SN
SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC
MARCH 22, 2014

Clouds Complicate Climate Prediction

Vitamin C Boosts Chemo

Native Americans' DNA Ancestry

Fire Ants Meet Their Match

PULLING OUT OF ADDICTION

Surveys suggest that substance abuse can be conquered for life

Secret Gold Deposit FOUND!

Strike it rich every hour with the 24K gold-faced Stauer Midas Watch for only $149!

Man's quest for gold started centuries ago. Throughout history, explorers, fortune hunters and pirates have scoured the planet in search of the precious metal. They ventured into the catacombs of Ancient Egypt. They led expeditions into the wild heart of the Amazon rainforest and chased shipwrecks into the depths of the Atlantic Ocean. Some went mad with lust and greed. Some discovered treasure beyond their wildest imagination. But not one of them was as lucky as you.

Your quest for gold starts and ends here. The Stauer ***Midas Watch*** is a spectacular timepiece with a 24K gold face, available to you today for the unbelievable price of **only $149!** You read that right. Own this luxury classic—featuring a magnificent dial layered in hammered sheets of .999 pure gold—for less than $150! Put it on your wrist and your concept of time and luxury will change forever.

Inspired by the greatest goldsmiths of Europe. The ***Midas Watch*** was born after we went to Venice to visit the shimmering domes of St. Mark's Basilica. Most of the massive gold mosaics in the cathedral were completed in the 13th-century, but every surface still glows with a fiery light. That's the power of pure gold. There's nothing like it on Earth.

The face of the ***Midas Watch*** burns with that same legendary luster, beneath three gold-finished hands and easy-to-read date and day-of-the-week windows. But our ***Midas Watch*** is more than a showpiece. Underneath its gleaming gold exterior beats the heart of a precision time machine. Oscillating at 32,768 times per second, the precision movement is consistently accurate to within two seconds per day.

Your satisfaction is 100% guaranteed. Take the Stauer *Midas Watch* for a test drive on the Gold Coast. Wear it for a few weeks and if you're not completely impressed, send it back within 30 days for a full refund of your purchase price. History is full of men who spent their lives in search of the ultimate precious metal prize. But once you bring home the Stauer ***Midas Watch***, you'll get to strike gold every hour!

Stauer Midas Watch— ~~$395~~

Insider Promotional Code Price *only* **$149** + S&P

You must use the insider promotional code to get the lowest price.

1-888-201-7083

Your Promotional Code: MIW137-02
Please use this code when you order to receive your discount.

Stauer®
14101 Southcross Drive W.,
Dept. MIW137-02
Burnsville, Minnesota 55337
www.stauer.com

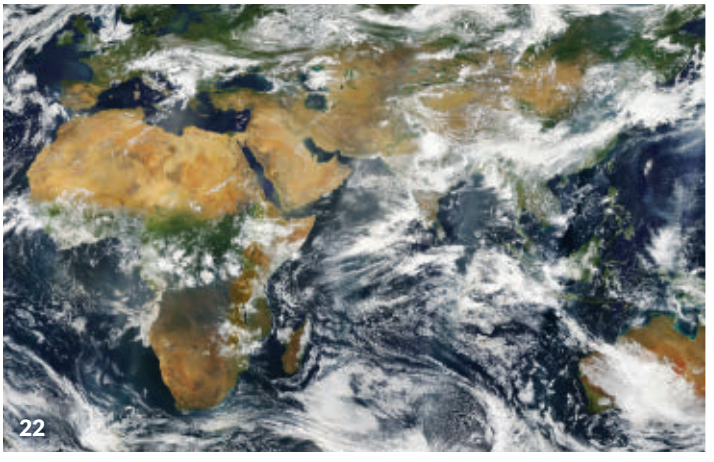
ACCREDITED BUSINESS
Rating of A+

Smart Luxuries—Surprising Prices™

Precision quartz movement - .999 genuine gold leaf dial - Day and date of the week windows - Fits wrists up to 8 ½" - Water-resistant to 3 ATM

VOL. 185 | NO. 6

ScienceNews



Features

News

CLOCKWISE FROM TOP LEFT: NASA; © CHRISTY STEWART; S.L. ANZICK

Departments

COVER Though addiction can be a lifelong struggle, some research suggests that most substance abusers do fully recover. *Tang Yau Hoong*

Beating addiction: impossible or surprisingly common?

