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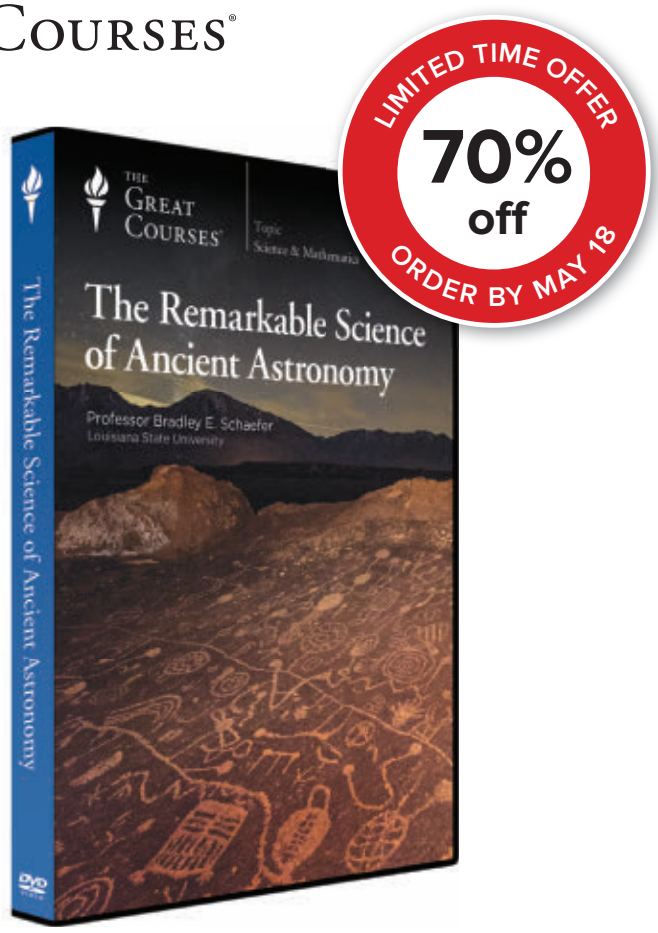

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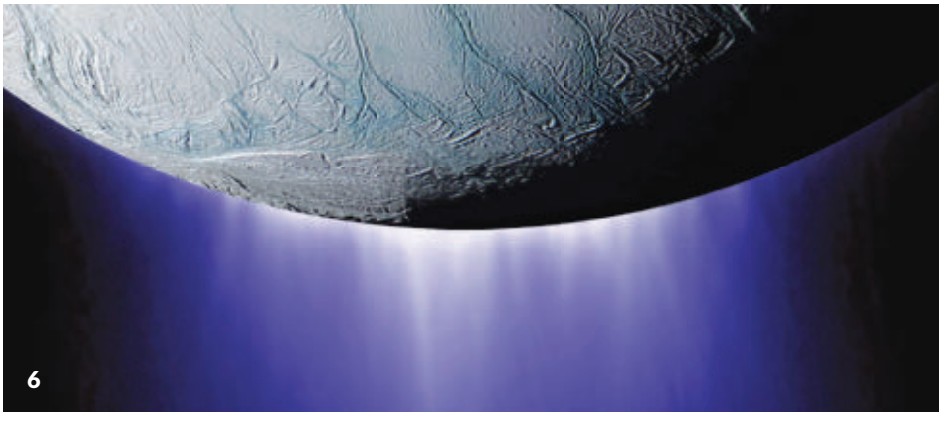
Features

News



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Departments

COVER Warming waters in Lake Huron and many lakes worldwide could have ripple effects on recreation and commerce. *AlpamayoPhoto/Getty*

CLOCKWISE FROM TOP: JAMES PROVOST; KATE RAMSAYER/NASA; JPL-CALTECH/NASA

March highlights questions about benefits of science

On April 22, tens of thousands of scientists and science enthusiasts marched for science in Washington, D.C., and in other cities around the globe. Many participants expressed overtly political messages, but, as *Science News* reported live via Twitter from the National Mall, many marchers also focused on how much they value science. People gathered en masse in part to recognize science as a fruitful and worthy endeavor that has improved lives — and thus is deserving of society's support.

I suspect most *Science News* readers would agree with that message. It's easy to list examples of how science has benefited humankind. Deeper understandings of how the human body works have led to effective medicines. Research on earthquakes, materials and mechanics has led to shake-resistant buildings; atmospheric science helps us predict the weather and prepare for storms. Einstein's theory of relativity makes accurate GPS devices possible for navigation. In this issue alone, we report on ancient advances in dentistry (Page 15) that would have treated tooth decay, and a new technology that, if developed, could alleviate water shortages (Page 10). Scientific understanding enriches people's lives by putting their individual experiences into broader perspective.

But science's achievements often mix risks with benefits; science brought us nuclear bombs, chemical weapons and DDT. Antibiotics fight disease but lead inevitably to antibiotic resistance. Computers enable many of life's modern conveniences but bring worries about cybersecurity and cyberbullying.

And sometimes, science is done poorly or improperly, causing irreparable damage — such as the discredited British study that still fuels the antivaccine movement. Even the best science sometimes generates more confusion than clarity, as illustrated by current debates over the widespread use of statins (Page 22). Science also tells us things that are hard to hear and that we don't know how to fix: Climate change is melting glaciers, raising sea levels and, new research shows, even affecting the ecosystems in our beloved lakes (Page 18).

Such complexities muddle the key questions that society faces when it comes to supporting science. Those who marched on April 22 are concerned with ensuring science's role in shaping public policy and with how much funding science receives. And there are deeper concerns, too: Should society value science highly? Should science be trusted as the proper method for drawing conclusions about the workings of our world? Does science really enhance human health, promote happiness and enrich the human condition?

The marchers overwhelmingly agreed that the answers to those questions are yes. But science's power has its limits; there are always gaps in the data, flaws in procedures and qualifications to the conclusions. Science is done by people, who themselves make mistakes — some innocent, some rooted in misconduct or attempts for personal benefit. That's why science journalism has an important dual purpose: to report on science's advances and benefits while also illuminating its flaws and shortcomings, so that science can improve and better serve society and thus continue to warrant the support and respect that so many of us have been giving it. — *Elizabeth Quill, Acting Editor in Chief*

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Single copies are $3.99 (plus $1.01 shipping and handling).
Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.
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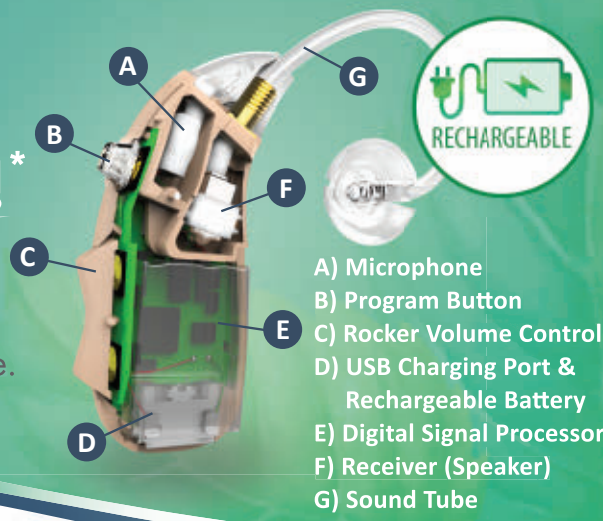

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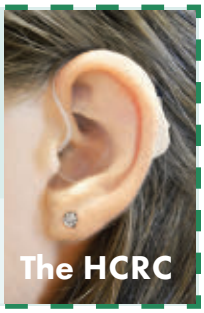

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Excerpt from the May 20, 1967 issue of *Science News*

50 YEARS AGO

Mosquitoes on the way out

By 1973, just nine years after the start of an antimosquito campaign, the *Aedes aegypti* will be eradicated from the United States. The mosquito, a potential carrier of yellow fever, dengue and hemorrhagic fever, has been the target of a $23 million attack launched in 1964.... The carrier of these viral diseases can still be found in 10 southern states, Hawaii, the Virgin Islands and Puerto Rico.

UPDATE: The eradication program, which used chemical sprays and eliminated breeding sites, never came close to getting rid of *A. aegypti*. Today, the virus-carrying insect's potential range includes more than 20 states and other U.S. territories. And some carrying the Zika virus have been found in the continental United States. Researchers are investigating new ways to conquer *A. aegypti*, by inserting faulty genes into its DNA or dosing it with a sterilizing bacterium (*SN: 4/1/17, p. 10*).

SOAPBOX

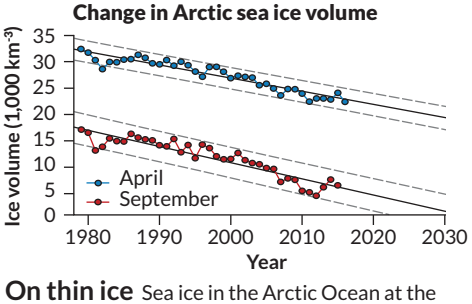
Radical idea could restore Arctic Ocean's sea ice

Warmer conditions in the Arctic are melting sea ice (as seen here near Barrow, Alaska). Now is the time to develop ways to save the ice, a scientist argues.

Leave it to a researcher who studies icy moons in the outer solar system to come up with an out-there scheme to restore vanishing sea ice in the Arctic.

Ice is a good insulator, says Steven Desch, a planetary scientist at Arizona State University in Tempe. That's why moons such as Jupiter's Europa and Saturn's Enceladus (see Page 6), among others, may be able to maintain liquid oceans beneath their thick icy surfaces. On Earth, sea ice is much thinner, but the physics is the same. Ice grows on the bottom surface of floating floes. As the water freezes, it releases heat that must make its way up through the ice before escaping into the air. The thicker the ice, the more heat gets trapped, which slows down ice formation. That's bad news for the Arctic, where ice helps keep the planet cool but global warming is causing ice to melt faster than it can be replaced.

The answer to making thicker ice more quickly? Suck up near-freezing water from under the ice and pump it directly onto the ice's surface during the long polar winter. There, the water would freeze more quickly than underneath the ice, where it usually forms.



On thin ice Sea ice in the Arctic Ocean at the end of summer (red) is on track to disappear by midcentury, satellite data suggest. End-of-winter sea ice volume (blue) is also declining.

In theory, Desch says, the pumps used for this top-down approach to ice growth could be driven by technology no more sophisticated than the windmills that have long provided water to farms and ranches on the Great Plains.

Desch and colleagues envision putting such pumps on millions of buoys throughout the Arctic. During winter, each pump would be capable of building an additional layer of sea ice up to 1 meter thick over an area of about 100,000 square meters, or about the size of 15 soccer fields, the researchers estimate in the January issue of *Earth's Future*.

It won't be easy. The Arctic's harsh environment poses many problems such as frozen pipes. But many of those hitches are being addressed by engineers familiar with developing and maintaining Arctic infrastructure such as small-scale wind turbines and drinking-water systems, Desch says. To build and ship each ice-making buoy to the Arctic would cost about $50,000, he estimates. Over a decade, covering 10 percent of the Arctic Ocean with buoys would cost about $50 billion per year. "It's a big project, but the point is, it's not an impossible one," he argues.

Now is the time to begin detailed designs and build prototypes, Desch says. The Arctic Ocean's end-of-summer sea ice coverage has decreased, on average, more than 13 percent per decade since 1979. "There'll be a time, 10 to 15 years from now, when Arctic sea ice will be accelerating to oblivion, and there'll be political will to do something about climate change," Desch says. "We need to have this figured out by the time people are ready to do something."

— Sid Perkins

FROM TOP: KATE RAMSAYER/NASA; S. DESCH *ET AL/EARTH'S FUTURE* 2017

INTRODUCING

Worm snail is a super slimer

A new species of worm snail is rather snotty. *Thylacodes vandyensis* shoots out strands of mucus that tangle together, building a weblike trap for plankton and other floating snacks, researchers report April 5 in *PeerJ*.

Other worm snails use this hunting technique, but *T. vandyensis* stands out because of the copious amounts of mucus it ejects, says study coauthor Rüdiger Bieler. This goo net, which can stretch up to 5 centimeters across, exits the animal's tentacles at "a snail's pace," jokes Bieler, a curator at the Field Museum of Natural History in Chicago.

Bieler discovered *T. vandyensis,* which glues itself in place and typically grows half as tall as a pinkie finger, on the hull of the *USNS General Hoyt S. Vandenburg*, a ship intentionally sunk in 2009 as an artificial reef in the Florida Keys. But the creature doesn't belong there. DNA analysis shows that its closest relatives are in the Pacific Ocean. The potentially invasive worm snail may have made its way to the Atlantic Ocean as a stowaway on a ship, Bieler says.

— Elizabeth S. Eaton

A newfound species of worm snail, *Thylacodes vandyensis*, named after the sunken ship it was found on, oozes out a mucus web (blue, upper left) to trap and reel in its prey.

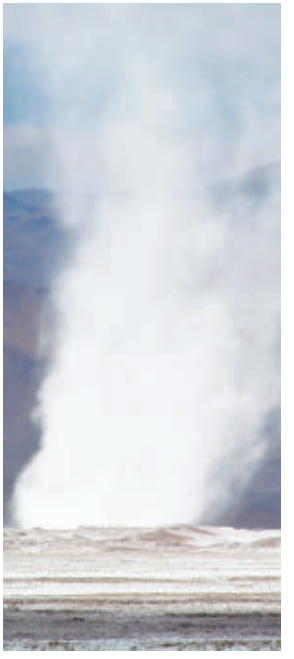
SAY WHAT?

Gravel devil \GRAV-uhl DEV-uhl\ n.

A whirlwind of gravel-sized debris

Towering, crystal-filled twisters periodically swirl in a valley nestled between two volcanoes in the Andes, newly reported observations show. The odd weather events are the first record of large pieces of gravel efficiently moving across a landscape by suspension in air.

Geologist Kathleen Benison of West Virginia University in Morgantown spotted the whirlwinds during an expedition in 2007 to an otherworldly region of northern Chile. There gypsum crystals form from evaporating volcanic pools of salty, acidic water. When the pools dry, exposing the crystals within, whirlwinds as big as half a kilometer across can sweep the crystals aloft, Benison reports in the May issue of *Geology*. She saw storms of crystals travel as far as five kilometers before dropping their payloads into large, dunelike piles.



Swirling winds in the Andes carry gypsum crystals several kilometers before dumping them in large piles.

Over time, the far-flung crystals, some as long as 27 centimeters (which geologists still classify as gravel), cement into a massive hunk. If found in the rock record, such crystal conglomerations could help geologists identify where strong whirlwinds howled long ago, Benison proposes. *— Thomas Sumner*

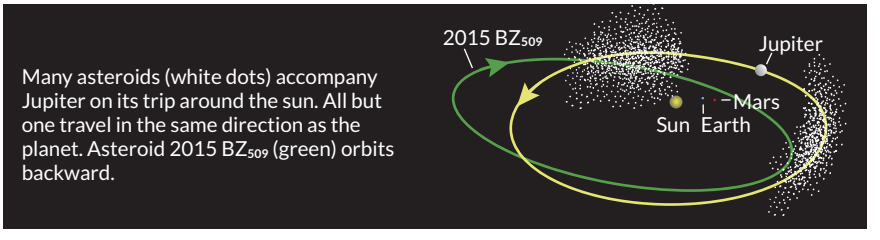
HOW BIZARRE

Asteroid in Jupiter's orbit goes its own way

One of Jupiter's companions is a bit of a nonconformist.

The gas giant shares its orbit around the sun with a slew of asteroids, but scientists have now discovered one that goes against the flow. It journeys around the solar system in reverse — in the opposite direction of Jupiter and all the other planets. Asteroid 2015 BZ_{509} is the first solar system object found to orbit in the same region as a planet but traveling backward, researchers from Canada and the United States report in the March 30 *Nature*.

