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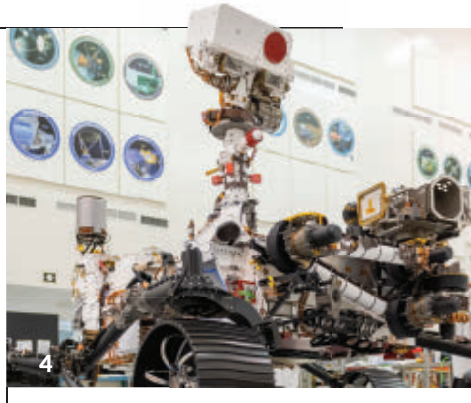
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Departments

COVER Last December, MOSAiC scientists drilled cores into an ice floe near the North Pole. *Alfred Wegener Inst., Esther Horvath (CC BY 4.0)*

FROM TOP: MAYUR KAKADE/GETTY IMAGES; JPL-CALTECH/NASA; J. BLOMSTER AND V.S. CHÁVEZ/*SCIENCE ADVANCES* 2020

Sticking to our mission: covering science writ large

A magazine cover featuring scientists on an expedition to the Arctic may seem like an odd choice when the world is in the throes of a pandemic. But while we all struggle to adapt to a frightening new reality, here at *Science News* we're continuing our mission to report on news across the sciences.

The SARS-CoV-2 coronavirus has suddenly overturned every corner of life. Our staff has decamped from our office to work from home, in an effort to practice social distancing and help slow the spread of the virus. Schools are closed; like so many people across the country, we're juggling child care, work and worry. We're scanning the internet for the latest news. And we're wondering what will happen next.

The pandemic has prompted huge changes in our newsroom, with almost everyone involved in some way. We've launched new ways to deliver the news, including our twice-weekly Coronavirus Update e-mail newsletter and home-learning resources at *Science News for Students*. We feel fortunate to have the scientific training and experience to be able to report accurately on the fast-moving science of the virus and efforts to tame it. Every day brings new research findings that add another piece to the puzzle and help counter an online miasma of misinformation. Often, we have to say that the science is unclear. But even knowing that helps as we all learn together.

While we're working flat out to cover the pandemic, we're also continuing to cover other developments in the sciences. It might not seem important right now to find out what astronomers are wondering about the sudden dimming of the star Betelgeuse (Page 6), or about an artificial intelligence system that detects odors by mimicking how mammals smell (Page 8), but science continues. And we all need to be able to take a break from pandemic news — a brief reminder of a wider world, and a respite.

But the new coronavirus manages to elbow its way into topics that seem very far removed. The two features in this issue, one on the MOSAiC expedition to the Arctic (Page 14) and another on experiments to design playgrounds that encourage physical activity (Page 20), didn't escape the virus's ghostly touch. One participant on the airborne part of the MOSAiC expedition was infected with the coronavirus, forcing the cancellation of research flights, and some areas have asked that children avoid play equipment in order to reduce transmission. It turns out that while children and teenagers are less likely to become seriously ill with COVID-19, they can easily spread the virus to others.

For the latest news on the science of the coronavirus outbreak, plus news on physics, astronomy, climate change, artificial intelligence, paleontology and other fields of science, visit sciencenews.org. E-mail us questions at feedback@sciencenews.org. As the pandemic continues, we will answer a selection of your questions in our newsletter and on our Feedback page. In this issue, we look at how the coronavirus stacks up against the flu and whether there are really two strains of the coronavirus circulating (Page 30).

We may no longer be in the office, but we're still hard at work for you.

— Nancy Shute, Editor in Chief

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Editorial/Letters: feedback@sciencenews.org
***Science News* in High Schools:** snhs@societyforscience.org
Advertising/Sponsor content: ads@societyforscience.org
Science News (ISSN 0036-8423) is published 22 times a year with double issues in May, July, October and December by the Society for Science and the Public, 1719 N Street, NW, Washington, DC 20036.
Print, online and tablet access: Activate your subscribing member account, including digital access, at www.sciencenews.org/activate
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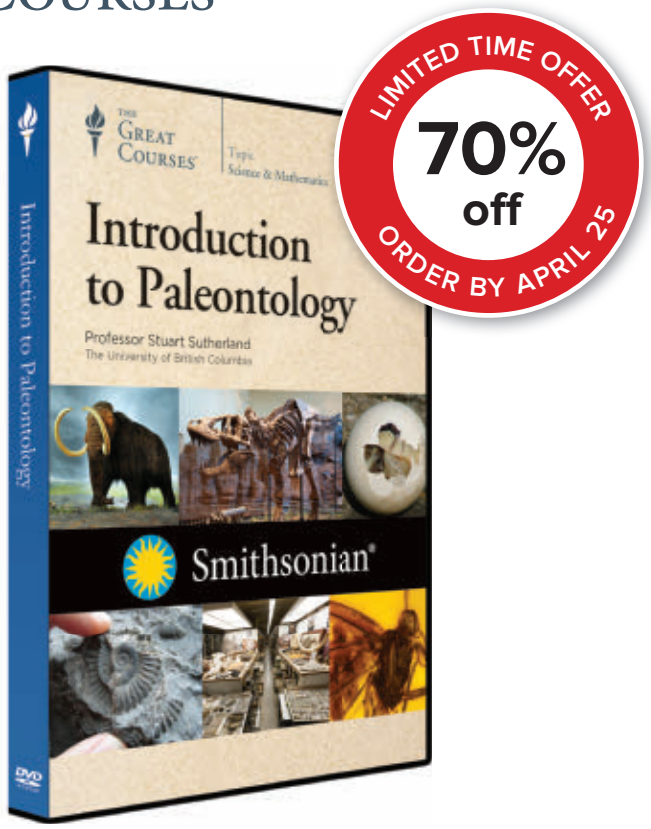

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Excerpt from the April 11, 1970 issue of *Science News*

50 YEARS AGO

Water pollution

A new water pollution control bill that provides clear assignments of liability without proof of negligence to the source of an oil spill was signed into law by President [Richard] Nixon last week.... It would add pesticide levels to the factors involved in formulating all new water quality criteria.

UPDATE: That bill laid the foundations for the Clean Water Act of 1972, establishing U.S. regulations for releasing pollutants into navigable waters. While the law protects "waters of the United States," the definition of what "waters" meant remained vague until a 2015 regulation defined eight categories of protected waters, which included headwater streams, lakes and wetlands. President Donald Trump's administration revised that definition in 2020 to exclude groundwater and some streams. The change also reduces the number of protected wetlands by roughly half.

A hummingbird-sized predatory bird is the smallest known dinosaur to live during the Mesozoic Era, between 252 million and 66 million years ago.

THE –EST

This ancient dinosaur was no bigger than a hummingbird

A tiny, toothed bird that lived 99 million years ago is the smallest known dinosaur from the Mesozoic, the era that lasted from about 252 million to 66 million years ago. The creature's 14.25-millimeter-long skull was encased in a chunk of amber found in northern Myanmar, researchers report in the March 12 *Nature*.

Oculudentavis khaungraae was similar in size to the smallest modern bird, the bee hummingbird. Three-dimensional images of the skull reveal a surprising number of teeth, suggesting the ancient bird was a predator. It might have dined on small fish or invertebrates such as arthropods.

The bird had deep, conical eye sockets, similar to those of modern owls. A deep socket can increase the eye's visual ability without increasing eye diameter. The trait suggests the tiny bird had sharp eyesight. But while owls' eyes face forward, increasing their depth perception, the eyes of the tiny bird faced out to the side.

Evolutionary miniaturization, whereby animals evolve smaller adult body sizes, may explain some of the bird's odd traits, such as its side-facing deep eye sockets and fused jaw. But understanding the species' evolutionary significance requires figuring out where it belongs on the tree of life. The bird's odd features may make that tough. — *Carolyn Gramling*

HOW BIZARRE

Heavy metal may rain from the sky of an exoplanet

On one distant world, "heavy metal" could be a weather forecast. Telescope observations indicate that an exoplanet nearly 640 light-years from Earth has iron rain.

The planet, WASP 76b, is an ultrahot gas giant. Such worlds get blasted with so much stellar radiation that their dayside temperatures rival that of some stars, while the nightsides tend to be much milder. No one had gotten a good enough look at an ultrahot gas giant to see how the temperature contrasts affect the chemistry across its atmosphere. Now, researchers using the Very Large Telescope in Chile have detected chemical components in WASP 76b's atmosphere by examining starlight filtering through the atmosphere as the exoplanet passed in front of its sun during two orbits in 2018.

While the atmosphere showed traces of iron gas where the planet was transitioning toward nighttime, no iron was detected at the transition from night to day, the researchers report online March 11 in *Nature*. This suggests that as gaseous iron on WASP 76b's dayside swirls toward the nightside — which is almost 1,000 degrees Celsius cooler — the iron condenses into raindrops. And those raindrops fall deep into the atmosphere overnight, so astronomers don't see the iron gas where the planet moves from night to day. With no solid ground on the gaseous planet, the researchers suspect the iron raindrops eventually reach depths so hot the drops vaporize back into iron gas. — *Maria Temming*

HAN ZHIXIN

SOAPBOX

New electrode works better with curly hair

Snugged up against the scalp, electrodes eavesdrop on a brain's electrical activity. But the signals can weaken when electrodes can't get close enough to the scalps of people with very curly hair.

This design flaw can end up excluding people with this type of hair, including many people of African descent, from studies, says Pulkit Grover, an engineer at Carnegie Mellon University in Pittsburgh. Leaving out whole populations also has clinical implications.

Electroencephalograms, or EEGs, which rely on arrays of scalp electrodes to record brain activity, are common clinical tests used to diagnose diseases such as epilepsy. If the electrodes don't work well, diagnoses are harder to make.

"It's not intentional. But at the same time, it's kind of sad," Grover says. "It's worth thinking about technology, and about who it has been designed for."

When undergraduate student Arnelle Etienne joined Grover's lab, she combed through the scientific research on EEG technology. "I noticed that a lot of the current solutions wouldn't work for my hair type," says Etienne, who is black.

EEG technicians try to make the equipment work, sometimes asking patients to straighten their hair before tests, Etienne says. Those work-arounds aren't ideal, especially if EEG tests are needed quickly. "Some people have been asked to shave parts of their hair," she says. "Luckily, that's not as frequent, but it was shocking to hear."

A team including Grover, Etienne and undergraduate student Tarana Laroia measured how much coarse, curly hair interfered with measuring brain signals. Standard electrodes placed on loose, curly hair created high impedance, a measurement of resistance to the electrical current.

Generally, a good EEG signal has less than 50 kilo-ohms of impedance; unbraided, curly hair with standard electrodes yielded 615 kilo-ohms.

For a closer connection with the scalp, braiders created braids that exposed study participants' scalps in strategic spots. The researchers also developed flexible electrode clips, shaped like dragonfly wings, designed to push under the flanking braids. Etienne, whose father is Haitian, and her colleagues call the electrode "sevo," after the Haitian Creole word for "brain."

Anchored by the braids, the clips moved the electrodes closer to the scalp and resulted in impedance measurements of 22.6 kilo-ohms in tests on eight participants, the researchers reported February 27 at bioRxiv.org. That was well within the range for a reliable EEG measurement.

New electrodes that clip underneath braided hair can improve brain signal detection in electroencephalograms.

The electrode issue "doesn't require the deepest, most amazing science to get a solution," Grover says. "It requires a good integration with the culture and the understanding of the clinical environment." —*Laura Sanders*

FROM TOP: A. ETIENNE *ET AL*/BIORXIV.ORG 2020; JPL-CALTECH/NASA

NAME GAME

NASA's newest Mars rover gets a name

Meet Perseverance, NASA's next ambassador to the Red Planet.

The Mars rover's new name was announced March 5, after a six-month "Name the Rover" essay competition that drew more than 28,000 entries from students in kindergarten through high school.

The winning entry came from seventh-grader Alex Mather at Lake Braddock Secondary School in Burke, Va. "We are a species of explorers, and we will meet many setbacks on the way to Mars. However, we can persevere," Mather read from his essay during a naming event broadcast from his school. His prize? An invitation to watch the rover's scheduled launch in July in Cape Canaveral, Fla.

Some 4,700 volunteer judges (including this reporter) whittled the entries down to 155, with NASA selecting the winner.

The six-wheeled vehicle (left), formerly known as Mars 2020, will land in a dry river delta in Jezero crater in February 2021. During its nearly two-year mission, Perseverance will seek signs of ancient life and store Martian dirt and rock until a future mission can collect the samples and bring them to Earth. —*Lisa Grossman*

ATOM & COSMOS

Betelgeuse is not about to explode

Puffs of dust could account for the star's recent dimming

BY LISA GROSSMAN

Betelgeuse, one of the brightest stars in the sky, suddenly faded in late 2019, startling astronomers and prompting speculation that the star was about to explode.

But by the end of February, Betelgeuse had started to brighten again, quashing rumors of its demise. Now a study suggests that the dimming was due to dust recently shed by the star.

"I think some people wanted this to be seen as the death throes of the star, and it's very much not," says astronomer Emily Levesque of the University of Washington in Seattle.

