

SN

SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC

NOVEMBER 10, 2018

Europa's
Icy
Spikes

Mouse
Pups With
Two Dads

Monkey
Malaria in
Humans

Electrons
Are Very
Round



FEAR Factor

Virtual reality helps people
attack the panic

“WE’RE MAKERS.”



NOTHING’S EVER REALLY FINISHED.”

We’ve got to get that last bit of performance. We’ve got make it better—no matter how good it is. Like the electric skateboard I built. It took a while to figure out how to get all the pieces to fit and make it work. But that’s not the end—it’s just the beginning.

It’s #howinerd. How do you? Take a photo, share it using #howinerd, and tag Rose-Hulman—we’re your nerd friend for life!

ROSE-HULMAN
INSTITUTE OF TECHNOLOGY



Makers
Gonna Make!

rose-hulman.edu/MakerLab

ScienceNews



Features

16 Erasing Fear

COVER STORY Confronting phobias, post-traumatic stress and other mental disorders may become possible for more people as virtual reality therapy goes mainstream. *By Maria Temming*

22 The Next Malaria Menace

People pick up malaria from mosquitoes. But in Southeast Asia, more of those biters are transmitting the parasites from monkeys to people. *By Yao-Hua Law*

News

6 Genetic engineers achieve the impossible: making a mouse with two dads

7 Round electrons are bad news for physicists trying to break the standard model

For the first time, astronomers spot a stripped-down supernova

8 Blades of ice could make landing on Jupiter's moon Europa a dicey proposition

Hundreds of tainted dietary supplements are sold in the United States

9 Burying beetles use gut microbes to transform a dead mouse into a not-so-smelly nursery

10 Several genetic variants are linked to sexual orientation in a large study

11 Brain's memory center slices life up into moments

Climate change contributed to the downfall of the medieval city of Angkor

12 World's earliest known fossils may not be fossils after all

13 Early bird fossil may contain traces of lungs

Tyrannosaurus rex had a bone-crushing bite force

14 News in Brief

Hurricane Michael's strength explained

How bees react to a total solar eclipse

"Vampire burial" found in an ancient Roman cemetery

Good navigators have good noses



Departments

2 EDITOR'S NOTE

4 NOTEBOOK

Bats hover on mighty wings; shrimp could teach self-driving cars to see

28 REVIEWS & PREVIEWS

Your house is teeming with life; Earth's atmosphere has stories to tell

30 FEEDBACK

32 SCIENCE VISUALIZED

Embryo images track development's progress

SOCIETY UPDATE

Teachers attend STEM research conference

COVER Virtual reality therapy may soon be available for home use to calm fears about tarantulas and even public places. *pets in frames/Shutterstock*





Screen time to heal, and perhaps to harm

In any given year, nearly 20 percent of U.S. adults, more than 40 million people, have to contend with a mental illness. Getting treatment is often a struggle; fewer than half of those affected get any sort of care, which can be especially hard to find in rural and underserved communities.

Virtual reality may seem like the least likely technology to address the lack of mental health care. But researchers are building the case for VR as a way to help people with diagnoses including phobias, anxiety, post-traumatic stress disorder and schizophrenia.

The VR approach employs a treatment called exposure therapy, in which people learn bit by bit to tolerate situations that they fear. In this issue (Page 16), technology writer Maria Temming explains how simpler, less expensive systems are making VR more accessible, to the point where people might be able to use them on their own, with only a virtual therapist as a guide.

This may sound like just the latest overhyped application for VR. But during an art meeting at *Science News*, as we watched a simulated stroll on an elevated catwalk that is used in therapy to help people contend with fear of heights, my stomach did a flip. And I'm not afraid of heights. Indeed, these faux experiences can spark real fears (*SN*: 8/4/18, p. 15).

These experiments in virtual therapy seem to inhabit a more benign corner of the larger question of what immersing ourselves for hours a day in the alternate realities of smartphones and tablets is doing to our brains. As neuroscience writer Laura Sanders has reported, not so long ago, the internet was a stationary experience, housed in a bulky computer in the office or in a corner of the family room. Now screens go where we go, and we adjust our behavior to suit them. "Portable technology has overhauled our driving habits, our dating styles and even our posture," Sanders writes (*SN*: 4/1/17, p. 18).

Spending hours a day entwined with technology is changing our brains, scientists say. I'm logging about 3.3 hours a day on just my phone, according to the iPhone's new Screen Time feature. But I like to tell myself that much of that time is being used to check work e-mail, not browsing Spotify playlists.

At least I'm doing a wee bit better than the typical U.S. kid, who spends 3.6 hours a day on average staring at screens for recreational use, according to a study published in September (*SN*: 10/27/18, p. 12). Most of the children blew past pediatricians' recommendations that children log no more than two hours a day of screen time. Many of these kids were also missing out on the recommended amounts of sleep and exercise. Those children fared worse on cognitive tests than those who led more balanced lives.

Of course, as Sanders points out, nearly everything we do changes the brain. Previous technologies, from electricity to airplanes to televisions, have had deep impacts on how we live. But this feels different. And it's too early to have evidence on how we'll ultimately fare.

Stay with us as we continue to follow developments in the nascent science of screen time, whether you're reading *Science News* on your phone, tablet or that time-tested technology, a printed magazine. — *Nancy Shute, Editor in Chief*

Society for Science & the Public is a 501(c)(3) nonprofit membership organization founded in 1921. The Society seeks to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire. Learn more at societyforscience.org. Copyright © 2018 by Society for Science & the Public. Title registered as trademark U.S. and Canadian Patent Offices. Reproduction of any portion of *Science News* without written permission of the publisher is prohibited. For permission to photocopy articles, contact permissions@sciencenews.org. Sponsor content and advertising appearing in this publication do not constitute endorsement of its content by *Science News* or the Society.

PUBLISHER Maya Ajmera
EDITOR IN CHIEF Nancy Shute

EDITORIAL

EDITOR, SPECIAL PROJECTS Elizabeth Quill
NEWS DIRECTOR Macon Morehouse
DIGITAL DIRECTOR Kate Travis
FEATURES EDITOR Cori Vanchieri
MANAGING EDITOR, MAGAZINE Erin Wayman
DEPUTY NEWS EDITOR Katy Daigle
ASSOCIATE EDITORS Emily DeMarco, Cassie Martin
ASSOCIATE DIGITAL EDITOR Helen Thompson
AUDIENCE ENGAGEMENT EDITOR Mike Denison
ASTRONOMY Lisa Grossman
BEHAVIORAL SCIENCES Bruce Bower
BIOMEDICAL Aimee Cunningham
EARTH AND CLIMATE Carolyn Gramling
LIFE SCIENCES Susan Milius
MOLECULAR BIOLOGY, SENIOR WRITER Tina Hesman Saey
NEUROSCIENCE Laura Sanders
PHYSICS Emily Conover
TECHNOLOGY Maria Temming
STAFF WRITER Laurel Hamers
EDITORIAL ASSISTANT Kyle Plantz
SCIENCE WRITER INTERN Jennifer Leman
CONTRIBUTING CORRESPONDENTS
Laura Beil, Tom Siegfried, Alexandra Witze

DESIGN

CHIEF DESIGN OFFICER Stephen Egts
DESIGN DIRECTOR Erin Otwell
ASSISTANT ART DIRECTORS Chang Won Chang, Tracee Tibbitts

SCIENCE NEWS FOR STUDENTS

EDITOR Janet Raloff
MANAGING EDITOR Sarah Zielinski
STAFF WRITER Bethany Brookshire
WEB PRODUCER Lillian Steenblik Hwang

SOCIETY FOR SCIENCE & THE PUBLIC

PRESIDENT AND CEO Maya Ajmera
CHIEF OF STAFF Rachel Goldman Alper
CHIEF MARKETING OFFICER Kathleen Collins
CHIEF PROGRAM OFFICER Michele Glidden
CHIEF, EVENTS AND OPERATIONS Cait Goldberg
CHIEF COMMUNICATIONS OFFICER Gayle Kansagor
CHIEF ADVANCEMENT OFFICER Bruce B. Makous
CHIEF TECHNOLOGY OFFICER James C. Moore
CHIEF FINANCIAL OFFICER Dan Reznikov

BOARD OF TRUSTEES

CHAIRMAN H. Robert Horvitz
VICE CHAIR Alan Leshner **SECRETARY** Paul J. Maddon
TREASURER Robert W. Shaw, Jr. **AT LARGE** Mary Sue Coleman
MEMBERS Hayley Bay Barna, Craig R. Barrett, Christine Burton, Martin Chalfie, Tessa M. Hill, Tom Leighton, Stephanie Pace Marshall, Scott A. McGregor, Joe Palca, Feng Zhang, Maya Ajmera, *ex officio*

ADVERTISING AND SUBSCRIBER SERVICES

ADVERTISING Daryl Anderson
SCIENCE NEWS IN HIGH SCHOOLS Anna Rhymes
PERMISSIONS Maxine David

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

Subscriber services:

E-mail subscriptions@sciencenews.org

Phone (800) 552-4412 in the U.S. or
(937) 610-0240 outside of the U.S.

Web www.sciencenews.org/join

For renewals, www.sciencenews.org/renew

Mail *Science News*, PO Box 292255, Kettering, OH 45429-0255

Editorial/Letters: editors@sciencenews.org

Science News in High Schools: snhs@societyforscience.org

Advertising/Sponsor content: ads@societyforscience.org

Science News (ISSN 0036-8423) is published biweekly except twice in September and monthly in January and April by the Society for Science and the Public, 1719 N Street, NW, Washington, DC 20036.

Print, online and tablet access: Activate your subscribing member account, including digital access, at www.sciencenews.org/activate. Subscribing memberships include 23 issues of *Science News* and are available for \$50 for one year (international rate of \$68 includes extra shipping charge). Single copies are \$3.99 (plus \$1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

Postmaster: Send address changes to *Science News*, PO Box 292255, Kettering, OH 45429-0255. Two to six weeks' notice is required. Old and new addresses, including zip codes, must be provided.



Storms?
Power outages?
Downed Wifi?
Not a problem.

Meteors?
Hard to say.

Home security is only as good as what it can handle. And SimpliSafe can handle a whole lot. With built-in backups. And backups for those backups. It protects your home through whatever mother nature or an intruder have in store. All with no contract or hidden fees. Try it out.

SimpliSafe™

Get SimpliSafe's exclusive holiday offer
at [SimpliSafe.com/pop](https://www.simplisafe.com/pop)

ADVERTISEMENT



Excerpt from the November 9, 1968 issue of *Science News*

50 YEARS AGO

Sea otters restocked in old home

When the [Atomic Energy Commission] first cast its eye on the island of Amchitka as a possible site for the testing of underground nuclear explosions, howls of anguish went up; the island is part of the Aleutians National Wildlife Refuge, created to preserve the colonies of nesting birds and some 2,500 sea otters that live there....

UPDATE: The commission said underground nuclear testing would not harm the otters, but the fears of conservationists were well-founded: A test in 1971 killed more than 900 otters on the Aleutian island. Some otters remained around Amchitka, but 602 otters were relocated in 1965–1972 to Oregon, southeast Alaska, Washington and British Columbia — areas where hunting had wiped them out. All but the Oregon population thrived, and today more than 25,000 otters live near the coastal shores where once they were extinct. “They were sitting on the precipice,” says James Bodkin, who is a coastal ecologist at the U.S. Geological Survey. “It’s been a great conservation story.”



IT'S ALIVE

How nectar bats fly nowhere

A Pallas's long-tongued bat hovers while sipping nectar. Its skinny tongue is tipped with nectar-catching microfingers.

Flying forward is hard enough, but flying nowhere, just hovering, is so much harder. Most bats and birds can manage the feat for only a few frantic seconds.

Hovering means losing an aerodynamic shortcut, says aerospace engineer and biologist David Lentink. As a bat or bird flies forward, its body movement sends air flowing around the wings, which provides some cheap lift. For animals on the scale of bats and birds, that's a big help. Without that boost, “you're going to have to move all the air over your wings by moving it *with* your wings,” says Lentink, of Stanford University. The power that's needed to stay in place by flapping wings back and forth like a hummingbird “is gigantic.”

So how do nectar-sipping vertebrates, for whom a lot of energy-sucking hovering is part of life, manage? For the first direct measurements of the wingbeat forces that make hovering possible, Lentink's Ph.D. student Rivers Ingersoll spent three years creating a flight chamber with exquisitely responsive sensors in the floor and ceiling. As a bird or bat hovers inside, the sensors can accurately measure — every two-hundredths of a second — tremors even smaller than a nanometer caused by air from fluttering wings.

Once the delicate techno-marvel of an instrument was perfected, the researchers packed it into 11 shipping cases and sent it more than 6,000 kilometers to the wilds of Costa Rica.

“Very difficult,” Ingersoll says. The Las Cruces Biological Station is great for field biology, but it's nothing like a Stanford engineering lab. Every car turning into the station's driveway set off the wingbeat sensors. Even the thick-walled room that held the machine warmed up enough each day to give the instrument a fever.

Babying the instrument as best he could, Ingersoll made direct measurements for 17 hovering species of hummingbirds and three species of bats, including Pallas's long-tongued bats (*Glossophaga soricina*). “Their up-pointy noses made me think of rhino faces,” he says.

Pallas's bats specialize in nectar sipping much as hummingbirds do. Comparing wingbeats, bat vs. bird, revealed differences, though. Hummers coupled powerful downstrokes and recovery upstrokes that twist part of the wings almost backward. The twist supplied about a quarter of the energy it takes to keep a bird aloft, the researchers reported in the September *Science Advances*. The two kinds of nectar bats got a little more lift from the upstroke than did a bat that eats fruit instead of strenuously hovering for nectar. Yet even the specialist nectar bats relied mostly on downstrokes: powerful, deeply angled downstrokes of really big wings.

Those bat wings span proportionally more area than hummer wings. So the bats get about the same hovering power per gram of body weight that hummingbirds do. Supersizing can have its own kind of design elegance. — *Susan Milius*

A long-billed hermit hummingbird gets some help hovering by twisting its wings on the upstroke.



SCIENCE STATS

In the United States, almost 2 million adult nonsmokers vape

Of the 10.8 million U.S. adults who used e-cigarettes in 2016, about 1.9 million were never smokers to begin with, a study estimates.

E-cigarette companies market the devices, which heat and vaporize liquids that typically contain nicotine, as a way to help people quit smoking. But some public health officials worry that e-cigarettes could become a means to nicotine addiction, rather than an end.

This is of particular concern when it comes to young adults and adolescents, whose developing brains are especially vulnerable to addiction and health risks from nicotine exposure. Among those who only vape, 63 percent — about 1.2 million — were young adults ages 18 to 24, a team of U.S. researchers reports online October 9 in *Annals of Internal Medicine*.

1.9
million

E-cigarette users in the United States in 2016 who were never smokers

63
percent

Portion of sole e-cigarette users who were young adults, ages 18–24

The work “highlights the potential need to regulate sales and marketing of e-cigarettes to protect vulnerable populations,” the authors write.

The researchers analyzed 2016 data from the U.S. Centers for Disease Control and Prevention’s Behavioral Risk Factor Surveillance System. Among 261,541 adult nonsmokers, defined as having fewer than 100 cigarettes in a lifetime, 1.4 percent reported vaping. That corresponds to about 1.9 million nonsmokers who vape when extrapolated to the U.S. adult population.