The asteroid was discovered with the Pan-STARRS observatory in Hawaii in 2015, with additional observations made with the Large Binocular Telescope Observatory in Arizona.



Many asteroids (white dots) accompany Jupiter on its trip around the sun. All but one travel in the same direction as the planet. Asteroid 2015 BZ_{509} (green) orbits backward.

Backward-going asteroids are rare — only 0.01 percent of known asteroids are in retrograde orbits. None were known to share a planet's orbit. Until recently, astronomers thought asteroids going in reverse couldn't coexist with a planet because interactions between the two celestial bodies — which would come very close twice per orbit — would knock the asteroid off track. But because 2015 BZ_{509} passes on alternating sides of Jupiter, the interactions cancel each other out, the researchers say. The first flyby of Jupiter pulls the asteroid outward and the next tugs it inward — keeping the maverick asteroid in line.

The asteroid's relationship with Jupiter is no short-term fling: The researchers determined that the two have shared an orbit for a million years.

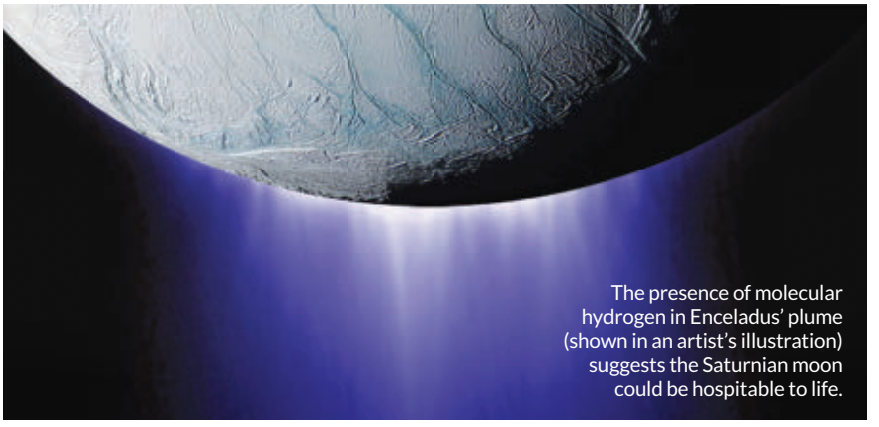
— Emily Conover

CLOCKWISE FROM MIDDLE LEFT: © R. BIELER/THE FIELD MUSEUM; K. BENISON/*GEOLOGY* 2017; © 2017 WESTERN UNIV., ATHABASCA UNIV., LARGE BINOCULAR TELESCOPE OBSERVATORY; ADAPTED BY T. TIBBITTS

ATOM & COSMOS

Food for microbes seen on Enceladus

Hydrogen in plume points to ongoing hydrothermal activity



The presence of molecular hydrogen in Enceladus' plume (shown in an artist's illustration) suggests the Saturnian moon could be hospitable to life.

BY ASHLEY YEAGER

Saturn's icy moon Enceladus packs snacks suitable for microbial life.

Data from the Cassini spacecraft show that the vaporous plume shooting out of the moon's southern pole contains molecular hydrogen. It is probably generated when water in the moon's subterranean ocean reacts with rock in its core, researchers report in the April 14 *Science*. Such reactions at hydrothermal vents and in other extreme places on Earth produce a lot of hydrogen, which some microbes use for food. Enceladus has enough of the gas to sustain microbial life, the team says.

"We are not saying Enceladus has life, but the discovery does move the moon higher on the list of potentially habitable places in the solar system," says study coauthor J. Hunter Waite of the Southwest Research Institute in San Antonio.

Enceladus became a good target for finding life beyond Earth when scientists detected a global ocean under the moon's icy exterior and hints of hydrothermal activity (*SN: 10/17/15, p. 8*; *SN: 4/18/15, p. 10*). The big question was whether the ocean harbored molecular hydrogen, an energy source that, along with carbon dioxide, could help to fuel microbes in the absence of sunlight, says Chris McKay, an astrogeophysicist at NASA Ames Research Center in Moffett Field, Calif., who was not involved in the study.

Researchers had previously tried to measure hydrogen in the plume. But Cassini was moving too quickly, about 64,800 kilometers per hour, Waite says. In 2015, the spacecraft took a deep dive into the plume at about half that speed, giving the team enough time to take a precise measurement: Molecular hydrogen makes up 0.4 to 1.4 percent of the plume's gas. The majority of the ejected material is water, with traces of carbon dioxide, methane and ammonia, the team reports.

"The level of H_2 is way above the limit for life," McKay says. Lab studies show that microbes fueled by hydrogen need as little as 10 parts per million of it in their environment to survive; 0.4 percent, or 4,000 parts per million, would provide an abundance of food, he says.

Such a hydrogen abundance was surprising, Waite says. He and colleagues considered whether the gas might come from hydrothermal activity, other processes or material left over from the moon's formation. Calculations showed that only ongoing hydrothermal activity could produce enough hydrogen. ■

ATOM & COSMOS

Jupiter's Great Red Spot has company

Aurora may fuel big cold patch in planet's northern atmosphere

BY ASHLEY YEAGER

Jupiter's got a second giant spot.

Named the Great Cold Spot, this dark mark is twice as big as Earth, but cooler and more fickle than the planet's similarly sized Great Red Spot. The cool spot sits in Jupiter's atmosphere not far from the planet's northern aurora. The aurora may play a role in creating the newly detected dark mark, researchers report online April 10 in *Geophysical Research Letters*.

"We can't be exactly sure how the spot forms," says Tom Stallard, a planetary scientist at the University of Leicester in England. "But we are sure it is there because we observed it numerous times."

Stallard and colleagues got their first clue that the spot existed while mapping the temperature and density of Jupiter's atmosphere with the Very Large Telescope in Chile. Within an area of the atmosphere that ranged from about 420° to 560° Celsius, the team found a region that was about 100 degrees cooler. Comparing the data with data from the NASA Infrared Telescope Facility in Hawaii revealed that the dark mark had been in the same place for over 15 years.

But its size and shape change, perhaps because the cool spot is tied to the influx of energetic particles from the Jovian moon Io that help generate Jupiter's auroras. On Earth, auroras can produce vortices in the upper atmosphere that are cooler than the surrounding gas. The Great Cold Spot may be a similar kind of system that waxes and wanes as the intensity of Jupiter's northern aurora changes.

Scientists thought aurora-induced temperature contrasts would be smoothed out quickly, says Jeffrey Morgenthaler, a Planetary Science Institute researcher based in Maine. "To see weather in this region of the atmosphere is weird." ■

JPL-CALTECH/NASA

Young human plasma renews old mice

Infusions boosted memory, altered gene activity in brain cells

BY LAURA SANDERS

Plasma taken from human umbilical cords can rejuvenate old mice's brains and improve their memories, a new study suggests. The results, published online April 19 in *Nature*, may ultimately help scientists develop ways to stave off aging.

Earlier studies have turned up youthful effects of young mice's blood on old mice (*SN: 12/27/14, p. 21*). Young human plasma, the new results suggest, confers similar benefits, says Joseph Castellano, a study coauthor and neuroscientist at Stanford University. The study also identifies a protein that's particularly important for the youthful effects, a detail that "adds a nice piece to the puzzle," Castellano says.

Identifying the exact components responsible for rejuvenating effects is important, says Matt Kaeberlein, a geroscientist at the University of Washington in Seattle. That knowledge will bring scientists closer to understanding how old tissues can be refreshed. And having the precise compounds in hand means that scientists might have an easier time translating therapies to people.

Kaeberlein cautions that the benefits were in mice, not people. Still, he says, "there is good reason to be optimistic that some of these approaches will have similar effects on health span in people."

Like people, as mice age, brain performance begins to slip. Compared with younger generations, elderly mice perform worse on some tests of learning and memory, taking longer to remember the location of an escape route out of a maze, for instance. Researchers suspect that these deficits come from age-related trouble in the hippocampus, a brain structure important for learning and memory.

Every fourth day for two weeks, Castellano and colleagues injected old mice with human plasma taken from umbilical cords, young adults or elderly adults. Some of the plasma infusions changed the behavior of genes in the hippocampus, the researchers found.

> "There is good reason to be optimistic that some of these approaches will have similar effects on health span in people."
>
> MATT KAEBERLEIN

Elderly mice that received umbilical cord or young adult plasma showed gene behavior changes that go along with improved hippocampal functioning. And after infusions of human cord plasma, more hippocampus cells churned out a protein called c-Fos, a marker of a busy brain that's known to decline with age. Elderly mice that received elderly human plasma showed no such changes.

These brain changes also came with behavioral improvements. Elderly mice that received umbilical cord plasma were quicker to learn and better at remembering the location of an escape hatch in a maze than elderly mice that didn't receive the plasma. Mice that received these injections were also more adept at learning associations between a room and a painful electric shock, and better at making nests for babies, a skill that usually suffers with age.

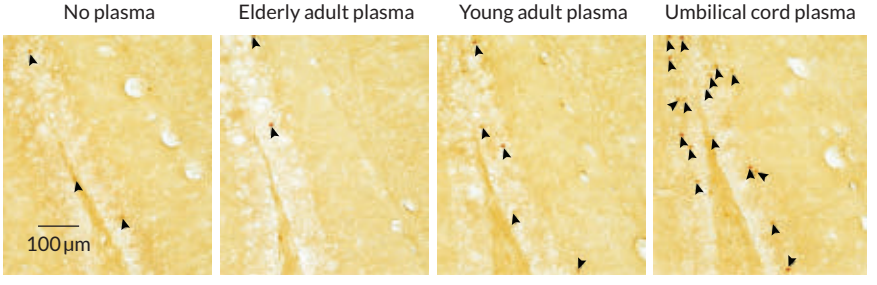
Castellano and colleagues searched for the ingredient responsible for the effects by comparing plasma proteins whose abundance changes with age in mice and people. One candidate seemed particularly promising: Levels of a protein called TIMP2 started out high early in life but then dropped with age, in both mice and people.

Infusions of mouse TIMP2 had positive effects on elderly mice, both in their brains and in their behavior, the team found in further experiments. And when the researchers removed TIMP2 from young mice, the animals grew worse at remembering new objects.

The study doesn't explain how TIMP2 might work in the brain, says Gillian Murphy, a molecular cell biologist at the University of Cambridge who studies TIMP proteins and the proteins that TIMPs interact with. "Before any realistic interpretation of these data can be made," she says, it's essential to figure out how TIMP2 affects cells in the hippocampus.

In the meantime, a clinical trial designed to test whether young human plasma can slow the cognitive decline of people with Alzheimer's disease is under way. Data have been collected and are being analyzed, says Tony Wyss-Coray, an Alzheimer's researcher at Stanford University who coauthored the new study in *Nature*. Wyss-Coray and Castellano have ties to the company Alkahest, which is involved with the clinical trial and therapies to counter aging. ■

Effect of human plasma injections on mouse brains



Infusions with young human plasma improved elderly mice's memories and altered gene activity in the hippocampus. In an elderly mouse that got plasma from human umbilical cords, brain cells produced the protein c-Fos (pointed out by black arrows), a marker of nerve cell activity known to decline with age. Some c-Fos protein was seen in elderly brains that got plasma from young adults. Very little c-Fos was present when plasma came from old people or when no plasma was injected.

J. CASTELLANO ET AL/NATURE 2017

HUMANS & SOCIETY

Clovis spearpoints absorbed shock

Chipping away part of weapon's base kept tip from snapping

BY BRUCE BOWER

Ancient North Americans hunted with spearpoints crafted to absorb shock.

Clovis people, who crossed from Asia to North America about 13,500 years ago, fashioned stone weapons that slightly crumpled at the base rather than breaking at the tip when thrust into prey, say civil engineer Kaitlyn Thomas of Southern Methodist University in Dallas and colleagues. The Clovis crumple rested on a toolmaking technique called fluting, in which a thin groove was chipped off both sides of a stone point's base, the researchers report in the May *Journal of Archaeological Science*.

Research on stone replicas of spearpoints (two at right) used by Clovis people suggests that points fluted at the base absorbed shock, preventing tip breakage while hunting. Three casts of actual fluted Clovis points are on the left.

M. EREN/KENT STATE UNIV.

Computer models and pressure testing of replicas of fluted and unfluted Clovis points support the idea that fluted bases worked like shock absorbers, preventing tip breakage. Slight compression and folding of stone at the base of fluted points after an impact did not cause enough damage to prevent the points from being reused, the scientists say.

"Fluted Clovis points have a shock-absorbing property that increases their durability, which fit a population that needed reliable weapons on a new, unknown continent," says archaeologist and study coauthor Metin Eren of Kent State University in Ohio. While Clovis people weren't the first New World settlers (*SN: 6/11/16, p. 8*), they roamed throughout much of North America, traveling great distances to find food and move among seasonal camps, Eren says.

Computer models run by Thomas, Eren and colleagues indicated that fluted points increasingly divert pressure away from the tip and toward the base as physical stress grows. Computerized, 3-D versions of fluted Clovis points exposed to high-impact pressure crumpled at the base, leaving the tip intact. Unfluted replicas, however, frequently broke at the tip.

Comparable results emerged when the researchers tested 60 fluted and unfluted stone replicas of Clovis points in a viselike machine that applied precise pressures.

Fluted Clovis points may have been attached to handles or shafts in ways that also enhanced their resilience, Eren says. But no such handles have been found.

Previous finds suggest that as many as 1 in 5 Clovis points broke as fluted sections were prepared. If all goes well, it takes 40 to 50 minutes to produce a

BODY & BRAIN

Data back ban of artificial trans fats

Heart attack, stroke cut by New York eatery restrictions

BY AIMEE CUNNINGHAM

Taking artificial trans fats off the menu reduces hospitalizations for heart attack and stroke, a new study suggests. The findings portend large public health benefits after a ban on artificial trans fats begins in the United States in 2018.

After some counties in New York restricted the fats' use, hospital admission rates for heart attacks declined 7.8 percent more in those counties than in counties without restrictions, researchers report online April 12 in *JAMA Cardiology*.

"This is the first study that links a trans fats ban to a reduction in heart disease and stroke in large populations," says nutritional epidemiologist Frank Hu of the Harvard T.H. Chan School of Public Health. "The evidence from this study indicates that implementation of a nationwide ban on trans fats will reduce heart disease and save many lives."

Heart disease causes 1 in every 4 deaths in the United States. Coronary heart disease, the most common kind, kills more than 370,000 people each year. Past research finds that eating foods containing artificial trans fats, also called trans-fatty acids, increases the risk of coronary heart disease. Among other effects, consuming these fats leads to higher levels of low-density lipoprotein cholesterol, or "bad" cholesterol, a component of artery-clogging plaque. Artificial, or industrial, trans fats occur in vegetable oils that are partially hydrogenated. Foods typically made with these oils include deep-fried fast foods, baked goods, crackers and margarine.

Beginning in 2007, New York City restricted artificial trans fats in food bought at restaurants and other eateries. A number of New York counties followed suit over the next several years, providing a chance to examine changes in cardiovascular health, says study coauthor Eric Brandt, a Yale University internist.

Brandt and colleagues analyzed 11 counties that restricted artificial trans fats and 25 counties that did not. The researchers looked at hospital admission rates for heart attack or stroke from 2002 to 2013. Heart attack and stroke admissions already were trending down before the restrictions due to improvements in medication and treatment.

At least three years after the artificial trans fats restrictions took effect, admission rates for heart attacks and strokes combined dropped an additional 6.2 percent in restricted counties versus nonrestricted counties. For every 100,000 people, there were 43 fewer heart attacks

fluted Clovis point, Eren estimates.

Fluting techniques became increasingly elaborate until the practice was abandoned around 9,500 years ago. At that time, familiarity with North America's landscapes and stone sources triggered a shift to making unfluted spearpoints designed to kill more effectively, but not necessarily to last, Eren suspects. Some of those stone points may have been intended to shatter on impact, creating shrapnel-like wounds, he says.

