pockets of low density. The relative amounts of those two structures, which result from different arrangements of hydrogen bonds between the molecules, would change as the temperature changes, explaining why water behaves strangely as it is cooled. ■

ATOM & COSMOS

Planets with big families may breed life

Single exoplanets with eccentric orbits hint at a chaotic past

BY LISA GROSSMAN

If you’re looking for life beyond the solar system, there’s strength in numbers.

Systems with multiple planets tend to have rounder orbits than those with just one, indicating a calmer family history, a study suggests. Current only-child systems and planets with more erratic paths hint at past planetary sibling clashes violent enough to knock orbits askew, or even lead to banishment. A lasting abundance of sibling planets might be part of what made life on Earth possible, says astronomer Uffe Gråe Jørgensen of the Niels Bohr Institute in Copenhagen.

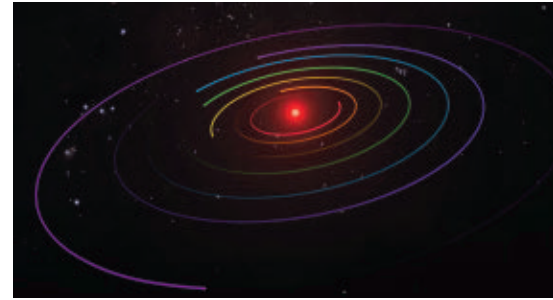
“Is there something other than the Earth’s size and position around the star that is necessary in order for life to develop?” Jørgensen says. “Is it required that there are many planets?”

Most exoplanets with known orbits have elongated, or eccentric, orbits. That’s a striking difference from the circular orbits of the planets in our solar system. Those round orbits are perfectly normal—for a system with so many planets packed together, Jørgensen and his Niels Bohr colleague Nanna Bach-Møller report in the January *Monthly Notices of the Royal Astronomical Society*.

Bach-Møller and Jørgensen analyzed the paths of 1,171 exoplanets around 895 stars. The more planets a system has, the pair found, the more circular the orbits.

Previous but much smaller studies have noted a similar association, says astrophysicist Diego Turrini of the Italian National Astrophysics Institute in Rome. “This is a very important confirmation,” Turrini says. “It is providing us an idea of... how likely it is there will be no fight in the family, no destructive events, and your planetary system will remain as it formed... long enough to produce life.”

Systems with as many planets as ours seem to be rare. Only the TRAPPIST-1 system, with seven worlds, comes close (*SN: 3/18/17, p. 6*). Our system is the only one known to have at least eight. Extrap-



In TRAPPIST-1 (illustrated) and other systems with a lot of planets, the planets tend to have more circular orbits than singleton worlds.

olating out to the number of stars in the galaxy expected to have planets, Bach-Møller and Jørgensen estimate that about 1 percent have as many planets as we do.

That low estimate may help explain why life seems to be rare, Jørgensen says. Exoplanet studies indicate that there are billions of worlds the same size as Earth, whose orbits would make them good places for liquid water—but that may not be enough to make a planet habitable.

“If there are so many planets where we could in principle live, why are we not teeming with UFOs all the time?” asks Jørgensen. The answer might lie in the different histories of planetary systems with eccentric versus circular orbits. Solar system formation theories predict young planets should have circular orbits.

Planets that end up on elliptical orbits may have gotten there via violent encounters with neighboring planets, whether direct collisions or near misses that toss the planets about. Some of those encounters may have ejected planets from their systems altogether, possibly explaining why planets with eccentric orbits have fewer siblings.

Earth’s survival and the rise of life may therefore have depended on the planet’s neighbors playing nice for billions of years. “It’s not the Earth that is important,” Jørgensen says. “It’s the whole configuration of the planetary system that’s important for life to originate on an Earthlike planet.” ■



A burst of gamma-ray light in another galaxy (shown in an artist's illustration) hints that colliding neutron stars produced a magnetar.

ATOM & COSMOS

Birth of a magnetar potentially spotted

Astronomers have never observed such a formation before

BY LISA GROSSMAN

A surprisingly bright cosmic blast might have marked the birth of a magnetar. If so, it would be the first time that astronomers have witnessed the formation of this kind of rapidly spinning, extremely magnetized stellar corpse.

That dazzling flash of light was made when two neutron stars collided and merged into one massive object, astronomers report in an upcoming issue of the *Astrophysical Journal*. Though the especially bright light could mean that a magnetar was produced, other explanations are also possible, the researchers say.

Wen-fai Fong, an astrophysicist at Northwestern University in Evanston, Ill., and colleagues first spotted the site of the neutron star crash on May 22 as a burst of gamma-ray light detected with NASA's orbiting Neil Gehrels Swift Observatory. Follow-up observations in X-ray, visible and infrared wavelengths of light showed that the gamma rays were accompanied by a characteristic glow called a kilonova.

Kilonovas are thought to form after two neutron stars, the ultradense cores of dead stars, collide and merge. The merger sprays neutron-rich material “not seen anywhere else in the universe” around the collision site, Fong says. That material quickly produces unstable heavy elements, and those elements soon decay, heating the neutron cloud and making it glow in optical and infrared light.

Astronomers think that kilonovas form every time a pair of neutron stars merge. But mergers produce other, brighter light as well, which can swamp the kilonova signal. As a result, astronomers have seen only one definitive kilonova before, in 2017 (*SN: 11/11/17, p. 6*), though there are other potential candidates.

The glow that Fong's team saw, however, put the 2017 kilonova to shame. “It basically breaks our understanding of the luminosities and brightnesses that kilonovae are supposed to have,” Fong says.

For instance, the Hubble Space Telescope measured infrared light about three and 16 days after the gamma-ray burst. That light was 10 times as bright as infrared light seen in previous neutron star mergers.

“That was the real eye-opening moment, and that's when we scrambled to find an explanation,” Fong says. “We had to come up with an extra source [of energy] that was boosting that kilonova.”

Her favorite explanation is that the crash produced a magnetar, which is a type of neutron star. Normally, when neutron stars merge, the resulting mega-neutron star is too heavy to survive. Almost immediately, the star succumbs to intense gravitational forces and produces a black hole.

But if the mega-neutron star is spinning rapidly and is highly magnetically charged (in other words, is a magnetar), it could save itself from collapsing. Both its

own rotation and its dumping of energy, and thus some mass, into the surrounding neutron-rich cloud could keep the star from turning into a black hole, Fong and colleagues suggest. That extra energy in turn would make the cloud give off more light—the extra infrared glow that Hubble spotted.

But there are other possible explanations for the extra bright light, Fong says. If the colliding neutron stars produced a black hole, that black hole could have launched a jet of charged plasma moving at nearly the speed of light (*SN: 3/30/19, p. 7*). The details of how the jet interacts with the neutron-rich material surrounding the collision site could also explain the extra kilonova glow, she says.

If a magnetar was produced, “that could tell us something about the stability of neutron stars and how massive they can get,” Fong says. “We don't know the maximum mass of neutron stars, but we do know that in most cases they would collapse into a black hole [after a merger]. If a neutron star did survive, it tells us about under what conditions a neutron star can exist.”

Finding a baby magnetar would be exciting, says astrophysicist Om Sharan Salafia of Italy's National Institute for Astrophysics in Merate. “A newborn highly magnetized, highly rotating neutron star that forms from the merger of two neutron stars has never been observed before,” he says.

But he also thinks that it's too soon to rule out other explanations. What's more, recent computer simulations suggest that it might be difficult to see a newborn magnetar even if it formed, he says. “I wouldn't say this is settled.”

Observing how the object's light behaves over the next four months to six years, Fong and her colleagues have calculated, will prove whether or not a magnetar was born.

Fong herself plans to keep following the mysterious object with existing and future observatories for a long time. “I'll be tracking this till I'm old and gray, probably,” she says. “I'll train my students to do it, and their students.” ■

First progeria drug is approved

Treatment slows progression of the rapid-aging disease

BY CAROLYN WILKE

The U.S. Food and Drug Administration has approved a treatment that could give children with a rare genetic illness that causes premature aging more time to live.

People with the disease, known as Hutchinson-Gilford progeria syndrome, or progeria, often die of heart failure, heart attack or stroke as teenagers. The drug, called Zokinvy, is the only approved progeria treatment, the FDA announced November 20. Previously, doctors could only treat complications and offer palliative care.

In clinical trials of 62 children receiving the drug, Zokinvy increased life span by about three months on average during the first three years of treatment, com-

pared with 81 youngsters from a separate study who didn't take the drug. After following children who continued to receive Zokinvy for up to 11 years, researchers found that, on average, the drug lengthened life span by about 2.5 years.

"This is not a cure," cautions Monica Kleinman, a pediatric critical care doctor at Boston Children's Hospital who was involved with the clinical trials. But "we've hopefully extended the life span...by slowing the pace of the disease."

An estimated 350 to 400 people worldwide have progeria. A single mutation interferes with the gene responsible for making the protein lamin A, which helps hold cell nuclei's membranes together. Children with progeria make higher amounts of a defective protein called progerin, which can form instead of lamin A. This protein gets stuck in cell membranes and can't be recycled for fresh proteins, causing cells to prematurely age and making blood vessels and connective tissue stiffer, Kleinman says.

Everyone makes some progerin, and

the body makes more as it gets older, Kleinman says, but "children with progeria make a huge amount." These kids experience loss of hair and body fat, joint stiffness, cardiovascular disease and other symptoms of accelerated aging.

Made by Eiger BioPharmaceuticals in Palo Alto, Calif., Zokinvy blocks some but not all of that progerin production.

The drug builds on decades of research on the lamin A protein, including the "seemingly esoteric chemical modification" that forms progerin, says Tom Misteli, a cell biologist at the National Cancer Institute in Bethesda, Md., who wasn't involved with work on the drug. "Nobody studying this protein or the modification could have expected it to become a drug target."

Now the focus is on testing more drugs or therapeutics in combination with Zokinvy, Misteli says. That could help lengthen lives even further. Researchers are also investigating gene therapy approaches, with the goal of fixing the mutation that causes the illness. ■

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HUMANS & SOCIETY

Who invented bone points?

Homo erectus, not humans, may have been the innovators

BY BRUCE BOWER

A type of bone tool generally thought to have been invented by Stone Age humans got its start among hominids that lived hundreds of thousands of years before *Homo sapiens* evolved, a study concludes.

A set of 52 previously excavated but little-studied animal bones from Olduvai Gorge in Tanzania includes the oldest known barbed bone point, an implement probably crafted by *Homo erectus* at least 800,000 years ago, researchers say. Made from a piece of a large animal's rib, the artifact features three curved barbs and a carved tip, the team reports in the November *Journal of Human Evolution*.

The previous oldest barbed bone points were found at a site in Central Africa and dated to about 90,000 years ago (*SN*: 4/29/95, p. 260), and were assumed to reflect a toolmaking ingenuity exclusive to *H. sapiens*. Those implements include carved rings around the base of the tools where wooden shafts were presumably attached. Barbed bone points found at *H. sapiens* sites were likely used to catch fish and perhaps to hunt large land prey.

The Olduvai Gorge barbed bone point, which had not been completed, shows no signs of having been attached to a handle or shaft. How *H. erectus* used such implements is unclear, report Michael Pante, an anthropologist at Colorado State University in Fort Collins, and colleagues.

This find and four other bone implements date to at least 800,000 years ago, based on their original positions below Olduvai sediment that records a known reversal of Earth's magnetic field about 781,000 years ago. Another bone artifact dates to roughly 1.7 million years ago.

Unearthed at Olduvai Gorge in Tanzania, this ancient bone tool, made from an animal's rib, features three curved barbs and a carved tip.

"The Olduvai point implicates *H. erectus* as the inventor of barbed bone point technology," Pante says, because stone tools previously excavated in the same Olduvai Gorge sediment resemble those that have been found at other African sites with *H. erectus* fossils.

Archaeologist Christian Tryon of the University of Connecticut in Storrs questions whether the Olduvai specimen can be definitively classed as a barbed bone point because it wasn't finished. But the new report shows that Olduvai hominids, whether they were *H. erectus* or some other prehuman population, carefully selected bones as well as stones for toolmaking, Tryon says. "They were expert craftsmen or women."

New York University archaeologist Justin Pargeter agrees. Although it's unclear whether the Olduvai artifact was a pointed bone tool comparable to those later made by *H. sapiens*, he says, the existence of any bone toolmaking 800,000 years ago shows that this practice is far older than typically assumed.

Along with bone toolmaking, a series of crucial behavioral advances in hominids occurred before the emergence of *H. sapiens* about 300,000 years ago. These developments include the invention of stone tools, controlled fire use and the ability to survive in new environments. Exploiting bone to make tools such as barbed points would have aided ancient *Homo* groups migrating through unfamiliar regions where locations of stone sources were unknown, Pante suspects.

Jewelry making, cave painting and other symbolic acts may represent "modern human behaviors" that eluded earlier hominids, Pante says. But some researchers suspect that now-extinct *Homo* species also created symbolic items. ■

LIFE & EVOLUTION

Sauropod success tied to volcanoes

Altered plant life may have benefited the giant dinosaurs

BY CAROLYN GRAMLING

Long-necked sauropods, the largest animals ever to walk on Earth, may have thundered into dominance thanks to a large burst of volcanic activity that began about 184 million years ago, a study suggests. The resulting environmental crisis may have caused a shift in plant life that gave the giant herbivores an advantage over other plant eaters.

The find comes from the discovery in Argentina of a fossil of one of the earliest "true" sauropods. Sediments bearing the dinosaur, dubbed *Bagualia alba*, are precisely dated to 179 million years ago, Diego Pol, a paleontologist at the Paleontological Museum Egidio Feruglio in Trelew, Argentina, and colleagues report in the Nov. 25 *Proceedings of the Royal Society B*.

B. alba had the telltale characteristics of true sauropods: massive size, column-like legs, a long neck, broad and strong jaws, and large, spoon-shaped teeth with thick enamel. Also called eusauropods, this group came to dominate the Middle and Late Jurassic, roughly 174 million to 145 million years ago.

During the Early Jurassic, between about 201 million and 174 million years ago, Pol says, plant-eating sauropods competed with many other herbivores — including sauropodomorphs, distant relatives with less powerful jaws and shorter necks. What gave eusauropods a leg up on their competition has been unclear, in part because there are relatively few fossils dating to the transition between Early and Middle Jurassic.

One possible cause was an environmental crisis that occurred toward the end of the Early Jurassic, an episode of global warming and ocean acidification that led to a series of extinctions. Scientists have previously suggested this episode was linked to large volcanic

eruptions in the Southern Hemisphere.

That pulse of volcanism may also have led to a major shift in plant life in the region. The Early Jurassic was dominated by seed ferns, cycads and ginkgos, but by the Middle Jurassic, conifers began to flourish in the more arid, warmer climate. That, in turn, may have made life difficult for many sauropodomorphs, which vanish from the fossil record after the Early Jurassic.

But *B. alba* was alive and well. With their extra-powerful jaws and teeth, the species and other eusauropods may have been best positioned to chomp on the conifers' very tough leaves. And the

animals' oversized guts were well-adapted to digest the tough plant matter, allowing it to sit and ferment for days, Pol and colleagues suggest.

The careful dating of the new fossil is a crucial piece of the puzzle, Pol says. "It provides the first precise evidence [that] the large sauropods became the dominant herbivores in terrestrial ecosystems right after the massive volcanic event."

The fossil "is an important addition to our frustratingly incomplete picture of early sauropod evolution," says Paul Barrett, a paleontologist at the Natural History Museum in London. And the coincidence between the age of the fossil

and a major pulse of volcanic activity in the region is intriguing.

But, he says, "I'd like to see a bit more evidence before scaling this up to a global event" that led to shifts in both plant and dinosaur evolution. Although this is the earliest true sauropod fossil yet found, the lineage of sauropods is thought to go back another 40 million years, into the Late Triassic, based on analyses of the animals' family tree. Scientists know very little about how those earlier sauropods might have fed, or even where they may have lived. It's possible the first true sauropods lived in places where those climatic and floral changes didn't occur. ■

LIFE & EVOLUTION

Toads on two islands are shrinking fast

Introduced in the 1920s, the species is as much as a third smaller

BY JAKE BUEHLER

On two islands in the Indian Ocean, the toads just aren't what they used to be. Less than a century after their introduction by humans, the toads have shrunk in size by as much as a third.

The finding, reported in the November *Biology Letters*, potentially illustrates that "island dwarfism," when animals evolve to be smaller after settling on an island, can occur over short timescales.

"When you imagine [island] dwarfism, you imagine this happening over thousands or millions of years," says James Baxter-Gilbert, an invasion biologist at Stellenbosch University in South Africa. "But this [research] has the potential to show it happening in four orders of magnitude shorter time frame."

Guttural toads (*Sclerophrys gutturalis*) are native to much of the eastern half of sub-Saharan Africa. Humans brought the toads to Mauritius — an island east of Madagascar, about 2,000 kilometers from mainland Africa — in 1922 to devour cane beetles. Five years later, toads from Mauritius were brought to the nearby island of Réunion to control mosquitoes.

