SN
SCIENCE NEWS MAG
SOCIETY FOR SCIENCE & TH
MARCH 31, 2018

Fake News Spreads Faster

Meet the Viral Titans

Opioid Death Demystified

When Stars Switched On

A fighting CHANCE

Can a vaccine save Ethiopia's wolves?

The Stone That Makes Even the Emerald Green With Envy

Over 23 total carats of gorgeous green Helenite for ***only $95***

"Nothing greens greener," is how Roman historian Pliny the Elder described emerald gemstones in his "Natural History" text. But that was 2,000 years before, when the raw volcanic materials that would form Helenite were still brewing in the belly of Mount St Helens in the Pacific Northwest. The volcano finally erupted in 1980, filling the sky with fire. Soon after, we discovered that its explosive contents could form a powerfully green new stone, known as Helenite.

Had Pliny the Elder laid eyes on Helenite he would surely be tempted to rewrite his history, even more so if he knew we were selling it for just **$95.**

The *Green Goddess Ring* showcases Helenite in all its glory. This generous American-grown 23 carat stone is prong set with just a sprinkling of scientifically-grown Diamond*Aura*®, and its diamond cut invites plenty of light to play off the verdant shade inside the stone.

Over 23 carats of green perfection that keeps the green in your wallet. Helenite's vivid color and immaculate clarity rivals mined emeralds that can sell for as much as $15,000 a carat. In fact, clear green color in a stone this size is rarely found in emeralds, and if so it would be prohibitively expensive. Instead, you can own this stop-and-stare beauty called "American's Emerald" for less than you'd spend on a fancy dinner.

Satisfaction guaranteed or your money back. Enjoy the *Green Goddess Ring* for 30 days. If it doesn't pass with flying colors, send it back for a full refund of the item price.

Limited Reserves. This is a lot green for the money. We cannot guarantee availability for long. Call today!

Green Goddess Ring (23.3 ctw) **$95** + S&P

Also available

Green Goddess Ring with 14K Gold Setting (23.3 ctw) **$495** + S&P

You must use the offer code to get our special price.

1-800-333-2045

Offer Code: GGR133-01

What customers are saying about Stauer Helenite Rings...

★★★★★

"The clarity & color are amazing. I wear it proudly and enjoy the compliments." — Diane, St. Louis, MO

23 carat Helenite & Diamond*Aura*® accents • Yellow gold-finished .925 sterling silver setting • Whole ring sizes 5–10

Stauer®

Stauer...Afford the Extraordinary.™

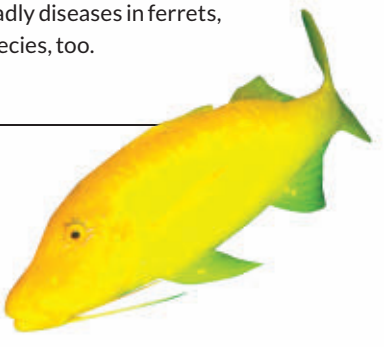
stauer.com

VOL. 193 | NO. 6

ScienceNews

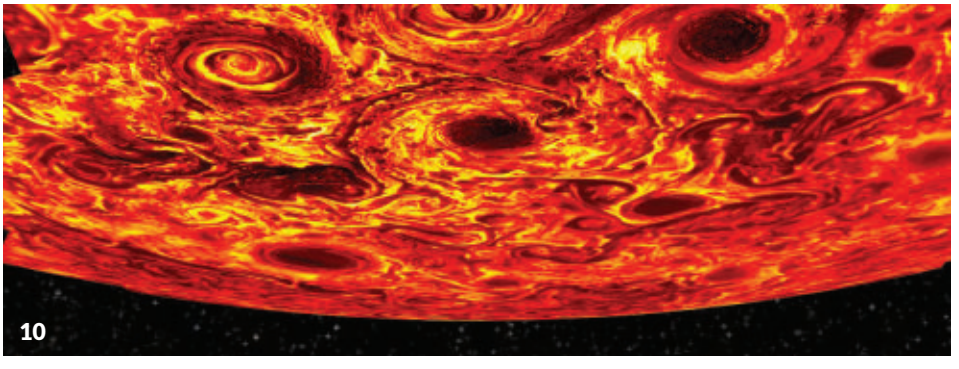
20

Features



4

News



10

Departments

COVER An Ethiopian wolf pack's dominant female breeds once a year and has two to six pups (one shown). © *Burrard-Lucas Photography*

Why it's great to have a geologist in the house

Science has a way of surprising us when we least expect it. Like with mud rocks.

We science journalists can be a cranky lot, eternally skeptical as to whether a touted advance is really significant enough to warrant coverage. So when *Science News*' managing editor Erin Wayman waxed enthusiastic about a study explaining how ancient plants may have played a key role in making Earth muddier, I perked up.

Geologists have long known that mud started to take hold at some point, but as earth and climate writer Carolyn Gramling reports in this issue (see Page 9), "no one had ever pinpointed when that muddening happened."

Clearly erosion must have been a factor, but that's as far as my mud expertise goes. A geologist I am not. Fortunately, Gramling is a geologist, with bachelor's degrees in both geology and European history and a Ph.D. in marine geochemistry. I asked her what it was about this study that convinced her it was worth a look. "It struck me because I like to know what makes things tick," she said during a conversation in my office. "It was surprising."

This wasn't a big sexy science story: no neutron star collisions, no gene-editing breakthroughs, no advances in immunotherapy. Instead, we have grayish rocks. But they have something to tell us. The researchers, at the University of Cambridge, looked at ancient riverbed deposits and found that the amount of mud rock, which is primarily made of clay, silt and other fine particles, increased about 458 million years ago. That's also when a group of primitive land plants known as bryophytes, which include modern mosses and liverworts, became common on Earth.

The ancestors of modern bryophytes including mosses and this *Marchantia* liverwort populated Earth before the advent of rooted plants.

The fact that bryophytes could have had that much impact is another surprise, Gramling said. "These are not rooted plants," she added. "They're these little mats of mosses on the surface, but they still have this profound effect." Indeed, the author of a commentary accompanying the study in *Science* called the plants "tiny, little scrappy things."

I like the notion of scrappy little underdog plants helping to transform the face of our planet. And I very much like having a writer on staff who's a scientist with deep expertise who can say, yes, this is as neat as it sounds.

Gramling was quick to note that we don't know exactly how ancient plants made Earth muddier. But even simple plants can help keep wind and water from eroding sediments. Plants may also help break down rock chemically, too.

Mud is often the bane of gardeners. But as this spring blooms, it wouldn't be out of place to offer a nod of thanks to the scrappy little ancient plants who helped make mud happen. —*Nancy Shute, Editor in Chief*

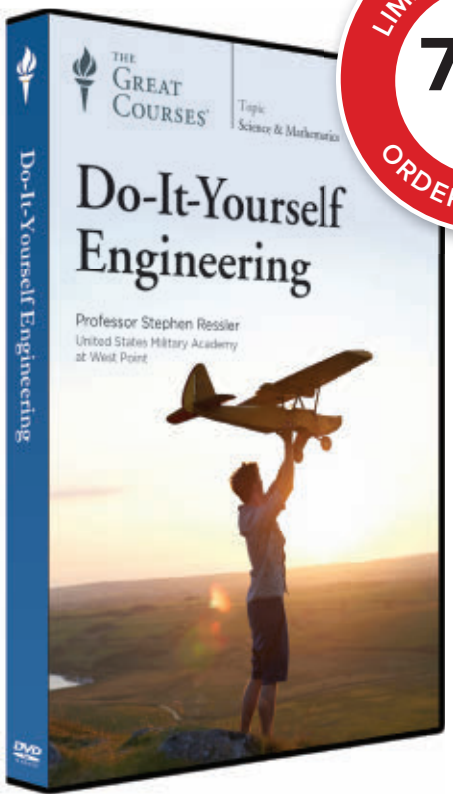
Science News
1719 N Street NW, Washington, DC 20036
(202) 785-2255

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

Alliance for Audited Media

Editorial/Letters: editors@sciencenews.org
***Science News* in High Schools:** snhs@societyforscience.org
Advertising/Sponsor content: ads@societyforscience.org
Science News (ISSN 0036-8423) is published biweekly except twice in September and monthly in January and April 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
Subscribing memberships include 23 issues of *Science News* and are available for $50 for one year (international rate of $68 includes extra shipping charge). Single copies are $3.99 (plus $1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.
Postmaster: Send address changes to *Science News*, PO Box 292255, Kettering, OH 45429-0255. Two to six weeks' notice is required. Old and new addresses, including zip codes, must be provided.

THE GREAT COURSES®



A Do-It-Yourselfer's Dream Come True

The best way to learn science is by doing science. It's also the most enjoyable. You can confidently tackle a working suspension bridge, airplane, helicopter, catapult, clock, and other technological wonders, learning key engineering concepts along the way.

Do-It-Yourself Engineering shows you how through 17 engaging DIY projects that you create exactly as an engineer does: starting with the concept, working out the design, plunging into construction, and finally putting the product to the test. Your enthusiastic guide is award-winning teacher Stephen Ressler, a DIY addict and Professor Emeritus of Engineering at the United States Military Academy at West Point.

Using in-studio and in-shop demonstrations, detailed drawings, and 3D computer models, Professor Ressler walks you through the entire process, including the crucial planning phase where most people wonder, "Where do I start?" Above all, he teaches you how to think like an engineer in approaching any problem.

Offer expires 04/21/18

THEGREATCOURSES.COM/7SN

1-800-832-2412

Do-It-Yourself Engineering

Taught by Professor Stephen Ressler
UNITED STATES MILITARY ACADEMY AT WEST POINT

LESSON TITLES

1. Why DIY Engineering?
2. Exploring the Science of Structure
3. Design and Build a Cardboard Tower
4. Bridging with Beams
5. Make a Suspension Bridge
6. Design a Concrete Sailboat
7. Set Sail!
8. Make a Radio-Controlled Blimp
9. Exploring Aerodynamics
10. Build a Model Airplane
11. Take Flight!
12. Build a Model Helicopter
13. This *Is* Rocket Science
14. Build a Rocket
15. Make an Electric Launch Controller
16. Let's Do Launch!
17. A Tale of Three Catapults
18. Build a Ballista, Onager, and Trebuchet
19. Design a Hydraulic Arm
20. Make a Water Turbine
21. Design a Gear Train
22. Make a Mechanical Clock
23. Design a Motor-Powered Crane
24. Creative Design: A Tribute to Rube Goldberg

Do-It-Yourself Engineering
Course no. 1144 | 24 lessons (30 minutes/lesson)

SAVE UP TO $190

DVD	~~$269.95~~	**NOW $79.95**
Video Download	~~$234.95~~	**NOW $59.95**

+$10 Shipping & Processing (DVD only)
and Lifetime Satisfaction Guarantee

Priority Code: 157775

For over 25 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free apps for iPad, iPhone, Android, Kindle Fire, or Roku. Over 600 courses available at www.TheGreatCourses.com.

Excerpt from the March 30, 1968 issue of *Science News*

50 YEARS AGO

Biological invasion via Suez

The Red Sea is invading the Mediterranean.... So far about 140 life-forms, mostly animal and mostly invertebrate, have crossed the Isthmus of Suez.... It is possible that this ... will result in the loss of a few native fish and invertebrate populations to stiff competition from the newcomers.

UPDATE: Whether the movement of creatures through the Suez Canal, called the Lessepsian migration, is good or bad has been debated from the time the waterway opened in 1869. The number of species invading the Mediterranean from the Red Sea now tops 400, scientists estimate. Some of these aliens have an unusual way of making the journey. At least 10 species of foraminifera hitch rides inside the guts of rabbitfish, which defecate out the still-living protists in the Mediterranean. The rabbitfish devour algal forests and the tiny interlopers carpet the seafloor, driving out some native species. In 2015, the Egyptian government widened part of the canal, allowing for more ship traffic — and unwanted invaders.

IT'S ALIVE

Goatfish triumph together with selfish goals

The only fish known to hunt with wolf pack moves may not be true team players, just lemon-yellow me-firsts.

Yellow saddle goatfish (*Parupeneus cyclostomus*) do more than school together as they dart over Indo-Pacific coral reefs. Like wolves, the goatfish take different roles in a pursuit. One or two fish may rush straight toward prey as the others shoot to the sides, blocking escape.

"They look harmless, but they're vicious predators," says Redouan Bshary of the University of Neuchâtel in Switzerland. "That's why it's fun to follow them — there's always action."

Bshary and colleagues have documented other fishy hunting partnerships, such as groupers pairing with crevice-wriggling moray eels. The goatfish collaborate with members of their own species that probably are not close kin, Bshary's team has reported. The fish chase other small, fast reef fish. It's "a little bit like Ultimate Frisbee," says Dominique Roche, in Bshary's lab. "It's a game of sprinting and stopping." The bright yellow goatfish dart into a reef "like a lightning flash."

When wolves hunt together, some will take a risky role even though they won't get a greater share of the reward, Roche says. A goatfish pack, however, doesn't deal in heroics. In lab studies of goatfish pursuing a lure on a string, any help a fish gives its comrades could be explained as an accidental by-product of self-interest, according to Bshary, Roche and colleague Marc Steinegger.

Pure self-interest could explain the smoothly coordinated moves and effective collaboration in hunting packs of yellow saddle goatfish.

In the tests, two goatfish swimming close to each other when the lure appeared usually shot after it together, the researchers reported in the Jan. 31 *Proceedings of the Royal Society B*. If the two fish were more than a body length apart, however, the trailing fish typically darted to the side, where it might catch the frantic prey if it veered from the lead pursuer toward some shelter.

Those side moves are a lagging fish's best chance for a catch, Roche says. Watching goatfish in the Red Sea close in on some little fish, he typically sees the goatfish space themselves just about evenly around their prey. The simple rule of taking the best position considering a goatfish's starting point could easily — and unintentionally — help a fellow hunter nab a meal.

Goatfish don't share their prey. But as the hunting party darts among the corals, collaborators come upon prey at different angles, boosting their chances of catching more together than any fish would alone.

"There was a strong belief for a long time," Roche says, that for true collaborative hunting "you must need a really big brain to process complex information." The tests, he says, show what can be done when a "small-brain fish" makes self-interested decisions. — *Susan Milius*

FROM TOP: M. STEINEGGER; ALBERT KOK/WIKIMEDIA COMMONS (CC BY-SA 3.0)

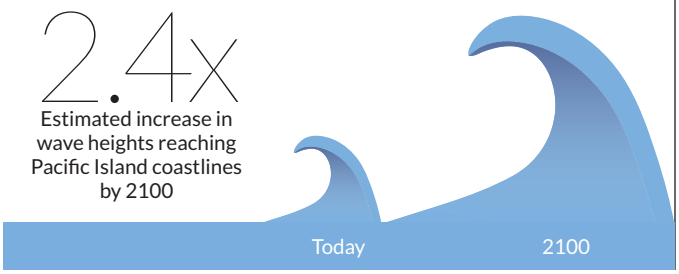
SCIENCE STATS

Damaged corals mean bigger waves

A complex coral reef full of nooks and crannies can diffuse the power of ocean waves hitting the shore. But coral die-offs over the next century could expose coastlines to taller waves, simulations suggest.

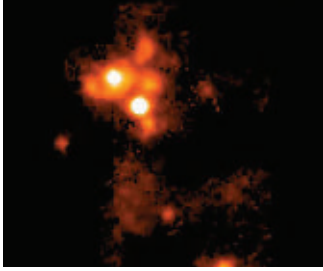
Coral reefs dissipate wave energy through friction, calming waves before they reach the shore. Researchers compared simulations of current and future sea level and reef conditions at four sites near the French Polynesian islands of Mooréa and Tahiti. The team then simulated the height of a wave after it had passed a reef under several scenarios.

Under the most likely scenario, based on projections of the Intergovernmental Panel on Climate Change, average post-reef wave heights at the four sites would be 2.4 times as high in 2100 as today — mean winter wave heights would rise from 2 meters to nearly 5, largely due to drops in reef complexity, the team reports February 28 in *Science Advances*. Conserving reefs is crucial, the researchers say, to protect coastal communities in a changing climate. — *Carolyn Gramling*



HOW BIZARRE

Star-making drifters



Data from the MUSE spectrograph in Chile help reveal abundant clumps of hydrogen gas in two clouds.

A pair of dark loners wander a distant cluster of galaxies. The two small gas clouds have been roaming the Virgo cluster, some 55 million light-years from Earth, for at least a billion years. Such small, isolated clouds of gas shouldn't be able to form stars on their own — and yet they are doing just that.

Astronomer Michele Bellazzini of the Italian National Institute for Astrophysics in Bologna and his colleagues found the dim clouds in 2014 in the SECCO survey, which looks for the building blocks of galaxies. The two clouds are moving at similar speeds and have the same chemical composition. Together, the clouds, called SECCO 1, have just 160,000 solar masses' worth of stars, but 20 million solar masses of hydrogen gas — a lot more hydrogen than found in other small starry bodies. And the duo is abnormally isolated: The nearest potential parent galaxies are about 815,000 light-years away. To be so alone for such a long time is unusual, and forming stars after wandering so long is hard to explain.