Betelgeuse, a type of massive, aging star called a red supergiant, lies about 700 light-years from Earth and marks the shoulder of the constellation Orion. Astronomers have known for decades that at some point, possibly soon, the star is going to run out of fuel and detonate in a brilliant supernova (*SN: 2/18/17, p. 24*).

So when the star began dimming in October 2019, astronomers took notice. By December 23, it had slipped from the sixth or seventh brightest star in the sky to the 21st. That didn't necessarily mean an explosion was imminent, but any strange behavior in a red supergiant is worth watching, Levesque says.

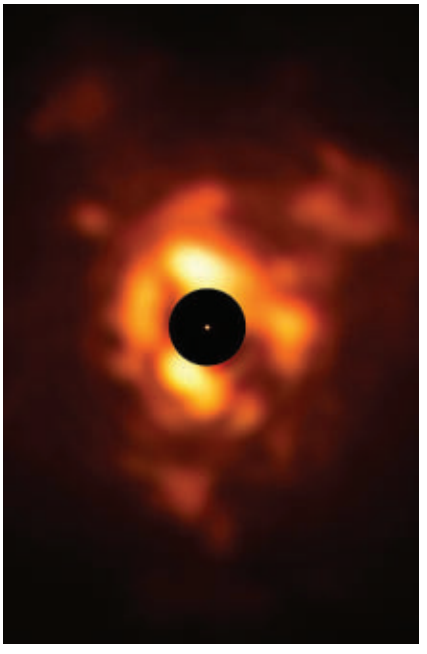
"When people think about stars that are visible in our sky that could explode soon, Betelgeuse is near the top of the list," she says. "So when people said this star is doing something weird, it caught people's attention."

Levesque and astronomer Philip Massey of the Lowell Observatory in Flagstaff, Ariz., decided to see if more mundane possibilities could explain the dimming, rather than an imminent supernova. Those options include the star's surface cooling suddenly, as boiling blobs of plasma rise and sink within it, or a cloud of dust puffing off the star, temporarily obscuring starlight and making Betelgeuse appear dimmer than it is.

Using a Lowell Observatory telescope, Levesque and Massey observed the star on February 14, when it was nearly at its dimmest. The pair looked for signs of titanium oxide molecules in Betelgeuse's outer layers, a clue to the star's temperature. Comparing those observations with similar ones that Levesque had taken in 2004 showed that the temperature had dropped by about a measly 50 degrees Celsius.

"To our surprise, Betelgeuse didn't look that different," Levesque says. "The temperature couldn't explain how much dimmer Betelgeuse had gotten in the last few months."

So the dust explanation is more likely, the scientists argue in a study to appear in the *Astrophysical Journal Letters*. "It's partly process of elimination," Levesque says. Red supergiants like Betelgeuse are known to puff out clouds of gas that condense into dust. And the star dimmed uniformly over all wavelengths of light that Levesque and Massey measured, which supports the idea that dust from the star is to blame. By contrast, dust that lies in the spaces between stars would block certain wavelengths of light more than others.



This infrared image of Betelgeuse (orange dot), taken in December 2019, shows dust around the star (the added black disk blocks most of the starlight so the dust can be seen). That dust may explain why Betelgeuse recently dimmed.

ESO, P. KERVELLA, M. MONTARGÈS *ET AL*, ERIC PANTIN

The study "is a first step to a better understanding of what is happening to Betelgeuse," says astrophysicist Miguel Montargès of KU Leuven in Belgium.

Montargès and colleagues have observed Betelgeuse with the Very Large Telescope in Chile. The star looked markedly dimmer in December 2019 than it did when the telescope observed Betelgeuse in January 2019, before the fade-out began. But the dimming seemed to appear only in the star's southern hemisphere, not uniformly across Betelgeuse, according to an image the team released February 14, 2020. That could be explained by an asymmetrical dust cloud, though the situation may be more complicated. Montargès' team observed Betelgeuse again on March 18 and plans to release the results in the future.

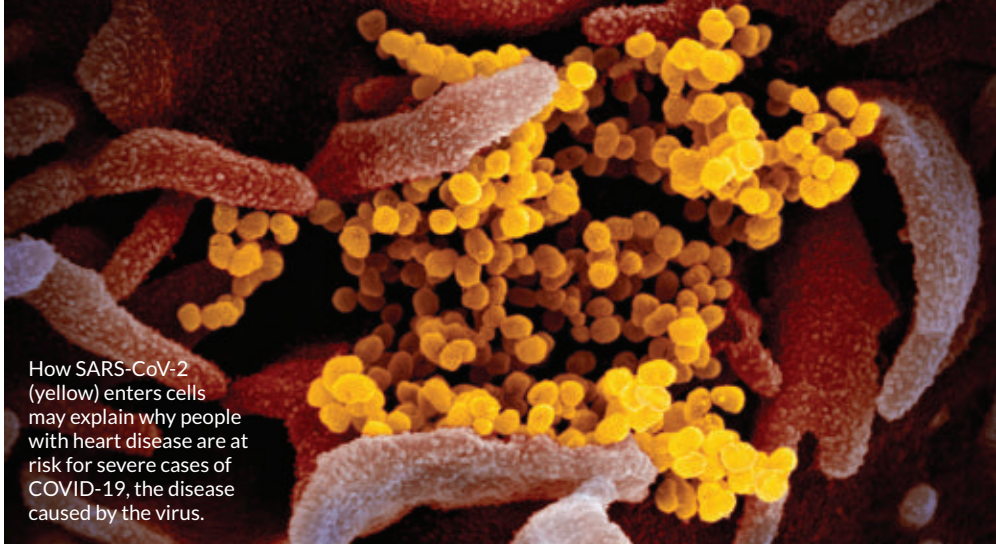
If the dimming is due to dust, that will give astronomers an opportunity to watch a nearby star losing mass in real time. "There's that famous quote, 'We are stardust,' " Montargès says, paraphrasing a line spoken by astrophysicist Carl Sagan. "Perhaps the atoms we are looking at will one day be part of a planet, and perhaps sentient beings. That's why it's really exciting."

Other astronomers are holding out for more information. "The dust model is viable, but it also doesn't rule out changes in the star itself," says Edward Guinan of Villanova University in Pennsylvania, who has been observing Betelgeuse since last fall. Betelgeuse naturally dims and brightens on a roughly 425-day cycle, and although the dimming is not usually this extreme, it could still be nothing out of the ordinary, Guinan says. "I think the jury is still out." ■

BODY & BRAIN

Why COVID-19 is bad for the heart

People with heart disease are at risk for serious infections



How SARS-CoV-2 (yellow) enters cells may explain why people with heart disease are at risk for severe cases of COVID-19, the disease caused by the virus.

RML/NIAID/FLICKR (CC BY 2.0)

BY AIMEE CUNNINGHAM

As researchers examine deaths from COVID-19, heart patients appear especially vulnerable.

In Italy, which has been especially hard hit, public health officials said March 17 that among 355 people who died, 76 percent had hypertension and 33 percent had heart disease. Among over 44,000 confirmed COVID-19 cases in China, the case fatality rate for people with underlying conditions was highest for those with cardiovascular disease, at 10.5 percent. The overall fatality rate was 2.3 percent.

Infections can take a toll on people who have other health problems. But SARS-CoV-2, the virus that causes COVID-19, may pose particular danger to the heart because of how the virus gets into cells, researchers speculate.

To invade a cell, the virus latches onto a protein called angiotensin-converting enzyme 2, or ACE2. This protein is found on lung cells, allowing the virus to invade the cells and cause respiratory symptoms. But ACE2 also is on heart muscle cells and cells that line blood vessels.

With the involvement of ACE2, COVID-19 may damage the heart directly, researchers wrote March 5 in a commentary in *Nature Reviews Cardiology*. The commentary described COVID-19 patients who have developed myocardial injury, the death of heart cells for reasons other than a heart attack. Nearly 20 percent of 416 patients hospitalized with COVID-19 in Wuhan, China, had evidence of heart damage, other researchers reported March 25 in *JAMA Cardiology*.

But ACE2 does more than offer the virus an entry point. The protein is also part of a system of hormones, called the renin angiotensin aldosterone system, that regulates blood pressure and cardiovascular and kidney function. Drugs that target other proteins in this system are widely prescribed to lower blood pressure in people with hypertension and cardiovascular disease.

Two classes of these drugs are suspected of playing a part in disease severity. ACE inhibitors block ACE proteins, which are different than ACE2 proteins. The aim is to stop ACE from helping to make angiotensin II protein, which raises blood pressure in arteries. Angiotensin II receptor blockers, or ARBs, stop angiotensin II from functioning.

Some evidence in animals suggests that these drugs can lead to more ACE2 protein on heart cells. But there haven't been studies showing this in people, or studies in the context of COVID-19. Nor have there been reports describing the types of medications that patients who've had severe COVID-19 infections were taking.

But the animal evidence has led some to wonder if ACE inhibitors and ARBs can increase the risk of severe disease. "If you look at the mechanistic rationale for concern ... it's there," though it's "an extrapolation," Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases in Bethesda, Md., said March 18 in a webcast interview with the editor in chief of *JAMA*. "We really need to get data, and we need to get data fast."

As of March 25, when this magazine went to press, the American College of Cardiology, the American Heart Association and the Heart Failure Society of America advised people with hypertension, cardiovascular disease or heart failure to keep taking the drugs. For those who develop COVID-19, the condition of the individual patient should be considered to determine whether it's necessary to stop the drugs, the groups recommended in a March 17 statement.

Besides the possibility that the virus targets the heart itself, researchers have evidence that the body's response to infections can put the heart in danger, especially for those with underlying medical conditions. For example, having the flu can increase the risk of a heart attack, a 2018 study in the *New England Journal of Medicine* found.

"Respiratory infections in general have the potential to increase the workload that the heart is under," says cardiologist Scott Solomon of Brigham and Women's Hospital and Harvard Medical School in Boston. "That means that your heart's going to need more oxygen." As flu and COVID-19 can interfere with the lungs' ability to deliver oxygen, "that can put an additional strain on the heart," he says.

An infection also stresses other parts of the cardiovascular system, notably where arteries are narrowed by plaques. As the body's immune system fights the virus, "inflammation can cause a plaque rupture," says preventive cardiologist Erin Michos of the Johns Hopkins University School of Medicine. That rupture induces blood clotting that can block an artery and lead to a heart attack.

"The question is, why is the heart getting weak" during a COVID-19 infection? Michos says. She recommends that her patients take seriously the recommendations to wash hands and to practice social distancing. "I am telling them to stay home if they can," she says. "I'm very concerned for everybody, but particularly for my cardiac patients." ■

BODY & BRAIN

Transplant science learns from cancer

Rat immune system is tricked into ignoring donor tissue

BY ERIN GARCIA DE JESUS

To help rats accept transplanted limbs as their own, researchers have harnessed a ruse that cancer cells use to hide from the immune system — effectively reprogramming the animals' defenses to ignore foreign tissue.

Rats injected with engineered microparticles tolerated a hind limb transplant from another type of rat for more than 200 days, even in the absence of drugs that suppress immune responses, researchers report March 13 in *Science Advances*.

When injected into the transplanted tissue, the microparticles released a protein known as CCL22, which is secreted from cancer cells and attracts specialized immune cells. These cells, regulatory T cells, marked the rat's new tissue as "self," protecting it from an onslaught of immune defenses that normally attack foreign material.

White Lewis rats that got donor legs (one shown) from brown Norway rats tolerated the transplant thanks to a treatment that helped hide the leg tissue from the immune system.

The microparticle treatment is "fundamentally different than anything that is used right now in clinical medicine simply because it doesn't suppress the animal's immune system," says James Fisher, a bioengineer at the University of Pittsburgh.

Patients who receive donor organs or tissue typically spend the rest of their lives taking immunosuppressants. Without these drugs, the immune system would attack and reject the donor tissue, unless it is a perfect genetic match.

But long-term use of immunosuppressive drugs can put patients at risk for infectious diseases or cancer.

Steven Little, a chemical engineer at the University of Pittsburgh, says he was inspired by therapies designed to block cancer's strategies for concealment. "The thought came into my head: I wonder if we were able to synthetically mimic [what cancer cells do], could we trick the body into accepting a transplant?"

Little, Fisher and colleagues transplanted hind limbs from brown Norway rats onto white Lewis rats and injected CCL22-releasing microparticles into the new legs. The team then monitored how long the rats tolerated the appendage without immunosuppressive drugs.

Most rats treated with microparticles maintained healthy limbs; all the rats that didn't get the treatment rejected the transplant. In treated rats, regulatory T cells migrated to the transplant site and appeared to decrease inflammation.

A rat's tolerance for additional new tissue was specific to the original donor.

MATH & TECHNOLOGY

Algorithm mimics how mammals smell

This type of artificial intelligence could help monitor air quality

BY MARIA TEMMING

When it comes to identifying scents, a "neuromorphic" artificial intelligence beats other AI by more than a nose.

The new AI learns to recognize smells more efficiently and reliably than other algorithms. And unlike other AI, this system can keep learning new aromas without forgetting others, researchers report in the March *Nature Machine Intelligence*. The key to success is the program's neuromorphic structure, which resembles the neural circuitry in mammalian brains more than other AI designs.