Searching for signs of crumpling and crushing on the bottoms of early and later fluted Clovis points could help researchers see if the tools always worked as shock absorbers, says archaeologist Ashley Smallwood of the University of West Georgia in Carrollton.

Researchers have previously proposed that fluting was a stylistic twist with no practical impact, was a way for toolmakers to advertise their skills and suitability as mates, or was part of prehunt rituals. The new work offers a practical explanation for fluting's popularity that deserves further study, says archaeologist Daniel Amick of Loyola University Chicago. ■

and strokes. This drop is beyond that expected by population trends alone.

In restricted counties, hospital admission rates for heart attacks alone also declined more than in nonrestricted counties, probably due to the artificial trans fats restrictions. Stroke rates alone also dropped in counties with the restriction, but that may not have been primarily related to the trans fat policy, Brandt says.

Along with previous work tying the consumption of trans fats to coronary heart disease, "it's a very powerful nail in the coffin for industrial trans fats," says cardiologist Dariush Mozaffarian of Tufts University in Boston.

The Food and Drug Administration, which has determined that partially hydrogenated oils are no longer "generally recognized as safe," has ordered food manufacturers to ensure products are free of these oils by June 2018. This will effectively eliminate artificial trans fats from the U.S. food supply, Mozaffarian says. ■

A. SUJAN ET AL./*JAMA* 2017

BODY & BRAIN

No autism link to antidepressants

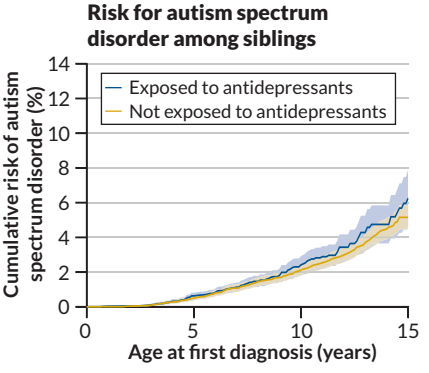
Studies may reassure pregnant women treated for depression

BY AIMEE CUNNINGHAM

Taking antidepressants during pregnancy does not increase a baby's risk of autism or attention-deficit/hyperactivity disorder, two large studies suggest. Genetic or environmental influences, rather than prenatal exposure to the drugs, may have a greater influence on whether a child will develop these disorders. The studies appear in the April 18 *JAMA*.

Clinically, the message is "quite reassuring for practitioners and for mothers needing to make a decision about antidepressant use during pregnancy," says psychiatrist Simone Vigod of Women's College Hospital in Toronto, a coauthor of one of the studies. Past research has questioned the safety of expectant moms taking antidepressants (*SN: 6/5/10, p. 22*).

"A mother's mood disturbances during pregnancy ... impact the health of mothers and their children," says developmental pediatrician Tim Oberlander of the University of British Columbia in Vancouver. About 1 in 10 women develop a major depressive episode during pregnancy. "All treatment options should be explored. Nontreatment is never an option," says Oberlander, who coauthored a commentary in the same issue of *JAMA*.



Sib similarity Kids exposed to antidepressants in the womb and their unexposed siblings had essentially the same risk for developing autism, a new study shows.

Previous studies indicated that antidepressant use came with developmental risks for offspring: autism spectrum disorder, ADHD, premature birth and poor fetal growth. "The key question is whether those risks are due to the actual medication," says psychologist Brian D'Onofrio of Indiana University Bloomington, whose group authored the other study.

Both studies relied on big samples. D'Onofrio's team looked at over 1.5 million Swedish children born from 1996 to 2012 to nearly 950,000 mothers. More than 22,000, or 1.4 percent, of these kids had mothers who reported using antidepressants, mostly selective serotonin reuptake inhibitors, in the first trimester.

The researchers compared siblings in families in which the mother used antidepressants in one pregnancy but not another. Siblings had essentially the same risk for autism, ADHD and poor fetal growth whether they were exposed to antidepressants in the womb or not.

When looking at antidepressant use only, without accounting for other possible influences, "children have roughly twice the risk of having autism if the mother takes antidepressant medication during the first trimester," says D'Onofrio. "But that association goes completely away when you compare siblings." Although it's not clear exactly what's responsible for the increased risk, "our results suggest that it is actually not due to the medication itself," he says.

Vigod and colleagues studied women who qualified for public drug coverage in Ontario, Canada, from 2002 to 2010. Of 35,906 children born in that group, mothers took antidepressants in 2,837 of the pregnancies. The team compared exposed children with their unexposed siblings and found no link between autism risk and antidepressant use.

"The use of sibling matches in both studies is a very innovative way to account for genetics and a shared environment," says Oberlander. "We can't ignore the fact that there are shared genetic mechanisms that might relate autism and depression. The genetic reason that brought the mom to use the drug may say more about the risk of autism in the child." ■

MATH & TECHNOLOGY

New device harvests water from air

Prototype works in low humidity and requires little energy

BY THOMAS SUMNER

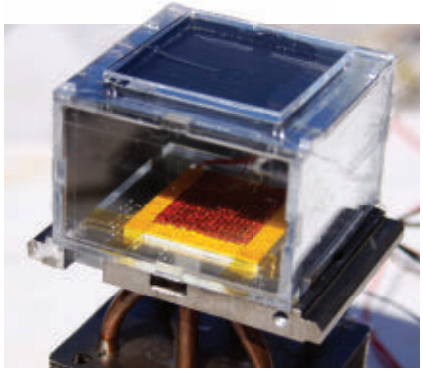
A new device the size of a coffee mug can generate drinkable water from desert air using nothing but sunlight.

With this kind of device, "you can harvest the equivalent of a Coke can's worth of water in an hour," says cocreator Omar Yaghi, a chemist at the University of California, Berkeley. "That's about how much water a person needs to survive in the desert."

The technology, Yaghi and colleagues say, could be scaled up to supply freshwater to some of the most parched and remote regions of the globe, such as in the Middle East and North Africa.

Previous attempts at low-energy water collection struggled to function below 50 percent relative humidity (roughly the average afternoon humidity of Augusta, Ga.). Thanks to a special material, the new device pulled water from air with as low as 20 percent relative humidity, Yaghi and colleagues report online April 13 in *Science*. That's like conjuring water in Las Vegas on a typical afternoon.

Drinking water supplies aren't keeping up with the rising demands of a growing human population, and shifts in rainfall caused by climate change are expected to exacerbate the problem. Already, two-thirds of the world's population is experiencing water shortages (*SN: 8/20/16, p. 22*). One largely untapped source is the atmosphere, which contains enough vapor and droplets to fill over 5 billion Olympic-sized pools.



This prototype device pulls moisture out of the air and turns it into liquid. In sunlight, the black-painted layer (top) heats up and releases the moisture as vapor into a container, where the vapor condenses into liquid water.

Getting that moisture out is easy when air is saturated with water. But humid regions aren't where the water-shortage problems are, and drawing water from the air in parched areas is a greater challenge. Spongy materials such as silica gels can extract moisture from air at low relative humidity. Those materials, however, either amass water too slowly or require lots of energy to extract the collected water from the material.

The new device uses a material that avoids both problems. Yaghi, MIT mechanical engineer Evelyn Wang and colleagues repurposed an existing material made of electrically charged metal atoms linked by organic molecules. This metal-organic framework, christened MOF-801, has a network of microscopic spongelike pores. At room temperature, water vapor collects in the pores. As temperatures rise, the water escapes.

The team's prototype includes a layer of MOF-801 mixed with copper foam. In the shade, this layer collects water vapor from air. When moved into direct sunlight, the layer heats up and the water vapor escapes into an underlying chamber. A condenser cools the vapor, converting it into a liquid. This entire process takes about two hours.

Lab tests of the device harvested 2.8 liters of water per day for every kilogram of MOF-801 used. As it is now, the device could be used as a personal water source in areas without proper infrastructure, Yaghi says, or the system could be scaled up to serve a whole community.

Producing water at low relative humidity is a breakthrough, says Georgia Tech chemical engineer Krista Walton. The ingredients used in the metal-organic framework "aren't exotic," she says. Making a lot of the material "would definitely be possible if the demand were there." ■

GENES & CELLS

Human knockouts provide drug clues

People's missing genes help reveal their normal function

BY TINA HESMAN SAEY

Some Pakistani people are real knockouts, a new DNA study finds. Knockout in this sense doesn't refer to boxing or a stunning appearance, but to natural mutations that inactivate, or "knock out," certain genes. The study suggests that human knockouts could help scientists understand how genes work and develop drugs.

Among 10,503 adults participating in a heart disease study in Pakistan, 1,843 people have at least one gene of which both copies have been knocked out, researchers report in the April 13 *Nature*. Researchers also drew blood from many of the participants and used medical records to study more than 200 traits, such as heart rate, blood pressure and blood levels of sugar, cholesterol, hormones and other substances. Studying how the knockout mutations affect those traits and health could point to genes that are potentially safe and effective targets for new drugs.

Combining genetic data with medical information will provide "a rich dataset for many applications," says Robert Plenge, a human geneticist formerly with the pharmaceutical company Merck.

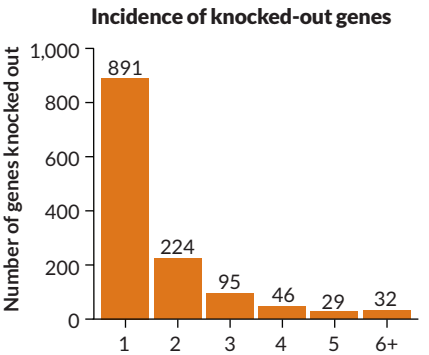
Scientists have traditionally learned about genes' roles by deleting the genes from mice and then cataloging abnormalities in how those mice developed and behaved. Such animal research will always be needed. But studies of people naturally lacking certain genes "will change the nature of the scientific investigation of the genetic basis of human disease," Plenge wrote in a commentary in the same issue of *Nature*.

Often, a person will inherit a broken copy of a gene from one parent and a healthy copy from the other. But in this study, 39 percent of the people had

LAB OF E. WANG/MIT

parents who were closely related — often first cousins — increasing the odds of inheriting two mutant copies of the same gene. Of the study's 1,843 participants with knockouts, 1,504 had both copies of a single gene knocked out. The rest had more than one gene knocked out; one person had six genes that were predicted to be completely nonfunctional.

In one example, geneticist Sekar Kathiresan and colleagues found four people in which both copies of the *APOC3* gene had inactivating mutations. Kathiresan and colleagues had previously found that people with one mutated copy of *APOC3* are protected against heart disease. Normally, the gene's protein stops dietary fat from being cleared from the body. People who had one mutant copy of the gene got rid of fat more quickly than normal, reducing the amount left to clog arteries, says Kathiresan, of the Broad Institute of MIT and Harvard. Scientists reasoned that drugs that inactivate the protein would also reduce heart attack risk in people who have two working copies of *APOC3*.



Junked genes In a new study, 1,843 people had mutations disabling both copies of a gene. For most genes (891), only one person had both copies disabled, or "knocked out." Thirty-two genes were incapacitated in six or more people.

But scientists worried that drugs that completely abolish the activity of the protein might be dangerous. Previous genetic studies encompassing nearly 200,000 people had never found a person with both copies of *APOC3* knocked out, indicating that people might not be able to do without the gene entirely. Finding people who have almost none of the *APOC3* protein in their blood indicates that it is probably safe to get rid of the protein's activity.

Further tests on 28 family members of one man who had both copies of *APOC3* knocked out showed that his wife (who was his first cousin) and all nine of the couple's children also lacked *APOC3*. The researchers fed fat-filled milkshakes to 13 of the family members — six who lacked *APOC3* and seven who had two functional copies of the gene. Within six hours after the milkshake, levels of triglyceride — a type of fat in the blood — shot up two to three times over premilkshake levels in family members with two functional copies of the gene. But in those in which the gene was knocked out, "triglyceride levels didn't go up. It didn't budge at all," Kathiresan says. That finding suggests *APOC3* could be a good target for drugs that reduce triglyceride levels in the blood and fend off heart disease, he says. ■

D. SALEHEEN *ET AL*/*NATURE* 2017

ATOM & COSMOS

Wind is an asteroid's deadliest weapon

Simulations tally up all of the ways impactors could kill people

BY THOMAS SUMNER

It won't be a tsunami. Nor an earthquake. Not even the crushing impact of the space rock. No, if an asteroid kills you, gusting winds and shock waves from falling and exploding space rocks will most likely be to blame. That's one of the conclusions of a recent computer simulation effort that investigated the fatality risks of more than a million possible asteroid impacts.

In one extreme scenario, a simulated 200-meter-wide space rock whizzing 20 kilometers per second whacked London, killing more than 8.7 million people. Nearly three-quarters of that doomsday scenario's lethality came from winds and shock waves, planetary scientist Clemens Rumpf and colleagues report online March 27 in *Meteoritics & Planetary Science*.

In a separate report, the researchers looked at 1.2 million potential impactors up to 400 meters across striking around the globe. Winds and shock waves caused about 60 percent of the total deaths from all the asteroids, the team's simulations showed. Impact-generated tsunamis, which many previous studies suggested would be the top killer, accounted for only around one-fifth of the deaths, Rumpf and colleagues report online April 19 in *Geophysical Research Letters*.

"These asteroids aren't an everyday concern, but the consequences can be severe," says Rumpf, of the University of Southampton in England. Even asteroids that explode before reaching Earth's surface can generate high-speed wind gusts, shock waves of pressure in the atmosphere and intense heat. Those rocks big enough to survive the descent pose even more hazards, spawning earthquakes, tsunamis, flying debris and, of course, gaping craters.

While previous studies typically considered each of these mechanisms individually, Rumpf and colleagues assembled the first assessment of the relative deadliness of the various effects of such impacts. The estimated hazard posed by each effect could one day help leaders make one of the hardest calls imaginable: whether to deflect an asteroid or let it hit, says Steve Chesley, a planetary scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif., who was not involved with either study.

4,126
Average number of predicted deaths from a 50-meter-wide asteroid strike

18,424
Average number of deaths from a 100-meter-wide asteroid

276,311
Average number of deaths from a 400-meter-wide asteroid

The 1.2 million simulated impactors each fell into one of 50,000 scenarios, which varied in location, speed and angle of strike. Each scenario was run with 24 different asteroid sizes, ranging from 15 to 400 meters across. Asteroids in nearly 36,000 of the scenarios, or around 72 percent, descended over water.

The deadliness assessment began with a map of human populations and numerical simulations of the energies unleashed by falling asteroids. Those energies were then used alongside existing casualty data from studies of extreme weather and nuclear blasts to calculate the deadliness of the asteroids' effects at different distances. Rumpf and his team focused on short-term impact effects, rather than long-term consequences such as climate change triggered by dust blown into the atmosphere.

(The kill count of each effect was calculated independently of the other effects, meaning people who could have died of multiple causes were counted multiple times. This double counting allows for a better comparison across

Large asteroid impacts are rare. Space rocks as big as the 20-meter-wide meteor that left behind a smoky trail across the sky above Chelyabinsk, Russia, in 2013, for instance, strike about once every 100 years. But to best prepare for such events when they do occur, a research group is assessing the relative deadliness of various effects.

OLEG KARGOPOLOV/AFP/GETTY IMAGES

effects, Rumpf says, but it does give deaths near the impact site more weight in calculations.)

While the most deadly impact killed around 117 million people, many asteroids posed no threat at all, the simulations revealed. More than half of asteroids smaller than 60 meters across — and all asteroids smaller than 18 meters across — caused zero deaths. Rocks smaller than 56 meters wide didn't even make it to Earth's surface before exploding in an airburst. Those explosions could still be deadly, though, generating intense heat that burns skin, high-speed winds that hurl debris and pressure waves that rupture internal organs, the team found.