— Aimee Cunningham



FUTUROLOGY

Climate change threatens beer

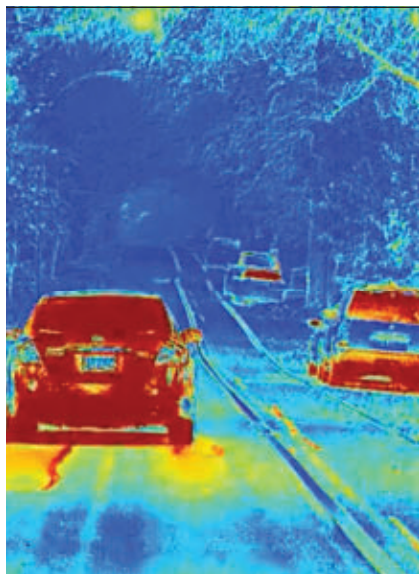
Beer lovers could be left with a sour taste, thanks to news from the latest study to map the effects of climate change on crops.

Barley, a key ingredient in beer, is particularly sensitive to temperature change and drought, both of which are likely to increase due to climate change. As a result, average global barley crop yields could drop as much as 17 percent by 2099, compared with the average yield from 1981 to 2010, under the more extreme climate change projections, researchers report October 15 in *Nature Plants*.

That decline “could lead to, on average, a doubling of [beer] price in some countries,” says coauthor Steven Davis, an Earth systems scientist at the University of California, Irvine. Beer consumption would also drop globally by an average of 16 percent, or about what people in the United States consumed in 2011.

The results are based on computer simulations projecting climate conditions, plant responses and global market reactions through 2099. Under the mildest climate change predictions, average barley yields would still go down by at least 3 percent, and average prices would rise some 15 percent, the study says.

Other crops such as maize, wheat, soy beans and wine grapes are also threatened by the global rise in average atmospheric temperatures as well as by pests emboldened by erratic weather (*SN: 4/1/17, p. 14*). There’s still hope for beer aficionados. The study did not account for technological innovations or genetic tweaks that could spare the crop, Davis says. — Jennifer Leman



TEASER

Self-driving cars see better with shrimp vision

A new type of camera inspired by the eyes of mantis shrimps could help self-driving cars better gauge their surroundings, researchers report in the Oct. 20 *Optica*. The camera — which detects polarized light, or light waves vibrating on a single plane (as seen at left) — has roughly half a million sensors that each capture light and dark spots within a single frame. That’s similar to how mantis shrimps see the world.

The researchers wanted to “mimic the animals’ ability to detect a wide range of light intensities” as the crustaceans move in and out of crevices in shallow waters, says electrical engineer Viktor Gruev of the University of Illinois at Urbana-Champaign. The range of light intensities a camera takes in is measured in decibels. Earlier polarization cameras operated within a 60-decibel range; the new one works in a 140-decibel range.

A variety of technologies help guide autonomous vehicles, including lidar (light detection and ranging equipment), GPS and digital cameras, but those cameras aren’t good at handling lighting transitions, and they have trouble in fog (*SN: 12/24/16, p. 34*). Gruev says the new cameras could cost as little as \$10. — Jennifer Leman

News

GENES & CELLS

Gene edits make mice with 2 dads

Motherless pups survived for only a few days after birth

BY TINA HESMAN SAEY

For the first time, scientists have created mice with two dads. No female contributed to the rodents' genetic makeup.

This unusual reproduction took place in a lab where researchers gathered stem cells from two males and used them to produce embryos that were implanted into surrogate mothers. The technique required scientists to edit the animals' genes so the mice could mature enough to be born. Even so, mouse pups with only fathers died a few days after birth, the researchers report online October 11 in *Cell Stem Cell*.

But the study also shows that some gene-edited mice with only mothers can survive to adulthood and have offspring of their own, confirming previous work.

The researchers did the experiments to learn why mammals can reproduce only sexually — requiring two parents of the opposite sex — while other vertebrates, including turkeys, snakes and sharks, can sometimes reproduce with only one parent, says study coauthor Qi Zhou of the Chinese Academy of Sciences in Beijing. Females of those species can sometimes cause an unfertilized egg to produce offspring, a process called parthenogenesis.

Researchers have previously made zebrafish with only an individual father's DNA. But no one before now has reported achieving male-only reproduction, or androgenesis, in mammals.

In the new work, mouse pups with two mothers were smaller than usual and



This mouse, which did not survive to adulthood, was produced in a lab from the stem cells of two males.

had other abnormalities, the researchers found. Those deficits happened because some genes that the pups inherited from their mothers were imprinted, or marked with molecules known as methyl groups that are attached to DNA in spots near the gene. Imprinting may cause some genes to be more active and others less active.

So the scientists used a molecular scissors known as CRISPR/Cas9 to snip out three imprinted regions near important genes in stem cells that were then used to produce embryos. Of 210 embryos implanted in surrogate mothers, 29, or about 14 percent, were born. Those gene-edited pups grew normally and became adults with normal fertility.

Making embryos from stem cells of two male mice wasn't as successful.

To even get embryos made from two dads' stem cells to form, the researchers had to snip out six imprinted pieces of DNA. Still, only 12, or about 1.2 percent, of 1,023 embryos with the six edits produced pups. Those pups were twice the size of normal pups and died soon after birth. Cutting out a seventh imprinted region resulted in pups of normal size, but only two pups lived more than 48 hours and neither survived to adulthood.

Still, the work is an important first step in understanding what the imprinted regions do during normal development, says B. Duygu Özpolat, a developmental biologist at the Marine Biological Laboratory in Woods Hole, Mass., who was not involved in the work.

That knowledge might help correct birth defects caused by imprinting errors, she says.

Making mammals from single-sex parents might also help endangered species that have animals of only one sex left, Özpolat says. For instance, the last male northern white rhinoceros died earlier this year, leaving only two females (*SN*: 8/4/18, p. 8). Gene editing might help researchers bring white rhinos back by making all-female populations from lab-grown stem cells.

"It might be too expensive, and might not work for every species, but it's something," Özpolat says. As for human same-sex couples hoping to have a biological baby together, she says, "that's the far future for the moment."

Zhou adds that it could be too dangerous to try the technique in people. There's no guarantee that the imprinted regions involved in mouse reproduction are the same ones involved in human reproduction. At any rate, he says, "to apply this technique into human is not one of our goals." ■

Making mammals from single-sex parents might help endangered species.

What electrons' roundness means

New results once again hold up physicists' standard model

BY LISA GROSSMAN

Electrons are almost perfectly round, a new measurement shows. The result stymies the search for new physics because a more squished shape could hint at the presence of never-before-seen subatomic particles.

The electron gets its shape from the way that positive and negative charges are distributed inside the particle. The best theory for how particles behave, known as the standard model of particle physics, holds that the electron should keep its rotund figure almost perfectly.

But some theories suggest that an entourage of hypothetical subatomic particles outside the electron could create a

slight separation between the positive and negative charges, giving the electron a pear shape. That charge separation is called an electric dipole moment, or EDM. Searching for an electron EDM can reveal if particles not accounted for in the standard model are hanging around.

Now, the Advanced Cold Molecule Electron Electric Dipole Moment, or ACME, search, based at Harvard, has probed the electron's EDM with the most precision yet. The results show no sign of smooshing, researchers report in the Oct. 18 *Nature*.

The finding improves the team's last best measurement (*SN Online*: 12/19/13) by a factor of 10 to find an EDM of 10^{-29} electron charge centimeters. That's as round as if the electron were a sphere the size of Earth, and you shaved less than two nanometers off the North Pole and pasted it onto the South Pole, says Yale University physicist David DeMille, a member of the ACME team.

DeMille's group tried to make electrons

in a thorium monoxide molecule flop over in an electric field, the way a pear tips over due to gravity, to test for the presence of new particles. None toppled. The group calculated that any new particles that could distort the electron's shape must carry more than three terraelectron volts.

That's twice the energy of particles created in collisions at the Large Hadron Collider, located at CERN near Geneva. That result implies that any undiscovered particles may be beyond the LHC's reach. "We've now surpassed what the LHC will be able to see," DeMille says.

The proposed successor to the LHC, the Future Circular Collider, could reach such high energies if it's built. But smaller, cheaper experiments may beat the collider to the punch, says physicist Brent Graner of the University of Washington in Seattle. "The real virtue in doing EDM experiments at all is, if you do see something at the level of what we can detect at the moment, it's a real, unambiguous sign of new physics." ■

Astronomers find a wimpy supernova

Weak explosion sheds light on the origins of neutron star pairs

BY LISA GROSSMAN

A faint, fleeting supernova may be key to learning how neutron star duos are born.

Astronomers have spotted what seems to be an ultrastripped supernova: a massive star in its death throes after its outer layers of gas have been siphoned off slowly by a compact companion such as a neutron star or black hole.

"This is the first of its kind: The first ultrastripped supernova that has been observed," says astronomer Kishalay De of Caltech. Similar supernovas could lead to binary neutron stars like the pair that was caught colliding in 2017, he and

colleagues report in the Oct. 12 *Science*.

The supernova was spotted in 2014 in a galaxy about 930 million light-years from Earth by an automated sky survey called the intermediate Palomar Transient Factory and was named iPTF 14qqr. Most supernovas detonate when a star more than eight times as massive as the sun has burned through all its fuel and can no longer hold itself up against gravity. The star's core collapses, leaving a dense neutron star behind. Meanwhile, a rebounding explosion ejects the remaining outer layers of gas outward as a bright flare that usually lasts for 17 to 20 days.

But iPTF 14qqr's light faded after just seven days. The supernova also emitted unusually little energy. That wimpy burst suggests that the star, about 10 times the sun's mass to begin with, ejected only one-fifth of the sun's mass when it exploded. The star must have lost much of its material sometime before it died, the researchers suspect.

That's expected for an ultrastripped supernova. An extremely massive companion, like a neutron star or black hole, could have stolen the matter. Whatever remained could still explode, but faintly.

Astrophysicist Thomas Tauris of Aarhus University in Denmark predicted such strange supernovas in 2013. "It is really fantastic that observers can now verify their existence in detail," he says.

The result of this type of explosion would be a close pair of compact stellar corpses, such as two neutron stars or a neutron star and black hole. Scientists knew that neutron star duos exist, but weren't sure how the stars get so close. The new discovery suggests that they are born close and only get closer. ■

A spiral galaxy about 930 million light-years from Earth is shown before, during and after (left to right) an explosion of a faint supernova called iPTF 14qqr (inside the dotted circle, middle).



ATOM & COSMOS

Giant spikes of ice may stud Europa

Spires could complicate plans to land a probe on the moon

BY JENNIFER LEMAN

Europa's frozen landscape could be treacherous territory for future landers.

Jagged spires of ice may stud the Jovian moon's equator, scientists report October 8 in *Nature Geoscience*. These structures, called penitentes, could reach heights of 15 meters and occur roughly every 7.5 meters, computer simulations show, potentially making parts of the moon hazardous for future missions.

"All kinds of interesting things might be on the surface" of Europa, says Jeff Moore, a planetary geologist at NASA's Ames Research Center at Moffett Field, Calif. "You'd want to know about them if you wanted to send a lander."

Penitentes on Earth are sculpted through sublimation, when sunlight transforms snow or ice in a dry envi-

ronment into water vapor without first melting it. As parts of the snow or ice sublimate more quickly than others, surface depressions form. Those spots concentrate sunlight, speeding up sublimation even more and carving the icy blades.

Earth's icy spires grow at high altitudes in tropical and subtropical latitudes where conditions are just right: abundant sunlight but low temperatures.

The structures haven't been directly observed on Europa because imagery resolution is so low. "The best pictures we have of Europa don't show things any smaller than a house," Moore says. "You can't really make out any detail."

Drawing on data from previous missions, Moore and colleagues developed

simulations to test how easily penitentes could form on Europa. The simulations suggest that proper conditions exist along the equator to support penitente growth and that these structures could stretch as high as a five-story building.

Penitentes could explain odd radar observations and unusual temperature readings from the moon. Radar signals from the Arecibo Observatory in Puerto Rico, for example, hinted at uneven features on Europa. Perhaps the signals bounced back and forth between deep crevices and ridges of icy spires before surging back to their receiver, says study coauthor Daniel Hobley, a planetary geologist at Cardiff University in Wales. And abnormally chilly readings collected



Icy spires known as penitentes, like these in Chile's Chajnantor plain, may circle the equator on Jupiter's icy moon Europa.

BODY & BRAIN

Tainted supplements flood the market

Hundreds of dietary products contain potentially harmful drugs

BY AIMEE CUNNINGHAM

From 2007 to 2016, the U.S. Food and Drug Administration flagged nearly 800 over-the-counter dietary supplements as tainted with potentially harmful pharmaceutical drugs, a study shows. And less than half of those products were recalled by their makers.

Researchers in California analyzed the FDA's public database of tainted supplements, identifying both the type of contaminating ingredients they contained and how the products were marketed. Most of these supplements, which are allowed to contain only dietary ingredients, included drugs such as steroids, the active ingredient in Viagra and a weight-loss drug banned from the U.S. market. The products had been marketed pri-

marily for sexual enhancement, weight loss or muscle building, scientists report in the October *JAMA Network Open*.

More than half of U.S. adults have reported taking dietary supplements, such as vitamins, minerals and other specialty products. More than 85,000 supplements are estimated to be available in the United States, and the FDA says it cannot test all of them.

These supplements aren't subject to the same regulations, testing and approval process that are required for pharmaceutical drugs. But if the FDA identifies tainted supplements after they're on the market, the agency can issue public

warnings or suggest that the company voluntarily remove the product.

Whether that approach is effective raises questions, though, says general internist Pieter Cohen of Cambridge Health Alliance in Cambridge, Mass., who was not involved in the new work. Voluntary recalls don't ensure a product is completely removed from shelves or that consumers become aware and stop using a product, Cohen's research has found.

Only 360 of the 776 supplements flagged as tainted from 2007 to 2016 were recalled, the new study found. "What really jumped out at me," Cohen says, is that "when the FDA detects drugs in supplements, more than half the time the product isn't even recalled."

Supplement use carries health risks. A 2015 study estimated that 23,000 emergency room visits each year are linked to supplements. And about 2,100 patients

46
percent

Portion of tainted supplements recalled in the United States from 2007 to 2016

by NASA's Galileo probe during nighttime flybys of the moon may be due to the data being captured from an oblique angle, measuring only the frozen tips of the penitentes instead of the surface as a whole.

Kevin Hand, a planetary scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif., is skeptical of the simulations. Ice that forms penitentes on Earth may have dust particles, but is largely free of contaminants. "On Europa, we're talking about ice that contains salts and all sorts of sulfur compounds," he says. "This changes the sublimation and morphology story significantly."

Cynthia Phillips, a planetary geologist also at NASA's Jet Propulsion Laboratory, notes that the data used to create the simulations are "just not precise." But, she says, "it's a very testable hypothesis."

NASA's Europa Clipper mission, set to launch in the 2020s, will carry cameras, instruments to measure Europa's magnetic field and ice-penetrating radar to chart the moon's finer details. "We'll be able to go look for" the penitentes, Phillips says. "That's pretty exciting." ■

are hospitalized annually, often for symptoms related to heart trouble.

In 2013, 20 percent of drug-induced liver injuries recorded in the Drug-Induced Liver Injury Network registry were caused by supplements. That's up from 7 percent in 2004. Liver damage can be fatal or require a liver transplant.

"The law allows companies to advertise supplements as if they're good for your health, even if there's no evidence in humans that that's the case," Cohen says. He began studying dietary supplements after noting that his patients developed health problems, including panic attacks, chest pain and kidney failure, related to weight-loss supplements. One patient was suspended from his job when his urine tested positive for amphetamine; a chemical derivative of the drug was found in the weight-loss pills that he was taking.

Cohen's recommendation? Avoid supplements "that promise you anything." ■

LIFE & EVOLUTION

How to turn a corpse into a nursery

Beetle parents' microbial goo might prevent decomposition

BY SUSAN MILIUS

Growing up inside a dead mouse could really stink, but not for some burying beetles. Their parents' gut microbes keep the cadaver fresh, creating a nursery where the larvae can thrive.

What burying beetles do with a small dead animal is remarkable, says Shantanu Shukla of the Max Planck Institute for Chemical Ecology in Jena, Germany. "It looks different. It smells different. It's completely transformed by the beetles."