Simulations suggest SECCO 1 was stripped from a trio of interacting dwarf galaxies, Bellazzini and colleagues report online February 16 at arXiv.org. Its latest bout of star formation started a recent 4 million years ago. But how? Bellazzini thinks the key could be the Virgo cluster. Hot gas there may surround the clouds and compress them enough to make them light up. — *Lisa Grossman*

CLOCKWISE FROM TOP: G. BECCARI *ET AL/MON. NOTICES ROYAL ASTRON. SOC.* 2017; D. STEC, K. ARAKAWA AND Ł. MICHALCZYK/*PLOS ONE* 2018; T. TIBBITTS

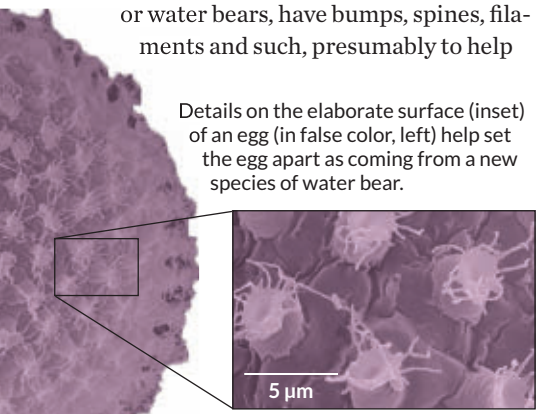
INTRODUCING

Tardigrade lays eggs covered with doodads

What a spectacular Easter basket tardigrade eggs would make — at least for those celebrating in miniature.

A new species of the pudgy, eight-legged microscopic creatures lays pale, spherical eggs studded with domes topped in long streamers.

Eggs of many land-based tardigrades, or water bears, have bumps, spines, filaments and such, presumably to help attach to a surface, says species codiscoverer Kazuharu Arakawa. The combination of a relatively plain surface on the egg itself (no pores, for instance) plus a filament crown helps distinguish the new water bear as its own species, named *Macrobiotus shonaicus,* Arakawa and colleagues report February 28 in *PLOS ONE.*



Details on the elaborate surface (inset) of an egg (in false color, left) help set the egg apart as coming from a new species of water bear.

About 20 new species are added each year to the roster of these icons of extreme survival (*SN Online: 7/14/17*).

"I was actually not looking for a new species," Arakawa says. He happened on it when searching through moss he plucked from the parking lot at his apartment. He routinely samples stray spots in search of tardigrades, one of his main interests as a genome biologist at Keio University in Tsuruoka City, Japan. These particular moss-loving creatures managed to grow and reproduce in the lab — "very rare for a tardigrade," he says. He didn't realize they were an unknown species until he started deciphering the DNA of some of their genes. The sequences he found didn't match any in a worldwide database.

His two coauthors, at Jagiellonian University in Krakow, Poland, worked out that he had found a new member of a storied cluster of relatives of the tardigrade *M. hufelandi.* That species, described in 1834, kept turning up around the world — or so biologists thought for more than a century. Realization eventually dawned that the single species that could live in such varied places was actually a complex of close cousins. Now *M. shonaicus* adds another cousin to a group of about 30. And, says Arakawa, "I think there are lots more species to be identified." — *Susan Milius*

The universe's first stars may have turned on by 180 million years after the Big Bang. Ultraviolet light from early stars (illustrated) interacted with hydrogen, which absorbed background radiation to create a detectable signal.

NICOLLE RAGER FULLER, NSF

ATOM & COSMOS

Scientists find 'fingerprint' of first stars

Dark matter clues may also be embedded in radio observations

BY EMILY CONOVER

For the first time, scientists may have detected hints of the universe's primordial sunrise, when the first twinkles of starlight appeared in the cosmos.

Stars began illuminating the heavens by about 180 million years after the universe was born, researchers report in the March 1 *Nature*. This "cosmic dawn" left its mark on the hydrogen gas that surrounded the stars (*SN: 6/8/02, p. 362*). A radio antenna has reportedly picked up that resulting signature.

"It's a tremendously exciting result. It's the first time we've possibly had a glimpse of this era of cosmic history," says H. Cynthia Chiang, an observational cosmologist at the University of KwaZulu-Natal in Durban, South Africa, who was not involved in the research.

The oldest galaxies seen directly with telescopes sent their starlight significantly later: several hundreds of millions of years after the Big Bang, which occurred about 13.8 billion years ago. The new observation used a technique that was over a decade in the making and relies on probing the hydrogen that filled the early universe. That approach holds promise for the future: More advanced measurements may eventually reveal details of the early universe throughout its most difficult-to-observe eras.

But experts say the result needs additional confirmation, in particular because the signature doesn't fully agree with theoretical predictions. The signal — a dip in the intensity of radio waves across certain frequencies — was more than twice as strong as expected.

The unexpectedly large signal suggests that the hydrogen gas was colder than predicted. If confirmed, this observation might hint at a new phenomenon taking place in the early universe. One possibility, suggested in a companion paper in the same issue of *Nature* by theoretical astrophysicist Rennan Barkana of Tel Aviv University, is that the hydrogen was cooled via new types of interactions between it and particles of dark matter, a mysterious substance that makes up most of the matter in the universe.

If the interpretation is correct, "it's quite possible that this is worth two Nobel Prizes," says Avi Loeb, a theoretical astrophysicist at Harvard University. One prize could be given for detecting the signature of the cosmic dawn, and another for the dark matter implications. But Loeb has reservations about the result: "What makes me a bit nervous is the fact that the [signal] that they see doesn't look like what we expected."

Experimental cosmologist Judd Bowman of Arizona State University in Tempe and colleagues teased out their evidence for the first stars from the impact the light had on hydrogen gas. "We don't see the starlight itself. We see indirectly the effect that the starlight would have had" on the cosmic environment, says Bowman, a collaborator on the Experiment to Detect the Global Epoch of Reionization Signature, EDGES, which detected the stars' traces.

Collapsing out of dense pockets of hydrogen gas early in the universe's history, the first stars flickered on, emitting ultraviolet light that interacted with the surrounding hydrogen. The starlight altered the proportion of hydrogen atoms found in different energy levels. That change caused the gas to absorb light of a particular wavelength, about 21 centimeters, from the cosmic microwave background — the glow left over from around 380,000 years after the Big Bang (*SN: 3/21/15, p. 7*). A distinctive dip in the intensity of the light at that wavelength appeared as a result.

Over time, that light's wavelength was stretched to several meters by the expansion of the universe, before being detected on Earth as radio waves. Observing the amount of stretching that had taken place in the light allowed the researchers to pinpoint how long after the Big Bang that light was absorbed, revealing when the first stars turned on.

Still, detecting the faint dip was a challenge: Other cosmic sources, such as the Milky Way, emit radio waves at much higher levels, which must be accounted for. To avoid interference from sources on Earth — like FM radio stations — Bowman and colleagues set up their table-sized antenna far from civilization, at the Murchison Radio-astronomy Observatory in the Australian outback.

Scientists hope to use similar techniques with future, more advanced instruments to map out where in the sky stars first started forming and to reveal other periods early in the universe's history. "This is really the first step," Bowman says, "in what's going to become a new and exciting field." ■

LIFE & EVOLUTION

Termites are just social cockroaches

Science society strips famous insect group of its own order

BY SUSAN MILIUS

Termites are the new cockroach. Literally. The Entomological Society of America is updating its master list of insect names to reflect decades of genetic and other evidence that termites belong in the cockroach order, Blattodea.

As of February 15, "it's official that in the eyes of the ESA, termites no longer have their own order," says Mike Merchant of Texas A&M University in College Station, chair of the society's common names committee. Now all termites on the list are being recategorized.

The demotion brings to mind Pluto getting kicked off the roster of planets, says termite biologist Paul Eggleton of the Natural History Museum in London. He does not, however, expect a galactic outpouring of heartbreak and protest over the termite downgrade. Among specialists, discussions of termites as a form of roaches date back to at least 1934, when researchers reported that microbes that digest wood in termite guts live in some wood-eating cockroaches too.

Once biologists figured out how to use DNA to work out genealogical relationships, evidence began to grow that termites had evolved as a branch on the many-limbed family tree of cockroaches. In 2007, Eggleton and colleagues used genetic evidence from an unusually broad sampling of species to publish a new tree of these insects (*SN: 5/19/07, p. 318*). The study placed termites on the tree near a *Cryptocercus* cockroach.

Some *Cryptocercus* roaches live in almost termitelike style in the Appalachian Mountains, not too far from chemical ecologist and cockroach fan Coby Schal of North Carolina State University in Raleigh. Monogamous pairs of *Cryptocercus* roaches eat tunnels in wood and raise young there. Offspring feed on anal secretions from their parents, which provide nutrition and starter doses of the wood-digesting gut microbes that eventually let the youngsters eat their way into homes of their own.

Termites are "nothing but social cockroaches," Schal says. Various roaches have some form of social life, but termites go to extremes. They're eusocial, with just a few individuals in colonies doing all of the reproducing.

After years of debate, the society's common names committee voted to switch to the new view of termites. At a meeting of the society board, there was no objection. Common names of individual termite species will remain as something-something "termite." ■

EARTH & ENVIRONMENT

Plants rebound in the Chesapeake Bay

Regulations limiting runoff are an environmental success story

BY LAUREL HAMERS

Underwater plants are growing back in the Chesapeake Bay. The plants now carpet more than three times as much real estate as in 1984, thanks to over 30 years of efforts to reduce nitrogen pollution. This environmental success story shows that regulations to protect the bay's health have made a difference, researchers report online March 5 in *Proceedings of the National Academy of Sciences*.

Rules limiting nutrient runoff from farms and wastewater treatment plants helped to decrease nitrogen concentrations in the bay by 23 percent since 1984. That decline in nitrogen has allowed the recovery of 17,000 hectares of vegetation, the new study shows — enough to cover roughly 32,000 football fields.

"This is one of the best examples we have of linking long-term research data with management to show how important that [linkage] is in restoring this critical habitat," says environmental scientist Karen McGlathery of the University of Virginia in Charlottesville. "I don't know of any other system that's so large and so complicated where these connections have been made."

The bay's vegetation, including seagrasses and freshwater plants, is an important part of coastal ecosystems, says Jonathan Lefcheck, a study coauthor and marine ecologist at the Bigelow Laboratory for Ocean Sciences in East Boothbay, Maine. Underwater plants act as nurseries that shelter young fish and invertebrates. The plants clean the water by trapping particulates and stabilize shorelines by preventing erosion.

But the once lush foliage began dying off in the 1950s when the region's human population boomed, and cities and farms dumped increasing amounts of nitrogen and other nutrients into the bay. In the late 1970s and early 1980s, state and federal agencies took action, limiting the amount of nutrients that could enter the bay from human sources. Those agencies also instituted programs to monitor the bay's health, building up the stockpile of data that Lefcheck's group analyzed.

Once dwindling, vegetation in the Chesapeake Bay has made a comeback in recent years, providing habitat for critters like this blue crab.

JAY FLEMING

The team looked at aerial surveys of the bay, and data on water temperature and nutrient levels, as well as land and fertilizer use. Using equations to test which variables had the biggest impact on plant regrowth, the team pinned down nitrogen reduction as the driving force. That makes sense: Too much nitrogen promotes the growth of both plankton, which can block sunlight, and algae, which can smother plants. ■

BODY & BRAIN

Mice can become forgetful after flu

Study raises concern about people's response to influenza

BY LAURA SANDERS

The fevers, chills and aches of the flu can pound the body. Some influenza viruses may hammer the brain, too. Months after a flu infection, mice had signs of brain damage and memory trouble, researchers report online February 26 in the *Journal of Neuroscience*.

It's unclear if people's memories are affected in the same way. But the study adds to evidence suggesting that some body-wracking infections also harm the brain, says Columbia University epidemiologist and neurologist Mitchell Elkind.

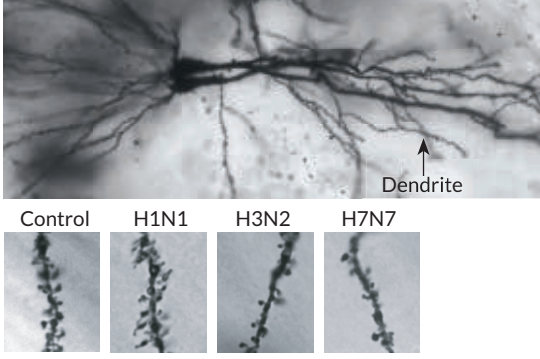
Obvious to anyone who has been waylaid by the flu, brainpower can suffer at the infection's peak. But not much is known about any potential lingering effects on thinking or memory. "It hasn't occurred to people that it might be something to test," says study coauthor Martin Korte, a neurobiologist at Technische Universität Braunschweig in Germany.

The study examined the effects of three types of influenza A: H1N1, the strain behind 2009's swine flu outbreak; H7N7, a dangerous strain that rarely infects people; and H3N2, the strain behind much of the current flu season's misery (*SN: 2/17/18, p. 12*). Korte and colleagues shot these viruses into mice's noses, then looked for memory problems 30, 60 and 120 days later.

A month after infection, the mice all appeared to have recovered. But those that had received H7N7 and H3N2 had trouble remembering the location of a hidden platform in a pool of water. Mice that received no flu or the milder H1N1 virus performed normally on the task.

Researchers also studied brain tissue under a microscope and found that the memory problems tracked with changes in nerve cells. A month after H7N7 or H3N2 infection, mice had fewer nerve cell connectors called dendritic spines on cells in the hippocampus, a brain region involved in memory. Nerve cells' signal-sending abilities were impaired, electrical experiments on cells in dishes revealed.

The mouse brains also looked inflamed under the microscope, full of immune cells called microglia that were still revved up 30 and 60 days after infection. Cell counts revealed that mice that had suffered through H7N7 or H3N2 had



In mice, some flu strains affect the dendrites of nerve cells (top) in the hippocampus, a brain structure important for memory. Message-receiving dendritic spines (bumps in lower panels) were sparse after H3N2 and H7N7 infections. No decreases were seen in mice infected with H1N1 or not infected at all.

S. HOSSEINI *ET AL./JOURNAL OF NEUROSCIENCE* 2018

GENES & CELLS

Skin bacteria might be cancer fighters

Microbial compound disrupts DNA formation, inhibits tumors

BY AIMEE CUNNINGHAM

Certain skin-dwelling microbes may be anticancer superheroes, reining in uncontrolled cell growth. This surprise discovery could one day lead to drugs that treat or even prevent skin cancer.

The bacteria's secret weapon is a chemical compound that stops DNA formation in its tracks. Mice slathered with one strain of *Staphylococcus epidermidis* that made the compound developed fewer tumors after exposure to damaging ultraviolet radiation compared with those treated with a strain lacking the compound, researchers report February 28 in *Science Advances*.

The findings highlight "the potential of the microbiome to influence human disease," says Lindsay Kalan, a biochemist at the University of Wisconsin–Madison who was not involved in the study.

Staphylococcal species are the most numerous of the many bacteria that normally live on human skin. Richard Gallo and colleagues were investigating the antimicrobial powers of these bacteria when the team discovered a strain of *S. epidermidis* that made a compound — 6-N-hydroxyaminopurine, or 6-HAP — that looked a lot like one of the building blocks of DNA. "Because of that structure, we wondered if it interfered with DNA synthesis," says Gallo, a physician scientist at the University of California, San Diego. In a test tube experiment, 6-HAP blocked the enzyme that builds DNA chains and prevented the chains from growing.

Cancer cells have runaway growth, so the researchers thought the compound might inhibit those cells. Sure enough, 6-HAP stopped DNA formation in different tumor cells grown in the lab. But the compound was not able to do so in normal skin cells. Certain enzymes in normal skin cells deactivated 6-HAP, the researchers found, and the tumor cells tested appeared to lack those enzymes.

Gallo and colleagues found that the compound had an effect when either injected or applied topically. Among mice injected with skin cancer cells, some received a shot of 6-HAP while others got a dummy shot. Tumors grew in all the mice, but the tumors in mice given 6-HAP were about half the size of those in mice without the compound.

The team then spread *S. epidermidis* on the backs of hairless mice subjected to UV rays. Some mice got a strain that makes 6-HAP; others got a strain that does not. After 12 weeks of periodic exposure to UV rays, the first group of mice developed one tumor each; mice in the second group were saddled with four to six tumors.

S. epidermidis may have the ability to stop DNA synthesis to prevent other

more active microglia than mice infected with H1N1 or no virus at all. The lingering activity was surprising, Korte says, because immune cells in the body usually settle down soon after an infection clears.

Memory problems and signs of brain trouble were gone by 120 days, which translates to about a decade in human time. "I'm not saying that everyone who has influenza is cognitively impaired for 10 years," Korte says, noting that human brains are much more complex than those of mice. "The news is more that we should not only look at lung functionality after the flu, but also cognitive effects, weeks and months after infection."