This kind of algorithm, which excels at detecting faint signals amid background noise and at learning on the job, could help with air quality monitoring, toxic waste detection or medical diagnoses.

The AI is an artificial neural network, composed of many computing elements that mimic nerve cells to process scent information. The AI "sniffs" by taking in electrical voltage readouts from chemical sensors that were exposed to plumes of different scents, such as methane or ammonia, in a wind tunnel. The whiff of a new smell triggers a cascade of electrical activity among the artificial nerve cells, or neurons, which the system remembers and can recognize in the future.

Like the olfactory system in the mammal brain, some of the AI's neurons react to chemical inputs by emitting differently timed pulses. Others learn to recognize patterns in those blips that make up the odor's electrical signature.

This brain-inspired setup better primes the neuromorphic AI for learning new smells than a traditional artificial neural network, which starts as a uniform web of identical, blank slate neurons. If a neuromorphic neural network is like a sports team whose players have assigned positions and know the rules of the game, an ordinary neural network is initially like a bunch of random newbies.

Thomas Cleland of Cornell University and Nabil Imam of Intel in San Francisco pitted their neuromorphic AI against a traditional neural network in a test of 10 odors. To train, the neuromorphic system sniffed a single sample of each odor. The traditional AI underwent hundreds of trials to learn each odor. During the test, each AI sniffed samples in which a learned smell made up only 20 to 80 percent of the overall scent, mimicking real-world conditions where target smells are often intermingled with other aromas. The neuromorphic AI identified the right smell 92 percent of the time; the standard AI, 52 percent of the time.

Priyadarshini Panda, a neuromorphic

UPMC

When the researchers grafted skin from a third type of rat onto animals that had received a new limb — but didn't inject the animals with microparticles to train the immune system to accept the new donor tissue — the new skin was rejected and sloughed off. But skin grafted from another Lewis rat or a brown Norway rat healed and eventually grew hair.

Skin has a lot of immune cells ready to attack invaders or heal injuries, which poses a problem for successful transplants. "Anytime you throw skin into the mix, it makes things all the more difficult," Fisher says. Since the rats could tolerate some types of skin, the rats may also be able to accept any other type of tissue.

It's exciting to see that the rodents in the study could retain transplanted tissue, says transplant immunologist Anita Chong of the University of Chicago. Some details of the mechanism are still unclear, so the technique "is far, far away" from being used in humans, she says.

The researchers next plan to try the technique in pigs — an animal that shares many physiological traits with humans. ■

engineer at Yale University, is impressed by the neuromorphic AI's keen sense of smell in muddled samples. The new AI's learning strategy is also more energy-efficient than typical AI systems, which "tend to be very power hungry," she says.

Another perk: The AI can keep learning new smells after its original training if new neurons are added. It's a different story for traditional AI, where the neural connections for recognizing a certain odor, or set of odors, are more broadly distributed across the network. Adding a new smell is liable to disturb those connections, so a typical AI struggles to learn new scents without forgetting others, unless it's retrained from scratch.

Continual learning seems to work well for the neuromorphic system when there are few scents involved, Panda says. "But what if you make it large-scale?" In the future, researchers could test whether this neuromorphic system can learn a much broader array of scents. But "this is a good start," she says. ■

HUMANS & SOCIETY

Ancient ball courts found in Mexico

Discovery offers clues to where a Maya and Aztec game began

BY BRUCE BOWER

An ancient ball court in the mountains of southern Mexico has scored surprising insights into a game that played a big role in Maya and Aztec societies.

Excavations at a site called Etlatongo revealed the roughly 3,400-year-old ball court, the second oldest of its kind yet found. The discovery shows that at a time when societies in Mexico and Central America, a region known as Mesoamerica, were growing larger and more politically complex, population centers in the mountains contributed to ball court design, and possibly to rules of the game, researchers report March 13 in *Science Advances*.

The new find "shows that some of the earliest villages and towns in highland Mexico were playing a game comparable to the most prestigious version of the sport known as *ullamaliztli* some three millennia later by the Aztecs," says Boston University archaeologist David Carballo. Until now, most evidence pointed to coastal settlements in southern Mexico's Gulf and Pacific lowlands as the developers of a game that assumed ritual and political importance.

More than 2,300 probable ball courts have been found at Mesoamerican sites. Many come from centers dating to between about 1,800 and 1,100 years ago during the Classic Period of the Maya empire, as well as from the Aztec empire, which lasted from about 675 to 500 years ago.

Spectators at Aztec games sometimes watched tense contests between teams from rival kingdoms, as well as games punctuated by human sacrifices.

Anthropological archaeologists Jeffrey Blomster and Victor Salazar Chávez, both of George Washington University in Washington, D.C., found two ball courts during excavations from 2015 through 2017. Radiocarbon dating places the older ball court at about 1374 B.C. That estimate pushes the appearance of ball courts in the Mexican highlands back by about 800 years.

The second, larger ball court dates to about 1200 B.C. Between 1174 B.C. and 1102 B.C., that ball court was burned and taken out of use, Blomster says. Excavated remnants of a ceremonial burning there include pieces of at least 14 ceramic ballplayer figurines.

Some figurines depict Olmec-style attire, such as thick belts, loincloths and chest plates. More than 3,000-year-old art from the Olmec, a Gulf coast society, shows ballplayers, but no courts have been definitively identified at Olmec sites. The oldest known ball court is at a roughly 3,650-year-old Pacific coast site.

While the Olmec may have influenced how ballplayers were portrayed at Etlatongo, ball courts originated outside the Gulf coast, Blomster suspects. ■

Partial ballplayer figurines such as this one (shown from the front and side) were unearthed at an archaeological site in southern Mexico.

J. BLOMSTER AND V.S. CHÁVEZ/*SCIENCE ADVANCES* 2020

Vertebrate paleontologist Daniel Field holds a 3-D printed skull of *Asteriornis maastrichtensis*, a bird that lived 66.7 million years ago.

D.J. FIELD/UNIV. OF CAMBRIDGE

LIFE & EVOLUTION

Earliest known modern bird unearthed

Close relative of chickens and ducks lived 66.7 million years ago

BY CAROLYN GRAMLING

Behold the Wonderchicken, the earliest modern bird ever found.

Asteriornis maastrichtensis lived 66.7 million years ago, less than a million years before the asteroid impact that doomed all nonavian dinosaurs. The winged and beaked descendants of this roughly quail-sized bird, however, survived that mass extinction event, forming a long lineage that includes modern chickens and ducks.

Based on analyses of fossil remains, which consist of a nearly complete skull and a few limb bones, the bird is closely related to the most recent common ancestor of land fowl and waterfowl, researchers report in the March 19 *Nature*.

A. maastrichtensis' skull is "a never previously seen mash-up of ducklike and chickenlike features," says Daniel Field, a vertebrate paleontologist at the University of Cambridge. "It's like a turducken."

Previous estimates, based on molecular analyses of living bird groups, had suggested that modern birds evolved before the mass extinction event roughly 66 million years ago. But these are the first fossils to definitively place a modern ancestor on the scene. The age of the fossils, in fact, suggests that those previous estimates, ranging from 139 million to 89 million years ago, might have overestimated how early these birds arose, vertebrate paleontologist Kevin Padian of the University of California, Berkeley wrote in a commentary in the same issue of *Nature*.

Modern-type birds share several key traits, such as toothless beaks and fused foot bones. The almost 11,000 living bird species — divided among the paleognaths (flightless birds such as ostriches), anseriformes (waterfowl), galliformes (land fowl) and neoaves (the remaining 95 percent of living bird species) — all share a common ancestor, Field says. "We think that ancestor lived at some time before the end of the Age of Dinosaurs." But there are very few bird fossils surviving from before the asteroid impact.

The new fossils were discovered in Belgium, in a small rock made of hardened marine sediments. The rock looked like nothing special from the outside, Field says, just "a few broken bird limb bones poking out." But any bird bones dating to just before the mass extinction event are intriguing.

So Field and colleagues used computed tomography, a kind of X-ray scanning, to peer inside the rock. And that's when they saw the skull. They knew right away they had something special. "The timeline was: See the skull, scream 'Holy shit,' give my Ph.D. student a high five, and then start calling it the Wonderchicken."

The front part of the skull is chickenlike, including the nasal bone that formed part of the nostril, helping to shape the beak. "A barnyard chicken will eat anything you put in front of it," Field says, and that's reflected in the chicken's nonspecialized beak shape. That's in contrast to birds that have beaks clearly specialized for particular diets — think the tearing bill of a raptor or the long slender sipping beak of a hummingbird.

The generalized beak shape suggests that, like chickens, the ancient bird was also not a picky eater. And that may have been a crucial trait, Field says. "An unspecialized diet is the kind of feature that might have helped animals like the Wonderchicken survive" after the asteroid impact.

But part of the skull is more characteristic of waterfowl like ducks. Those features include a distinctive bone that goes from the back of the skull to the base of the eye socket and a hooked bone at the back of the jaw. Analyses of the limb bones, meanwhile, suggest that *A. maastrichtensis* had fairly long legs. The fact that the rock containing the fossils consists of marine sediments suggests that the bird was a shorebird.

"This is one of the most important bird fossils that has been found in quite some time," says Stephen Brusatte, a vertebrate paleontologist at the University of Edinburgh. "It raises the intriguing possibility that small size and a shoreline habitat may have helped these birds survive the end-Cretaceous extinction," when so many other, larger dinosaurs did not. ■

EARTH & ENVIRONMENT

Hurricane Maria's rain felled trees

Surprisingly, wind wasn't the main threat to Puerto Rican forests

BY MARIA TEMMING

Wind may be the usual suspect for knocking down trees during hurricanes, but a survey of forest damage in Puerto Rico after back-to-back hurricanes highlights the power of a strong downpour.

When Hurricane Irma passed by Puerto Rico in 2017, the storm brought heavy rains but little forest damage. Hurricane Maria, which struck two weeks later, was a different story. The strongest hurricane to make direct landfall in Puerto Rico in almost a century, Maria brought wind speeds over 200 kilometers per hour and dropped nearly 1.5 meters of rain in two days on some areas.

Using satellite images and ground observations at 25 forest plots across Puerto Rico, scientists determined that roughly 10.44 million metric tons, or about 23 percent, of Puerto Rico's forest biomass was ruined during the storms. Comparing the fraction of forest lost in different places against other local factors, such as wind and rain exposure, revealed that severe damage was more closely linked to heavy rains than to strong winds during Maria, researchers report March 9 in *Scientific Reports*.

"It wasn't something that I was expecting," says ecologist María Uriarte of Columbia University. Hurricane Maria's rainfall toppled trees by pressing down on tree canopies while loosening soil, Uriarte and colleagues suggest. Badly damaged areas tended to be places with soil that could hold a lot of water and that Irma had hammered with heavy rains. Because those waterlogged areas had their soils already loosened by Irma, they may have been primed to suffer worse damage from Maria.

The findings suggest that tools for forecasting tropical storm impacts may need to give more weight to rainfall, says Weimin Xi, an ecologist at Texas A&M University–Kingsville. This may be especially important as the warming climate is expected to brew hurricanes with stronger winds and heavier rains.

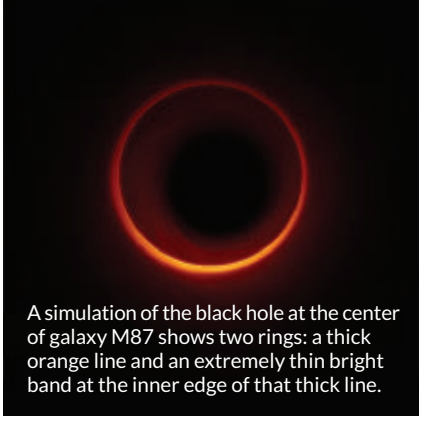
Future strong hurricanes might have other unexpected consequences. In a 2019 study in *Nature Communications*, Uriarte's team inspected tree damage in northeastern Puerto Rico after Hurricane Hugo, a Category 3 storm in 1989, and again after Maria, nearly a Category 5 while over Puerto Rico. Larger trees with dense wood proved more resistant to breakage during Hugo, but these species were not more resilient than more flexible trees, such as palms, during Maria.

If Maria-caliber storms become more common, trees that fared well during middling hurricanes of the past may be more vulnerable. That could release more carbon into the air as larger felled trees decompose and could shrink habitats. ■

ATOM & COSMOS

How to find a black hole's 'photon ring'

Space telescopes could help confirm an Einstein prediction



A simulation of the black hole at the center of galaxy M87 shows two rings: a thick orange line and an extremely thin bright band at the inner edge of that thick line.

BY EMILY CONOVER

Faint rings of light surrounding giant black holes could be spotted with the help of a future generation of space telescopes.

The doughnut-shaped glow spotted in the first image of a black hole, released last year by the Event Horizon Telescope team (*SN: 4/27/19, p. 6*), is more complex than EHT's worldwide network of radio telescopes could discern. The black hole's gravity is so intense that some particles of light circle the black hole partway — or once, twice or more times — before escaping to be picked up by telescopes. Those orbiting photons produce a "photon ring," made up of a series of subrings, circles of light that appear successively thinner and are harder for telescopes to pick out.

