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DECEMBER 8, 2018

Parkinson's May Start in the Gut

Finding Planetary Graveyards

Kilogram Goes Fundamental

Greenland Hides a Big Crater

Beavers on the move

The dam builders reshape Alaska's tundra

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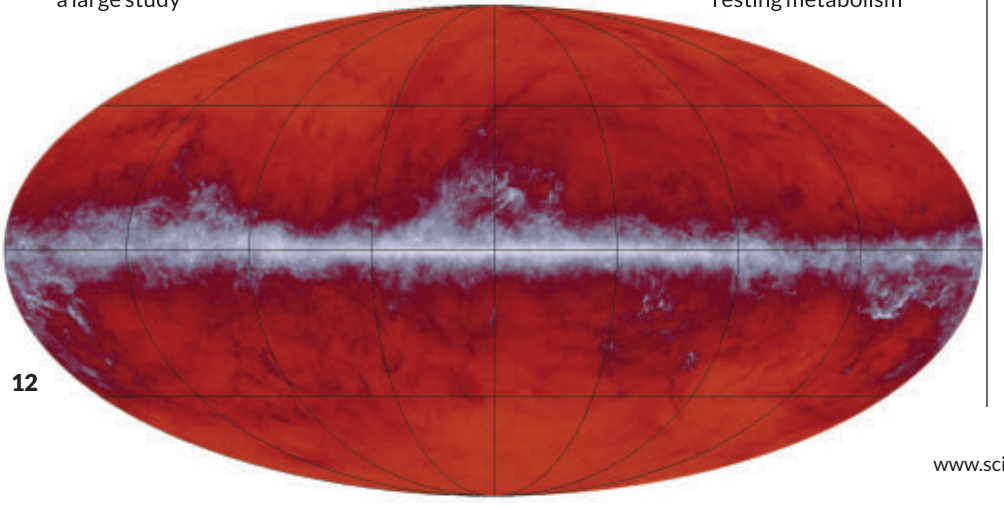
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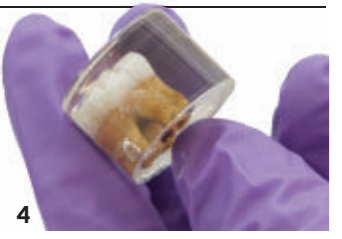
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Departments

COVER To some people, beavers are pests. But as they move into Arctic tundra, the animals may help other species. *Design Pics Inc/Alamy Stock Photo*

FROM TOP: MATT NAGER; S. QUANE AND B. ANDREWS/SMITHSONIAN INST.; PLANCK/ESA, NASA, IPAC INFRARED SCIENCE ARCHIVE

Seeking a panacea in the gut's microbiome

It almost feels like people think every known disorder could be cured by tweaking the gut microbiome: The list of possibilities includes obesity, liver disease, diabetes, autism, multiple sclerosis and rheumatoid arthritis, depression and anxiety. The length of that list alone invites skepticism among those of us who cover science. But there's enough evidence that gut microbes influence disease to make it an exciting area of study.

The challenge in covering an emerging field of scientific inquiry is to accurately convey the basis for excitement while avoiding hype. That's especially true when reporting on a disease like Parkinson's, a neurodegenerative disorder that afflicts millions of people worldwide and has no cure. *Science News* contributor Laura Beil takes on that challenge in this issue (Page 22). She interviewed researchers around the world who are trying to figure out how the gut and brain could be communicating. Beil also talked with a woman who created a company to help fund research into the potential role of the gut microbiome in Parkinson's after her husband was diagnosed at age 44.

Balancing one family's compelling story against the hard fact that the science may not pan out is a challenge, one that many journalists fail. But Beil was well aware of the pitfalls. She has covered biomedical research for decades, first at the *Dallas Morning News* (where she worked with former *Science News* Editor in Chief Tom Siegfried) and then as a contributor for *Science News* and other publications. She's also the brains behind the podcast "Dr. Death." In October, Beil was awarded the Victor Cohn Prize for Excellence in Medical Science Reporting, one of the greatest honors in science journalism.

She also has a deep personal connection to the story. Her father was diagnosed with Parkinson's in the mid-1990s while in his 50s. Beil quickly immersed herself into research on potential treatments, hoping that her reporting skills could help connect her father with a cure. "I was completely obsessed with it," she says. But she couldn't find anything that could help. "There was nothing to do for him, really," she says. He died at age 70.

So when Beil heard about the gut-Parkinson's hypothesis, "the thought that there was something new to talk about was really exciting." Unfortunately, excitement doesn't mean that a treatment will develop out of this idea, or even that the notion is correct. "The excitement is for the idea," Beil told me. Scientists need to test the idea to see if the gut is really involved in the disease (the phase of many efforts now) and then figure out if a treatment can be devised. That research process typically takes decades, and the odds of failure are far higher than the odds of delivering a headline-worthy breakthrough. As Beil says, "it's still a long way between here and there."

A key part of our mission is covering new concepts in science from their earliest stages, knowing that many of these ideas eventually will be disproved by new evidence. It reminds us why a single study isn't the whole story, and why findings often contradict each other. It's not a flaw; it's the core of the scientific process. High-quality journalism that tempers excitement with skepticism helps make that clear. — *Nancy Shute, Editor in Chief*

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SSP

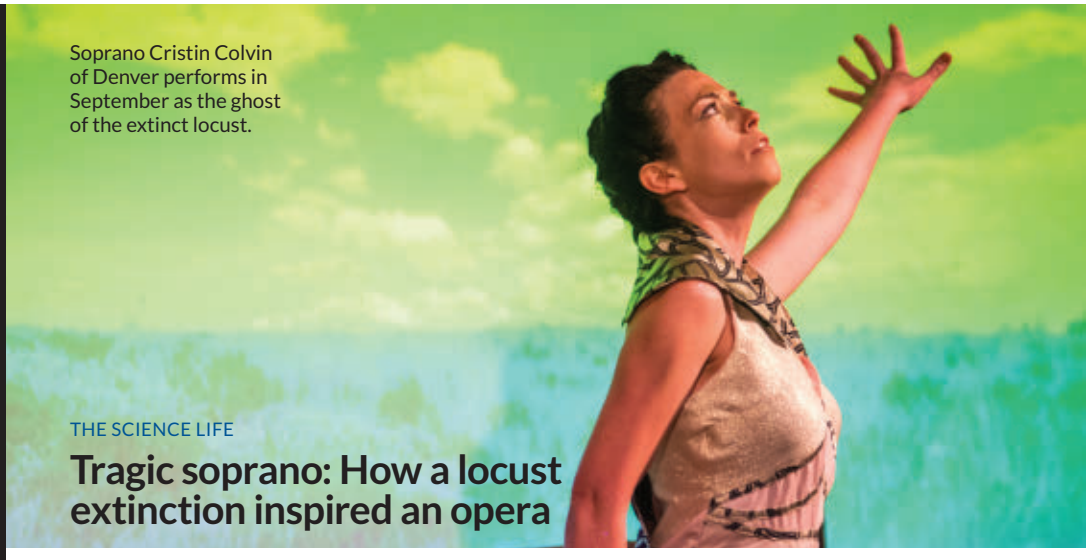
Excerpt from the November 30, 1968 issue of *Science News*

50 YEARS AGO

64 armadillos threaten a theory

Armadillos come in fours, quadruplet offspring from a single egg, and are endowed with identical genes. Yet, the quadruplets are often not identical, a fact that calls into question the assumption that genes encased in the nucleus of the cell are the sole determinants of heredity.

UPDATE: What comes naturally to the nine-banded armadillo, the species that baffled scientists 50 years ago, is rare in other mammals. Polyembryony, producing many offspring from a single fertilized egg, does result in genetically identical armadillo pups. But scientists now know that other factors also stir the developmental pot. For example, epigenetic marks, the chemical tags that control a gene's activity level, can make identicals look very different. Though genetically fascinating, armadillos never topped rodents as research subjects — possibly due to their fresh insect diet and long time between litters. Scientists do use the tanklike creatures to study leprosy, a disease the animals can pick up and pass on to humans (*SN: 5/21/11, p. 9*).



Soprano Cristin Colvin of Denver performs in September as the ghost of the extinct locust.

THE SCIENCE LIFE

Tragic soprano: How a locust extinction inspired an opera

Locust: The Opera finds a novel way to doom a soprano: species extinction.

The libretto — written by Jeff Lockwood, an entomologist at the University of Wyoming in Laramie — features a scientist, a rancher and a dead insect. The scientist tenor agonizes over why the Rocky Mountain locust went extinct at the dawn of the 20th century. He comes up with hypotheses, three of which unravel to music and frustration.

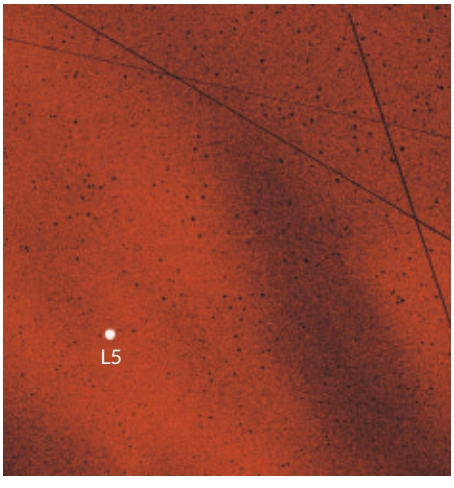
The project hatched in 2014. "Jeff got in

MYSTERY SOLVED

Dusty pseudomoons detected near Earth

Meet the Kordylewski dust clouds, shimmering pseudomoons orbiting Earth. Hungarian astronomers and physicists say they spotted light scattered from one of the clouds, providing evidence after nearly 60 years of controversy that the clouds really exist.

The twin dust clouds gather at two points in space where Earth's gravity cancels out the moon's gravity. That gravitational stability makes these spots, called Lagrange points, good places to park spacecraft — and trap interplanetary debris.



Using a special telescope filter, astronomers spotted evidence of one of Earth's elusive dust satellites. The dust cloud (brighter red) is in a gravitational dead zone known as L5.

No one had definitively seen the dust clouds since Polish astronomer Kazimierz Kordylewski reported the first sighting in 1961. Some think the sun's stronger gravity sweeps the two spots clear periodically, which could explain the "now you see it, now you don't" results of past searches.

Judit Slíz-Balogh, András Barta and Gábor Horváth, all of Eötvös Loránd University in Budapest, searched through a special telescope filter that detects light polarized from bouncing off dust grains. After months, the group spotted a telltale shimmer around one of the gravitational dead zones, the team writes in a paper to appear in the Jan. 1 *Monthly Notices of the Royal Astronomical Society*. The physics of Lagrange points suggests that, if one cloud exists, the other does, too. — *Lisa Grossman*

FROM TOP: AMBER BAESLER; J. SLÍZ-BALOGH

his head, 'Oh, opera is a good way to tell science stories,' which takes a creative mind to think that," says Anne Guzzo, who composed the music. Guzzo teaches music theory and composition at the University of Wyoming.

The *Melanoplus spretus* locust brought famine and ruin to farms across the western United States. "This was a devastating pest that caused enormous human suffering," Lockwood says. Epic swarms would suddenly descend on and eat vast swaths of cropland. "On the other hand, it was an iconic species that defined and shaped the continent."

Lockwood had written about the locust's mysterious and sudden extinction in the 2004 book *Locust*, but the topic "begged in my mind for the grandeur of opera."

He spent years mulling how to create a one-hour opera for three singers about the swarming grasshopper species.

Then the ghost of Hamlet's father in

The Rocky Mountain locust sometimes flew in giant, ravenous swarms that destroyed crops.

the opera *Amleto*, based on the play by Shakespeare, inspired a breakthrough. Lockwood imagined a spectral soprano locust, who haunted a scientist until he figured out what killed her kind.

To make one soprano represent trillions of locusts, Guzzo challenged her music theory class to find ways of evoking the sound of a swarm. The students tried snapping fingers, rattling card stock and crinkling cellophane. But "the simplest answer was the most elegant," Guzzo says — tasking the audience with shivering sheets of tissue paper in sequence, so that a great wave of rustling swept through the auditorium.

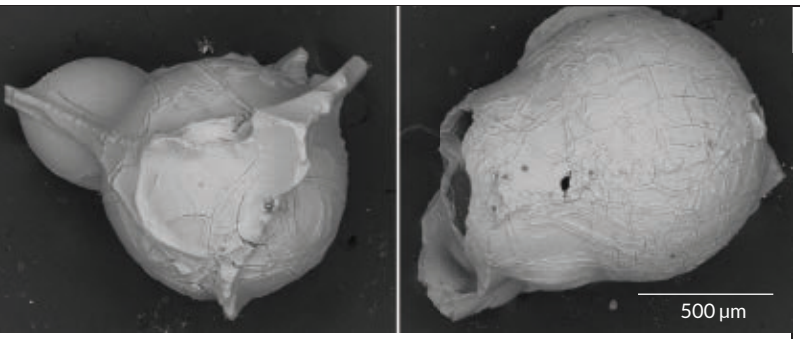
For the libretto, Lockwood took an unusually data-driven approach. After surveying opera lengths and word counts, he paced his work at 25 to 30 words per minute, policing himself sternly. If a scene was long by two words, he'd find two to cut.

He wrote the dialog not in verse, but as conversation, some of it a bit professorial. Guzzo asked for a few line changes. "I just couldn't get 'manic expressions of fecundity' to fit where I wanted it to," she says.