H7N7 can infect brain cells directly. But H3N2 and H1N1 don't typically get into the brain. Some flu viruses may cause brain trouble remotely, perhaps through inflammatory signals in the blood making their way into the brain. If that pathway is confirmed, then many types of infections could cause similar effects on the brain. "It is plausible that this is a general phenomenon," Elkind says. ■

bacteria from growing, Gallo says. In that way, the bacteria protect their homestead from other invading pathogens. "Perhaps we evolved to provide a safe haven for these organisms because they also benefit us when they're doing this," Gallo says. The researchers estimate that 20 percent of people have on their skin *S. epidermidis* strains that make 6-HAP.

More work needs to be done to understand how *S. epidermidis* makes 6-HAP and how much of the compound is on the skin, Kalan says. "It is important to understand how the microbiome interacts with its human host before we can begin to manipulate it for disease treatment." One approach could be to develop probiotics for the skin — adding helpful bacteria to ward off infection or maybe even prevent cancer, she says.

Along with its activity in skin cancer cells, 6-HAP also blocked DNA synthesis in lymphoma cells, cancerous immune system cells. It's too early to say, but there is potential for this secret weapon to slay more than one villain. ■

V. ALTOUNIAN/*SCIENCE* 2018, ADAPTED BY C. CHANG

EARTH & ENVIRONMENT

Ancient land plants mucked up Earth

As botanical species spread, mud rocks increased in riverbeds

BY CAROLYN GRAMLING

Early plants made Earth muddier. Ancient riverbed deposits of mud rock — rock containing bits of clay and silt smaller than grains of sand — began increasing about 458 million years ago, around the time that rootless plants became common.

Anecdotally, geologists have long noted that early sediment deposits became muddier at some point and suggested a connection with plants (*SN: 6/22/74, p. 398*). But no one had pinpointed when that muddening happened.

So geologists William McMahon and Neil Davies, both of the University of Cambridge, decided to look for when amounts of mud rock began increasing in 704 ancient river deposits from 3.5 billion to 300 million years ago. The researchers searched through nearly 1,200 papers for data on mud rock in river deposits and collected field data at 125 ancient river outcrops. At those outcrops, the pair calculated the percent of mud rock in the overall deposit by measuring the thickness of the muddy layers compared with the thickness of layers containing larger grains such as sand.

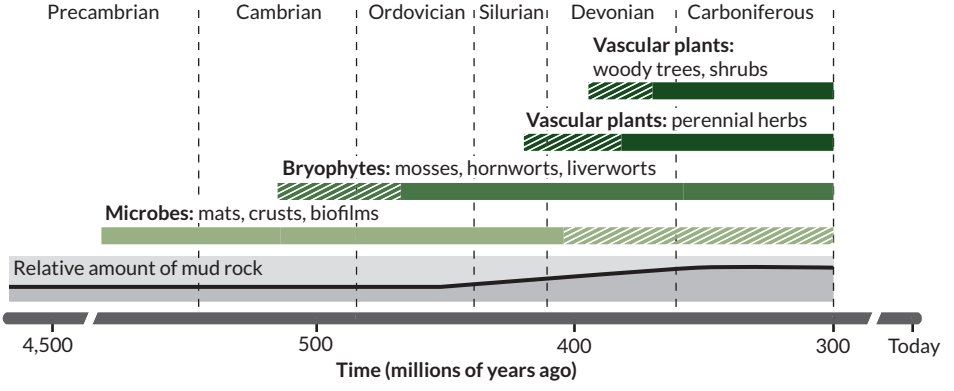
The resulting fractions show that the median mud content was about 1 percent before around 458 million years ago. At that point, the mud content steadily increased over the next 100 million years or so to reach a median of about 26 percent in outcrops from 359 million to 299 million years ago, McMahon and Davies report in the March 2 *Science*.

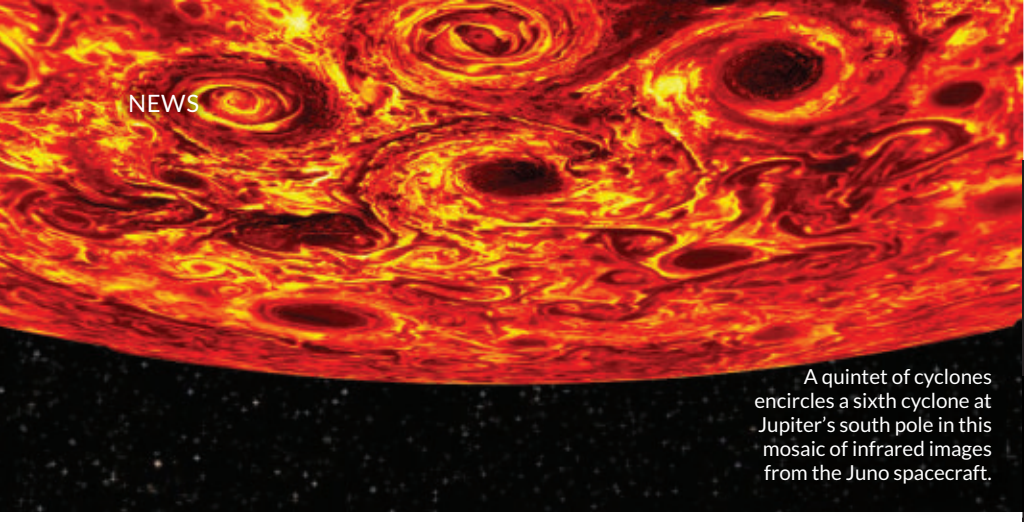
That steady upsurge suggests that neither cyclical nor episodic forces — such as glacial-interglacial changes or tectonic events — could have driven the increase in mud. Instead, plants are the likeliest culprit. Rootless plants called bryophytes, which include modern mosses, had probably become common by about 458 million years ago. Rooted plants further increased the mud content when they arose and began to spread about 430 million years ago, eventually forming great forests by about 382 million years ago.

That bryophytes influenced mud's formation long before roots appeared is a surprise, says Woodward Fischer, a Caltech geobiologist who wrote a commentary about the study in *Science*. "The plants of that time were tiny, little scrappy things. They're closer to green mats."

How plants, rooted or not, helped increase Earth's muddiness is still uncertain. Earth had mud before it had plants: Weathering of rocks can create the silt and clay that make up mud, and bacteria and fungi also erode rock material into tinier bits. But plants can speed up the production of clays by, for example, secreting organic acids that change soil chemistry. ■

Mud's rise The spread of bryophytes, early land plants, coincided with a rise in mud rock starting about 458 million years ago. The origin and spread of rooted, or vascular, plants led to further increases. In the diagram, slashes denote lesser abundance.





A quintet of cyclones encircles a sixth cyclone at Jupiter's south pole in this mosaic of infrared images from the Juno spacecraft.

ATOM & COSMOS

Juno beams back 4 Jupiter surprises

Complex cyclones, massive atmosphere are among the finds

BY CHRISTOPHER CROCKETT

Bit by bit, Jupiter is revealing its deepest, darkest secrets.

The latest findings from the Juno spacecraft, which has been mapping what lurks beneath Jupiter's clouds since July 2016 (*SN: 6/25/16, p. 16*), unveil, among other things, the roots of the planet's storms and a striking geometric layout of cyclones parked around the gas giant's north and south poles.

"We're at the beginning of dissecting Jupiter," says Juno mission leader Scott Bolton of the Southwest Research Institute in San Antonio. And the picture that's emerging — still just a sketch — topples many preconceived notions, he says.

Check out these four surprising findings, published in four papers in the March 8 *Nature*, that reveal Jupiter is one of a kind.

1. Rings of cyclones

Parked at each pole is a cyclone several thousand kilometers wide. That part isn't surprising. But each of those cyclones is encircled by a polygonal arrangement of similarly sized storms — eight in the north and five in the south. The patterns have persisted throughout Juno's visit.

"We don't really understand why that would happen, and why they would collect up there in such a geometric fashion," Bolton says. "That's pretty amazing that nature is capable of something like that."

2. More than skin deep

Researchers have long debated whether the photogenic bands of clouds that wrap around Jupiter have deep roots or just skim the top of the gas giant's atmosphere. Juno's new look shows that the bands penetrate approximately 3,000 kilometers below the cloud tops. That's about 30 times as thick as the thickest part of Earth's atmosphere. Although just a tiny fraction of Jupiter's diameter, the cloud bands extend deeper than scientists previously thought, Bolton says.

3. Weighty weather

Those 3,000 kilometers are what pass for an atmosphere on Jupiter. It's the stage on which the planet's turbulent weather plays out. The atmosphere alone is about three times as massive as all of Earth, or 1 percent of Jupiter's entire mass, researchers estimate.

4. Stuck together

Below the atmosphere, Jupiter is fluid. But unlike most fluids, the planet rotates as if it's a solid mass. Like kids playing crack-the-whip, atoms of hydrogen and helium figuratively link arms and spin around the planet in unison, scientists report. Earlier results from Juno also indicate there's no solid core lurking beneath this fluid (*SN: 6/24/17, p. 14*), so anyone dropped toward the planet can expect a terribly long fall. ■

HUMANS & SOCIETY

People defy sleep habits of primates

Need to learn, terrestrial life may have led to less shut-eye

BY BRUCE BOWER

People have evolved to sleep much less than chimps, baboons or any other primate studied so far.

A large comparison of primate sleep patterns finds that most species get somewhere between nine and 15 hours of shut-eye daily, while humans average just seven. An analysis of several lifestyle and biological factors, however, predicts people should get 9.55 hours, researchers report online February 14 in the *American Journal of Physical Anthropology*. Most other primates in the study typically sleep as much as the scientists' statistical models predict they should.

Two long-standing features of human life have contributed to short sleep times, argue evolutionary anthropologists Charles Nunn of Duke University and David Samson of the University of Toronto Mississauga. First, when humans' ancestors descended from the trees to sleep on the ground, individuals probably had to spend more time awake to guard against predator attacks. Second, humans have faced intense pressure to learn and teach new skills and to make social connections at the expense of sleep.

As sleep declined, rapid-eye movement, or REM, sleep — linked to learning and memory — came to play an outsize role in human slumber, the researchers propose. Non-REM sleep accounts for an unexpectedly small share of human sleep, though it may also aid memory.

"It's pretty surprising that non-REM sleep time is so low in humans, but something had to give as we slept less," Nunn says.

Nunn and Samson's sample of 30 species is too small to reach any firm conclusions, cautions evolutionary biologist Isabella Capellini of the University of Hull in England. Estimated numbers of primate species often reach 300 or more.

JPL-CALTECH/NASA, SWRI, ASI, INAF, IAPS

If the findings hold up, Capellini suspects that getting most of our sleep in one major bout per day, rather than in several episodes of varying durations as some other primates do, substantially lessened human sleep time.

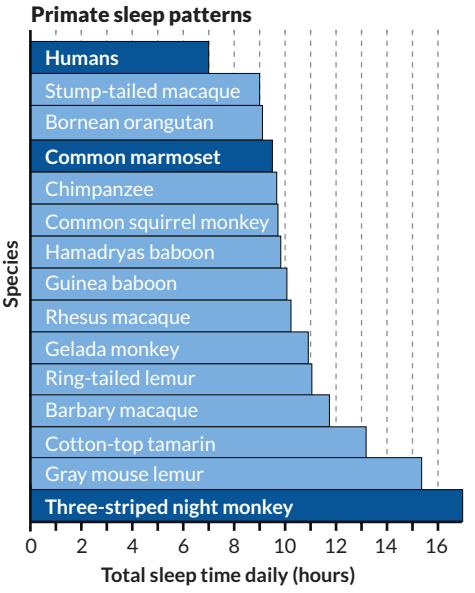
Nunn and Samson used two statistical models to calculate expected daily amounts of sleep for each species. For 20 species, enough data existed to estimate expected REM and non-REM sleep.

Estimates of all sleep times relied on databases of previous findings, largely involving captive animals wearing electrodes that measure brain activity during slumber. To generate predicted sleep values for each primate, the researchers consulted earlier studies of links between sleep patterns and various aspects of primate biology, behavior and environments. For instance, nocturnal animals tend to sleep more than those awake during the day. Species traveling in small groups or inhabiting open habitats along with predators tend to sleep less.

Based on such factors, the team predicted humans should sleep an average of 9.55 hours each day. People actually sleep an average of seven hours, and even less in some small-scale groups (*SN: 2/18/17, p. 13*). The 36 percent gap between actual and predicted sleep is far greater than for any other primate in the study.

Nunn and Samson estimated that people now spend an average of 1.56 hours of snooze time in REM, about as much as the models predict should be spent in that sleep phase. An apparent rise in the proportion of human sleep devoted to REM resulted mainly from a hefty decline in non-REM sleep, the scientists say. By their calculations, people should spend an average of 8.42 hours in non-REM sleep daily, whereas the actual figure reaches only 5.41 hours.

One other primate, South America's common marmoset (*Callithrix jacchus*), sleeps less than predicted, with an average of 9.5 hours. One species sleeps more than predicted: South America's three-striped night monkey (*Aotus trivirgatus*) gets nearly 17 hours every day. Why these species' sleep patterns don't match with expectations is unclear, Nunn says. Neither monkey departs from predicted patterns to the extent that humans do. ■



Bedtime Humans sleep less than other primates examined in a new study and were among three species (dark blue) whose sleep times differed from predictions. SOURCE: C.L. NUNN AND D.R. SAMSON/*AM. J. PHYS. ANTHROPOL.* 2018

E. OTWELL

MATTER & ENERGY

Quantum communication gets weirder

A single particle can send information in two directions at once

BY EMILY CONOVER

Communication is a two-way street. Thanks to quantum mechanics, that adage applies even if you've got only one particle to transmit messages with.

Using a single photon, or particle of light, two people can simultaneously send information to one another, scientists report in a pair of papers. The feat relies on a quirk of quantum mechanics known as superposition, the phenomenon through which particles can effectively occupy two places at once.

Sending information via quantum particles is a popular research subject, thanks to the promise of unhackable quantum communication (*SN: 12/23/17, p. 27*). The studies specify a previously unidentified twist on that technique. "Sometimes you overlook a cool idea, and then it's just literally right in front of your nose," says Philip Walther, an experimental physicist at the University of Vienna.

Imagine that two people, Alice and Bob, are stationed some distance apart. In standard classical physics, Alice and Bob would each require their own photon to send each other messages simultaneously, with each light particle transmitting a single bit, 0 or 1.

But if Alice and Bob possess a photon that is in a superposition — simultaneously located near Alice and near Bob — both of them can manipulate that photon to encode a 0 or 1, and then send it back to the other. How each manipulates the photon determines which of the two receives the photon in the end. If Alice and Bob put in the same bit — both 0s or both 1s — Alice receives the photon. If their bits don't match, Bob gets it. Since Alice knows whether she sent a 0 or a 1, she immediately knows whether Bob encoded a 0 or 1, and vice versa.

Theoretical physicists Flavio Del Santo of the University of Vienna and Borivoje Dakić of the Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences describe the theory behind this two-way quantum communication in the Feb. 9 *Physical Review Letters*. Walther, Del Santo, Dakić and colleagues follow up with a demonstration of the technique in a paper posted at arXiv.org on February 14.

To show that such communication is possible, Walther and colleagues sent single photons through an arrangement of mirrors and other optical devices. This put the photon in a superposition, sending it simultaneously to two stations that represented Alice and Bob.

By changing the phase of the light's electromagnetic wave — shifting where the troughs and peaks of the wave fell — the researchers encoded the photon with a 0 or 1 at each station. Then, the photon — still in limbo between Alice and Bob — was sent to the opposite station. Along the way, the photon interacted with itself, interfering like water ripples combining to amplify their strength or cancel out. That interference determined whether the final photon was detected at Alice's station or Bob's.

"It's a very nice idea," says University of Oxford physicist Giulio Chiribella. "This is another way in which quantum mechanics catches us off guard." ■

LIFE & EVOLUTION

The last wild horses aren't truly wild

When it comes to wild claims, hold your horses.

Considered to be the only living equines never domesticated, free-roaming Przewalski's horses of Central Asia (shown below) have a tamed ancestor, a genetic analysis of ancient horse bones finds. That makes Przewalski's horses feral, not wild. The analysis also debunks the idea that these same domesticated ancestors, known as Botai horses, gave rise to all other modern horses, leaving the progenitors of today's domesticated horses a mystery, researchers report online February 22 in *Science*.

The earliest known domesticated horses were those of the ancient Botai people in Kazakhstan (*SN: 3/28/09, p. 15*). Evidence of harnesses and pots with horse-milk residue are scattered at Botai sites dating to around 5,500 years ago, suggesting the animals provided both transportation and food.

Evolutionary geneticist Ludovic Orlando of the Natural History Museum of Denmark in Copenhagen and colleagues analyzed DNA from 88 horses spanning the last 5,000 years or so across Europe and Asia. Horses from the last 4,000 years had less than 3 percent Botai ancestry, suggesting that different and unknown horses founded today's populations. But Botai horses are direct ancestors of Przewalski's horses, the study found. — *Erika Engelhaupt*

FOTOHALO/ISTOCKPHOTO

ATOM & COSMOS

Superconductors found in space rocks

Strange materials known on Earth are discovered in 2 meteorites

BY EMILY CONOVER

In the search for new superconductors, scientists are leaving no stone — and no meteorite — unturned. A team has now found the unusual materials, famous for their ability to conduct electricity without resistance, within two space rocks.