Tsunamis became the dominant killer for water impacts, accounting for around 70 to 80 percent of the total deaths from each impact. Even with the tsunamis, though, water impacts were only a fraction as deadly on average as land-hitting counterparts. That's because impact-generated tsunamis are relatively small and quickly lose steam as they traverse the ocean, the researchers found.

Land impacts, on the other hand, cause considerable fatalities through heat, wind and shock waves and are more likely to hit near large population centers. For all asteroids big enough to hit the land or water surface, heat, wind and shock waves continued to cause the most casualties overall. Land-based effects, such as earthquakes and blast debris, resulted in less than 2 percent of total deaths.

> "These asteroids aren't an everyday concern, but the consequences can be severe."
>
> CLEMENS RUMPF

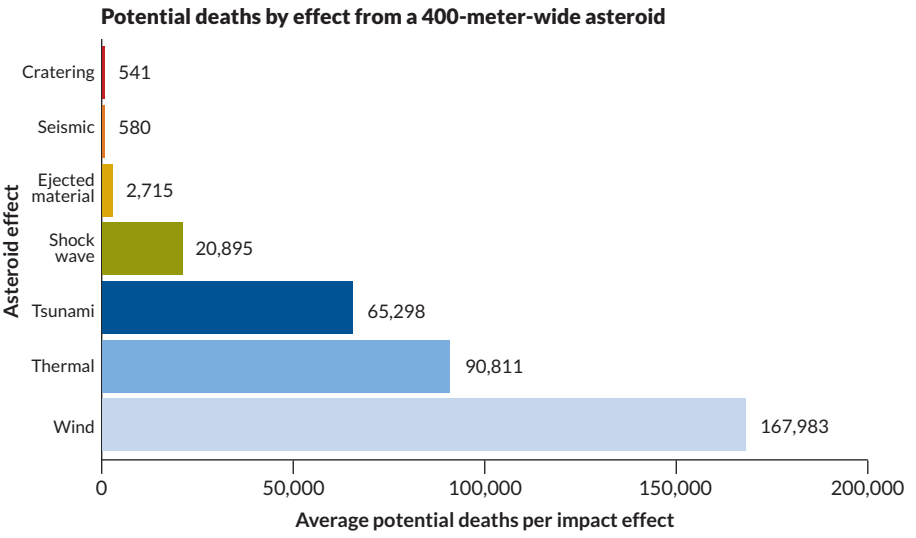
Deadly asteroid impacts are rare, though, Rumpf says. Most space rocks bombarding Earth are tiny and harmlessly burn up in the atmosphere. Bigger meteors such as the 20-meter-wide rock that lit up the sky and shattered windows around the Russian city of Chelyabinsk in 2013 only frequent Earth about once a century (*SN Online: 2/15/13*). Impacts capable of inducing extinctions, like the at least 10-kilometer-wide impactor blamed for the end of the dinosaurs 66 million years ago (*SN: 2/4/17, p. 16*), are even rarer, striking Earth roughly every 100 million years.

But asteroid impacts are scary enough that today's astronomers scan the sky with automated telescopes scouting for potential impactors. So far, they've cataloged 27 percent of space rocks 140 meters or larger estimated to be whizzing through the solar system. Other scientists are crunching the numbers on ways to divert an earthbound asteroid. Proposals include whacking the asteroid like a billiard ball with a high-speed spacecraft or frying part of the asteroid's surface with a nearby nuclear blast so that the vaporized material propels the asteroid away like a jet engine.

The recent research could offer guidance on how people should react to an oncoming impactor: whether to evacuate or shelter in place, or to scramble to divert the asteroid. "If the asteroid's in a size range where the damage will be from shock waves or wind, you can easily shelter in place a large population," Chesley says. But if the heat generated as the asteroid falls, impacts or explodes "becomes a bigger threat, and you run the risk of fires, then that changes the response of emergency planners," he says.

Making those tough decisions will require more information about compositions and structures of the asteroids themselves, says Lindley Johnson, who serves as the planetary defense officer for NASA in Washington, D.C. Those properties in part determine an asteroid's potential devastation, and the team didn't consider how those characteristics might vary, Johnson says. Several asteroid-bound missions are planned to answer such questions, though the recent White House budget proposal would defund a NASA project to reroute an asteroid into the moon's orbit and send astronauts to study it (*SN Online: 3/16/17*).

In the case of a potential impact, making decisions based on the average deaths presented in the new study could be misleading, warns Gareth Collins, a planetary scientist at Imperial College London. A 60-meter-wide impactor, for instance, caused on average about 6,300 deaths in the simulations. Just a handful of high-fatality events inflated that average, though, including one scenario that resulted in more than 12 million casualties. In fact, most impactors of that size struck away from population centers and killed no one. "You have to put it in perspective," Collins says. ■



Death from the skies A new project simulating 1.2 million asteroid strikes estimates how many deaths could result from each effect of a falling space rock (averages for the largest class of asteroid simulated are shown). People who could have died from two or more effects are included in multiple columns. SOURCE: C.M. RUMPF *ET AL/GEOPHYS. RES. LETT.* 2017

T. TIBBITTS

EARTH & ENVIRONMENT

Mystery over methane rise deepens

Emissions may not explain increasing levels of the greenhouse gas

BY THOMAS SUMNER

A recent upsurge in planet-warming methane may not be caused by increasing emissions, as thought, but by methane lingering longer in the atmosphere.

That's the conclusion of two independent studies that indirectly tracked concentrations of hydroxyl, a highly reactive chemical that rips methane molecules apart. Hydroxyl levels in the atmosphere decreased roughly 7 or 8 percent since the early 2000s, the studies estimate.

The teams propose that the hydroxyl decline slowed the breakdown of atmospheric methane, boosting levels of the greenhouse gas. Atmospheric concentrations have crept up since 2007, but during the same period, methane emissions from human activities and natural sources remained stable or even fell slightly, both studies suggest. The groups report their findings online April 17 in *Proceedings of the National Academy of Sciences*.

"If hydroxyl were to decline long-term, then it would be bad news," says Matt Rigby, an atmospheric scientist at the University of Bristol in England who coauthored one of the studies. Less methane would be removed from the atmosphere, he says, so the gas would hang around longer and cause more warming.

The stability of methane emission levels might vindicate previous work that found no emissions rise. The Environmental Protection Agency has reported that U.S. emissions largely plateaued from 2002 to 2014 (*SN Online: 4/14/16*).

Methane enters the air from a range of sources, from decomposing biological material in wetlands to leaks in natural gas pipelines. Since the start of the Industrial Revolution, atmospheric methane concentrations have more than doubled. By the early 2000s, though, methane levels flatlined. In 2007, methane levels just as mysteriously rose again. The lull and subsequent upswing puzzled scientists.

Previous attempts to solve the mystery haven't accounted for what happens once methane enters the atmosphere. Most methane molecules in the air last about a decade before being broken apart during chemical reactions with hydroxyl. Monitoring hydroxyl is tricky because the molecules are so reactive that they survive for less than a second before undergoing a chemical reaction.

Neither study conclusively shows that hydroxyl levels changed, says atmospheric scientist Stefan Schwietzke of the National Oceanic and Atmospheric Administration's Earth System Research Laboratory in Boulder, Colo. The papers nevertheless add a new twist in explaining the methane rise, he says. "These studies are opening a new can of worms, and there was no shortage of worms."

Despite being conducted by two separate teams — one headed by Rigby and the other by Harvard atmospheric scientist Alex Turner — the new studies used the same roundabout approach to tracking hydroxyl concentrations over time.

Both teams followed methyl chloroform, a now-banned ozone-depleting substance. Like methane, methyl chloroform also breaks apart in reactions with hydroxyl. Methyl chloroform emission rates are easier to track, though, because the chemical is entirely human-made.

Examining methyl chloroform measurements gathered since the 1980s revealed that hydroxyl concentrations have probably wobbled over time, contributing to the odd pause and rise in methane levels. But to know for sure, scientists will need to take a more detailed look at regional emissions, Rigby says.

Why hydroxyl levels might have fallen is unclear. Turner's group says the 1989 ban on ozone-depleting chemicals might be the cause. The ozone layer blocks some ultraviolet light, an ingredient in hydroxyl formation. Identifying the cause of the hydroxyl changes could help scientists better predict future methane levels. ■

A. CÓZAR

EARTH & ENVIRONMENT

The Arctic is awash in plastic

The Arctic Ocean is a final resting place for plastic debris dumped into the North Atlantic Ocean, new research suggests.

A 2013 circumpolar expedition discovered hundreds of metric tons of plastic debris (some shown), from fishing lines to plastic films, ecologist Andrés Cózar of the University of Cádiz in Spain and colleagues report April 19 in *Science Advances*. While many areas remain relatively unpolluted, the density of plastic trash in the Arctic waters east of Greenland and north of Europe rivals plastic pileups in waters closer to the equator, despite few nearby human populations. Even more plastic may lurk on the seafloor, the researchers suspect.

Ocean currents probably brought the plastic from the North Atlantic Ocean. The debris most likely originated from the U.S. East Coast and Europe. Right now, the Arctic contains less than 3 percent of all global floating plastic, the researchers estimate, but that number could go up. — *Thomas Sumner*

HUMANS & SOCIETY

Stone Age people treated cavities

Foragers dabbled in dentistry before the rise of farming

BY BRUCE BOWER

Stone Age dentists didn't drill and fill cavities. They scraped and coated them.

Two teeth from a person who lived in what's now northern Italy between 13,000 and 12,740 years ago bear signs of someone having scoured and removed what must have been infected soft, inner tissue. The treated area was then covered with bitumen, a sticky, tarlike substance Stone Age folks used to attach stone tools to handles, says a team led by biological anthropologists Gregorio Oxilia and Stefano Benazzi, both of the University of Bologna in Italy.

The find indicates that techniques for removing infected parts of teeth developed thousands of years before carb-rich farming diets made tooth decay more common, the team reports online March 27 in the *American Journal of Physical Anthropology*. Farmers may have used tools to drill cavities as early as 9,000 years ago (*SN: 4/8/06, p. 213*).

About 13,000 years ago, someone tried to mend this front tooth's cavity (chewing surface shown in this reconstruction).

Oxilia and Benazzi's group reported in 2015 that a stone tool had apparently been used to remove decayed dental tissue from the tooth of a man who lived in Italy about 14,000 years ago.

While these finds represent the only known examples of dental treatments by Stone Age hunter-gatherers, "they may be part of a broader trend, or tradition, of dental interventions among late [Stone Age] foragers in Italy," Benazzi says.

Other possible causes of tooth damage — such as regularly using the front teeth to grip wood, hides and other material or modifying tooth shapes for cultural reasons — appear less likely than dentistry, says Isabelle De Groote, a paleoanthropologist at Liverpool John Moores University in England.

Previous excavations at Italy's Riparo Fredian site yielded dental remains of six people, including the two front teeth analyzed in the new study. Microscopic study of decayed tissue in these specimens revealed scrape marks and flaking, produced when someone used a pointed stone implement to widen cavities before removing tissue. If that sounds painful, it probably was, Benazzi says.

Chemical and microscopic analyses of dark bits of material on cavity walls identified bitumen, plant fibers and some possible hairs. Placing bitumen over treated tissue might have protected against further infection, Benazzi says.

The scrape-and-coat treatment developed from an older practice of using pieces of stone or wood as toothpicks, Benazzi suspects. Members of the human genus, *Homo*, may have wielded toothpicks as early as 1.77 million years ago. ■

S. BENAZZI

ATOM & COSMOS

Collider data hint at new particle

Shortage of muons in B meson decays supported by more data

BY EMILY CONOVER

A handful of measurements of decaying particles has seemed slightly off-kilter for years, intriguing physicists. Now a new decay measurement at the Large Hadron Collider in Geneva has amplified that interest into tentative enthusiasm, with theoretical physicists proposing that weird new particles could explain the results. Scientists with the LHCb experiment reported the new result April 18 in a seminar at the European particle physics lab CERN, which hosts the LHC.

"It's incredibly exciting," says theoretical physicist Benjamin Grinstein of the University of California, San Diego. The new measurement is "a further hint that there's something new and unexpected happening in very fundamental interactions."

Other physicists, however, are more cautious, betting that the series of hints will not lead to a new discovery. "One should always remain suspicious of an effect that does not show up in a clear way" in any individual measurement, says Carlos Wagner of the University of Chicago.

Taken in isolation, none of the measurements rise beyond the level that can be explained by a statistical fluctuation, meaning that the discrepancies could easily disappear with more data. But, says theoretical physicist David London of the University of Montreal, there are multiple independent hints, "and they all seem to be pointing at something."

The measurements all involve a class of particle called a B meson, which can be produced when protons are smashed together in the LHC. When a B meson decays, it can produce a type of particle called a kaon that is accompanied either by an electron and a positron (an antimatter version of an electron) or by a muon — the electron's heavier cousin — and an antimuon.

> "One should always remain suspicious of an effect that does not show up in a clear way" in any individual measurement.
>
> **CARLOS WAGNER**

According to physicists' accepted theories, muons and electrons should behave essentially identically aside from the effects of their differing masses. That means the two kinds of particles should have an even chance of being produced in such B meson decays. But in the new result, the scientists found only about seven decays with muons for every 10 with electrons.

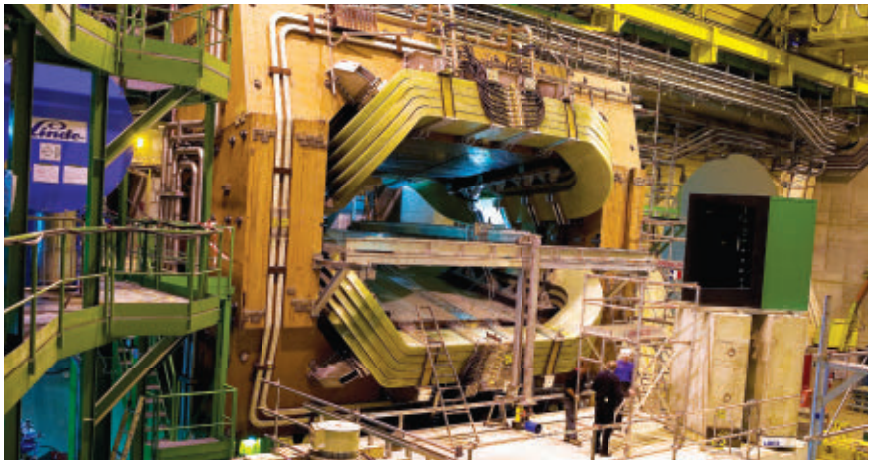
B mesons come in several varieties. All are made up of one quark — a type of fundamental particle that also makes up protons and neutrons — and one antiquark. One of the two particles is a type called a "bottom" quark (or antiquark), hence the B meson's name.

Earlier measurements of another variety of B meson decay also found a muon shortage. What's more, measurements of the angles at which particles are emitted in some types of B meson decay also appear slightly out of whack, adding to the sense that something funny may be going on in such decays.

"We are excited by how [the measurements] all seem to fit together," says experimental physicist Guy Wilkinson of the University of Oxford, a spokesperson for LHCb. If more data confirm that B mesons misbehave, a likely explanation would be a new particle that interacts differently with muons than it does with electrons. One such particle could be a leptoquark — a particle that acts as a bridge between quarks and leptons, the class of particle that includes electrons and muons. Or it could be a heavy, electrically neutral particle called a Z-prime boson.

Physicists witnessed a similar hubbub in 2016, when the ATLAS and CMS experiments at the LHC saw hints of a potential new particle that decayed to two photons (*SN: 5/28/16, p. 11*). Those hints evaporated with more data, and the current anomalies could do likewise. Although the two sets of measurements are very different, says Wolfgang Altmannshofer of the University of Cincinnati, "from the point of the overall excitement, I would say the two things are roughly comparable."