Baxter-Gilbert was fascinated by how those introductions might have influenced the toads' evolution and biology.

Thanks to previous genetic work, it was clear that the island toads' progenitors were from Durban, South Africa.

So Baxter-Gilbert and colleagues caught nearly 500 toads from Durban, Mauritius and Réunion, noting each toad's sex and measuring body length.

Island toads were much smaller than the roughly 7-centimeter-long Durban toads. Females were on average about 34 percent shorter on Mauritius and 26 percent shorter on Réunion. Male Mauritius toads were about 22 percent shorter, while male Réunion toads were about the same size as Durban toads.

Nature is full of examples of island

dwarfs, such as Ice Age elephants, mammoths and hippos on islands in the Mediterranean. Such shrinking may be the result of less food being available on islands, making smaller bodies more advantageous. The reduction could also be an evolutionary response to a lack of predators.

"In the case of [dwarf] elephants, they have the luxury to evolve miniature size when no lions and tigers are on the hunt for their calves," says paleontologist Alexandra van der Geer of Naturalis Biodiversity Center in Leiden, Netherlands, who wasn't involved with this research. Perhaps the situation is similar for toads. On the mainland, being larger may be more useful in dissuading their predators, she says, which include snakes and birds.

Baxter-Gilbert acknowledges that the shrinking may not be due to natural selection and could instead be a consequence of the toads having the developmental flexibility to respond to a quirk of their island environment. Another possibility is the toads are smaller due to a dietary deficiency, or maybe the climate isn't quite right for the toads to reach full size.

He wants to raise some island toads on the African mainland with their Durban counterparts in a "common garden" experiment. This could help determine if diet, temperature or some other environmental condition on the islands, rather than rapid evolution, could be behind the toads' diminutive size. ■



Adult female guttural toads in South Africa (left) are substantially larger than their island relatives on Mauritius (right, the pale-throated toad is female, and the other is male).

HUMANS & SOCIETY

Goliath was not so giant after all

The warrior's height may be a reference to his city's defenses

BY BRUCE BOWER

Early versions of the Bible describe Goliath — an ancient Philistine warrior best known as the loser of a fight with the future King David — as a giant whose height in ancient terms reached four cubits and a span. But don't take that measurement literally, new research suggests.

Archaeological findings at biblical-era sites including Goliath's home city, a Philistine settlement called Gath, indicate that those ancient measurements work out to 2.38 meters, or 7 feet, 10 inches. That's equal to the width of walls forming a gateway into Gath that were unearthed in 2019, according to archaeologist Jeffrey Chadwick of Brigham Young University in Provo, Utah.

Rather than standing taller than any NBA player ever, Goliath was probably described metaphorically by an Old

Depictions of Goliath as a giant may have started as a metaphor, a researcher suggests.



Testament writer as a warrior who matched the size and strength of Gath's defensive barrier, Chadwick said November 19 at the virtual annual meeting of the American Schools of Oriental Research.

People known as Canaanites first occupied Gath in the early Bronze Age, roughly 4,700 to 4,500 years ago. The city was rebuilt more than a millennium later by the Philistines, known from the Old Testament as enemies of the Israelites (*SN*: 12/24/16 & 1/7/17, p. 8). Gath reached its peak during the Iron Age around 3,000 years ago, the time of biblical references to Goliath. Scholars continue to debate whether David and Goliath were real people who met in battle around that time.

The remains of Gath are found at a site called Tell es-Safi in Israel. A team led by archaeologist Aren Maeir of Bar-Ilan University in Ramat-Gan, Israel — who Chadwick collaborated with to excavate the Gath gateway — has investigated Tell es-Safi since 1996. Other discoveries at Gath include a pottery fragment inscribed with two names possibly related to the name Goliath. Evidence of Gath's destruction about 2,850 years ago by an invading army has also been recovered.

Archaeologists have long known that in ancient Egypt a cubit corresponded to 52.5 centimeters and assumed that the same measure was used at Gath and elsewhere in and around ancient Israel. But careful evaluations of many excavated structures over the last several years have revealed that standard measures differed slightly between the two regions, Chadwick said.

Buildings at Gath and several dozen other cities from ancient Israel and nearby kingdoms of Judah and Philistia, excavated by other teams, were constructed based on three primary measurements, Chadwick has found. Those include a 54-centimeter cubit (versus the 52.5-centimeter Egyptian cubit), a 38-centimeter short cubit and a 22-centimeter span that corresponds to the distance across an adult's outstretched hand.



Archaeologist Jeffrey Chadwick stands next to a pillar of an Iron Age gateway in Israel. The pillar is 2.38 meters, or four cubits and a span, wide. That's also the width of walls at Goliath's home city and the height used to describe him.

Dimensions of masonry at these sites display various combinations of the three measurements, Chadwick said. At a settlement called et-Tell in northern Israel, for instance, two pillars at the front of the city gate are each 2.7 meters wide, or five 54-centimeter cubits. Each of four inner pillars at the city gate measures 2.38 meters wide, or four 54-centimeter cubits and a 22-centimeter span. Excavators of et-Tell regard it as the site of a biblical city called Bethsaida.

Chadwick's 2019 excavations found one of presumably several gateways that allowed access to Gath through the city's defensive walls. Like the inner pillars of et-Tell's city gate, Gath's gate walls measured 2.38 meters wide, or four cubits and a span, the same as Goliath's biblical stature.

"The ancient writer used a real architectural metric from that time to describe Goliath's height, likely to indicate that he was as big and strong as his city's walls," Chadwick said.

Although the research raises the possibility that Goliath's recorded size referred to the width of a city wall, Chadwick "will need to do more research to move this beyond an intriguing idea," says archaeologist and Old Testament scholar Gary Arbino of Gateway Seminary in Mill Valley, Calif. For one thing, Arbino suggests, it needs to be established that the measure applied to Goliath, four cubits and a span, was commonly used at the time as a phrase that figuratively meant "big and strong." ■

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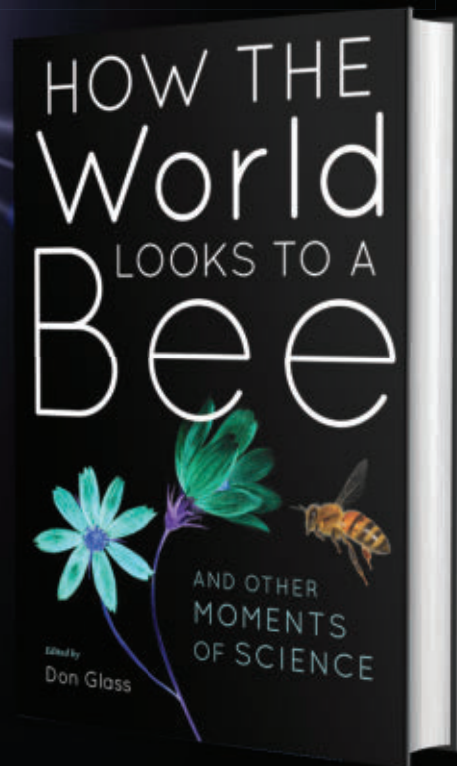


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A Year Like No Other

To say that 2020 was challenging is an understatement. A world laid low by a pandemic. Racial inequities laid bare through social protests. Regions laid waste in the wake of extreme natural disasters. Yet science often rose to tackle these challenges.

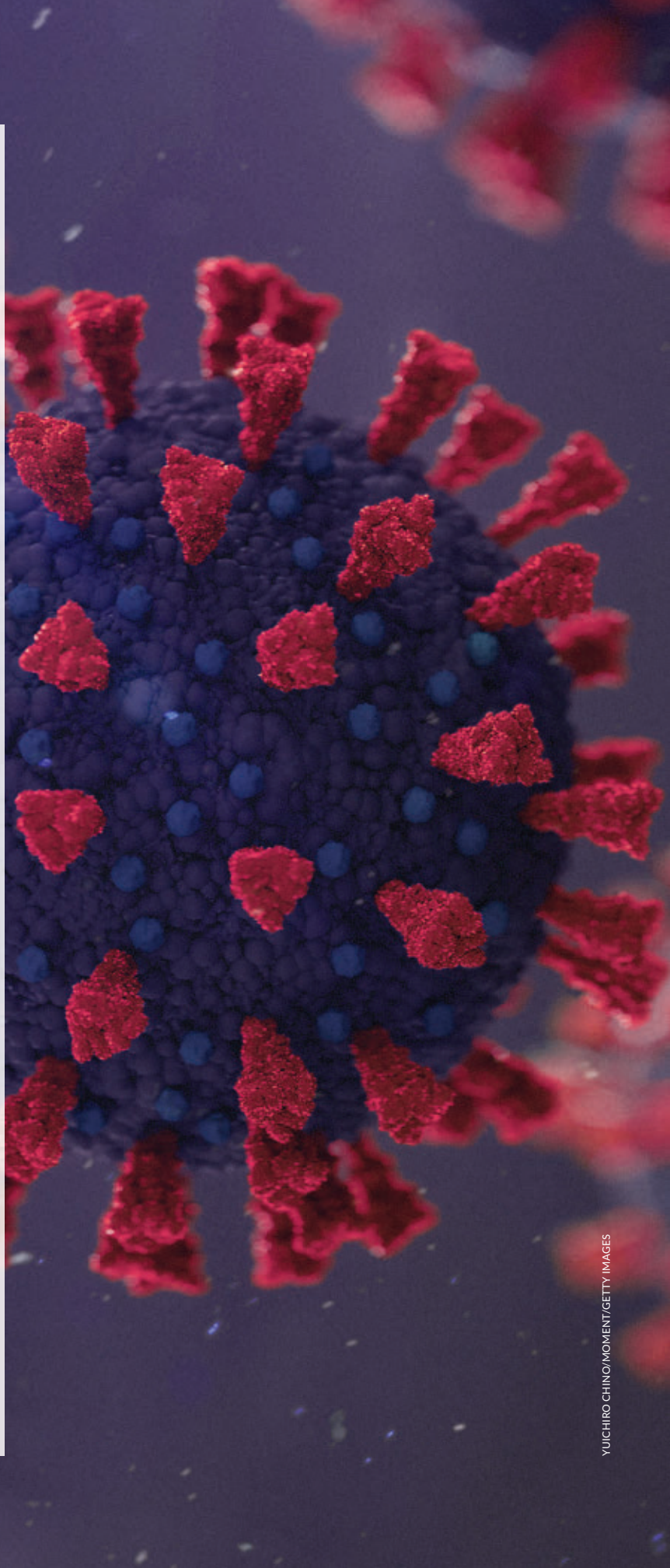
We started the year knowing next to nothing about the novel coronavirus. Huge questions remain, but thanks in part to extraordinary efforts to develop vaccines that appear effective, we enter 2021 with glimmers of hope (see Page 17).

Hope is also emerging from a gut-wrenching reckoning with racial inequities, sparked by police killings of unarmed Black men and women in the United States. Through #BlackInSTEM and similar social movements, scientists are using their voices to shine light on a lack of diversity in their fields and to drive change (Page 26).

It is harder to find any positive angles to 2020's record-breaking fires, hurricanes and extreme Arctic heat (Page 32). Yet science played a role here, too, helping us see the connections between our actions and our changing world.

In this year-end issue, we at *Science News* also felt the need to spark some joy and spotlight the thrill of discovery, whether it's finding the edge of the Milky Way (Page 40) or the fossil of the oldest known modern bird, delightfully dubbed "Wonderchicken" (Page 34). — *Macon Morehouse, News Director*

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YUICHIRO CHINO/MOMENT/GETTY IMAGES

Lingering questions about COVID-19

More than 64 million infected with the novel coronavirus and more than 1.4 million dead. 2020 has been a year defined by global sickness and loss.

In the face of this extraordinary threat, it's easy to forget how much we have accomplished. Doctors, nurses and staff in hospitals around the world have learned how to better care for those sick with COVID-19. Researchers have uncovered secrets of a virus that, not so long ago, was wholly unknown.

Accelerated efforts to create vaccines succeeded beyond even the most optimistic predictions, with the United Kingdom granting emergency use of a vaccine on December 2 and the United States poised to follow suit before the end of the year.

Meanwhile, public health officials have fought to inform the public about how to reduce the risk of infection amid an onslaught of false reports about cures and treatments, and denials about the pandemic's severity. Millions of people have donned masks and dramatically reshaped their daily lives to help fight the virus.

In early January, we had no tests for detecting the virus, no treatments, no vaccines. And though we're not where we want to be, we've made progress on all those fronts. But we still have so much to learn. Here are pressing questions that scientists seek to answer. — *Emily DeMarco*

Why do some people get sick while others don't?

A person's age and preexisting medical conditions are risk factors for more severe disease, and men appear to be at higher risk than women (*SN Online*: 4/23/20). But scientists don't have many answers to explain the wide variety of experiences people have with SARS-CoV-2, the coronavirus that causes COVID-19. Many people have no symptoms. Some struggle to breathe, suffer strokes, or progress to organ failure and death.

People who develop severe disease

do have something in common: "a very severe inflammatory response," says cancer immunologist Miriam Merad of the Ichan School of Medicine at Mount Sinai in New York City. The body's own immune response can get out of whack and inflict inflammatory damage in a misguided attempt to make things right (*SN*: 8/29/20, p. 8).

Scientists have begun to pick out immune system players that seem to gum up the works during a severe bout of COVID-19. For example, a problem can arise with type 1 interferons, proteins that kick off the initial immune response to an intruder and activate production of pathogen-destroying antibodies. Patients with severe COVID-19 can have a weak interferon response; in some patients, genetic errors can interfere with the production of interferons, in others, the immune system incapacitates the proteins (*SN Online*: 9/25/20).

Meanwhile, some severely sick people produce an excess of other components of the body's early immune response. In nearly 1,500 people hospitalized with COVID-19, Merad and colleagues measured four immune proteins that contribute to inflammation. High levels of two of the proteins, interleukin-6

and TNF alpha, predicted that a patient would go on to have severe illness and possibly die, even after accounting for age, sex and underlying medical conditions, the researchers reported in August in *Nature Medicine*.

It may be that people with no or mild symptoms have some degree of pre-existing immunity. Some people who haven't been exposed to SARS-CoV-2 have white blood cells called T cells that nonetheless recognize the virus. This appears to be due to past colds from common coronaviruses, researchers reported in October in *Science*. They speculated that this preexisting T cell immunity may contribute to differences in COVID-19 disease severity. — *Aimee Cunningham*

What are the long-term health consequences of an infection?

This question could take years to resolve.

For now, we know that for some people, the symptoms and suffering from COVID-19 can go on for months after the initial infection (*SN Online*: 7/2/20). There isn't an agreed-upon definition for what some call "post-COVID syndrome" or "long COVID," but symptoms tend to include fatigue, shortness of breath, brain fog and heart abnormalities. And

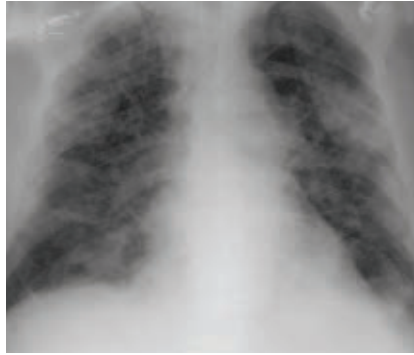


During the pandemic, family and friends wishing to visit nursing home residents, among the most vulnerable to severe disease, often must wave from behind glass, as in this May image from Tokyo.

these problems aren't necessarily tied to a more severe initial illness.

It's not yet clear how widespread the syndrome is or what to do about it. But studies are beginning to offer clues as to how common persistent illness is. Of 143 patients in Italy who had been hospitalized with COVID-19, 32 percent had one or two symptoms and 55 percent had three or more symptoms an average of two months after first feeling sick, researchers reported in August in *JAMA*. And in a survey of 274 symptomatic adults who had a positive test for SARS-CoV-2 but weren't hospitalized, 35 percent were not back to their normal state of health two to three weeks after testing, according to a July study in *Morbidity and Mortality Weekly Report*.

One of the largest surveys so far comes from the COVID Symptom Study, in which people logged their symptoms into an app. Of 4,182 users with COVID-19, 13.3 percent had symptoms lasting more than four weeks, 4.5 percent had symptoms for more than eight weeks and



A chest X-ray of a patient with COVID-19 pneumonia shows the telltale white areas, or densities, in the lungs.

2.3 percent topped 12 weeks. The risk of persistent symptoms rose with age, researchers reported in October in a preliminary study posted at medRxiv.org.

To learn about the long-term physical and mental health effects of COVID-19, the U.S. National Institutes of Health plans to follow for months to years people who have been infected. And a trial by Steven Deeks, an internal medicine physician at the University of California, San Francisco School of Medicine, and

colleagues will assess the role of inflammation in persistent health effects.