The discovery implies that small amounts of superconducting materials might be relatively common in meteorites, physicist James Wampler of the University of California, San Diego reported March 6. While the materials weren't new to science, additional interplanetary interlopers might harbor new, more technologically appealing varieties of superconductors, the team suggests.

Superconductors could potentially beget new, energy-saving technologies, but they have one fatal flaw: They require very cold conditions to function. So scientists are on the hunt for new types that work at room temperature (*SN: 12/26/15, p. 25*). If found, such substances could lead to dramatic improvements in power transmission, computing and high-speed magnetically levitated trains, among other things.

Space rocks are a good avenue to explore, Wampler says. "Meteorites are formed under these really unique, really extreme conditions," such as high temperatures and pressures.

What makes the meteorite superconductors special, the researchers say, is that they occurred naturally, instead of being fabricated in a lab. In fact, says Ivan Schuller, a physicist at UC San Diego who led the research, these are the highest-temperature naturally occurring superconductors known — though they still have to be superchilled to about 5 kelvins (–268.15° Celsius) to work. They are also the first known to have formed extraterrestrially.

"At this point, it's a novelty," says Robert Cava, a chemist at Princeton University. Although Cava is skeptical that scrutinizing meteorites will lead to new, useful superconductors, he says it's "kinda cool" that superconductors show up in meteorites.

Wampler, Schuller and colleagues bombarded bits of powdered meteorite with microwaves and looked for changes in how those waves were absorbed as the temperature changed. The technique can pick out minute traces of superconducting material. Analysis of powdered scrapings from more than a dozen meteorites showed that two contained superconducting material.

But the superconductors were run-of-the-mill varieties, made from alloys of metals including indium, tin and lead already known to superconduct. "The idea is, try to look for something that is very unusual," Schuller says. ■

MEETING NOTES

Google moves toward quantum supremacy

Researchers from Google are testing a quantum computer with 72 quantum bits, or qubits, scientists reported March 5 — a big step up from the company's previous nine-qubit chip.

The team hopes to use the larger quantum chip to demonstrate quantum supremacy for the first time, performing a calculation that is impossible with traditional computers (*SN: 7/8/17, p. 28*), Google physicist Julian Kelly reported.

Achieving quantum supremacy requires a computer of more than 50 qubits, but scientists are still struggling to control so many finicky quantum entities at once. Unlike standard bits that take on a value of 0 or 1, a qubit can be 0, 1 or a mashup of the two, thanks to a quantum quirk known as superposition.

Nicknamed Bristlecone because its qubits are arranged in a pattern resembling a pinecone's scales, the computer is now being put through its paces. "We're just starting testing," says physicist John Martinis of Google and the University of California, Santa Barbara. "From what we know so far, we're very optimistic." The quantum supremacy demonstration could come within a few months if everything works well, Martinis says.

Google is just one company attempting to achieve supremacy. IBM announced it was testing a 50-qubit quantum computer last November (*SN Online: 11/10/17*), and Intel announced a 49-qubit test chip in January. — *Emily Conover*

With a twist, double-layer graphene superconducts

Give a graphene layer cake a twist and it superconducts — electrons flow freely through it without resistance. Made up of two layers of graphene, a form of carbon arranged in single-atom-thick sheets, the structure's weird behavior suggests it may provide a fruitful playground for testing how certain unusual types of superconductors work, MIT physicist Pablo Jarillo-Herrero reported March 7.

The superconductivity occurs when the second layer of graphene is at a "magic angle" of about 1.1 degrees relative to the first, and when cooled below 1.7 kelvins (about –271° Celsius). Surprisingly, Jarillo-Herrero and colleagues report, the material can also be nudged into becoming an insulator, in which electrons are stuck in place. That close relationship with an insulator is a characteristic shared by certain types of high-temperature superconductors, which function at dramatically warmer conditions than other superconductors, above about 77 kelvins, or about –196° C, though they still require cooling.

The discovery, also detailed in two papers published online in *Nature* on March 5, could help explain the still-murky physics behind high-temperature superconductors (*SN: 1/20/18, p. 11*). — *Emily Conover*

HUMANS & SOCIETY

In Twitter race, fiction beats fact

Fake news travels further than real stories, analysis finds

BY MARIA TEMMING

There's been a lot of talk about fake news running rampant online, and now there's fresh data to back up the discussion.

An analysis of more than 4.5 million tweets and retweets posted on Twitter from 2006 to 2017 indicates that inaccurate news stories spread faster and further on the social media platform than true stories. And people play a bigger role in sharing falsehoods than do bots, the research suggests.

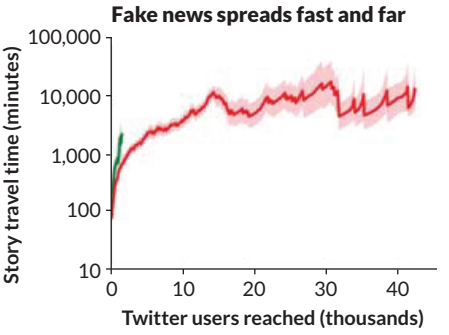
These findings, reported in the March 9 *Science*, could guide strategies for curbing misinformation on social media. Until now, most investigations into the spread of fake news have been anecdotal, says Filippo Menczer, an informatics and computer scientist at Indiana University Bloomington not involved in the work. "We didn't have a really large-scale, systematic study evaluating the spread of misinformation."

To study rumormongering trends on Twitter, researchers examined about 126,000 tweet cascades — families of tweets composed of one original tweet and all the retweets born of that original post. All of those cascades centered on one of about 2,400 news stories that had been verified or debunked by at least one fact-checking organization.

Deb Roy, a media scientist at MIT, and colleagues investigated how far and fast each cascade spread. Discussions of false stories tended to start from fewer original tweets, but some of those retweet chains then reached tens of thousands of users, while true news stories never spread to more than about 1,600 people. True news stories also took about six times as long as false ones to reach 1,500 people. Overall, fake news was about 70 percent more likely to be retweeted than real news.

Roy and colleagues initially removed the activity of automated Twitter accounts called bots from the analysis. But when bot traffic was added back into the mix, the researchers found that these computer programs spread false and true news about equally. So humans, rather than bots, are primarily to blame for spreading fake news on the platform.

People may be more inclined to spread tall tales because these stories are perceived to be more novel, says study coauthor Soroush Vosoughi, a data scientist at MIT. Compared with the topics of true stories, fake news topics tended to deviate more from the tweet themes users were exposed to in the two months before a user retweeted a story. Tweet replies to false news stories also contained more words indicating surprise.



Truth and lies On Twitter, retweet chains about true news stories (green) took longer, on average, to reach the same number of people and didn't spread as far as conversations about fake news (red).

It's not entirely clear what kinds of conversations these stories sparked among users, as the researchers didn't inspect the full content of all the posts in the dataset. Some people who retweeted fake news posts may have added comments to debunk those stories. But Menczer says the analysis still provides a "very good first step" in understanding what kinds of posts grab the most attention. ■

LIFE & EVOLUTION

Rare rain awakens Atacama's undead

Microbes go dormant to survive in one of Earth's driest spots

BY LAUREL HAMERS

Chile's Atacama Desert is so dry that some spots see rain only once every few years. Salt turns the sandy soil inhospitable, and ultraviolet radiation scorches the surface. So little can survive that scientists have wondered whether snippets of DNA found in the soil are traces of long-dead microbes or bits of hunkered-down but still living colonies.

A rare deluge has solved that mystery. Storms that dumped a few centimeters of rain on the Atacama in March 2015 — several years' worth in one day — sparked a microbial superbloom, researchers report online February 26 in *Proceedings of the National Academy of Sciences*.

That storm threw a wrench into scientists' plans to get a snapshot of microbial life under normal, hyperarid conditions. "But in the end, it came back as a lucky stroke," says astrobiologist Dirk Schulze-Makuch of Technische Universität Berlin. His group drove mining vehicles into the desert to collect soil a few weeks after the storm, then returned in 2016 and 2017 to track changes as the moisture dissipated.

The team found a mix of living archaea, bacteria and fungi that are tolerant of desiccation, salinity and UV light. The species were fairly consistent across sampling sites, suggesting there's something of a native microbial community that survives by going dormant between rains, Schulze-Makuch says. The team also found ample evidence of active cell metabolism in the initial sampling period, which then declined as the soil dried out.

Finding microbes that survive in the Atacama, a potential proxy for conditions on Mars, is good news for alien hunters. "If we're finding that, on Earth, truly dry places are still inhabited," says astrobiologist Armando Azua-Bustos of the Centro de Astrobiología in Madrid, "that opens the door to finding life elsewhere in the universe." ■

S. VOSOUGHI ET AL/SCIENCE 2018

Computers can diagnose eye problems

Artificial intelligence may boost health care in underserved areas

BY MARIA TEMMING

The computer will see you now.

Artificial intelligence algorithms may soon bring the diagnostic know-how of an eye doctor to primary care offices and walk-in clinics, speeding up the detection of health problems and the start of treatment, especially in areas where specialized doctors are scarce. The first such program pending approval by the U.S. Food and Drug Administration is trained to spot symptoms of diabetes-related vision loss in eye images.

While other already approved AI programs help doctors examine medical images, there's "not a specialist looking over the shoulder of [this] algorithm," says Michael Abràmoff. He founded the company, IDx, that developed the system under FDA review, dubbed IDx-DR. "It makes the clinical decision on its own."

IDx-DR and similar AI programs — which are learning to predict everything from age-related sight loss to heart problems just by looking at eye images — don't follow preprogrammed guidelines for how to diagnose a disease. Instead, these programs are machine-learning algorithms that researchers teach to recognize symptoms of a particular condition by using example images labeled with whether a patient had that condition.

IDx-DR studied over 1 million eye images to learn how to identify symptoms of diabetic retinopathy, which develops when high blood sugar damages retinal blood vessels. As many as 24,000 people in the United States lose their vision to diabetic retinopathy yearly, but the condition can be treated if caught early.

Abràmoff, a retinal specialist at the University of Iowa in Iowa City, and colleagues compared how well IDx-DR detected diabetic retinopathy in more than 800 U.S. patients with diagnoses made by three human specialists. Of the patients identified by IDx-DR as having at least moderate diabetic retinopathy, more than 85 percent actually did. And IDx-DR was correct in more than 82.5 percent of the cases where it concluded a patient had mild or no diabetic retinopathy, the researchers reported February 22 in Beverly Hills, Calif., at the annual meeting of the Macula Society.

The FDA's decision about IDx-DR is expected within a few months, Abràmoff says. If approved, it would become the first autonomous AI to be used in primary care offices and clinics.

AI algorithms to diagnose other eye diseases are in the works, too. An algorithm described in the Feb. 22 *Cell* studied over 100,000 eye images to learn the signs of different eye conditions. These included age-related macular degeneration, or AMD — a leading cause of vision loss in adults over age 50 — and diabetic macular edema, a condition that develops from diabetic retinopathy.

This AI was designed to flag advanced AMD or diabetic macular edema for urgent treatment and to refer less severe cases for routine checkups. In tests, the algorithm was 96.6 percent accurate in diagnosing eye conditions from 1,000 pictures. Six ophthalmologists made similar referrals based on the same eye images.

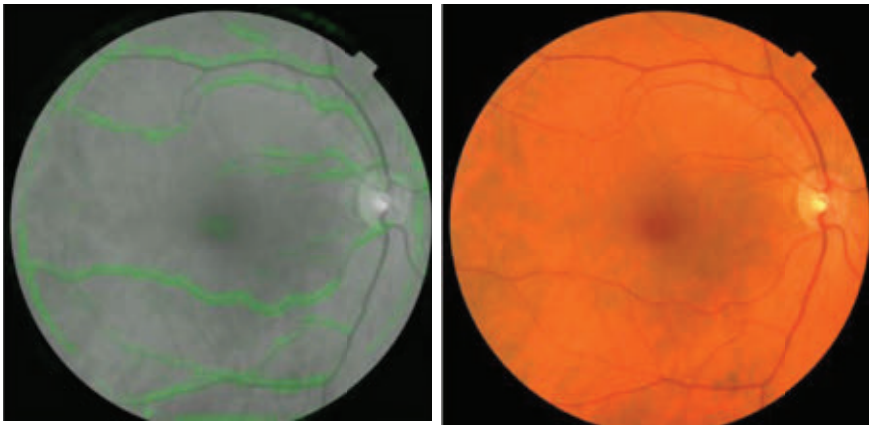
Researchers still need to test how this algorithm fares in the real world where the quality of images may vary from clinic to clinic, says Aaron Lee, an ophthalmologist at the University of Washington in Seattle. But this kind of AI could be especially useful in rural and developing regions where medical resources and specialists are scarce and people otherwise wouldn't have easy access to in-person eye exams.

AI might also be able to use eye pictures to identify other kinds of health problems. One algorithm that studied retinal images from over 284,000 patients could predict cardiovascular health risk factors such as high blood pressure.

When researchers tested the algorithm's powers of prediction, the program was 71 percent accurate in distinguishing between eye images from smoking and nonsmoking patients, according to a report published February 19 in *Nature Biomedical Engineering*. In 70 percent of cases, the program correctly predicted which patients went on to have a major cardiovascular event, such as a heart attack, within five years of when the photos were taken.

With AI getting more adept at screening for a growing list of conditions, "some people might be concerned that this is machines taking over" health care, says Caroline Baumal, an ophthalmologist at Tufts Medical Center in Boston. But diagnostic AI can't replace the human touch. "Doctors will still need to be there to see patients and treat patients and talk to patients," Baumal says. AI may just help people who need treatment get it faster. ■

An algorithm still in testing uses eye images to predict cardiovascular health. A green heat map (left) overlaid on a retinal fundus image (right) highlights the areas — most notably blood vessels — that factor most heavily into the program's prediction about a patient's blood pressure.



R. POPLIN ET AL/NATURE BIOMEDICAL ENGINEERING 2018

BODY & BRAIN

Brain waves may help sculpt attention

Neuronal oscillations keep information flowing, studies suggest

BY LAURA SANDERS

We can't see it, but brains hum with electrical activity. Brain waves created by the coordinated firing of huge collections of nerve cells pinball around the brain. The waves can ricochet from the front of the brain to the back, or from deep structures all the way to the scalp and then back again.

Called neuronal oscillations, these signals are known to accompany certain mental states. Quiet alpha waves ripple soothingly across the brains of meditating monks. Beta waves rise and fall during intense conversational turns. Fast gamma waves accompany sharp insights. Sluggish delta rhythms lull deep sleepers, while dreamers shift into slightly quicker theta rhythms.

Researchers have long argued over whether these waves have purpose, and what those purposes might be. Some scientists see waves as inevitable but useless by-products of the signals that really matter — messages sent by individual nerve cells. Waves are simply a consequence of collective neural behavior, and nothing more, that view holds. But a growing body of evidence suggests just the opposite: Instead of by-products of important signals, brain waves are key to how the brain operates, routing information among far-flung brain regions that need to work together.

MIT's Earl Miller is among the neuroscientists amassing evidence that waves are an essential part of how the brain operates. Brain oscillations deftly route information in a way that allows the brain to choose which signals in the world to pay attention to and which to ignore, his recent studies suggest.

Other research supports this view, too. Studies on people with electrodes implanted in their brains suggest brain waves, and their interactions, help enable emotion, language, vision and more.

When these waves are abnormal, brainpower suffers, studies find. Detailed looks at how the brain uses these waves raise the possibility of tweaking the signals with electrical nudges — interventions that could lead to therapies that can correct memory problems and mental illness, for instance. Already, early attempts have led to improvements in people's memory.

> "The oscillations are the most powerful signal in the brain."
>
> EARL MILLER

These insights about brain waves coincide with a shift in neuroscience away from a view that reduces the brain down to the behavior of single nerve cells, or neurons. That's like thinking of the brain as "a giant clock, and if you figure out each gear, you'll figure out the brain," Miller says. But "it's not just individual neurons in a giant clock. It's networks interacting in a very dynamic, fluid way."

Central to those interactions, Miller and others think, are coordinated brain waves. "The oscillations are the most powerful signal in the brain," Miller says. "How could evolution not have taken advantage of that?"

In three recent papers, Miller and colleagues argue that two different types of brain waves — beta and gamma — work together to selectively choose the information that makes it into working memory. Gamma waves that cycle 30 to 80 times per second (30 to 80 hertz) help coordinate information streaming in from our senses — what we feel, see and smell. In contrast, slower 12 to 30 Hz beta waves are the messages that help keep us on task by guiding the brain toward the sensory signals worth paying attention to.