Luckily, LHCb scientists still have a lot more data to dig into. The researchers used particle collisions only from before 2013, when the LHC was running at lower energy than it is now. "We have to get back to the grindstone and try and analyze more of the data we have," says Wilkinson. Updated results could be ready in about half a year, he says, and should allow for a more definitive conclusion. ■



Something funny may be going on in certain particle decays measured in the LHCb experiment in Geneva (shown). A new measurement has now added to evidence for a possible new particle.

R. PLACKETT/CERN

LIFE & EVOLUTION

Volcanic eruptions nearly snuffed out Gentoo penguin colony

Penguins have been pooping on Ardley Island off the coast of the Antarctic Peninsula for a long, long time. The population there is one of the biggest and oldest Gentoo penguin (*Pygoscelis papua*) colonies. But evidence from ancient excrement suggests that these animals didn't always flourish.

Stephen Roberts of the British Antarctic Survey and colleagues set out to see how the Ardley population responded to past changes in climate to better inform future conservation efforts. The researchers studied the geochemical makeup of lake sediment samples and identified elements from penguin guano. Knowing the fraction of guano in lake sludge over time let the researchers track penguin population changes.

The Gentoo penguin colony was nearly wiped out three times over the 6,700 years that the penguins have occupied Ardley Island. But rather than lining up with changes in temperature or sea ice levels, these population dips corresponded to volcanic ash preserved in the geologic record from big eruptions of a volcano on nearby Deception Island. After each population crash, the colony took 400 to 800 years to recover, the team reports April 11 in *Nature Communications*. *— Helen Thompson*

S. ROBERTS

Volcanoes were an ancient threat to one of today's most successful Antarctic penguin colonies, researchers learned after studying preserved Gentoo penguin guano.

ATOM & COSMOS

Nitrogen fizz fuels 'magic island' on Titan, simulation suggests

Saturn's main moon, Titan, has a "magic island" that might be made of streams of nitrogen bubbles, scientists report April 18 in *Nature Astronomy*.

Images from NASA's Cassini spacecraft show that the island, which appears as a bright spot, comes and goes. It sits in Ligeia Mare, a sea made of methane, ethane and nitrogen in Titan's northern polar region. The sea is probably 100 to 200 meters deep and frigid, about −183° to −193° Celsius.

The sea may also be stratified, with more ethane in the deeper layers and methane near the surface. If currents occasionally pull methane down to the deeper sea, the methane and ethane can mix, simulations by Daniel Cordier of the University of Reims Champagne-Ardenne in France and colleagues suggest. Nitrogen doesn't like this combo, so the gas would separate out of the liquid, fizzing back to the sea surface in centimeter-sized bubbles.

Cassini had one last chance to search for signs of bubbles or some other explanation for the island when it flew by Titan a final time on April 22 (*SN Online: 4/21/17*). *— Ashley Yeager*

BODY & BRAIN

Frog slime protein fights off the flu

The next flu drug could come from frog mucus. It's not as crazy as it sounds: For decades, scientists have searched for new antiviral drugs by mining proteins that animals produce to protect themselves from microbes. In lab tests, proteins found in amphibian secretions can defend against HIV, herpes and now the flu.

David Holthausen of Emory University in Atlanta and colleagues sampled slime from the skin of *Hydrophylax bahuvistara*, a recently discovered frog species from southern India. They tested the influenza-fighting ability of 32 slime peptides. Four showed promise, but three proved toxic to mammals.

The fourth peptide, however, was safe and showed a propensity for fighting off the flu. When exposed to four H3N2 and eight H1N1 strains, this peptide, dubbed urumin, inhibited H3N2 viruses to a degree but was particularly adept at killing H1N1 viruses, which are more common among humans. The frog slime protein even cut viral numbers in a set of seven drug-resistant strains and protected mice during flu infections. Urumin blows up flu virus particles by targeting the stalk region of the hemagglutinin protein in H1 varieties, the team found. With further development, urumin could form the basis of future influenza drugs, the researchers write in the April 18 *Immunity*. *— Helen Thompson*

ATOM & COSMOS

New particle probably can't explain neutrino mystery

A puzzling neutrino shortfall seems to be due to faulty predictions, not a new particle.

In experiments at nuclear reactors, scientists have consistently found about 6 percent fewer antineutrinos, the antimatter form of neutrinos, than expected. That deficit could hint that the lightweight particles are morphing into undetectable new particles called sterile neutrinos (*SN: 3/19/16, p. 14*). But in a paper posted online April 4 at arXiv.org, researchers with the Daya Bay experiment, located near a nuclear power plant in China, point to the calculations that underlie scientists' predictions to explain the missing antineutrinos.

Inside nuclear reactors, multitudes of antineutrinos are born in radioactive decays of isotopes such as uranium-235 and plutonium-239. Scientists can predict how many antineutrinos each isotope should produce. If sterile neutrinos are the source of the disagreement, detectors should observe an antineutrino deficit from both isotopes. Instead, the researchers found that plutonium-239 agreed with predictions, but researchers detected fewer antineutrinos than expected from uranium-235. That means there's probably something funny with the uranium-235 calculations.

This isn't the end for sterile neutrinos — there are other hints that they exist. If so, sterile neutrinos could constitute dark matter, an unknown invisible substance that pervades the universe. *— Emily Conover*

IN HOT WATER

Warming lakes have ecological and human effects

By Alexandra Witze

About 40 kilometers off Michigan's Keweenaw Peninsula, in the waters of Lake Superior, rises the stone lighthouse of Stannard Rock. Since 1882, it has warned sailors in Great Lakes shipping lanes away from a dangerous shoal. But today, Stannard Rock also helps scientists monitor another danger: climate change.

Since 2008, a meteorological station at the lighthouse has been measuring evaporation rates at Lake Superior. And while weather patterns can change from year to year, Lake Superior appears to be behaving in ways that, to scientists, indicate long-term climate change: Water temperatures are rising and evaporation is up, which leads to lower water levels in some seasons. That's bad news for hydropower plants, navigators, property owners, commercial and recreational fishers and anyone who just enjoys the lake.

When most people think of the physical effects of climate change, they picture melting glaciers, shrinking sea ice or flooded coastal towns (*SN: 4/16/16, p. 22*). But observations like those at Stannard Rock are vaulting lakes into the vanguard of climate science. Year after year, lakes reflect the long-term changes of their environment in their physics, chemistry and biology. "They're sentinels," says John Lenters, a limnologist at the University of Wisconsin–Madison.

Globally, observations show that many lakes are heating up — but not all in the same way or with the same ecological consequences. In eastern Africa, Lake Tanganyika is warming relatively slowly, but its fish populations are plummeting, leaving people with less to eat. In the U.S. Upper Midwest, quicker-warming lakes are experiencing shifts in the relative abundance of fish species that support a billion-dollar-plus recreational industry. And at high global latitudes, cold lakes normally covered by ice in the winter are seeing less ice year after year — a change that could affect all parts of the food web, from algae to freshwater seals.

Lake Tanganyika is a major food source for people throughout eastern Africa. Fish stocks are dwindling as water temperatures in the lake rise.

ROBERTHARDING/ALAMY

Understanding such changes is crucial for humans to adapt to the changes that are likely to come, limnologists say. Indeed, some northern lakes will probably release more methane into the air as temperatures rise — exacerbating the climate shift that is already under way.

Lake layers

Lakes and ponds cover about 4 percent of the land surface not already covered by glaciers. That may sound like a small fraction, but lakes play a key role in several planetary

processes. Lakes cycle carbon between the water's surface and the atmosphere. They give off heat-trapping gases such as carbon dioxide and methane, while simultaneously tucking away carbon in decaying layers of organic muck at lake bottoms. They bury nearly half as much carbon as the oceans do.

Yet the world's more than 100 million lakes are often overlooked in climate simulations. That's surprising, because lakes are far easier to measure than oceans. Because lakes are relatively small, scientists can go out in boats or set out buoys to survey temperature, salinity and other factors at different depths and in different seasons.

A landmark study published in 2015 aimed to synthesize these in-water measurements with satellite observations for 235 lakes worldwide. In theory, lake warming is a simple process: The hotter the air above a lake, the hotter the waters get. But the picture is far more complicated than that, the international team of researchers found.

On average, the 235 lakes in the study warmed at a rate of 0.34 degrees Celsius per decade between 1985 and 2009. Some warmed much faster, like Finland's Lake Lappajärvi, which soared nearly 0.9 degrees each decade. A few even cooled, such as Blue Cypress Lake in Florida. Puzzlingly, there was no clear trend in which lakes warmed and which cooled. The most rapidly warming lakes were scattered across different latitudes and elevations.

Even some that were nearly side by side warmed at different rates from one another — Lake Superior, by far the largest of the Great Lakes, is warming much more rapidly, at a full degree per decade, than others in the chain, although Huron and Michigan are also warming fast.

"Even though lakes are experiencing the same weather, they are responding in different ways," says Stephanie Hampton, an aquatic biologist at Washington State University in Pullman.

Such variability makes it hard to pin down what to expect in the future. But researchers are starting to explore factors such as lake depth and lake size (intuitively, it's less teeth-chattering to swim in a small pond in early summer than a big lake).

Depth and size play into stratification, the process through which some lakes separate into layers of different temperatures. Freshwater is densest at 4° C, just above freezing. In spring, using the Great Lakes as an example, the cold surface waters begin to warm; when they reach 4°, they become dense enough to sink. The lake's waters mix freely and become much the same temperature at all depths.

But then, throughout the summer, the upper waters heat up relatively quickly. The lake stops mixing and instead separates into layers, with warm water on top and cold, dense water at the bottom. It stays that way until autumn, when chilly air temperatures cool the surface waters to 4°. The newly dense waters sink again, mixing the lake for the second time of the year.

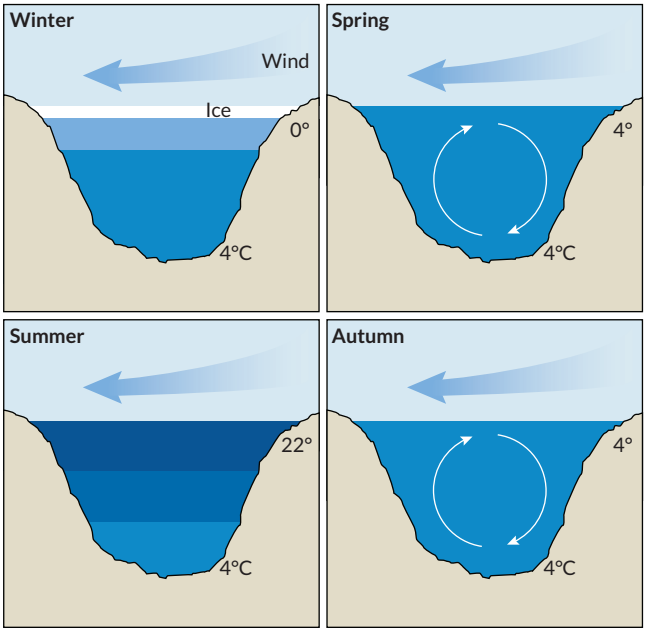
Lake Superior is warming so quickly because it is stratifying earlier and earlier each year. It used to separate into its summer layers during mid- to late July, on average. But rising air temperatures mean that it is now stratifying about a month earlier — giving the shallow surface layers much more time to get toasty each summer. "If you hit that starting point in June, now you've got all summer to warm up that top layer," Lenters says.

Deep lakes warm very slowly in the spring, and small changes in water temperature at the end of winter can lead to large changes in the timing of summer stratification for these lakes. Superior is about 406 meters deep at its greatest point, so it is particularly vulnerable to such shifts.

In contrast, shallow lakes warm much more quickly in the spring, so the timing of their summer stratification is much less variable than for deep lakes. Lake Erie is only 64 meters deep at its maximum, which is why Erie is not experiencing big changes in its stratification start date. Erie is warming one-tenth as fast as Superior, just 0.1 degrees per decade.

Superior is also warming because of a decline in cloud cover over the Great Lakes in recent years; more heat from solar radiation hits the lakes, Lenters said at a limnology meeting in Honolulu in March. Why the cloud cover is changing isn't known — it could be natural variability. But the increased sunlight means another source of warming for Superior and the other Great Lakes.

On top of that, evaporation, measured from spots like Stannard Rock, also plays into the complexity. High evaporation rates in a warm autumn can actually lead to more ice cover the following winter and slower ice breakup in the spring, because the water is colder after evaporation. "When lakes sweat, they cool off," Lenters says. All these factors conspire to



Seasonal cycle Some lakes stratify twice a year, separating into layers of different temperatures. Surface waters become warm enough (in spring) or cool enough (in autumn) to reach 4° Celsius, the temperature at which these waters become dense and sink toward the lake's bottom, mixing the waters. In summer and winter, the layers separate. Lake Superior is stratifying earlier each year, giving its surface waters more time to heat up in summer, contributing to its long-term warming.

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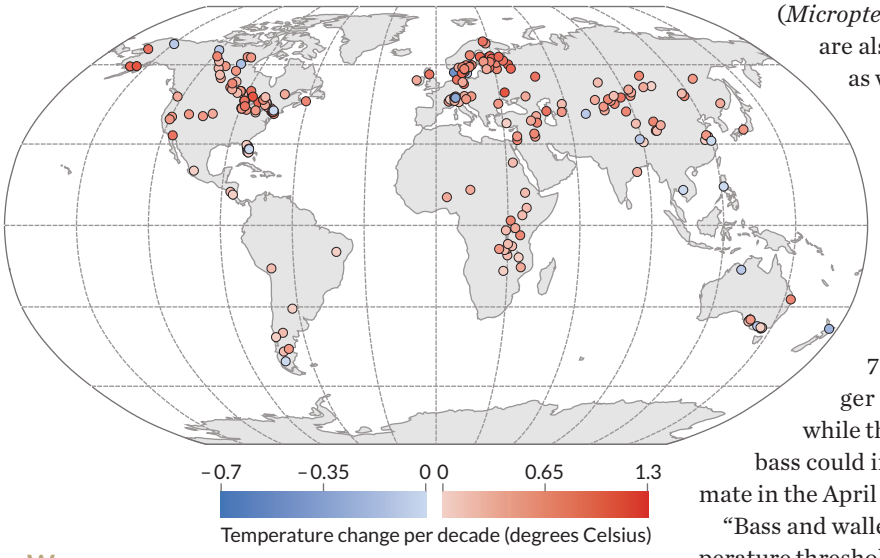


Warm up A recent survey of 235 lakes worldwide found that from 1985 to 2009 most warmed (red dots) while several cooled (blue).

complicate the picture of why Superior is warming so quickly, and what people in the Great Lakes region can do about it.

A new reality

Warming water — even small changes — can have a big impact on a lake's ecology. One of the most famous examples is Lake Tanganyika in eastern Africa. It has been warming relatively slowly, about 0.2 degrees per decade. But that is enough to make it more stratified year-round and less likely to mix. With layers stagnating, nutrients that used to rise from the bottom of the lake become trapped down low, Hampton says.

With fewer nutrients reaching the upper waters, lake productivity has plummeted. Since the late 1970s, catches of sardines and sprats have declined by as much as 50 percent, and the hundreds of thousands of people who depend on the lake for food have had to find additional sources of protein. Factors such as overfishing may also play a role, but a study published last August in *Proceedings of the National Academy of Sciences* found that lake temperatures in the last century were the highest of at least the previous 500 years.

Elsewhere, lake warming seems to be shifting the relative abundances of fish within certain lakes. This is apparent in a study of walleye (*Sander vitreus*), a popular recreational fishing target in the lakes of the U.S. Upper Midwest.

In Wisconsin, recreational freshwater fishing brings in more than $1.5 billion annually. So officials were worried when, around 2000, anglers and biologists began reporting that walleye numbers seemed to be dropping.