It's hard to find anyone whose life hasn't been touched by addiction, in some form or another. Whether it's my unbridled coffee intake, a friend's pack-a-day cigarette habit, a cousin's problem drinking or a brother's drug abuse, addictions are all around us. By definition, these are the habits that are hard to break. But what pushes them into "addiction" territory is these habits' ability to harm, destroying bodies (some slowly, some swiftly) and even shattering lives.

Evidence points to two ways to think about addiction: as a chronic, brain-based disease or as a dysfunctional if temporary coping strategy — a bad habit — that a person can overcome in time. In his story on Page 16, Bruce Bower lays out the evidence for the latter. The conflict between the two views, Bower reveals, comes from different ways of studying the natural history of addiction. Research that focuses on people who have sought formal treatment paints a picture of lifelong struggle — these people tend to relapse over and over. In contrast, long-term studies of the general population identify many addicts who, a few years on, have given up the habit, usually without any structured treatment.

That's an empowering message, so why don't you hear it more often? Labeling addiction as a disease, and not a choice, may lead to more compassionate treatment of those who suffer with addiction and more support for public health measures to reduce it. But if scientists could learn more about how people pull themselves out of addiction, that information would be invaluable to public health.

Climate scientists are grappling with another two-sided problem: whether clouds, which act as both umbrellas and blankets around the planet, will have a net warming or cooling effect as climate warms. While the answer is still a bit hazy, as Gabriel Popkin reports on Page 22, it doesn't seem as though clouds will lessen global warming, as some had hoped.

You'll find some more definitive results in this issue as well: A new genetic study points to the Clovis people as ancestors to all indigenous Americans (Page 6). A second, larger wave of the H7N9 bird flu virus has hit China (Page 32). And the recent hiatus in global warming may well be due to stronger Pacific trade winds (Page 12). — *Eva Emerson, Editor-in-Chief*

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
Audit Bureau of Circulations
1719 N Street NW, Washington, DC 20036
Phone: (202) 785-2255
Customer service: member@societyforscience.org
Editorial/letters: editors@sciencenews.org
Sponsor content: snsales@sciencenews.org

Science News (ISSN 0036-8423) is published biweekly by Society for Science & the Public, 1719 N Street, NW, Washington, DC 20036.

Online and iPad access: Activate your subscribing member account, including digital access and the ability to opt out of print, at sciencenews.org/activate

Subscribe:
Web Visit sciencenews.org/join to become a subscribing member or renew at sciencenews.org/renew
Phone Call (800) 552-4412 in the U.S. or (570) 567-1191 outside of the U.S.
E-mail member@societyforscience.org
Mail *Science News*, PO Box 1205, Williamsport, PA 17703-1205

Subscribing memberships include 26 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 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

SANDY SCHAEFFER

Pure China Silver Sparks American Demand

AS LOW AS $29.95

Lock in new 2014 China Silver Pandas before they disappear!

Each year, as China releases its Silver Panda coin, millions of collectors and silver lovers around the world swarm the market for these silver coins. *Why?* The answers are surprisingly simple.

Massive 99.9% Pure Silver

Each hefty, One Ounce China Silver Panda is official legal tender struck in 99.9% pure silver—among the purest silver coins ever struck! In addition, each coin is guaranteed to be in stunning Brilliant Uncirculated (BU) condition.

One-Year-Only Design

Unlike comparable U.S., Canadian, and other world silver coins whose designs don't change, each years' China Silver Panda features a new, one-year-only design. This leads many to seek out each and every year for their beauty and collectibility.

The China Silver Rush is ON!

The China Silver Panda has been one of the world's most popular coins for the last thirty years. But remarkably, an old 1949 law prohibited Chinese citizens from owning these coins until the law was changed in 2004. When the law was finally changed, millions of China's prosperous new middle class buyers flooded into the market. The Chinese silver rush is on!

Current prices for past-year Pandas:

Due to availability and demand, some past-year One Ounce Silver Pandas command impressive values these days:

2002 Silver Panda $120.00
2003 Silver Panda $158.00
2004 Silver Panda $108.00
2008 Silver Panda $99.00

Of course, no one can predict the future, but you can secure your 2014 Silver Pandas NOW for as little as $29.95 each.