These two types of brain oscillations engage in a neural seesaw: When beta waves are strong, akin to a stereo blasting, gamma waves are weak, as if the volume had been dialed down, and vice versa. Miller and colleagues saw this push-and-pull action in the brains of monkeys with implanted electrodes as the animals completed a tricky memory task, one that required the monkeys to hold several pieces of information in their minds at the same time. The results were described January 26 in *Nature Communications*. "At all these complex decision points, you can see the beta and gamma doing this complex dance in a way that you'd expect if they're controlling working memory," Miller says.

These two types of waves were generated in different parts of the brain, offering spatial clues about how the brain focuses itself, the researchers also found. Sensory information, organized by gamma waves, skims the superficial layers of the brain, experiments on monkeys showed. But slower, more goal-directed waves, a mix of alpha and beta waves, are deeper in the brain. And those slower, deeper waves could actually dial down the strength of the gamma waves that rippled along the outer brain. The deeper waves were selecting which sensory information to pay attention to, the researchers proposed in the Jan. 30 *Proceedings of the National Academy of Sciences*.

A third paper, in the Feb. 7 *Neuron,* shows similar interactions between gamma and beta waves while monkeys matched patterns of dots on a computer screen. Some of the patterns were clearly different but still belonged to the same category, an easy task akin to knowing that both a dog and a cat are types of animals. Other times, the patterns were harder to classify and required more sophisticated mental work, similar to knowing that trains and bicycles are both types of transportation. Gamma waves were present when the monkeys were puzzling out an easy category. But when higher-level categorization was required, beta waves started to roll.

These interactions between gamma and beta waves might be how the brain solves an information overload problem, Miller suspects. Incoming sensory input constantly bombards the brain, and much of it is meaningless. The brain needs a way to figure out if it should ignore the feeling of a scratchy shirt, but pay attention to

the ringing phone. These two rhythms may offer a way for "volitional control over what you think about," Miller says, allowing a person to consciously choose what information to bring to mind.

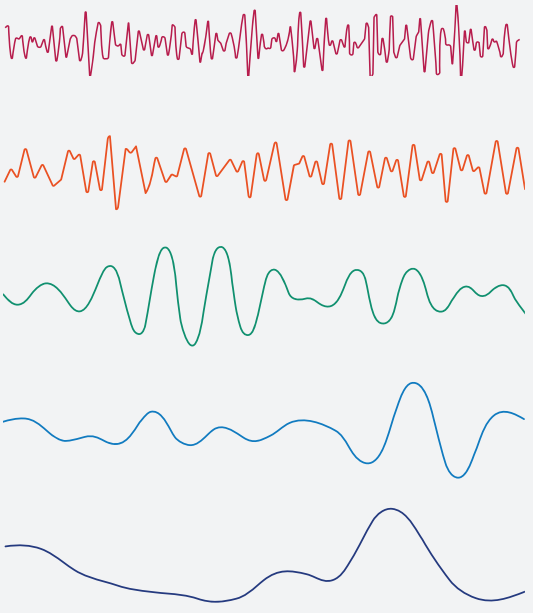
Oscillations may also shape visual information as it travels through the brain, says Charles Schroeder, a neuroscientist at the Nathan S. Kline Institute for Psychiatric Research in Orangeburg, N.Y. He and colleagues are studying a different ebb and flow of oscillations from the one Miller recently described. This one probably involves a host of different kinds of waves, including theta waves, and happens in the split second when your eyes dwell on a scene — a pause that usually lasts about 200 milliseconds.

When you look at a scene, the first half of the time it takes to stare is spent on visual information streaming into your brain. But toward the end of that fixation time, "the information flow reverses," Schroeder says. Different neuronal oscillations carry signals from the brain's command center, ready to direct the eyes to the next spot. "Literally within a tenth of a second before you move your eyes, there is this incredible flash of network activity in the front of the brain, and then the eyes move," Schroeder says. "It's really a dramatic thing." Schroeder and colleagues have caught this action in monkeys' brains, and more recently, in people implanted with electrodes as part of epilepsy treatment.

But some vision researchers still dismiss these oscillations as noise, convinced that the activity of single neurons — and not the collective waves that result from that activity — is the key to understanding the brain, Schroeder says. "It's still difficult to convince people that brain oscillations are functional."

Researchers may argue over the function of brain waves for years to come, says neuroscientist and neurologist Robert Knight of the University of California, Berkeley. He believes that information, at its core, is held in the signals zipped off by neurons. But work from his lab has convinced him that oscillations help those signals reach the right spot, connecting brain areas in important ways. "You've got to have a way to get brain areas communicating," he says. "What oscillations do is provide a routing mechanism."

Catch a wave Scientists are studying how oscillations generated by nerve cells affect brain function. Although the boundaries between different wave types can be fuzzy, these oscillations can be grouped by frequency.



Fast **gamma** waves have been linked to states of high attention. **Frequency: 30 to 80 hertz**

Beta waves may be involved in movement and complex tasks such as memory and decision making. **12 to 30 Hz**

Alpha waves, the first neuronal oscillations discovered, appear when a relaxed person closes his or her eyes. **8 to 12 Hz**

Theta oscillations may help the brain sort information essential for navigation. **4 to 8 Hz**

Slow **delta** waves mark deep sleep and anesthesia. **1.5 to 4 Hz**

C. CHANG

And oscillations do this quickly, he says. Human brains are incredibly fast. "We're handling massive amounts of information in subsecond time periods," Knight says. "And you have to have some way to shape it, to control it." Waves, he says, give the brain a way to tune out extraneous information by temporarily shutting down unnecessary communication lines.

Knight and colleagues recently spotted fast gamma waves at work as people did a wide range of tasks, including repeating words, answering questions about themselves and distinguishing male faces from female. A certain gamma wave pattern seemed to predict when people would get the right answer on these tasks, the team reported in December 2017 in *Nature Human Behavior*. Gamma waves, the team suspects, link up areas of the brain that are needed to turn goals into action.

If oscillations are crucial information routers in the brain, then changing them might be beneficial when information is distorted or lost. Altered oscillations have been observed in disorders such as autism, Parkinson's disease, depression and anxiety, and even in normal aging.

A study published February 6 in *Nature Communications* hints at the potential of tweaking these rhythms. Youssef Ezzyat, a neuroscientist at the University of Pennsylvania, and colleagues studied memory abilities in 25 people who had electrodes implanted in their brains as part of their epilepsy treatment.

As the researchers gave the people lists of words to remember, electrodes monitored neural oscillations. A computer algorithm then figured out which assortment of brain waves indicated when a person was likely to remember the word, an assortment that varied slightly from person to person.

When those good performance signals were missing, the researchers delivered a short burst of electricity to the brain — "a bit of a nudge to course correct," Ezzyat says. And these nudges improved performance.

Specifically manipulating brain waves to treat brains is a long way off, Ezzyat cautions. But he and colleagues are making progress. In the meantime, his results and others' are powerful signs that brain waves aren't just an idle hum. ■

FATAL FIX

Opioids are a potent way to shut down breathing

By Laura Sanders

Deaths from opioid overdoses among U.S. residents are mounting with breathtaking speed. These powerful drugs — including heroin, morphine and fentanyl — can relieve pain and evoke intense feelings of pleasure.

But the same drugs, whether prescribed by a doctor or bought on the street, can quickly turn deadly by messing with crucial systems in the body.

Among the many rapid effects that opioids have on the body, one is particularly lethal: Breathing is restricted.

"Opioids kill people by slowing the rate of breathing and the depth of breathing," says medical toxicologist and emergency physician Andrew Stolbach of Johns Hopkins University School of Medicine.

Breathing delivers fresh oxygen to the body's cells and eliminates carbon dioxide. Opioids can interfere with that life-sustaining process in multiple, dangerous ways.

Here's how opioids kill

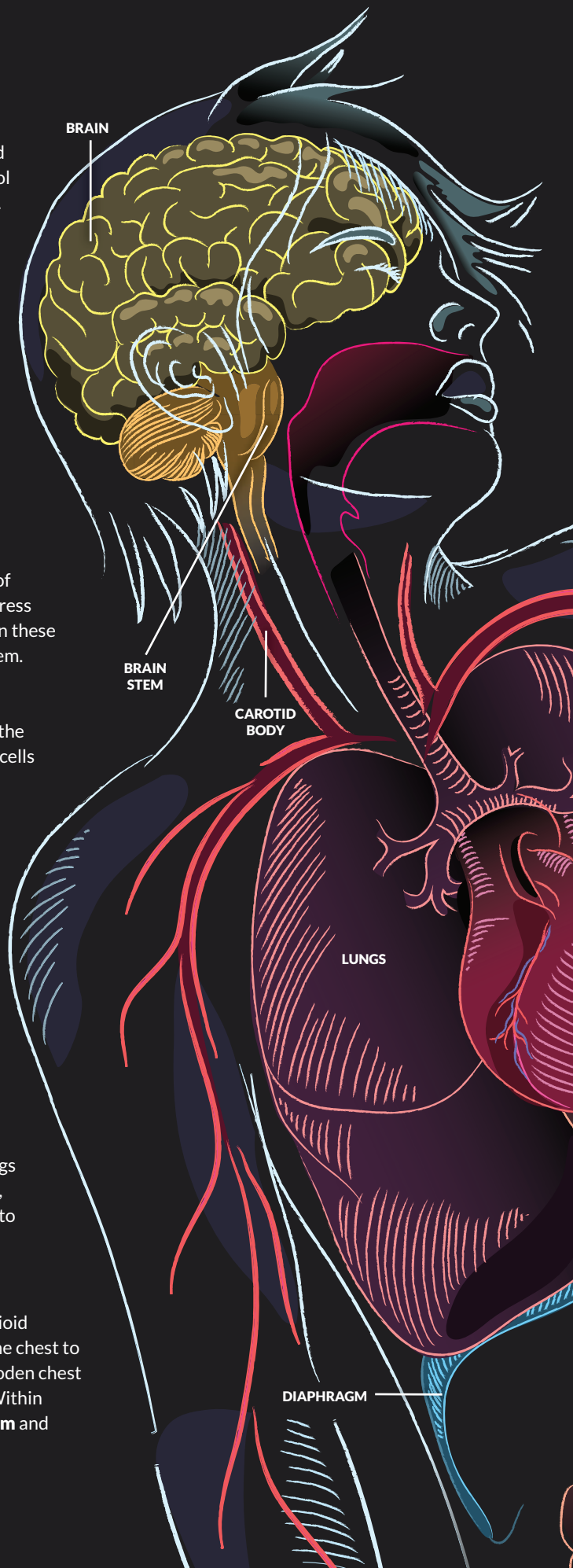
In the **brain stem**, regions called the medulla and the pons control the depth and rate of breathing. Both are loaded with opioid receptors — proteins that sit on the surface of cells and grab onto opioids. Upon activating, the receptors change the behavior of cells in ways that can slow or even stop breathing.

Opioid receptors have also been found in areas of the **brain** that regulate voluntary breathing — when you feel the need to take in a deep swallow of air, you do it. Opioids might depress breathing by working directly on these brain areas outside the brain stem.

Sensing small increases in CO_2, the **carotid body**, a small cluster of cells in the neck, spurs big increases in breathing to remove excess CO_2 and keep a person out of trouble. But opioids dampen these sensors and silence the body's CO_2 warning system.

One of the telltale signs of opioid overdose is frothy fluid around the nose and mouth and fluid in the **lungs**, called pulmonary edema. It's not clear how opioids trigger this, but filled with fluid, the lungs can't oxygenate blood very well, and a person may slip further into respiratory trouble.

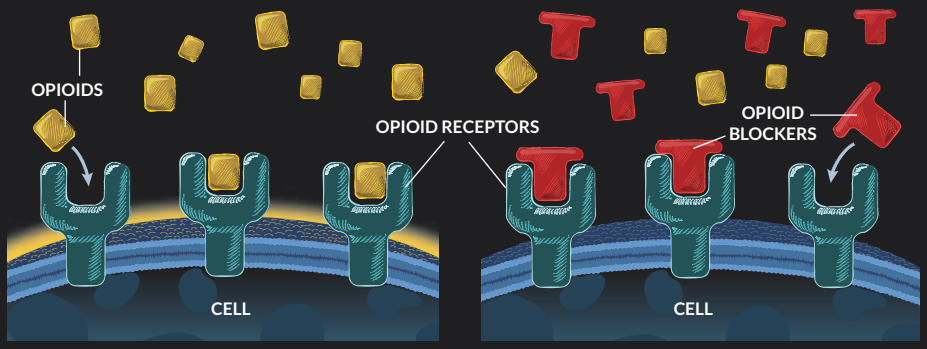
A fast-acting injection of the opioid fentanyl can cause muscles in the chest to seize up, a condition called "wooden chest syndrome" (*SN: 9/3/16, p. 14*). Within seconds of a dose, the **diaphragm** and nearby muscles are paralyzed.



NICOLLE RAGER FULLER

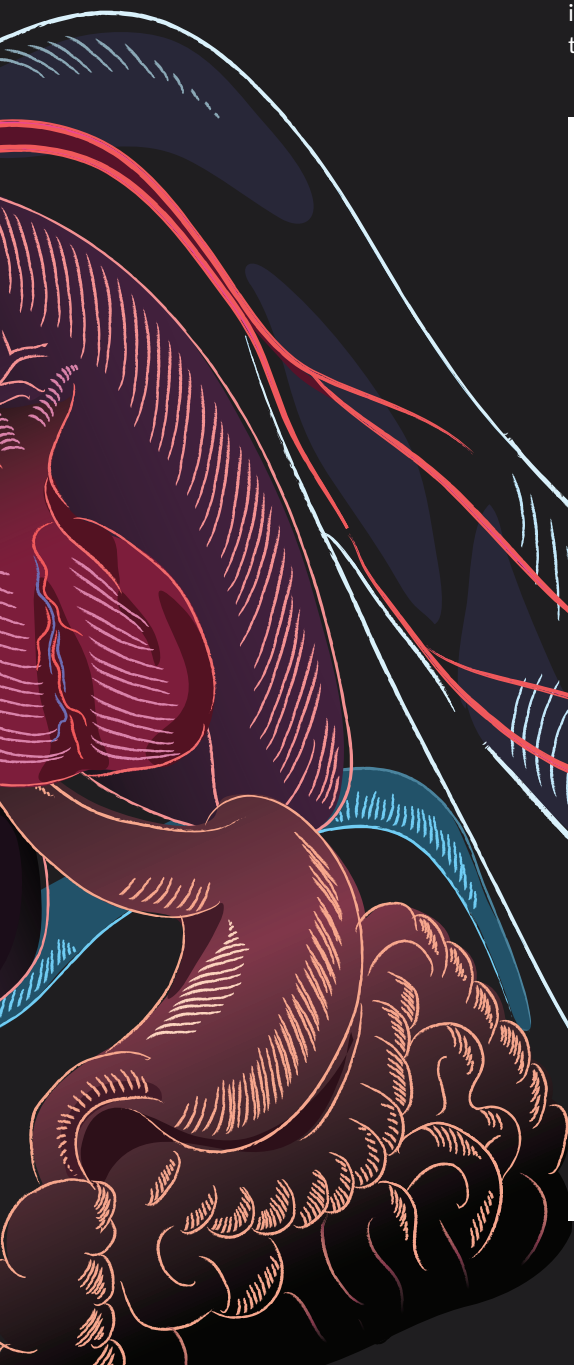
Effects that don't kill

Opioid receptors exist throughout the body, so the drugs can cause plenty of nonlethal problems, some of which can signal to medical staff that a person has recently taken opioids. A dose of opioids can suppress the throat's gag reflex, cause a slight drop in blood pressure or trigger an abnormal heart rhythm. The drugs also dilate blood vessels in the arms and legs, shrink the pupils to pinpoints and slow digestion. Changes in digestion can cause constipation and may even affect the microbes that dwell in the gut.



Blocking the receptors

To treat an opioid overdose, doctors use drugs such as naloxone, often sold as Narcan. The potent opioid blocker latches onto opioid receptors, preventing other opioids from triggering the cell to take actions that can shut down breathing or freeze muscles. Usually injected or inhaled, naloxone starts working in minutes and, in many cases, can reverse the overdose.

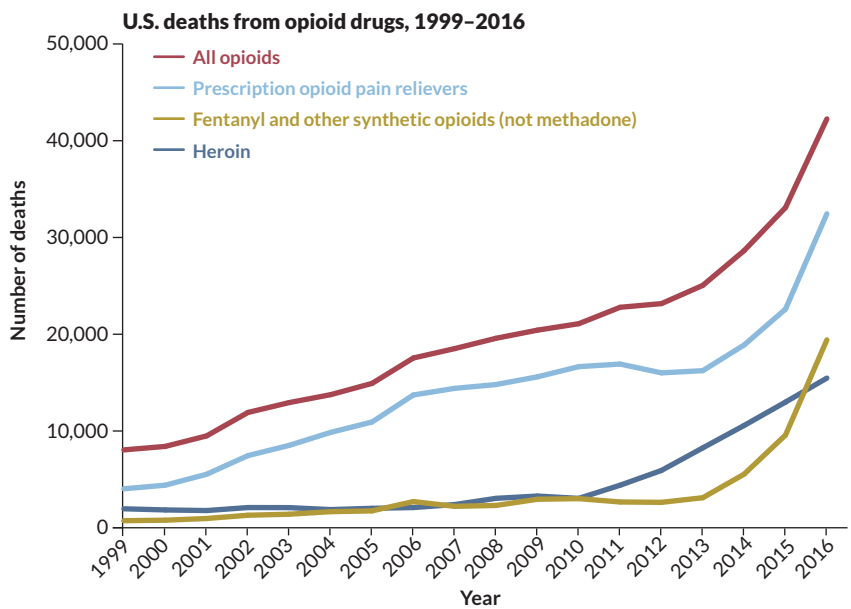


Deadly direction

Roughly 64,000 U.S. residents died from a drug overdose in 2016, according to the U.S. Centers for Disease Control and Prevention. Opioids were involved in the vast majority of those deaths.