Nicrophorus vespilloides carrion beetles start family life by burying a small dead vertebrate, which they keep fresh enough for baby food. Parents open a little flesh-cave in the cadaver, and hatchlings creep in to gorge. As the youngsters grow, the parents regularly refresh a dark microbial film inside the cavity. That helpful goo is not the usual slime that blooms in carcasses. It resembles the parent beetles' gut microbiomes and helps offspring grow, Shukla and colleagues report online October 15 in the *Proceedings of the National Academy of Sciences*.

The carcass that parents smear with oral and anal secretions develops a "peculiar smell," but "it definitely isn't as bad as a dead animal that is buried in soil for several days," Shukla says. "You can hold it under your nose, and there's no offensive smell."

Both the parents and larvae produce antimicrobial substances, and biologists

at first wondered if these prevented rot just by suppressing microbial growth. In recent years, Shukla's lab and others have switched the focus to beetle secretions that spread desirable microbes: The beetles aren't eliminating a microbial community. They're just restructuring it.

In lab experiments on these carcass nurseries, Shukla and colleagues checked for benefits of the restructured microbial community. Some beetle broods got full exposure to the living film of microbes that parents tend inside the cavity. With others, Shukla swabbed out daily the parent-made biofilm as the parents renewed it. Larvae raised in scrubbed cavities used their food less efficiently and gained about a third less weight per gram of carcass consumed than larvae that got their parents' gut goo.

Shukla's group kept beetles under conditions as natural as possible. Parents tended the cavity and guarded the young. But this approach makes it hard to separate how the larvae and parents contribute to the biofilms, says Daniel Rozen of Leiden University in the Netherlands, who has also studied the burying beetle microbiome. Larvae also manipulate the cavity, adding their own secretions and eating away bacteria — and sometimes, almost everything else.

"What will remain is the tail of the mouse," Shukla says, "and the skull and a few pieces of skin." ■



Burying beetle parents tend the carcass where their brood of youngsters thrives, feeding from the inside out. Preserving the nursery with gut microbes helps larvae grow, experiments suggest.

GENES & CELLS

Same-sex sexuality linked to DNA

Specific genes involved in mate choice aren't yet known

BY TINA HESMAN SAEY

SAN DIEGO — For some people, choosing a same-sex partner may be in their DNA.

In a study of more than 490,000 men and women in the United States, the United Kingdom and Sweden, researchers discovered four genetic variants that occur more often in people who indicated on questionnaires that they have had same-sex sexual partners. Andrea Ganna, a geneticist at the Broad Institute of MIT and Harvard, reported the results October 19 at the annual meeting of the American Society of Human Genetics.

Two of the variants were specific to men's sexual partner choice. The other two influence sexual partner choice for both men and women.

Collectively, the DNA differences explained only 8 to 12 percent of the heritability of having same-sex partners. "There is no gay gene, but rather non-heterosexuality is influenced by many tiny-effect genetic factors," Ganna said.

The new research is an advance over previous attempts to find "gay genes," says psychologist J. Michael Bailey of Northwestern University in Evanston, Ill. The study's size is its main advantage, he says. "It's huge. Huge."

Ganna and colleagues examined DNA data from more than 400,000 participants in the U.K. Biobank and more than 69,000 people who had their DNA tested by the company 23andMe. People who gave their DNA to these projects also answered a battery of questions, including ones about sexual partners. Ganna's group replicated results from these datasets with data from three other studies, including one from Sweden.

Findings from such large studies are more likely to be replicated than the small studies of the past, Bailey says. Researchers have "really gotten these studies down now and if they find things, it's pretty sure that they're true."

Previous genetic studies of sexual orientation, including some Bailey was involved in, may also have suffered from bias because they relied on volunteers. People who offer to participate in a study, without being randomly selected, may not reflect the general population, Bailey says.

But even the new research has some limitations. For instance, it doesn't define non-heterosexuality as people's attraction to members of the same sex. Some people who have had sex with a same-sex partner don't consider themselves gay and aren't exclusively attracted to people of the same sex, says Bailey. He calls the study's definition of non-heterosexual behavior — having ever had a same-sex partner — "a flawed, but not ridiculous indicator of sexual orientation."

Men in the new investigation who said they have had same-sex partners tended to be more exclusively homosexual than women were, Ganna and colleagues found. But people of both sexes ran the gamut of sexual orientations. In the U.K. Biobank dataset, younger people reported having same-sex partners more often than older people did. Homosexual activity was illegal in the United Kingdom until 1967.

The new research is also notable for being the first study to link genetic variants to female sexual orientation, says Lisa Diamond, a psychologist at the University of Utah in Salt Lake City who studies the nature and development of same-sex sexuality. The results are consistent with previous studies suggesting that genetics may play a bigger role in influencing male sexuality than female sexuality. It's not unusual for one sex of a species to be more fluid in their sexuality, choosing partners of both sexes, Diamond says. For humans, male sexuality may be more tightly linked to genes.

But that doesn't mean that genes

"This is not the only complex human phenomenon for which we see a genetic influence without a great understanding of how that influence works."

LISA DIAMOND

control sexual behavior or orientation. "Same-sex sexuality appears to be genetically influenced, but not genetically determined," Diamond says. "This is not the only complex human phenomenon for which we see a genetic influence without a great understanding of how that influence works." Other complex human behaviors, such as smoking, alcohol use, personality and even job satisfaction, all have some genetic component.

Previous research had suggested that genes influencing sexual orientation are located on the X chromosome (*SN: 11/4/95, p. 295; SN: 7/7/93, p. 37*). But Ganna and colleagues found no evidence that the X chromosome is involved in partner choice, he said.

Instead, the researchers found genetic variants known as single nucleotide polymorphisms, or SNPs, located on four other chromosomes. SNPs are naturally occurring spots in the DNA where some people have one DNA base, or letter, and other people have another. The variants didn't change any genes, but were found near some genes that may be involved in influencing sexual orientation.

For instance, a variant on chromosome 15 linked to men having sex with men is also associated with male pattern baldness. Another variant in the study is on chromosome 11 near the *ORA51A* gene, which is involved in the ability to smell certain chemicals. That's interesting, Ganna said, because smell has been linked to attraction (*SN Online: 3/12/15*).

The researchers don't yet know which genes are involved in mate choice or how they influence behavior. ■

How your brain is like a film editor

Hippocampus partitions events to store them as memories

BY LAURA SANDERS

The brain's hippocampus may be the film editor of our lives, slicing continuous experiences into discrete cuts that can be stored as memories. That's the idea raised by a study that analyzed brain scan data from people watching the movie *Forrest Gump*.

"Research like this helps us identify 'What is an event?' from the point of view of the brain," says memory psychologist Gabriel Radvansky of the University of Notre Dame in Indiana.

Many lab tests of memory involve taking in discrete, dull lists of information. "So much research is done with these little bits and pieces — words, pictures, things like that," Radvansky says. But those dry tidbits aren't what the human

brain usually handles. "The mind is built to deal with complex events."

As a closer approximation to real life, researchers studied functional MRI data from 15 people who watched *Forrest Gump* and 253 people who watched Alfred Hitchcock's TV drama *Bang! You're Dead*. A separate group of 16 observers watched each of the productions and pressed buttons to indicate when they thought one event ended and another began.

With the data in hand, cognitive neuroscientists Aya Ben-Yakov and Rik Henson of the University of Cambridge aligned participants' brain activity with the transition points marked by the observers. A brain structure called the hippocampus, important for memory and navigation, seemed particularly active at these junc-

tures, the team reports online October 8 in the *Journal of Neuroscience*. The brain structure was most active when the observers had indicated a shift from one event to another.

These transitions didn't always involve jumps to new places or times in the story. One such boundary came near the beginning of *Forrest Gump* as Forrest sits quietly on a bench. Suddenly, he blurts out his famous greeting: "Hello. My name's Forrest. Forrest Gump." The hippocampus may have helped slice that continuous bench scene into two events: before talking and after talking. Such divisions may help package information into discrete pieces that can then be stored as memories, the researchers suspect.

Of course, films only approximate firsthand experiences, Ben-Yakov says. It's not clear how the hippocampus behaves when people are personally involved in events. "Our goal is to understand real life," she says. ■

HUMANS & SOCIETY

Climate change doomed Angkor

Shifts from drought to floods ruined water infrastructure

BY BRUCE BOWER

At the medieval city of Angkor, flooding after decades of scant rainfall triggered a devastating breakdown of the largest water system in the preindustrial world, new evidence suggests.

Intense monsoon rains bracketed by decades of drought set off a chain reaction of failures in Angkor's interconnected water network, in what's now Cambodia, computer simulations show. The climate-induced crumbling of the system hastened the city's demise, scientists conclude October 17 in *Science Advances*.

"Angkor's critical [water] infrastructure acted to accelerate the impact of climatic disruption," says geoscientist Dan Penny of the University of Sydney.

Penny and colleagues devised a model of how a rapid shift to periods of intense

rainfall affected Angkor's water system at the peak of its complexity in the 1300s. A series of simulations indicate that, above a critical volume of water flow, earthen channels carrying water into the system began to erode and widen. Water was then unevenly shunted through junctions in the network, gushing into some connected channels and trickling into others.

Meanwhile, accumulating sediment further decreased the volume of water that newly parched channels could carry, intensifying the uneven flow of water through the system. A breakdown of the entire water network — used for irrigation, drinking water and flood control — would soon have followed.

By the 1200s, Angkor was the world's most extensive city, covering about 1,000 square kilometers (*SN*: 5/14/16, p. 22). The city had spent the previous several hundred years building and expanding a network of canals, embankments, reservoirs, moats and other structures devoted to water management.

In the 1400s, Angkor's king and many commoners mysteriously abandoned the city. Some scientists have attributed the



Medieval Angkor (Angkor Wat temple shown) suffered a big blow when the city's water system reacted badly to a fluctuating climate, computer simulations suggest.

city's demise to war with neighbors and possibly the tumultuous replacement of Hinduism with Buddhism in the region.

But the new study paints a convincing picture of climate-induced infrastructure collapse, says archaeologist Charles Higham of the University of Otago in Dunedin, New Zealand. Angkor, for example, depended on irrigation for rice fields. A breakdown of the water system would have undermined not only harvests but also weakened public beliefs that the king held supernatural powers justifying his rule, Higham suspects. ■

LIFE & EVOLUTION

Earth's oldest fossils may not be fossils

Tectonic forces may have shaped 3.7-billion-year-old structures

BY CAROLYN GRAMLING

Tiny mounds touted as the earliest fossilized evidence of life on Earth may just be twisted rock.

Found in 3.7-billion-year-old rocks in Greenland, the mounds strongly resemble cone-shaped microbial mats called stromatolites, researchers reported in 2016. But a new analysis suggests that the mounds were actually formed by tectonic activity driven by heat and pressure in Earth's crust. The new work, led by astrobiologist Abigail Allwood of NASA's Jet Propulsion Laboratory in Pasadena, Calif., was published online October 17 in *Nature*.

The further back in time you go, the more devilishly difficult it is to identify signs of life. Allwood herself is familiar with the skepticism that comes with making such a big claim: In 2006, she and colleagues suggested that 3.45-billion-year-old features in an Australian rock formation were stromatolites. Though that claim was met with skepticism initially, a growing body of research has ultimately supported it.

Then, in 2016, Allen Nutman, a geologist at the University of Wollongong in Australia, and colleagues reported finding a series of mounds within a group of ancient Greenland rocks known as the Isua supracrustal belt. Most of the belt has been twisted over time by tectonic forces. But Nutman's group discovered the mounds within a portion of the belt that appears relatively unaltered. The team presented numerous lines of evidence suggesting that the structures were stromatolites (*SN*: 12/24/16, p. 24; *SN*: 10/1/16, p. 7). If true, the discovery would push back the date of the earliest fossils by some 200 million years.

But that study, too, has been met with skepticism, including from Allwood. "The evidence that was presented was robust," she says. "But there were a couple of things about the structures that seemed odd." For one thing, stromato-

lites would all grow upward from the seafloor, forming cones that point in one direction. But one of the cone-shaped structures in the 2016 study was, curiously, oriented downward.

So Allwood took a closer look, going to Greenland in 2016 to study the outcrops featuring the structures. Her team cut a chunk of rock off the end of one of the two sites where the structures had been found. "We took a slightly bigger sample than Nutman had taken," she says. "That was a good thing, because it provided the context that gave us the answer."

That sample gave a 3-D picture of one of the structures. Although cone-shaped when viewed from one side, from a different angle, the structure was flatter, more like a ridge than a cone. That's significant, Allwood says. Cones "are difficult to produce by anything other than biology. If it's an elongate ridge, it's no longer in that special category."

Her team analyzed several other lines of evidence that could point to a

stromatolite, including internal layers, chemical composition and the environment in which the mounds probably formed. Stromatolites are mats that build slowly in shallow marine environments as algae secrete layer after layer of carbonate-rich sediment.

But the new structural and chemical analyses of the fine layers within the Greenland structures suggest that the layers are chemical alteration fronts. The fronts, Allwood's team says, were produced by the gradual reaction of carbon-rich fluids circulating in the silicate-rich rock, part of the long history of tectonic alteration in this belt. "It's like taking a piece of sponge cake, dropping it in alcohol and watching it change from the outside in," Allwood says.

In addition, rocks surrounding the structures show signs of metamorphic deformation, changes in rock such as minor folds and cleavage caused by heat and pressure. In the end, Allwood's team concluded, the structures probably formed tectonically, not biologically.

Nutman and colleagues stand by their interpretation. He says the sample collected by Allwood's team was not representative of the other structures: It appeared at the edge of one of the two outcrop sites described in the original study—a location that was more tectonically altered than the other parts of the site. "This is a classic comparing apples and oranges scenario," Nutman says.

Mark van Zuilen, a geomicrobiologist at the Institut de Physique du Globe de Paris who has studied the Isua supracrustal belt, says that when the 2016 paper came out, he was excited. But he also wondered about deformation features in the rocks. The new study reveals "clear signs of deformation," says van Zuilen, who wrote a commentary accompanying the new study.

"The big trouble is that these rocks are so old and metamorphosed. They have been completely recrystallized and deformed under high pressure and high temperature," he says. "This means we are always sorting out what features of the rock are primary, and what features were caused at a later stage." ■



This rock is from a site in Greenland where scientists claimed to find fossilized stromatolites, conical structures formed by microbes. A structure (right) looks conical, but a cut into the rock shows no cone (left)—a sign that the structure wasn't made by microbes, a study suggests.

LIFE & EVOLUTION

Possible lungs preserved in bird fossil

But some paleontologists are skeptical of the one-of-a-kind find

BY CAROLYN GRAMLING

An ancient bird fossil that appears to contain preserved lung tissue may breathe new life into studies of early avian respiration. If confirmed as lungs, the find marks the first time scientists have spotted the respiratory organs in a bird fossil.

Scientists have previously described fossils of *Archaeorhynchus spathula*, among the earliest members of the lineage that led to modern birds. But unlike those fossils, a newly described specimen dating to about 120 million years ago has significant traces of plumage and the probable remnants of a pair of lungs, vertebrate paleontologist Jingmai O'Connor and colleagues announced October 18.

It's rare for soft tissue to survive fossilization. But scientists are increasingly finding preserved feathers, skin and even bits of brain (*SN: 11/26/16, p. 9*). Fossilized lungs are also not unheard of: The organs have been preserved with the fossils of a salamander and a mammal (*SN Online: 10/21/15*).

"But we're arguing that this is the first lung tissue preservation that is anatomically informative," said O'Connor, of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing.