"It's sort of like a hall of mirrors, where we're getting an infinite series of images," says astrophysicist Michael Johnson of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

Now, Johnson and colleagues calculate that, with the help of new telescopes in space, the subrings theoretically could be observed around the supermassive black hole at the center of galaxy M87, the subject of the first black hole snapshot.

EHT combines the powers of telescopes across the world so that they operate like one, larger telescope. But to tease out more details, such as black hole subrings, scientists would need to add telescopes separated by even larger distances.

A telescope orbiting Earth could detect the first subring, Johnson's team reports March 18 in *Science Advances*. Observing the second subring would require a telescope on the moon, and the third subring would require a telescope 1.5 million kilometers from Earth.

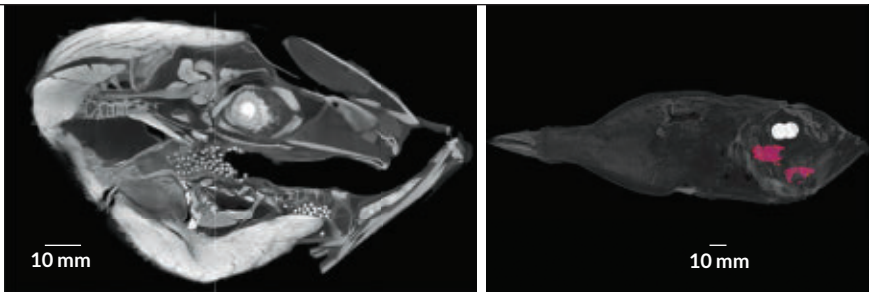
EHT wouldn't directly photograph the subrings; it would detect their existence. That detection would reaffirm Einstein's general theory of relativity, which predicts the rings' existence, and could allow for better measurements of the black hole's mass and spin rate.

The idea "will be challenging, but it's something to look forward to," says astrophysicist Avi Loeb of Harvard. "It is an exciting goal for the next generation." ■

LIFE & EVOLUTION

Mouthbrooder lives in the deep

Egg-carrying behavior is not limited to shallow-water fish



Scientists found over 500 eggs in a fish's mouth using CT scans. A side view of the head (left) shows a mouth full of eggs. Egg masses are colored red (right) to show their placement in the mouth.

BY JAKE BUEHLER

Most fish are broadcast spawners, casting eggs and sperm in clouds and leaving young to develop alone. But less than 2 percent are "mouthbrooders," with fertilized eggs (and sometimes hatchlings) protected in the fish's mouth. Now, a study reveals the first fish known from the deep sea to mouthbrood, researchers report February 27 in *Scientific Reports*.

In 2015, ichthyologist Randy Singer, now at the University of Michigan Museum of Zoology in Ann Arbor, was identifying fish found by a remotely operated underwater vehicle. A red-glinting fish flashed by the vehicle's camera some 500 meters deep, near Puerto Rico.

Later, Singer identified the fish as a *Parazen pacificus*, a poorly known species found in the deep West Atlantic, Indian and West Pacific oceans. Based on that disjointed range, Singer suspected these fish were multiple species. So he started examining specimens from these oceans.

Singer got a surprise while peeling back the gill cover of a specimen from Taiwan. "There was just this big, gnarly clump of something in its mouth."

Initially thinking the fish had gobbled up another's eggs, Singer looked closer and saw that the membrane-enveloped masses were attached to the inside of the mouth by "alienlike tendrils." CT scanning revealed about 530 embryos.

Deep-sea fish normally spawn externally. The young go to shallow waters before returning to the food-scarce deep as adults. Mouthbrooding is a more costly investment. Some mouthbrooders eat with a mouth full of eggs, which is difficult and energy-intensive. Others abstain from eating as the young develop, draining energy reserves. That a deep-sea fish would invest so much in protecting young in such scarcity begs for further investigation, Singer says.

Evolutionary biologist Ashley Robart of Occidental College in Los Angeles points out that the fish seems to live in a sandy-bottomed area with little refuge from predators. "This [environment] may also favor mouthbrooding since eggs or free-swimming larvae would be difficult to defend in such an exposed habitat." ■

FROM TOP: M.D. JOHNSON *ET AL/SCIENCE ADVANCES* 2020; R. SINGER *ET AL/SCIENTIFIC REPORTS* 2020

BODY & BRAIN

HIV drugs disappoint as a treatment for COVID-19

Doctors scrambling to find treatments for coronavirus-infected patients may have had one hope dashed.

Scientists thought some drugs for HIV might also work against the new coronavirus (*SN: 3/28/20, p. 20*). Both viruses need a protease enzyme to make infectious virus. The HIV drugs, called lopinavir and ritonavir, inhibit the protease's action.

A clinical trial in Wuhan, China, tested the drugs on severely ill people with pneumonia caused by COVID-19. Comparing outcomes from 94 people who got the drugs with results from 100 patients who did not showed no benefit from the drugs, researchers report online March 18 in the *New England Journal of Medicine*.

The drugs shortened the time it took to see clinical improvement from 16 days in the standard care group to 15 days in the treatment group. That slight improvement happened only for people who got the drugs within 12 days of symptoms appearing. Perhaps people in the trial were already too ill to benefit from the drugs. Treatment earlier in the infection may work better, the researchers suggest.

The drugs didn't stop viral replication as measured by testing for RNA, the virus's genetic material. Researchers don't know whether people who got the drugs produced fewer infectious viruses. — *Tina Hesman Saey*

ATOM & COSMOS

Asteroid's texture offers clues to how rapidly planets formed

The asteroid Ryugu is light and fluffy. Data from Japan's Hayabusa2 spacecraft suggest the asteroid is highly porous, scientists report online March 16 in *Nature*.

"It is something like freeze-dry coffee," says planetary scientist Tatsuaki Okada of the Japan Aerospace Exploration Agency. If our solar system's early protoplanets had similar structures, planets may have formed quickly.

As an ancient, carbon-rich asteroid, Ryugu is thought to be a time capsule of the solar system's history. To read that history, Hayabusa2 explored Ryugu from June 2018 to November 2019.

Hayabusa2 observed how Ryugu's surface retained and released heat, a clue to the asteroid's composition and structure. Dense rocks take in heat slowly and hold that heat longer; more porous rocks change temperature quickly, like sand on a beach.

Ryugu's heat map shows that the asteroid is about 50 percent porous, meaning half of it is holes. That airiness fits with the idea that Ryugu is a rubble pile formed after the breakup of a larger body (*SN: 4/13/19, p. 11*). The new data suggest that the parent body also was porous.

Planetary scientists think the early solar system was a violent place, with protoplanets colliding, breaking up and reaccumulating all the time. Porous protoplanets might fall apart and come together again more easily than dense ones, Okada says. That means planets might have formed faster than scientists once thought, he says. — *Lisa Grossman*

HUMANS & SOCIETY

Megastructure was made of woolly mammoth bones

Ancient people took on a mammoth project, in more ways than one.

Excavations at Russia's Kostenki 11 site have uncovered one of the oldest, largest Ice Age structures made of mammoth bones. About 25,000 years ago, hunter-gatherers assembled bones from at least 60 mammoths into an imposing ring, researchers report in the April *Antiquity*.

Sieving of soil identified charred wood from fires set inside the nearly flat ring, but it's unclear how its makers used the roughly 12.5-meter-wide structure.

Bones from at least 60 mammoths went into building this roughly 12.5-meter-wide Ice Age structure discovered in Russia.

A. PRYOR ET AL/ANTIQUITY 2020

Circular structures of mammoth bones, most dating to no more than 22,000 years ago, have been found across eastern Europe and western Russia (*SN: 12/13/86, p. 379*). Researchers have often assumed that these constructions, including two others found at Kostenki 11, housed people during harsh winters.

The new discovery challenges that idea. A large, open space in the ring appears unsuitable for long-term occupation, in part because it would have been difficult to roof, the researchers say. And only a few stone tools were found. Hunter-gatherers may have stored food or conducted ritual ceremonies in their mammoth creation, the researchers speculate. — *Bruce Bower*

ATOM & COSMOS

Physicists narrow the mass range for proposed dark matter particle

Bit by bit, physicists are winnowing down the potential masses for hypothetical particles called axions.

If they exist, the subatomic particles could make up dark matter, a mysterious source of mass that pervades the universe. Axions are expected to be very lightweight — between a millionth and a thousandth of an electron volt. But there were no sightings of the particles in a mass range between 2.81 millionths and 3.31 millionths of an electron volt, physicists with the ADMX experiment report in the March 13 *Physical Review Letters*.

Previously, ADMX searched masses between 2.66 millionths and 2.81 millionths of an electron volt. The new result is "one step on a long road to exploring the whole plausible range," says physicist Gray Rybka of the University of Washington in Seattle, a spokesperson for ADMX.

Another team searched for axions with masses of about 6.7 millionths of an electron volt. Part of the CAPP-8TB experiment, the team reported in the March 13 *Physical Review Letters* that there were no signs of axions. But the experiment is not yet sensitive enough to exclude the possibility that axions might be present in that mass range. — *Emily Conover*

Life in the Dark Arctic

MOSAiC expedition will spend a year studying the base of the Arctic food web **By Shannon Hall**

MOSAiC scientists look at an ice block on their temporary ice floe home on October 23, 2019.

ESTHER HORVATH

Allison Fong dangles over the edge of a "river" running through a massive chunk of sea ice floating between the North Pole and Russia's Komsomolets Island. The river cracked open in the ice just a few days ago, exposing the Arctic Ocean below. Already starting to freeze over, the river's surface is a dark scar in the white landscape.

The crack could open further, destabilizing or even cleaving the 3-kilometer-wide floe. To avoid falling into the hypothermia-inducing waters (which hover at –1.8° Celsius), Fong distributes her weight on her hands and knees and is tethered to a stronger piece of ice a few meters away.

She looks at ease as she pulls a chunk of recently frozen ice from the crack and squeezes it slightly. It seems solid, but it compresses like a cube of Jell-O, which means the chunk hasn't completely frozen and still contains small chambers of liquid water. Those chambers are home to microscopic organisms that will remain trapped in the ice throughout winter — enduring pitch-black days and frigid temperatures from October until March, when the sun finally returns.

And yet those organisms manage to thrive. Fong, a biologist with the Alfred Wegener Institute in Bremerhaven, Germany, wants to know how.

Even phytoplankton, a type of algae that relies on sunlight to fuel photosynthesis, are far from dormant in the dark. Scientists suspect that these microscopic creatures rely on stored deposits of fats or feed on small particles in the winter waters.

Finding out for sure is important given that these algae form the foundation of the Arctic food web. Their massive springtime blooms provide a buffet for other critters, particularly zooplankton, tiny sea animals that are munched on by larger squid and fish, which are dinner for the seals that are eaten by whales and polar bears.

Any change to the algae will surely rock the food web — and change is brewing. Rising temperatures in the Arctic have caused the ice to melt and thin. As a result, algal blooms are growing earlier in the season and farther north. Blooms have even been seen under the ice itself. To better predict these changes and how they might affect the food web, scientists first have to grasp how algae and other microscopic organisms survive polar night and how they respond to the lowest levels of light.

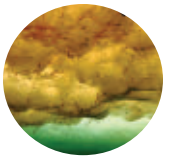
Much about the Arctic remains a mystery. There are more than 1,000 species of microalgae in the frigid waters, and none have been studied close to the North Pole. "There's literally no data about animals and their activities during polar night from the central Arctic," Fong says.

That's because every winter, the central Arctic becomes a fortress of sea ice too thick for ships to penetrate. Most research vessels flee south. But in early October, the German icebreaker *Polarstern* ventured north and steered into a massive ice floe at 85° N latitude. There, the captain killed the ship's engines, so the vessel could freeze in place.

The mission, known as MOSAiC, for Multidisciplinary drifting Observatory for the Study of Arctic Climate, is now traveling across the Arctic like a barnacle on that massive ice floe for one year. Fong

Alfred Wegener Institute biologist Allison Fong (left) and chemical oceanographer Robert Rember of the University of Alaska Fairbanks sample water and ice — to study the organisms within — from a crack on the ice floe on October 10.

Arctic food web



Algae

↓

Zooplankton

↓

Arctic cod

↓

Ringed seal

↓

Polar bear

Feeding time Algae, such as phytoplankton, form the foundation of the Arctic food web, passing nutrients from the smallest creatures to the largest.

FROM TOP: ANDREW THURBER/WIKIMEDIA COMMONS (CC BY-SA 4.0); HIDDEN OCEAN 2005 EXPEDITION; NOAA OFFICE OF OCEAN EXPLORATION; ERLING SVENSEN/ARTSDATABANKEN (CC BY 4.0); NOAA SEAL SURVEY/WIKIMEDIA COMMONS; ALAN WILSON/WIKIMEDIA COMMONS (CC BY-SA 3.0); ESTHER HORVATH

Left to right: Bioluminescent organisms sparkle in the water as scientists lean over the edge of the *Akademik Fedorov* — an icebreaker that accompanied the *Polarstern* at the start of the MOSAiC mission.