From 2015 to 2016, the number of deaths from lab-made opioids, including fentanyl and chemical kin such as carfentanil (used to tranquilize large animals), more than doubled in the United States. Overdose deaths in 2017 are still being counted, but data through July suggest that it was also a bad year.

Hidden in these national statistics are stories of individuals. Researchers are still struggling to understand how lifestyle factors, such as prior drug use and stress, as well as genetics and other risk factors, might make people more likely to overdose on these deadly drugs.



SOURCE: CDC

Saving the WOLVES

A final push for an oral rabies vaccine may help more than the endangered animals of Ethiopia

By Helen Thompson

With less land to roam and dogborne diseases closing in, Ethiopian wolves stand on the ledge of extinction.

Deep in the Bale Mountains of Ethiopia, wildlife workers trek up above 9,800 feet to save some of the world's most rare carnivores, Ethiopian wolves.

"It's cold, tough work," says Eric Bedin, who leads the field monitoring team in its uphill battle.

In this sparse, sometimes snowy landscape, the lanky and ginger-colored wolves (*Canis simensis*) reign as the region's apex predators. Yet the combined threats of rabies, canine distemper and habitat reduction have the animals cornered.

Bedin and his colleagues, traveling by horse and on foot through dramatically shifting temperatures and weather, track these solitary hunters for weeks at a time. Team members know every wolf in most packs in these mountains. The team has vaccinated some wolves against rabies, only to have hopes dashed when the animals died of distemper months later.

"These guys work their asses off to protect these wolves," says Claudio Sillero, a conservation biologist at the University of Oxford who heads up the Ethiopian Wolf Conservation Programme, of which the field monitoring team is an integral part. Down the line, humans stand to benefit from all this work too.

Sillero and his colleagues have been at this for 30 years. They've seen four major outbreaks of rabies alone, each leaving dozens of carcasses across the highlands and cutting some populations by as much as 75 percent.

Today, fewer than 500 Ethiopian wolves exist — around half of them in the Bale Mountains. A new oral rabies vaccine program aims to give the endangered animals a fighting chance. It may be their best hope for survival, Sillero says.

Later this year, if all goes well, oral vaccines hidden in hunks of goat meat will be scattered across wolf ranges and eaten by the animals. One dose every two years should bolster immunity against rabies among these iconic animals immortalized on several of their country's postage stamps.

One Health

Vaccinating endangered animals en masse in the wild is rarely attempted. Making the case for vaccination takes years of testing. And even when the case is strong for stepping in, the tools needed to vaccinate wildlife aren't often available, says Tonie Rocke, an epizootiologist with the U.S. Geological Survey in Madison, Wis. On the opposite side of the globe from Bale, on North America's Great Plains, Rocke's lab is testing an oral vaccine to protect prairie dogs and endangered ferrets from plague.

A recent synergy has made these new oral vaccine efforts possible: improvements in vaccine technology (developed for humans and domesticated animals) and growing public and scientific interest in "One Health." The conservation buzzword refers to efforts to help one species that also benefit others, including humans.

The researchers pushing for a green light in Ethiopia point to the one shining success in oral vaccines for wild animals, and to its One Health benefits. From 1978 to 2010, oral vaccines sprinkled across parts of Europe eliminated rabies in red foxes. Europe's rabies cases in humans and other animals dropped by 80 percent from 1984 to 2014. But rabies is still common in certain parts of the world, including Ethiopia. Worldwide, more than 59,000 people die from the disease each year.

Successes on the plateaus of Bale and the prairies of North America could open the door for other vaccines to protect threatened species. Vaccines against Ebola in great apes and white-nose syndrome in bats are in the works.

But introducing vaccines into natural environments is a hard sell and can come with controversy and unexpected consequences.

A last resort

To the average U.S. vet or dog owner, vaccination is a no-brainer. But for endangered species, the stakes are high. Some conservationists are reluctant to intervene with disease-preventing vaccines in the wild, says Karen Laurenson, an epidemiologist and veterinarian with the Frankfurt Zoological Society.

Disease has its place in ecosystems. It can control population levels and put pressure on species to develop natural resistance, says Laurenson, who started working with the wolf project in the mid-1990s. Using a vaccine to take a disease out of the mix could leave a population vulnerable to future outbreaks should the vaccine become ineffective or stop being used. In an ecosystem with multiple power players, one vaccinated predator could gain an unnatural advantage over its competitors.

Some vaccines also bring direct risks. Injectable vaccines often require trapping the animal — a costly endeavor that's stressful and dangerous for both wild animals and the humans doing the vaccinating. Oral vaccines could be scooped up and eaten by other animals. Plus, for an oral or injectable attenuated vaccine, which contains a living but harmless version of a virus, there's a slim possibility that evolutionary pressure could eventually drive the virus, now distributed through the population, to become lethal again.

Because room for error is slim for a species on the brink of extinction, most instances of vaccine use have been limited to emergency responses during ongoing outbreaks.

Projects that don't go well can have lasting repercussions. In 1990, researchers tried to vaccinate some packs of endangered African wild dogs (*Lycaon pictus*) in Tanzania and Kenya against rabies, assuming the disease was behind a recent dip in numbers. Every dog in

Outbreaks of rabies and distemper in Delanta, a remote area in Ethiopia's Wollo Highlands, slashed wolf numbers. Here, two wildlife monitors release a survivor back into the wild after it was trapped and injected with a vaccine.

© E. BEDIN/EWCP

the study died. The stress of getting vaccinated, shot by dart from a distance, may have made the dogs more susceptible to disease, though that theory was never proven. The incident increased skepticism about vaccines and caused some African countries to tighten vaccine regulations. "It left a terrible legacy," says veterinarian Richard Kock of the University of London.

The long game

The uphill battle faced by Sillero's team involves more than the challenges of canvassing the Ethiopian highlands. Making a case to government officials that oral vaccines are necessary conservation tools took decades of fieldwork, genetic testing and meetings upon meetings. "The credit really goes to Claudio and the others for persisting," Laurenson says. "Even when the doors have been shut, sometimes they've kept banging."

Sillero arrived in Ethiopia in 1987 to study the wolves. A rabies outbreak hit in late 1989. Just as it does in dogs and humans, the disease attacks a wolf's brain, causing aggressive behavior and, eventually, death. Canine distemper appeared in 1992. Marked by severe diarrhea, vomiting and coughing, the disease appears to hit wolves harder than dogs, Sillero says. The Ethiopian packs have faced four more major flare-ups of rabies and two of distemper. Two of the eight populations of wolves he came to study have gone extinct in that time.

"This is a human-caused problem, not a natural dynamic," Laurenson says. Each year, shepherds and farmers move higher up into the wolves' habitat, bringing grazing livestock. These people also bring domesticated dogs — the primary carriers of rabies and canine distemper. In one area of Ethiopia, wolf habitat shrunk by 34 percent from 1985 to 2003. Islands of wolf populations persist in remote highland areas surrounded by oceans of free-ranging dogs.

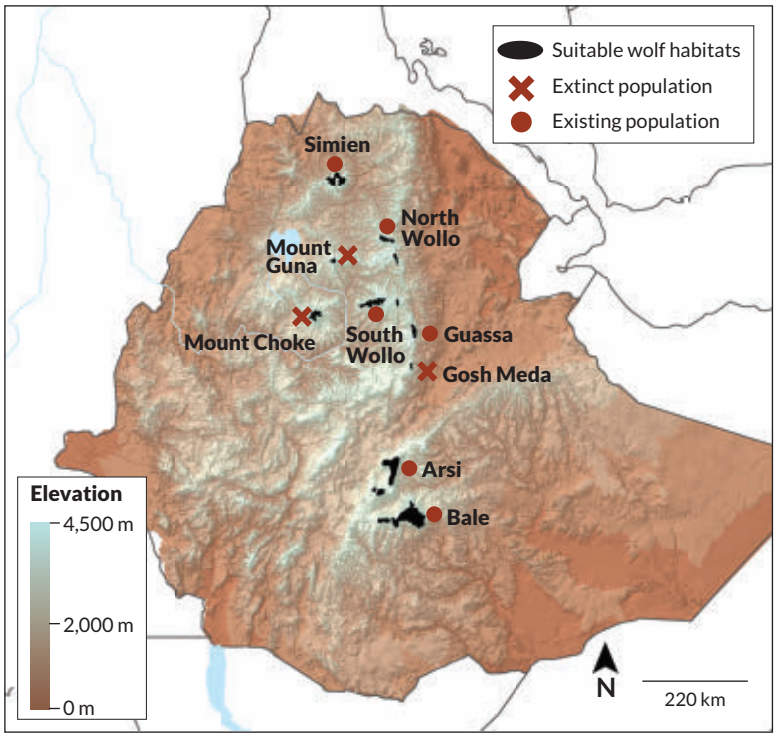
Vaccinating the wolves was plan B, after the lower-risk approach of vaccinating domestic dogs didn't cut it. Because the dogs roam far and wide, dog vaccination programs didn't reach enough animals to generate prolonged protection and prevent outbreaks in wolves. "I'm sure we were improving the situation and reducing the chance of spillovers in wild carnivores, but we weren't preventing them altogether," Sillero says.

Going with oral vaccines was plan C. In 2003, the government approved use of an injectable vaccine only in response to outbreaks. Sillero's team first had to collect samples and send them to international labs to confirm that an outbreak was happening. The researchers were always behind. An oral option that proactively protects the animals started to sound like a smart way to go.

Deliver the dose

On paper, the wolves look like good candidates for an oral vaccine intervention. Few other animals brave the highlands habitat, so the odds are low that a vaccine distributed in bait would get eaten by the wrong creatures. And not vaccinating is arguably riskier than making the effort. Consecutive rabies and distemper

Lay of the land Over the last 20 years, two Ethiopian wolf populations have died out; another disappeared early in the 20th century, historical evidence suggests. Modern oral vaccines could save the remaining six populations from a similar fate. On alpine plateaus across Ethiopia, local monitors like Muzeyen (pictured at bottom) follow the ups and downs of every pack, staying on the lookout for potential outbreaks.



FROM TOP: © EWCP; © BURRARD-LUCAS PHOTOGRAPHY

outbreaks recently cut one of the smallest known wolf populations down to two individuals, Sillero's team reported in December in *Emerging Infectious Diseases*.

The Ethiopian team chose to test an oral rabies vaccine, called SAG2, that had been used successfully in red foxes. Twenty million baits had been dropped across Europe with no vaccine-induced rabies cases or reported deaths. SAG2 also passed safety tests in a slew of different species, including African wild dogs. "That work was absolutely fundamental," Laurenson says.

Getting the vaccine into the animals is the trickiest part. Animals have to bite into the bait to puncture an internal packet that contains the vaccine, rather than swallow the bait whole. "You've got to make the bait such that the [wolf] would chew it," says Anthony Fooks, a vaccine researcher who runs a U.K. government lab that handles sample tests for the wolf project.

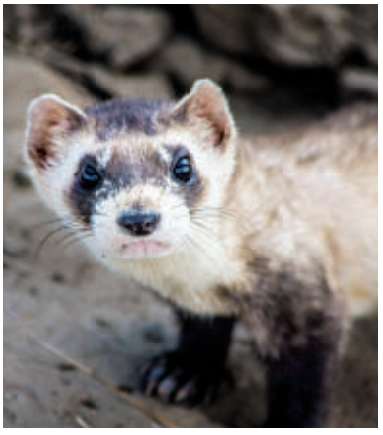
So Sillero and his team launched a series of pilot studies of an oral SAG2. "We set up cafeteria-type experiments, with different baits and delivery methods," Sillero says. The researchers dropped 445 baits in locations around Bale. Hiding the vaccine in goat meat and distributing the goods at night worked better than other options, the team reported in 2016 in *Vaccine*. Of 21 wolves trapped a couple of weeks later, 14, or 67 percent, carried a biomarker showing the vaccine was in the wolf's system. Of those, 86 percent had developed immunity against rabies. The impact on other wildlife was low: Only a few raptors snatched up vaccines meant for the wolves.

With all that data in hand, Sillero's team finally won over Ethiopia's Wildlife Conservation Authority in December, receiving an official thumbs-up to move forward. This month, 4,000 vaccines arrived; the mass vaccination program could get off the ground this summer.

It'll be the first mass oral vaccination program to target an endangered species in the wild. The basic plan: Distribute the oral vaccines at night once every two years, vaccinate at least 40 percent of a chosen wolf population and use motion-sensing cameras to see if each pack's high-ranking males and females — the primary pup producers — take the bait. It's important to keep the top producers healthy.

Drones and peanut butter

Having a readily available oral vaccine for the wolves was a lucky break for the researchers in Ethiopia. A research team in the United States had no such luck. Tonie Rocke and her colleagues had to develop their own oral plague vaccine for prairie dogs. The team devised a raccoon poxvirus that produces plague proteins once inside the prairie dog body. The proteins train the immune system to fight the plague-causing *Yersinia* bacteria.



Endangered black-footed ferrets (left) catch plague from eating sick prairie dogs, which in turn catch the disease from fleas. Peanut butter–flavored oral vaccines delivered near prairie dog homes across the Great Plains could give the ferrets a shot at a comeback — and even save some at-risk prairie dogs (one at right, holding bait).

Saving plague-ridden prairie dogs (*Cynomys* spp.) is an indirect way to protect the real target: an endangered predator, black-footed ferrets (*Mustela nigripes*) of the Great Plains. The ferrets survive on a diet of mostly prairie dogs and had nearly gone extinct in the 1970s due to centuries of habitat loss, prey declines and plague.

On top of captive breeding and reintroduction programs to keep the ferret species afloat, the U.S. Fish and Wildlife Service traps and vaccinates wild ferrets directly. But it's not enough.

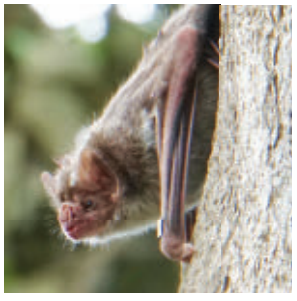
Rocke and her colleagues went ahead and developed a peanut butter–flavored oral plague vaccine. They distributed it by drones and four-wheelers in small test plots in seven states to limit prairie dog carriers (Plaque can threaten prairie dog populations too, so everybody wins.)

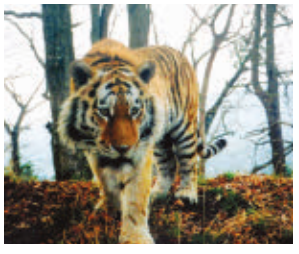
Last June, the researchers published the results of these successful small-scale field trials in *EcoHealth*. A prairie dog's odds of surviving in plague-ridden areas just about doubled. And the peanut butter pellets were as good at reducing plague levels as traditional insecticides that kill plague-carrying fleas. It's unclear just how many prairie dogs in colonies need to be vaccinated to protect the ferrets from plague.

Getting the vaccine approved wasn't as tortuous as it has been in Ethiopia. Collaborators at Colorado Parks and Wildlife already had a cheap way to make the baits, and in 2017, Colorado

Researchers tested oral rabies vaccines hidden in raw goat meat, boiled goat intestines and dead grass rats. Raw goat meat (shown) enticed wolves the most.

CLOCKWISE FROM TOP LEFT: USFWS MOUNTAIN-PRAIRIE/FLICKR.COM (CC BY 2.0); T. ROCKE/USGS; C. SILLERO-ZUBIRI *ET AL/VACCINE* 2016





Vaccines are becoming more accepted among conservation scientists. If projects in wolves and ferrets succeed, efforts to vaccinate (from top) gorillas, bats and Amur tigers could be next.

Serum Company licensed the product through the U.S. Department of Agriculture.

This year, Rocke hopes to conduct larger-scale field trials to determine the levels of immunity required for success in a mass vaccination. Ultimately, the application will be limited — just selected populations of prairie dogs that are either in ferret territory or endangered themselves, such as the Utah prairie dog (*C. parvidens*). Plague infects a handful of humans and domesticated animals each year as well, and the team is looking into using the vaccine in areas where humans spend time, like national parks.