Eventually, the scientist solves the mystery, but takes no joy in admitting to the beautiful ghost that humans had unwittingly doomed her kind by destroying vital locust habitat. For tragedy, Lockwood says, "there has to be a loss tinged with a kind of remorse."

The opera, performed twice in Jackson, Wyo., will next be staged in March in Agadir, Morocco.

— Susan Milius



SAY WHAT?

Bread-crust bubble \bred kruhst BUH-buhl\ n.

Tiny, gas-filled beads of volcanic ash

A newly discovered kind of volcanic ash consists of tiny bubbles with a crusty exterior.

Scientists have identified a new type of volcanic ash found at an eastern Oregon volcano that erupted some 7 million years ago. Bread-crust bubbles, each no more than a millimeter wide, can reveal secrets about how volcanoes erupt, researchers reported November 4 at the Geological Society of America annual meeting in Indianapolis.

Viewing the volcanic ash through a scanning electron microscope showed a crusty exterior, which can indicate both the bubble's depth at the time of eruption and how quickly it expanded and rose to the surface without popping. The Oregon ash formed about 500 to 2,000 meters below ground — a short distance, geologically — and erupted at a rate of about 30 to 80 meters per second. *— Jennifer Leman*

–EST

Neandertal teeth reveal earliest known signs of lead exposure

Traces of lead in the molars of two young Neandertals found in southeast France provide the earliest evidence of lead exposure in hominids.

Like tiny time capsules, the 250,000-year-old teeth contain chemical signatures that chronicle specific times — mostly in winter — when the two Neandertals probably ingested lead-tainted food or water, researchers say October 31 in *Science Advances*. The teeth revealed layers with elevated lead levels at multiple points in the lives of the individuals, both of whom died before adulthood. Chemical analysis of one tooth showed signs of lead exposure at about 2½ months old, spiking after 2 years old.

"There are clocks inside our mouths," says Tanya Smith, a human evolutionary biologist at Griffith University in Brisbane, Australia. One possible source of the exposure: Present-day lead mines 25 kilometers from where the teeth were found. "It's not hard to believe that they may have encountered deposits or consumed food that was contaminated," Smith says.

— Jennifer Leman

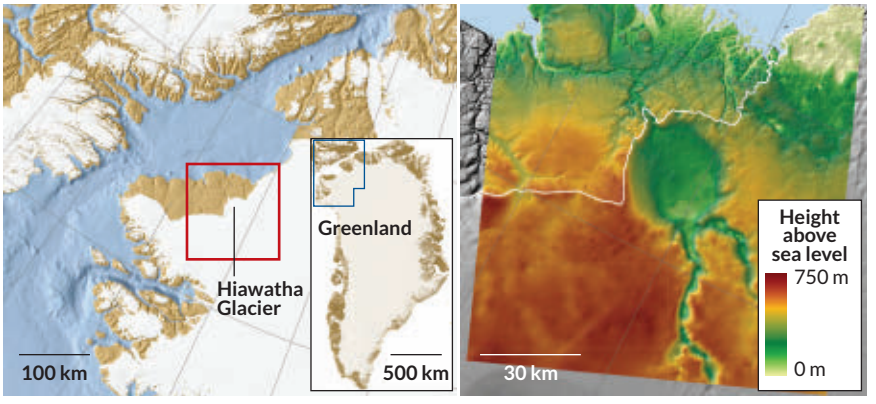
Fossilized teeth (one shown) from two Neandertals suggest that the ancient hominids were exposed to lead as children.

FROM TOP: JULIUS BIEN/WIKIMEDIA COMMONS; S. QUANE AND B. ANDREWS/SMITHSONIAN INST.; T.M. SMITH/GRIFFITH UNIV.

EARTH & ENVIRONMENT

Giant crater found in Greenland

Meteorite impact's effect on an ancient cold snap is unclear



Hidden bowl Airborne radar data revealed a round depression (green circle, right) buried beneath almost a kilometer of ice at the edge of Hiawatha Glacier in northwest Greenland (left). Geochemical clues suggest that the depression is an impact crater.

BY CAROLYN GRAMLING

There's something big lurking beneath Greenland's ice. Using ice-penetrating radar, scientists have discovered a 31-kilometer-wide crater, larger than the city of Paris, buried under as much as 930 meters of ice.

The meteorite that the researchers say hit Earth and formed the pit would have been about 1.5 kilometers across. That's large enough to have caused environmental damage across the Northern Hemisphere, glaciologist Kurt Kjær of the University of Copenhagen and colleagues report November 14 in *Science Advances*.

The crater is the first one found in Greenland and one of the 25 or so largest craters yet found on Earth.

Though the crater has not been dated, data from glacial debris as well as ice-flow simulations suggest that the impact happened sometime during the Pleistocene Epoch, 2.6 million to 11,700 years ago. The discovery could breathe new life into a controversial hypothesis that an impact about 13,000 years ago triggered a mysterious 1,000-year cold snap known as the Younger Dryas (*SN: 7/7/18, p. 18*).

Members of the research team spotted a rounded shape at the edge of Hiawatha Glacier in northwest Greenland during a scan by NASA's Operation IceBridge in 2015. The mission uses airborne radar to map the thickness of polar ice. The researchers suspected that the shape represented the edge of a crater, Kjær says.

For a more detailed look, the team hired an aircraft equipped with ultra-wideband radar, which can send pulses of energy toward the ice at a large number of frequencies. Combining the Operation IceBridge and the ultra-wideband radar data, the team mapped the inner and outer contours of its target.

The object is almost certainly an impact crater, says team member and electrical engineer John Paden of the University of Kansas in Lawrence. "It's so conspicuous in the satellite imagery now. There's not another good explanation."

On the ground, the team hunted for geochemical and geologic signatures of an impact within nearby sediments. Sampling from within the crater itself was impossible, as it is covered by ice. But just beyond the edge of the ice, meltwater from the base of the glacier had, over the years, deposited sediment.

A sediment sample collected from within that glacial outwash contained several telltale signs of an impact: "shocked" quartz grains with deformed crystal lattices and glassy grains that may represent flash-melted rock. The sample also had elevated concentrations of certain elements, including nickel, cobalt, platinum and gold, relative to what's normally found in Earth's crust. That profile points not only to an impact, the researchers say, but also suggests that the impactor was an iron meteorite.

Determining when that iron meteorite slammed into Earth is trickier.

Ice-penetrating radar revealed that the crater bowl itself has several distinct layers of ice. The topmost layer has a continuous sequence of smaller layers, representing the gradual deposits of snow and ice through the last 11,700 years, a period known as the Holocene. At the base of that layer is a distinct, debris-rich layer that has been seen elsewhere in Greenland ice cores and is thought to represent the Younger Dryas cold period 12,800 to 11,700 years ago. Beneath the Younger Dryas layer is another large layer — but unlike the smooth Holocene layer, this one is jumbled and rough.

"You see folding and strong disturbances," says study coauthor Joseph MacGregor, a glaciologist with Operation IceBridge. "And below that, we see yet deeper, complex basal ice." Radar images of that bottommost layer within the crater show several peaks, which MacGregor says could represent material from the ground that got incorporated into the ice. "Putting that all together, what you have is a snapshot of an ice sheet that looked fairly normal during the Holocene, but was quite disturbed before that," he says.

Those data suggest that the impact is at least 11,700 years old, Kjær says. And the rim of the crater appears to cut through a preexisting ancient river channel that must have flowed across the land before Greenland became covered with ice about 2.6 million years ago.

Planetary scientist Clark Chapman of the Southwest Research Institute in Boulder, Colo., is skeptical that the crater formed within the last couple of million years. It's "quite unlikely," he says. Such strikes are rare in general, and asteroids barreling into Earth are far more likely to land in the ocean. And, he says, "it would be at least a hundred times less likely that it could have happened so recently as to have affected the Younger Dryas." ■

BOTH: K.H. KJÆR ET AL/SCIENCE ADVANCES 2018

MATTER & ENERGY

It's official: Kilogram will be redefined

Measurement system will soon rely on fundamental constants

BY EMILY CONOVER

Out with the old — kilogram, that is.

Scientists will soon ditch a specialized hunk of metal that defines the mass of a kilogram. For years, every measurement of mass made anywhere on Earth has been tied back to this one cylindrical object. Known as "Le Grand K," the cylinder, cast in 1879, is kept carefully sequestered in a secure, controlled environment outside of Paris.

On November 16, at a session of the 26th General Conference on Weights and Measures in Versailles, France, representatives of countries from around the world voted to kick that convoluted system to the curb, enacting a plan to redefine several units of measurement (*SN: 11/12/16, p. 24*).

COURTESY OF BIPM

Carefully secured under several bell jars, a metal cylinder known as Le Grand K will no longer define the kilogram starting next year.

For a small cadre of scientists called metrologists — researchers who specialize in the science of measurement — the news is big. "It's about as excited as you're going to see metrologists get," says David Newell of the National Institute of Standards and Technology in Gaithersburg, Md. He has spent much of his career working toward the change. "I can't believe we're finally getting it done," he says.

> "It's about as excited as you're going to see metrologists get."
>
> **DAVID NEWELL**

On May 20, 2019, Le Grand K will lose its special status. The mass of a kilogram will be defined by a fundamental constant of nature known as the Planck constant. At the same time, other mainstays of the metric system will also be revamped: the ampere (the unit of electric current), the kelvin (the unit of temperature) and the mole (the unit for an amount of substance).

Now, instead of being based on arbitrary quantities or physical artifacts that might change over time, all definitions will be based on fundamental constants, says metrologist Estefanía de Mirandés of the International Bureau of Weights and Measures in Sèvres, France.

Those unchanging numbers, which include the speed of light and the charge of the electron, are the same everywhere in the universe, making them useful pegs upon which to hang the metric system's hat. Out of seven basic units in the metric system, three already met this criterion. Now the remaining four will conform to this ideal. "It's a very big change of paradigm, and now it's complete," says de Mirandés.

Most people won't notice the switcheroo: A kilogram of ground beef will still make the same number of burgers. But metrologists say the change will put precision measurements on a firmer foundation. For example, it will be easier to measure masses that are much smaller than a kilogram, something that could be useful for tasks like doling out tiny quantities of pharmaceuticals.

In preparation for the kilogram's update, several teams of scientists carefully measured the Planck constant, quantifying it to an accuracy of about 10 parts per billion. After May 20, the value of the Planck constant will be fixed at exactly $6.62607015 \times 10^{-34}$ kilograms times meters squared per second.

As a result, Le Grand K will no longer be a perfect kilogram — its mass will have a fudge factor of plus or minus 10 micrograms. Despite Le Grand K's loss of stature, metrologists will keep studying the object to understand how stable its mass is over time. Scratches or gunk on the surface of the cylinder may cause its mass to change slightly, for example.

The kilogram's history can be traced back to 1795, when France adopted a standardized system of units, the metric system. The kilogram was originally designed to be equal to the mass of a liter of water. Soon, the mass came to be represented by a cylinder, and other countries adopted the units.

A key idea behind the development of the metric system, known formally as the International System of Units, was that the units should be accessible to everyone and last forever. "When they defined the kilogram, they fell short of this," says NIST physicist Stephan Schlamminger. Only a select few people have access to Le Grand K while countries have to rely on imperfect copies of the official kilogram. Soon anyone with the right expertise will be able to use the fixed value of the Planck constant to measure mass, using a device known as a Kibble balance.

In celebration of the new, more accessible kilogram, Schlamminger and Newell had the Planck constant tattooed on their arms, along with the French phrase, "*A tous les temps, à tous les peuples*" — for all times and for all people — an ideal that the new kilogram will now meet. ■

HUMANS & SOCIETY

Borneo hosted Stone Age cave artists

Horned animal painting may be the oldest known figurative art

BY BRUCE BOWER

Discoveries on the island of Borneo illustrate that cave art emerged in Southeast Asia as early as in Western Europe, and with comparable complexity, researchers say.

A limestone cave in eastern Borneo features a reddish-orange painting of a horned animal, possibly a wild cow. The painting dates to at least 40,000 years ago, concludes a team led by archaeologist Maxime Aubert of Griffith University in Southport, Australia. This creature represents the oldest known example of a painted figure anywhere in the world, the scientists argue online November 7 in *Nature*.

The same cave walls contain two hand outlines framed in reddish-orange pigment that were made at least 37,200 years ago and a similar hand stencil with a maximum age of 51,800 years.

Three nearby caves display instances of a second style of rock art that appeared about 20,000 years ago, the investigators say. Examples include purple-hued, humanlike figures and hand stencils, some decorated with lines or dots. Painted lines link some hand stencils to others.

Age estimates rest on analyses of uranium in mineral deposits that had formed over and underneath parts of each cave painting. Scientists used known decay rates of radioactive uranium in these deposits to calculate maximum and minimum dates for the paintings.

Aubert's group previously used this technique, called uranium-series dating, to calculate that people on the nearby Indonesian island of Sulawesi created hand stencils on cave walls nearly 40,000 years ago (*SN: 11/15/14, p. 6*).

"Cave art could have potentially been exported from Borneo to Sulawesi and all the way to Papua and Australia," Aubert says. Australian cave paintings of humanlike figures resemble those found on Borneo, he says, but the ages of the Australian finds remain uncertain.

No Southeast Asian cave paintings have been found from when humans first arrived in the region, between 70,000 and 60,000 years ago. At that time and up to the end of the last ice age around 10,000 years ago, Borneo formed mainland Eurasia's easternmost tip thanks to lowered sea levels.