"We've seen declines in some of our most valuable fish," says Jordan Read, a limnologist at the U.S. Geological Survey in Middleton, Wis. Hoping to figure out why, Read and colleagues analyzed water temperatures in 2,148 Wisconsin lakes from 1989 to 2014. Some of these lakes had seen populations of walleye drop as populations of largemouth bass (*Micropterus salmoides*) increased. Largemouth bass are also popular catches, although not as popular as walleye.

The scientists simulated how lake temperatures would probably rise through the year 2089 and how that might affect walleye survival in the state's lakes. The team used a measure that describes whether walleye can spawn and their young can survive in a particular environment, compared with the relative abundance of largemouth bass. Up to 75 percent of the lakes studied would no longer be able to support young walleye by 2089, while the number of lakes that could support lots of bass could increase by 60 percent, the researchers estimate in the April *Global Change Biology*.

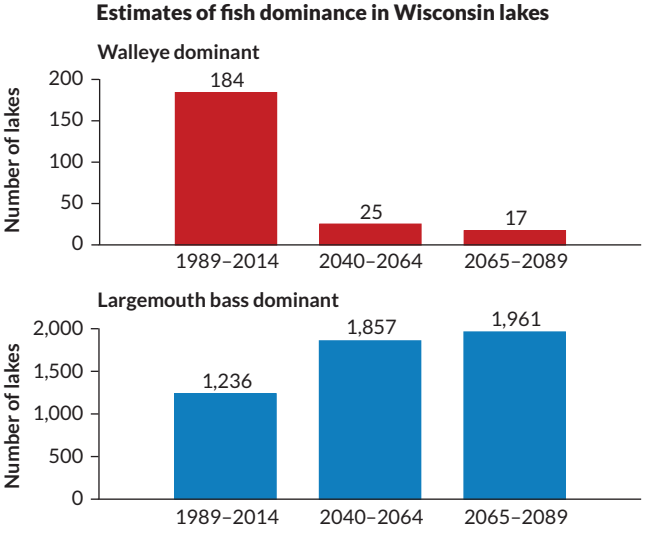
"Bass and walleye seem to be responding to the same temperature threshold but in opposite directions," says Gretchen Hansen, a fisheries scientist at the Minnesota Department of Natural Resources in St. Paul who led the work.

The reason isn't yet clear. Physiologically, walleye should still be able to survive in the higher temperatures. But something is already causing them to wane — perhaps they have fewer food sources, or they spawn less successfully. Field studies are under way to try to answer that question, Hansen says.

Variability in lake warming offers hope for the walleye. The study identified lakes where the walleye might be able to hold on. Some of these places have warmed less than others, making them more amenable to walleye, even as largemouth bass take over other lakes.

If the researchers can identify lakes that are likely to keep walleye healthy in the future, then officials can foster walleye

Fishing favorites Climate change is expected to increase the number of Wisconsin lakes dominated by largemouth bass and decrease those in which walleye — a more popular recreational fishing species — thrive. A recent analysis used global circulation models to study the future of more than 2,100 lakes. SOURCE: G. HANSEN *ET AL/GLOBAL CHANGE BIOLOGY* 2016



C.M. O'REILLY *ET AL/GEOPHYS. RES. LETT.* 2015

spawning in those places and keep the state's fishing industry healthy for decades to come. "While the outlook isn't great, there are ... lakes that are a good target of management action," Read says. The scientists are now expanding their analysis into Minnesota and other neighboring states.

Less ice

Ecological changes put into motion during a particularly cold or hot time can send ripples during the following seasons, researchers are finding. "What happens in previous seasons sometimes matters more than the current season," Lenters says. This is especially true for lakes at high latitudes that are covered in ice each winter but may see less ice as temperatures rise. Ice acts as an insulator, protecting the waters from big changes in the air temperature above. When the ice finally melts in spring, the water is exposed to warming from the atmosphere and from sunlight. "It's a way the temperature can really rapidly increase in those lakes," Hampton says.

Siberia's Lake Baikal, for example, sees three to four weeks less ice cover than it did a century ago. That shift could affect Baikal seals (*Pusa sibirica*), the world's only freshwater seals, which depend on ice cover to birth and shelter their pups each spring. There are no hard data on seal declines, in part because annual surveys of seal populations ceased in the early 1990s when the Soviet Union broke apart. "But if the ice duration is too short, then the pups may be exposed to predators before they're ready," Hampton says.

More broadly, and at other lakes, big questions remain about how winter and summer ecosystems connect. Biologists are assessing what wintertime ecosystems look like now, as a framework for understanding future change.

In a survey of 101 ice-covered lakes, Hampton and colleagues found more plankton under the ice than they had expected; chlorophyll levels were 43 percent of what they were in the summer. "It surprised me it was that high," she says. "Some of these are snow-covered lakes not getting a lot of light." The team reported its puzzling findings in January in *Ecology Letters*.

As winter shortens, fish may find more nutrients available to them earlier in the year than usual. Other algae-grazing creatures may become more abundant as the food web adjusts to what's available with less ice cover.

More methane

Warming lakes themselves might exacerbate climate change. As temperatures rise, methane from bacteria at the lake's bottom bubbles up through the water column — particularly in northern lakes — and adds to the atmosphere's greenhouse gas load.

At the Honolulu meeting, biogeochemist Tonya DelSontro of the University of Quebec in Montreal reported on methane release from boreal lakes, those lying between 50° and 70° N in realms such as Canada and Siberia. The boreal region contains up to half of the world's carbon, with lakes an important source and sink.

DelSontro simulated how the boreal zone's 9 million lakes would behave in the future. Just a 1 degree rise in surface temperature would boost methane emissions from boreal lakes by about 10 percent, DelSontro found. That's not taking into account other factors such as a lengthening of the ice-free season, which would also put more methane into the air.

10 percent
Estimated increase in methane emissions if boreal lake surface temperatures rise 1 degree Celsius

And at the University of Exeter in England, lake expert Gabriel Yvon-Durocher has been working to measure, on a small scale, how exactly ponds and lakes will respond to rising temperatures. His team built a series of experimental ponds, each of which is warmed by a certain temperature range over a certain period of time.

After heating the ponds by 4 to 5 degrees over seven years, the scientists found the lakes' methane emissions more than doubled. In the same period, the ability to suck down carbon dioxide was cut almost by half. Such shifts could make climate change even worse, the team wrote in February in *Nature Climate Change*.

With so much variability among lakes, and so much uncertainty remaining about where they may head in the future, Lenters argues that limnologists need to keep gathering as much information as possible. Just as the Stannard Rock lighthouse is providing key data on Lake Superior, other locations need to be pressed into service to keep an eye on what lakes are doing. "There are aspects of the Pacific Ocean we know better than Lake Superior," he says. "Lakes are woefully understudied." ■

Baikal seals rely on sufficient springtime ice cover in Siberia's Lake Baikal to care for their newborn pups. Ice duration has shortened in the past century, which has scientists concerned.

STRELUK/ISTOCKPHOTO

Explore more

- Global Lake Temperature Collaboration: www.laketemperature.org
- USGS visualization of a Wisconsin walleye study: owi.usgs.gov/vizlab/climate-change-walleye-bass

THE STATIN UMBRELLA

Yes, the drugs protect hearts. But critics are questioning their expanding use

By Laura Beil

Cholesterol is so important to life that practically every human cell makes it. Cells use the compound to keep their membranes porous and springy, and to produce hormones and other vital substances. The body can make all the cholesterol it needs, but Americans tend to have a surplus, thanks in large part to too little exercise and too much meat, cheese and grease. Fifty years ago, researchers began to suspect that all this excess cholesterol was bad for arteries. But the idea remained difficult to prove — until statins came along.

Once the powerful cholesterol-busting drugs appeared, in the 1980s, scientists were able to show that a drop in cholesterol could keep a person who had suffered one heart attack or stroke from having a second. Later studies pointed to protection for even relatively healthy people. Researchers writing in the *American Journal of Cardiology* in 2010 declared that the drugs were such cardiovascular heroes they could essentially neutralize the health risks from a Quarter Pounder with cheese plus a milkshake.

The news just kept getting better. Studies even floated the idea that statins could protect against cancer and influenza (*SN: 5/5/12, p. 30*). People joked about dumping statins into the water supply. One pioneering London heart surgeon suggested that the drugs were so good and so safe they should be made available over the counter to everyone over age 40.

16.3
percent
Americans 40 and older using statins in 2003–2004

23.2
percent
Americans 40 and older using statins in 2011–2012

SOURCE: CDC

So it may come as a surprise that there are scientists still reluctant to join Team Statin. To them, studies showing benefit for people who haven't had a heart attack aren't as clean or overwhelmingly convincing as patients and many doctors probably believe. The statin skeptics worry that too little is understood about unintended consequences, especially for a drug taken for years on end by nearly one-quarter of adults past middle age, according to the Centers for Disease Control and Prevention's most recent data. After all, only after 30 years of study did researchers discover that statins could raise the risk of type 2 diabetes. Many other sobering but unconfirmed possible side effects appear in the medical literature, including cognitive decline, cataracts and kidney problems.

Muscle damage tops the list of concerns, says James Wright, chairman of the Therapeutics Initiative at the University of British Columbia in Vancouver. "Over time there could be a cumulative effect. I'm predicting we're going to have an aging population suffering from sarcopenia, where they can't stand up." He calls the mass prescribing of statins "the biggest human experiment we've ever done."

In November, a commentary in *JAMA* carried the headline, "The debate is intense, but the data are weak." And long-simmering tensions between two major British medical journals recently erupted into an all-out editorial war over the drugs. Rory Collins doesn't hide his irritation over the enduring controversy. "I can't think of another circumstance in health care where there is such a lot of nonsense that has been persisting for so long," says Collins, a medical epidemiologist at the University of Oxford and one of the leaders of the Cholesterol Treatment Trialists' Collaboration. In his view, statin naysayers are peddling distortions or outright misrepresentations of evidence. Which raises the question: How can respectable scientists see the same data and reach such different conclusions?

At its core, the debate is about how studies are designed, carried out, evaluated and sliced and diced after the fact. No one argues that the vast majority of people prescribed a statin will be taking a drug — probably for the rest of their lives — that they never needed. At issue is whether they stand a good chance of gain, and whether they are putting themselves in unacceptable danger.

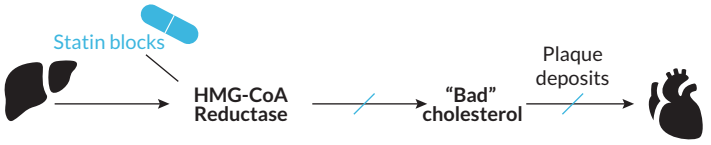
"Statins are arguably the most widely studied medicines ever," says Jeremy Sussman, a primary care provider at the University of Michigan and the Department of Veterans Affairs in Ann Arbor. "They are also among the most widely used. This makes any controversy an important one."

Birth of a blockbuster

Like many tales of drug discovery, the statin story starts in a petri dish. During the mid-20th century, scientists worked out the chemical steps that cells, most commonly in the liver, use to convert acetyl CoA, a chemical formed during metabolism, into cholesterol. More than 30 different enzymes orchestrate the process, but one central to the assembly line is called 3-hydroxy-3-methylglutaryl-CoA (or HMG-CoA) reductase, an early step in a long line of steps.

In the late 1960s, Japanese microbiologist Akira Endo was inspired to search for an HMG-CoA blocker during a two-year stint in New York, where he was struck by the fatty excesses of the American diet. Returning to Japan, he happened upon a compound in a fermented broth of *Penicillium citrinum*, a rice mold taken from a shop in Kyoto, that blocked the action of

OPPOSITE: JAMES PROVOST



Cholesterol blockers Most cholesterol is made in the liver, through a series of chemical steps that convert acetyl CoA into cholesterol. Statins block the action of an enzyme, HMG-CoA reductase, which is essential to the process.

HMG-CoA reductase. In 1978, scientists at Merck & Co. found another microbe-produced chemical that also disabled HMG-CoA reductase. The Japanese discovery fizzled in laboratory trials, but Merck's compound eventually emerged as the first cholesterol-lowering drug, lovastatin (brand name Mevacor).

Lovastatin targeted low-density lipoprotein, or LDL, cholesterol, often referred to as the "bad" cholesterol because it contributes to plaque buildup inside arteries. The drug didn't lower another type of cholesterol, high-density lipoprotein, or HDL, which was thought to protect against heart disease because it scavenges cholesterol from arteries and ferries it to the liver for recycling. Today, HDL's role is less clear (*SN: 6/16/12, p. 14*). Although statins demonstrated their ability to combat LDL cholesterol, proof that they saved lives was not established until a watershed study appeared in *Lancet* in 1994.

In that experiment, researchers from a collective of Scandinavian countries, and funded by Merck, followed more than 4,400 patients who had chest pain or had suffered a heart attack. After about five years, 8 percent of patients who took simvastatin (a synthetic version of lovastatin, marketed as Zocor) had died, compared with 12 percent who took a placebo, a 30 percent lower mortality rate. Doctors cheered. A blockbuster was born.

In the years following, a posse of other cholesterol fighters joined simvastatin to create what would become a $20 billion–plus annual market: pravastatin (Pravachol), fluvastatin (Lescol), atorvastatin (Lipitor), cerivastatin (Baycol), rosuvastatin (Crestor) and finally pitavastatin (Livalo). The drugs are now available as lower-priced generics, poised to further drive consumption. Together, statins have been subject to more than two dozen large clinical trials that have collectively included about 175,000 people with and without heart disease. And yet, some doctors worry that even this avalanche of data isn't enough.

"The reality is there is more we don't know than we do know," says Wright. Among the conundrums he cites: The drugs vary widely in their ability to lower cholesterol, yet regardless of their potency, they appear to have the same potential to prevent a second heart attack or stroke. "Fluvastatin is the least potent," he says. "Yet it appears to reduce cardiovascular events as much as rosuvastatin, which is the most potent. There's something we're not getting."

Primary cares

To be clear, little if any disagreement exists over "secondary prevention," or using the drug to prevent a second heart attack or stroke in someone with established disease. The contention arises over "primary prevention" — when an otherwise healthy person, whose main concern is simply elevated cholesterol, takes the drug to keep from taking that ambulance ride in the first place. This is a crucial context. If you have already survived one attack, you know you're at increased risk for another. You're willing to tolerate a certain level of side effects.

But healthy people, even healthy people whose cholesterol is too high, start with much lower odds of dying from cardiovascular disease than people already afflicted. It's less certain whether they need the drug at all. A healthy person takes on the same risk of side effects as someone already struck by disease, but for potentially much less gain. That makes it vital to understand the true risk and benefit balance — and that's precisely where the dispute lies.

The 500-pound gorilla of the statin research world is the Cholesterol Treatment Trialists' Collaboration, commonly referred to as the CTT. Formed in 1994 and headquartered in the United Kingdom and Australia, the CTT consists of about 150 researchers who compile and interpret clinical trial data on statins. Their funding comes primarily from government sources and foundations. The individual trials the CTT evaluates were largely funded by the pharmaceutical industry.

> "The reality is there is more we don't know than we do know."
>
> JAMES WRIGHT

Since in science no one study is a final answer, CTT gathers data from numerous clinical trials and feeds them into a meta-analysis — a calculation that combines data from different studies to come up with a wide-angle view. Scientists also obtain results by using systematic reviews, which compare the bottom line of different studies to determine where the true impact probably lies. Done well, these methods of blending data can provide a result with strong statistical power, finding an effect that might be missed in a single study.

But they are only as good as the studies that go into them. Depending on which studies are included (or excluded) and how they are analyzed, compilations can distort results or amplify biases and weaknesses in the research.