Encouraging others

Success for one species could be good news for others. Similar preventative strategies might work in other threatened animals, including other members of the dog family dealing with rabies and ungulates like zebras at risk of catching anthrax while grazing. Researchers are testing preventative vaccines to protect wild Hawaiian monk seals from a seal-specific distemper virus.

Oral vaccines aren't the only nontraditional delivery method. Rocke's lab is working on a topical vaccine against white-nose syndrome, which threatens bats (*SN Online: 3/31/16*), and one to combat rabies in common vampire bats (*Desmodus rotundus*). Vampire bats in particular nuzzle each other during social grooming. "It's an easy way to get the vaccine distributed amongst members of the colony," Rocke says.

> "I have to see the wolves taking up the baits before I can congratulate the team."
>
> CLAUDIO SILLERO

In October in *PLOS Neglected Tropical Diseases*, her lab reported that the vaccine works in captured big brown bats (*Eptesicus fuscus*), but it still hasn't been tested in vampire bats, key rabies carriers in South America. Rocke and colleagues hope to start trials in vampire bats this year in Mexico and Peru.

Great apes can fall victim to some of the same pathogens as humans, such as measles and Ebola. In March 2017 in *Scientific Reports*, a research team published successful lab tests of an oral vaccine against Ebola in captive chimpanzees (*Pan troglodytes*). The vaccine relies on the rabies virus to deliver Ebola proteins that elicit an immune response in chimps, but it hasn't been tested in the field yet.

Such a vaccine should be used selectively, Kock says. Vaccinating great apes against Ebola in preserves where the animals might encounter human carriers makes sense. But vaccinating gorillas across large forests in the Congo "is just silly," he says.

Protecting isolated species on the brink of extinction is where vaccines could do the most good. Endangered Amur tigers (*Panthera tigris altaica*) have been hit hard by canine distemper, their numbers falling to around 500 individuals in their Siberian habitat. Vaccines have been debated as a potential option and injectables have been tested in captive tigers.

Sillero doesn't expect to see any oral options developed against distemper in the future, because there's not a big economic incentive. Unlike rabies, the disease doesn't cause problems in humans. So he's working with the shots available. Genetic analyses of locally circulating distemper strains published in July 2017 suggest the injectable distemper vaccines should work for the Ethiopian wolves, Fooks says. Sillero's team is testing one in the field now. Preliminary data suggest the shot elicits a good immune response.

What's good for the wildlife

Greater awareness about the overlap of human, livestock and wildlife health on shared lands underlies many of these projects. Ethiopia has one of the highest rabies death rates among humans in the world, and lowering the disease prevalence in any animals that humans come in contact with has benefit.

"This will have positive impacts for the threatened animals, for the welfare of domestic dogs and livestock, and for the health and finance of the human community," Sillero argues. The One Health mind-set is also behind programs run in a few areas of Ethiopia's northern highlands, to teach local farmers how to build more efficient stoves that require less firewood, and thus, less foraging in wolf territory.

"Vaccination and eradication of things like rabies ... needs a whole of society approach," Kock says. "It cannot be done piecemeal."

For Ethiopia's impending oral vaccine launch that has been so many years in the making, Sillero is optimistic. But he's still holding his breath.

"I have to see the wolves taking up the baits before I can congratulate the team," he says. "But I think we're nearly there." ■

Explore more

- Ethiopian Wolf Conservation Programme: www.ethiopianwolf.org

FROM TOP: ROD WADDINGTON/FLICKR (CC BY-SA 2.0); T. ROCKE/USGS; WCS RUSSIA PROGRAM

#SCIFEST

USA SCIENCE & ENGINEERING FESTIVAL

PRESENTING EXPO SPONSOR: LOCKHEED MARTIN

INSPIRE THE NEXT GENERATION

APRIL 5-8, 2018 | WASHINGTON, DC

Join us in inspiring the next generation of scientists and engineers at the 5th USA Science & Engineering Festival. Bring your families to the largest K-12 STEM celebration with over 365,000 attendees, exciting stage shows and 3,000 hands-on exhibits from the nations top STEM organizations.




XSTEM
APRIL 5, 2018

SPONSORED BY: pwc, NBC4 WASHINGTON, D.C., FOUNDATION

SNEAK PEEK FRIDAY
APRIL 6, 2018

PRESENTED BY Chevron Human Energy

FESTIVAL EXPO
APRIL 7 & 8, 2018

PRESENTED BY: LOCKHEED MARTIN

@USASCIENCEFEST | USASCIENCEFESTIVAL

USASCIENCEFESTIVAL.ORG

PRESENTING EXPO SPONSOR: LOCKHEED MARTIN

K&L GATESIUM: K&L GATES

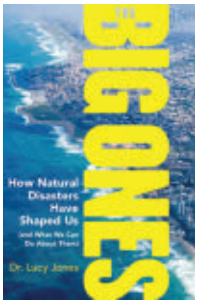
AMERICIUM: Chevron Human Energy, DoDSTEM, Parents, Family Fun, FOUNDATION

EINSTEINIUM: AAAS, AACT, Abbott, American Chemical Society (ACS), American Physical Society, American Scientist,Chemical & Engineering News (C&EN), Events DC, Howard University, Innovation & Tech Today, Linder Global, MasterCard, National Institutes of Health (NIH), National Science Foundation (NSF), ResMed Foundation and Farrell Family Foundation, Sigma Xi, Stanley Black & Decker

NOBELIUM: CAREER, engineering.com, EY, HONDA The Power of Dreams, MARS, NASA, NBC4 WASHINGTON, D.C., pwc, SCIENCE BUDDIES, STEAM, STEMconnector®, U.S. AIR FORCE, WORKFORCE OF TOMORROW

INTERVIEW

Past natural disasters offer lessons for the future



The Big Ones
Lucy Jones
DOUBLEDAY, $26.95

People call Lucy Jones the "earthquake lady." For nearly 40 years, Jones, a seismologist, has been a leading voice in California on earthquake science and safety. A few months after retiring from the U.S. Geological Survey in 2016, she founded the Dr. Lucy Jones Center for Science and Society to bring policy makers and scientists together to discuss disaster resilience.

Now Jones is bringing that discussion to the public in her new book, *The Big Ones*. She offers a fascinating history of how catastrophic natural events — including the Lisbon earthquake of 1755, Iceland's Laki volcanic eruption in 1783 (*SN: 2/17/15, p. 29*) and Hurricane Katrina in 2005 — have shaped politics, culture and society. *Science News* talked with Jones about the book, which she hopes will be a wake-up call, encouraging people to be ready for *when*, not *if*, the next disaster strikes. The discussion that follows has been edited for length and clarity. — *Kyle Plantz*

Why is now the time to write about the science behind natural disasters and the stories of people affected?
We need stories to believe that these disasters can really happen to us. I'm a scientist. I know that research isn't based on stories, but the stories help communicate the science. And disasters all have such cool stories, don't they?

How did you choose which disasters to include?
I wrote about disasters that were big enough to imperil the nature of society. Look at the Laki eruption. The country of Iceland completely changed. They lost a quarter of their population. Most of their records, like the church records of baptisms and deaths, disappeared. People can't trace their families back before that time because the country fell apart. That's one of the things that I wanted to do: discuss that level of catastrophe.

You write that you were surprised that presenting data, like earthquake probabilities, doesn't move people to act. Why do you think hard numbers don't motivate people?
The numbers are often about the things we don't understand, the uncertainty. Scientists and engineers actually like uncertainty; that's why we spend our lives studying it. When we talk about the probabilities of an earthquake, we're talking about the part we don't understand, which is: When will it happen? That gives people a reason to say, I won't deal with it now. If we have a 50 percent chance of rain today, and the storm veers off and doesn't happen, then the rain never gets to us. So if it doesn't happen today, it's just not going to happen at all. We use exactly the same words to say we've got a 50 percent chance of an earthquake in the next 50 years. And that allows people to think, well, maybe if it doesn't happen in this time, then it's not going to happen. I want people to realize it's going to happen; we just don't know when. When people ask me what's the probability of an earthquake, I say, it's 100 percent, just give me enough time.

One of the themes in *The Big Ones* is disaster preparedness. How can people be ready for a disaster?
What matters is community. And when you have a disruption that imperils society itself, people will leave unless they've got a good reason to stay. The reason you stay is the people you care about. That whole "prepper" movement, I think, is a counterproductive approach because it tends to be, "I'm sure society is falling apart, so I'm getting my guns. I'm getting my stuff. I'm going to protect my family." And that's an implicit message that your neighbor is going to be your enemy. It becomes self-fulfilling. That type of prepper is one of the contributions to the world falling apart.

Seismologist Lucy Jones advises California officials on earthquake risks (in Ventura County in 2017, top) and champions preparedness (at the 2015 signing of a building safety law in Los Angeles, bottom right).

How to prepare for disasters

The Big Ones provides some tips on what people can do to make their homes and communities more resilient to natural hazards.

Educate yourself. Find out what risks your community faces and prioritize preparing for the disasters most likely to strike.

Don't assume the government has you covered. Do your own homework. Consult, for instance, a structural engineer to find out what you can do to make your home or workplace safer.

Engage with local leaders. Tell elected officials that you care about taking action before a disaster hits, such as investing in safe infrastructure and preserving natural floodplains. Stronger building codes, for instance, will up the odds that structures will remain standing after an earthquake.

HEADSHOT: HELEN BERGER; OTHERS: COURTESY OF DR. LUCY JONES CENTER FOR SCIENCE AND SOCIETY

Wolfram Language

Programming Languages for All Ages

Solve Any STEM Math Problem!

Can carry in Pocket

Chromium Ad Free Browsing

Games for All Ages

Libre Office Suite

24/7 Math Tutor

Data Secured on SD Card

Hooks to Any USB Mouse or Keyboard

Power Up in 30 Seconds!

Hooks to Any HDMI TV or Monitor

SupraComputer.org/S3

CONVERSATIONS WITH MAYA

GIDEON YU
CO-OWNER, SAN FRANCISCO 49ERS
EXECUTIVE CHAIRMAN, BOWERS & WILKINS

Maya Ajmera, President & CEO of Society for Science & the Public and Publisher of *Science News*, sat down to chat with Gideon Yu, co-owner and former President of the San Francisco 49ers, Executive Chairman of Bowers & Wilkins and former CFO at Facebook and YouTube. We are thrilled to share an edited summary of the conversation.

I would love to start by discussing your experience as an International Science and Engineering Fair (ISEF) finalist in 1989.

Before I share my experience, I do want to make one acknowledgement to Professor David Wilson of Vanderbilt, who unfortunately passed away last year. He was a local legend in Nashville. He was a chemistry professor who gave back to the community by offering local students the ability to apply their math aptitude in the lab.

I had just won an Algebra 1 math contest, and this older gentleman came up to me and said: "Hey, would you like to apply your math? There's this competition called the International Science and Engineering Fair, and if you can commit to me for a few years, when you're a junior or senior, you can apply to that competition. If you stick with me and give me your best, you will do well there."

So that summer we went through trigonometry, calculus and differential equations. When you're a kid, you don't appreciate the time that adults put into you. But now in hindsight, I don't know where he found the time or the energy to give me all that effort.

Mentors are so, so important in this work. You don't get anywhere without a mentor or teacher, especially when doing research.

So, I just got finished winning the Tennessee state fair, which is a far cry from ISEF. Dr. Wilson sat me down and said, "Look, the best projects from Tennessee have gotten third or second place, so you need to be happy with that."

I went to ISEF, which was in Pittsburgh that year, and was sitting in the Grand Awards Ceremony. Third place comes, no name. Second place comes, no name. Embarrassingly, I was very emotional that I didn't make it. I put my head down, and I had tears in my eyes. Some of the people at my table were consoling me.

There was a really awkward moment where the person sitting next to me said, "Hey, didn't you say you were from Nashville?" I said, "Yeah." He said, "I think they just called your name." I looked at him and said, "That's not a funny joke." Then several of the other people around the table said, "They just called you. Go up there!" I went up to the stage with my hand covering my mouth, which was wide open. Everybody else was smiling, and I just looked like I was completely shocked and didn't think I belonged up there. I won the Grand Award in the environmental sciences category.

You grew up the son of a minister in the South. You're Korean-American. Tell us about that, how those experiences and upbringing impacted your career path?

In 1972, my parents decided to immigrate to Nashville from South Korea. I was 1 year old. In 2018, it's difficult to think back to what it was like in the Deep South at that time, but to put the region and time in context, the civil rights marches from Selma to Montgomery were in 1965, and they took place less than a day's drive from my home.

We immigrated with no money as an ethnic minority into the South when people were still facing discrimination regarding their civil rights. To have lived through that time, with my father as the pastor of my church and moral compass of our community … it was, how do I put it? It was tough. It was challenging, and it is something that I feel really shaped who I am today. More importantly, I would not have had it any other way.

I think when you grow up around racism, around racial and ethnic segregation, you realize that that the world is very aware of an individual's race. Adversity is a challenge, but it's also an opportunity and a fact of life.

SAN FRANCISCO 49ERS

"IF WE CAN'T WORK TOGETHER AND BE KIND AND UNDERSTANDING TO EACH OTHER, I DON'T SEE HOW WE'RE GOING TO HAVE A CHANCE TO FIX OUR BIGGEST PROBLEMS."

Gideon Yu with his science fair awards.

You've had this incredible trajectory of working with the most well-known tech companies in the world. Yahoo, YouTube, Facebook. What was your guiding force along that path? Was it more about being at the right time at the right place or was there a larger plan?

I wish that I could tell you that it was all planned out. And that I'm smart enough to have figured that out, but that'd be very imprecise.

Let me go backwards to answer this question a little bit. I got my undergraduate degree from Stanford and my MBA from Harvard. It was 1999 and I came out to Silicon Valley. I went to two start-ups as the CFO; both failed. I needed to figure out what my career path should be.

I realized that I didn't really feel passionate about either company and took those jobs because I thought they were good career moves. I decided that to the extent that I was lucky enough to have a choice, my future career moves would be consistent with things that I am passionate about.

Is it right place, right moment? Look, to the extent that that phrase indicates a humility and an understanding that you work really hard and then you get some good breaks, then absolutely, it was right place, right time. But I will tell you this: My overarching strategy was, if I'm going to fail, I might as well fail doing something that I love.

So, let's talk about football and how you ended up becoming president and co-owner of the San Francisco 49ers in 2012.

The traditional career path to become a president in the NFL is certainly not science and finance. I'll tell you, Maya, that the comment I just made a little bit ago about following your passions is really what put me on the path to the NFL. I love football. I was on a charity board with the owners of the 49ers, and after a meeting commented that I had read they were having a difficult time raising the financing to build a new stadium. I offered to help, and a few months later they took me up on my offer. I made some suggestions, and they asked me to join them.

I took the plunge and was later named president of the team and was offered a chance to buy into the team. Although I'm no longer president, I remain a co-owner of the team.

To become an owner in the NFL, or even a co-owner, you must be voted in by all the other NFL owners. When I was voted in, they noted that I was going to be the first ethnic minority president in the history of the NFL. After the vote, Dallas Cowboys owner Jerry Jones shook my hand and said, "Welcome to the club. This is history." That's the moment when all of the hard work is worth it.

Do you remember any books in high school that got you excited, and what are you reading now?

In high school, the book that I read that just blew my mind was *A Brief History of Time* by Stephen Hawking. Outside of the Bible, I don't think there's been a book that's had more impact in my life. Reading Stephen Hawking's book made me realize that you can pull together all these topics you learn in high school — not just math and science, but also philosophy and religion. You realize the world is a cosmically big place.

Lastly, with so many challenges in front of us as a world, what keeps you up at night?

I think we are forgetting how to be kind and compassionate to one another. In 2018, it's much more fashionable to show outrage, to be critical. Even though I have worked for some groundbreaking social media companies, I think social media tends to amplify this trend by highlighting the loudest and the craziest among us. Compassion and kindness don't get the headlines. If we don't watch out, this trend can get away from us. If we can't work together and be kind and understanding to each other, I don't see how we're going to have a chance to fix our biggest problems. ◆

COURTESY OF GIDEON YU

FEBRUARY 17, 2018

SOCIAL MEDIA

That's a wrap

A DNA analysis revealed that a pair of ancient Egyptian mummies known as the Two Brothers were actually half brothers — they shared the same mother but had different fathers, **Bruce Bower** reported in "DNA solves mummy brothers mystery" (*SN: 2/17/18, p. 15*). Twitter user **@MichaelJPartyka** joked about the ancient DNA test: "23BC and Me."

Join the conversation

E-MAIL editors@sciencenews.org

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

Connect with us

Flight of fantasy

*Similar to their hunter-gatherer counterparts, many children in Western societies prefer play that mimics the things that adults do, **Bruce Bower** reported in "The realities of play"* (SN: 2/17/18, p. 22)*. But fantasy play may still be valuable.*

Reader **Pat Rapp** wondered about the implications of an experiment that showed that children who engaged in pretend games displayed a greater ability to control their emotional responses to another person's apparent pain compared with kids who participated in more practical games.