Long-term studies of entire communities will be especially important to learn how common persistent symptoms are, how long they last and why they're happening, Deeks says. "Right now, we have just a whole long list of questions," he says. "It's going to take a lot to figure this out." — *Aimee Cunningham*

How long might immunity last?

There are signs that the immune system can learn how to deal with the virus, bestowing at least temporary immunity. Most people appear to make immune proteins that stop SARS-CoV-2 in its tracks, called neutralizing antibodies, and also T cells that help coordinate the immune response or kill infected cells, says epidemiologist Aubree Gordon of the University of Michigan in Ann Arbor. Those antibodies and T cells can stick around in the body for at least six months, if not longer, studies suggest. "So that's promising," Gordon says.

But scientists don't know how long a person will be protected from a future bout with the virus. "There's just been a limited time for people to study this," she says.

Still, SARS-CoV-2 is not the only coronavirus that infects people. For instance, four others that cause the common cold circulate around the globe. "We can get some evidence from what goes on with some of the human endemic coronaviruses," says immunologist Brianne Barker of Drew University in Madison, N.J. For those viruses, protection lasts about a year. People can get infected with the same virus over and over again once their immunity wears off, though the severity of a second infection varies. The duration of immunity after an infection with the coronaviruses that cause SARS and MERS is unknown.

To date, there have been a few documented reinfections with SARS-CoV-2, suggesting that, for some, immunity doesn't last very long. Efforts — including a study Gordon is working on — are under way to figure out how common reinfection really is and whether subsequent



VOICES FROM THE PANDEMIC

Yvette Calderon

Chair of emergency medicine, Mount Sinai Beth Israel Hospital. She was on the front lines of New York's early pandemic surge.

Q: Tell us about your experience.

A: It was very isolating. [I] saw the fear on everyone's face, not only the patients, but peers, staff. It was just incredibly tense. Yet there was nowhere else that I wanted to be.

Q: What surprised you about the public's response to the pandemic?

A: Nothing. New Yorkers are awesome. How New Yorkers came together in this crisis, from the 7 o'clock clapping to people going out of their way with food for health providers, making sure that the elderly had [what they needed], kids creating incredible masks and shields for our essential workers.

Q: What has made your job hard?

A: I haven't seen my mom in several months, and I lost my father [to COVID] on April 6. Both of them had COVID. I made an appointment to see [Mom] this week. But [the nursing facility] can call me and say there's another outbreak and then I can't see her. To be a physician that has spent your whole life taking care of patients, holding patients' hands when they're at the end of their life, crying with the patient's family, and to not be able to be with my father was the biggest heartbreak of all. — *all interviews by Maryn McKenna, edited for length and clarity*

infections are any different from the initial one. — *Erin Garcia de Jesus*

What can we expect from the treatments and vaccines being developed?

Because of crucial advances in 2020, “we know more about the virus and some of the complications it causes and how to prevent and predict and treat those complications,” says Amesh Adalja, an infectious disease physician at Johns Hopkins Center for Health Security.

Doctors have learned tricks that help people breathe easier, such as putting hospitalized COVID-19 patients on their stomachs. And two drugs — the antiviral remdesivir and the steroid dexamethasone — have shown promise against the virus (*SN Online: 6/16/20*). The U.S. Food and Drug Administration approved remdesivir for use in hospitalized COVID-19 patients ages 12 and older in October because some studies showed that it can shorten hospital stays. But the drug, which is the only FDA-approved drug for COVID-19, didn’t reduce the chance of dying or going on a ventilator in a large study by the World Health Organization (*SN Online: 10/16/20*).

In November, the FDA gave a cancer drug called baricitinib emergency use authorization. In combination with remdesivir, the drug shaved an extra day off hospital stays compared with

remdesivir alone in a large clinical trial. But many doctors aren’t convinced of baricitinib’s effectiveness.

Ideally, doctors could treat people before they are sick enough to need the hospital. Some drugs are in early stage clinical trials to determine if they can help people early in an infection (*SN: 9/26/20, p. 8*). Some antibodies taken from COVID-19 survivors and lab-made antibodies are also being

put to the test (*SN Online: 9/22/20*). Lab-made antibodies from Eli Lilly and Company and Regeneron were given emergency use authorization in November for treating people newly diagnosed with COVID-19, making the therapies the first available to people who aren’t ill enough to go to the hospital. (Regeneron Pharmaceuticals is a major donor to the Society for Science & the Public, which publishes *Science News*.)

Vaccines are being developed on a fast track. Russia was the first country to announce it had a vaccine for the public, though scientists question its efficacy (*SN Online: 8/11/20*). China has also given the nod for emergency use of some vaccines for the military (*SN: 8/1/20, p. 6*) and general public, although those vaccines are still in testing too. The United Arab Emirates authorized two vaccines made in China for use by its citizens.

Both Pfizer and Moderna announced in November that their mRNA-based vaccines were about 95 percent effective at preventing illness (*SN Online: 11/16/20; SN Online: 11/18/20*). On December 2, the United Kingdom OK’d Pfizer’s vaccine for emergency use,



VOICES FROM THE PANDEMIC

Lisa Fitzpatrick

Health literacy advocate and clinical professor of medicine, George Washington University School of Medicine in Washington, D.C. She is a coronavirus vaccine trial volunteer.

Q: What do you want people to know?

A: I want people to know it’s always relevant to connect and listen to people. More than ever, the pandemic is showing how disconnected we are. Anything that’s wild and crazy spreads like wildfire. The things I’m hearing on the street — Is 5G transmitting coronavirus? Is there a chip in the vaccine? Is coronavirus real? — people are so distrustful of government and the health care system. It’s a perfect environment for distrust to spread. Credible messengers have to be part of the solution.

Q: Why did you join a vaccine trial?

A: One day, a gentleman told me he didn’t want to have anything to do with Trump’s vaccine. When I asked him what would have to happen for him to decide to take the vaccine, he said, “I would consider it if I saw some other Black people working on it.” And I thought, well, I’ve been a research investigator. I’m a Black woman. I’m a physician. I can be a bridge between science and the community and let my experience speak.

Researchers at BioNTech in Mainz, Germany (shown) and at Pfizer developed a COVID-19 vaccine that is reported to be 95 percent effective at preventing illness.



FROM TOP: PARTHA NANDI; ABDUL HAMID HOSBAS/ANADOLU AGENCY VIA GETTY IMAGES

making the vaccine the first to get the nod after thorough testing. AstraZeneca and the University of Oxford reported that their vaccine prevents illness too, and may cut down on transmission of the virus (*SN Online: 11/23/20*).

Over 200 other vaccines are in development worldwide, says Esther Krofah, executive director of FasterCures, part of the Milken Institute think tank. But getting doses of a vaccine, at least initially, “will not be as straightforward as calling up your local CVS,” she says.

In the United States, 21 million health care workers and about 3 million people living in long-term care facilities are expected to be first in line for the vaccines (*SN Online: 12/1/20*). Children may be among the last to be immunized. That’s because vaccines haven’t been tested in kids under 12, and children are less likely to die or develop severe disease than adults.

Bottom line: A COVID-19 vaccine may not be widely available in the United States until late spring or summer 2021.

Even when a vaccine is approved for broad use and there’s a large enough supply, “the bigger challenge will come in distributing vaccines widely,” says Julie Swann, a health systems engineer at North Carolina State University in Raleigh. Pfizer’s vaccine, for instance, has to be kept frozen at supercold temperatures. So distributors must either be able to give out all of their doses within a couple of days after receiving a shipment, or have access to special freezers or dry ice to keep the vaccines cold enough. Big cities may have more access to those measures than rural areas.

Many of the vaccines in testing require two doses. Keeping track of who has gotten which vaccine and when it’s time for a booster, and whether booster shots are available, could also be challenging, Swann says. — *Tina Hesman Saey*

Will the pandemic end in 2021?

“I don’t think anyone can say with clarity what the end of the pandemic might look like,” says Michael Osterholm, an epidemiologist at the University of Minnesota in Minneapolis. If a vaccine



VOICES FROM THE PANDEMIC

Abigail Echo-Hawk

Citizen of the Pawnee Nation of Oklahoma, chief research officer at the Seattle Indian Health Board. She serves American Indians and Alaska Natives in the Puget Sound region.

Q: How has the pandemic changed your work?

A: I had to take my staff and redirect them, which means that the work we’re doing on cancer prevention and HIV prevention is going to suffer. HIV is an epidemic within our community. But right now, COVID-19 is killing our people every single day.

Q: What do you want people to know?

A: We are really suffering from a lack of resources, and that suffering is not new. As a result of the continuous underfunding of public health infrastructure within the Native community, and all public health infrastructure, this country set up a perfect environment for a pandemic to run wild.

Q: What has surprised you about the public’s response?

A: Some tribal nations made incredible public health decisions before states did, before counties did, before cities did. They closed off their reservations, they shut down businesses, they worked to put together support systems to take care of their elders.

can confer long-lasting immunity, on the order of years to decades, widespread community transmission around the globe could cease, he says.

But “a vaccine is nothing until it becomes a vaccination in somebody’s arm,” Osterholm says. And those arms must be willing. Vaccine development has progressed at a record pace, but some experts worry that speed, and the politicization of certain drugs, have seeded distrust (*SN: 8/1/20, p. 6*). “Acceptance is going to be a huge issue,” he says.

Of course, many countries managed to slow the virus’ spread without a vaccine. In the United States, “we don’t have to wait to get this under control,” says public health researcher Megan Ranney of Brown University in Providence, R.I. “We already know that basic, multimodal public health interventions work.”

Such interventions include widespread and easily accessible testing that spurs contact tracing and case isolation, as well as consistent public health messaging around the importance of wearing masks, social distancing and

avoiding crowded indoor spaces.

Thus far in the United States, these basic public health interventions have been patchy and inadequate on a national scale (*SN Online: 7/1/20*). That’s allowed the “first wave” of infections to slosh around the country, growing in size to about 150,000 new cases each day in late November. Whether this dire trend worsens in the early months of 2021 depends in large part on federal action, both Osterholm and Ranney say.

“We need a national plan, and we don’t have a national plan,” Osterholm says. That may change with the election of Joe Biden, who campaigned on creating a coronavirus national plan. Osterholm is part of the president-elect’s Transition COVID-19 Advisory Board, which has begun planning a new federal response.

Broadly, that plan includes clear and consistent public health messaging, a well-funded national testing strategy, support for states to boost contact tracing, supplying personal protective equipment to essential workers and mask mandates. “If we have all those things in place, the coming year could

be somewhat similar to where we'll be with widespread vaccination," Ranney says. People could go about most normal activities with a little extra caution, wearing masks and avoiding crowds indoors.

Still, measures like universal mask wearing, social distancing and contact tracing only work if people abide by them. As the pandemic wears on, experts worry that complacency and fatigue could further fracture an already uneven response to the disease.

If the United States "continues on the path we're on now, we're going to continue to see increasing numbers of people hospitalized and dead, continue to go through this seesaw of full lockdown then full reopening, confusing messages, unmitigated anxiety and fear and a worsening economy," Ranney says. — *Jonathan Lambert*

Once the pandemic ends, will the virus still circulate?

When the pandemic eventually fizzles out, the coronavirus itself will probably stick around for a while, experts say. How long, however, depends on how well our immune system and available vaccines protect us from reinfection.

So far, it's impossible to say how frequently reinfections with SARS-CoV-2 happen based on the small number of these cases identified. But if reinfections become common in the face of waning immunity, then the virus is likely here to stay.

For example, if immunity lasts around 40 weeks, as it does for some cold-causing coronaviruses, then there may be yearly outbreaks of COVID-19, researchers reported in May in *Science*. If the immune system's memory of the virus lasts slightly longer, say two years, then there may be biannual outbreaks. Permanent immunity could mean the virus may disappear entirely, though that possibility is unlikely since respiratory viruses like influenza and viruses that cause colds rarely lead to this sort of long-lasting immunity.

Adding an effective vaccine to the mix would help build — and maintain —



To reduce the risk of virus transmission, many airlines require passengers and crew to wear masks. This flight was leaving Athens on August 13, as COVID-19 cases in Greece rose sharply.

immunity among people to control potential future outbreaks. And if a vaccine is highly effective and enough people take it plus any boosters or follow-up vaccinations as needed, that could help prevent the virus from spreading at all. But those are big ifs.

Because SARS-CoV-2 can be spread by people without symptoms, some experts do not anticipate the virus will go away any time soon, unlike the coronavirus that caused SARS. That virus stopped circulating among people a little more than a year after it appeared, in part

because it wasn't spread by people with no symptoms. That allowed public health experts to more easily isolate sick patients and quarantine their contacts to prevent the virus' spread. It's estimated that around 30 percent of people infected with SARS-CoV-2 don't show symptoms, making such total containment much harder.

"From everything we're seeing so far," says Barker, the Drew University immunologist, "this virus may become endemic and may be with us for a long time." — *Erin Garcia de Jesus*



VOICES FROM THE PANDEMIC

Michael Bowen

Executive vice president of Prestige Ameritech in North Richland Hills, Texas, maker of surgical masks and respirators. He predicted a future epidemic would eat up U.S. supplies of personal protective equipment because most PPE is made in other countries.

Q: How has the pandemic changed your life?

A: We work all the time, my business partner and I. I am the face of the company; I have the easy job. He has an RV parked at the office and goes home only on weekends. Our sales have increased 600 percent. We were selling 75,000 respirators per month. We're now selling 5 million per month. By January or February, we'll be making 10 million a month.

Q: What do you want people to know?

A: I've gotten thousands of e-mails in a day: "My daughter is a nurse and she's been wearing the same mask for 30 days. Can you help me?" It was heartbreaking. I want people to know that America needs to make its own products.

Q: What do you miss about your old life?

A: The ability to make everyone who calls me happy. We had great products and we served people right. If they had a problem or ran out of product, we would put it in a truck and drive it there. I can't do that anymore. I can't help everyone.

A year of living with a new virus

Few people noticed on New Year's Eve last year when China reported a mystery illness to the World Health Organization. But soon, the never-before-seen coronavirus responsible for the disease was infiltrating the rest of the world. As we prepare to enter the second year of the COVID-19 pandemic, *Science News* looks back on how the disease took over 2020 and how society attempted to fight back.



From top: Initial coronavirus cases are linked to a Wuhan market (shown before the pandemic), though experts now doubt that's where the outbreak started. In February, the *Diamond Princess* cruise ship has one of the largest outbreaks outside of China at the time. On March 9, soldiers patrol Rome as a national lockdown begins.

DECEMBER 31, 2019

China notifies the World Health Organization about a cluster of pneumonia cases of unknown cause in Wuhan.

JANUARY 9, 2020

The WHO announces a novel coronavirus is the cause of the pneumonia.

JANUARY 10

Scientists release the virus's complete genetic blueprint.

JANUARY 13

Thailand reports the first known novel coronavirus infection outside of China. Within a week, Japan and South Korea report cases.

JANUARY 21

The first U.S. infection is reported in the state of Washington.

Scientists announce the virus can spread person-to-person.

JANUARY 23

Wuhan goes into lockdown to stem the virus' spread.

JANUARY 24

France reports the first cases in Europe.

JANUARY 25

Australia reports its first case.

JANUARY 30

Scientists say an infected person spread the virus before showing symptoms.

FEBRUARY 3

The *Diamond Princess* cruise ship is quarantined in Japan. Eventually, 712 of the 3,711 people on board test positive. Through mid-March, cruise ship travelers represent about 17 percent of known U.S. cases.

FEBRUARY 5

The U.S. Centers for Disease Control and Prevention releases a flawed COVID-19 diagnostic test, delaying the country's ability to screen widely for the virus.

FEBRUARY 11

Virologists name the virus "severe acute respiratory syndrome coronavirus 2," or SARS-CoV-2, because it is related to the virus that caused the 2002-2003 SARS outbreak. The disease caused by SARS-CoV-2 is named "COVID-19."

FEBRUARY 14

Egypt reports Africa's first case.

FEBRUARY 26

Brazil reports South America's first case.

MARCH 9

Italy begins a national lockdown. Ten days later, the country's COVID-19 deaths top 3,400, surpassing China's death toll.

MARCH 10

After a choir in Washington state meets for a practice, over 80 percent of attendees get infected, suggesting airborne transmission of the virus.

MARCH 11

The WHO declares the outbreak is a pandemic. The virus has spread to at least 114 countries, killed over 4,000 people and infected nearly 120,000.

MARCH 16

COVID-19 vaccine safety tests begin in the United States and in China.

MARCH 17

Contrary to conspiracy theories, a study confirms the

virus was not made in or released from a lab. Subsequent research suggests a bat is the most likely source.

MARCH 19

California issues the first statewide stay-at-home order.

MARCH 27

As the number of U.S. cases surpasses 100,000, the United States becomes the new epicenter of the pandemic.

MARCH 28

The U.S. Food and Drug Administration grants emergency use authorization for hydroxychloroquine, an antimalaria drug, to treat some hospitalized patients.