The CTT published its first meta-analysis of 14 clinical trials for secondary prevention in 2005, concluding that for every 39-point drop in LDL cholesterol (roughly equivalent to 1 millimole per liter of blood) among people who took a statin, the odds of a heart attack or stroke dropped by 21 percent, and mortality from coronary artery disease fell by 19 percent. More CTT-authored publications have appeared in the decade since, including analyses that extend the benefit to stroke prevention. Most recently, Collins and more than two dozen collaborators authored a 30-page review in *Lancet* last November, bolstered by more than 300 references. That analysis of published large randomized trials calculated that each 77-point drop in LDL

J. HIRSHFELD

cholesterol (a 2 millimole per liter drop) reduced the risk of a major cardiovascular event — heart attack, stroke or the need for a coronary-clearing procedure — by 45 percent. Those kinds of LDL drops are realistic, at least in the short term. A 2015 review of studies of the widely prescribed drug atorvastatin found LDL reductions averaging 64 to 90 points in studies of three to 12 weeks, depending on the dose of drug used.

The degree of benefit depends on whether you've already had a heart attack or stroke. The CTT researchers calculated the number of patients who need to be treated to benefit one person. They estimated that if 10,000 people with heart disease lowered their LDL cholesterol by 77 points, 1,000 of them would be spared a second major event over the next five years. If 10,000 seemingly healthy people lowered their LDL by the same amount, an estimated 500 of them would be spared.

Insurance policy

What about those 9,500 healthy people who gained nothing from taking the drug those five years? The reality is, there is no way to sort them out ahead of time. Collins likens it to buying insurance. Everyone pays with the understanding that no one knows who is going to have an accident. If it's your car, though, that policy can be a lifesaver.

"In insurance, you don't know which people are benefiting," he says, you just know that some people will. "The important thing is, there are heart attacks and strokes that are being prevented." Also, he says, data suggest that the benefits continue to accumulate. If 500 people are spared a heart attack or stroke over five years, "over 10 years the number would double," Collins says.

So the bottom line, according to the CTT estimates, is that for 5 percent of healthy people taking a statin, the drug means the difference between life and death, health or disability. And in return, the other 95 percent aren't putting themselves at much risk for dangerous side effects.

Wright, of the University of British Columbia, remains unconvinced. He thinks that the numbers in the *Lancet* review go far beyond what the data show. The CTT numbers, he says, are based on extrapolations of cholesterol reductions greater than those achieved in reality. In a response to the *Lancet* review published in March, he and colleagues noted that the average cholesterol reductions actually achieved among lower risk groups in the trials were far below the 77 points that formed the basis for the conclusions.

Wright's research group has performed its own analysis of primary prevention, published in 2010. In that calculation, the number of people who would avoid a cardiovascular event is not 5 percent, as the review in *Lancet* estimated, but somewhere between 1 and 2 percent — which means only 100 or at most 200 of every 10,000 healthy people taking a statin would benefit.

Even considering the seriousness of nonfatal heart disease, the ultimate test is not whether statins keep a person from an angioplasty or even heart attack, but whether the drugs save lives. Studies of primary prevention, because they start with healthy populations, have a much higher hurdle to show a reduction in mortality. Over the typical length of a major clinical trial, the overall risk of death is low to begin with.

Still, Collins points to evidence that lives are saved. In 2012 in *Lancet*, a CTT meta-analysis of 27 randomized trials found that even among people with no previous vascular disease, those who had a 39-point decrease in LDL had a 9 percent lower overall mortality risk over about five years.

But there's another way to look at those data: a straight-up comparison of low-risk volunteers who take the drug with those taking a placebo. Following the *Lancet* publication in 2012, Wright and colleagues recalculated the numbers and did not find a mortality benefit among people who had less than a 20 percent chance of having a heart attack in the next five years, based on established prediction measures.

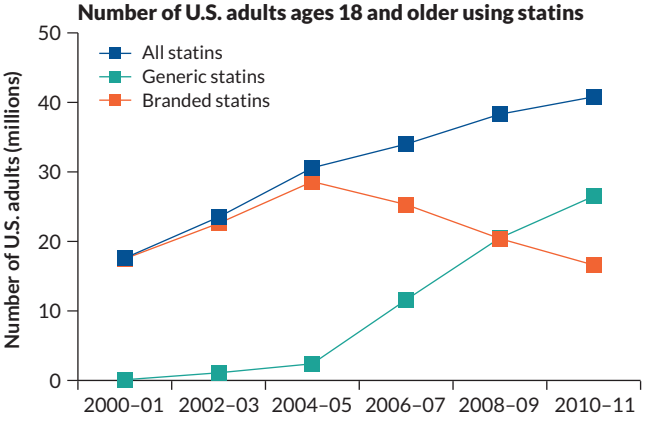
After that analysis appeared in *BMJ* in 2013, Collins demanded a retraction, but two independent statistical reviews concluded that the paper did not meet any criteria for withdrawal.

Downsides debated

Mortality is not even the most contentious issue in the statin wars. That prize goes to the question of harm: How much might healthy people — the ones who weren't going to have a heart attack or stroke anyway — be hurt by the drug. To Collins and other CTT leaders, side effects, especially serious ones, are rare and clear up when people stop taking the drug. To others, the story is not that simple.

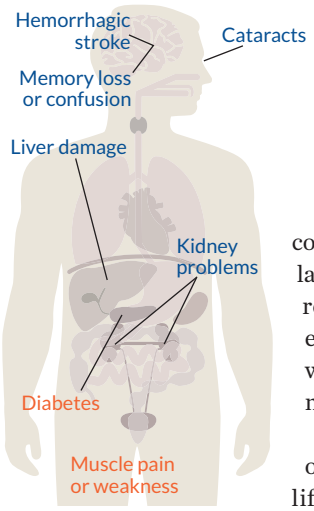
Critics talk mostly about effects on muscles, particularly pain and weakness. One early statin called Baycol was withdrawn from the market in 2001 after it was linked to 52 deaths from a breakdown of muscle tissue. Studies following the scandal suggested that statins might impede protection from oxidative stress or alter other chemical reactions in muscle cells.

It's important to note that randomized studies haven't found side effects even remotely as prevalent as critics



On the rise Since their introduction in 1987, statins are among the best-selling drugs in pharmaceutical history. By 2011, they were prescribed to more than 40 million Americans 18 and older. SOURCE: AHRQ

J. HIRSHFELD



Bad with the good Statins carry the risk of side effects. Statin advocates say such effects are rare, and only diabetes and muscle pain have been confirmed.
Side effects, confirmed
Side effects, unconfirmed

contend. Back to that theoretical population of 10,000 in the November *Lancet* review, only five people would experience muscle problems, and just one would have a serious breakdown of muscle tissue.

And even those small numbers might overestimate what occurs in everyday life, says Richard Hobbs, head of the department of primary care health sciences at the University of Oxford, who defended statins last year in *BMC Medicine*. He points out that clinical trial volunteers are regularly quizzed about possible side effects — and says that asking the question may plant the suggestion in their minds. "The trials, because they are searching for adverse effects, may overstate them," he says.

The reason for the stark difference in opinion over side effects comes down to how much weight is given to patients who were not included, or not counted, in meta-analyses, says Rita Redberg, a cardiologist at the University of California, San Francisco and a prominent voice of concern over statins. In some trials, she says, people who complained of side effects beforehand were not allowed to participate, dropped out before the studies were completed or were not counted because the criteria for being put in the side effects category were so narrowly defined.

To qualify as having muscle weakness in the CTT studies, a person had to not only feel muscle aches, but also have elevated levels of a certain enzyme (a criterion Collins says is necessary to show the drug caused the effect). Redberg also worries that there are still problems that might be undetected because no one is looking for them, diabetes being a case in point. A link between diabetes and statins wasn't discovered until a 2008 analysis of almost 18,000 people published in the *New England Journal of Medicine*, which found that 216 people taking a placebo developed type 2 diabetes while 270 taking a statin did.

Redberg says observational data — which follow real-world patients on statin therapy — report side effect risks much higher than those in the CTT analyses. In one routine-care study, reported in 2013 in *Annals of Internal Medicine*, 8 percent of patients stopped taking statins because of side effects. One study from an international team of researchers, published in *JAMA* in 2016, found that among people who previously complained of problems with taking statins, 43 percent developed muscle pain after taking the drug in the study, atorvastatin, compared with 27 percent who took a dummy pill.

"I can tell you side effects are quite common," Redberg says. "Among my patients, the most common are muscle problems, also malaise, fatigue, feeling in a fog."

Redberg and others have also criticized the CTT for not releasing the raw data of clinical trials, which would allow other independent researchers to mine the data for adverse reactions. When asked about this, Collins counters: "It's not our data." The results that have informed CTT calculations were provided with the understanding that the numbers belonged to the original investigators. And, he says, the CTT doesn't have data on side effects beyond what has been reported.

In the end, the potential risk that any patient is willing to take may hinge on how much danger they are in to start with. Guidelines released in 2013 by the American Heart Association and the American College of Cardiology say that people between the ages of 40 and 75 should take a statin if their risk of cardiovascular disease is 7.5 percent or higher over the next 10 years. In the United States, that makes an estimated 78 million adults eligible for statin prescriptions. European guidelines set a higher threshold: between 10 and 20 percent risk over the next 10 years. The U.S. Preventive Services Task Force updated its recommendations in November, saying adults should consider statins if they have one or more major risk factors for heart disease.

Sussman, of Michigan, refers to one of several online calculators that can help determine what that risk number is for any particular person. These kinds of tools take into account each person's unique set of circumstances. In one online tool, a sedentary 60-year-old white male with a weight of 250 pounds, a total cholesterol of 225, no high blood pressure and no personal or family history of heart disease might have a 9 percent risk of having a heart attack in the next 10 years. A 60-year-old African-American woman with diabetes but all other parameters the same would have a 13 percent risk.

The guiding principle Sussman tells his patients is that the lower your risk of disease in the first place, the less you have to gain from statins. Patients also have to factor in their own sense of how much they fear a heart attack or stroke — all the while knowing there are other means of prevention with almost no risk that can get lost in the statin debate, including weight loss, exercise and a better diet. That theoretical 60-year-old man with a 9 percent risk could drop his risk to about 5 percent with 20 minutes of moderate activity each day and better eating habits.

"You say to a patient, 'Here's a pill, and the odds of benefit are small, but you'll have to take it the rest of your life,'" says Sussman. Over the coming decades, the drug may cause you problems you never would have had. But one of the people who hits the jackpot — and dodges a devastating heart attack or stroke — might be you. "That's a hard choice." ■

Explore more

■ Roger Chou *et al.* "Statins for prevention of cardiovascular disease in adults: Evidence report and systematic review for the U.S. Preventive Services Task Force." *JAMA*. November 16, 2016.

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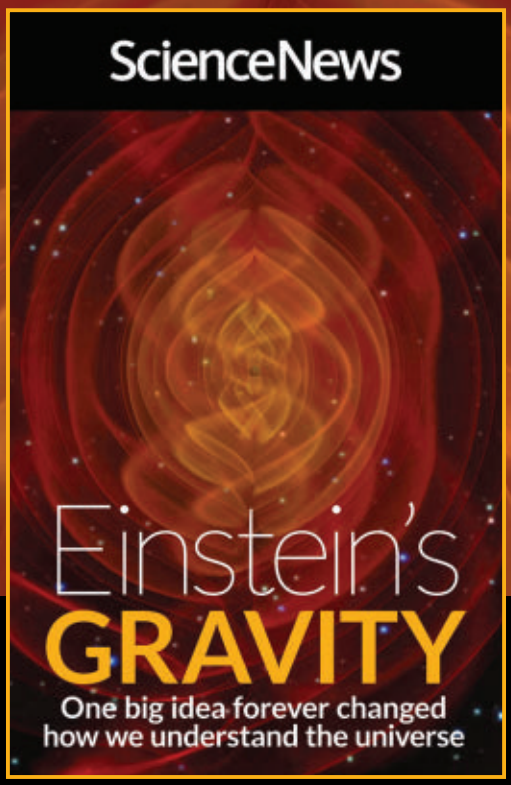
Einstein's BIG IDEA



Albert Einstein reinvented gravity.
Gravity has reinvented the cosmos.

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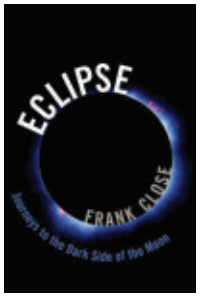
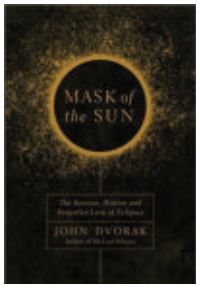
ScienceNews

In the Shadow of the Moon
Anthony Aveni
YALE UNIV., $28



Eclipse
Frank Close
OXFORD UNIV., $21.95



Mask of the Sun
John Dvorak
PEGASUS BOOKS, $27.95

BOOKSHELF

Science of solar eclipses continues to amaze

In August, the United States will experience its first coast-to-coast total solar eclipse in nearly a century. Over the course of an hour and a half, the moon's narrow shadow will slice across 12 states, from Oregon to South Carolina (*SN: 8/20/16, p. 14*). As many as 200 million people are expected to travel to spots where they can view the spectacle, in what could become one of the most watched eclipses in history. Excitement is building, hence the flurry of new books about the science, history and cultural significance of what is arguably one of Earth's most awesome celestial phenomena.

Total solar eclipses happen when the moon passes in front of the sun as seen from Earth, and the moon blocks the entire face of the sun. This event also blocks sunlight that would otherwise scatter off the molecules in our atmosphere, reducing a source of glare and so allowing an unfettered view of the sun's outer atmosphere, or corona. Total solar eclipses arise from a fluke of geometry that occurs nowhere else in the solar system, astronomer Anthony Aveni explains in *In the Shadow of the Moon*. Only Earth has a moon that appears, from the planet's viewpoint, to fit so neatly over the sun — a consequence of the fact that the sun is a whopping 400 times as large as the moon but also 400 times farther away. Moons orbiting other planets are either too small to fully cover the sun's face or are so large that they fully block any view of the corona.

Total solar eclipses arise from a fluke of geometry that occurs nowhere else in the solar system.

In fact, the fluke of geometry is also a fluke of history: Because the moon's orbit drifts about four centimeters farther from Earth each year, there will come a time when the moon will no longer appear to cover the sun, notes planetary scientist John Dvorak in *Mask of the Sun*. We already get a preview of that distant day: When the moon passes in front of the sun during the most distant portions of its orbit (and thus appears its smallest), Earth is treated to a ring, or annular, eclipse.

In the Shadow of the Moon, *Mask of the Sun* and physicist Frank Close's *Eclipse* all do a good job of explaining the science behind total solar eclipses. That includes clarifying why one is seen somewhere on Earth once every 18 months or so, on average, instead of every time the moon crosses paths with the sun during the new moon. In short, it's because the moon's orbit is slightly tilted compared with Earth's orbit around the sun, making the moon pass either above or below the sun during most new moons.

Many solar eclipses are preceded by a lunar eclipse about two weeks earlier — a coincidence that may have helped ancient astrologers "predict" an eclipse, Close writes. Additional observations, Dvorak notes, may have helped these nascent astronomers notice the long-term pattern in solar eclipses with similar paths, which tend to recur roughly every 18 years. While ancient Babylonians could predict the onset of a solar eclipse within a few hours — and ancient Greeks to within about 30 minutes — today's astronomers can pin down eclipses to within a second.

That precision has fueled the craze of "eclipse chasing," in which scientists and nonscientists alike trek to often remote regions to gather data or to simply experience the brief darkness — rarely more than seven minutes, and sometimes less than one second — of totality. In 1925, scientists chased an eclipse with an airship; in 1973, they did so at supersonic speed in a Concorde. All three books describe in detail various historical expeditions to view eclipses, everywhere from New York's Central Park to exotic hot spots such as the South Pacific and Pike's Peak in Colorado (which was pretty remote and exotic in 1878).

Each book shares many of the same anecdotes and recounts many of the same scientific breakthroughs that resulted from eclipse research. Both *In the Shadow of the Moon* and *Mask of the Sun* take readers on a largely chronological path through eclipse history. But their organizations differ slightly: The science of eclipses is deftly scattered throughout *Mask of the Sun*, while *In the Shadow of the Moon* addresses various scientific topics in wonderfully thorough chapters of their own.