That's because modern birds have a highly specialized and efficient respiratory system that allows them to absorb enough oxygen to meet the demands of powered flight. Unlike mammalian lungs that are elastic and pump air in and out, bird lungs don't change size when the bird breathes. Instead, several air sacs connected to the lungs act like a bellows to draw the air in through the lungs. The lungs themselves contain highly subdivided tissue with tiny air capillaries that transfer oxygen and carbon dioxide.

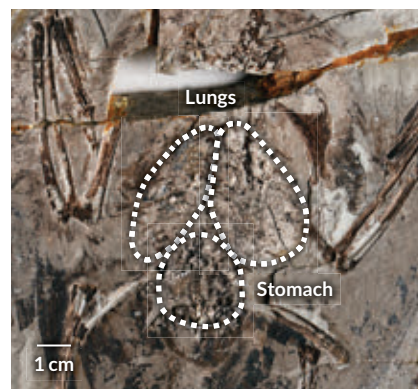
The newly described *Archaeorhynchus* fossil contains many of the same structures, O'Connor's team reported online October 22 in the *Proceedings of the National Academy of Sciences*, suggesting that these respiratory adaptations

existed early in the modern bird lineage.

The *Archaeorhynchus* specimen is split into two halves, a main slab and its mirror image called a counterslab. Both slabs have unusual features. The chest cavity on the main slab contains a white speckly region. And the counterslab has two nearly symmetrical lobe-shaped regions corresponding to the speckly region. The lobes' position, and that there were two of them, suggests the possibility of lungs, O'Connor said. The structures were unlikely to be stomach contents, which usually appear black and carbonized in fossils. And the liver tends to appear reddish due to its high iron content.

O'Connor's team used scanning electron microscopy to study 22 samples from the fossil, including 12 from the purported lungs. The images revealed a highly subdivided region of tissue known as the parenchymatous region, which had many closely packed air cells. That structure is similar to the air capillaries found in small modern birds, O'Connor noted.

Still, other scientists aren't convinced that the material represents lungs. "I'd



This *Archaeorhynchus spathula* fossil reportedly preserves the ancient bird's lungs (outlined at top) and stomach.

very much like it to be true, but there are a few too many question marks about how such tissues could have been preserved," says vertebrate paleontologist Corwin Sullivan of the University of Alberta in Edmonton, Canada.

"I knew that a lot of people would be rightfully skeptical," O'Connor said. But bird lungs have some sturdy structures that may have aided preservation, or perhaps the environment in which the bird died was particularly conducive to preservation. But these are just hypotheses, O'Connor said. The team is planning research to address this and other questions about how this bird breathed. ■

MEETING NOTE

***T. rex* pulverized bones with intense force**

A lethal combination of a powerful bite, strong teeth and repeated crunching let *Tyrannosaurus rex* pulverize its prey's bones, researchers said October 20.

To access nutritious bone marrow, most bone crushers have to be able to clamp their jaws together to crunch through the dense outer layer of bone. Some carnivorous mammals, like spotted hyenas, can do this. But bone-crushing is unknown among living reptiles because their upper and lower teeth don't fit together, or occlude, in a way that allows clamping.

Tyrannosaurs didn't have occluding teeth either, but the dinosaurs still crunched bone. To figure out how, anatomist Paul Gignac of Oklahoma State University in Tulsa and vertebrate paleontologist Gregory Erickson of Florida State University in Tallahassee examined fossil evidence of the creatures' dining behavior. The duo also investigated the bite forces of modern birds and crocodiles. Extrapolating from that evidence, the researchers estimated *T. rex*'s bite force to be as much as about 34,000 newtons — more than twice as strong as a crocodile's bite force, the strongest of all living animals. And the tip of each tooth could exert up to about 3,000 megapascals; that intense pressure would help create cracks that weakened bone. Fossil evidence suggests that *T. rex* would also gnaw at one spot, further weakening the bone. — Carolyn Gramling

EARTH & ENVIRONMENT

Unusually warm waters and wet air fueled Hurricane Michael's fury

Call it an October surprise: Hurricane Michael strengthened unusually quickly before slamming into the Florida Panhandle on October 10 and remained abnormally strong as it swept into Georgia. The storm made landfall with sustained winds of about 250 kilometers per hour, just shy of a Category 5 storm, making it the strongest storm ever to hit the region, according to the National Hurricane Center.

Warm ocean waters fuel hurricanes by adding heat and moisture. By contrast, the drier air over land strips storms of strength. So hurricanes nearing the Florida Panhandle, a curving landmass surrounding the northeastern Gulf of Mexico, tend to weaken as they pull in drier air from land. But waters in the Gulf that were about 1 to 2 degrees Celsius warmer than average for early October and abundant moisture in the air over the eastern United States helped to supercharge Michael.

Although it is not possible to attribute the generation of any one storm to climate change, scientists have long predicted that warming ocean waters would lead to more-intense hurricanes. Recent attribution studies have borne out that prediction, suggesting that very warm waters in the tropical Atlantic helped fuel 2017's powerful storm season, which spawned hurricanes Irma and Maria (*SN Online*: 9/28/18). — *Carolyn Gramling*

LIFE & EVOLUTION

Bees took a break during the Great American Eclipse

When the Aug. 21, 2017 total solar eclipse hit totality and the sky went dark, bees noticed.

Microphones in flower patches at 11 sites in the eclipse's path in Oregon, Idaho and Missouri picked up the buzzing sounds of bees flying among blooms before and after totality. But those sounds were noticeably absent during the full solar blackout.

Dimming light and some cooling during the onset of the eclipse didn't

appear to make a difference to the bees. But the deeper darkness of totality did, researchers report online October 10 in the *Annals of the Entomological Society of America*. The change in buzzing was abrupt at totality, says study coauthor and ecologist Candace Galen of the University of Missouri in Columbia. Buzzing resumed soon after totality.

The study provides the first formal data published on bees during a solar eclipse, as far as Galen knows. "Insects are remarkably neglected," she says. "Everybody wants to know what their dog and cat are doing during the eclipse, but they don't think about the flea." — *Susan Milius*

HUMANS & SOCIETY

Vampire burial unearthed in Italy

Excavations in an ancient Roman cemetery turned eerie last summer.

In one grave lay a roughly 10-year-old child, possibly the victim of malaria, with a stone inserted in his or her mouth. That practice was part of a funeral ritual intended to prevent the youngster from rising zombielike and spreading disease to the living, researchers say.

The team found this "vampire burial" at the Cemetery of the Babies, a mid-fifth century site in Italy. The results will be presented in January at a meeting of the Archaeological Institute of America.

A malaria outbreak in the region killed many babies and young children around the time of the child's burial. Bones of several kids buried there have yielded DNA of malaria parasites. Many of the



A child buried in an ancient Roman cemetery had a stone placed in the mouth as part of a ritual to keep the body from returning to life.

children were accompanied by objects associated with beliefs in witchcraft and magic, such as raven talons and toad bones. Stones had been placed on the hands and feet of a 3-year-old, another practice used by various cultures to keep the dead in their graves.

Such rituals attempted to keep whatever evil that people thought had fatally contaminated bodies from getting out, says classical archaeologist David Soren of the University of Arizona in Tucson, who participated in the dig. — *Bruce Bower*

BODY & BRAIN

People who have a good sense of smell are also good navigators

We may truly be led by our noses. A sense of smell and a sense of navigation are linked in our brains, scientists propose.

Neuroscientist Louisa Dahmani and colleagues asked 57 people to navigate through a virtual town on a computer screen before being tested on how well they could get from one spot to another. The same people's smelling abilities were also scrutinized. After a sniff of one of 40 odor-infused felt-tip pens, participants chose which of four words on a screen matched the smell. On these tasks, the superior smellers and the superior navigators turned out to be one and the same.

Scientists linked both skills to spots in the brain: The left orbitofrontal cortex and the right hippocampus were both larger in the better smellers and better navigators. While the orbitofrontal cortex has been tied to smelling, the hippocampus is known to be involved in both smelling and navigation. A separate group of nine people who had damaged orbitofrontal cortices had more trouble with navigation and smell identification, the scientists report October 16 in *Nature Communications*. Dahmani, who's now at Harvard University, did the work while she was at McGill University in Montreal.

A sense of smell may have evolved to help people find their way. Specific aspects of smell, such as how good people are at detecting faint whiffs, may also be tied to navigation, the researchers say.

— *Laura Sanders*

Stay Safer & More Independent with a Jacuzzi® Luxury Walk-In Bathtub

SAVE \$1,500

on your NEW Walk-In Tub
with ONE DAY installation

NEW!

Epsom Salt Compatible

Now enjoy the relaxing health benefits of Epsom salt in your tub without the worry of rust or damage to your tub's components.

Enjoy Legendary

Jacuzzi®

Jet Technology

Low Entry Step

Don't let mobility concerns end your ability to enjoy a relaxing & therapeutic bathing experience

The safety features of the Jacuzzi® Walk-In Bathtub help with mobility in and out of the tub, and also help you feel more secure and independent when bathing at home.

- ✓ **NEW!** A quieter and energy efficient pump provides a more enjoyable bathing experience
- ✓ **NEW!** Heated back and seat for more comfort and relief
- ✓ **NEW!** Relaxing Bubble Foot Massage
- ✓ **PLUS!** Installation in as little as one day!

CALL TODAY & SAVE \$1,500

Call now for limited-time savings on your new Walk-In Bathtub
and details on installation that takes as little as ONE DAY!

Call: 1-888-344-7372

or Visit: www.JacuzziWalkIn.com

**The NEW Gold Standard
of Walk-In Bathtubs**



ERASING FEAR

Virtual reality therapy has real-life benefits for some disorders

By Maria Temming



JAIME JACOB

Edwin adjusted his headset and gripped the game controller in both hands. He swallowed hard. The man had good reason to be nervous. He was about to enter a virtual environment tailor-made to get his heart pumping way more than any action-packed video game: a coffee shop full of people.

Determined to overcome his persistent fear that other people want to hurt him, Edwin had enrolled in a study of a new virtual reality therapy. The research aimed to help people with paranoia become more comfortable in public places. In this program, described in March in the *Lancet Psychiatry*, Edwin could visit a store or board a crowded bus.

Virtual strangers can be scary, just like real people. Edwin, who had been diagnosed with paranoid schizophrenia, often found simple errands like grocery shopping overwhelming and exhausting.

But facing simulated crowds came with perks. At a nearby computer sat clinical psychologist Roos Pot-Kolder of VU University Amsterdam. She could customize the number of avatars and set their friendliness levels in each scene. That way, Edwin could progress at his own pace.

During one session, Pot-Kolder coached Edwin to challenge his own paranoid assumptions. If he saw an angry-looking avatar, she asked, “What could be other reasons for looking mad, besides wanting to hurt you?” Edwin offered: The person could be tired or having personal problems.

After three months of VR treatment, public outings were easier, said Edwin, who asked that his last name not be used. “I felt more freedom, more relaxed.” He even performed a poem for 500 people at a talent show, which he “would not have dared” before.

Researchers have been developing virtual reality systems that help people overcome specific phobias since the 1990s. VR therapy has since expanded to address more complex anxiety disorders, such as social anxiety and post-traumatic stress, and even the anxiety associated with paranoid schizophrenia for people like Edwin.

“The key ingredient to an effective treatment for anxiety disorders is ... you need to face your fears,” says Stéphane Bouchard, a clinical cyberpsychologist at the University of Quebec in Outaouais, Canada. He’s referring to what’s known as exposure therapy. With emotional support from a therapist, exposure therapy helps desensitize



the patient to whatever the fear is. Patients typically face their fears in real life or, if their fear is a traumatic memory, repeatedly relive the event in their imagination.

But confronting fears can be easier in a virtual setting. A flight-phobic patient can take off and land many times in a single VR session without the cost and hassle of actual flights. Veterans with post-traumatic stress who can’t remember a traumatic memory in great detail can reenact a close proxy in VR for a more potent therapeutic experience. The same goes for those who repress painful memories.

Until recently, the price and complexity of VR equipment, which could run tens of thousands of dollars, limited VR therapy to a few research labs and clinics. Now, there are computer-based headsets like the Oculus Rift that cost only a few hundred dollars, as well headsets such as the Samsung Gear VR that turn smartphones into virtual reality displays for about 100 bucks.

With cheaper, more user-friendly systems poised to make virtual reality therapy available to many more patients, researchers are testing the bounds of VR’s therapeutic powers to treat a broader range of disorders or, in some cases, replace the therapist altogether.

A VR system that helps people with paranoia get more comfortable in public places, such as a café or grocery store (shown), uses avatars that can be made to look friendlier or more hostile, depending on a patient’s progress.

31 percent

U.S. adults who experience an anxiety disorder at some point in life

SOURCE: NATIONAL INSTITUTE OF MENTAL HEALTH

Real feel

The power of VR therapy comes from the fact that people automatically react to fear cues, even in an environment they consciously know isn’t real. That’s because the brain’s emotional command center, or limbic system, responds to stressors in a matter of milliseconds — way faster than logic can kick in (*SN*: 2/26/11, p. 22).

As a result, patients who confront their fears in VR have shown increased levels of the stress hormone cortisol, higher heart rate and higher skin conductivity, says Barbara Rothbaum, a clinical

psychologist at Emory University in Atlanta. Those are all telltale signs of a fight-or-flight response (*SN Online*: 2/2/17).

Back when Rothbaum and colleagues began to study VR treatment for a psychological disorder in the early 1990s, the researchers weren't sure that a computer simulation could provoke those reactions. But their VR program, which took height-phobic patients onto bridges, balconies and for a ride in a glass elevator, worked almost too well.

Rothbaum recalls the very first patient test. "We were so excited, and she was getting anxious. We just kept her going in it, and she ended up throwing up." The patient, it turned out, was susceptible to motion sickness — a problem that still plagues VR (*SN*: 3/18/17, p. 24). "We thought that was going to be the end of the study right there."

But Rothbaum's team forged ahead. The group learned to give patients a break after about

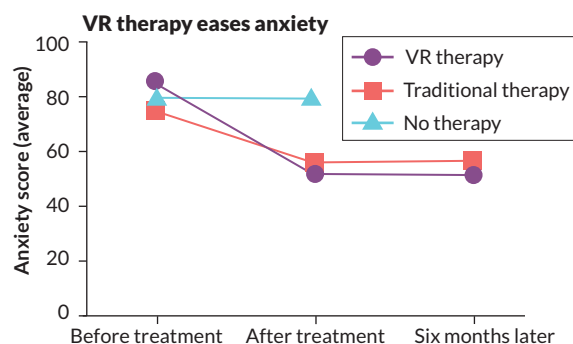
Back in Iraq

Wilfredo Serrano Waters didn't know what to expect when he began VR therapy at Emory Healthcare in Atlanta. He'd played games and watched movies on his VR headset at home, but the 34-year-old wasn't sure how it would feel to relive some of his own worst memories in virtual reality. Would VR help relieve the post-traumatic stress he'd suffered since deployments to Iraq from 2007 through 2009?

The experience was "extremely immersive," Serrano Waters says of the two-week course. While wearing a headset and headphones, he sat in a chair on a platform that could vibrate. "If there's an explosion, not only do you see it and hear it, but you feel it." As Serrano Waters reenacted each traumatic experience, with his therapist encouraging him to focus on his thoughts and feelings in the moment, the virtual world felt increasingly realistic (a typical combat scene shown below). His heart pounded, his hands got sweaty, his mind raced.

"It was stressful," he says. "But that was the purpose of it...so I could learn how to tolerate and manage my emotions." The treatment also involved putting himself in real, everyday situations that were taxing due to his post-traumatic stress, like being around crowds. "I would have to spend... time just sitting at the mall or a Starbucks in the middle of lunch

hour," he says. Since finishing treatment in June, Serrano Waters says he's less anxious and more comfortable around crowds. And he's not as frightened by sudden noises. "I was very easily startled," he recalls. "Still [am] a little bit, honestly, but not as much." — *Maria Temming*



Social stress Among patients with social anxiety, those treated with VR therapy dropped an average of 33 points on an anxiety scale of 0 to 144. Anxiety among patients receiving traditional therapy dropped about 19 points. These improvements held six months later.