A polar bear and her cub were frequent visitors to the expedition site.

Frozen vessel
The *Polarstern* headed northeast from Tromsø, Norway, toward the North Pole. The ship has been floating (dotted line) as part of a large ice floe on an expedition that will end in October.

and scientists from 20 countries have the unprecedented opportunity to gather data in the central Arctic during polar night to learn how climate change is affecting the vast landscape and its inhabitants — from the tiniest algae to the 900-pound polar bears.

A frozen metropolis

In mid-September, a team of MOSAiC scientists — plus a few lucky journalists including myself — set sail from Tromsø, Norway, and headed east along Russia's coast before veering toward the North Pole. As we edged north, the days grew shorter. Soon, the sun would disappear altogether, as did any signs of other ships and birds. In every direction, the light gray sky collided with dark blue waves — and nothing else. The world seemed empty of life.

Then one night after the sun had set, I stood at the ship's stern watching the waves in our path when I saw what looked like a shooting star in the water. The light disappeared as quickly as it had appeared. Then another flashed. And another. For several nights, the lights danced and sparkled as bioluminescent organisms (probably a type of marine plankton) produced light within the wake.

For me, it was the first hint that the seemingly dead landscape was thriving with microbial life. But it wasn't the last. When we entered the edge of the Arctic ice cap — a mosaic of ice floes that jostle at the top of the world — I would often watch as the icebreaker crashed through sheets of white ice. Large, overturned chunks would rock the ship — often with such power that it felt as though we had run aground — and then scrape against the steel hull with a whine like nails across a chalkboard. Those chunks occasionally revealed hidden layers of turquoise ice. And every so often, the ice would be yellowish brown — a sign of ice algae.

The sight of that "dirty ice" sent the scientists into a state of euphoria, eager to take a closer look at the very organisms they were there to study. Luckily, the group didn't have to wait long. On October 4, we crashed into the ice floe that would serve as MOSAiC's home for the next year, and scientists immediately spread out onto the ice. In a race to set up research stations before the sun set over our latitude one last time until March, teams leveled roads, set up power lines and moved instruments onto the ice.

The work was often waylaid by the challenging environment — and a furry visitor or two. Six days after the scientists began their work, a curious polar bear and her cub ambled into the camp, knocking down power lines and munching on instruments. With each subsequent visit, the ship's horn and a radio announcement sent scientists back to the ship, halting all work on the ice.

But the furry visitors weren't the only obstacle. Ships that were sent to the ice floe every few months were often delayed by weather, and air missions were grounded in March to keep the coronavirus off the ship.

The ice didn't always cooperate either. A few days after we reached our new home, a storm rocked the floe, opening several cracks beyond the ship's bow. Until then, the floe had felt so stable — even continent-like — that it was easy to forget that it was just a thin veneer of ice that could be tossed about by the wind. Unfortunately for Fong, the location beyond the ship's bow, the spot she had been eyeing for her research station, became unattainable.

Unlike other scientists who set up camp within a few hundred meters of the ship, Fong needed to work far from the ship's bright lights to study how the Arctic's natural light (or lack thereof) affects the tiniest critters. Once the storm dashed her

PHOTOS FROM LEFT: MARIO HOPPMANN/ALFRED WEGENER INST.; S. HALL; MAP: C. CHANG

Left to right:
The *Polarstern* as seen from a helicopter during a flight to survey damage after a storm in mid-October.

Stefanie Arndt, an Alfred Wegener physicist, takes a selfie on the ice floe in early March at twilight.

FROM LEFT: S. HALL; S. ARNDT/ALFRED WEGENER INST.

initial plan, it took a few weeks for her to find a new location, more than a kilometer from the ship's starboard side.

Shortly after I departed the expedition aboard a second icebreaker, Fong's team — 10 scientists and two polar bear guards — piled into four snowmobiles and six wood sleds once a week. The group cruised along a bumpy road, past small mountains of snow and ice dubbed "the fortress," to the other edge of the ice floe. There, in the dark, the team collected cores of ice for analysis in a dark and cold lab back on the ship. "That will give us a sense of who's there," Fong says, and how active those organisms might be — in the absence of light.

Dark secrets

In 2007, Jørgen Berge, a marine biologist at the Arctic University of Norway in Tromsø, was analyzing data from an instrument that had been moored to the seafloor in the low Arctic, when he noticed that masses of zooplankton had been migrating up and down the water column in winter. That behavior is typical during much of the year when daylight is in play. The creatures rise to the surface at night to feed on phytoplankton and dive back down during the day. Seeing such activity in the dark of Arctic winter, Berge thought he'd found an error in the data. But later research suggested that the zooplankton's movement was driven by the moon's faint light (*SN: 7/6/19 & 7/20/19, p. 32*).

Just because we perceive the Arctic as pitch-black during winter, other species might not. "No matter where you look, whether it's in the marine environment or the terrestrial environment, organisms have different ways of experiencing the world and sensing the world," says marine biologist Jonathan Cohen of the University of Delaware in Lewes.

On two Arctic cruises in 2014 and 2015, Cohen and colleagues measured what little light was available during polar night. The levels, they found, were 100 million times lower than those observed during Arctic summer. But even during the perpetual night of the Arctic winter, there is still a difference between day and night. Sunlight reflected from below the horizon actually makes the day a little brighter than the night. Plus, the moon and possibly the northern lights add a measurable glare. Still, Cohen wasn't sure if that minimal light was enough for Arctic animals to use.

So his team hooked electrodes up to zooplankton to measure how the creatures responded to flashes of faint light. The animals reacted most strongly to the bluish colors that penetrated deep into the water column, which explains how zooplankton migrate throughout polar winter.

And those swimmers aren't alone. Scientists have begun to realize that the Arctic — even during polar night — is astonishingly alive. Seabirds, which are thought to be visual predators, forage in the middle of winter. So do multiple species of fish and krill. Clams grow at similar rates in the winter as they do during the summer. And all kinds of organisms, including snails on the seafloor, reproduce despite the cold and darkness.

Even phytoplankton stay active. Although scientists can't yet say exactly how, they suspect that some species live on stored deposits of fats, and others might undergo a dramatic metamorphosis every winter.

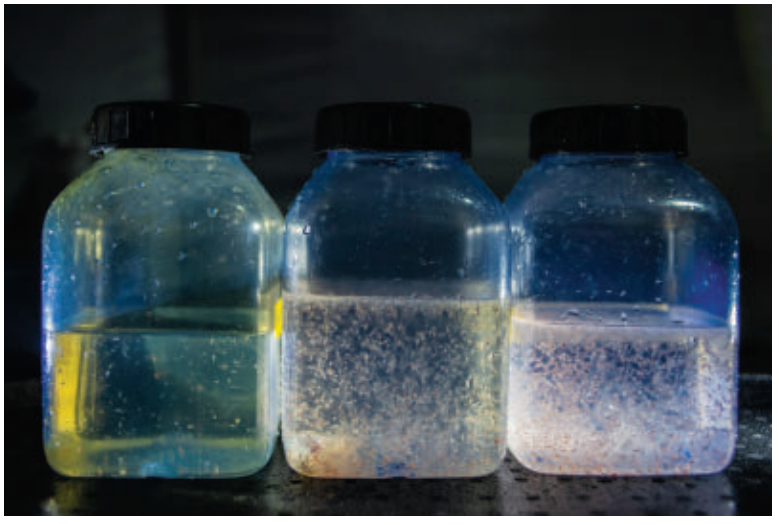
Micromonas pusilla, one of the most abundant species of phytoplankton, actually switches to a more animal-like lifestyle, feeding on bacteria and other small particles in the water column. Yet the phytoplankton manage to keep their photosynthetic apparatus intact throughout the dark polar night, which enables them to respond within hours to the return of sunlight in the spring.

"There's a whole world that thrives during the darkness," says Eva Leu, a marine biologist with Akvaplan-niva in Tromsø, a daughter company of the Norwegian Institute for Water Research. Leu helped plan biology experiments for MOSAiC.

But the studies that reveal the Arctic's active nightlife barely scrape the surface. Many were performed in the lower Arctic at roughly 80° N, but MOSAiC floated closer to the North Pole — where winter is darker and lasts longer — than any other ship yet during Arctic winter.

MOSAiC went *north* of the northern lights, to a completely different marine environment with an ocean that extends four kilometers deep (as opposed to a shallow continental shelf). As such, many of the results from past studies cannot be extrapolated to the central Arctic.

So, MOSAiC researchers will conduct physiological and genetic analyses on the life within thousands of samples in a lab onboard the ship (some will be sent to different labs for analysis). Although Fong returned to Germany in January, others kept the studies going all winter. But as the mission continues, Leu and other scientists are most eager to collect samples once another drastic change occurs in the Arctic: the return of the sun.



Alfred Wegener biologist Nicole Hildebrandt (top) looks at zooplankton collected from under the ice floe. A net raked under the sea in early December pulled up several samples (bottom) for study in the ship's lab.

BOTH: ESTHER HORVATH

Spring awakening

Every spring, the sun's rays hit the top of the world for the first time in months — creating a pink glow and warming the sea ice. Temperatures rise, the snow and ice begin to melt and life starts to flourish. Although polar night is a busier world than scientists initially imagined, it doesn't compare to spring when phytoplankton form massive blooms that provide scrumptious meals for the rest of the Arctic food web.

Certain species of zooplankton, which spend winter at great depths, migrate to the surface in the spring to feed on the rich algal blooms. Those small animals become food for fish, eventually supporting the rest of the food web. California gray whales, barnacle geese and 135 other species of birds migrate to the top of the world to feed on the many animals that feed from the bloom. Arctic terns even travel 30,000 kilometers from the Antarctic to the Arctic. The springtime feeding frenzy is — without a doubt — the main event in the Arctic ecosystem.

"That's the food that then carries the entire food web throughout the rest of the year," Cohen says.

The success of this feast depends on the timing and location of the springtime blooms. "What happens during the winter months sets the stage for the coming productivity peak," Leu says. So scientists are eager to better understand those dark months.

Knowing how different species of algae respond to low levels of light, for example, will help scientists better predict when and where those blooms might appear and even their composition.

It's a crucial question now that the timing and location of these blooms are being altered by climate change.

In 2011, Kevin Arrigo, a marine biologist at Stanford University, was on a research cruise between Alaska and Siberia, deep in the Chukchi Sea ice pack, when instruments submerged a few meters below the surface registered high concentrations of chlorophyll — a proxy for phytoplankton. It seemed impossible since he was surrounded by ice and snow. Both would reflect any incoming solar radiation, leaving no sunlight

A guard scans the horizon for polar bears. During polar night, he has to rely on his headlamp and spotlights from the ship.

LUKAS PIOTROWSKI

for plankton in the waters below. "We thought our instruments were malfunctioning," Arrigo says. A bloom simply could not exist below the ice. But when his team drilled a hole through the thin sheet and hit the ocean below, green water flushed upward.

"It was an eye-opener," Arrigo says. "I would have bet my life savings that there was no way you would ever find anything like this under the ice." But only a phytoplankton bloom would have colored those waters, and it was as big as Montana.

There's a simple explanation for this surprise finding. A stunning 95 percent of the Arctic's oldest, thickest ice has disappeared in the last 33 years, according to the National Oceanic and Atmospheric Administration. Now, the top of the globe contains mostly young, thin ice that allows light to penetrate into the upper ocean and reach the phytoplankton below.

Since Arrigo's 2011 study, roughly a dozen blooms have been spotted under the ice. "It's just an absolutely amazing discovery that we never would have expected," says Chris Horvat, a climate scientist at Brown University in Providence, R.I.

In addition, algal blooms have been spotted earlier in the season and creeping farther north — changes that will have ramifications across the Arctic. If blooms occur in a new location or at a different time, grazers, from zooplankton to Arctic terns, might miss the blooms entirely.

That change worries Fong. "It's like bees and flowers," she says. Plants bloom based on the temperature, but usually require insects for pollination. If those insects are not at a stage in their life cycle to be active pollinators, then a fruit tree that blooms too early won't produce any fruit.

"Phytoplankton can grow and grow and grow," Fong says. "But the only way that material gets transferred up the food web is if the primary consumers are there and able to graze upon them."

When blooms occurred later in the season, the waters were quite warm; zooplankton reproduced and their offspring munched on phytoplankton falling through the water column. But now that blooms are occurring earlier, when the water is still colder, the zooplankton have not yet reproduced; there's no offspring to scoop up the phytoplankton.

In this new scenario of earlier blooms, most of the phytoplankton could reach the bottom of the ocean causing the low-lying ecosystem to thrive. Gray whales, walruses and clams all feed on the bottom. But bowhead whales, Arctic cod and salmon feed in the water column — and may thus suffer the consequences if zooplankton miss their chance to dine.

Though of course much of this is speculation based on early changes. "The jury is still out on exactly what will happen," Horvat says. MOSAiC scientists will need to complete their dark sojourn to shed light on the changing Arctic. ■

Explore more

■ MOSAiC expedition: mosaic-expedition.org

Shannon Hall is a freelance science journalist based in Colorado. She was aboard MOSAiC's main ship from October 3 to October 17.