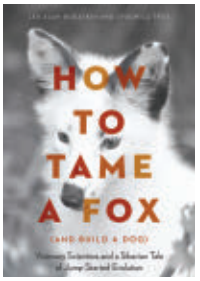
Of this trio of books, *Eclipse* — more a memoir of Close's lifetime fascination and personal experiences with eclipses than a detailed chronicle of historical lore — provides the most amusing and insightful descriptions of eclipse chasers. They are, Close writes, "an international cult whose members worship the death and rebirth of the sun at moveable Meccas, about half a dozen times every decade."

A teacher kindled Close's love of eclipses in 1954 when Close was an 8-year-old living north of London. He reached his 50s before experiencing a total eclipse (1999 in extreme southwestern England), but since then has seen a handful more, including from a cruise ship southwest of Tahiti and a safari camp in Zambia.

Who knows how many budding young scientists the Great American Eclipse of 2017 — or these books — will inspire.
— *Sid Perkins*

BOOKSHELF

Scientists try to replay domestication



How to Tame a Fox (and Build a Dog)
Lee Alan Dugatkin and Lyudmila Trut
UNIV. OF CHICAGO, $26

In 1959, Lyudmila Trut rode trains through Siberia to visit fox farms. She wasn't looking for furs. She needed a farm to host an audacious experiment dreamed up by geneticist Dmitry Belyaev: to create a domestic animal as docile as a dog from aggressive, wily silver foxes.

Evolutionary biologist Lee Alan Dugatkin helps Trut recount this ongoing attempt to replay domestication in *How to Tame a Fox*. The mechanics of domestication are still a matter of intense scientific debate. Belyaev's idea was that ancient humans picked wolves and other animals for docility and that this artificial selection jump-started an evolutionary path toward domestication.

Back in the 1950s, testing the idea was dangerous work, and not just because untamed foxes bite. In 1948, the Soviet Union, under the scientific leadership of Trofim Lysenko, outlawed genetics research. Lysenko had risen to power based on fabricated claims that freezing seeds in water could increase crop yields. "With Stalin as his ally, he launched a crusade to discredit work in genetics, in part, because proof of the genetic theory of evolution would expose him as a fraud," Dugatkin and Trut write. Geneticists often lost their jobs, were jailed or even killed, as was Belyaev's own brother. So Belyaev cloaked his domestication experiments in the guise of improving the fur-farming business.

Fox researchers started by testing the temperament of about 100 silver foxes each year. About a dozen of the foxes, slightly calmer than most, were bred annually. Within a few generations, some foxes were a bit more accepting of people than the starting population. That small difference convinced Belyaev of the experiment's promise, and he recruited Trut to carry out a larger breeding program.

After choosing a farm, in 1960, Trut brought a dozen calm foxes from the preliminary project, including two that would let her pick them up. She also chose the calmest 10 percent of the foxes at the new farm for breeding, both to increase the number of animals and to increase genetic diversity. Eventually, she began breeding aggressive foxes as a comparison group for the tame ones.

Trut and Dugatkin lovingly recount some of the experiment's milestones, including the first fox born with a wagging tail and the first one with droopy ears — two hallmarks of domesticated animals. Trut recalls the foxes she's lived with and, heartbreakingly, the ones she lost, or had to sacrifice to keep the experiment going after the collapse of the Russian economy in 1998 led to funding problems. At every step, the authors skillfully weave the science of domestication into the narrative of foxes becoming ever-more doglike.

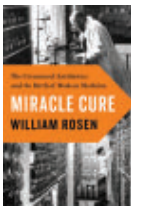
Lyudmila Trut has been working for almost 60 years to domesticate silver foxes. Trut is shown with one of the foxes.

VASILY KOVALY

Trut has kept Belyaev's dream alive for nearly 60 years. Now in her 80s, she still runs the experiment and has eagerly collaborated with others to squeeze every drop of knowledge from the project. The work has shown that selecting for tameness alone can also produce a whole suite of other changes (curly tails, droopy ears, spotted coats, juvenile facial features) dubbed the domestication syndrome. With the help of geneticist Anna Kukekova, Trut is searching for the genes involved in this process.

The project now sells some of the foxes as pets to raise money, although one could argue they aren't fully domesticated. The foxes may wag their tails and flop on their backs to get their bellies rubbed, but Trut says they still don't follow commands like dogs do. It probably took Stone Age humans hundreds or thousands of years to domesticate wolves. The silver fox experiment has replayed the process in fast-forward. It may speed scientists' quest to understand the DNA changes that transformed a wolf into a dog.
— *Tina Hesman Saey*

BOOKSHELF



Miracle Cure
William Rosen
In retelling the story of the discovery and invention of antibiotics, this book also traces the rise of the modern pharmaceutical industry. *Viking, $28*

The Paper Zoo
Charlotte Sleigh
A science historian gathers 500 years' worth of beautiful natural history illustrations to explore the relationship between art and science. *Univ. of Chicago, $45*

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Auto-focus eyeglasses rely on liquid lenses

University of Utah graduate student Nazmul Hasan is the first to admit that the glasses he helped design may not look cool. But what these prototypes lack in style, they make up for in smart design. An app will download one's eyeglass prescription to the frames. From then on, the specs will focus on whatever the wearer looks at, such as a phone text. The frames send out light pulses that bounce off surfaces in front of them to calculate the distance. Tiny motors then bend the lenses, made of liquid glycerin, as much as the prescription calls for. Voila! The text will come into focus. — *Stephen Ornes*

Read more: www.sciencenewsforstudents.org/article/auto-focus-eyeglasses-rely-liquid-lenses

Concerns explode over new teen risks from vaping

Students as young as 12 or 13 are now more likely to vape than smoke. Many assume that because e-cigarettes contain no tobacco, they pose little risk. Yet recent data show their vapors mess with wound healing. "Smoker's cough" and bloody sores have been showing up in teens who vape. A new vaping behavior — dripping — threatens to intensify a teen's risks. And data now suggest e-cigarette vapors can contain cancer-causing chemicals. Concludes Yale University's Suchitra Krishnan-Sarin, adolescents ignore such risks at their peril. — *Lindsey Konkel*

Read more: www.sciencenewsforstudents.org/article/concerns-explode-over-health-risks-vaping

Cool Jobs: Reaching out to E.T. is a numbers game

Searching for aliens may sound like science fiction. Yet for many scientists, it has become serious business. In the second of a three-part series, we meet three researchers using math in their quest to find other living beings in our universe. One is calculating the likelihood of finding life on other planets. Another is trying to figure out where best to beam a "hello" to E.T. The third is looking for a common language with extraterrestrials — and it will probably be numbers. — *Ilima Loomis*

Read more: www.sciencenewsforstudents.org/article/cool-jobs-reaching-out-et-numbers-game

CLOCKWISE FROM TOP: DAN HIXSON/UNIVERSITY OF UTAH COLLEGE OF ENGINEERING; CHAOWALIT466/ISTOCKPHOTO; ALIEN: LENA_GRAPHICS/ISTOCKPHOTO, NUMBERS: VALERYBROZHINSKY/ISTOCKPHOTO, COMPOSITE BY L. STEENBLIK HWANG

APRIL 1, 2017

Have a cow

Camera traps captured a badger burying an entire cow by itself, a group of researchers reported in the journal *Western North American Naturalist*. It is the first time scientists have documented American badgers squirreling away animals so much larger than themselves, **Sarah Zielinski** wrote in "Camera trap catches a badger burying a cow" (*SN Online: 3/31/17*) for the *Wild Things* blog. "Maybe he likes ground beef," reader **Bruce Baker** commented on Facebook. Watch the video at bit.ly/SN_badger

COURTESY OF EVAN BUECHLEY

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Sugarcoated

A new wave of potential immune therapies aims to target the network of complex sugars that coat cancer cells, ***Esther Landhuis*** *reported in "Cancer's sweet cloak"* (SN: 4/1/17, p. 24)*. Some of these sugars, called sialic acids, help tumors hide from the immune system.*

"Are the offending sugars referred to in this article the ones we are eating or are they the result of metabolizing other carbs that we eat?" **Gene Yagla** asked.

Cancer cells don't build their disguises from the sugars and carbohydrates that we eat, says **Ajit Varki**, a glycobiologist at the University of California, San Diego. In general, cells make all of the components they need for their sugary coatings themselves.

However, **Varki** notes that one dietary sugar may be linked to cancer. N-glycolylneuraminic acid, a sugar found in red meat, causes an immune response when cells absorb it, he and colleagues reported in *Molecular Aspects of Medicine* in 2016. "This phenomenon is one likely explanation for the human-specific negative impact of excessive red meat intake and its association with cancer, atherosclerosis and other inflammatory processes," **Varki** says.

Digital dependence

A slew of recent studies hint that near-constant interactions with digital technology may change how people's brains remember, navigate and create happiness, ***Laura Sanders*** *reported in "Digital minds"* (SN: 4/1/17, p. 18)*. In one small study of 104 college students, more than half unlocked their phones an average of 60 times a day and spent upward of 3½ hours on the devices.*

"If people are looking at their smart devices 60 times a day, there must be some feedback mechanism causing this behavior. Is there any research exploring the internal reward process to determine what part of the brain is affected?" **Leonard Bohlman** asked. Maybe smartphones stimulate pleasure centers in people's brains the same way food, sex and social interactions do, he wondered.

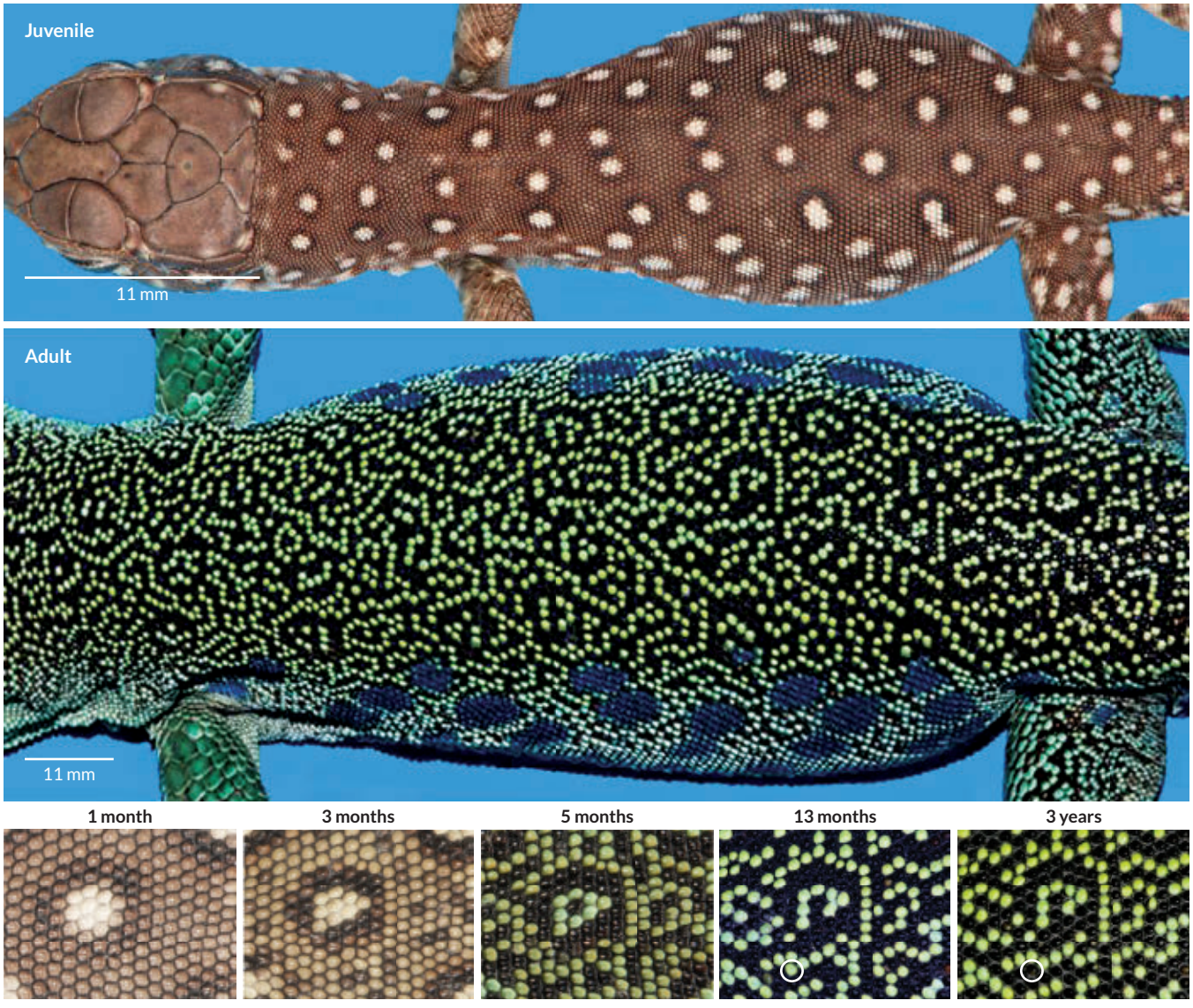
Explanations for the allure of smartphones abound. "I heard about an interesting idea from neurologist Adam Gazzaley of the University of California, San Francisco, who describes humans as 'information foragers,'" **Sanders** says. "He argues that the same neural circuits that drove our ancient ancestors to find food have morphed into human brains that push us to relentlessly seek information. That powerful need might help explain why so many of us feel compelled to peek at our digital devices," she says.

Correction

A study published September 2 in *Science* suggested that dog brains comprehend speech in a similar way to human brains. Researchers found that dogs' left hemispheres process meaningful words while right hemispheres process tone, **Laurel Hamers** wrote in "Dog brains divide language tasks" (*SN: 10/1/16, p. 11*).

But when results from the functional MRI scans of dogs' brains were reported in *Science*, left and right hemispheres were accidentally reversed in all images, the researchers wrote in a correction published April 7 in the journal.

While the brain hemispheres dogs use to process meaning and intonation don't match what's seen in most humans, as was originally suggested, lead author **Attila Andics** says the more important finding still stands: Dogs' brains process different aspects of human speech in different hemispheres.



How lizards are like computer programs

A lizard's intricately patterned skin follows rules like those used by a simple type of computer program.

As the ocellated lizard (*Timon lepidus*) grows, it transforms from a drab, polka-dotted youngster to an emerald-flecked adult. Its scales first morph from white and brown to green and black (series, bottom row). Then, as the animal ages, individual scales flip from black to green, or vice versa (circles).

Biophysicist Michel Milinkovitch of the University of Geneva realized that the scales weren't changing their colors by chance. "You have chains of green and chains of black, and they form this labyrinthine pattern that very clearly is not random," he says. That intricate ornamentation, he and colleagues report April 13 in *Nature*, can be explained by a cellular automaton, a concept developed by mathematicians in the 1940s and '50s to simulate diverse complex systems.

A cellular automaton is composed of a grid of colored pixels. Using a set of rules, each pixel has a chance of switching its shade, based on the colors of surrounding pixels. By comparing photos of *T. lepidus* at different ages, the scientists showed that its scales obey such rules.

In the adult lizard, if a black scale is surrounded by other black scales, it is more likely to switch than a black one bounded by green, the researchers found. Eventually, the lizards' scales settle down into a mostly stable state. Black scales wind up with around three green neighbors, and green scales have around four black ones. The researchers propose that interacting pigment cells could explain the color flips.

Computer scientists use cellular automata to simulate the real world, re-creating the turbulent motions of fluids or nerve cell activity in the brain, for example. But the new study is the first time the process has been seen with the naked eye in a real-life animal. — *Emily Conover*

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Watch a video of a lizard's color-changing scales at **bit.ly/SN_Scales**

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