SOURCE: S. BOUCHARD ET AL./BRITISH JOURNAL OF PSYCHIATRY 2017

40 minutes in VR, dial the thermostat down and warn nausea-prone patients not to move their heads so much. In that first study, reported in 1995 in the *American Journal of Psychiatry*, 10 participants showed a substantial decrease in fear of heights after seven weekly sessions of VR therapy compared with seven patients who received no therapy. Two decades on, studies have shown that VR treatments for specific phobias can soothe fears about as well as real-life exposure.

More recently, researchers have designed and tested VR systems to help people with more nuanced and diverse fear triggers, such as social anxiety or obsessive-compulsive disorder. For social anxiety, Bouchard and colleagues tested a VR system that allowed patients to work through tense social situations, such as a job interview or declining to purchase something from a persistent store clerk. The researchers assigned 17 socially anxious people to VR therapy and another 22 to typical exposure treatment that involved exercises like talking to strangers in public. A third group assigned to a waiting list got no therapy.

Before and after 14 weekly therapy sessions, participants reported their fear and avoidance of social situations from 0 to 144, with higher scores indicating more severe anxiety. Starting scores averaged between 75 and 85. Participants who got VR treatment dropped an average of 33 points, whereas real-life exposure participants dropped an average of 19. The no-treatment group stayed about the same. These results, reported in the April 2017 *British Journal of Psychiatry*, suggest that VR is at least as effective as real-life exposure for social anxiety.

Helping patients with post-traumatic stress disorder confront their fears is often more complex

than simulating a generic high-rise or spider. One system that provides a broad menu of fear cues to patients with PTSD, created by VR therapy developer Albert “Skip” Rizzo and colleagues at the University of Southern California in Los Angeles, helps people suffering from post-traumatic stress after military duty in Iraq and Afghanistan.

To relive a traumatic memory in this VR system, the patient first chooses the setting, like a roadway checkpoint or a hospital. As the patient narrates the memory aloud, the therapist customizes the scene. If “the patient is saying, ‘I’m driving down a roadway,’ the therapist sets it up,” Rizzo says. If the memory happened around noon, the therapist sets the virtual clock accordingly. If the patient recalls the rumble of a Humvee, “*Rrrrrp*. Crank up the vehicle sound.”

Rizzo’s team tested an earlier version of the system by randomly assigning 162 military personnel to either a waiting list, 10 sessions of therapy that involved using the virtual Iraq/Afghanistan system or 10 sessions of traditional therapy. For traditional treatment, therapists coached patients through traumatic memories in their imaginations, and helped patients put themselves in everyday situations that they’d come to fear because of their trauma, such as crowded public places. Immediately after the study, both treatment groups showed substantial improvement in PTSD symptoms compared with those on the wait list, the researchers reported in November 2016 in the *Journal of Consulting and Clinical Psychology*.

“The real question is, if VR is as good as traditional therapies, which one should we do for which patients, and why?” says Greg Reger, a clinical psychologist at the University of Washington and VA Puget Sound Health Care System in Seattle.

By analyzing a subset of military personnel from the 2016 study, Reger and colleagues identified a few factors — like being younger and not taking antidepressants — that seemed to point to people who would fare better with VR. It makes sense that younger folks would be more responsive to tech-heavy treatment, but researchers have no idea why medication use would be relevant. Further investigations like Reger’s, reported in the June *Depression and Anxiety*, could help therapists decide when to pull out the headset.

Through the looking glass

To clinical psychologist Daniel Freeman of the University of Oxford, “the beauty of VR” is that it goes beyond rendering realistic experiences. “You can do stuff that you can’t do in real life.”



For instance, coaching a socially anxious patient through a conversation often involves redirecting that person’s attention away from themselves and toward their environment, he says. In VR, a therapist can direct a patient’s attention to particular aspects of the virtual world to help him or her forget their self-consciousness.

Gerard Jounghyun Kim, a computer scientist at Korea University in Seoul, and colleagues are testing a mix of real and fantastical elements to help people with panic disorder. In the researchers’ new VR program, a user can visit a potentially panic-inducing situation, like a parade or a crowded elevator. If a panic attack ensues, the user can hit an escape button and be transported to a peaceful beach. In that safe haven, patients get instructions to calm their breathing, while they hold a thumping device in their hand and see a virtual heart that pumps in time with their own.

Seeing, hearing and feeling the pulsation of this virtual heart is supposed to help patients focus their attention and recognize that they can get their heart rate under control, Kim says. Of five patients with panic disorder who tested the system, three reported that they found the heart-in-hand scenario helpful for recovering from panic.

This pilot trial, presented in 2017 in Gothenburg, Sweden, at the ACM Symposium on Virtual Reality Software and Technology, was much too small to show exactly how helpful this system might be for patients with panic disorder. Kim and colleagues are now doing a more comprehensive analysis with dozens of patients.

Face time

While Kim’s team is creating virtual versions of patients’ hearts, a group in Canada is rendering virtual bodies for the voices inside the minds of

To help people with panic disorder practice mindfulness and overcome panic attacks, one VR system lets the patient hold a feedback device (the white ball shown in the woman’s right hand) that pulses in time with the user’s heart.

patients with schizophrenia.

Many people who take antipsychotic medication for schizophrenia continue hearing voices, says Alexandre Dumais, a psychiatrist at the University of Montreal. Traditionally, therapists advise patients to ignore these residual hallucinations, but recent research has shown that engaging the voices in conversation may actually help reduce patients' sense of helplessness.

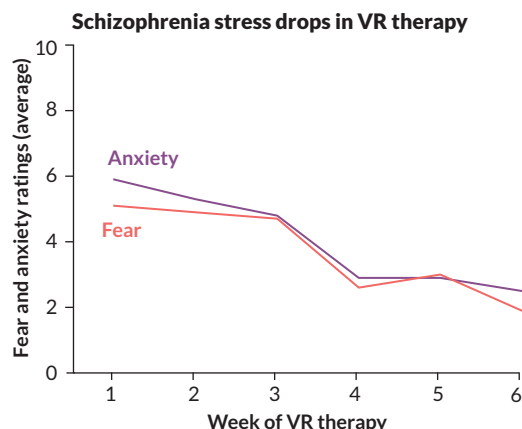
So Dumais' team built a VR system in which a patient designs an avatar that embodies a bothersome hallucinatory voice. The therapist voices this avatar using patient-suggested sentences and gradually makes the avatar friendlier, encouraging the patient to get more comfortable and assertive in addressing the voice.

Dumais' team tested this system, described in July in *Schizophrenia Research*, on 19 patients with schizophrenia. Four dropped out after the first session because they either didn't like the program or found it too scary. The remaining 15 rated how scary they found each VR therapy session from 0 to 10, with 10 being the most distressing. Scores dropped over six weekly sessions. Moreover, at the end of treatment, the patients' scores on a 0 to 20 scale measuring general hallucination-related distress dropped from an average of 16.1 to 10.9.

"We're very much in the early days" of simulating impossible situations in VR for therapeutic purposes, Freeman says. But as VR becomes more pervasive, more researchers may have the opportunity to develop creative new treatments that exploit virtual unreality.

DIY therapy

Virtual avatars, good for filling simulated coffee shops, may also serve as therapists, transforming VR from a tool available only in a clinic to a new



Head games Schizophrenia patients who heard voices and conversed with them in VR rated how scary and anxiety-provoking six weekly therapy sessions were. Over time, patients gradually found the VR experience less stressful. SOURCE: O. PERCIE DU SERT ET AL/SCHIZOPHRENIA RESEARCH 2018

type of self-help. This may be especially useful for patients who are averse to visiting a therapist, such as people with social anxiety or agoraphobia, or for people living in remote areas without access to specialists.

The first fully automated virtual reality therapy, designed for fear of heights, was described in the *Lancet Psychiatry* in August (SN: 8/4/18, p. 15). In this program, an animated therapist guides a patient up a 10-story office complex. The user performs increasingly difficult tasks, from standing near a drop-off to going out on a platform over a central atrium. The virtual therapist periodically checks how the patient is feeling and offers encouragement. Freeman and colleagues tested this program on 100 patients: Forty-nine were randomly assigned to two weeks of VR treatment; the other 51 got no treatment.

"I anticipated it was just going to be like a game," one VR participant said, but the program "pushed the limits in terms of what I thought I would be able to achieve."

On a scale measuring fear of heights from 16 to 80, the scores of people who used the VR program dropped, on average, about 25 points after treatment. The no-treatment group kept about the same scores as before. While results are encouraging, researchers don't yet know how this program measures up to real-life therapy.

Another self-led treatment, this one to calm fear of spiders, has been tested against face-to-face therapy. The three-hour VR program involves various arachnids — a cartoonish, slipper-wearing spider to a realistic tarantula. The spiders approach the user while a virtual



One VR program treats arachnophobia by exposing users to spiders, working up from a cute, cartoonish spider to a more realistic tarantula (shown).

therapist offers instructions and encouragement.

"I'm not sure if anyone ripped the headset off, but a lot of people definitely started crying," says Philip Lindner, a clinical psychologist at Stockholm University. One patient who was virtually sitting in a living room with a lot of spiders crawling around on the floor "physically put up her legs and sat like that for, like, 15 minutes."

Researchers tested this system on 97 arachnophobia patients and described the results last November in San Diego at the Annual Association for Behavioral and Cognitive Therapies Convention. Half of the volunteers were randomly assigned to receive VR therapy and then encouraged to try approaching spiders in the real world. The other half completed a three-hour session of normal exposure therapy, where participants worked up from catching spiders in cups to holding a spider in each hand.

Before treatment, both sets of participants generally wouldn't go near a spider in a clear container, Lindner says. After treatment, VR participants could stand next to or even put their hands inside the container, and real-world exposure patients could touch the spider. One year later, though, some VR patients could touch the spider too.

Lindner suspects that the VR experience reduced patients' fears enough for them to try



In one fully automated VR therapy program, a virtual therapist helps users overcome their fear of heights by guiding them through a tall building with ledges overlooking an atrium.

real-world exposure on their own, so they caught up with the normal exposure group.

Despite the early successes for specific phobias, it's unclear whether therapist-free VR therapy for more complex disorders could be used at home.

In simulated social interactions, therapists carefully control virtual avatars' responses to address each patient's idiosyncratic anxieties. Computer-generated therapists aren't yet so versatile that they can have conversations with patients that go in any direction, Bouchard says. He does believe, however, that virtual humans will eventually reach that level of sophistication. Even if virtual therapists are up to the job, many patients may not be driven enough to complete treatment on their own, Lindner says. "There was a lot of hype about [smartphone] mental health apps, and very few of them saw any kind of extensive real-world use."

Motivation isn't the only barrier to self-help. In some cases, self-led therapy may simply be too stressful. For patients using the personified-hallucinations program, "it's really difficult to do at the beginning, because you're hearing really bad things, like, 'You're an asshole, go kill yourself,'" Dumais says. "I don't think a person can manage that alone."

But developers shouldn't discount potential stand-alone treatments before they've been tested, Reger says. These systems may make therapy, at least for some disorders, accessible to many patients who can't or don't want to see a human therapist. If automated treatments for complex disorders like PTSD were found safe and effective, he says, "I would certainly be a fan." ■

More to come

Scientists are testing VR programs to help with a broadening list of challenges, such as:

Depression

Learn to practice self-compassion

Stroke

Help survivors relearn motor skills

Addiction

Reduce cravings for people in recovery

Medical procedures

Distract during painful procedures

Eating disorders

Improve body image

Wheelchair users

Practice getting around



Young cancer patients at South Carolina's Clemson University are testing VR to relieve treatment-related pain and anxiety.

Explore more

- Albert "Skip" Rizzo and Sebastian T. Koenig. "Is clinical virtual reality ready for primetime?" *Neuropsychology*. November 2017.



THE NEXT MALARIA MENACE

Deforestation brings monkeys and humans close enough to share an age-old disease

By Yao-Hua Law

Vinita Surukan knew the mosquitoes were trouble. They attacked her in swarms, biting through her clothes as she worked to collect rubber tree sap near her village in Sabah, the northern state of Malaysia. The 30-year-old woman described the situation as nearly unbearable. But she needed the job.

There were few alternatives in her village surrounded by fragments of forest reserves and larger swaths of farms, oil palm plantations and rubber tree estates. So she endured until a week of high fever and vomiting forced her to stop.

The night of July 23, Surukan was trying to sleep off her fever when the clinic she visited earlier in the day called with results: Her blood was teeming with malaria parasites, about a million

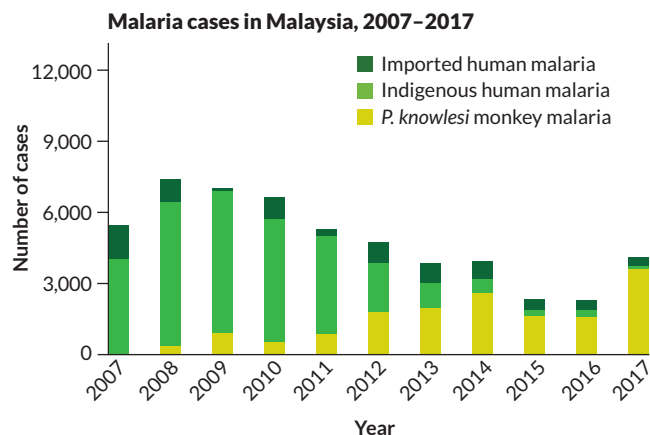
in each drop. Her family rushed her to the town hospital where she received intravenous anti-malarial drugs before being transferred to a city hospital equipped to treat severe malaria. The drugs cleared most of the parasites, and the lucky woman was smiling by morning.

Malaria has terrorized humans for millennia, its fevers carved into our earliest writing on ancient Sumerian clay tablets from Mesopotamia. In 2016, four species of human malaria parasites, which are spread by mosquito from person to person, infected more than 210 million people worldwide, killing almost 450,000. The deadliest species, *Plasmodium falciparum*, causes most of the infections.

But Surukan's malaria was different. Hers was not a human malaria parasite. She had *P. knowlesi*, which infects several monkey species. The same parasite had recently infected two other people in Surukan's village — a man who hunts in the forest and a teenager. Surukan suspects that her parasites came from the monkeys that live in the forest bordering the rubber tree estate where she worked. Some villagers quit working there after hearing of Surukan's illness.

Several states in Malaysia, including Sabah (above left), have lost large swaths of forest to oil palm and rubber tree plantations. As a result, macaques (center), which can carry malaria parasites, are living closer to people. Researchers collect blood samples from local residents to check for malaria parasite DNA (right).

FROM LEFT: PEACEFOO/SHUTTERSTOCK; DONALD WALKER/SHUTTERSTOCK



Fornace, an epidemiologist at the London School of Hygiene and Tropical Medicine. After testing blood samples of nearly 2,000 people from areas in Sabah with various levels of deforestation, she found that people staying or working near cut forests were more likely than people living away from forests to have *P. knowlesi* infections, she and colleagues reported in June in *PLOS Neglected*

Emerging threat

Malaysia is close to eliminating human malaria. Yet cases of *P. knowlesi* malaria transmitted from monkeys are up tenfold since 2008. SOURCE: MINISTRY OF HEALTH MALAYSIA 2018

Monkey malaria, discovered in the early 1900s, became a public health concern only in the last 15 years. Before that, scientists thought it was extremely rare for monkey malaria parasites, of which there are at least 30 species, to infect humans.

Yet since 2008, Malaysia has reported more than 15,000 cases of *P. knowlesi* infection and about 50 deaths. Infections in 2017 alone hit 3,600.

People infected with monkey malaria are found across Southeast Asia near forests with wild monkeys. In 2017, another species of monkey malaria parasite, *P. cynomolgi*, was found in five Malaysians and 13 Cambodians. And by 2018, at least 19 travelers to the region, mostly Europeans, had brought monkey malaria back to their home countries.