APRIL 2

Global cases hit 1 million. More than 53,000 people have died.

APRIL 3

With evidence mounting that the virus can spread through the air and that asymptomatic people are contagious, the CDC recommends people wear face coverings in public.

APRIL 11

U.S. death toll hits 20,000 people, surpassing the number of deaths in Italy.

APRIL 28

U.S. cases reach 1 million.

MAY 1

The FDA grants emergency use authorization for the antiviral drug remdesivir for severely ill patients after preliminary findings suggest the drug can shorten hospital stays.

MAY 14

The CDC sends out an advisory about cases of a multi-system inflammatory syndrome in children who test positive for the virus.

JUNE 15

The FDA revokes emergency use authorization for hydroxychloroquine after multiple studies show no benefit.

JUNE 16

Dexamethasone, a steroid, is the first drug found to reduce COVID-19 deaths, among people sick enough to need respiratory support.

JUNE 25

China approves a vaccine for use by the military, before final safety and efficacy testing is completed.

JUNE 28

Less than six months after the disease is named, more than 10 million people worldwide have been infected with the virus and over 500,000 have died.

JULY 10

Gilead Sciences, the maker of remdesivir, claims the drug reduces risk of death from COVID-19.

JULY 27

Pfizer and Moderna begin recruiting tens of thousands of volunteers for late-phase clinical trials of their vaccines.

AUGUST 11

Russian President Vladimir Putin announces that a vaccine dubbed Sputnik V will be available to the general public, even though all phases of testing are not yet completed.

AUGUST 17

A week into the fall semester, the University of North Carolina at Chapel Hill announces all undergraduate classes will move online because of high infection rates on campus.

AUGUST 23

The FDA grants emergency use authorization for convalescent plasma to treat hospitalized patients, despite a lack of clinical trials assessing whether blood from recovered patients actually helps fight the disease.

AUGUST 25

The first report of a person being reinfected with the virus raises concerns about how long immunity lasts.

SEPTEMBER 28

More than 1 million people have died from COVID-19; over 40 percent of deaths have occurred in the United States, Brazil and India.

OCTOBER 2

President Donald Trump tweets that he is infected, becoming the latest in a series of world leaders to get COVID-19. He is later hospitalized and receives remdesivir, dexamethasone and an experimental antibody treatment.

OCTOBER 22

Remdesivir becomes the first drug to win full FDA approval for treating COVID-19. A week earlier, however, a WHO study found that the drug does not reduce COVID-19 deaths, countering the drugmaker's earlier claim.

OCTOBER 23

Researchers report that Hispanic and Black residents are disproportionately represented among U.S. COVID-19 deaths. From May through August, Hispanic or Latino people accounted for 24.2 percent of the total deaths. Non-Hispanic Black people accounted for 18.7 percent of the deaths.

NOVEMBER 9

Based on preliminary data, Pfizer says its vaccine appears to be 90 percent effective at preventing people from getting sick from the coronavirus. Subsequent findings suggest 95 percent effectiveness.

The FDA grants emergency use authorization for Eli Lilly's monoclonal antibody therapy. The lab-made antibodies may keep virus levels low in newly infected people and prevent hospitalizations.

NOVEMBER 16

Moderna says its vaccine is 95 percent effective.

NOVEMBER 20

Pfizer seeks emergency FDA approval for its vaccine. Ten days later, Moderna requests the same.

NOVEMBER 23

AstraZeneca reports its vaccine is 62 to 90 percent effective.

DECEMBER 2

The United Kingdom clears Pfizer's vaccine for emergency use.

Global cases stand at more than 64 million, with more than 1.4 million deaths.



From top: Workers bury the remains of people unclaimed by relatives in Ciudad Juárez, Mexico, in May; Mexico has one of the world's highest COVID-19 mortality rates. President Donald Trump leaves the hospital October 5 after treatment for COVID-19. With cases surging in November, people line up for drive-through testing in El Paso, Texas.

What will life be like post-pandemic?

As 2020 blessedly clangs to a close, it's tempting to wonder where we're headed once the pandemic is history. In the spirit of year-end curiosity about COVID-19's possible long-term effects, *Science News* posed this question to a few scholars: What major social changes do you see coming after the pandemic? As baseball's Yogi Berra once said, "It's tough to make predictions, especially about the future." The following forecasts, edited for length and clarity, aren't written in stone and aren't meant to be. But they raise some provocative possibilities. — *Bruce Bower*

John Barry

Historian, Tulane University

Author, *The Great Influenza: The Story of the Deadliest Pandemic in History*

What happens in the next six months will have a disproportionate impact on what happens in the more distant future. If vaccines are very effective, if immunity lasts for a few years, if therapeutic drugs come online that are highly effective and if we have broad usage of cheap rapid antigen tests that can assure people that others around them are safe, I would foresee relatively few changes other than the really obvious ones, such as more work from home, teledoc services and a decimation of small business.

If the virus remains a threat, changes could be pretty profound, all stemming from a de-densifying, if there is such a word, of life in general. This trend would affect where and how people live and work, the housing market, commercial real estate practices and the interior design of buildings. There would be more cars and less mass transit.

Katherine Hirschfeld

Anthropologist, University of Oklahoma
Author, *Gangster States: Organized Crime, Kleptocracy and Political Collapse*

The changes that I think are most likely include increasing political division and increased economic inequality in the United States and elsewhere, with the



A New York University professor holds class over Zoom in April. Remote learning could become more common, a sociologist predicts.

basic science of epidemiology and public health attacked and undermined by conspiracy theories spread on social media. If an effective vaccine is developed and becomes widely available in 2021, then the pandemic will contract, but the social environment will still support new disease outbreaks. There is no reason to assume that a post-COVID world will be a post-pandemic world.

If this sounds unusually grim, it may be due to my years of research exploring post-Soviet conflicts, when many multicultural countries fell apart in warring factions that triggered epidemics of easily preventable diseases.

Anna Mueller

Sociologist, Indiana University

2020 SN 10: Scientist to Watch

The pandemic has shown us how online teaching can be a tool that makes the classroom more accessible, particularly for students with disabilities. In the past, I've had students who sometimes struggled to attend class because they were coping with anxiety or living with significant pain. They needed my empathy and flexibility with class attendance but still missed the classroom experience. I now realize how easy it is to turn on a camera and pop on a microphone so they can join from the comfort of their homes.

Given the number of families that have lost jobs or income due to the pandemic, we're going to see an increase in children who have experienced deprivation, insecurity and traumatic

stress. These challenges early in life can have lasting consequences for physical and mental health, and for academic achievement. Without active steps to help affected children and their families, this will have a long-term tragic effect on U.S. society.

Mario Luis Small

Sociologist, Harvard University

Author, *Someone to Talk to: How Networks Matter in Practice*

COVID-19 has shown that a lot, though by no means all, of higher instruction can happen online. Parents and students will likely ask how much of the on-campus experience is truly needed and demand alternatives. And when the virus is under control, I suspect that companies, organizations, governments and individuals will take a look at their travel practices and decide to cut back, although many of us will yearn to engage in the physical contact that is part of social interaction.

I wonder what new strategies people will have learned to fight loneliness and avoid isolation, which of them will last after the pandemic ends and how those strategies will affect our sense of being part of the collective.

Christopher McKnight Nichols

Historian, Oregon State University

Author, *Promise and Peril: America at the Dawn of a Global Age*

We could see a dramatic rise in leisure activities and collective gatherings post-pandemic, including live music concerts and sports events. That's what happened in the 1920s as societies emerged from the 1918 [influenza] pandemic and World War I. In the United States, the rise [in popularity and national prominence] of professional baseball and college football occurred. In Europe, professional soccer expanded. We're not having fun together right now.

It's an open question whether social behaviors we took for granted, such as hand shaking and hugging, will endure. ■

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Fiorato is one of the most famous Murano glassmaking techniques resulting in beads of unparalleled beauty. First, the master creates the base of the bead, and then, holding the base under the flame, decorates it with exquisite roses, swirls, dots, and aventurina (glittery) streaks by carefully applying thin threads of molten colored glass onto the surface of the bead.

#BlackInSTEM leaders make change happen

As the Black Lives Matter movement gained momentum this year, Black scientists jumped in to call for inclusivity at school and work. Within days of the news that a Black bird watcher, Christian Cooper, had been harassed in New York City’s Central Park, the social media campaign #BlackBirdersWeek was launched (*SN Online*: 6/4/20), followed closely by #BlackInNeuro, #BlackInSciComm and many others.

Young scientists led many of these efforts to make change happen. *Science News* talked with some of these new leaders, as well as a few researchers who have been pushing for diversity in the sciences for years and see new opportunities for progress.

The following conversations have been edited for length and clarity.



Deja Perkins
URBAN ECOLOGIST
 North Carolina State University
 President, BlackAFinSTEM
 Co-organizer, #BlackBirdersWeek

What prompted you to act?

After the May 25 incident that happened to Christian Cooper, Anna Gifty, another member of BlackAFinSTEM [a collective of Black professionals working across STEM fields], thought

that it would be wise to highlight other Black birders. BlackAFinSTEM organized a week of events within about 48 hours. It was a good way to capture the momentum and bring attention to the experience of Black people outdoors. Any one of us could have been Christian Cooper. A lot of BlackAFinSTEM members have experienced racism in the field or have had negative experiences with the police.

What makes this year’s diversity initiatives different?

The collective effort of all of these events — #BlackHikersWeek, #Black-BotanistsWeek, #BlackInNationalParks, #BlackInNeuroWeek — is bringing more attention to the murders and harassment of Black people who are carrying out everyday tasks. These initiatives are making it easier for people who want to hop on board and make a difference.

Have you seen immediate effects?

Some organizations quickly responded to break down some of the barriers that prevent Black and Indigenous people from entering into the environmental space. The Free Binoculars for Black Birders campaign provided binoculars to anyone who identified as Black and wanted a pair of binoculars, and a similar campaign launched specifically for kids. Some organizations, such as the Wilson Ornithological Society, offered free memberships. And we have seen an increase in organizations reaching out to BlackAFinSTEM to hire some of our members for presentations, workshops and program development.

What could get in the way of lasting change?

One barrier I can foresee is gatekeeping. It’s still on a lot of organizations, nonprofits and government agencies to hire qualified Black professionals. Those

groups hold the power for change, and so they have to take the initiative to hire qualified individuals.

With #BlackBirdersWeek and BlackAFinSTEM, we have been creating our own table to get more people engaged and involved in the outdoors. But we can only do so much. It really comes down to partnerships, working with other established organizations to continue to make change. — *Carolyn Wilke*



Raven Baxter
SCIENCE EDUCATION GRADUATE STUDENT
 University at Buffalo
 Raven the Science Maven on YouTube
 Founder, #BlackInSciComm

What prompted you to act?

I founded #BlackInSciComm out of the need for Black voices in the science space. This year has been very hard for many, but particularly for Black people. And we’ve been feeling like Black science communicators have been using their voices advocating for racial justice and for their lives and for their freedom. That comes at a great price. They are sacrificing their voices in science to make sure that people understand that their lives matter. And, you know, that shouldn’t even have to be the case.

What makes this year’s diversity initiatives different?

We saw the importance of owning our own narrative. That’s why we’re seeing so many “Black in X” movements. Everybody is unique and doing special work. It should all be celebrated.

FROM LEFT: D. PERKINS; R. BAXTER

What long-term effects do you envision?

I think it's going to be amazing for future generations. One of the biggest issues that marginalized folks have is imposter syndrome — the product of not feeling like you belong because you don't see anybody like you in your field. So you're doing well and you're succeeding, but you feel like you're an imposter because the narrative that's been pushed for so long is that we're not in these fields or that we don't do well in these fields. But that's not true.

How do this year's efforts make you feel?

We're setting roots that spread a message that Black people do belong in things, and building up new generations of STEM professionals. I can tell that people want to support and amplify Black voices and invest in the community and it's so cool. I just feel very loved, and I feel like we are giving love.
— *Bethany Brookshire*



Brian Nord
COSMOLOGIST, Fermilab
Co-organizer, Strike for Black Lives

What prompted you to act?

In early June, Chanda Prescod-Weinstein of the University of New Hampshire and I initiated the Strike for Black Lives. The Particles for Justice collective, a group of scientists who originally convened to condemn sexism in STEM, organized and promoted the strike very quickly.

I had worked for a long time within the institutionally paved pathways to make change, and I tried to make new pathways. But, when I looked around, I saw promises unkept and much work to be done. For years, there's been way too few Black faculty in physics plus too little investment by academic institutions in Black communities. And there's been little to no accountability for racist and misogynist behavior that drives Black people away from research. It's time for these things to end. We needed to do something different.

What was the aim of the June 10 Strike for Black Lives?

The core objective was for non-Black scientists to stop doing science for a day and invest their time into building an antiracist, just research environment. For Black scientists and other academics, the day was intended for rest or doing the work they may not have otherwise had time to do. Often, when I spend time fighting racism in STEM, this is time that I don't spend doing research or with family. That's time that my white colleagues have to get research done.

I have the privilege to explore nature, to investigate and extend the edge of knowledge. How many more [people] have wanted to do this but have been denied the opportunity? I'm here to imagine and learn how the universe works. I'm also here to imagine and build just research communities, where Black people have the opportunity to pursue their cosmic dreams.

Have you seen any immediate effects from the strike?

I've seen many scientists begin to invest time in the study of racism, white supremacy, misogyny, and begin to observe how these forces permeate society — including the scientific community — to disenfranchise Black people and other people of color. I've also seen scientists begin to take action to deflate or confront these forces, and to start creating a just research environment.
— *Maria Temming*



Angeline Dukes
NEUROSCIENCE GRADUATE STUDENT
University of California, Irvine
Founder and president, #BlackInNeuro

What prompted you to act?

A lot of it was being one of two Black women in my department. It's very isolating. Thank God I have her to talk to. But a lot of other Black students in neuroscience don't even have that.

And we don't have any Black faculty in our department. It's not like we have someone who understands what it's like to be a Black person and to be witnessing these brutal murders and all this police brutality. It's emotionally and mentally draining, but we still have to be in the lab. And of course, it's still a pandemic. There is so much going on.

Having a community who just gets it, and understands exactly what we're going through and can support and uplift and just be there for us, is a major driving force in #BlackInNeuro. There are people out there who care about you and understand your experiences without you having to explain why you feel this way.

What initiative did you launch?

It started with a tweet: "Sooo when are we doing #BlackInNeuro week?" I didn't expect to get a huge response. I didn't have a huge following on Twitter. But a lot of people were very interested.

The same night I sent the tweet out, we made a Slack channel. We had about 22 people join. That was on Friday. By Sunday we had our first meeting. In about three weeks, we had organized the

whole week [July 27 to August 2].

We got speakers and panelists from different career stages to talk about their experiences. We used hashtags to plan events and different ways of highlighting and amplifying Black voices and Black research and Black people in neuroscience-related fields. We want this to be a lasting thing. One week isn't nearly enough for us to actually make a continuous change.

What makes #BlackInNeuro have such potential?

It is led by Black people for Black people. We are mostly graduate students and postdocs, so it's a trainee-led initiative. There aren't a lot of Black people in faculty positions. There are more of us at the graduate level. We have the energy and the drive to build a community and hopefully retain more of us in these fields so we can get those faculty positions.

What long-term effects do you envision?

The Society for Neuroscience meeting was canceled because of COVID. Black trainees would have used that as an opportunity to present their research. We held a mini-conference in late October to have a space for them to get that presentation experience and networking experience and professional development workshops.

How did this year's efforts make you feel?

We did a #BlackInNeuro roll call [an invitation for people to share their own stories on social media]. What was really nice about that was seeing all the different Black neuroscientists, Black neuroengineers. Just seeing that there were so many Black people in this field was amazing to me.

We had a [virtual] social for Black women in neuro. It meant the world to me to be able to connect in that way with so many other Black women. I got to see them as people and not just names on paper. The whole week, I really loved all of it. — *Laura Sanders*



Gary Hoover

ECONOMIST, University of Oklahoma
Cochair, Committee on the Status of Minority Groups in the Economics Profession, American Economic Association

What initiative have you been involved with?

For the last eight years, I have served as cochair of the Committee on the Status of Minority Groups in the Economics Profession. As such, I see all the data on minority representation and the number of minorities that we have in our field. That number always has been really, really low. In fact, economics has a lower percentage of minorities, or at least Blacks, than does pure mathematics. That is damning.

In early 2019, the American Economic Association sent out a survey about the state of our profession. The results showed that women and minorities didn't feel good about things. My committee cochairs Ebonya Washington, Amanda Bayer and I realized that the survey only included people in the profession.

For our survey, appearing in the Summer 2020 *Journal of Economic Perspectives*, we found people who had left the profession by looking at former participants in a decades-old summer program aimed at training undergraduates for careers in economics. Minority students didn't always feel welcomed into the field. They weren't told, "This is

a big tent and there's room for you here in this profession."