Playgrounds with engaging equipment and areas for imaginative play boost activity.

MAYUR KAKADE/GETTY IMAGES

Building playgrounds that get kids moving

The right design can provide a needed nudge

By Emily Anthes

The playground at Lake County Intermediate School in Leadville, Colo., was in desperate need of a makeover. The schoolyard didn't offer much — just a few swings, some rusty climbing equipment, a cracked basketball court and a play area of dirt and gravel.

In the spring of 2014, the community replaced the run-down equipment, installing a spider web–like climbing net, twisting slides and colorful swings. A new basketball court went in, along with a grassy play area and walking paths. Kids got access to balls, Hula-Hoops and other loose equipment.

The overhaul did more than improve how the playground looked; it turbocharged the kids' recess activity. When researchers observed the playground that November, they found that the share of children participating in vigorous physical activity had tripled. And the changes appeared to last — a year after the overhaul, the students were still more active than they'd been before, the researchers reported in 2018 in the *American Journal of Preventive Medicine*.

"A lot of things, when they're new and shiny, lead to increased physical activity, but it's not always sustained," says Elena Kuo, a senior evaluation and learning consultant at Kaiser Permanente Washington Health Research Institute

in Seattle, who coauthored the study. "That's why it's a pretty exciting finding."

Being physically active has many benefits for kids: It reduces obesity risk and improves overall physical and mental health, fosters social and emotional development and boosts academic performance. The World Health Organization recommends that schoolchildren get 60 minutes of moderate to vigorous activity every day. Most kids fall far short of that goal. Globally, 81 percent of 11- to 17-year-olds fail to hit that threshold, according to an analysis reported in January in the *Lancet*.

Playgrounds offer a chance to encourage kids to be more active in their everyday lives. "You've got a captive audience and a lot of kids," says Kuo, calling outdoor play areas "an opportunity to have a high impact." Overhauling playgrounds to encourage active play is gaining momentum, she says.

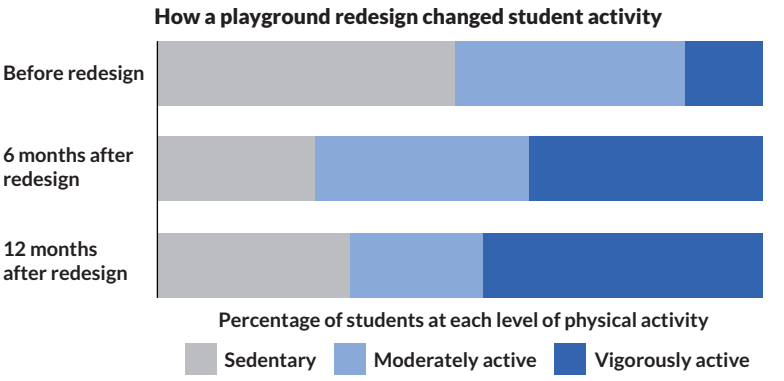
Scientists across the globe are studying how to maximize the opportunity that playgrounds provide. Research teams are using accelerometers, GPS tags and other wearable technology to probe how kids behave on playgrounds and are conducting randomized controlled trials to assess whether certain playground features, programs and designs can encourage kids to move more.

The results so far suggest that there are ways to subtly nudge children into being more active on playgrounds. And scientists say that there's now enough evidence to begin making some specific recommendations to cities and schools that want to create playgrounds that foster movement. "When they come to us, we are now able to give them some pointers," says Jasper Schipperijn, a sports scientist at the University of Southern Denmark in Odense.

While "evidence-based" playgrounds and playground-based programs won't be a cure-all, they could make a real difference for some kids. "You'll have children that will be active regardless of how their school or playground looks," Schipperijn says. "But then there's another group of kids that needs a bit more help." (Editors' note: During the coronavirus pandemic, many municipalities have asked that children not use playground equipment.)

Sparking play

By the time Leadville embarked on its playground renovation, scientists had already identified several strategies for boosting playground activity. One of the first interventions to amass considerable research support used nothing more than some cans of colorful paint.



Behavior change After the Lake County Intermediate School in Leadville, Colo., transformed its mostly barren schoolyard into a colorful, active playground (shown above), fewer fifth- and sixth-graders were sedentary and more were vigorously active (running, climbing or in fast-paced action) during recess at both six and 12 months after the redesign (results at top). SOURCE: M.C. FROST *ET AL/AM. J. PREV. MED.* 2018

In the late 1990s, Gareth Stratton, a sports and exercise scientist then at Liverpool John Moores University in England, launched a pilot study at a local primary school. Stratton worked with the young students to develop a set of fun, brightly colored designs — including a castle, pirate ship, dragon, clockface, hopscotch board and maze — to paint on the playground surface.

The markings seemed to spark active, imaginative play and changed how students used the space, reducing the dominance of soccer and creating new play areas and opportunities for kids who might otherwise just opt out, says Stratton, now at Swansea University in Wales. "There's no sitting on the sidelines anymore because there aren't sidelines as such."

When Stratton attached heart monitors to 36 of the schoolchildren, he discovered another benefit of the markings. During the month before markings were added, kids spent an average of 27 minutes of their daily recess time — which totaled about an hour a day, divided into three play sessions — engaged in moderate to vigorous physical activity, he reported in 2000 in

FROM TOP: T. TIBBITTS, GREAT OUTDOORS COLORADO

Studies dating back two decades reveal that painting colorful markings on playgrounds, like this chutes and ladders design at a school in Liverpool, England, can boost recess activity.

Ergonomics. In the month after the designs were painted, that number jumped to 45 minutes a day. The children's playtime heart rates also increased by an average of seven beats per minute. (The activity of children at a nearby school without the markings increased more modestly over the study period, from 29 minutes to 36, and there was almost no change in their heart rates.)

In the years since, Stratton and other researchers have confirmed and expanded upon these findings — and schools have put the lessons into practice. "This is something that's actually had traction and is actually really useful in a real-world setting," Stratton says.

In addition to playground markings, loose play equipment, like the balls and Hula-Hoops added at Leadville, can encourage kids to move more. Two studies published in 2019 in the *Journal of School Health* used a popular observational tool known as the System for Observing Play and Leisure Activity in Youth, or SOPLAY, to demonstrate the power of these supplies. To use SOPLAY, researchers systematically scan the play area, counting the number of children who are sitting, walking or engaged in higher-intensity pursuits.

Unconventional play materials, like these crates at a primary school in Sydney, can prompt creative, active play among children.

In the first study, the proportion of students engaged in moderate to vigorous physical activity at 19 schools in Los Angeles County was roughly 10 to 20 percentage points higher in play areas with loose equipment.

The second study, based in two school districts in Colorado, demonstrated that the more play equipment schools provided, the bigger the activity gains.

"If there's something fun to do, kids will do it," Kuo says. "Even something as simple as having a bunch of balls available and having Frisbees around — it's just more fun than a random open field."

Unconventional equipment

And the options go beyond traditional sports equipment. For Australia's Sydney Playground Project, which began in 2009, researchers enrolled 12 inner-city primary schools and randomly assigned half to receive a two-part intervention.

The playgrounds at the intervention schools were stocked with an assortment of recycled "loose parts" — hay bales, tires, crates and foam pool noodles. "We just put them on the playground with no instruction to the children about what you should do with them, and we asked the adults to try to step back from the children and let them do whatever they wanted," says Anita Bundy, a play researcher who led the Sydney Playground Project at the University of Sydney. (She has since moved to Colorado State University in Fort Collins.)

To encourage adults to keep their distance, Bundy and colleagues put parents, teachers and school staff through "risk reframing" workshops designed to reinforce the idea that active, independent free play — even seemingly dangerous kinds of play, such as climbing trees or running down hills — has myriad benefits for kids.

The intervention was a hit. Many teachers and parents reported that the workshops gave them a new perspective on potentially perilous play, and the kids embraced the strange playground supplies. The children combined and recombined those materials "in zillions of different ways, and they loved that," Bundy says. At one school, some kids created an imaginary amusement park with the loose parts. At another, students invented new sports. "They'd have a whole team full of people playing pool noodle hockey," Bundy says.

FROM TOP: N. RIDGERS; SYDNEY PLAYGROUND PROJECT

Different children have different desires and needs. This Danish school created a wide variety of play spaces to engage more kids.

LEIF TUXEN

Indeed, an in-depth analysis of one Sydney primary school revealed that the loose parts prompted kids to play more than they had before and to engage in more creative play and a wider variety of activities, the researchers reported in 2018 in the *Journal of Adventure Education and Outdoor Learning*.

In a separate analysis, Bundy and colleagues tracked students' activity levels using accelerometers fastened to the kids' clothes. After the intervention, students at the experimental schools spent 12 percent more recess time participating in moderate to vigorous physical activity than children at the control schools, the researchers reported in 2013 in *Preventive Medicine*.

However, the absolute increases were modest. The amount of time that kids at the intervention schools spent engaged in moderate to vigorous physical activity increased by just two minutes, on average. It's possible that the data from the accelerometers — which are better at picking up on when children start running than on the lifting, pushing, pulling, climbing and building that many of the kids were engaged in — underestimated the benefits of the loose materials.

But the results also highlight the limitations of relying on playgrounds as the singular secret to better child health. Recess tends to be short, and even "successful" interventions often add just a few extra minutes of activity to kids' days.

So some experts caution that while creating more active, appealing playgrounds may be a step in the right direction, getting kids to move more requires a multipronged approach. "I wouldn't put all my eggs in that basket," says Mark Tremblay, who directs the Healthy Active Living and Obesity research group at the Children's Hospital of Eastern Ontario Research Institute in Ottawa. Playgrounds, he says, are "one option, and I think there needs to be many, many options."

Playground researchers argue that even small increases in activity matter, that a few extra minutes a day add up. "Is it enough? No it's not, but it's definitely a good step along the way," says Schipperijn, in Denmark.

And studies, which tend to report averages, might miss positive effects. A playground overhaul may prompt some kids to be *much* more active while having no effect whatsoever on others. "The chances that it will work for all children is very small," Schipperijn says. "Simply because different children need different things."

Though individual kids vary enormously, in general, boys tend to be more active than girls. Schipperijn's research suggests that at least some of the gender difference results from a social hierarchy in which boys tend to claim the most desirable amenities. Providing more play spaces could boost girls' participation.

Varied landscapes

Different kids are also attracted to different activities, so it's important to provide not just plenty of play spaces, but also varied ones.

In a study published in November 2019 in *Landscape and Urban Planning*, Schipperijn tracked students at three Danish schools before and after major playground renovations. Though each renovation was unique, in all three cases, the paved, mostly featureless schoolyards were converted into rich and varied playscapes. Each had some combination of sports courts, swings, four square and hopscotch markings, climbing structures, balance bars, trampolines, an obstacle trail, a climbing wall, hills, tree stumps and dedicated dancing areas with mirrors, loudspeakers and video screens. After the redesigns, there were more physical activity "hot spots" — for both boys

Girls, who tend to be less active during recess than boys on average, play on climbing equipment in a Danish schoolyard.

and girls — than before, the researchers found.

More structured play programs could also help pull the most sedentary kids into the action. That's what researchers have found in studies of Playworks, a nonprofit that sends full-time coaches into low-income American schools to organize group games and activities during recess.

Researchers studied the effects of the program in various demographic groups in a randomized controlled trial that enrolled 29 schools spread across six American cities. Seventeen of the schools were randomly assigned to receive Playworks, while the other 12 schools served as controls. In the control group, black students spent an average of 14.1 percent of their recess time engaged in moderate to vigorous physical activity, while white students spent 19.2 percent of recess being similarly active.

Playworks appeared to close this gap, prompting black students to spend 20.4 percent of recess in moderate to vigorous physical activity, while the activity levels of white students remained essentially steady, at 19.7 percent, scientists reported in 2016 in the *Journal of Physical Activity and Health*. In a separate study, researchers also discovered that Playworks prompted girls, but not boys, to move substantially more.

The program may have leveled the proverbial playing field, making it easier for less active kids to participate in schoolyard games. "The Playworks coaches ... were equally getting everyone involved and teaching kids games at the same time," says Martha Bleeker, a senior researcher involved in both studies at the policy research firm Mathematica. "It's not like one group had ownership over that activity."

"The biggest challenge at the moment is that time allocated to recess and lunchtime is decreasing in schools."

NICOLA RIDGERS

It's also possible that any effort to remake playgrounds yields the biggest dividends for the kids who are the least active, and who thus have the most room for improvement.

To get the most out of playground redesigns and programs, schools may also need to rethink certain practices and policies. In many schools in Australia, for instance, kids aren't allowed to play at recess if they don't have a hat to protect them from the blazing sun, says Anne-Maree Parrish, a childhood physical activity researcher at Australia's University of Wollongong.

In a randomized controlled trial published in 2016 in the *Journal of Science and Medicine in Sport*, Parrish found that providing loose play equipment alongside policy changes, including one that allowed hatless kids to play in the shade, boosted the share of break time that students spent in moderate to vigorous physical activity by 9 to 13 percentage points.