> "Western European and Southeast Asian cave art seem to first appear at about the same time and with remarkable similarities."
>
> SUE O'CONNOR

Those first Southeast Asians may have created cave art that hasn't been discovered, Aubert says. Or small groups of early colonizers may not have painted on cave walls until their populations expanded, leading to more complex social and ritual behaviors. It's also possible that another human migration from elsewhere in Asia brought rock art to Borneo roughly 50,000 years ago.

Whatever the case, "Western European and Southeast Asian cave art seem to first appear at about the same time and with remarkable similarities," says archaeologist Sue O'Connor of Australian National University in Canberra, who did not participate in the new study.

Other investigators have used the uranium-series technique to date a painted red disk in a Spanish cave to at least 40,800 years ago (*SN: 7/28/12, p. 15*). Another study this year suggested that Neandertals painted abstract shapes and hand stencils on the walls of several Spanish caves at least 64,800 years ago (*SN: 3/17/18, p. 6*).

But there have been disagreements over how to collect mineral samples from rock art for dating. Aubert's team, for instance, has criticized the Neandertal study, saying the researchers may have unintentionally dated mineral deposits that are much older than the artworks. If so, humans rather than Neandertals could have created the Spanish cave art.

Two of the authors of that study, archaeologist João Zilhão of the University of Barcelona and archaeologist Paul Pettitt of Durham University in England, have their own quibbles with the new work. The pair don't doubt that cave painting emerged in Southeast Asia at least 40,000 years ago. But descriptions of sampled mineral deposits from the Borneo caves leave it unclear whether, for instance, Aubert's group dated the horned animal figure or adjacent paint remnants of some other, unidentified figure, Zilhão says. ■

A reddish-orange animal (lower left) painted on a cave wall in Borneo dates to at least 40,000 years ago, scientists say.

LUC-HENRI FAGE

BODY & BRAIN

Fish oil pill may cut heart disease risk

But the drug was tested only in patients already taking statins

BY AIMEE CUNNINGHAM

Cholesterol-lowering drugs may one day gain a sidekick in the battle against heart disease. Taking a potent drug derived from fish oil along with a statin lowers the risk of heart attack and stroke in some high-risk people, researchers say.

A clinical trial called REDUCE-IT tested the approach in over 8,000 participants who either had cardiovascular disease or were at high risk for it. These people were already on statins to lower their cholesterol and had high blood levels of fats called triglycerides.

People took either a two-gram pill of a highly purified omega-3 fatty acid — the oil found in fatty fish — twice daily or a placebo, and were followed up to six years. Of the omega-3 group, 17.2 percent had a fatal or nonfatal heart attack or stroke; 22 percent in the placebo group did.

Overall, the drug, called Vascepa, reduced the risk of heart attack or stroke by 25 percent, researchers announced November 10. The results were also published in the *New England Journal of Medicine*.

The results are "strikingly positive," says Carl Orringer, a cardiologist at the University of Miami Miller School of Medicine in Florida who was not involved in the study. For people taking statins and working to combat high levels of triglycerides with healthy diet and exercise, the drug appears to provide additional benefit, he says.

But he warns that the finding doesn't mean that popular, but less potent, supplements containing omega-3 fatty acids will have a similar effect. "We don't want people to go running out to the drugstore to buy a fish oil pill," Orringer says. "It won't help them."

Cardiovascular disease is the leading cause of death for both men and women in the United States. People primarily take statins to reduce high levels of "bad" LDL cholesterol because excess LDL cholesterol contributes to the buildup of plaques in artery walls.

For some patients taking statins, doctors also monitor triglycerides because high levels of the fats can increase the risk of heart attack and stroke. Conditions like obesity and diabetes can lead to high triglyceride levels.

Vascepa has already been approved by the U.S. Food and Drug Administration to lower triglycerides in people with very high levels (500 milligrams per deciliter of blood or higher). In the new Phase III clinical trial — conducted to gain approval for the drug's use in a different group of people — preventive cardiologist Christie Ballantyne and colleagues tested whether the drug could help prevent heart attacks and strokes in heart disease patients and in those with risk factors like diabetes.

The drop in heart-related health risk observed in the study is "very encouraging," says Ballantyne, of Baylor College of Medicine in Houston. ■

BODY & BRAIN

Benefits of vitamin D pills questioned

In a study, supplements didn't prevent heart disease or cancer

BY MARCIA FRELLICK

Taking a vitamin D supplement does not reduce the risk of having a heart attack or stroke, or of getting an invasive cancer.

A large clinical trial called VITAL found no significant difference in cancer or heart health risk between people taking 2,000 international units of vitamin D a day and those who took a placebo, researchers reported November 10.

"What this does show is that the general population does not need to be taking vitamin D for cardiovascular health or cancer health," says Erin Michos, a preventive cardiologist at Johns Hopkins University School of Medicine who wasn't involved in the trial.

Researchers have long known that people with low blood levels of vitamin D are at higher risk for heart attacks, strokes, heart failure and an irregular heartbeat known as atrial fibrillation. But VITAL, a Phase III clinical trial, is the largest randomized trial to specifically test whether boosting vitamin D levels prevents cardiovascular disease.

JoAnn Manson, an epidemiologist at Brigham and Women's Hospital and Harvard Medical School in Boston, and colleagues followed 25,871 U.S. men ages 50 and older and women ages 55 and older for up to six years. Participants were relatively healthy, with no history of cardiovascular disease or cancer, except non-melanoma skin cancer, at the start. The trial also included 5,106 black participants, important because people with darker skin have lower levels of the vitamin because pigmentation reduces production of the vitamin in the skin.

Among people taking vitamin D, 396 had a heart attack or stroke, or died from cardiovascular disease, compared with 409 taking a placebo. Differences were similarly insignificant for cancer: 793 people taking vitamin D were diagnosed with invasive cancers compared with 824 people taking a placebo.

The results were published online November 10 in the *New England Journal of Medicine*.

Previous trials hinted that vitamin D falls short in preventing heart disease and cancer. But those trials were smaller and used lower doses, and most were designed to test effects on other health issues, such as bone strength.

But vitamin D doesn't appear to help bone health either. A study in the Nov. 1 *Lancet Diabetes & Endocrinology* found no evidence that vitamin D reduces fractures or falls, or improves bone density.

"Low vitamin D in the blood might just be a marker of someone in a poorer health state in general," Michos says. ■

LIFE & EVOLUTION

Arctic grows riskier for ground nesters

Warming may be boosting predator attacks on shorebird eggs

BY SUSAN MILIUS

Climate change may be flipping Arctic neighborhoods into killing fields for baby birds.

Every year, shorebirds migrate thousands of kilometers from their southern winter refuges to reach Arctic breeding grounds. But what was once a safer region for ground-nesting birds now has higher risks from predators than the tropics do, says Vojtěch Kubelka, an evolutionary ecologist at Charles University in Prague.

Kubelka had heard about regional studies of how predator risk changes by latitude. He, however, wanted to go global. Shorebirds make a great group for a large-scale comparison, he says, because there's not a lot of variation in how nests look to predators. A feral dog in the United States and a fox in Russia both creep up on some variation of a slight ground depression.

Kubelka and colleagues crunched data from decades of records of predator attack rates on about 38,000 nests of sandpipers, plovers and other shorebirds.

Climate change may be spoiling the Arctic as a save haven for ground-nesting shorebirds like these spoonbill sandpipers.

The study zeroed in on 237 populations from a total of 111 species at 149 places scattered worldwide.

On average, these bird species lost about 43 percent of their nests to predator attacks before 1999, but that number has since reached 57 percent, the team says in the Nov. 9 *Science*. The most dramatic upward swoop came from the Arctic. There, that number rose from about 40 percent in the last century to about 65 or 70 percent since 1999. Tropical perils in the Northern Hemisphere changed "only modestly," from about 50 to about 55 percent.

The growing dangers to nests fit with climate change trends, the team found.

Biologists have discussed the idea that migrating toward the poles to breed was a way to escape the tropical abundance of snakes, rodents and other egg lovers.

But rapid Arctic warming might have discombobulated some predator-prey relationships, says coauthor Tamás Székely, a conservation biologist at the University of Bath in England. For example, arctic foxes used to get much of their nourishment from rodents. Skimpy snow cover in warmer winters doesn't insulate rodents as well as it used to, resulting in shrinking rodent populations. So foxes may be shifting more to eggs and nestlings.

That scenario sounds "highly probable," but may be just part of what's going on, says Dominique Fauteux, an ecologist at the Canadian Museum of Nature in Ottawa. A 2010 study suggested that nest predation in the Canadian Arctic was still lower than in temperate areas. There may be some global pattern, but on the ground, Fauteux says, "there clearly are nuances." ■

LIFE & EVOLUTION

Moth's stealth wings thwart bats

Sound-absorbing scales interfere with echolocation

BY JENNIFER LEMAN

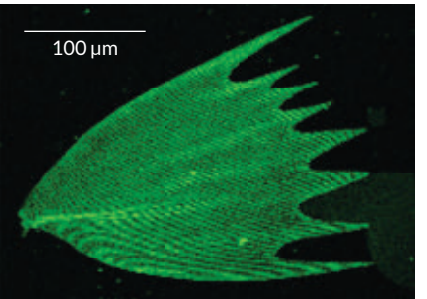
Some moths aren't so easy for bats to detect. The cabbage tree emperor moth has wings with tiny scales that absorb sound waves sent out by bats looking for food. That absorption reduces the echoes that bounce back to bats, allowing *Bunaea alcinoe* to avoid being as noticeable to the nocturnal predators, scientists report online November 12 in the *Proceedings of the National Academy of Sciences*.

"They have this stealth coating on their body surfaces which absorbs the sound," says Marc Holderied, a bioacoustician at the University of Bristol in England.

Bats sense their surroundings using echolocation, sending out sound waves that bounce off objects and return as echoes. Cabbage tree emperor moths, having no ears that might alert them to a predator, have evolved scales of a size, shape and thickness suited to absorbing ultrasonic sound frequencies used by bats, Holderied and colleagues found.

The team shot ultrasonic sound at a single, microscopic scale and observed it transferring sound wave energy into movement. The team then simulated the process with a 3-D computer model that showed the scale absorbing up to 50 percent of the energy from sound waves.

It's not just scales that aid moths that lack ears. Some other species have sound-absorbing belly fur, the same scientists report in the September *Journal of the Acoustical Society of America*.



Cabbage tree emperor moths have wings covered in tiny scales (one shown in this confocal microscopy image) that help absorb sound sent out by echolocating bats.

For moths with ears, defenses can include swerving out of a bat's way. Some moths produce toxins. Having sound-absorbent fur or scales "might require a lot less energy," says Akito Kawahara, an evolutionary biologist at the Florida Museum of Natural History in Gainesville. "It's a very different kind of passive defense system." ■

FROM TOP: PAVEL TOMKOVICH; Z. SHEN *ET AL*/*PNAS* 2018

BODY & BRAIN

Loneliness may be bad for brains

Mice deprived of social lives have shrunken neurons

BY LAURA SANDERS

Mice yanked out of their community and held in solitary isolation show signs of brain damage.

After a month of being alone, the mice had smaller nerve cells in certain parts of the brain. Other brain changes followed, scientists reported at a news briefing November 4.

It's not yet known whether similar damage happens in the brains of isolated humans. If so, the results have implications for the health of people who spend much of their time alone, including the estimated tens of thousands of inmates in solitary confinement in the United States and elderly people in institutionalized care facilities.

The new results, along with other recent brain studies, clearly show that for social species, isolation is damaging, says neurobiologist Huda Akil of the University of Michigan in Ann Arbor. "There is no question that this is changing the basic architecture of the brain."

Neurobiologist Richard Smeyne of Thomas Jefferson University in Philadelphia and colleagues raised communities of multiple generations of mice in large enclosures packed with toys, mazes and things to climb. When some of the animals reached adulthood, they were taken out and put individually into "a typical shoebox cage," Smeyne said.

This abrupt switch induced changes in the brain, Smeyne and colleagues found. The overall size of nerve cells, or neurons, shrank by about 20 percent after a month of isolation. That shrinkage held roughly steady over three months as mice remained in isolation.

To the researchers' surprise, after a month of isolation, the mice's neurons had a higher density of spines — structures for making neural connections — on message-receiving dendrites. An increase in spines usually signals something positive. "It's almost as though the brain is trying to save itself," Smeyne said.

But by three months, the density of dendritic spines had dropped back to baseline levels, perhaps a sign that the brain couldn't save itself when faced with continued isolation. "It's tried to recover, it can't, and we start to see these problems," Smeyne said.

The scientists uncovered other worrisome signals, including reductions in a protein called BDNF, which spurs neural growth. Levels of the stress hormone cortisol changed, too. Compared with mice in groups, isolated mice also had more broken DNA in their neurons.

The researchers studied neurons in the sensory cortex, a brain area involved in taking in information, and the motor cortex, which helps control movement. It's not yet known whether similar effects happen in other brain areas, Smeyne said.

It's also not known how the neural changes relate to mice's behavior. In people, long-term isolation can lead to depression, anxiety and psychosis. Brainpower is affected, too. Isolated people develop problems reasoning, remembering and navigating.

Smeyne is doing longer-term studies aimed at figuring out the effects of neuron shrinkage on thinking skills and behavior. He and colleagues plan to return isolated mice to their groups to see if the brain changes can be reversed. Those types of studies get at an important issue, Akil says. "When is it too far gone?" ■

MEETING NOTES

Lack of sleep can induce anxiety

A sleepless night can leave the brain spinning with anxiety the next day. In healthy adults, overnight sleep deprivation triggered anxiety the next morning, along with altered brain activity patterns, scientists reported November 5.