The rise of monkey malaria in Malaysia is closely tied to rapid deforestation, says Kimberly

Tropical Diseases. Stepping over felled trees, humans move closer to the monkeys and the parasite-carrying mosquitoes that thrive in cleared forests.

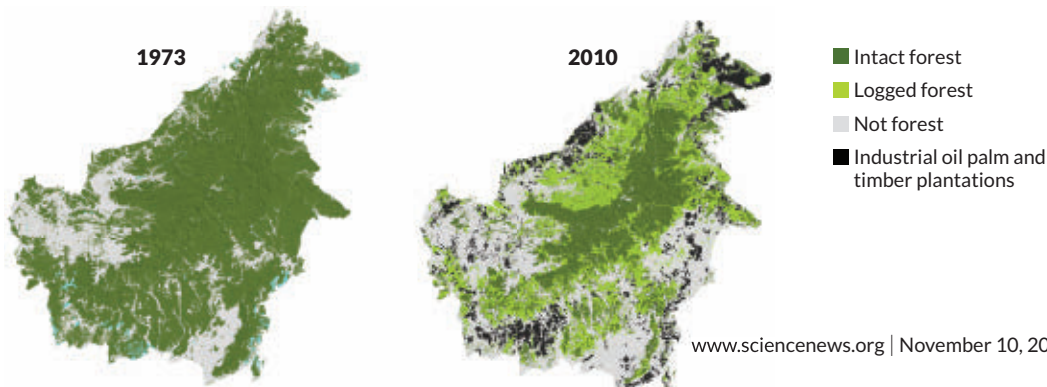
It's out there

There's no feasible way to treat wild monkeys for an infection that they show no signs of. "That's the problem with *P. knowlesi*," says Singapore-based infectious disease specialist Fe Espino, a director of the Asia Pacific Malaria Elimination Network.

In 2015, the World Health Organization set a goal for 2030: to stop malaria transmission in at least 35 of the 91 malaria-endemic countries. WHO targets the four human malaria parasites: *P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale*. Monkey malaria is excluded from the campaign because the agency regards it as an animal

Forests to farms

From 1973 to 2010, Borneo's intact forests dwindled as farming and logging grew, satellite images show.



disease that very rarely infects humans.

But as countries reduce human malaria, they will eventually have to deal with monkey malaria, Espino says, echoing an opinion widely shared by monkey malaria scientists.

“Something nasty” could emerge from the pool of malaria parasites in monkeys, says malariologist Richard Culleton of Nagasaki University in Japan. Culleton studies the genetics of human and monkey malaria. Malaria parasites can mutate quickly — possibly into new types that can more easily infect humans (*SN*: 9/6/14, p. 9). To Culleton, the monkey malaria reservoir “is like a black box. Things come flying out of it occasionally and you don’t know what’s coming next.”

Malaysia is very close to reaching the WHO target of human malaria elimination. In 2017, only 85 people there were infected with human malaria. But that success feels hollow as monkey malaria gains a foothold. And while monkey malaria has swelled into a public health threat only in Malaysia, the same could happen in other parts of Southeast Asia and beyond. Even in southeastern Brazil, where human malaria was eliminated 50 years ago, the *P. simium* malaria parasite that resides in howler monkeys caused outbreaks in humans in 2015 and 2016.

From tool to threat

In the late 1800s, scientists discovered the *Plasmodium* parasite and its *Anopheles* mosquito carriers. Humans retaliated by draining marshes to stop mosquito breeding and spraying insecticides over whole communities. Governments and militaries pursued antimalarial drugs as the

disease claimed countless soldiers during the two World Wars.

Scientists soon found malaria parasites in birds, rodents, apes and monkeys. To the researchers, the parasites found in monkeys were a tool for testing antimalarial drugs, not a threat. An accident, however, showed otherwise.

In 1960, biologist Don Eyles had been studying the monkey malaria *P. cynomolgi* at a National Institutes of Health lab in Memphis, Tenn., when he fell ill with malarial fevers. He had been infected with the parasites found in his research monkeys. His team quickly confirmed that the malaria parasites in his monkeys could be carried by mosquitoes to humans. Suddenly, monkey malaria was not just a tool; it was an animal disease that could naturally infect humans.

The news shook WHO, McWilson Warren said in a 2005 interview recorded by the Office of NIH History. Warren, a parasitologist, had been Eyles’ colleague. Five years before Eyles became infected, WHO had launched the Global Malaria Eradication Programme. Banking on insecticides and antimalarial drugs, the agency had aimed to end all malaria transmissions outside of Africa. A monkey malaria that easily infects humans would sink the program because there would be no way to treat all the monkeys.

A team of American scientists, including Eyles and Warren, traveled to Malaysia — then the Federation of Malaya — where the *P. cynomolgi* parasites that infected Eyles came from. Funded by NIH, the scientists worked with colleagues from the Institute of Medical Research in Kuala Lumpur, established in 1900 by the British to study tropical diseases.

From 1961 to 1965, the researchers discovered five new species of monkey malaria parasites and about two dozen mosquito species that carry the parasites. But the researchers did not find any human infections. Then, in 1965, an American surveyor became infected with *P. knowlesi* after spending several nights camping on a hill about 160 kilometers inland from Kuala Lumpur.

Warren surveyed the forested area where the infected American had camped. The hill sat beside a meandering river. Monkeys and gibbons, a type of ape, lived on the hill and in adjacent forests. The closest house was about two kilometers away. Warren sampled the blood of four monkeys and more than 1,100 villagers around the hill; he collected mosquitoes too.

He found *P. knowlesi* parasites in the monkeys, but none among the villagers. Only one mosquito

After becoming infected in 1960 with the malaria parasite found in his research monkeys, biologist Don Eyles took a team from the National Institutes of Health to Southeast Asia to study the parasites in nature. He is shown here with his pet gibbon, a type of ape, in Kuala Lumpur.



species, *A. maculatus*, appeared capable of transmitting malaria between monkeys and humans, but Warren deemed its numbers too low to matter. He concluded that monkey malaria stayed in the forests and rarely ever spilled into humans.

With those results, NIH ended the monkey malaria project, Warren said, and the Institute of Medical Research in Kuala Lumpur returned to its primary focus: human malaria, dengue and other mosquito-borne diseases. Monkey malaria was struck off the list of public health concerns.

Wake-up call

P. knowlesi landed back in the spotlight in 2004, with a report in the *Lancet* by malariologist Balbir Singh and his team. The group had found 120 people infected over two years in southern Malaysian Borneo. The patients were mostly indigenous people who lived near forests. Clinicians initially had checked the patients' blood samples under microscopes — the standard test — and diagnosed the parasites as human malaria. But when Singh, of Universiti Malaysia Sarawak, applied molecular tools that identify parasite species by their DNA, he revealed that all the samples were *P. knowlesi*. Monkey malaria was breaking out of the diminishing forests.

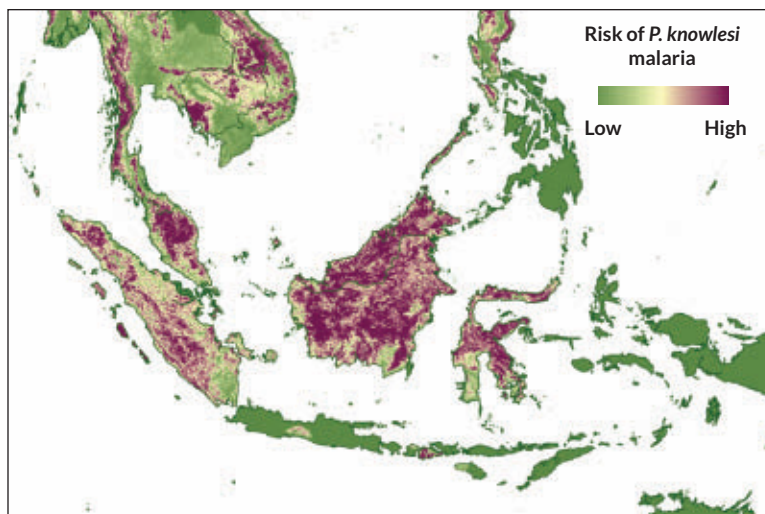
By 2018, *P. knowlesi* had infected humans in all Southeast Asian countries except for East Timor. Singapore, declared malaria free in 1982, reported that six soldiers were infected with *P. knowlesi* from wild monkeys in a forest reserve. The parasite also turned up in almost 380 out of 3,700 visitors to health clinics in North Sumatra, Indonesia, an area that is close to being deemed free of human malaria.

Many scientists now recognize *P. knowlesi* as the fifth malaria parasite species that can naturally infect humans. It is also the only one to multiply in the blood every 24 hours, and it can kill if treatment is delayed. People pick up *P. knowlesi* parasites from long-tailed macaques, pig-tailed macaques and Mitred leaf monkeys. These monkeys range across Southeast Asia. So far, malaria parasites have been found in monkeys near or in forests, but rarely in monkeys in towns or cities.

Scientists propose several reasons for the recent rise in monkey malaria infections, but two stand out: improvement in malaria detection and forest loss.

Malaysia, for instance, finds more monkey malaria cases than other Southeast Asian countries because it added molecular diagnostic tools

Predicted risk of *P. knowlesi* infection in humans in Southeast Asia



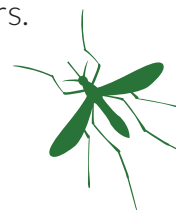
Expanded risk Malaysia bears the brunt of *P. knowlesi* malaria infections. But this 2016 map shows high predicted risk of disease (maroon) in other parts of Southeast Asia as well, based on epidemiologic and environmental factors.

in 2009. Other countries use only microscopy for detection, says Rose Nani Mudin, who heads the vectorborne disease sector at Malaysia's Ministry of Health. Since 2008, annual monkey malaria cases in Malaysia have climbed tenfold, even as human malaria cases have plummeted. "Maybe there is a genuine increase in [monkey malaria] cases. But with strengthening of surveillance, of course you would detect more cases," she says.

Data collected by Malaysia's malaria surveillance system have also revealed strong links between infection risk and deforestation. Fornace, the epidemiologist, examined the underlying drivers of monkey malaria in Surukan's home state of Sabah. Fornace mapped monkey malaria cases in 405 villages, based on patient records from 2008 to 2012. Satellite data showed changes in forested areas around those villages. The villages most likely to report monkey malaria infections were those that had cut more than 8 percent of their surrounding forests within the last five years, she and colleagues reported in 2016 in *Emerging Infectious Diseases*.

Fornace's team went into the field for a follow-up study, published in June in *PLOS Neglected Tropical Diseases*. The team collected blood samples from almost 2,000 people in two areas in Sabah and checked for current and past malaria infection. People who farmed or worked in plantations near forests had at least a 63 percent higher risk of *P. knowlesi* infection, and — like in the 2016 study — forests and cleared areas escalated risk of infection.

The villages most likely to report monkey malaria infections were those that had cut more than 8 percent of their surrounding forests within the last five years.





Kimberly Fornace (left) and collaborators at Universiti Malaysia Sabah collect blood samples from people in northern Sabah. The group checks blood for evidence of current and past malaria infections.

“It feels almost like *P. knowlesi* follows deforestation,” Fornace says. Several years after a forest is cut back, nearby communities “get a peak of *P. knowlesi*.”

Today, the hill where the American surveyor camped in 1965 is a small island in a sea of oil palm estates. From 2000 to 2012, Malaysia cleared a total amount of forest equaling 14.4 percent of its land area, more than any other country, according to a study published in 2013 in *Science*. A study in 2013 in *PLOS ONE* used satellite images to show that in 2009, only one-fifth of Malaysian Borneo was intact forest. Almost one-fourth of all forest there had been logged, regrown and logged many times over.

Since 2008, oil palm acreage in Malaysian Borneo has increased from 2.08 million hectares to 3.1 million, according to the Malaysian Palm Oil Board. In Malaysia, the four states hit hardest by deforestation — Sabah, Sarawak, Kelantan and Pahang — report 95 percent of the country’s *P. knowlesi* cases.

Fornace thinks deforestation and the ecological changes that come with it are the main drivers of monkey malaria’s rise in Malaysia. She has seen long-tailed macaques spend more time in farms and near houses after their home forests were being logged. Macaques thrive near human communities where food is abundant and predators stay out. Parasite-carrying mosquitoes breed in puddles made by farming and logging vehicles.

Where monkeys go, mosquitoes follow. Indra Vythilingam, a parasitologist at University of Malaya in Kuala Lumpur, studied human malaria in indigenous communities in the early 1990s. Back then, she rarely found *A. cracens*, the mosquito species that carries monkey malaria in Peninsular Malaysia. But in 2007, that species made up over 60 percent of mosquitoes collected

at forest edges and in orchards, she reported in 2012 in *Malaria Journal*. “It’s so much easier to find them” now, she says.

As Fornace points out, “*P. knowlesi* is a really good example of how a disease can emerge and change” as land use changes. She recommends that when big projects are evaluated for their impact on the economy and the environment, human health should be considered as well.

What to expect

While *P. knowlesi* cases are climbing in Malaysia, scientists have found no evidence that *P. knowlesi* transmits directly from human to mosquito to human (though many suspect it happens, albeit inefficiently).

Following a review by experts in 2017, WHO continues to exclude *P. knowlesi* from its malaria elimination efforts. Rabindra Abeyasinghe, a tropical medicine specialist who coordinates WHO malaria control in the western Pacific region, says the agency will reconsider *P. knowlesi* as human malaria if there is new evidence to show that the parasite transmits within human communities.

In Malaysia last year, only one person died from human malaria, but *P. knowlesi* killed 11. “We don’t want that to happen, which is why [*P. knowlesi*] is our priority even though it is not in the elimination program,” says Rose Nani Mudin from the country’s Ministry of Health.

Unable to do much with the monkeys in the trees, Malaysian health officers focus on the people most likely to be infected with *P. knowlesi*. Programs raise awareness of monkey malaria and aim to reduce mosquitoes around houses. New mosquito-control methods are needed, however, because conventional methods like insecticide-treated bed nets do not work for monkey malaria mosquitoes that bite outdoors around dusk.

Fighting malaria is like playing chess against an opponent that counters every good move we make, says Culleton in Japan. Malaria parasites can mutate quickly and “go away and hide in places and come out again.” Against malaria, he says, “we can never let our guard down.” ■

Explore more

- Bridget E. Barber *et al.* “World Malaria Report: time to acknowledge *Plasmodium knowlesi* malaria.” *Malaria Journal*. March 31, 2017.

Yao-Hua Law is a freelance science writer based in Kuala Lumpur, Malaysia.

SOCIETY UPDATE

200 STEM educators share best practices for building a science research program



Society for Science & the Public recently gathered 200 science research teachers in Washington, D.C., to discuss key science education issues at the Research Teachers Conference, sponsored by Regeneron. Educators talked about leading students in scientific research and best practices for recruiting underserved students. Teachers also met with elected officials to discuss the importance of STEM education.

“The young people sitting in science classrooms today will someday be solving our world’s largest challenges,” says Maya Ajmera, President and CEO of the Society and Publisher of *Science News*. “I’m thrilled that through the Research Teachers Conference, the Society is providing teachers with the tools they need to guide their students through scientific research and help foster a love of science.”