And even the best-designed playgrounds won't make much difference if kids don't get time to play on them. Although the share of U.S. school districts that mandate regular recess for elementary school students is up from 46 percent in 2000 to 65 percent in 2016, the average amount of daily recess time has actually ticked down slightly, from 30 minutes in 2000 to 27 in 2014.

"The biggest challenge at the moment is that time allocated to recess and lunchtime is decreasing in schools," says Nicola Ridgers, a researcher at the Institute for Physical Activity and Nutrition at Deakin University in Australia. "So it's really [about] trying to protect that time and make sure that kids have the opportunity to play."

While playgrounds won't single-handedly remedy the problem of childhood inactivity, they can be part of the solution — instilling a love of movement and setting the stage for a lifetime of healthy habits. As Parrish notes, "Any opportunity to try and increase their physical activity somewhere is always a bonus." ■

Explore more

- Henriette Bondo Anderson *et al*. "What we build makes a difference — mapping activating schoolyard features after renewal using GIS, GPS and accelerometers." *Landscape and Urban Planning*. November 2019.

Emily Anthes is a freelance science journalist based in Brooklyn, N.Y. Her book The Great Indoors *will be published in June.*

LEIF TUXEN

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Spacefarers
Christopher Wanjek
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BOOKSHELF

A guide to how humans will colonize space

By 20th century expectations, we are way behind schedule on colonizing the solar system. After the Apollo moon landings, some scientists and NASA officials envisioned launching astronauts to Mars in the 1980s and building cities in space to be habitable by the 2000s. But the only humans in space today are a few astronauts in a lone space station orbiting Earth.

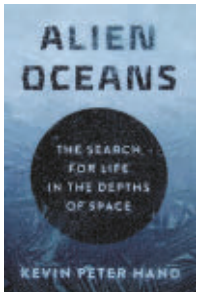
That may soon change, says science writer Christopher Wanjek. China is preparing to send crewed missions to the moon by the 2030s. SpaceX founder Elon Musk hopes to take people to the Red Planet, while Bigelow Aerospace is drawing up plans for Earth-orbiting hotels. Increasing competition for the geopolitical power and profits promised by space travel (*SN: 12/21/19 & 1/4/20, p. 31*) may finally get astronauts back to the moon and beyond, Wanjek says. In *Spacefarers*, he explores how this 21st century space race could play out.

Drawing on the science and history of space exploration, Wanjek paints scenes of future human activity across the solar system. "A two-week trip to the moon [would] be much like an African safari was 150 years ago," he writes. "Initially for the wealthy, with a tinge of danger, and certainly not for the kids, at least not at first." On Mars, too far for a weekend getaway, self-sufficient colonies could serve as a pit stop between Earth and minable asteroids and as the frontier of the outer solar system. Wanjek expects a permanent human presence on Mars in the 2050s and visits to Jupiter's moons by 2100.

Wanjek tempers these far-out ideas with frank discussions about the perils of space travel. There are oft-cited worries, like the fact that, as Wanjek puts it, "living in microgravity sucks." Weightlessness weakens bone and muscle, and Wanjek is not convinced that the International Space Station diet and exercise regimen is enough to keep astronauts fit for the long haul to another planet. Then there are less obvious concerns, like how a Mars colony growing light-sensitive crops underground is supposed to restock LED bulbs.

Experiments in the 1990s provide a humbling illustration of how space missions could go awry. Inside a prototype Mars colony dubbed Biosphere 2 in Arizona, bugs multiplied, crops failed and crew members split into factions. After the disaster that was the first two-year mission, a second attempt in 1994 lasted just six months before dissolving into "vandalism, foul language, lawsuits, finger-pointing, shaming," Wanjek writes. "You know, typical Mars colonization kind of stuff."

Despite spending much of *Spacefarers* poking holes in space travel schemes, Wanjek is optimistic that humans will eventually need to specify a solar system body on postal addresses. "You can't launch humans to Mars on a tank of hope," he writes, but humans have never been closer to embarking on a voyage beyond the moon. — *Maria Temming*



Alien Oceans
Kevin Peter Hand
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BOOKSHELF

Distant, hidden oceans may harbor alien life

Life as we know it requires liquid water. That's why astronomers get excited when a planet is found in a star's "habitable zone," the Goldilocks region in which a planet is neither too close nor too far from its star to have liquid surface water.

In *Alien Oceans*, NASA scientist Kevin Peter Hand argues that the notion of the habitable zone should be expanded. At least six moons in the outer solar system are likely to have oceans of water beneath icy facades. For these orbs, the sun isn't the heat source that keeps oceans liquid. Instead, the decay of radioactive elements inside a moon's rocky core might keep things warm. Another possibility is tidal flexing: If a moon follows an elongated orbit around a planet, ever-changing tides would create friction within the core and release heat. Similar conditions could allow for ice-covered oceans on planetary bodies in other solar systems too.

Chapter by chapter, Hand lays out the evidence for the existence of distant oceans in our solar system. Take Europa, Jupiter's fourth-largest moon. As far back as the early 1970s, spectroscopic images from an Earth-based telescope hinted at the presence of water ice. During the late 1990s and early 2000s, repeated flybys of Europa by the Galileo spacecraft helped reveal how the moon's mass is distributed in layers; some layers are denser than others, hinting at the presence of water. Data from Galileo's magnetometer, which detected changing magnetic fields caused by the flow of charged particles, bolstered the idea that the moon hosts a salty ocean.

Similar observations point to subsurface oceans on two other moons of Jupiter, Callisto and Ganymede; Enceladus and Titan, which circle Saturn; and Neptune's moon Triton.

Liquid water alone is not enough to make these moons habitable. Hand discusses other conditions needed for life, including chemical substances that would have to be present for organisms to build bodies and have metabolisms. He also describes plans to further explore these places. Missions could include landers that carry robotic probes that would melt or drill their way through ice and then release a mini-sub to explore the hidden ocean (*SN: 5/17/14, p. 20*).

Alien Oceans offers a historical look — as well as a peek into the future — at one of the most exciting aspects of space exploration. With the technology at hand, we could determine whether there's life beyond Earth. — *Sid Perkins*

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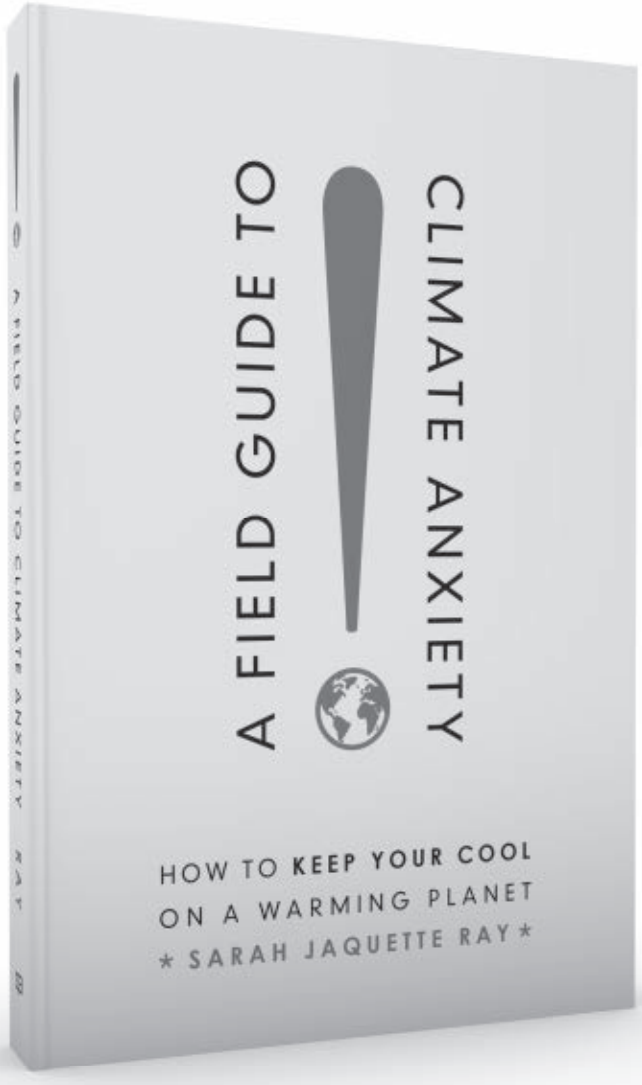

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—Leslie Davenport, author of *Emotional Resiliency in the Era of Climate Change*

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CELEBRATING OUR VOLUNTEERS

Milena Acosta
Community Engagement Manager at Natural History Museum of Los Angeles County

How I got started

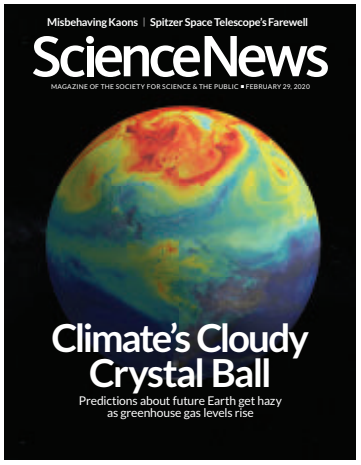
I first got involved in the International Science and Engineering Fair (ISEF) in 2010. At that time, I was working for the Aquarium of the Pacific in Long Beach, Calif., and my boss was connected to the chair of the Local Arrangements Committee (LAC), the group of local volunteers who help the Society for Science & the Public plan ISEF. I represented the aquarium at the LAC meetings and I quickly understood just how amazing this event was. I wanted everybody to know about it and dove right into the work. In 2014 and 2017, I served as chair of the LAC in Los Angeles.

My favorite memory

On Judging Day, I interpret for Spanish-speaking students. The years have started to blur a bit, but I always enjoy being able to spend time with finalists and learning more about their impressive projects. One year, a team from Mexico developed a better formula to make biofuel from discarded bananas. They were motivated to do so after learning that a local company's method wasn't as efficient as it could be. Their passion was written all over their project. The students' school never had ISEF finalists and didn't understand the value of the event. They didn't want the students to attend. Their parents and other community members rallied behind the finalists to send them to Los Angeles. The finalists persisted and were so enthused to be at ISEF; you could see the fire inside of them.

What keeps me coming back

An event like ISEF brings light to the power of what one person can do to better their community. The finalists conduct independent research based on their interests, but they are raising science awareness as well. They are starting meaningful conversations about science and the positive impact it can have at the local level. I wasn't sure what to expect when I first started volunteering, and then I was drawn into this ever-expanding network of science-oriented individuals. I am also in awe of the sheer number of people who come together once a year to support the next generation of scientists. It is a wonderful opportunity to learn from others who are propelling STEM forward. I am still connected to the friends I made at my first ISEF. I still talk to them and I still see them every year at ISEF. I don't see an end to my involvement. It's empowering and gives me a jolt of energy.



FEBRUARY 29, 2020

Come together

*Climate change is altering the world at an increasing pace, transforming ecosystems and harming indigenous communities. Scientists observing these changes are frustrated and grieving, **Jonathan Lambert** reported in "When grief comes with the job"* (SN: 2/29/20, p. 22).

Readers were moved by the story and many shared their experiences observing ecological changes in their own backyards.

"I live at a lake that is maintained by natural springs and I've been there all my life," reader **Rhonda Embelton** wrote. "My heart breaks for my beloved lake. Frogs declining, I don't see bats anymore, I could go on and on. Young people don't miss what they don't see, so I feel that I have a responsibility to do what I can, as little as that may be! Thank you, to all scientists [who] work hard to reverse and bring awareness to everyone."

Lambert's story brought reader **Rebecca Hepburn** to tears. "I'm no environmentalist, but there are less and less birds in my yard, my neighbors poison the earth to make their yards look better and the fertilizers and pesticides roll into our yard," **Hepburn** wrote. "Anyway, thank you for this. It makes me feel a little less crazy."

Patric Hedlund, a managing editor at a small California newspaper, detailed his experience diving among coral reefs. "I am familiar with the distress that can be overwhelming at times to see the impact on nature of human choices," **Hedlund** wrote. "As writers and journalists, we try to articulate the ... dread, in hope that our words can ... mobilize others to take effective action. But human change is glacial, while warming is accelerating exponentially," he wrote. "Hope is a resource that can be self-regenerating by action or depleted by stubbornly resistant systems and attitudes. The children get it. They hold the seeds of hope that will fuel the urgency that is needed now. But they need all of us — and all our higher-order institutions — to ... make this a priority."

COVID-19 Q&A

Science News *reporters **Tina Hesman Saey**, **Aimee Cunningham**, **Jonathan Lambert** and **Erin Garcia de Jesus** are working hard to keep you up to date on the coronavirus pandemic. As cases rise, the team is answering reader questions about COVID-19.*

"Why are people in such a tizzy about it?" reader **Joe B.** asked. "With regard to numbers killed, influenza in the U.S. alone far surpasses it. It just seems like the level of concern is disproportionate to the actual threat."

COVID-19 is many times deadlier than the flu. Like the flu, this virus seems to hit older people hard. Unlike the flu, there isn't yet a vaccine. And because this virus is new, no one has developed immunity against it. That means everyone is susceptible to getting infected and transmitting the virus to others, so it can spread rapidly and widely. If numbers of U.S. cases continue to rise rapidly, like in other countries, COVID-19 patients could have to compete with other sick people for hospital space. Too big a spike could overwhelm hospitals.