People with anxiety disorders often have trouble sleeping. The new results uncover the reverse effect — that poor sleep can lead to anxiety. "The sleep loss makes the anxiety worse, which in turn makes it harder to sleep," says sleep researcher Clifford Saper of Harvard Medical School.

Sleep researchers Eti Ben Simon and Matthew Walker of the University of California, Berkeley studied the anxiety levels of 18 people. Following either a night of sleep or a night of staying awake, participants took anxiety tests. After sleep deprivation, these people's anxiety levels were 30 percent higher than when they had slept. On average, anxiety scores reached levels seen in people with anxiety disorders, Ben Simon said in a news briefing.

What's more, sleep-deprived people's brain activity changed. In response to emotional videos, brain areas involved in emotions were more active, and the prefrontal cortex, an area that can put the brakes on anxiety, was less active, functional MRI scans showed. — *Laura Sanders*

Pot may change decision-making parts of teen boys' brains

Marijuana use during the teenage years may change the brain in key decision-making areas, a study in rats suggests.

Behavioral neuroscientist Eliza Jacobs-Brichford of the University of Illinois at Chicago and colleagues gave adolescent male and female rats a marijuana-like compound. Afterward, the team found changes in parts of the brain involved in making decisions. Normally, many of the nerve cells there are surrounded by sturdy webs that help stabilize connections between nerve cells. But in males that had been exposed to the compound, fewer of these nerve cells, which help put the brakes on other cells' activity, were covered by nets. Drug exposure didn't seem to affect females' nets. "Males look more susceptible to these drugs," Jacobs-Brichford said November 7. — *Laura Sanders*

ATOM & COSMOS

Scientists seek planetary graveyards

Other stars' Oort clouds may be visible in universe's first light

BY LISA GROSSMAN

A thick sphere of icy debris known as the Oort cloud shrouds the solar system. Other star systems may harbor similar icy reservoirs, and those clouds may be visible in the universe's oldest light, researchers report.

Astronomer Eric Baxter of the University of Pennsylvania and colleagues looked for evidence of such exo–Oort clouds in maps of the cosmic microwave background, the cool cosmic glow of the first light released after the Big Bang, about 13.8 billion years ago. No exo–Oort clouds have been spotted yet, but the technique looks promising, the team reports in the November *Astronomical Journal*. Finding exo–Oort clouds could help shed light on how other solar systems — and perhaps even our own — formed and evolved.

The Oort cloud is thought to be a planetary graveyard stretching between about 1,000 and 100,000 times as far from the sun as Earth. Scientists think this reservoir of billions or trillions of icy objects formed early in the solar system's history, when violent movements of the nascent giant planets tossed smaller objects outward. Every so often, one of those frozen planetary fossils dives back in toward the sun and is visible as a comet (*SN: 11/16/13, p. 14*).

But observing the Oort cloud directly from within it is difficult. Despite a lot of circumstantial evidence, no one has actually seen the Oort cloud.

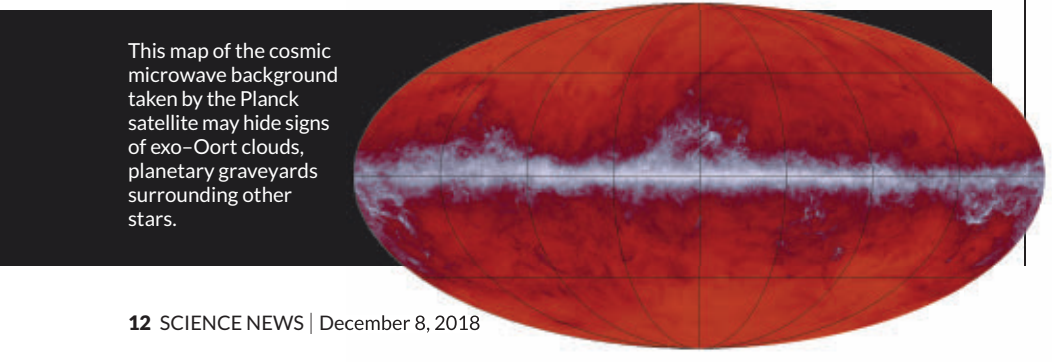
Baxter and colleagues thought exo–Oort clouds might be easier to spot. Objects in an exo–Oort cloud wouldn't reflect enough starlight to be seen directly, but they would absorb starlight and radiate it back out into space as heat. For the sun's Oort cloud, that heat signal would be smeared evenly across the entire sky from Earth's perspective. But an exo–Oort cloud's warmth would be limited to a tiny region around its star.

Baxter's group calculated that the temperature of an exo–Oort cloud should be about –265° Celsius, or 10 kelvins. That's right in range for experiments that detect the cosmic microwave background, or CMB, which is about 3 kelvins.

The team used data from the CMB-mapping Planck satellite to search for areas across the sky with the right temperature (*SN Online: 7/24/18*). Then the researchers compared the results with the Gaia space telescope's ultraprecise stellar map to see if those regions surrounded stars (*SN: 5/26/18, p. 5*).

Although the astronomers found some intriguing signals around several bright, nearby stars, it wasn't enough to declare victory. Other ongoing CMB experiments with higher resolution, like those with the South Pole Telescope and the Atacama Cosmology Telescope in the Chilean Andes, could confirm if those hints of exo–Oort clouds are real.

"It's a super clever observational idea," says astronomer Nicolas Cowan of McGill University in Montreal. Cowan has suggested that the CMB could also be used to search for a hypothetical planet known as Planet Nine in the sun's Oort cloud. "The very coolest thing would be if we could get measurements of the exo–Oort clouds and find planets in those systems." ■



This map of the cosmic microwave background taken by the Planck satellite may hide signs of exo–Oort clouds, planetary graveyards surrounding other stars.

PLANCK/ESA, NASA, IPAC INFRARED SCIENCE ARCHIVE

HUMANS & SOCIETY

Early treks in the Americas retraced

Humans got to South America in at least 3 waves, DNA hints

BY TINA HESMAN SAEY

Two new genetic studies give a more detailed and complicated picture of the peopling of the Americas than ever before.

People from North America moved into South America in at least three migration waves, researchers report in the Nov. 15 *Cell*. The first migrants, who reached South America by at least 11,000 years ago, were genetically related to a toddler who lived in Montana about 12,600 years ago (*SN: 3/22/14, p. 6*). Known as Anzick-1, the child's skeleton was found with artifacts from the Clovis people, who researchers used to think were the first people in the Americas, although that idea has fallen out of favor. Scientists also previously thought the Clovis were the only ancient migrants to South America.

But analysis of DNA from 49 ancient people suggests that a second wave of settlers replaced the Clovis group in South America about 9,000 years ago. And a third group related to ancient people from California's Channel Islands spread over the central Andes about 4,200 years ago, geneticist Nathan Nakatsuka of Harvard University and colleagues found.

People who settled the Americas were also much more genetically diverse than previously thought. At least one group of ancient Amazonians shared DNA with modern indigenous Australians, a different group of researchers reports online November 8 in *Science*.

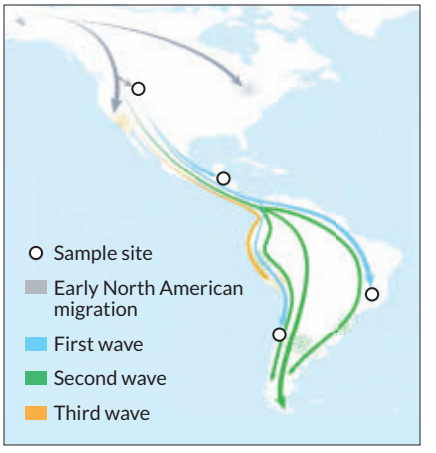
Genetically related but distinct groups of people came into the Americas and spread quickly and unevenly, says Eske Willerslev, a geneticist at the Natural History Museum of Denmark in Copenhagen and a coauthor of the study in *Science*. "People were spreading like a fire across the landscape and very

quickly adapted to the different environments they were encountering."

Both studies offer details that help fill out an oversimplified narrative of the prehistoric Americas, says Jennifer Raff, an anthropological geneticist at the University of Kansas in Lawrence. "We're learning some interesting, surprising things."

For instance, Willerslev's group analyzed the DNA of 15 ancient Americans not studied by Nakatsuka's group. A tooth found in Trail Creek in southern Alaska was from a baby related to a group called the ancient Beringians, who occupied the temporary landmass between Alaska and Siberia called Beringia. Sometimes called the Bering land bridge, the landmass was above water before glaciers receded at the end of the last ice age. The ancient Beringians stayed on the land bridge and were genetically distinct from the people who later gave rise to Native Americans, Willerslev and colleagues found.

The link between Australia and ancient Amazonia also hints that several genetically distinct groups may have come across Beringia into the Americas, given that researchers don't think early Australians paddled across the Pacific Ocean to South America. One possibility, Raff suggests, is that an ancestral group of people from Asia split into two groups, with one heading to Australia and the other crossing the Bering land bridge into the Americas. No Australian genetic signature has been found in ancient North or Central Americans. So the group that entered Beringia either didn't leave any living descendants in the north or scientists just haven't found evidence of this particular migration yet. ■



Roads taken People who crossed from Siberia into Alaska gave rise to the first groups that settled North America (gray). Prehistoric Americans then moved into South America in at least three migratory waves, a study finds.

GENES & CELLS

Re-creating mitochondria evolution

Hybrid cells hint at how cells' powerhouses came to be

BY TINA HESMAN SAEY

Yeast intentionally stuffed with bacteria may teach scientists something about the origins of cells' powerhouses.

Those power-generating organelles, called mitochondria, are thought to have once been bacteria captured by single-celled microbes called archaea. Today, almost all eukaryotic cells, those with a nucleus, have mitochondria. At first, the bacteria may have lived in archaea as endosymbionts, organisms that cooperate with their hosts. Over time, mitochondria may have lost many genes and become an integral part of the cell.

This scenario has support from genetics. But to have greater confidence in the idea, scientists should be able to make something similar in the lab, says chemical biologist Peter Schultz. So Schultz, of the Scripps Research Institute in La Jolla, Calif., and colleagues made a hybrid cell by fusing two popular lab organisms: baker's yeast and *E. coli*.

"It's a pioneering approach," says evolutionary biologist Antonio Lazcano of the National Autonomous University of Mexico in Mexico City. No one has made such a hybrid organism before. The work, described in the Nov. 13 *Proceedings of the National Academy of Sciences*, suggests that turning a free-living organism into an endosymbiont may not be so difficult, Lazcano says.

Not that it was easy to get *E. coli* bacteria to grow inside yeast cells. Scientists had to give the yeast and *E. coli* a reason to team up.

Schultz's group disabled a gene in yeast's mitochondria so that the they couldn't produce chemical energy in the form of adenosine triphosphate, or ATP, under some circumstances. *E. coli* were engineered to lack a gene needed to make the B vitamin thiamine, which the bacteria need to live. The team also outfitted the bacteria with a transporter protein that can move ATP and its precursor adenosine diphosphate, or ADP, in or out of the cell. When the bacteria were put inside the yeast cells, the bacteria supplied the ATP the yeast needed to live, and the yeast made thiamine for the bacteria.

It wasn't a perfect arrangement. The yeast kept digesting the bacteria. So Schultz's team equipped the *E. coli* with SNARE proteins from a bacterium that can live inside human cells. SNARE proteins prevent a host cell's digestive compartments, called lysosomes, from coming together to dismantle invading microbes. SNARE-outfitted *E. coli* were able to grow inside yeast cells. Hybrid yeast-bacteria cells grew for more than 40 generations.

There's no way to know the exact environmental and physiological conditions that microbes faced 1.5 billion years ago that led to the formation of eukaryotic cells, says evolutionary biologist Ryan Gawryluk of the University of Victoria in Canada. Exchanging energy for nutrients may have been one impetus for bacteria and archaea to join forces, but some scientists don't think it was the evolutionary force that shaped the partnership, he says. After all, "bacteria have no interest in sending ATP outside of their cells." Mitochondria-precursor bacteria may have been parasites or endosymbionts that gradually lost the ability to live outside the host for other reasons.

Still, Gawryluk says, the study offers "an exciting result ... showing how this potentially could have happened." ■

C. POSTH ET AL/CELL 2018

MATH & TECHNOLOGY

Avatars watch YouTube to learn moves

Computer program improves on motion capture technology

In a new computer program, virtual characters learned full-body motions, such as cartwheels, by watching people in video clips.

BY MARIA TEMMING

Animated characters can learn from online tutorials, too. A new computer program teaches avatars new skills such as dances and martial art moves from YouTube videos. This kind of system, described in the November *ACM Transactions on Graphics*, could render more physically coordinated characters for movies and video games, or serve as a virtual training ground for robots.

"I was really impressed," says Daniel Holden, a machine-learning researcher at Ubisoft La Forge in Montreal. Rendering accurate, natural-looking movements based on everyday video clips "has always been a goal ... in this field."

Animated characters typically have learned full-body motions by studying motion capture data from a camera that tracks markers attached to actors' bodies. But this method needs special equipment and often works only indoors.

The new program leverages a computer code known as an artificial neural network, which mimics how the human brain processes information. Trained on about 100,000 images of various poses, the program first estimates an actor's pose in each frame of a video clip. Then it teaches a virtual avatar to re-create the actor's motion using reinforcement learning, giving the character a "reward" when it matches the actor's pose.