ALABAMA

Kathy Eldridge

ARIZONA

Katy Gazda
Florence Hulihee
Rachna Nath
Lisa Randall
Merissa Remus
Meena Rustagi
Robert Talasek
Elyse Wexler
Jeremy Williams

ARKANSAS

Melissa Donham
Amanda Sellers

CALIFORNIA

Jordan Adler
Lisa Battig
Jennifer Claudio
Julianne Cotta
Dominique Evans
Aidy Gonzalez-Serricchio
Michael Gruden
Jake Hardey
Emilie Hill
Chrystal Johnson
Andrea McKinley
Cathy Messenger
Cheryl Miller
Thuy-Anh Nguyen
Heriberto Olive
Stacie Richard
Diane Tucker
Josh White

COLORADO

Samantha Agoos
Paul Strode

CONNECTICUT

Michelle Bellinger
Deborah Day
Kim Felton-Patnaude

Kaitlin Johnson
Corazon Libao-de Leon
Corey Nagle
Jenn Rinehart
Lauren Ziccardi

DISTRICT OF COLUMBIA

Jon Alexis
Angel Ballard
Geneva Jost
Rickey Torrence
Bill Wallace

FLORIDA

Renae Allen
Lauren D'Ambrosio
Jennifer Gordinier
Jill Hansen
Andrew Harshman
Tavia Marex
Michelle McGurr
Karen Perry
Ariel Simonton
Cheri Stephens
Mary Wildmon

GEORGIA

Robert Bice
Laura Elsarelli
James Holden
Cathrine Nolan

IDAHO

Janna Privette

ILLINOIS

Nita Bhatt
Sandrine Clairardin
Jasara Hines

Bill Kane

Cameron Martin

Jenny Morris

INDIANA

Ashley Cosme
Brittany Croy
Leah Hinderlider

Kimberly Holifield

IOWA

Kevin Brasser
Edward Griesel
Alicia Schiller Haynes
Stacey Rector

KANSAS

Amy Hammett
Eric Kessler

LOUISIANA

Regina Humphrey

MAINE

Peter Southam

MARYLAND

Christal Long
Erin Radebe
Gerald Saunders
Keondra Whaley

MASSACHUSETTS

Kathleen Bateman
Jared Courtney
Beth Dietz
Brenda Perez
Goodrum

MICHIGAN

James Carrow
Nancy Schultz-Speck
Julie Smith

MINNESOTA

Dennis Boxrud
Princesa Hansen
Devon Vojtech
Cynthia Welsh

MISSISSIPPI

Krystal Chatman

MISSOURI

Cathy Farrar
Peggy Veatch

MONTANA

Dave Jones

Nancy Males
Linda Rost

NEBRASKA

Deanne Bishop

NEVADA

Freda Vine

NEW JERSEY

Gerardo Arias
Denise (Dennie) Glenn
Kelly Hadden
Roxanne Spencer

NEW MEXICO

Ivy Alefante
Arnel Dela Cruz
Creighton Edington
Sandra Mack
Nate Raynor

NEW YORK

Shanaz Baksh
Hanh Bui
Annie Chien
Lena Cosentino
Claudia Diaz
Michelle Flannory
Vivienne Forrester
Victoria Hernandez
Lutz Holzinger
Nancy Hunter
June Morrison Jones
Niegel La Borde
Ellen McGlade-McCulloh
Joshua Modeste
Nicole Monaco
James Nelson
Lisa Reece
Gilana Reiss
Anthony Samonte
Mary Simons
Michael Vaccariello
Tom Vartuli
Marge Whitehead

Maria Zeitlin

NORTH CAROLINA

Jessie Howington
Brandon Staton
Ana Maria Topliceanu

OHIO

Jeanette Marshall
Crystal Miller
Kelly Nyzen
Gina Smearsoll

OKLAHOMA

Christopher Hurt
Deborah Pettus
David Swift

OREGON

Karen Doersam
Diego Martinez

PENNSYLVANIA

Diane Fox
Terese Grateful
Patti Griest
Janelle Roberts
Lakshmi Shrikantia
Janet Waldeck

PUERTO RICO

Maria de los Angeles Rodriguez
Jan Lugo
Yamitza Rosas
Nelson Ruiz

RHODE ISLAND

Mark Fontaine

TENNESSEE

Cameron Cooley
Jack Gray
Jeannie Long
Art Scott

TEXAS

Remelia Arpino
Lorie Beckner
Rhonda Christman

Sean Doyle

Gabriela Gomez
Raymond Haraway
Kathleen Howell
Courtney Johnson
Laura Johnson
Daniel Krall
Priscilla Lumbreras
Suraida Nanez-James
Ron Riley
Eva Sanchez
Rebecca Saunders
Karen Shepherd
Shonqualla West
Laura Wilbanks
Melissa Winkler

UTAH

Alicia Garff
Alisa Poppen
David Vick

VERMONT

Lori Fretta

VIRGINIA

Katharine Davis
Charlotte Embrey
Shanee' Frazier
Rhett Woo
Cynthia Woosley

WASHINGTON

Bridget McKay
Beverly Painter
Jennifer Santjer
Maritza Tavaraz-Brown
Jaci Washam

WEST VIRGINIA

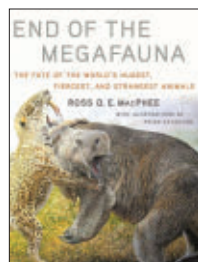
Shane Price

WISCONSIN

Andy Hartman
Jeff Ostheimer
Joe Rodich

WYOMING

Joel Kuper



End of the Megafauna
Ross D.E. MacPhee
and Peter Schouten
(illustrator)
W.W. NORTON & CO.,
\$35

BOOKSHELF

What wiped out the behemoths?

Today's land animals are a bunch of runts compared with creatures from the not-too-distant past. Beasts as big as elephants, gorillas and bears were once much more common around the world. Then, seemingly suddenly, hundreds of big species, including the woolly mammoth, the giant ground sloth and a lizard weighing as much as half a ton, disappeared. In *End of the Megafauna*, paleomammalogist Ross MacPhee makes one thing clear: The science on what caused the extinctions of these megafauna — animals larger than 44 kilograms, or about 100 pounds — is far from settled.

MacPhee dissects the evidence behind two main ideas: that as humans moved into new parts of the world over the last 50,000 years, people hunted the critters into oblivion, or that changes in climate left the animals

too vulnerable to survive. As MacPhee shows, neither scenario matches all of the available data.

Throughout, Peter Schouten's illustrations, reminiscent of paintings that enliven natural history museums, bring the behemoths back to life (such as the elephant bird of Madagascar, right, shown with modern lemurs for scale). At times, MacPhee slips in too many technical terms. But overall, he offers readers an informative, up-to-date overview of a fascinating period in Earth's history. — *Erin Wayman*



Never Home Alone
Rob Dunn
BASIC BOOKS, \$28

BOOKSHELF

There's a hidden world living in your house

As I write this in my basement office, a sticky trap lies beneath my desk catching whatever insects wander by. Its current haul is pretty typical: a cricket, a spider and some small flies. But as Rob Dunn writes in his intriguing new book, *Never Home Alone*, I'm missing a lot if I think that's all that lurks beneath my slippers.

Dunn has carved out an unusual niche as an ecologist, studying the myriad fauna that inhabits houses. These creatures are mostly small, such as microbes and insects, but that's only one reason they've gone largely undocumented.

There's also a bias worth noting. "As ecologists, we're trained to study life in 'nature,' which we have come to believe means the absence of humans," Dunn writes. But it's impossible to know what harmful or helpful species might live alongside us, he argues, if no one ever looks. So as Dunn relates in this backstage pass to his work, he and a team of fellow renegades set out to catalog life in unnatural spaces.

The team immediately found surprises. In their first look at house dust, Dunn and colleagues identified almost 8,000 bacterial species, including many new to science. What's more, an average home had about 100 species of arthropods (*SN*: 9/3/16, p. 15). The team also revealed that a giant species of Japanese camel cricket had invaded American homes without anyone noticing. And that was just the beginning.

In shower heads, Dunn's group discovered an entire ecosystem. There were dozens of species of *Mycobacteria*, some of

which can cause diseases including tuberculosis and some of which might impart health benefits. Alongside these microbes live predatory swimming bacteria, multicelled protists that eat the swimmers, and tiny worms that eat the protists. "This is the food web that falls upon you as you bathe," Dunn writes.

In their searches over the last several years, Dunn and colleagues have found about 200,000 different species in homes.

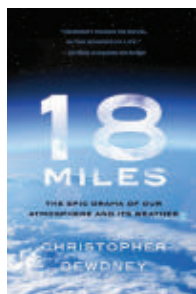
If your skin is starting to crawl at the thought of all these uninvited houseguests, don't despair. Most are harmless, or even helpful, Dunn has found. To that end, he's not only identifying who's there, but also asking what they're doing there, and if they might be useful in some way.

Some have potential, he's learned — even the camel cricket. By considering the insect's ecology — camel crickets typically live in caves, where food is scarce and difficult to digest — Dunn reasoned that bacteria in the cricket's gut may help it break down scraps of detritus. And in fact, he and colleagues have identified bacteria from the camel crickets that could perhaps break down industrial waste. Who knows what talents may lie in silverfish or drain flies?

Seen through Dunn's curious eyes, a house becomes not just a set of rooms, but a series of habitats to be explored. His writing and research lend a new appreciation of what many of us consider pests.

For the most part, it's our fight to sterilize our homes that's actually harmful, Dunn argues. Chlorinating tap water kills off many "good" bacteria to the benefit of harmful ones, and our efforts to exterminate the German cockroach have served only to create ones that are harder to kill.

Rather than trying to seal everything out, Dunn says, we should welcome a little bit of nature into our homes. Open a window and enjoy the abundance of life. — *Erika Engelhaupt*



18 Miles
Christopher Dewdney
ECW PRESS, \$17.95

BOOKSHELF

Take a journey through Earth's atmosphere

How thick is Earth's atmosphere? Sorry, that's a bit of a trick question: Our planet's air simply gets thinner with altitude, fading away to nothingness somewhere far above the height at which the lowest satellites orbit. It's a fact, though, that 99 percent of Earth's air lies below an altitude of 18 miles.

Naturalist Christopher Dewdney uses that distance as the title of his latest book, which takes a deep dive into the science behind weather and climate.

18 Miles is full of fun facts: A cloud a few hundred meters cubed contains only a bathtub's worth of water, for instance. And the phrase "cloud nine" references a category that the *International Cloud Atlas* uses in its cloud classification system.

But the book is so much more than trivia. *18 Miles* also contains detailed yet readable explanations of weather-related phenomena, from the annual cycle of seasons to how Earth's rotation influences the spin of hurricanes and the large-scale wind patterns that drive such storms across long distances.

Beyond the science of weather and climate, Dewdney delves into history and culture, including recounting the evolution of weather forecasting. A few thousand years ago, the Babylonians surmised weather from observations of cloud patterns, Dewdney notes. Now, meteorologists use computer simulations to prognosticate conditions nearly a week into the future.

A chapter that chronicles a handful of occasions when weather changed the course of history, including how bitter cold thwarted Napoleon's invasion of Russia in 1812, is particularly fascinating.

Dewdney's stories of the scientists who teased out the details of weather and climate are equally engaging. For example, in the late 1960s, the Japanese physicist Tetsuya Fujita analyzed the damage generated by tornadoes in the United States and then invented the twister-rating scale that bears his name. About two decades earlier, he used similar techniques to study the immense destruction left by the atomic bombs dropped on Hiroshima and Nagasaki during World War II — analyses that helped estimate the immense power of those bombs and reinforced Japan's decision to surrender.

From our planet's formation to the present day and beyond, *18 Miles* relates the epic tale of Earth's atmosphere and its influence on our planet's inhabitants. It's well worth a read. — *Sid Perkins*

THE GRADUATE CENTER

CITY UNIVERSITY
OF NEW YORK



Graduate Science Programs

Top-tier Ph.D. and master's degree programs
advance your career at The Graduate Center, CUNY.

Join us in the heart of New York City. We offer exceptional research and professional opportunities that move you ahead.

To explore our programs,
and to apply, visit

[@GCsciences](http://gc.cuny.edu/science)

- Ph.D. Audiology
- Ph.D. Biology
- Ph.D. Biochemistry
- Ph.D. Chemistry
- Ph.D. Computer Science
- Ph.D. Earth and Environmental Sciences
- Ph.D. Mathematics
- Ph.D. Nursing Science
- Ph.D. Physics
- Ph.D. Psychology
- Ph.D. Speech Language Hearing Sciences
- M.S. Cognitive Neuroscience
- M.S. Data Science
- M.S. Data Analysis and Visualization
- M.S. Quantitative Methods in the Social Sciences



SEPTEMBER 29, 2018

SOCIAL MEDIA

Do the twist

Breaking dry spaghetti noodles without shattering them is almost impossible. But using a custom device, researchers found that twisting and bending a noodle will create a clean break, **Maria Temming** reported in “How not to shatter spaghetti” (SN: 9/29/18, p. 5). Twitter user **Charles Tam** poked fun at the work: “Why would anyone pastably consider this sort of research? It’s bound to land in hot water ... it’s a noodle scratcher. #dadjokes.”

Join the conversation

E-MAIL editors@sciencenews.org

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

Connect with us



Hot stuff

A new material that converts sunlight into heat could someday melt ice off airplane wings, wind turbines and rooftops, **Maria Temming** reported in “Light gives new deicer an assist” (SN: 9/29/18, p. 17). “What happens when the object (such as an airplane wing) to which the material has been applied is subjected to the sun on a hot summer day?” asked online reader **Nell Kroeger**. “Could the object dangerously overheat?”

The material can heat up to tens of degrees Celsius above the ambient temperature, says **Susmita Dash**, an engineer at the Indian Institute of Science in Bangalore. A coated airplane wing on a hot summer day will heat up, she says, but “I don’t think it will reach a dangerously high temperature.”

Dash suggests one way to avoid potential overheating: use the material only during the cold season. “In the case of rooftops ... I think it can be used as a laminate during winters and can be easily removed and stored during the summers,” she says.

Bloom food

*Scientists around the United States are developing programs that can predict in advance toxic red tides, like one that’s ravaging Florida’s coast, as well as other harmful algal blooms, **Leah Rosenbaum** reported in “New tools aim to predict toxic tides” (SN: 9/29/18, p. 14).*

“Coastal states plagued with blooms ... seem to be spiraling toward disaster from global warming and runoff from agriculture,” reader **Enrique Petrovich** wrote. “Would agricultural chemical runoff cause these toxic algal blooms if the farms were converted to organic?” he asked.

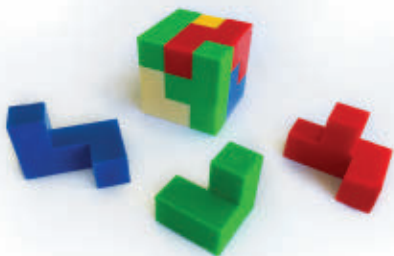
Excess nutrients — such as nitrate and phosphate — whether organic, inorganic or synthetic are all usable by algae and can lead to rapid growth, says oceanographer **Clarissa Anderson** of the Scripps Institution of Oceanography in La Jolla, Calif.

Unless organic farms are better at controlling runoff, **Rosenbaum** adds, they can still contribute to blooms.