FIRST RELEASE—Lock In and SAVE!

As a distributor, our very first official mint allocation is now available on a strictly first come, first served basis. By ordering today, you can lock in our lowest current price—plus the security of our full 30-day satisfaction guarantee.

Legal Tender Silver
Actual Size: 40mm

If you are not satisfied, simply return within 30 days for a full refund *(less all s/h)*.

Buy more and SAVE MORE!

$34.95 each for 1–4 coins (*plus s/h*)
$32.95 each for 5–9 coins (*plus s/h*)
$29.95 each for 10+ coins (*plus s/h*) Save $50 or MORE!

Toll-Free 24 hours a day

1-888-201-7662

Offer Code DPS131-01
Please mention this code when you call.

GovMint.com®
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive W., Dept. DPS131-01
Burnsville, Minnesota 55337
www.GovMint.com

Prices and availability subject to change without notice. Past performance is not a predictor of future performance. NOTE: GovMint.com® is a private distributor of worldwide government coin and currency issues and other collectible numismatic products, and is not affiliated with the United States government. Facts and figures deemed accurate as of February 2014. ©2014 GovMint.com

Excerpt from the March 21, 1964, issue of *Science News Letter*

50 YEARS AGO

Cell Visible by Own Light

Scientists can now "see" a single living cell made visible by its own light. A new image intensifier, which amplifies the very faint light of an individual cell in a way somewhat like the television screen makes its bright picture, has been developed. It can be made to amplify light as much as a million and a half times.... George T. Reynolds of Princeton ... used the image intensifier with a microscope to take pictures of *Noctiluca miliaris*, a tiny sea creature that gives the ocean its phosphorescent glow when present in large numbers.... The image intensifier consists of a photo-sensitive surface and a viewing screen, with five intervening membranes of aluminum oxide, each a one-hundred-thousandth of an inch thick.

UPDATE: George Reynolds' imaging process sped up the process of crystallography, used to determine protein structures. Reynolds and his colleagues went on to develop automated X-ray detectors, which led to the charge-coupled devices or CCDs that now collect most protein structural data.

IT'S ALIVE

Pelican spiders: slow, safe assassins

This isn't your average spider profile. A tiny "pelican" species faces left with its pair of long, fang-tipped hunting tools to the front.

SAY WHAT?

Osmotroph \OZ-*moh-trofe*\ *n.*

An organism that eats by osmosis, relying on nutrients diffusing into its body from a higher concentration in its environment. About 550 million years ago, ambitious aquatic fronds (fossil shown) began growing taller and tapped into more nutrient-rich water than found at the seafloor surface. Researchers simulated fluid flow over early multicellular osmotrophs, which may be early precursors to animals, and found that taller fronds absorbed more nutrients. The fronds grew up to 2 meters tall at a time when oxygen levels were just beginning to rise on Earth, setting the stage for more complex life to follow, the researchers report February 3 in *Current Biology*.
— Paul Gabrielsen

FROM TOP: HANNAH WOOD; MARC LAFLAMME
OPPOSITE PAGE: CLOCKWISE FROM TOP: HANNAH WOOD; A.M. WING *ET AL.*, MODIFIED BY M. ATAROD; EMIRMEMEDOVSKI/ISTOCKPHOTO

Watch an animation of pelican spider hunting at **bit.ly/SNpelicanspider**

Spiders, thank goodness, haven't evolved assassin drones. But the specialized hunters of the family Archaeidae can kill at a distance.

It's a distance of only a few millimeters. But that's substantial for these teensy dramas, and enough space to let a group called pelican spiders bring down their wary and dangerous prey: other spiders.

The pelican name comes from their profiles. "They look like little birds," says Hannah Wood of the University of California, Davis. The spider's body is about the size of a grain of rice, with a front segment that has evolved into a stretched "neck" with a little round "head" on top. (The mouth is actually at the bottom of the "neck"). And a pair of jawlike fanged projections called chelicerae folds down against the neck, where a pelican would tuck its beak.

Pelican spiders are an ancient lineage (*Archaea paradoxa* shown, from Eocene epoch amber).