"Usually this type of result comes up in attempts to characterize autism, and it's interpreted to mean the child's empathy is 'disabled,'" **Rapp** wrote. "That is, it's taken as a 'negative,' opposite to the 'positive' interpretation in **Bower's** article. Is the difference just a matter of perspective, or is something more substantive underpinning this 'positive' interpretation?" **Rapp** asked.

The children in the study still experienced strong emotions when observing another person in pain but found ways to keep their feelings from spiraling out of control, **Bower** says. "That's not the same as experiencing little or no feeling upon seeing someone else in pain, as some people with autism do."

Blown away

*A laser system traps particles to create 3-D images in thin air, **Maria Temming** reported in "Lasers trace out floating 3-D images"* (SN: 2/17/18, p. 16)*. The technology could pave the way for futuristic displays similar to the iconic message Princess Leia sent to Obi-Wan Kenobi in* Star Wars: Episode IV — A New Hope.

Online reader **GORT** was curious about what would happen to such an image if a viewer happened to sneeze while looking at it. "Pushing a micrometers-wide particle through the air with a laser might be prone to distortion, if not outright failure, when even the slightest breeze wafts by," **GORT** wrote.

It's true that the images are sensitive to airflow, **Temming** says, and that's something the researchers tested in their study. The laser-trapped particles are resistant to low levels of airflow, including from human breathing and hand gestures, the researchers found. But in the system's current state, it's unlikely that these images could form outdoors without a protective enclosure.

Parched planets

*Dust storms are bleeding Mars of its remaining water. The storms can vault water vapor up to 80 kilometers into the planet's atmosphere, where ultraviolet light breaks down the vapor into hydrogen and oxygen. The free hydrogen easily escapes into space, **Dan Garisto** reported in "Dust storms rob Mars of water"* (SN: 2/17/18, p. 8)*.*

Reddit user **InevitableTreachery** asked if dust storms that ravaged parts of the United States and Canada in the 1930s — an era known as the Dust Bowl — affected Earth in a similar way. "Obviously, we still have plenty of water, but did we lose any due to the dust storms?"

Dust Bowl–era storms may have worsened a concurrent drought in the region by overloading Earth's atmosphere with particles, researchers reported in 2008 in *Geophysical Research Letters*. The particles could have acted like a shield, blocking out the sun and preventing some radiation from evaporating water on the planet's surface, resulting in even less rainfall.

But it's unlikely that these dust storms rose high enough into the atmosphere to liberate water vapor from the planet in the same way that storms on Mars do, says planetary scientist **Nicholas Heavens** of Hampton University in Virginia. "Dust storms on Earth rarely extend more than 10 kilometers from the surface," he says. "Even the strongest thunderstorms only reach altitudes of 20 kilometers."

Mars' dust storms can be much taller because the Red Planet's lower gravity and thinner atmosphere make it easier for dust particles heated by the sun to rise up, **Heavens** says.

MANCHESTER MUSEUM/UNIV. OF MANCHESTER

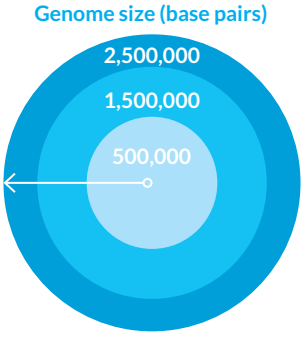
Viruses go big

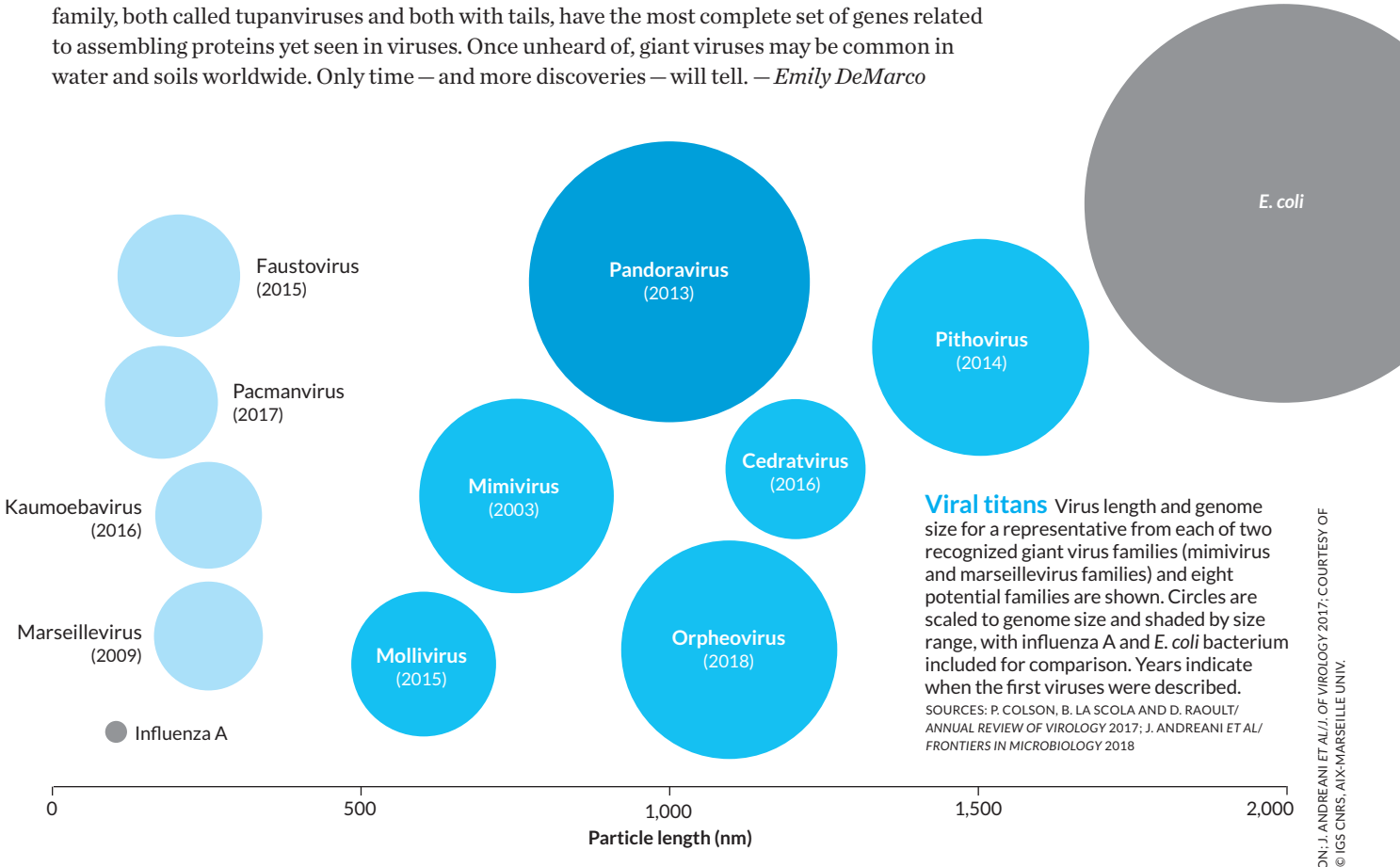
For decades, the name "virus" meant small and simple. Not anymore. Meet the giants.

Today, scientists are finding ever bigger viruses that pack impressive amounts of genetic material. The era of the giant virus began in 2003 with the discovery of the first *Mimivirus*. The viral titan is about 750 nanometers across with a genetic pantry boasting around 1.2 million base pairs of DNA, the information-toting bits often represented with A, T, C and G. Influenza A, for example, is roughly 100 nanometers across with only about 13,500 base pairs of genetic material.

In 2009, another giant virus called *Marseillevirus* was identified. It is different enough from mimiviruses to earn its own family. Since 2013, mega-sized viruses falling into another eight potential virus families have been found, showcasing a long-unexplored viral diversity, researchers reported last year in *Annual Review of Virology* and in January in *Frontiers in Microbiology*.

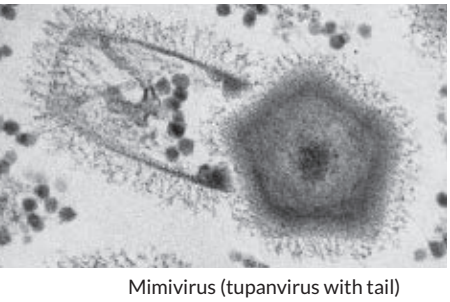
Giant viruses mostly come in two shapes: polyhedral capsules and egglike ovals. But one, *Mollivirus*, skews more spherical. *Pacmanvirus* was named for the broken appearance of its outer shell. Both represent potential families. Two newly discovered members of the mimivirus family, both called tupanviruses and both with tails, have the most complete set of genes related to assembling proteins yet seen in viruses. Once unheard of, giant viruses may be common in water and soils worldwide. Only time — and more discoveries — will tell. — *Emily DeMarco*



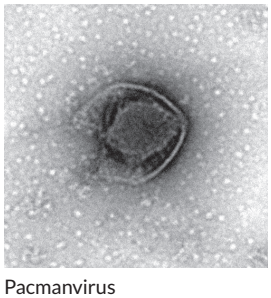


Viral titans Virus length and genome size for a representative from each of two recognized giant virus families (mimivirus and marseillevirus families) and eight potential families are shown. Circles are scaled to genome size and shaded by size range, with influenza A and *E. coli* bacterium included for comparison. Years indicate when the first viruses were described.

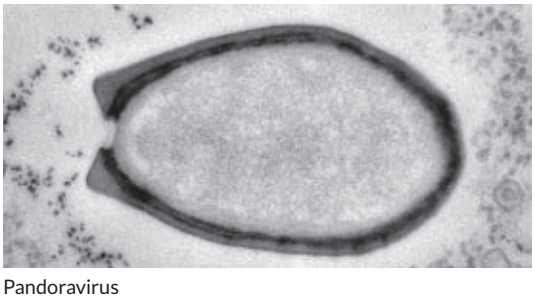
SOURCES: P. COLSON, B. LA SCOLA AND D. RAOULT/ *ANNUAL REVIEW OF VIROLOGY* 2017; J. ANDREANI *ET AL*/ *FRONTIERS IN MICROBIOLOGY* 2018



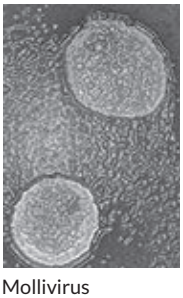
Mimivirus (tupanvirus with tail)



Pacmanvirus

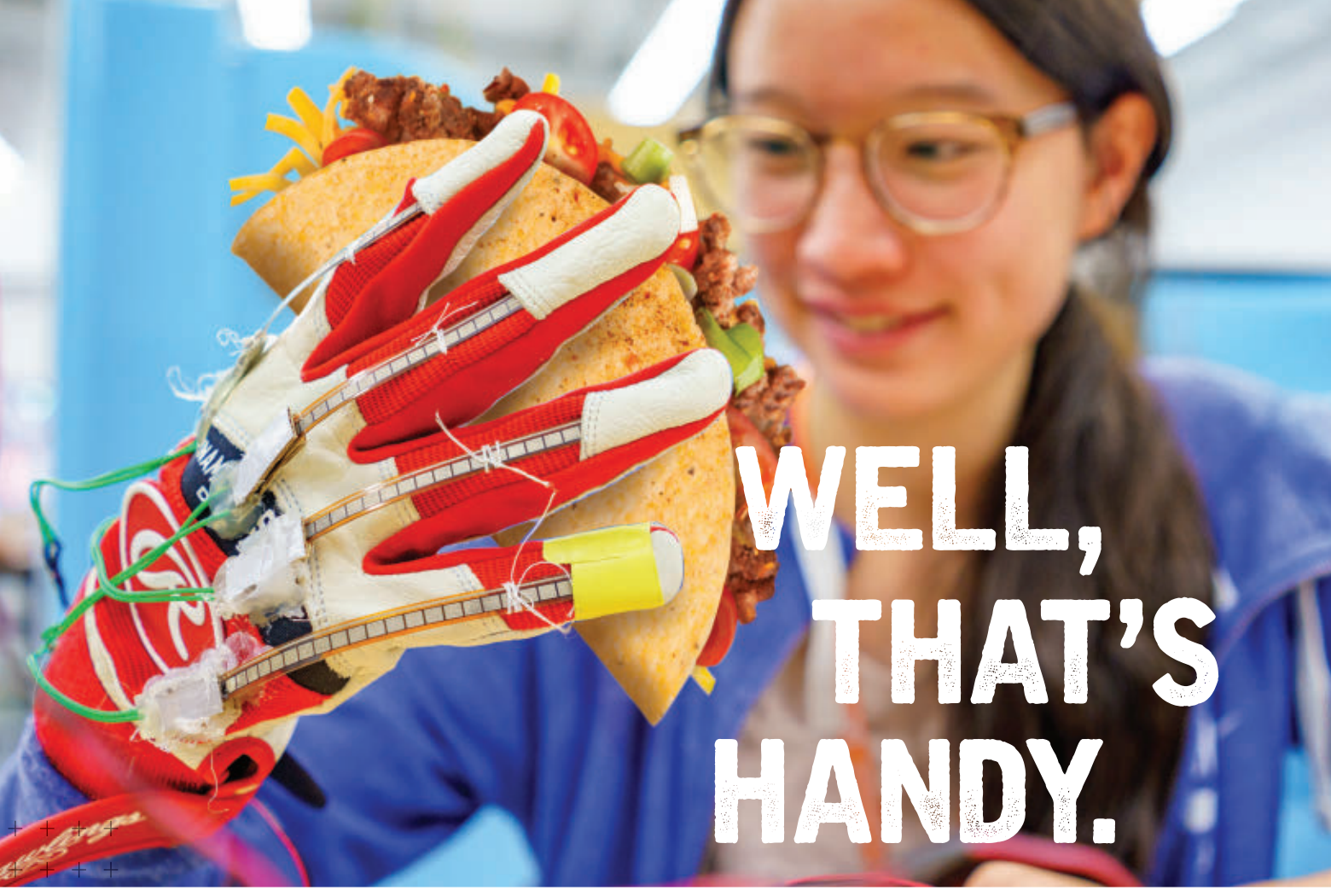


Pandoravirus



Mollivirus

GRAPHIC: C. CHANG; IMAGES, FROM LEFT: P. COLSON; J. ANDREANI *ET AL*/*J. OF VIROLOGY* 2017; COURTESY OF CHANTAL ABERGEL AND JEAN-MICHEL CLAVERIE; © IGS CNRS, AIX-MARSEILLE UNIV.



A PLACE THAT GIVES KIDS A FEEL FOR STEM.

Hungry for STEMulation? This summer, get your brain a tasty taco of science, engineering and math awesomeness.

Operation Catapult is that taco.

Layers of savory STEM opportunities in a delicious shell of fun that lets rising high school seniors reach into robotics, or do cool things like brew biodiesel or make a machine from scratch.

Forget Taco Tuesday.
Take a bite of Operation Catapult.

operation Catapult

ROSE-HULMAN INSTITUTE OF TECHNOLOGY

rose-hulman.edu/STEMtaco

Wear the Colors of Italy's Legendary Regatta

To show exquisite details, necklace shown is not exact size.

Raffinato™ Italy

The Regata Storica started in 1489, when the beautiful Caterina Cornaro, wife of the King of Cyprus, renounced her Cypriot throne in favor of Venice. The people of Venice welcomed her with a parade of elaborately-decorated gondolas, in a rainbow of popping colors. Every year since, the spirit of 1489 is recaptured in those world-famous canals when the famous Regata is repeated.

Our *Cornaro Necklace* is the essence of Venice, with the revelry of the Regata channeled into one perfect piece of jewelry. The gorgeous colors recall the Regata itself, and the 59 beads of authentic Murano are the only thing as historic and uniquely Venice as those gondolas. Each necklace is handmade by the legendary Murano glassmakers, where the proud Venetian tradition has been passed down from generation to generation, dating back to before the city threw that first famous party for Caterina.

Thanks to the Regata, we've visited Venice often and made great contacts, which is how we found and negotiated the best possible price on the highest quality Murano available. Now's your chance to share in the spirit of this legendary event without needing to break out your passport.

"...businesses on the crowded little island [Murano] also produce high fashion jewelry found on runways and in exclusive social settings around the world".
— The New York Times

Satisfaction guaranteed or your money back. Enjoy the gorgeous colors of the ***Cornaro Murano Necklace*** for 30 days. If it doesn't pass with flying colors, send it back for a full refund of the item price.

Limited Reserves. You could easily pay $300 or more for a Murano glass bead necklace, but at **$49**, this genuine handmade Murano won't last. Don't miss the boat! CALL 1-888-444-5949 TODAY!

Cornaro Murano Necklace

Stunningly affordable at **$49** + S&P

• **Made in Italy** • **Murano glass** • **28" necklace with lobster clasp** • **Gold-finished settings**

Call today. There's never been a better time to let your elegance shine. 1-888-444-5949

Offer Code: RFG117-01. You must use the offer code to get our special price.

Raffinato™ 14101 Southcross Drive W., Dept. RFG117-01, Burnsville, Minnesota 55337 www.raffinatoitaly.com

A collection of impeccable design & craftsmanship from Italy.