UNITED STATES POSTAL SERVICE® (All Periodicals Publications Except Requester Publications)			
1. Publication Title Science News		2. Publication Number 0 0 3 8 4 2 3	3. Filing Date October 1, 2018
4. Issue Frequency Bi-Weekly (except Jan, Apr, Sept)		5. Number of Issues Published Annually 24/year	6. Annual Subscription Price \$50.00
7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4) Society for Science & the Public 1719 N Street, NW, Washington, DC 20036-2801		8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer) Society for Science & the Public 1719 N Street, NW, Washington, DC 20036-2801	
9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)			
Publisher (Name and complete mailing address) Maya Ajmera, SCIENCE NEWS, 1719 N Street, NW, Washington, DC 20036-2801			
Editor (Name and complete mailing address) Nancy Shute, SCIENCE NEWS, 1719 N Street, NW, Washington, DC 20036-2801			
Managing Editor (Name and complete mailing address) Erin Wayman, SCIENCE NEWS, 1719 N Street, NW, Washington, DC 20036-2801			
10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)			
Full Name Society for Science & the Public		Complete Mailing Address 1719 N Street, NW, Washington DC 20036-2801	
11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box <input checked="" type="checkbox"/> None			
12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one) <input checked="" type="checkbox"/> The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes: <input type="checkbox"/> Has Not Changed During Preceding 12 Months <input type="checkbox"/> Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)			
13. Publication Title SCIENCE NEWS		14. Issue Date for Circulation Data Below October 13, 2018	
15. Extent and Nature of Circulation		Average No. Copies Each Issue During Preceding 12 Months	
a. Total Number of Copies (Net press run)		103,333	
b. Paid Circulation (By Mail and Outside the Mail)		108,790	
c. Total Paid Distribution (Sum of 15b(1), (2), (3), and (4))		110,467	
d. Free or Nominal Rate Outside-County Copies included on PS Form 3541		1,324	
e. Total Free or Nominal Rate Distribution (Sum of 15d(1), (2), (3), and (4))		1,754	
f. Total Distribution (Sum of 15c and 15e)		112,221	
g. Copies not Distributed (See Instructions to Publishers #4 (page #3))		1,112	
h. Total (Sum of 15f and g)		113,333	
i. Percent Paid (15c divided by 15f times 100)		97.42%	
16. Electronic Copy Circulation		Average No. Copies Each Issue During Preceding 12 Months	
a. Paid Electronic Copies		6,908	
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a)		113,333	
c. Total Paid Distribution (Line 15c) + Paid Electronic Copies (Line 16a)		113,333	
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 15f times 100)		98.33%	
<input checked="" type="checkbox"/> I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.			
17. Publication of Statement of Ownership <input checked="" type="checkbox"/> If the publication is a general publication, publication of this statement is required. Will be printed in the 11/30/2018 issue of this publication <input type="checkbox"/> Publication not required			
18. Signature and Title of Editor, Publisher, Business Manager, or Owner Maya Ajmera, Publisher Date: 10/19/2018			
I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).			

WORLD'S HARDEST PUZZLE



And also some easy ones. Stimulate your mind, or that of a child with this more universal version of the Soma shape puzzle. 33 pieces configure into 20,000 specific puzzles graded from easy to hard in a 52 page code book. One or two person play, can handicap by difficulty.

ZobristCube.com

or

AMAZON.COM
search "Zobrist Cube"

The most comfortable wallet you'll ever own.



Back pocket wallets are poorly designed - they're bulky, uncomfortable and easy to have stolen. So at our little leather shop in Maine, we reimagined the wallet and what it could be.

We started with a new design that was slim, secure, and shaped for your front pocket. We put the finest American leathers in the hands of our craftsmen and women. And we ended up with a wallet you'll want to carry for a lifetime. Not everyone cares about well-made leather goods. But if you're the type of person who does, we're glad you found us.

Rogue Industries
rogue-industries.com | 800-786-1768



FREE Report

**\$15.00
value**

**Scams
EXPOSED!**

Learn the truth about distilled, mineral, tap, spring, filtered, bottled, well, alkalized, reverse osmosis and more...

Which one is best for you?

www.waterscams.com/sn

—or call for **FREE**
Report & Catalog



Waterwise Inc PO Box 494000 Leesburg FL 34749

800-874-9028 Ext 662

© 2007-2018 Waterwise Inc



✓Yes



✓Yes



✓Yes



Complete Brake Kits!

✓Yes



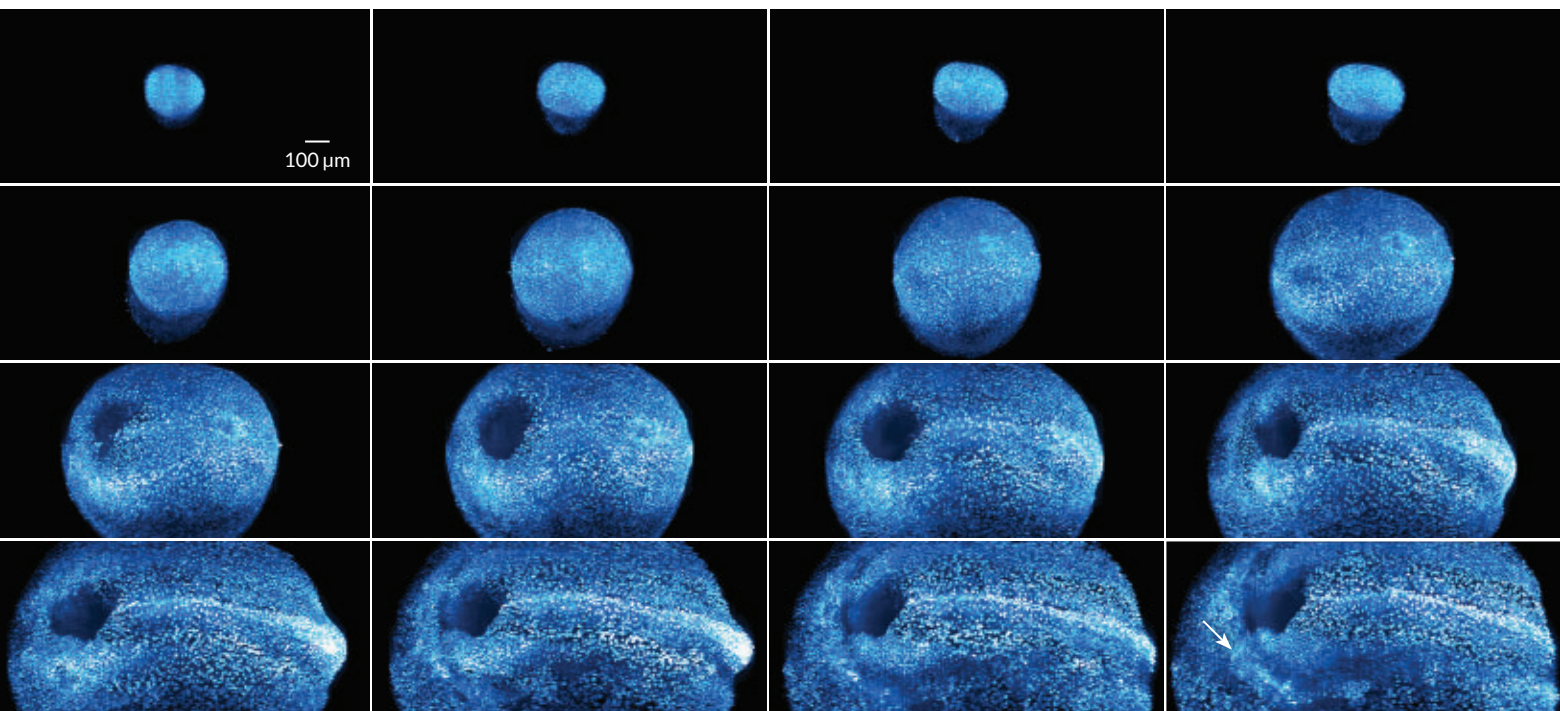
xNo



✓Yes

✓Reliably Low Prices
✓Easy To Use Website
✓Huge Selection
✓Fast Shipping
www.rockauto.com

ROCKAUTO.COM
ALL THE PARTS YOUR CAR WILL EVER NEED



See the most detailed views yet of a developing mouse

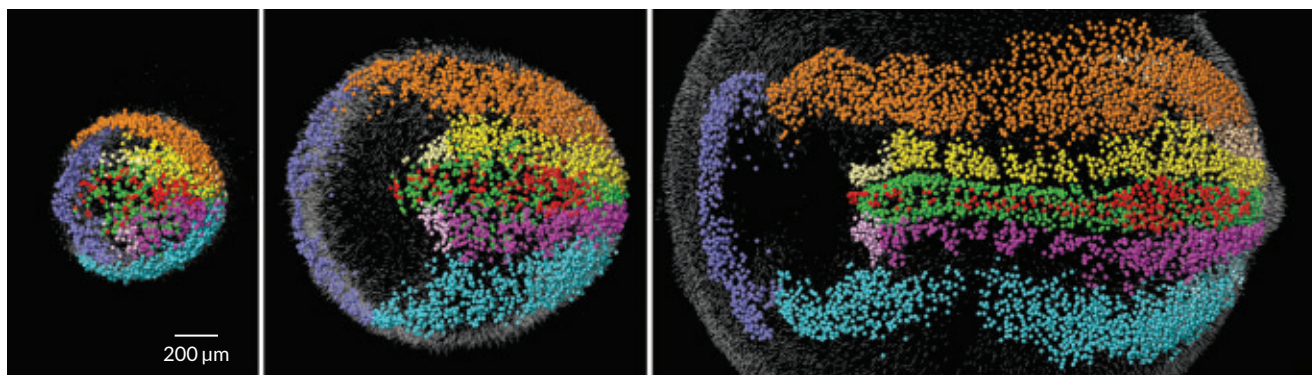
A new microscope is giving an unprecedented view of how mammals are built, cell by cell.

The device tracked developing mouse embryos in real time over roughly two days (one shown above in false color at about three-hour intervals). As the embryo rapidly expands in size, the gut (dark circle that appears in the third row, first box) starts to form when part of the embryo collapses. And a structure that eventually forms the brain and spinal cord, called a neural tube (white line), appears like a comet shooting across the night sky. Scientists also captured the first beats of heart cells (arrow) with the microscope, described in the Oct. 18 *Cell*.

“These are processes no one has been able to watch before,” says study coauthor Kate McDole, a developmental biologist at Howard Hughes Medical Institute’s Janelia Research Campus in Ashburn, Va. “It’s not like you can Google these things.”

Called a light sheet microscope, the instrument uses ultra-thin laser beams to illuminate sections of a specimen while cameras record those areas. Previous iterations have captured portraits of developing zebrafish and fruit fly embryos. The new version of the device let researchers monitor for the first time in such detail the development of a mammal, a larger and more complex organism.

Computer programs used the data — about a million images per embryo — to map the life history of each cell in an embryo (a selection of cell types seen in the visualizations below). Tracked cells include those of the heart (purple), neural tube (green), a structure that plays a key role in development called the notochord (red) and the embryo’s middle layer (all other colors). Such technology may help resolve how mammals develop from single cells to multicellular embryos, crucial information for scientists trying to grow human organs, McDole says. — *Cassie Martin*



ALL: K. MCDOLE ET AL/CELL 2018

The Science of Alzheimer's & the Promise of Prevention

Dr. Richard Isaacson, M.D., Weill Cornell Medicine

Scientists have uncovered **compelling defenses** against Alzheimer's. This **new audio course** gives you practical steps to keep your brain healthy.

Did you know that Alzheimer's disease (AD) begins in the brain decades before symptoms appear? But there is good news: you can take easy steps right now to ward off these symptoms — before or after their onset. Whether you or a loved one have Alzheimer's or you simply want to stay healthy, this 12-lecture series is for you.

The Science of Alzheimer's Prevention and the Promise of Prevention answers the most common questions patients and caregivers have about AD. Combining cutting-edge research and firsthand experience treating thousands of patients, Dr. Richard Isaacson, M.D., gives you a life-changing guide to your mental health. Armed with keen insights, you can fortify your mind today.

12 Lectures

1. What Is Alzheimer's Disease?
2. Alzheimer's Disease Stages
3. Alzheimer's Risk Factors
4. The Diagnosis of Alzheimer's Disease
5. An Overview of Alzheimer's Prevention and Treatment Strategies
6. Brain Health and Nutrition
7. Diet and Nutrition: What and How to Eat
8. Supplements and Vitamins
9. Physical Exercise
10. Cognitive Engagement, Brain Training, and Educational Attainment
11. Stress Reduction and Sleep Hygiene
12. The Future of Alzheimer's Disease

SALE ENDS 11/7/2018

1-800-955-3904

www.NowYouKnowMedia.com/ALZ

Now You Know Media, Inc.
12115 Parklawn Dr., Unit B • Rockville, MD 20852

ORDER TODAY

**SAVE UP TO
\$85**

Sale Ends Nov. 11



"I loved working with Dr. Isaacson to develop a personalized Alzheimer's risk reduction plan. He and his team are constantly on top of the latest research."

—Max Lugavere, filmmaker and journalist



THE SCIENCE OF ALZHEIMER'S AND THE PROMISE OF PREVENTION

12 LECTURES (25 MINUTES/LECTURE)

MP3s or Audio CDs ~~\$119.95~~ **NOW \$35.95**

+ \$8.95 shipping & handling for CDs
100% Satisfaction Guarantee

Coupon Code: A2197

This Necklace is NOT for Sale...

It's yours for **FREE***

No kidding. Only Stauer can give you
200 carats of genuine amethyst for **NOTHING**.

You may think you understood the concept of "priceless" jewelry. For years, "priceless" meant "astronomically expensive." Owning "priceless" treasures was a rare privilege reserved for celebrities, billionaires, and royalty. The best most of us could do was dream. Until now...

Stauer smashes the luxury status quo with the release of our **FREE*** 200-Carat **Lusso Amethyst Necklace**. That's right, we said **FREE...** as in "priceless." No charge.* **ZERO** dollars.* Call now and we'll send you this impressive helping of genuine amethyst (independently appraised at \$295) for **FREE**. We cut the price 100% and you pay only \$24.95, our regular charge for shipping, processing and insurance...we'll even **pay you back with a \$25 Discount Certificate—that's Better Than Free shipping!** There are no tricks or gimmicks. You aren't obligated to spend another dime or dollar with us... although we make it **VERY** hard to resist.

Why give away jewelry? We want your attention. Once you get a closer look at our rare gemstone treasures and vintage-inspired watches, and once you discover the guilt-free fun of getting luxury for less, we're betting that you'll fall in love with Stauer. If not? Keep your **FREE Lusso Amethyst Necklace** anyway. No hard feelings.

A collection of purple perfection. Your **Lusso Amethyst Necklace** is a 200-carat symphony of smooth purple genuine gemstones. Each gemstone's shape and translucence ignites the velvety, violet hues. The polished amethysts are hand-strung on double-knotted jeweler's thread, and the stunning 18" necklace (with 2" extender) secures with a gold-finished lobster clasp. Once you wear it, you'll see that it hangs with the same weight and elegance as similar strands that sell for hundreds more.

Too good to pass up. Too good to last long. Amethyst is one of the world's most coveted gemstones and our supply is extremely limited. We can only offer such an outrageous deal for a short time every few years. Over 30,000 thrilled customers were lucky enough to get this promotion last time. **We only have about 2500 left in stock.** Call to reserve your **FREE Lusso Amethyst Necklace** today and treat yourself (or someone you love) to a brilliant new definition of priceless luxury!

Lusso Amethyst Necklace (200 ctw) \$249**

Your Cost With Offer Code— **FREE***

*pay only shipping & processing of \$24.95

You must use the offer code below to receive this special free necklace.

1-800-333-2045

Offer Code LAN395-02
Mention this code for the free necklace.



Rating of A+

Stauer® 14101 Southcross Drive W., Ste 155, Dept. LAN395-02,
Burnsville, Minnesota 55337 www.stauer.com

"This necklace is beautiful. I could not believe my eyes...GREAT!"

—Bonnie
Longs, S. C.

FREE Amethyst Necklace
Limited to the first 2500
respondersto this ad only!

**Buy NOW,
pay NEVER.**

An Exclusive **FREE**
Jewelry Offer
from Stauer®

Necklace enlarged to
show luxurious detail.

200 carats of pure luxury

independently appraised at \$295+...yours **FREE!***

200 ctw of genuine amethyst • Gold-finished spacers • 18" + 2" length necklace

* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV, OR, SC, VA, ID and CA. These state residents will be charged one cent (\$.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address. ** Free is only for customers using the offer code versus the price on Stauer.com without your offer code. † For more information concerning the appraisal, visit <http://www.stauer.com/appraisedvalues.asp>.

Smart Luxuries—Surprising Prices™