Computer scientist Jason Peng and colleagues at the University of California, Berkeley fed YouTube videos into the system to teach characters to do somersaults, backflips and other stunts.

Even characters with bodies drastically different from those of their human video teachers mastered the motions. Characters also performed under conditions not seen in the training video, like moving across terrain riddled with holes.

The work is a step "toward making motion capture easier, cheaper and more accessible," Holden says. Videos could be used to render virtual versions of outdoor activities or to create lifelike avatars of large animals that would be difficult to attach motion capture markers to.

These animated characters still struggle with nimble dance steps such as the "Gangnam Style" jig and can learn from short clips featuring only a single person. Computer scientist David Jacobs of the University of Maryland in College Park looks forward to future virtual avatars that can reenact longer, more complex actions, such as pairs of people dancing. "This is only the beginning," Jacobs says. ■

NEWS IN BRIEF

ATOM & COSMOS

Neutrinos reveal Earth's mass

Puny particles have given scientists a glimpse inside Earth. And for the first time, physicists have measured the planet's mass using neutrinos.

Scientists have previously studied Earth's innards by quantifying the planet's gravitational pull and by studying seismic waves that penetrate the globe. Neutrinos provide an independent test. With data from the IceCube neutrino detector at the South Pole, researchers estimate Earth's mass is about 6 trillion trillion kilograms. That's in agreement with traditional measurements, a trio of physicists reports online November 5 in *Nature Physics*.

The team studied high-energy neutrinos. These neutrinos can zip clean through Earth, but sometimes smash into atomic nuclei and get absorbed instead. How often neutrinos are stopped in their tracks reveals the density of what they're traveling through. Neutrinos that arrive at IceCube from different angles probe different layers of Earth. By measuring how many neutrinos came from various angles, the team inferred the densities of different parts of Earth and its mass.

The technique might one day show whether any of Earth's mass comes from dark matter, a shadowy substance that scientists believe must exist to account for missing mass observed in measurements of other galaxies. — *Emily Conover*

GENES & CELLS

Calorie burning tied to time of day

People at rest burn about 129 more calories in the afternoon and evening than in the early morning, scientists report in the Nov. 19 *Current Biology*. But morning is better for burning carbohydrates, whereas fats are more likely to be burned in the evening. These findings add to evidence that when people eat and sleep may be as important as what they eat (*SN: 10/31/15, p. 10*).

The study followed seven people kept in windowless rooms for three weeks. Each night, the seven went to bed four hours later than the previous night. The schedule change let the researchers study the natural body rhythms of each subject.

Clear rhythms emerged for when people burned calories, with some variability. Resting calorie burning peaked on average around 5 p.m., with some people peaking around 2 p.m. and some at 8 p.m. The lowest calorie burning came around 5 a.m., but ranged from about 2 a.m. to 8 a.m, neuroscientist Jeanne Duffy of Brigham and Women's Hospital in Boston and colleagues found.

Irregular schedules can interrupt these rhythms, which can throw off metabolism, causing people to burn fewer calories and gain weight. — *Tina Hesman Saey*

XUE BIN PENG/UNIV. OF CALIFORNIA, BERKELEY

See how virtual characters learn new moves at **bit.ly/SN_Avatar**

Beavers, such as this one in Denali National Park and Preserve, have long lived in southern and central Alaska. But in the last couple of decades, the animals have infiltrated the treeless tundra of northwestern Alaska.

PAUL SOUDERS/DANITA DELIMONT/ALAMY STOCK PHOTO

Ecosystem **Engineers**

Beavers are moving in and changing the Alaskan tundra

By Sid Perkins

Beaver dams (arrows) convert a tundra stream in Alaska into a wetland, creating new habitat and thawing underlying permafrost. A beaver's protective lodge is shown, too.

CHRIS ARP/UNIV. OF ALASKA FAIRBANKS

In a broad swath of northwestern Alaska, small groups of recent immigrants are hard at work. Like many residents of this remote area, they're living off the land. But these industrious foreigners are neither prospecting for gold nor trapping animals for their pelts. In fact, their own luxurious fur was once a hot commodity. Say hello to *Castor canadensis*, the American beaver.

Much like humans, beavers can have an oversized effect on the landscape (*SN: 8/4/18, p. 28*). People who live near beaver habitat complain of downed trees and flooded land. But in areas populated mostly by critters, the effects can be positive. Beaver dams broaden and deepen small streams, forming new ponds and warming up local waters. Those beaver-built enhancements create or expand habitats hospitable to many other species — one of the main reasons that researchers refer to beavers as ecosystem engineers.

Beavers' tireless toils — to erect lodges that provide a measure of security against land-based predators and to build a larder of limbs, bark and other vegetation to tide them over until spring thaw — benefit the wildlife community.

A couple of decades ago, the dam-building rodents were hard to find in northwestern Alaska. "There's a lot of beaver around here now, a lot of lodges and dams," says Robert Kirk, a long-time resident of Noatak, Alaska — ground zero for much of the recent beaver expansion. His village of less than 600 people is the only human population center in the Noatak River watershed.

Beavers may be infiltrating the region for the first time in recent history as climate change makes conditions more hospitable, says Ken Tape, an ecologist at the University of Alaska Fairbanks. Or maybe the expansion is a rebound after trapping reduced beaver numbers to imperceptible levels in the early 1900s, he says. Nobody knows for sure.

And the full range of changes the rodents are generating in their new Arctic ecosystems hasn't been studied in detail. But from what Tape and a few other researchers can tell so far, the effects could be profound, and most of them will probably be beneficial for other species.

In the areas newly colonized by beavers, "some really interesting processes are unfolding," says John Benson, a wildlife ecologist at the University of Nebraska–Lincoln who studies wolves and coyotes, among other beaver predators. "I'd expect some pretty dramatic changes to the areas they take over."

Beavers' biggest effects on Arctic ecosystems may come from the added biodiversity within the ponds they create, says James Roth, an ecologist at the University of Manitoba in Winnipeg, Canada. These "oases on the tundra" will not only provide permanent habitat for fish and amphibians, they'll serve as seasonal stopover spots for migratory waterfowl. Physical changes to the environment could be just as dramatic, thawing permafrost decades faster than climate change alone would.

The Arctic tundra isn't the first place beavers have made their mark. Changes seen in beaver-rich areas at lower latitudes may offer some clues to the future of the Alaskan tundra, home to moose, caribou and snowshoe hares.

North through Alaska

As Earth's climate has warmed in recent years, some plants and animals — such as the mountain-dwelling pika, a small mammal related to rabbits — have fled the heat by moving to higher altitudes (*SN: 6/30/12, p. 16*). Others, from moose and snowshoe hares to bull sharks and bottlenosed dolphins, have moved toward the poles to take advantage of newly hospitable ecosystems (*SN: 5/26/18, p. 9*).

Arctic environments have changed more than most, Tape says. Polar regions are warming much faster than other parts of the world, he says. Studies estimate that average temperatures in the Arctic have risen about 1.8 degrees Celsius since 1900, about 60 percent faster than the Northern Hemisphere as a whole.

This warming is bringing great change to the Alaskan tundra, Tape says. Winter snow cover doesn't persist as long as it used to. Streams freeze later in the fall and melt earlier in the spring. Permafrost, the perennially frozen ground, is thawing, allowing shrubs to take hold. New species are moving in, few more noticeable than the

Moving on up
Beavers have begun moving (yellow arrows) beyond the tree line (orange) in Alaska and Yukon in northwestern Canada. In the next few decades, the rodents could spread farther into Alaska's North Slope (white arrows).

beaver. The dams they build and the ponds they create are hard to miss; these newly formed bodies of water even show up on satellite images.

Beavers have infiltrated three watersheds in northwestern Alaska in the last couple of decades. Together these drainages cover more than 18,000 square kilometers — an area larger than Connecticut.

On images of the region collected by Landsat satellites in summer months from 1999 through 2014, Tape and colleagues looked for new areas of wetness that covered at least half a hectare (1.24 acres), or about four times the area covered by an Olympic swimming pool.

The researchers then used newer, high-resolution satellite images to verify the presence of beaver ponds. Available aerial photographs taken before 1999 didn't pick up any signs of beaver activity in the area, Tape says. Kirk notes that beavers were present in the Lower Noatak River watershed before 1999, but in vastly smaller numbers than they are today.

Based on the images at hand, the researchers found 56 new complexes of beaver ponds in the area over the 16-year study period. On average, beavers expanded their range about 8 kilometers per year, Tape and colleagues reported in the October *Global Change Biology*.

"This is remarkable, but it shouldn't come as a surprise," Tape says. "Beavers are engineers that work every day, all summer long."

The animals have also made their way into western Alaska's Seward Peninsula and the northern foothills of the Brooks Range, mountains that stretch east to west across northern Alaska, the researchers found. If the animals' recent rate of expansion continues, beavers could spread throughout Alaska's North Slope in the next 20 to 40 years, the researchers say.

The Lower Noatak River watershed, one of the areas that Tape and colleagues studied, is mostly tundra. By definition that means treeless plain. But the area also is about 3.5 percent forest, mainly concentrated along the river and its tributaries. The watersheds just to the north are completely tundra. So how do the beavers there build dams without trees? In those areas, Tape says, the animals construct smaller dams than they might at lower latitudes, using the branches, twigs and foliage of willows and other shrubs.

"I never expected to see beavers on the tundra," Roth says, intrigued by Tape's team's findings.

Happy place

The beavers are not only persisting on the tundra, they're thriving. The moderately sized streams and flat terrain provide ideal habitat. And once they gain a foothold, these industrious creatures set about making improvements that are probably an overall plus for myriad other species, Tape says.

For instance, frigid conditions in the region cause shallow streams to freeze solid in winter. But when a beaver builds a dam, the water that gathers upstream of the structure becomes deep enough to remain liquid below a sheet of ice that provides insulation from the chilly winter air.

That persistent liquid lets the beavers move about under the ice even in the depths of winter. The water gives them a place to stockpile food, too, Tape notes. That constant supply of liquid water also provides year-round habitat for fish, amphibians and even some insects in their larval stages. None of these species are part of the beaver's diet, but they could serve as food for other creatures. "All that diversity would add whole new layers to food webs," Roth says.

Ecological changes could extend well beyond the beaver pond. The water impounded by beaver dams sometimes finds its way past the dam, Tape says. The satellite photos that he and his colleagues analyzed revealed that some stretches of river just downstream of beaver dams now remain unfrozen even in winter. That flowing water probably spills over the dam or around its edges, but some may seep through or under the structure.

That liquid water also helps thaw the underlying permafrost. Previous studies have shown that even a shallow pond less than a meter deep can boost sediment temperature by as much as 10 degrees C above the locale's average air temperature. That kind of warming causes permafrost to thaw decades earlier than it would

K.D. TAPE *ET AL/GLOBAL CHANGE BIOLOGY* 2018

without the pond. Although scientists are concerned that permafrost thawing will release stored carbon into the atmosphere, no one yet knows how that thawing will affect the balance of carbon emissions to the atmosphere (*SN: 1/21/17, p. 15*).

Field studies at lower latitudes hint that beavers will probably bring about other ecological changes, too, Tape says, which might shift over time. For example, moose and snowshoe hares eat the same willow shrubs that beavers consume and build their dams with. And ptarmigan, a crow-sized bird in the grouse family, rely on those shrubs for cover, especially during winter. So immediately after beavers move into an area and start clearing that brush, populations of those species may decline.

But the long-term benefits will probably outweigh the short-term impacts on those species, says Matthew Mumma, an ecologist at the University of Northern British Columbia in Prince George, Canada. Permafrost that thaws along the fringe of a beaver pond will probably boost numbers of the shrubs that these species depend on, Tape and colleagues suggest. So in the long run, the overall numbers of moose, hares and ptarmigan may rise.

Likewise, Mumma notes, beavers could provide big benefits for salmon and other migratory fish. Beaver dams were once thought to impede the travel of such fish upstream or to reduce the number of places where fish could spawn. But studies in the western United States, among other places, have suggested that the presence of beavers actually helps boost populations of salmon. For instance, the aquatic grasses in beaver ponds offer hiding places for young fish. Also, the languid ponds provide a resting spot for adult fish migrating upstream to spawning sites.

Better-fed wolves

Boosting herbivore populations on the tundra would be a boon for local predators, of course. Larger numbers of snowshoe hares, for example, could feed the populations of the arctic foxes that prey upon them, Mumma says. And more moose could mean better-fed wolves.

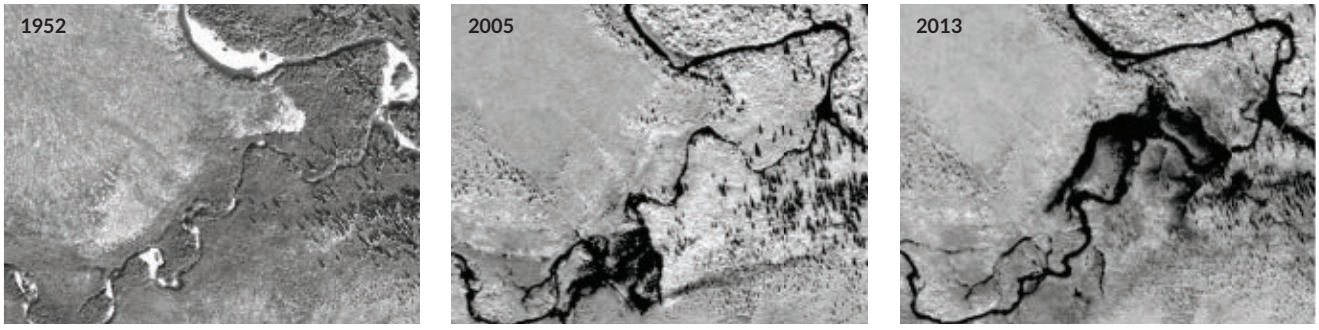
Beavers themselves make a meal for bears, wolverines and wolves. In areas where wolves and beavers coexist, the rodents make up as much as 30 percent of the wolf diet, Roth says. The presence of a more reliable and more diversified food supply could lead wolves to settle down in smaller territories rather than migrating widely.