Pelican spiders don't build webs. Instead they creep through foliage, tiptoeing upside down under leaves to hunt. A female will carry her eggs with her, in a silk bag she attaches to one leg in the third of her four pairs. The spiders' back six legs do the walking while the front two sweep circles in the air feeling for prey. A pelican spider that picks up the silk trail of another spider will spend hours at the edge of that spider's web, plucking now and then and waiting. Unlike the quick spiders you might see skittering up a garden shed wall, Wood says, stalking pelicans are "slow and deliberate."

But when they strike, it's fast. The jawlike chelicerae rise 90 degrees and then slam fanged tips into the prey. "Then they pull out one chelicera and leave the other one hanging out there with the spider prey impaled on it," Wood says.

Next it's just a matter of waiting for the venom to work. Thanks to the pelican spider's long neck and chelicerae, its prey struggles at a harmless distance.

Attacking at jaw's length is an ancient trick. Biologists first discovered extinct pelican spiders in fossils before realizing the family still lives (in Madagascar, South Africa and Australia). Today's species split off on their own trajectory as the supercontinent Pangaea was breaking up some 180 million years ago, Wood and her colleagues reported last year in *Systematic Biology*.

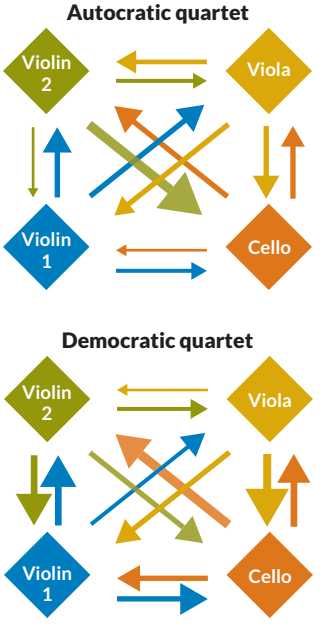
Now Wood studies a related family, the trap-jaw spiders (Mecysmaucheniidae), that has evolved the opposite approach to hunting. The spiders have shorter, thicker "necks," and their superpower is speed. They strike so fast that it's difficult to see more than a blur even in video recorded at 30,000 frames per second.

Ninjalike as pelican spiders are, they're not the stuff of nightmares. "I've never had one try to bite me," Wood says. When she reaches to catch them, they just drop to the ground. "They're very shy." —*Susan Milius*

MYSTERY SOLVED

How string quartets stay together

String quartet players continuously adjust the timing of their notes to stay in sync. But exactly how players do it has been unclear. New data tracking millisecond-scale corrections suggests that some ensembles are more autocratic — following one leader — while other musical groups are more democratic, making corrections equally. Researchers had two well-established quartets play Joseph Haydn's String Quartet op. 74 no. 1. Recordings from a short section of a movement showed that in one quartet, three players always followed the first violin, while the other ensemble shared the roles of leader and follower more equally, researchers report January 29 in the *Journal of the Royal Society Interface*. In both quartets, the cellist made the largest rhythmic leaps to stay with the group, seeming to counter the idea that the cello provides the basic rhythm for small ensembles. More research is needed to see whether that pattern holds up, but the analysis is a step forward in understanding the dynamics among conductorless musical ensembles. —*Ashley Yeager*



Who's first In a more autocratic quartet (top), violin 1 tended to influence the timing of other players more than she was influenced herself. Arrows show the influence that one player (arrow tail) has over another (arrow head).

GENES & CELLS

Native American ancestry unveiled

DNA from skeleton shows tribes come from one population

BY TINA HESMAN SAEY

An ancient baby's skeleton has revealed through its DNA that Native Americans descend from a single gene pool with roots in Asia.

The bones belong to an infant that died between 12,707 and 12,556 years ago in Montana. The baby was covered in red ochre and buried on a hillside along with more than 100 stone and bone tools characteristic of Clovis people, a Paleo-Indian culture that was widespread in North America at the time. The grave of the roughly 1-year-old boy, discovered by construction workers in 1968, is the only Clovis burial site ever found.

A report in the Feb. 13 *Nature* details the child's genetic makeup and suggests that the Clovis people were ancestors of present-day Native Americans. Like today's Native Americans, the Clovis baby's heritage traces to a child known as the Mal'ta boy who lived in Siberia 24,000 years ago (*SN: 12/28/13, p. 16*). The finding suggests that Native American populations have a common Asian heritage.