What prompted you to act?

My first job out of graduate school was at the University of Alabama. I was the first Black tenure-track faculty member hired in the business school. Once I received tenure, around 2003, the university made me the assistant dean for faculty and graduate student development. My job was to recruit and retain Black faculty. By the time I left that job in 2014, the University of Alabama business school had more Black faculty and graduate students than all the other schools in the Southeast Conference combined.

Since I left, those numbers have fallen off, which shows that we need active recruitment.

What change would you like to see?

As economists, we know that if you want to change people's behavior, you need incentives. For instance, we tell people they won't get tenure if they don't have a certain level and quantity of publications. That's clearly written out and people know that and they respond by producing the quantity and quality of publications that are necessary. Why don't we have that for diversity? If a school wants to diversify its econ department, it can say to the chair: "Your tenure status, your raises, your promotion are all tied to how well your department diversifies." We can get what we're looking for. It's economics. It's what we do. It works.

What is lost when minority voices aren't at the table?

Policy makers come to economists for advice. But when you've got a sizable portion of your labor force of economists sitting it out because the climate isn't inviting for them, then you can't give good advice. What's going to happen next is policy makers are going to start going to the fields that do give more inclusive advice. We're just going to get left behind. — *Sujata Gupta*

FAMOUS FRANCIS BINGO



Father of the Scientific Method

Director of the NIH

Nobel Prize Winner

Chemist

Person of Faith

Sir Francis Bacon



Francis Collins



Victor Francis Hess



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Disparities persist for Black scientists

BY BETSY LADYZHETS

Nationwide protests in response to the police killings of George Floyd, Breonna Taylor and other unarmed Black men and women in the first part of 2020 inspired calls to action within academia’s ivory tower.

Social media movements such as #BlackInSTEM brought attention to discrimination faced by Black students and professionals throughout the science, technology, engineering and mathematics pipelines. U.S. Black residents studying and working in STEM fields are underrepresented at every level, from undergraduate degree programs to the workforce.

The academic environment fails to support Black students, says Gary Hoover, an economist at the University of Oklahoma in Norman. “Black students in STEM are some of the most talented people around, and if the environment isn’t going to be welcoming, these folks just take their talents elsewhere.”

More U.S. students are getting science and engineering degrees than ever before. But the gap for Black students in these fields has been stubbornly wide, as population-adjusted figures show (see

graph below). In 2018, the most recent year for which data are available, about 238 of every 100,000 U.S. residents earned a STEM bachelor’s degree. If the Black community was adequately represented in STEM higher education, its rate would be similar — 238 of every 100,000 Black residents would have earned such degrees. Yet, only 161 of every 100,000 Black residents had earned these degrees.

The gap continues into graduate school. In 2018, Black residents were 12.3 percent of the U.S. population; but only 8.4 percent of bachelor’s graduates, 8.3 percent of master’s graduates and 5.5 percent of doctoral graduates.

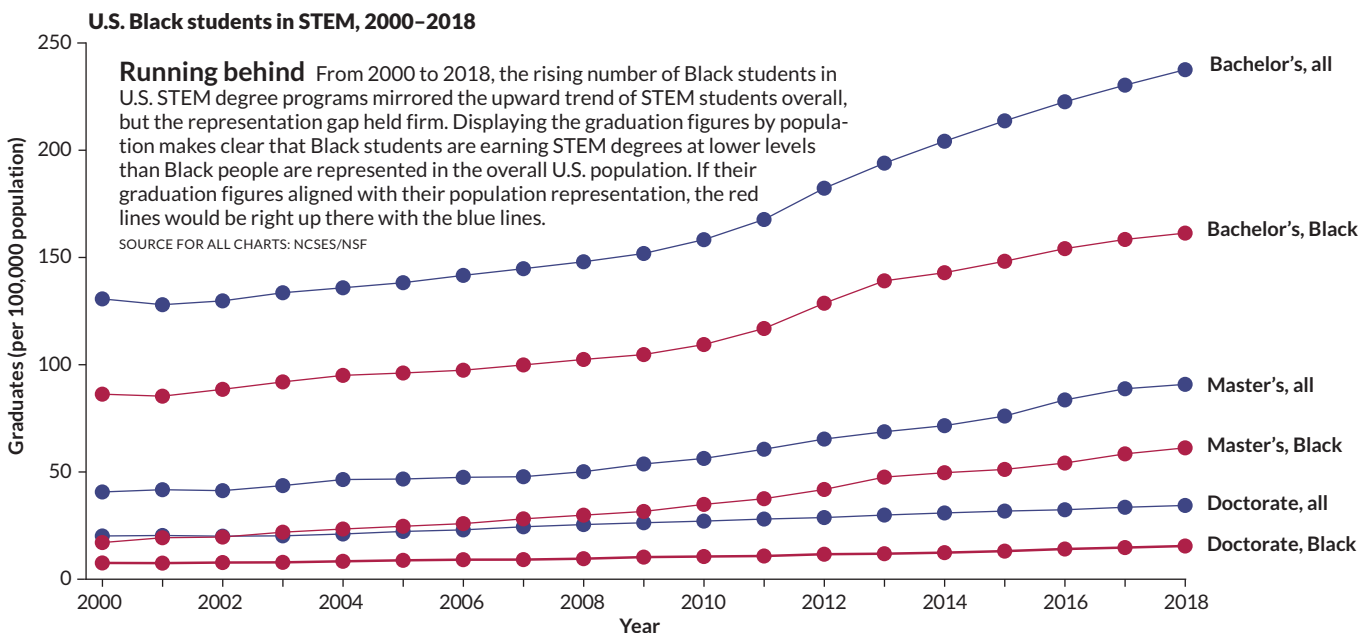
As Black STEM students make their way up the academic ladder, they may face learning and research environments that are unsupportive or actively hostile. In a 2018–2019 study by the American Institute of Physics, Black students in physics reported that they commonly experience a lack of financial support, as well as microaggressions, small interactions in which peers or superiors question a person’s presence or performance due to racially charged bias. These experiences negatively affected the person’s sense of belonging in the field. The

study results were based on a survey of 232 students, 53 percent of whom identified as Black or Black biracial. In the survey, 42 percent of the Black physics students reported that their department creates a supportive environment “most times,” compared with 53 percent of their white colleagues. Four percent of the Black students reported that their department “never” creates a supportive environment; none of the white students selected this response.

“As I reflect on my own academic journey... there were fewer and fewer Black students in my programs,” says anthropologist Stephanie Poindexter of the University at Buffalo in New York. Poindexter was one of very few Black students studying primates in her undergraduate program, and representation narrowed further as she progressed to a Ph.D.

“What I see is a lot of untapped potential,” Poindexter says: “interested students of color who are not fostered into higher degrees in the same way that other students are fostered.”

Within the U.S. STEM workforce, Black scientists are also underrepresented, as are Hispanic or Latino and



Native American scientists, according to 2017 data (see top graph below). Among 11 STEM professions reviewed by the National Center for Science and Engineering Statistics, or NCSES, only one field demonstrates a rate of Black representation that is close to the overall population: 92 of every 100,000 Black residents are social scientists, compared with 122 of every 100,000 U.S. residents overall (second graph below).

The disparity is especially severe in engineering. For example, 29 of every

100,000 U.S. residents are chemical engineers compared with 2 of every 100,000 Black residents. “Young Black potential engineers have few role models that look like them and/or come from similar backgrounds that they can emulate, manifesting in a deficit in the younger students cultivating these skills,” says Aaron Kyle, a senior lecturer in biomedical engineering design at Columbia University’s Fu Foundation School of Engineering and Applied Science. Kyle also notes that minority scientists may

be cited less than their peers, leading to challenges in career advancement.

Disparities in salary are found in most, but not all, STEM fields. Computer science has the largest disparity, with a median annual salary in 2017 of \$97,000 for white professionals compared with \$72,000 for Black professionals. There are so few working Black mathematicians that the NCSES couldn’t even make a comparison. Black scientists in the biological and social sciences, on the other hand, have higher median salaries than their white colleagues. Perhaps, Hoover says, some social sciences, such as political science, may be “more readily able and willing to embrace issues around ethnicity, race and inclusion” than other fields, allowing Black scientists to negotiate more equitable pay.

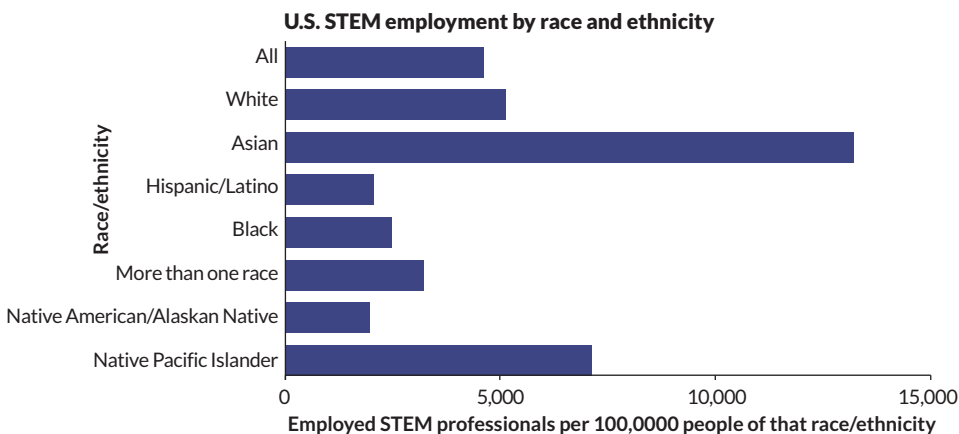
When Black students shift to other tracks, Black communities suffer from a lack of doctors, researchers and engineers who directly understand their experiences and needs. The loss leads to blind spots in innovation, Kyle says.

“We see clear examples of this, ranging from facial recognition software not accurately identifying Black faces all the way through race-based health care disparities: COVID-19 mortality, elevated maternal [death] in Black women, higher amputation levels amongst Black diabetics,” he says. For instance, the mortality rate for Black newborns was cut in half when the babies were cared for by Black doctors, according to a recent report in the *Proceedings of the National Academy of Sciences* (SN Online: 8/25/20).

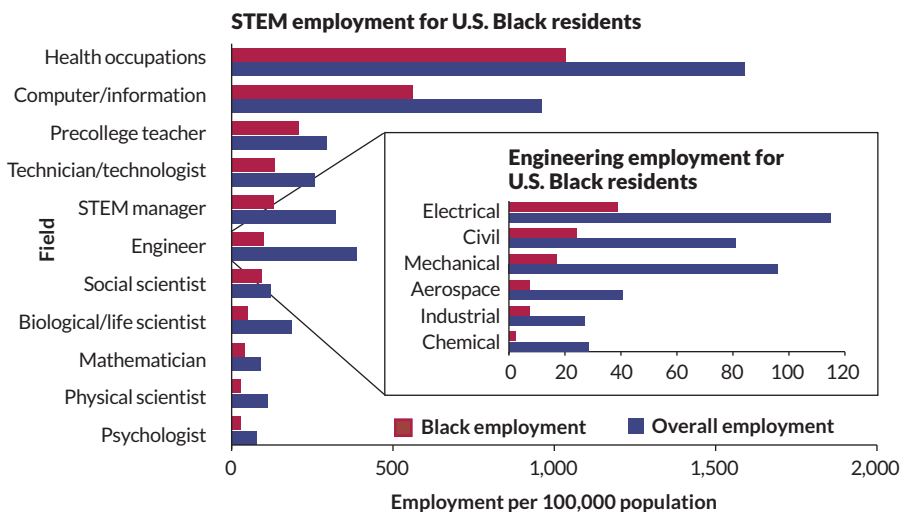
To improve Black representation in science, Poindexter, Hoover and Kyle all say that solutions must include new offerings of grants, promotions and research programs dedicated to supporting Black STEM students from elementary school into the workforce.

“There needs to be a concentrated effort and financial commitment to balance the scales in the next one to five years,” Poindexter says. ■

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



An imbalance In 2017, Black residents, Hispanic or Latino residents and Native Americans and Alaskan Natives were severely underrepresented among U.S. scientists, engineers and health care professionals, when compared with the overall populations for these identities.



Cloudy careers All major STEM fields in the United States have Black representation rates (red bars) far below the overall rates of U.S. working professionals (blue). The social sciences come the closest at 92 professionals per 100,000 Black residents compared with 122 per 100,000 U.S. residents overall. The physical sciences had the greatest disparity. Among engineers (inset), Black representation is lowest in chemical engineering. If Black professionals were represented equally, the red and blue bars would be the same length.

BOTH: T. TIBBITTS



Three of Colorado's largest recorded wildfires occurred in 2020, including the East Troublesome Fire (shown) near Rocky Mountain National Park.

Climate's broken records

BY CAROLYN GRAMLING

2020 was a year of unremitting extreme climate events, from heat waves to wildfires to hurricanes, many of which scientists have directly linked to human-caused climate change (*SN*: 9/26/20, p. 12). Each event has taken a huge toll in lives lost and damages incurred. As of early October, the United States alone had weathered at least 16 climate- or weather-related disasters each costing more than \$1 billion. The price tags of the late-season hurricanes Delta, Zeta and Eta could push the final 2020 tally of such expensive disasters even higher, setting a new record.

With the COVID-19 pandemic dominating the news, some of these events may have already faded into memory. Here, *Science News* takes a look at this year of climate extremes.

Australia's 'black summer'

The bushfires that burned southeastern Australia between July 2019 and March 2020 scorched roughly 11 million hectares and killed dozens of people. Climate change made those devastating fires at least 30 percent more likely to occur, researchers reported (*SN*: 3/28/20, p. 6). The primary reason: a prolonged and severe heat wave that baked the country in 2019 and 2020, which

itself was exacerbated by climate change.

The intensity of Australia's fires produced some striking sights. A particularly intense fire led to the formation of towering pyrocumulonimbus clouds that launched hundreds of thousands of metric tons of smoke into the stratosphere (*SN Online*: 6/15/20).

One massive plume of smoke, wrapped in rotating winds, ascended to a record 31 kilometers in the atmosphere, deep into Earth's protective ozone layer.



This injured koala, cared for at the Kangaroo Island Wildlife Park in January, was among the countless animals harmed or killed by the bushfires that blazed across Australia this year.

Although it's not clear what chemical scars it left, such a large smoke plume has the potential to trigger chemical reactions that destroy ozone.

The West on fire

Record-setting wildfires in the U.S. West also produced heartbreaking images: raging blazes, orange skies, destroyed homes, neighborhoods enveloped in acrid smoke. By mid-November, more than 9,200 fires in California had burned about 1.7 million hectares — more than double the acreage burned in 2018, the state's previous record fire year. Meanwhile, Colorado battled three of the largest wildfires in the state's history. Combined, those fires burned more than 219,000 hectares.

The role of climate change in these blazes is multipronged. From California to Colorado, rising temperatures due to climate change have led to earlier spring snow melting, resulting in drier vegetation by summer. In California, that extremely dry vegetation combined with a record-breaking heat wave primed the landscape for runaway fires.

Climate change is increasing the frequency of extreme climate conditions. California's average heat and dryness in both summer and autumn have become more severe, dramatically increasing

the number of days each year prone to extreme fire weather conditions (*SN*: 9/26/20, p. 12). Simulations of future climate change project increasing dryness over at least the next few decades — which means 2020's fire records aren't likely to stand for long.

Siberian meltdown

From January through July, Siberia was in the grips of a powerful heat wave that led to record-breaking temperatures, unprecedented wildfires in the Arctic and thawing permafrost, which in turn may have led to the collapse of a fuel storage tank that flooded nearby rivers with diesel fuel.

Such heat in Siberia — with temperatures as high as 38° Celsius (about 100° Fahrenheit) — would have been impossible without climate change (*SN*: 8/15/20, p. 13). Human influence made the heat wave at least 600 times as likely — and possibly as much as 99,000 times as likely, scientists reported. Moreover, the carbon dioxide churned into the atmosphere by this year's Arctic wildfires also smashed the previous record for the region, set in 2019. That CO₂ can beget further warming, and the fires can also speed up permafrost thaw, which could add more of another greenhouse gas, methane, to the atmosphere.