Benson and his team have already seen the impact of beaver populations on wolves, coyotes and wolf-coyote hybrids in Ontario's Algonquin Provincial Park from August 2002 until April 2011.

In that time, 37 of the 105 pups that had been tagged with radio transmitters died, Benson says. The second-highest cause of death was starvation. Every one of those starvation-related deaths took place in the western portion of the park, which has relatively rugged terrain and few beavers. In the eastern portion of the park, where beavers are plentiful, none of the pups starved, Benson and his

Researchers expect the beaver influx into Alaskan tundra to expand the food web. In the short term, newcomer beavers may reduce shrub availability for moose (top) and snowshoe hares (middle). But in the long run, forage for these species may increase as shrubs take hold in permafrost thawed around beaver ponds. Wolves (bottom) and other beaver predators will probably do better as well.

MOOSE AND HARE: TIM RAINS/DENALI NATIONAL PARK AND PRESERVE/FLICKR (CC BY 2.0); WOLF: JAY ELHARD/DENALI NATIONAL PARK AND PRESERVE/FLICKR (CC BY 2.0)



Bonus ponds
Satellite images from 2005 and 2013 (middle and right) show broad, dark beaver ponds that are not seen in a 1952 aerial image (left) of the same Alaskan tundra. The new ponds suggest that the rodents have been damming this stream only in recent decades.

team reported in 2013 in *Biological Conservation*.

In a separate study, Mumma and colleagues analyzed aerial surveys of beaver populations within seven broad regions in northeastern British Columbia in 2011 and 2012. Proximity to human activity, such as roadbuilding or oil and gas exploration, didn't seem to affect beavers' decisions to build at a particular locale. Nor did the presence of wolves in the area, the researchers reported in February in the *Canadian Journal of Zoology*.

Although having wolves nearby seemed to affect the number of beavers present (quite possibly via consumption), the predators didn't seem to scare the rodents away entirely, Mumma notes.

More beavers, fewer sick moose

Whether the presence of beavers on the Alaskan tundra ends up boosting the numbers of moose and other ungulates, the dam builders could have a big, though indirect, impact on the hoofed browsers' health.

Roth and parasitologist Olwyn Friesen, now at the University of Otago in Dunedin, New Zealand, recently studied how a wolf's diet affects the parasites it carries — which can then be passed on to other creatures in the environment. The researchers analyzed 32 wolf carcasses collected by provincial conservation officers in southeastern Manitoba in 2011 and 2012. Those remains came from hunters, trappers and roadkill.

In particular, the team tallied the parasites in the wolves' lungs, liver, heart and intestines. The group also measured the ratio of carbon-12 and carbon-13 isotopes in the wolf tissues, which provided insight into what sorts of prey each individual wolf had eaten near the time those tissues formed.

Typical prey for wolves in this area are, from most consumed to least: white-tailed deer, snowshoe hare, moose, beaver and caribou, Roth says. Each of these creatures has a distinct ratio of the two carbon isotopes in its tissues. That ratio gets passed along to the predators that eat them.

The wolves with diets heavier in beaver had, on average, fewer intestinal parasites called cestodes. (Tapeworms are the best-known members of that group.)

The implications are clear, Roth and Friesen reported in 2016 in the *Journal of Animal Ecology*. Beaver-eating wolves are much less likely to excrete parasites into the environment where they could be picked up by ungulates, such as moose and caribou. Wolves don't seem to be detrimentally affected by such parasites. But ungulates that become infected — especially older animals — may have reduced lung capacity, making escape from predators more difficult.

A new resource

Although beavers may speed changes in the Arctic, those effects may still take a long time to manifest.

Despite the proliferation of beavers in the Lower Noatak River watershed in the last couple of decades, "things around here grow so slowly, they're not really having a long-term impact yet," says local resident Kirk. Shrubs haven't yet noticeably spread into any areas of permafrost that have been thawed by waters impounded by recent dam-building.

Nor have the beavers made much of a mark on the local economy, he says. "There's a lot of people harvesting them now, since there's so many of them around," he adds. However, the pelts from those rodents are so far used by the trappers themselves, not sold to others.

The beavers haven't become a big draw on the local food scene, either. Even connoisseurs say the meat has a gamey, greasy taste. As Kirk puts it, "we haven't adjusted our taste buds to them yet." ■

Explore more

■ Ken D. Tape *et al*. "Tundra be dammed: Beaver colonization of the Arctic." *Global Change Biology*. October 2018.

Sid Perkins is a freelance science writer based in Crossville, Tenn.

K.D. TAPE *ET AL*/*GLOBAL CHANGE BIOLOGY* 2018

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Parkinson's Pathways

Researchers begin to explore the gut's link to this brain disease

By Laura Beil

John Carlin (left) was diagnosed with Parkinson's disease 16 years ago. His wife, Martha (right), founded a company to help research the theory that gut microbes play a role in the disease.

MATT NAGER

Martha Carlin married the love of her life in 1995. She and John Carlin had dated briefly in college in Kentucky, then lost touch until a chance meeting years later at a Dallas pub. They wed soon after and had two children. John worked as an entrepreneur and stay-at-home dad. In his free time, he ran marathons.

Almost eight years into their marriage, the pinky finger on John's right hand began to quiver. So did his tongue. Most disturbing for Martha was how he looked at her. For as long as she'd known him, he'd had a joy in his eyes. But then, she says, he had a stony stare, "like he was looking through me." In November 2002, a doctor diagnosed John with Parkinson's disease. He was 44 years old.

Carlin made it her mission to understand how her seemingly fit husband had developed such a debilitating disease. "The minute we got home from the neurologist, I was on the internet looking for answers," she recalls. She began consuming all of the medical literature she could find.

With her training in accounting and corporate consulting, Carlin was used to thinking about how the many parts of large companies came together as a whole. That kind of wide-angle perspective

made her skeptical that Parkinson's, which affects half a million people in the United States, was just a malfunction in the brain.

"I had an initial hunch that food and food quality was part of the issue," she says. If something in the environment triggered Parkinson's, as some theories suggest, it made sense to her that the disease would involve the digestive system. Every time we eat and drink, our insides encounter the outside world.

John's disease progressed slowly and Carlin kept up her research. In 2015, she found a paper titled, "Gut microbiota are related to Parkinson's disease and clinical phenotype." The study, by neurologist Filip Scheperjans of the University of Helsinki, asked two simple questions: Are the microorganisms that populate the guts of Parkinson's patients different than those of healthy people? And if so, does that difference correlate with the stooped posture and difficulty walking that people with the disorder experience? Scheperjans' answer to both questions was yes.

Carlin had picked up on a thread from one of the newest areas of Parkinson's research: the relationship between Parkinson's and the gut. Other than a small fraction of cases that are inherited, the cause of Parkinson's disease is unknown. What is known is that something kills certain nerve cells, or neurons, in the brain. Abnormally misfolded and clumped proteins are the prime suspect. Some theories suggest a possible role for head trauma or exposure to heavy metals, pesticides or air pollution.

People with Parkinson's often have digestive issues, such as constipation, long before the disease appears. Since the early 2000s, scientists have been gathering evidence that the malformed proteins in the brains of Parkinson's patients might actually first appear in the gut or nose (people with Parkinson's also commonly lose their sense of smell).

From there, the theory goes, these proteins work their way into the nervous system. Scientists don't know exactly where in the gut the misfolded proteins come from, or why they form, but some early evidence points to the body's internal microbial ecosystem. In the latest salvo, scientists from Sweden reported in October that people who had their appendix removed had a lower risk of Parkinson's years later (*SN: 11/24/18, p. 7*). The job of the appendix, which is attached to the colon, is a bit of a mystery. But the organ may play an important role in intestinal health.

If the gut connection theory proves true — still a big *if* — it could open up new avenues to one day treat or at least slow the disease.

"It really changes the concept of what we consider Parkinson's," Scheperjans says. Maybe Parkinson's isn't a brain disease that affects the gut. Perhaps, for many people, it's a gut disease that affects the brain.

Gut feeling

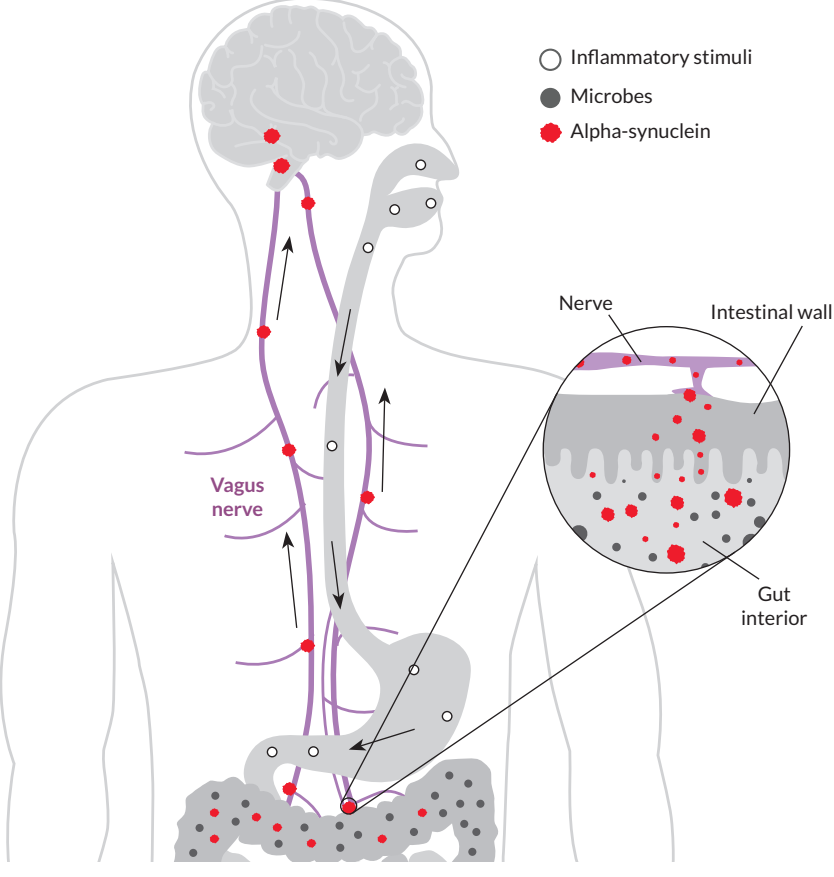
London physician James Parkinson wrote "An essay on the shaking palsy" in 1817, describing six patients with unexplained tremors. Some also had digestive problems. ("Action of the bowels had been very much retarded," he reported of one man.) He treated two people with calomel — a toxic, mercury-based laxative of the time — and noted that their tremors subsided.

But the digestive idiosyncrasies of the disease that later bore Parkinson's name largely faded into the background for the next two centuries, until neuroanatomists Heiko Braak and Kelly Del Tredici, now at the University of Ulm in Germany, proposed that Parkinson's disease might arise from the intestine. Writing in *Neurobiology of Aging* in 2003, they and their colleagues based their theory on autopsies of Parkinson's patients.

Road to the brain

One theory suggests that substances swallowed or sniffed set off an inflammatory reaction that alters the gut microbiome. In turn, proteins called alpha-synuclein may become misfolded and travel along the vagus nerve, from the lining of the gut to the brain, causing nerve cell death.

SOURCES: N. TITOVA *ET AL/NPJ PARKINSONS DISEASE* 2018; R.P. FRIEDLAND AND M.R. CHAPMAN/ *PLOS PATHOGENS* 2017



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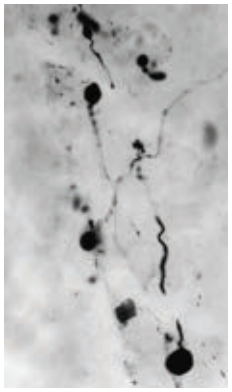


The exact role of Lewy bodies (black blobs) in nerve cell death is unclear, but their accumulation in the brain's substantia nigra is a hallmark of Parkinson's.

The researchers were looking for Lewy bodies, which contain clumps of a protein called alpha-synuclein. The presence of Lewy bodies in the brain is a hallmark of Parkinson's, though their exact role in the disease is still under investigation.

Lewy bodies form when alpha-synuclein, which is produced by neurons and other cells, starts curdling into unusual strands. The body encapsulates the abnormal alpha-synuclein and other proteins into the round Lewy body bundles. In the brain, Lewy bodies collect in the cells of the substantia nigra, a structure that helps orchestrate movement. By the time symptoms appear, much of the substantia nigra is already damaged.

Substantia nigra cells produce the chemical dopamine, which is important for movement. Levodopa, the main drug prescribed for Parkinson's, is a synthetic replacement for dopamine. The drug has been around for a half-century, and while it can alleviate symptoms for a while, it does not slow the destruction of brain cells.

In patient autopsies, Braak and his team tested for the presence of Lewy bodies, as well as abnormal alpha-synuclein that had not yet become bundled together. Based on comparisons with people without Parkinson's, the researchers found signs that Lewy bodies start to form in the nasal passages and intestine before they show up in the brain. Braak's group proposed that Parkinson's disease develops in stages, migrating from the gut and nose into the nerves to reach the brain.