Scientists worry that the virus could take hold in the United States, causing yearly epidemics like the flu, which killed about 34,000 Americans during the 2018–2019 season. That means we would have another serious respiratory disease to deal with regularly.

Reader **Ken M.** asked if there are two strains of the coronavirus, one that causes mild symptoms and another that has more severe effects.

There are not two strains of the virus going around in the United States or elsewhere. A study published online March 3 in the *National Science Review* claimed there were two types of the virus infecting people. One of the supposed types had a particular mutation. This type was more prevalent in Wuhan, China, in the early stages of the outbreak and produced more severe symptoms, researchers suggested. But that mutation doesn't change the virus's proteins and probably has no effect on disease severity, other experts say.

Join the conversation

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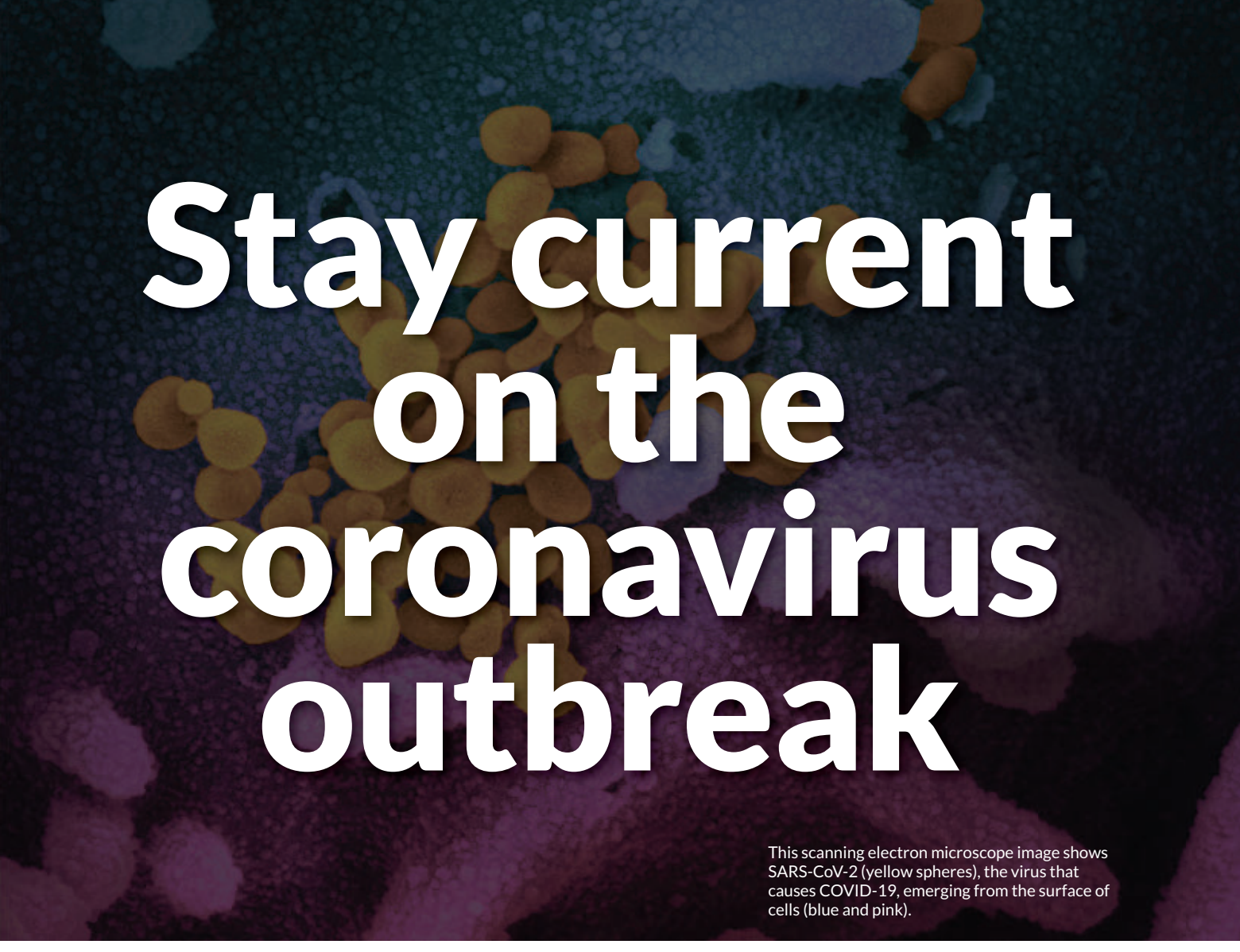

Stay current on the coronavirus outbreak

This scanning electron microscope image shows SARS-CoV-2 (yellow spheres), the virus that causes COVID-19, emerging from the surface of cells (blue and pink).

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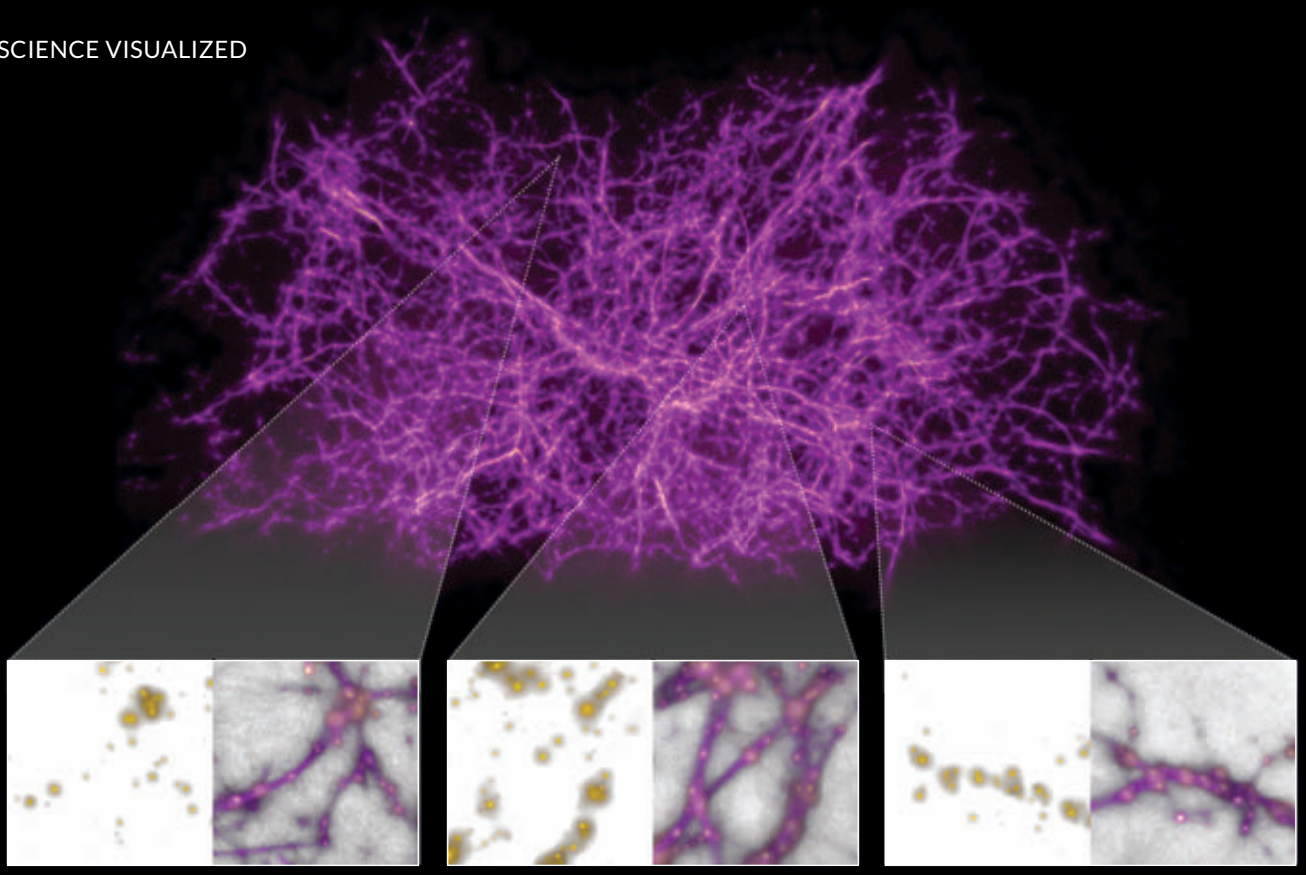
ScienceNews

Get COVID-19 news delivered to your e-mail inbox every Tuesday and Friday. *Science News* Coronavirus Update includes summaries of the latest research and data, links to relevant articles and answers to readers' questions about the coronavirus, COVID-19 and the pandemic.

Sign up at www.sciencenews.org/coronavirus-update



A universe of slime

Creeping tendrils of slime seem to mirror the structure of the universe's enormous filaments. That superficial similarity, in an organism called a slime mold, helped scientists map out the cosmic web, the vast threads of matter that connect galaxies.

The map (in purple at top) was created using the locations of over 37,000 known galaxies and is based on a slime mold's growth patterns, scientists report in the March 10 *Astrophysical Journal Letters*. The zoomed-in views show underlying galaxies (yellow circles) with the reconstructed filaments superimposed on top.

Made up of gas and the unidentified substance called dark matter, the cosmic web began forming early in the universe's history, as matter clumped together due to gravity. Computer simulations of that formation suggest that a tangled tatting should link galaxies, but the web is so ethereal that scientists struggle to image it directly (*SN: 11/9/19, p. 5*).

Enter the slime mold *Physarum polycephalum*, a single-celled organism that appears as a slimy yellowish lace (below), often seen bedazzling rotting tree trunks. Normally, a slime mold forms connections between sources of food. The organism's patterns have striking similarity to human-made networks, such as railroads.

Astronomer Joseph Burchett and computer scientist Oskar Elek, both of the University of California, Santa Cruz, and colleagues adapted a computer method for producing slime mold–like patterns so that, instead of food sources, it could connect galaxies sprinkled through space. Surprisingly, the technique reproduced the kinds of structures seen in computer simulations of the cosmic web.

The researchers compared their map with measurements that reveal the density of gas at certain points in the web. Brilliant sources of light called quasars shine through this network, which absorbs some of their light. By studying the amount of absorption, the team found that regions that the slime mold technique predicted should be somewhat denser also had more hydrogen gas.

— Emily Conover

FROM TOP: J.N. BURCHETT *ET AL*/*ASTROPHYS. J. LETT.* 2020; SCOTT CAMAZINE/SCIENCE SOURCE

GEOLOGIC ROAD TRIP OF THE MONTH

Where faults along the mountains' edge have tilted Paleozoic and Mesozoic strata 90 degrees or more, they have weathered into the spectacular towers, pinnacles, and mushroom rocks of Garden of the Gods. Pikes Peak looms in the distance.
—Felicie Williams photo

GARDEN OF THE GODS

In the narrow point of land between two major faults that edge the mountains near Colorado Springs, a wedge of folded and faulted Paleozoic and Mesozoic rocks has been tilted steeply. The road entering Garden of the Gods from the east crosses a broad swale underlain by soft Cretaceous shale, passing a small wall-like hogback of white rock, a resistant sandstone layer in the Morrison Formation. West of another swale eroded in soft red Triassic shale, the road slips through a narrow gateway into Garden of the Gods. The gigantic gateposts, as well as other tall monoliths, are eroded in salmon-colored Lyons Sandstone, a coastal dune deposit of probable Permian age. Its sand grains are cemented together tightly by silica and tiny grains of hematite, so although the sandstone layers are tilted 90 degrees or even slightly overturned, they are strong enough to stand as tall, thin, bladelike towers.

The towers continue in regimental rows south of Garden of the Gods, but south of Fountain Creek they are cut off abruptly by the Ute Pass fault and steep slopes of Cheyenne Mountain.

West of the monoliths of Lyons Sandstone, dark red sandstone alternates with deep red mudstone or shale and a few bands of pebbly conglomerate, all belonging to the Fountain Formation. Here, the strata tilt less steeply and are shaped into mushroomlike pedestals and balanced rocks by differential erosion of harder and softer layers. The Rampart Range fault, concealed by the soil of the valley floor, separates them from the tall gateway slabs farther east.

All these pink and red rocks were deposited in alluvial aprons by streams draining Frontrangia, part of the Ancestral Rockies. Look closely for sedimentary details in them: ripple marks, thin bands of stream-rounded pebbles, impressions of mudcracks. In places you can see sweeping lines of crossbedding cutting diagonally across sandstone layers.

The lack of fossils (except for a few animal footprints) or volcanic material in the Fountain Formation makes it impossible to date it precisely, so we have to deduce its age. We know it was deposited above Pennsylvanian shales and below Triassic ones. We know its older part is Pennsylvanian because the lowest layers alternate with thin gray shales that contain Pennsylvanian fossils. But the upper part, the pink sandstone of the tallest pinnacles, resembles the Permian Lyons Sandstone north of Boulder, suggesting that Fountain Formation deposition continued into Permian time.

Tears From a Volcano

Uniquely American stone ignites romance

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