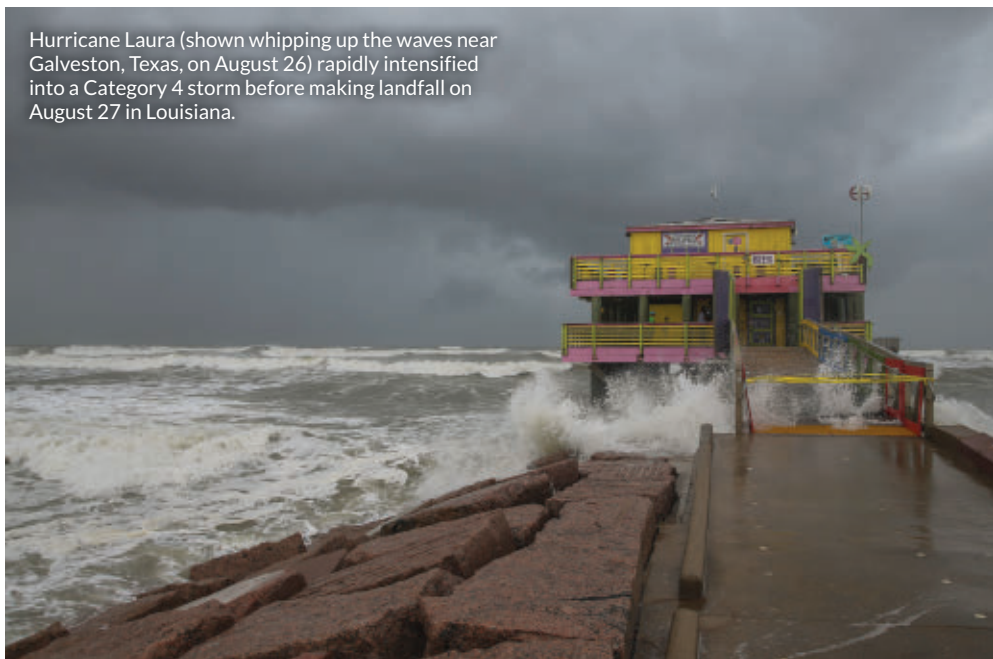
This year also saw the second-lowest extent of Arctic sea ice on record. Meanwhile, a roughly Manhattan-sized chunk of Canada's Milne ice shelf — close to half of what had been the country's last intact ice shelf — suddenly collapsed into the Arctic Ocean in August, carrying an ice-observing station away with it.

Supercharged hurricanes

As early as April, scientists predicted that the Atlantic hurricane season, which lasts from June 1 through November 30, would be busy, with about 18 named storms, compared with an average of 12 (*SN Online*: 4/16/20). By August, scientists upped their predictions to as many as 25. But 2020 surpassed those expectations too: By mid-November, there were 30 named storms, eclipsing a record set in 2005 (*SN Online*: 11/10/20).



A worker takes part in cleanup operations at a fuel spill in northern Russia. A heat wave thawed permafrost, which may have caused the collapse of a fuel tank in May that released about 20 million liters of diesel fuel.



Hurricane Laura (shown whipping up the waves near Galveston, Texas, on August 26) rapidly intensified into a Category 4 storm before making landfall on August 27 in Louisiana.

It's difficult to link climate change to the number of storms that form in a given year. Very warm ocean waters, such as in the Atlantic Ocean this year, foster tropical cyclone formation. It's true that those warm waters are linked to climate change, as the surface ocean swallows up excess heat from the atmosphere. But other factors are also involved in hurricane formation, including wind conditions, making it difficult to establish a link.

But there are established links between warming oceans and increasing hurricane intensity, as well as rainfall. Warm Atlantic waters gave a boost to the intense storms of the 2017 hurricane season, for

example (*SN Online*: 9/28/18). The warm waters can also provide enough energy to give hurricanes extra staying power even after landfall (*SN*: 12/5/20, p. 14).

And, as the world saw in 2020, very warm ocean waters can also speed up how quickly a storm strengthens — leading to dangerous, difficult-to-predict, suddenly supercharged storms. Such rapid intensification is defined as sustained wind speeds increasing by at least 55 kilometers per hour within just 24 hours (*SN Online*: 8/27/20). 2020 saw that in abundance, with 10 Atlantic storms rapidly intensifying in the region's bathlike waters before making landfall. ■

Superlative science

BY ERIKA ENGELHAUPT

From the biggest merger of black holes to the world's oldest string—fashioned by Neandertals, no less—discoveries in 2020 set new records that amazed and inspired.

Highest-temperature superconductor

After more than a century's wait, scientists have found the first superconductor that works near room temperature. Superconducting up to about 15° Celsius (59° Fahrenheit), it's made by squeezing carbon, hydrogen and sulfur between two diamonds and zapping the compound with a laser (*SN: 11/7/20, p. 6*). The new material allows current to flow without any energy loss, but only at high pressures, which means practical applications are still a distant vision.

Oldest, biggest Maya monument

Underneath a previously unexplored site in Mexico called Aguada Fénix, archaeologists uncovered an enormous raised ceremonial structure (*SN: 7/4/20 & 7/18/20, p. 6*). Built about 3,000 years

ago and featuring a 1,400-meter-long rectangular plateau with a platform longer than four American football fields, the discovery shows that the Maya civilization built big from its beginnings.

Best evidence for anyons

Theoretical physicists have long predicted the existence of anyons, a type of bizarre quasiparticle resulting from the movements of electrons that together behave as a particle. In a mind-twisting discovery, physicists braided anyons, which exist only in two dimensions, by looping them around one another within complex layers of materials (*SN: 8/15/20, p. 12*). The resulting disturbances observed in the 2-D sheets of material suggest that the quasiparticles are real.

Earliest modern bird

The nearly 67-million-year-old fossilized “Wonderchicken” (also known as *Asteriornis maastrichtensis*) is the oldest modern bird ever found, meaning that its descendants survived the asteroid impact that wiped out nonavian dinosaurs and led to the birds we see today

(*SN: 4/11/20, p. 10*). Wonderchicken did indeed look something like a chicken, if it were crossed with a duck and shrunk to the size of a quail.

Grossest discovery

For the first time, researchers observed a snake gnawing a hole in a toad's belly, slithering inside and gorging on the innards—all while the toad was alive (*SN Online: 10/2/20*). The snake may have been avoiding poison that the toad releases from its neck and back, or finding a way to eat a meal too big to swallow whole.

Oldest string

Not only was this scrap of cord handmade more than 40,000 years ago, but the hands that made it belonged to Neandertals, close human relatives who don't often get props for creativity. The string, made from bark fibers, was found clinging to an ancient tool discovered in France (*SN: 5/9/20 & 5/23/20, p. 5*).

Biggest black hole merger

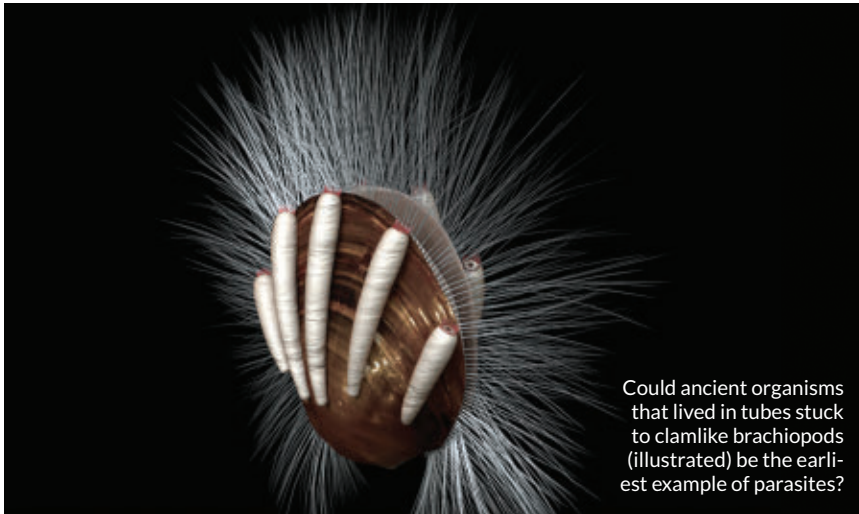
A detection of gravitational waves from two colliding black holes led to a bevy of records (*SN: 9/26/20, p. 7*). It's the first definitive evidence that midsize black holes—those with a mass between 100 and 100,000 times that of the sun—exist. The resulting merger is the most massive spotted so far using gravitational waves, as well as the farthest (17 billion light-years from Earth) and the most energetic: It radiated the equivalent in energy of about eight times the sun's mass.

Record-breaking animals

This year saw several record-breaking animal achievements, from the highest-living mammal—a yellow-rumped leaf-eared mouse found 6,739 meters above sea level in South America (*SN: 8/29/20, p. 4*)—to the longest dive by a marine mammal, a nearly four-hour plunge by a Cuvier's beaked whale (*SN: 11/7/20, p. 5*). There was also the coldest bird, the black metaltail hummingbird, which chills to about 3° Celsius (37° Fahrenheit) overnight to conserve energy (*SN: 10/10/20 & 10/24/20, p. 5*). ■



Clockwise from top: After chewing a hole into the belly of a toxic toad, a small-banded kukri snake shoved its head inside to eat. To make the first superconductor that works near room temperature, physicists squeezed to high pressure a material between the tips of two diamonds. The quail-sized “Wonderchicken” is the earliest known modern bird (3-D printed skull shown).



Could ancient organisms that lived in tubes stuck to clamlike brachiopods (illustrated) be the earliest example of parasites?

Extraordinary claims

BY CASSIE MARTIN

Discoveries about the cosmos and ancient life on Earth tantalized scientists and the public in 2020. But these big claims require more evidence before they can earn a spot in science textbooks.

Cloudy with a chance of life

The scorching hellscape next door may be a place to look for life. Telescopes trained on Venus' clouds spotted traces of phosphine in quantities that suggest something must be actively producing the gas (*SN: 10/10/20 & 10/24/20, p. 6*). On Earth, phosphine is emitted by certain bacteria or industrial processes, leading some astrobiologists to speculate that microbes may be living in Venus' relatively temperate upper atmosphere. But other research teams' analyses suggest the phosphine detection was a misread — perhaps the result of a fluke in data processing (*SN: 11/21/20, p. 16*).

Flashback

For the first time, astronomers may have glimpsed a fast radio burst in the Milky Way. Even more intriguing, the source of the super-bright boost of radio waves appears to be a magnetar — a type of neutron star with an intense magnetic field (*SN: 7/4/20 & 7/18/20, p. 12*). But it's too soon to claim that magnetars caused

any of the dozens of previously detected fast radio bursts, as those flashes came from galaxies too far away to trace the bursts back to a source.

Totally tubular

Tubes stuck to the outer shells of hundreds of fossilized brachiopods discovered in an outcropping in China may have housed the earliest-known parasites. The clamlike brachiopods lived about 512 million years ago. Researchers speculate that organisms living inside the tubes swiped food from their filter-feeding hosts (*SN: 7/4/20 & 7/18/20, p. 11*). That the tubes were never found alone or on other fossils in the outcropping suggests that the organisms could not survive on their own. But some critics question whether the relationship was truly parasitic, given that the tubed-up brachiopods didn't seem any worse off than their tube-free counterparts.

Found: ordinary matter

Only about half of the universe's expected amount of ordinary matter has ever been cataloged. But this year, astronomers claimed that the other half is hiding out in intergalactic space (*SN: 6/20/20, p. 6*). That conclusion is based on an analysis of how a small sample of fast radio bursts from other galaxies were distorted by particles on the way to Earth. Before the

case of the missing matter can be closed, though, more of these bright blasts of radio waves need to be examined.

Start your cosmic engines

A ghostly subatomic particle may have been revved up by a star's destructive encounter with a black hole. Sensed by the IceCube detector in Antarctica, the neutrino carried 200 trillion electron volts — about 30 times as much energy as that of a proton accelerated by the Large Hadron Collider. Scientists matched the neutrino detection to a flash of light in the sky caused by a black hole shredding a star. The probability of the neutrino and the flash coinciding by chance is just 0.2 percent. If the finding holds up, it would be only the second time a high-energy neutrino has been traced to its source, and the first direct evidence that shredding a star can accelerate neutrinos to high energies (*SN: 6/20/20, p. 9*).

On the move

The long-running debate over when humans first traveled to and from the Americas rages on. One group of researchers reported that people arrived to North America more than 15,000 years earlier than generally thought, based on the discovery of roughly 33,000-year-old stone tools unearthed in Mexico (*SN: 8/15/20, p. 6*). Some archaeologists, however, doubt that the artifacts are even stone tools and say they instead are just naturally broken rocks.

Another research group reported that Indigenous South Americans crossed thousands of kilometers of open ocean and reached eastern Polynesia more than 800 years ago, not long after settlers from Asia initially colonized the islands (*SN: 8/1/20, p. 15*). That conclusion rests on genetic evidence suggesting the intrepid South Americans mated with ancient Polynesians. But some anthropologists question whether early South American groups had the equipment or seafaring skills necessary for the journey. Ancient Polynesians, who were expert navigators, may have traveled to South America, bringing new DNA with them on a return trip home. ■

Space gets crowded

BY LISA GROSSMAN

So many things launched into space this year: Six humans traveled aboard commercial crew vehicles, three spacecraft began journeys to Mars and several hundred distractingly shiny satellites took to the sky.

Commercial crew

On May 30, SpaceX ferried a pair of astronauts to the International Space Station from Cape Canaveral, Fla. It was the first human launch on a commercial spacecraft and the first time astronauts flew from a U.S. launchpad since the space shuttle was retired in 2011 (*SN: 6/20/20, p. 16*).

As part of its Commercial Crew Program, NASA funded private space-flight companies, including SpaceX and Boeing, to develop ways to carry astronauts to and from the space station so the agency would no longer have to rely on the Russian Soyuz craft.

When the astronauts returned safely to Earth on August 2, the test of SpaceX's Crew Dragon spacecraft was deemed a success. The next flight, which launched November 15, took four astronauts. "I think you can say we're really no longer dependent on the Soyuz," says astrophysicist and space historian Jonathan McDowell of Harvard & Smithsonian's Center for Astrophysics in Cambridge, Mass.

Journey to Mars

Three spacecraft that left for Mars in July are due to arrive in February 2021. The Perseverance rover, NASA's fifth Martian rover (*SN: 7/4/20 & 7/18/20, p. 30*), will search a dry river delta for signs of ancient life and collect rock samples that a future mission will bring to Earth.

China and the United Arab Emirates hope this year's missions will mark their first successful voyages to the Red Planet (*SN Online: 7/30/20*). After entering



SpaceX and other companies want to launch thousands of internet satellites (illustrated) into orbit. Astronomers worry those reflective objects will mar observations of the night sky.

Mars' orbit, China's Tianwen-1 spacecraft is expected to drop a lander and rover onto the planet's surface in April. China plans to bring samples back from Mars in the next decade, and Tianwen-1 is a tech demo for that mission. The rover will also look for hidden pockets of water beneath the surface and explore Mars' geology and chemistry.

The UAE space agency was founded only in 2014 and launched its first satellite in 2018, making a Mars mission an ambitious leap. The country's Hope orbiter will gather evidence to address one of Mars' biggest unsolved mysteries: How does Martian weather work (*SN: 7/4/20 & 7/18/20, p. 24*)? By being the first spacecraft to orbit the planet's equator, Hope will provide a new view of how Mars' atmosphere changes daily, seasonally and at different altitudes.

Mega-constellations

SpaceX isn't just sending astronauts into orbit. The company has launched hundreds of satellites as part of its Starlink project to bring high-speed internet around the globe. Other companies plan to launch similar "mega-constellations." If all goes according to various companies' plans, there will be about 100,000 satellites in low orbits.

"That's a lot of satellites," McDowell says. As of August 1, just 2,787 operational satellites doing all kinds of jobs orbited the Earth. Scientists fear that the impending satellite surge could spoil the night sky for astronomy by reflecting

extra light down at earthly telescopes (*SN: 3/28/20, p. 24*).

By mid-October, SpaceX had already launched more than 900 Starlink satellites. The company tested a dark coating meant to make the satellites less reflective, but that didn't help enough. So now SpaceX is launching satellites with small visors to reduce reflectivity, which helps a bit, McDowell says.

The good news is that astronomers and space companies are discussing the problem. At a meeting in the summer, scientists presented simulations of the worst-case scenarios. The impact of these mega-constellations will depend on how many satellites actually launch, and what kind of astronomy you're considering, McDowell says. Some of the worst effects will be on observations to detect near-Earth asteroids.

"We might miss the rock that's coming to kill us all because the satellite streaks got in the way of calculating its orbit," McDowell says.

One thing that would help is government regulations about the characteristics of satellites that can be launched, McDowell says. Companies are "making all the right noises about wanting to help," he says, but noises and actions are not the same thing.

"I think with additional work and mitigations, we'll get to a point where it isn't fatal to ground-based astronomy, but it's still a huge impact," McDowell says. "We may not know the full consequences until we're really in it." ■

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Good news in health

BY LAURA SANDERS

The year will not be remembered as a good one for human health. But some notable bright spots did shine through.

Ebola outbreak ends

The second biggest Ebola outbreak in history is officially over. Beginning in 2018, the virus surged in eastern Congo, infecting 3,470 people and killing about two-thirds of them (*SN Online*: 6/25/20). The outbreak was declared done in June thanks to an aggressive public health response involving testing, isolating sick people and contact tracing—the same measures that could slow COVID-19’s spread.