Neural highway

Today, the idea that Parkinson's might arise from the intestine, not the brain, "is one of the most exciting things in Parkinson's disease," says Heinz Reichmann, a neurologist at the University of Dresden in Germany. The Braak theory couldn't explain how the Lewy bodies reach the brain, but Braak speculated that some sort of pathogen, perhaps a virus, might travel along the body's nervous system, leaving a trail of Lewy bodies.

There is no shortage of passageways: The intestine contains so many nerves that it's sometimes called the body's second brain. And the vagus nerve offers a direct connection between those nerves in the gut and the brain (*SN: 11/28/15, p. 18*).

In mice, alpha-synuclein can indeed migrate from the intestine to the brain, using the vagus nerve like a kind of intercontinental highway, as Caltech researchers demonstrated in 2016 (*SN: 12/10/16, p. 12*). And Reichmann's experiments have shown that mice that eat the pesticide rotenone develop symptoms of Parkinson's. Other teams have shown similar reactions in mice that inhale the chemical. "What you sniff, you swallow," he says.

To look at this idea another way, researchers have examined what happens to Parkinson's risk when people have a weak or missing vagus nerve connection. There was a time when doctors thought that an overly eager vagus nerve had something to do with stomach ulcers. Starting around the 1970s, many patients had the nerve clipped as an experimental means of treatment, a procedure called a vagotomy. In one of the latest studies on vagotomy and Parkinson's, researchers examined more than 9,000 patients with vagotomies, using data from a nationwide patient registry in Sweden. Among people who had the nerve cut down low, just above the stomach, the risk of Parkinson's began dropping five years after surgery, eventually reaching a difference of about 50 percent compared with people who hadn't had a vagotomy, the researchers reported in 2017 in *Neurology*.

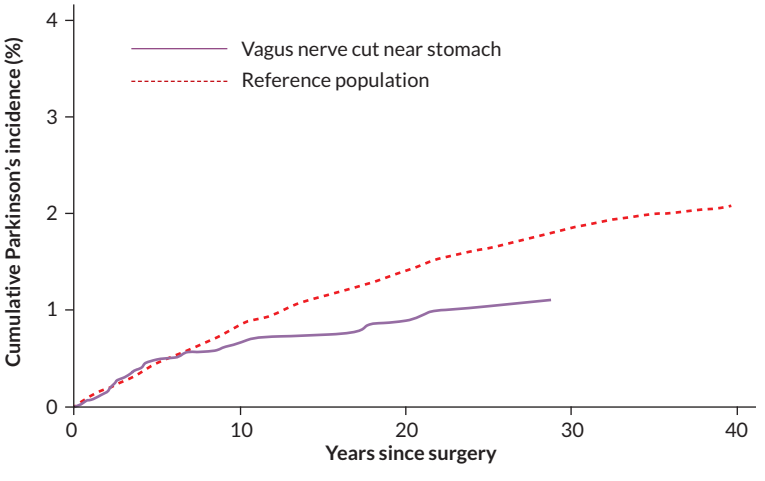
The studies are suggestive, but by no means definitive. And the vagus nerve may not be the only possible link the gut and brain share. The body's immune system might also connect the two, as one study published in January in *Science Translational Medicine* found. Study leader Inga Peter, a genetic epidemiologist at the Icahn School of Medicine at Mount Sinai in New York City, was looking for genetic contributors to Crohn's disease, an inflammatory bowel condition that affects close to 1 million people in the United States.

She and a worldwide team studied about 2,000 people from an Ashkenazi Jewish population, which has an elevated risk of Crohn's, and compared them with people without the disease. The

Radical protection

Because the vagus nerve is a route to the brain, scientists wondered if a severed vagus nerve helped protect against Parkinson's. In one study, patients who had undergone one type of vagotomy had lower disease incidence starting five years later than people who did not have the surgery. SOURCE: B. LIU *ET AL/NEUROLOGY* 2017

Parkinson's risk is lower in patients with a cut vagus nerve



FROM TOP: H. BRAAK *ET AL/NEUROSCIENCE LETTERS* 2006; C. CHANG

research led Peter and colleagues to suspect the role of a gene called *LRRK2*. That gene is involved in the immune system — which mistakenly attacks the intestine in people who have Crohn's. So it made sense for a variant of that gene to be involved in inflammatory disease. The researchers were thrown, however, when they discovered that versions of the gene also appeared to increase the risk for Parkinson's disease.

"We refused to believe it," Peter says. The finding, although just a correlation, suggested that whatever the gene was doing to the intestine might have something to do with Parkinson's. So the team investigated the link further, reporting results in the August *JAMA Neurology*.

In their analysis of a large database of health insurance claims and prescriptions, the scientists found more evidence of inflammation's role. People with inflammatory bowel disease were about 30 percent more likely to develop Parkinson's than people without it. But among those who had filled prescriptions for an anti-inflammatory medication called antitumor necrosis factor, which the researchers used as a marker for reduced inflammation, Parkinson's risk was 78 percent lower than in people who had not filled prescriptions for the drug.

Belly bacteria

Like Inga Peter, microbiologist Sarkis Mazmanian of Caltech came upon Parkinson's disease almost by accident. He had long studied how the body's internal bacteria interact with the immune system. At lunch one day with a colleague who was studying autism using a mouse version of the disease, Mazmanian asked if he could take a look at the animals' intestines. Because of the high density of nerves in the intestine, he wanted to see if the brain and gut were connected in autism.

Neurons in the gut "are literally one cell layer away from the microbes," he says. "That made me feel that at least the physical path or conduit was there." He began to study autism, but wanted to switch to a brain disease with more obvious physical symptoms. When he learned that people with Parkinson's disease often have a long history of digestive problems, he had his subject.

Mazmanian's group examined mice that were genetically engineered to overproduce alpha-synuclein. He wanted to know whether the presence or absence of gut bacteria influenced symptoms that developed in the mice.

The results, reported in *Cell* in 2016, showed that when the mice were raised germ free — meaning their insides had no microorganisms — they showed no signs of Parkinson's. The animals had no telltale gait or balance problems and no constipation, even though their bodies made alpha-synuclein (*SN: 12/24/16 & 1/7/17, p. 10*). "All the features of Parkinson's in the animals were gone when the animals had no microbiome," he says.

However, when gut microbes from people diagnosed with Parkinson's were transplanted into the germ-free mice, the mice developed symptoms of the disease — symptoms that were much more severe than those in mice transplanted with microbes from healthy people.

Mazmanian suspects that something in the microbiome triggers the misfolding of alpha-synuclein. But this has not been tested in humans, and he is quick to say that this is just one possible explanation for the disease. "There's likely no one smoking gun," he says.

Microbial forces

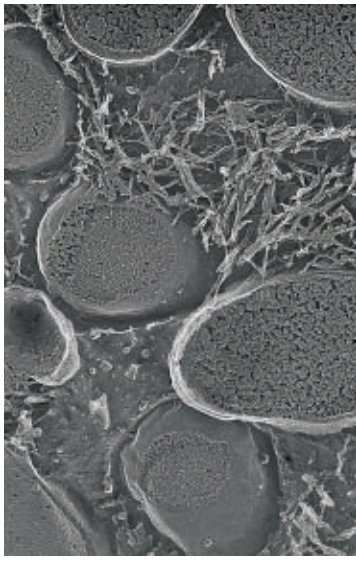
If the microbiome is involved, what exactly is it doing to promote Parkinson's? Microbiologist Matthew Chapman of the University of Michigan in Ann Arbor thinks it may have something to do with chemical signals that bacteria send to the body. Chapman studies biofilms, which occur when bacteria form resilient colonies. (Think of the slime on the inside a drain pipe.)

Part of what makes biofilms so hard to break apart is that fibers called amyloids run through them. Amyloids are tight stacks of proteins, like columns of Legos. Scientists have long suspected that amyloids are involved in degenerative diseases of the brain, including Alzheimer's. In Parkinson's, amyloid forms of alpha-synuclein are found in Lewy bodies.

Despite amyloids' bad reputation, the fibers themselves aren't always undesirable, Chapman says. Sometimes they may provide a good way of storing proteins for future use, to be snapped off brick by brick as needed. Perhaps it's only when amyloids form in the wrong place, like the brain, that they contribute to disease. Chapman's lab group has found that *E. coli* bacteria, part of the body's normal microbial population, produce amyloid forms of some proteins when they are under stress.

When gut bacteria produce amyloids, the body's own cells could also be affected, wrote Chapman in 2017 in *PLOS Pathogens* with an unlikely partner: neurologist Robert Friedland of the University of Louisville School of Medicine in Kentucky. "This is a difficult field to study because

E. coli bacteria, common in the human intestine, can form amyloids when under stress. Shown here is a biofilm of spherical *E. coli* cells surrounded by amyloid fibers. Lewy bodies, which contain amyloid forms of alpha-synuclein, are known for their role in degenerative brain diseases.



CHAPMAN LAB

A photo in their home shows Martha and John Carlin at their 1995 wedding. Since his diagnosis of Parkinson's at age 44, John's disease has progressed, although slowly.

MATT NAGER

it's on the border of several fields," Friedland says. "I'm a neurologist who has little experience in gastroenterology. When I talked about this to my colleagues who are gastroenterologists, they've never heard that bacteria make amyloid."

Friedland and collaborators reported in 2016 in *Scientific Reports* that when *E. coli* in the intestines of rats started to produce amyloid, alpha-synuclein in the rats' brains also congealed into the amyloid form. In their 2017 paper, Chapman and Friedland suggested that the immune system's reaction to the amyloid in the gut might have something to do with triggering amyloid formation in the brain.

In other words, when gut bacteria get stressed and start to produce their own amyloids, those microbes may be sending cues to nearby neurons in the intestine to follow suit. "The question is, and it's still an outstanding question, what is it that these bacteria are producing that is, at least in animals, causing alpha-synuclein to form amyloids?" Chapman says.

Head for a cure

There is, in fact, a long list of questions about the microbiome, says Scheperjans, the neurologist whose paper Martha Carlin first spotted. So far, studies of the microbiomes of human patients are largely limited to simple observations like his, and the potential for a microbiome connection has yet to reach deeply into the neurology community. But in October, for the second year in a row, Scheperjans says, the International Congress of Parkinson's Disease and Movement Disorders held a panel discussing connections to the microbiome.

"I got interested in the gastrointestinal aspects because the patients complained so much about it," he says. While his study found definite differences in the bacteria of people with Parkinson's, it's still too early to know how that might matter. But Scheperjans hopes that one day doctors may be able to test for microbiome changes that put people at higher risk for Parkinson's, and restore a healthy microbe population through diet or some other means to delay or prevent the disease.

One way to slow the disease might be shutting down the mobility of misfolded alpha-synuclein before it has even reached the brain. In *Science* in 2016, neuroscientist Valina Dawson and colleagues at Johns Hopkins University School of Medicine and elsewhere described using an antibody to halt the spread of bad alpha-synuclein from cell to cell. The researchers are working now to develop a drug that could do the same thing.

The goal is to one day test for the early development of Parkinson's and then be able to tell a patient, "Take this drug and we're going to try to slow and prevent progression of disease," she says.

For her part, Carlin is doing what she can to speed research into connections between the microbiome and Parkinson's. She quit her job, sold her house and drained her retirement account to pour money into the cause. She donated to the University of Chicago to study her husband's microbiome. And she founded a company called the BioCollective to aid in microbiome research, providing free collection kits to people with Parkinson's. The 15,000 microbiome samples she has collected so far are available to researchers.

Carlin admits that the possibility of a gut connection to Parkinson's can be a hard sell. "It's a difficult concept for people to wrap their head around when you are taking a broad view," she says. As she searches for answers, her husband, John, keeps going. "He drives, he runs biking programs in Denver for people with Parkinson's," she says. Anything to keep the wheels turning toward the future. ■

Explore more

- Robert P. Friedland and Matthew R. Chapman. "The role of microbial amyloid in neurodegeneration." *PLOS Pathogens*. December 21, 2017.

Connecting Society alumni

Each fall, Society for Science & the Public hosts a Signature Alumni & Friends Event for alumni of the Society's science competitions, as well as for teachers, Society members and *Science News* subscribers. We are thrilled to provide this experience for our community, thanks to the Broad Institute of MIT and Harvard University.

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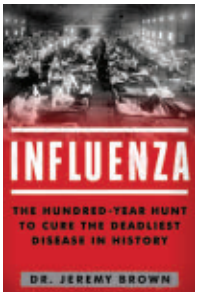
1. Panel discussion with (from left) Kristi Snell (STS 1985), Yield10 Bioscience; Tom Knight (STS 1965), Ginkgo Bioworks; Erika DeBenedictis (STS 2010, ISEF 2007–2010, DCYSC 2006), Broad Institute; and moderator Maya Ajmera (STS 1985), Society for Science & the Public

2. Left to right, top to bottom: Syamantak Payra (STS 2018, ISEF 2016–2018, BCM 2013–2014); Chiu Fan Bowen Lo (STS 2018, ISEF 2018); Grace Tian (STS 2018); Abilash Prabhakar (STS 2018); Raj Movva (STS 2018, BCM 2014); Marissa Sumathipala (STS 2018, ISEF 2017–2018); and Shahir Rahman

3. Nobel laureate Martin Karplus (STS 1947) and Yeonsoo Sara Lee (ISEF 2012)

4. From left, Kristi Snell (STS 1985), Yield10 Bioscience; Feng Zhang (STS 2000, ISEF 1998–1999), Broad Institute; and Tom Knight (STS 1965), Ginkgo Bioworks

Pandemic 1918
Catharine Arnold
ST. MARTIN'S PRESS, $27.99



Influenza
Jeremy Brown
TOUCHSTONE, $26.99

BOOKSHELF

Spanish flu left behind carnage and questions

The U.S.S. *Leviathan* set sail from Hoboken, N.J., on September 29, 1918, carrying roughly 10,000 troops and 2,000 crewmen. The ship, bound for the battlefields in France, had been at sea less than 24 hours when the first passengers fell ill. By the end of the day, 700 people had developed signs of the flu.