A vaccine, delivered to more than

300,000 people during the outbreak, and experimental drugs also helped. On October 14, one antibody-based treatment, Inmazeb, became the first Ebola drug approved by the U.S. Food and Drug Administration (*SN Online*: 10/15/20). With that approval, U.S. supplies of the drug may become more readily available for Ebola patients. (The drug’s maker, Regeneron Pharmaceuticals, is a major donor to the Society for Science & the Public, which publishes *Science News*.)

HIV’s elite controllers

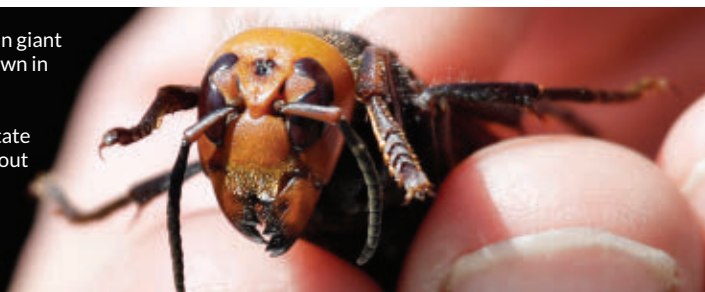
Most people with HIV take antiretroviral drugs to keep the virus in check. But in one rare person, the immune system seems to have wiped out the virus

all on its own. Among over 1.5 billion blood cells taken from this once-infected person, not a single working copy of HIV turned up (*SN*: 9/26/20, p. 6). In another patient, researchers found only one functional copy of HIV in more than a billion blood cells. Learning how these people, part of a select group called elite controllers, fought off HIV may lead to better treatments for others.

Peanut allergy protection

In January, the FDA approved the first drug for curbing peanut allergies in children and teens (*SN*: 2/29/20, p. 16). Called Palforzia, the drug contains peanut proteins and is given in escalating amounts, so the body gradually learns that these proteins aren’t dangerous. The drug doesn’t go as far as eliminating peanut allergies, but it can help people tolerate an accidental peanut encounter. ■

This dead Asian giant hornet was flown in from Japan so researchers in Washington state could learn about the insects.



Murder hornet madness

BY ERIKA ENGELHAUPT

As if 2020 needed an extra disaster, the year also brought us “murder hornets.”

When two Asian giant hornets (*Vespa mandarina*) were spotted in Washington and nearby British Columbia in May, news headlines heralded their “arrival” with a strange mix of horror and glee. Never mind that the invaders had been spotted in the state the year before; somehow it felt that they belonged in 2020.

Science News has tried to calm the buzz with facts. For one, the invasion is not as apocalyptic as some headlines have suggested, life sciences writer Susan Milius reported (*SN*: 7/4/20 & 7/18/20, p. 14). Not only is this not the first big hornet to invade the United States, the predatory insects hunt for honeybees, not people. And the hornets are not exactly taking over. Scientists have mounted an extensive effort to eradicate them—officials in Washington found and destroyed their first nest in October—and a map released this year suggests that swaths of challenging habitat might make it hard for the hornets to sweep across America (*SN*: 11/7/20, p. 12).

That hasn’t stopped people all over the country from thinking they’ve found one. “Suddenly, overlooked local wasp

and hornet species... hanging around in corners of people’s backyards for millennia become the subjects of panic-driven calls,” says Gale Ridge, an entomologist at the Connecticut Agricultural Experiment Station in New Haven. Ridge has been taking those calls.

Concerned readers have reached out to *Science News*, too. We shared with Ridge the half dozen photographs of suspected murder hornets we received. She spotted European hornets, bald-faced hornets (technically yellow jackets) and robber flies. No murder hornets.

“In the public mind, the hornets are ‘here,’” Ridge says. She patiently explains to her frazzled callers that the hornets are being intercepted nearly 3,000 miles away across an entire continent.

“The combination of half-listening and overdramatization of the facts by the media creates an anxiety-driven stew,” Ridge says. She combats that anxiety by teaching local residents about New England’s insects, such as European hornets and cicada-killer wasps that are often mistaken for Asian giant hornets. “One creates a fresh storybook of information on which callers can relax, feel comfortable and thrive,” she says. ■



CONGRATULATIONS

MAYA AJMERA

**2020 Public Service Award from the National Science Board,
the governing body of the National Science Foundation.**

The Board is recognizing Maya Ajmera, President & CEO of the Society for Science & the Public and Publisher of *Science News*, for “inspiring generations of young people to be science and technology leaders and innovators through the Society for Science & the Public, a non-profit organization best known for its world class science research competitions, award winning science journalism, and expansive outreach and equity programs.”



After taking a new look at sparkly Elvis worms, researchers realized that these deep-sea dwellers are actually four separate species.



Stories that sparked joy

BY ERIKA ENGELHAUPT

Everyone needed a respite from 2020, and tales of discovery provided a happy distraction from the worries of the day. Here are a few reminders that we still live in a world full of wonders.

Flowers at the South Pole

Antarctica was once home to a diverse rainforest. The unearthing of traces of vegetation in 90-million-year-old sedi-

ments off the coast of West Antarctica shows just how radically different the planet was during the age of dinosaurs, with conifers, ferns and blooming flowers where an ice sheet sits today (*SN: 4/25/20, p. 14*).

Life finds a way

Researchers are still identifying new species and cataloging the amazing diversity of life on Earth. This year saw the discovery that the sparkly “Elvis worm” of the

deep sea is actually four different species (*SN: 6/20/20, p. 16*). Other scientists found a bonanza of 10 new bird species and subspecies on remote Indonesian islands (*SN: 2/1/20, p. 7*). And the first complete count of plant species on New Guinea revealed more than 13,600 species of vascular plants, the most of any island on Earth (*SN: 9/12/20, p. 32*).

Raining reptiles

During a cold snap in southern Florida, lizards started falling from trees, landing legs-up (*SN: 12/5/20, p. 4*). The reptiles weren’t hurt, just so cold that they couldn’t move and lost their grip. Oddly, this may be good news for the six lizard species scientists examined. The ability to withstand temperatures down to about 5.5° Celsius may suggest some resilience to extreme weather caused by climate change.

Super chill

Hot water can sometimes freeze more quickly than cold, a baffling phenomenon called the Mpemba effect. Scientists couldn’t explain it — and weren’t sure it was even real. Now researchers have demonstrated the bizarre effect for the first time in the laboratory by cooling glass beads as a proxy for the more complex freezing process of water. In some conditions, the researchers say,



Roughly 90 million years ago, a diverse rainforest (shown in this artist’s reconstruction) flourished within about 1,000 kilometers of the South Pole.

FROM TOP: A.S. HATCH ET AL./ZOOKEYS 2020; J. MCKAY/ALFRED WEGENER INSTITUTE (CC BY 4.0)

materials can take a cooling “shortcut” that allows warmer objects to cool faster than colder ones (SN: 9/12/20, p. 16).

Edge of the map

Astronomers have found the edges of the Milky Way, for the first time showing its enormous span and potentially helping to gauge its heft. Our home galaxy stretches almost 2 million light-years across, more than 15 times as wide as the Milky Way’s spiral disk of stars and planets (SN: 4/25/20, p. 8). Beyond that disk lies a broad stretch of gas surrounded by a vast halo of invisible dark matter.

Go fly a snake

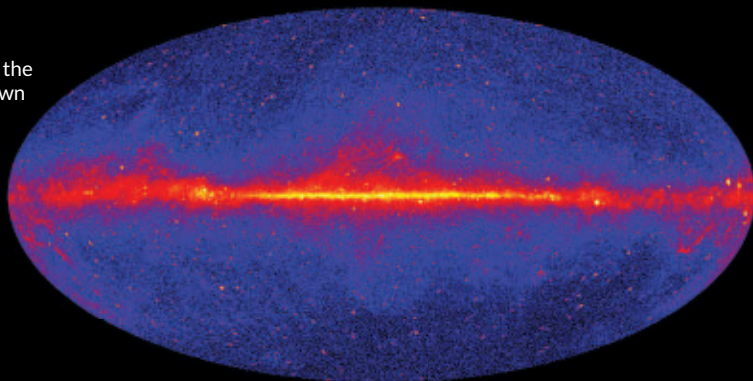
Paradise tree snakes can fling themselves 10 meters or more through the air, and engineers have now figured out how they stay aloft. Once the snakes are in the air, they undulate both side to side and up and down, giving them the stability needed to glide (SN: 8/1/20, p. 16).

Floats our boat

Here was a chance to witness the seemingly impossible: tiny toy boats floating along both the top and bottom of a levitating liquid. Physicists made this magic

Creating an antigravity effect in the lab allowed a toy boat to float upside down on the bottom of a layer of levitating liquid.

The vastness of the Milky Way (shown in a gamma-ray image) seems almost immeasurable, but this year, astronomers put limits on our home galaxy’s bounds.



happen by shaking a container of liquid, thus keeping a fluid layer aloft above a layer of air and allowing the inverted flotation (SN: 9/26/20, p. 32).

Will to survive

One inspiring creature just refused to accept being eaten. The *Regimbartia attenuata* water beetle is the first prey known to survive a trip through a frog’s entire digestive system, not just by taking a ride (like the fish eggs found this year to survive ducks’ digestive systems) but by actively escaping through the back door (SN: 8/29/20, p. 18; SN: 8/1/20, p. 13).

Everybody smile

From grins to grimaces, facial expressions may be universal across human cultures, and from ancient times to the modern day. Just by looking at the faces of sculptures crafted between 3,500 and 600 years ago, without the context of the

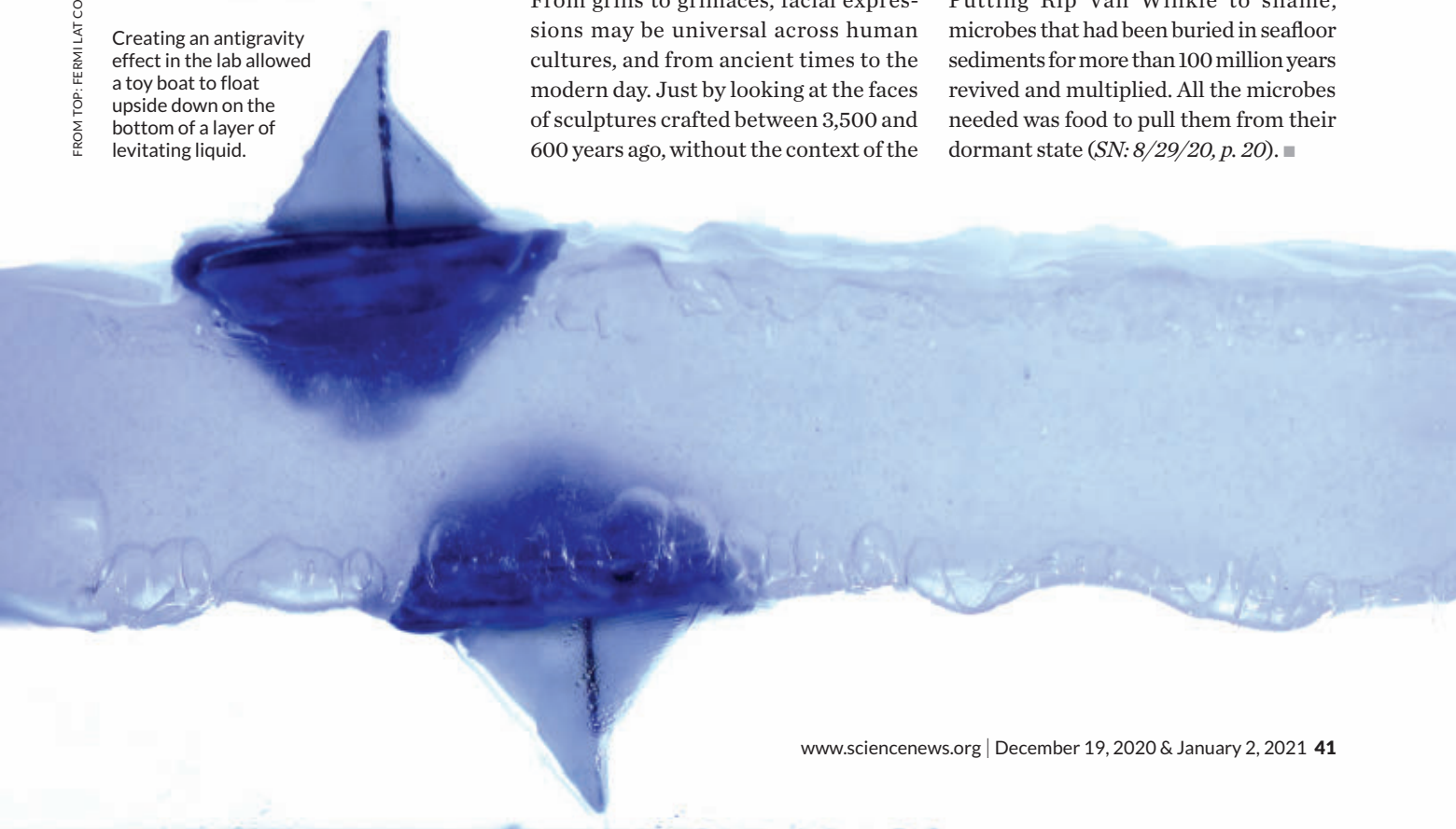
rest of the sculpture, present-day people correctly interpreted expressions such as anger in depictions of combat and pain in sculptures of people being tortured (SN: 9/12/20, p. 7).

Meet PigeonBot

A robotic bird made with real pigeon feathers can change the shape of its wings by fanning its feathers out or gathering them in, making for more birdlike flight. Using the robot, scientists discovered that a bird can steer into a turn by bending just one “finger” on one of its wings (SN: 2/15/20, p. 8).

It’s alive!

Putting Rip Van Winkle to shame, microbes that had been buried in seafloor sediments for more than 100 million years revived and multiplied. All the microbes needed was food to pull them from their dormant state (SN: 8/29/20, p. 20). ■

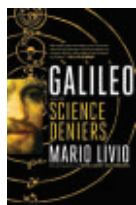


FROM TOP: FERMI/LAT COLLABORATION/DOE AND NASA; B. APPEL ET AL./NATURE 2020

BOOKSHELF

Our favorite books of 2020

A good read became a cherished distraction this year as many of us stayed home more than ever during the pandemic. Biographies of scientific legends and lesser-known luminaries, tales of amazing animals and stories of exploration captivated *Science News* staff. Find in-depth reviews at www.sciencenews.org/books2020



Galileo and the Science Deniers

Mario Livio

The story of Galileo's life, including his famous trial for heresy, has been told many times, but this new

biography still feels relevant as opposition to science remains a threat (*SN*: 8/15/20, p. 26). *Simon & Schuster*, \$28



Once Upon a Time I Lived on Mars

Kate Greene

Living atop a Hawaiian volcano for several months as part of a simulated Mars mission gives a

writer perspective on what life might be like for future Red Planet denizens, plus a chance to examine isolation, exploration, love and other themes (*SN*: 7/4/20 & 7/18/20, p. 32). *St. Martin's Press*, \$27.99



The End of Everything

Katie Mack

The universe will one day cease to exist, and an astrophysicist takes a look at the various ways it could end. The author's

humor and awe of physics transform a bleak notion into a captivating read (*SN*: 8/1/20, p. 28). *Scribner*, \$26



What Stars Are Made Of

Donovan Moore

In the 1920s, astronomer Cecilia Payne-Gaposchkin determined the chemical composition of stars. Her biography illuminates

the persistent work that was required to make the discovery and the challenges she faced as a woman in science (*SN*: 2/29/20, p. 26). *Harvard Univ.*, \$29.95

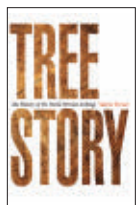


The Future We Choose

Christiana Figueres and Tom Rivett-Carnac

The world is already suffering the consequences of climate change, but it's not too late to achieve

the goals of the Paris Agreement, the authors argue as they outline the steps readers and society as a whole can take (*SN*: 5/9/20 & 5/23/20, p. 38). *Knopf*, \$23

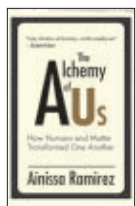


Tree Story

Valerie Trouet

An expert guides readers through the field of dendrochronology, revealing the wealth of historical and climatic

information recorded in tree rings (*SN*: 6/6/20, p. 30). *Johns Hopkins Univ.*, \$27

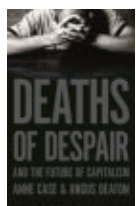


The Alchemy of Us

Ainissa Ramirez

By surveying clocks, lightbulbs and other momentous inventions, a materials scientist demonstrates how

humans have bent materials to their will and how those innovations have shaped humankind (*SN*: 4/25/20, p. 28). *MIT Press*, \$27.95



Deaths of Despair and the Future of Capitalism

Anne Case and Angus Deaton

Five years after introducing the concept of "deaths of despair" (*SN Online*:

11/2/20), two economists tie the rising number of U.S. deaths due to suicide, drug overdose and alcoholism to a string of economic and social stressors harming the working class. *Princeton Univ.*, \$27.95



Some Assembly Required

Neil Shubin

For centuries, fossils were the main clues to past life. But as a paleontologist explains, advances in genetics

over the last few decades have helped fill in new details about how life has evolved over the eons (*SN*: 3/28/20, p. 28). *Pantheon*, \$26.95

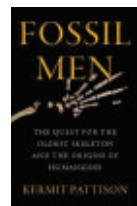


Great Adaptations

Kenneth Catania

From offering his arm to an electric eel to setting up a little fight club for wasps and cockroaches, a neurobiologist recounts

what his sometimes unconventional experiments have uncovered about some of the world's most remarkable creatures (*SN*: 10/10/20 & 10/24/20, p. 34). *Princeton Univ.*, \$27.95



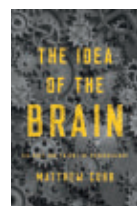
Fossil Men

Kermit Pattison

A journalist documents the intriguing backstory of one of the most significant, and controversial, discoveries in the field of

paleoanthropology: the unearthing of the 4.4-million-year-old hominid skeleton known as Ardi in the 1990s. The book also describes how the fossil's physical features challenged traditional ideas about how hominids evolved (*SN*: 11/21/20, p. 28).