The medical staff tried to separate the sick from the healthy, but that soon proved impossible. The poorly ventilated bunkrooms filled with the stench of illness. The floor grew slippery with blood from many nosebleeds, and the wails of the sick and dying echoed below deck. Bodies piled up and began decomposing, until finally the crew was forced to heave them into the sea. It was the stuff of nightmares.

This is just one of the grisly scenes in *Pandemic 1918* by historian Catharine Arnold. The book details how the movement of troops during World War I helped drive the spread of a deadly strain of influenza around the globe — from the American Midwest to Cape Town, South Africa, to New Zealand and beyond.

Scientists have yet to conclusively determine where that flu originated; Arnold suggests it was on a massive military base in Étaples, France. But all agree that the pandemic that became known as the Spanish flu didn't begin in Spain. And the disease, which ultimately killed more than 50 million people, wasn't caused by any ordinary influenza strain.

Grim eyewitness accounts chronicle the gory details of how this virus differed. Victims often bled from the nose or mouth, writhed in pain and grew delirious with fever. Their faces turned dusky blue as their lungs filled with pus. Healthy men and women in their prime were dying, sometimes within days of falling ill. And there was a smell associated with the sick, "like very musty straw," recalled one survivor. Arnold's graphic depictions of the carnage make for some gripping scenes, but the book is perhaps too ambitious. She zigzags between so many people and places that only the most careful reader will be able to keep track of who fell ill where.

Another book tied to the 100th anniversary of the Spanish flu, *Influenza*, by long-time emergency room doctor Jeremy Brown, covers some of the same ground. Both Arnold and Brown, for instance, chronicle the hunt for the 1918 virus in bodies buried in Arctic permafrost and efforts to reconstruct the virus's genetic code. But while Arnold's book is rooted primarily in the past, Brown spends more time on recent research. He provides an in-depth look at what scientists now know about the 1918 strain, an H1N1 virus that originated in birds and spent time in an unknown mammalian host before infecting humans. In 2005, researchers managed to re-create the virus and test it in mice. The experiment provided insight into how the virus might have wrought so much damage in the lungs, but it also renewed a debate over the ethics of reconstructing deadly viruses. These kinds of experiments can help scientists better understand the inner workings of pathogens, but might also help people build biological weapons.

The 1918 Spanish flu virus infected an estimated one-third of the world's population. A demonstration at a Red Cross ambulance station is shown.

Brown also provides a fascinating look at the factors that make the more common seasonal flu so challenging to predict and prevent. Because data collection relies on the generosity of health care workers and because doctors rarely test for influenza, researchers can't get a full picture of the scope of the disease. And because the virus mutates easily, scientists struggle to accurately predict what next year's outbreak might look like. The strains circulating when pharmaceutical companies begin making vaccines might not be the strains that are circulating when the vaccines reach clinics and pharmacies. That's why the flu shot's efficacy varies from about 10 to 60 percent each year (*SN: 10/28/17, p. 18*).

Both books provide fresh perspectives on the 1918 pandemic and the influenza virus that caused it. Readers interested in a deep dive into the harrowing details and eyewitness accounts from that dark time should pick up Arnold's book. For those who want more science with a frank discussion of the challenges influenza still poses, Brown delivers a clear and captivating overview. Together the books offer an unsettling picture of the damage influenza inflicted on the world 100 years ago and the misery that this virus might yet bring again. — *Cassandra Willyard*

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SOCIAL MEDIA

Funky fish

Researchers stumbled upon a new species of coral reef fish (below) sporting highlighter hues, **Helen Thompson** reported in "Meet a Technicolor creature from down deep" (*SN: 10/27/18, p. 5*). Readers on Twitter thought the fish belonged to a more colorful era. "It obviously evolved during the 1980s," **@BeTheShovel** wrote. "Unreal! I was thinking more like the '60s #psychedelic," replied **@stormkittykat**.

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Exomoonmoon

A sighting by the Hubble Space Telescope provides more evidence that there's a Neptune-sized moon, dubbed Neptmoon, orbiting the exoplanet Kepler 1625b, ***Lisa Grossman*** *reported in "Hubble spies signs of an exomoon" (*SN: 10/27/18, p. 14*).*

"If Neptmoon actually exists, could it possibly have moons of its own?" online reader **MAdScientist72** asked. "And what would we call a moon of a moon?"

It's certainly possible that Neptmoon could host a moon of its own, **Grossman** says. "It would probably be called a moonmoon, submoon or, my favorite, an exomoonmoon," she says. Those are hypothetical names — scientists have not yet spotted such a satellite. For Neptmoon to have an exomoonmoon, the object would have to be close enough to be captured by Neptmoon's gravity, but not so close that it would get torn apart, **Grossman** says.

At least four moons in our solar system are large enough to play host, astronomers Juna Kollmeier of Carnegie Observatories in Pasadena, Calif., and Sean Raymond of the University of Bordeaux in France reported online October 8 at arXiv.org. Saturn's moons Titan and Iapetus, Jupiter's moon Callisto and Earth's moon could theoretically host moonmoons.

Ain't no mountain high enough

Simulations suggest that, if real, the theoretical substance within neutron stars known as nuclear pasta may be the universe's strongest material, ***Emily Conover*** *reported in "Nuclear pasta is tougher than steel" (*SN: 10/27/18, p. 8*).*

Gravitational waves produced by spinning neutron stars could provide scientists with evidence of nuclear pasta's existence. But such spacetime ripples will occur only if a neutron star's crust has mounds, or "mountains," of dense material that are tens of centimeters tall.

Reader **Doug Quine** asked about Conover's word choice. "I would hardly describe the length of my arm as the height of a mountain," **Quine** wrote. "I suspect the units should have been ... kilometers."

The mountains are just centimeters tall, **Conover** says. "The reason scientists use the term 'mountains' despite the formations' diminutive size is because the gravity of a neutron star is so strong that something a centimeter tall is actually quite an extreme bump," she says.

Alien endeavors

According to a new calculation, the search for extraterrestrial intelligence, also known as SETI, has combed the equivalent of a hot tub's worth of Earth's oceans, ***Lisa Grossman*** *reported in "Our search for E.T. hasn't covered much space" (*SN: 10/27/18, p. 5*).*

Readers online were fascinated by the search for life elsewhere in the universe.

"We can't really explore the ocean one hot tub at a time," **Mark S.** wrote. "Perhaps a better approach would be to scan for emissions around each of the most promising exoplanets that have been discovered," he suggested. "Keeping with the ocean analogy, this is more like looking for fish around islands or atolls."

Scientists' inability to find intelligent life beyond Earth, despite the identification of planets beyond our solar system, emphasized for **Robert Stenton** just how unique Earth is. "We are probably one of the very few planets to not only have a civilization, but also unique intelligent life such as whales and elephants, or beautiful creatures such as pandas, Bengal tigers or giant sequoias," **Stenton** wrote.

He continued: "Perhaps if nothing else, we should have learned from SETI to treasure what we have and protect all of it, just as we now protect special habitats by declaring them national parks. Perhaps we should declare the whole Earth a 'Universe Treasure.' From what we now know, even something as lowly as a cockroach may exist nowhere else in the universe."

Dione's singular stripes

Saturn's moon Dione is streaked with long, bright stripes that are unlike any others seen in the solar system.

The thin lines (indicated with white arrows below) run surprisingly parallel for tens to hundreds of kilometers and seem unaffected by other features in the pocked and ridge-lined landscape, scientists say October 27 in *Geophysical Research Letters*. And no one knows how the markings got there.

"It's exciting when you see something really strange, and you're just trying to figure out what the heck it could possibly be," says planetary scientist Emily Martin of the Smithsonian National Air and Space Museum in Washington, D.C.

To that end, Martin and planetary scientist Alex Patthoff of the Planetary Science Institute based in La Habra Heights, Calif., mapped the structures and compared them with lines found on other celestial objects, including the Saturnian moon Enceladus, Earth's moon and Jupiter's moon Ganymede.

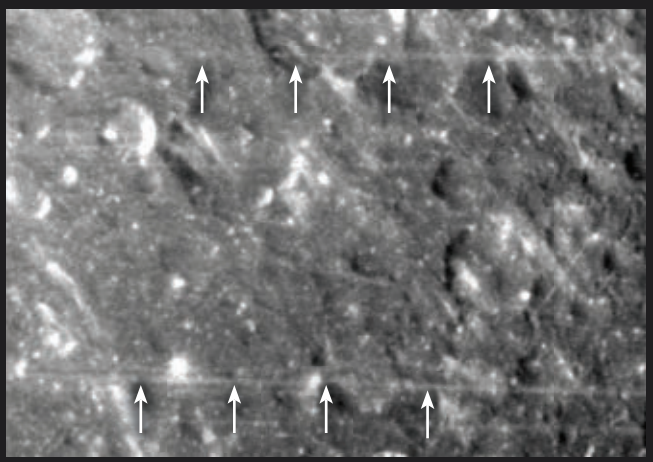
Enceladus spews water from "tiger stripes" (top, right) near the icy moon's south pole. Those lines are thought to be cracks in the crust that open and close with gravitational pushes and pulls from Saturn and other moons. But, unlike Dione's, the stripes have kinks that are related to the surface terrain.

Earth's moon sports long, linear grooves carved by rolling boulders (middle, right). These stripes are typically less than 10 kilometers long, have a scalloped shape and usually run downslope. Dione's stripes must be caused by something else, Martin and Patthoff say, since they're much longer and don't seem to follow hills.

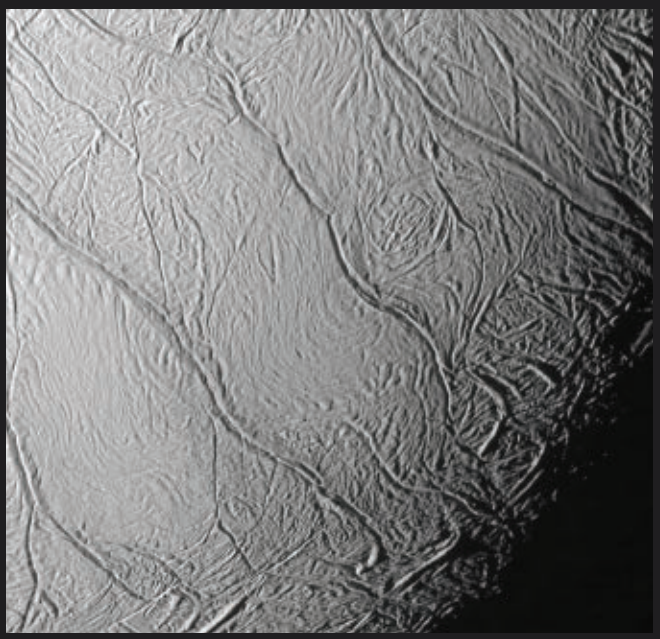
Jupiter's moon Ganymede (bottom, right) has craters arranged in straight rows. These pits form from bits of comets ripped apart by Jupiter's gravity. But that's not a good explanation for Dione's long, straight stripes, either.

Because Dione's lines don't track the topography, Martin and Patthoff think the stripes come from material that falls on the moon from the outside. But the duo isn't sure from where. One possibility: Saturn's rings, which shed material onto the planet in a constant "ring rain." —*Lisa Grossman*

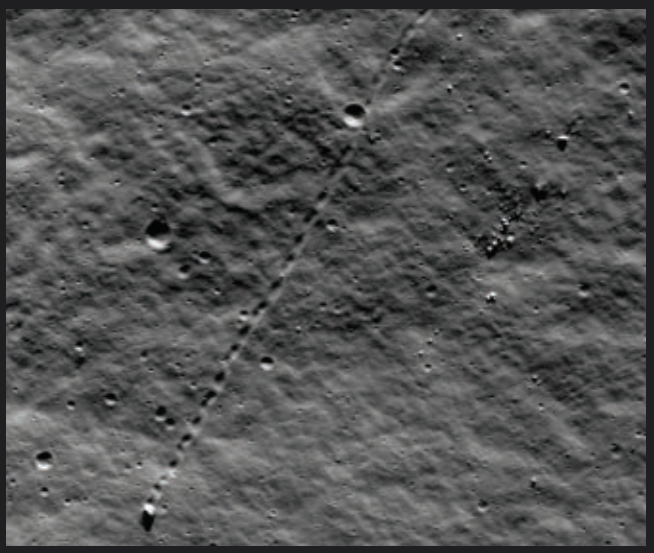
Dione



Enceladus



Earth's moon



Ganymede

CLOCKWISE FROM TOP: SSI, JPL-CALTECH/NASA; ASU, GSFC/NASA; GALILEO PROJECT, BROWN UNIV., JPL-CALTECH/NASA; E.S. MARTIN AND D.A. PATTHOFF/*GEOPHYS. RES. LETT.* 2018

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