William Morrow, \$32.50



The Idea of the Brain

Matthew Cobb

The human brain has been compared to plumbing pipes, telegraph wires and computers. By learning

how these concepts of the brain have changed over time, readers get a sense of how scientists came to understand the organ — and how much about the brain remains a mystery (*SN*: 4/25/20, p. 28). *Basic Books*, \$32

“This hearty graphic memoir is poised to inspire a new generation of naturalists.”

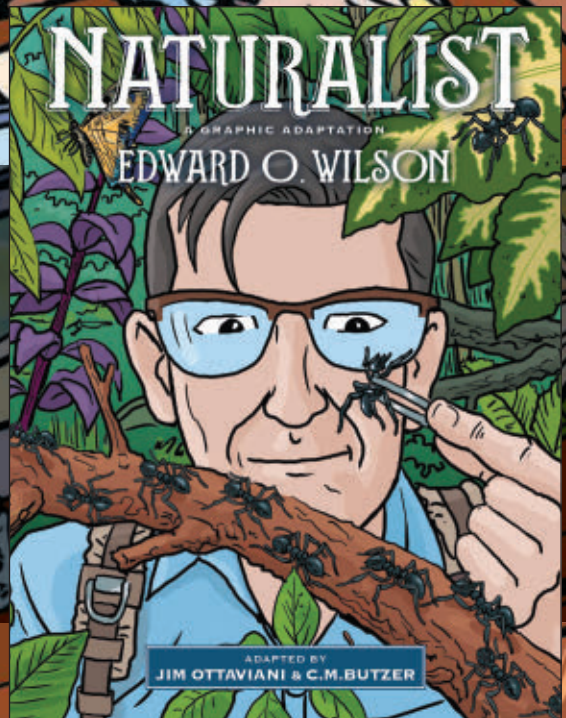
—*Publishers Weekly*

Naturalist A Graphic Adaptation

Edward O. Wilson

Adapted by Jim Ottaviani

Illustrated by C.M. Butzer



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2020 A Year Impacted by COVID-19

During the unprecedented time of the COVID-19 pandemic, the Society for Science & the Public has found ways to continue supporting STEM education.



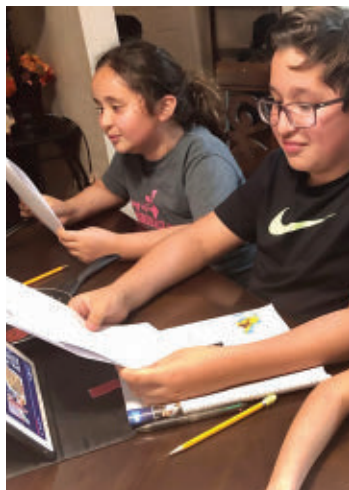
Science Research Competitions Go Virtual

In May, as much of the world was in lockdown, the Society was thrilled to bring the science fair community together for the virtual Regeneron International Science and Engineering Fair, with more than 18,500 registrants from 131 countries, regions and territories joining us. In the summer, Lillian Kay Petersen (shown left) of Los Alamos, N.M., won the \$250,000 top award in the virtual Regeneron Science Talent Search, the nation's oldest and most prestigious science and math competition for high school seniors, by developing a simple tool for predicting harvests early in the growing season. In the fall, Ishana Kumar from Chappaqua, N.Y., won the \$25,000 Samuelli Foundation Prize, the top award in the virtual Broadcom MASTERS®, a nationwide STEM competition for middle school students, with her project investigating whether retinal fatigue changes our perception of "imaginary colors."

Expanded Access to Science News

In March, *Science News* became a completely remote newsroom and launched a digital coronavirus newsletter to keep readers informed as the public health crisis continued to unfold.

In response to schools closing, *Science News* offered new resources from *Science News for Students* and *Science News in High Schools* to students, parents and educators so they had what they needed for learning outside the classroom.



Supporting Our Teachers

Sixty-six STEM educators were named Advocates by the Society to help underserved students enter science competitions. The Society also hosted two virtual conferences for STEM educators. To meet the demands and overcome limitations of this unusual school year, the Society provided teachers across the country with kits to enable scientific research outside the classroom. The Society also developed a series of Research at Home web pages with resources and advice to help promote research outside the lab.

Get involved at www.societyforscience.org



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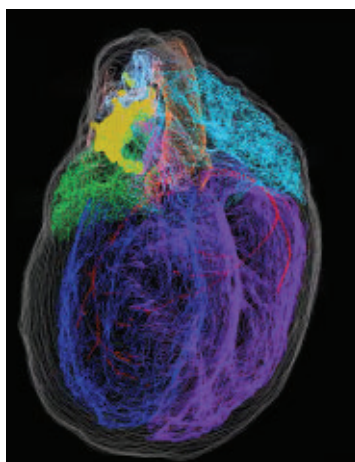
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Online favorites of 2020

Science News drew over 22 million visitors to our website this year. Our COVID-19 coverage was most popular (see opposite page). Here's a recap of the other most-read news stories and long reads of 2020.

Favorite visualization

"A new 3-D map illuminates the 'little brain' within the heart" (SN: 8/1/20, p. 32) enthralled online readers. An unprecedented view of the heart's nerve cell cluster (yellow in a reconstructed rat heart, below) could help scientists better understand what those cells do and perhaps lead to targeted therapies for heart diseases.



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Top news stories

1 In a first, a person's immune system fought HIV — and won
Scientists analyzed billions of cells from two people with HIV who don't require medication to keep the virus under control. What the team found was astonishing: One person had no working copies of HIV in any of the cells, while the other person had just one working copy. What's more, that one copy was imprisoned in tightly wound DNA (see Page 38).

2 The first room-temperature superconductor has finally been found
Up to 15° Celsius, a material made of carbon, sulfur and hydrogen can conduct electricity without resistance. While the room-temperature superconductor works only at high pressures, the discovery brings scientists a step closer to realizing a more energy-efficient future (Page 34).

3 Astronomers have found the edge of the Milky Way at last
Computer simulations and observations of nearby galaxies have revealed that the Milky Way stretches 1.9 million light-years across. The measurement could help tease out how massive the galaxy is and exactly how many galaxies orbit it (Page 40).

4 More 'murder hornets' are turning up. Here's what you need to know
An invasion of Asian giant hornets into North America could spell trouble for honeybees. But the threat that the world's largest hornet species poses to people is minimal (Page 38).

5 A star orbiting the Milky Way's black hole validates Einstein
The odd orbit of a star around the supermassive black hole at the Milky Way's center confirms Albert Einstein's general theory of relativity. Rather than tracing out a single ellipse, the star's orbit rotates over time — the result of the black hole warping spacetime (SN Online: 4/16/20).

Top feature stories

1 After the Notre Dame fire, scientists get a glimpse at the cathedral's origins
A fire that ripped through Paris' Notre Dame cathedral in April 2019 gave scientists the opportunity to dig into the cathedral's history and study the building's materials, including to learn more about climate change (SN: 1/18/20, p. 24).

2 New fleets of private satellites are clogging the night sky
SpaceX and other private companies are planning to launch thousands of internet satellites into orbit around Earth. Hundreds of the satellites already in outer space are obstructing the view of ground-based telescopes and interfering with astronomers' research (Page 36).

3 It's time to stop debating how to teach kids to read and follow the evidence
Research has identified the most effective approaches for teaching children how to read. Those findings could help resolve a long-standing debate that pits phonics against methods that emphasize understanding the meaning of words (SN: 4/25/20, p. 22).

4 To fight discrimination, the U.S. census needs a different race question
The U.S. census has failed to accurately count certain minority groups. As a result, some sociologists are calling for more nuanced census questions that better reflect how respondents view themselves, as well as how society views them — a clearer metric for measuring discrimination (SN: 3/14/20, p. 16).

5 What lifestyle changes will shrink your carbon footprint the most?
Individual actions around shelter, transportation and food can create ripple effects in society to help mitigate the effects of climate change. But to have the most impact, people need to tailor their efforts to their own circumstances (SN: 5/9/20 & 5/23/20, p. 34).

Pandemic post

Science News has reported on the COVID-19 pandemic since it began, but none of those stories were included in our most-read lists of 2020. That's because we think the coverage is in a league of its own.

Stories about when, during an infection, the coronavirus is most contagious (*SN Online: 3/13/20*) and debunking the claim that the virus was made in a lab (*SN Online: 3/26/20*) are among our most-read stories of all time. Readers also were drawn to stories about how the coronavirus spreads (*SN: 8/15/20, p. 15*) and COVID-19 vaccines (*SN: 8/1/20, p. 6*).

As Feedback editor, I review every e-mail we receive from *Science News* readers. In 2020, more than a third of the thousands of e-mails that filled our inbox were about COVID-19. Hunger for information, for certainty in an uncertain time, has been insatiable.

We've strived to answer readers' pandemic-related questions accurately, given the rapid pace of scientific research into the coronavirus and its effects. Some of those questions have been featured in the pages of this magazine, as well as in the *Science News* Coronavirus Update newsletter — a weekly e-mail that highlights the latest research, data and articles on the coronavirus and COVID-19.

Everyone at *Science News* thanks you, our readers, for your sharp, insightful comments and your continued support. We look forward to answering your many science questions, coronavirus-related and not, in the year ahead.

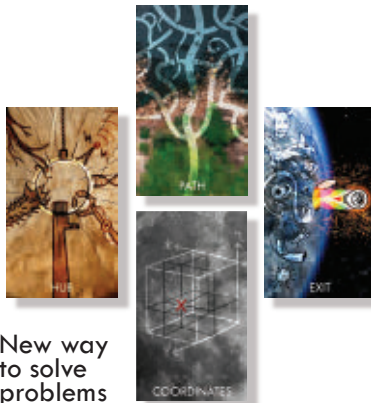
— Cassie Martin, Associate Editor

Correction

"Radiation measurement could help guide lengthy lunar missions" (*SN: 11/7/20, p. 5*) incorrectly stated that the average daily exposure to cosmic radiation on the moon is 1.5 million times as high as the average daily exposure on Earth. The average daily exposure on the moon is 1,500 times as high as the average daily exposure on Earth.

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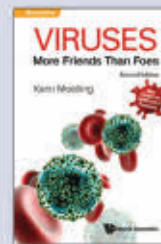
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Armored ants best bigger foes in battle

A leaf-cutting worker ant looks like it would be helpless against an enemy soldier ant that is many times its size. But the smaller ant has a secret: a body coated with a thin but tough layer of mineral armor.

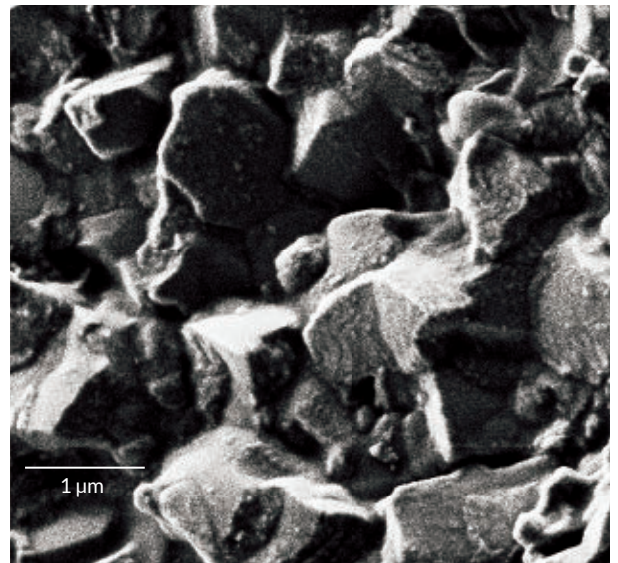
This is the first time that this type of external, whole-body mineralization has been found in an adult insect, researchers report November 24 in *Nature Communications*. Such mineral-based toughness is generally found in crabs and other crustaceans.

Evolutionary biologist Cameron Currie of the University of Wisconsin–Madison and colleagues first noticed a whitish sheen (visible in the microscope image above) on the exoskeletons of *Acromyrmex echinator* worker ants while researching the ants and their external microbes.

Chemical, X-ray and microscopic examinations revealed that the coating (closeup view shown at right, middle) is a thin layer of calcite containing high levels of magnesium. To see how protective the armor is, the researchers tested the hardness of the ant exoskeleton by poking armored and unarmored pieces until an indentation formed. Despite being a mere 7 percent of the overall thickness of the exoskeleton, the calcite coating at least doubles the exoskeleton's hardness, the team found.

In battles (one shown at right, bottom) between worker ants and a bigger soldier ant from a different species, *Atta cephalotes*, the armor tipped the scale in the workers' favor, the researchers say. Among ants raised not to produce armor, nearly all were killed by the soldier ant, while most of the armored ants survived.

— Christie Wilcox



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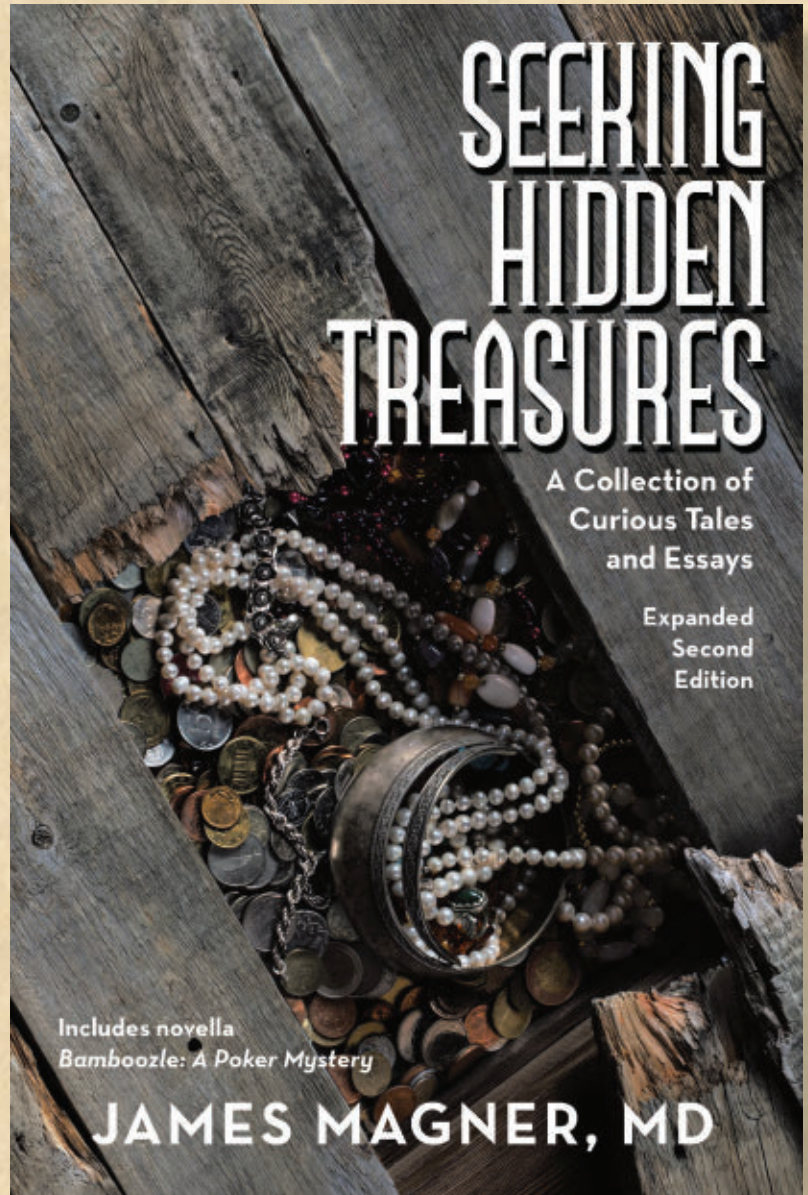
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