"This clearly shows that the homeland of the first Americans was Asia," says study coauthor Michael Waters, a geologist and archaeologist at Texas A&M University in College Station.

The study may put to rest an idea, known as the Solutrean hypothesis, that ancient Europeans crossed the Atlantic and established the Clovis culture in the New World. "It's not the last nail in the coffin, it's the last spade full of earth on the grave of the Solutrean hypothesis," says Jennifer Raff, an anthropological geneticist at the University of Texas at Austin who was not involved in the work.

The study may also settle speculation about the Clovis people's relationship to modern Native Americans. Clovis culture was widespread between 13,000 and 12,600 years ago, but other styles of toolmaking eventually replaced Clovis spearpoints. Along with other evidence, that shift suggested that the Clovis people may have been replaced by later groups settling the Americas.

DNA from a baby who died some 12,600 years ago provides new clues about Native American origins. Stone and bone tools (shown) buried with the infant mark him as a member of the Clovis culture.

S. L. ANZICK

"Their technology and tools vanished, but now we understand that their genetic legacy lives on," says study coauthor Sarah Anzick, a Montana-based molecular biologist who was 2 years old when the baby's grave was found on her family's land. She made it a personal project to decipher the Clovis baby's DNA.

The results establish for the first time that the Clovis people share ancestry with all modern Native Americans, says molecular anthropologist Connie Mulligan of the University of Florida in Gainesville. Study coauthor Shane Doyle, an expert in Native American studies at Montana State University in Bozeman and a member of the Crow tribe, says that's no surprise to native people. "This discovery confirms what tribes have never really doubted; that we've been here since time immemorial."

The analysis also reveals new details about the origins of native people in the Americas. The Clovis baby has the same amount of genetic ancestry from the Mal'ta people as other Native Americans; about one-third of his genome traces back to the ancient Siberian people, says study coauthor Eske Willerslev, an evolutionary geneticist at the University of Copenhagen. The remainder comes from an ancestral East Asian population, Willerslev says. The finding suggests that East Asians and Siberians interbred before the Clovis era to create the founding population from which all Native Americans descend.

About 80 percent of Native Americans, mainly those in Central and South America, are direct descendants of the Clovis baby's people, Willerslev says. Other native peoples, such as those in Canada, are also closely related to the child but from a different branch of the family. That pattern suggests that the Native Americans' founders split into at least two groups, one that gave rise to the people of Central and South America and one whose descendants now populate the Americas' northern region. The researchers didn't have data from native peoples in United States and so can't say exactly how they fit into the family picture.

Anzick and members of several Native American tribes are preparing to rebury the baby's remains where his people left him more than 12,000 years ago. ■

MATH & TECHNOLOGY

New shapes for molecular cages

Flat faces paradoxically make polyhedra rounder

BY DANA MACKENZIE

In the latest variation on a centuries-old mathematical refrain, scientists have ironed out the wrinkles in a large class of molecular cages. The cages have faces of 12 regular pentagons and up to 480 irregular hexagons, which puts them into a category of shapes called fullerenes. However, unlike most previously known fullerenes, the new shapes' faces are flat rather than warped, and the atoms in the molecule are equally spaced.

The shapes' flat faces make them convex polyhedra, which are highly symmetric, faceted solids first studied by the ancient Greeks. The first class to be discovered, called the Platonic solids, have identical faces that are all regular polygons, or shapes with equal sides and angles. The most complicated Platonic solid is the icosahedron (the shape of 20-sided dice). A less restrictive class, called the Archimedean solids, allows the faces to have different shapes, though they still must be regular polygons. An even less restrictive class, discovered by Johannes Kepler in 1611, allows quadrilateral faces with equal side lengths but unequal angles.

The new shapes don't fit into any of these categories. "This is the first new class of convex, equilateral polyhedra with icosahedral symmetry in 400 years," says UCLA neuroscientist Stan Schein. These polyhedra have hexagonal faces with equal sides but unequal angles, Schein and UCLA neuroscientist James Gayed say in the Feb. 25 *Proceedings of the National Academy of Sciences*.

Long the province of mathematicians, polyhedra attracted the interest of biologists and chemists in the 20th century. In 1962, Aaron Klug and Donald Caspar discovered that certain viruses have an icosahedron shape. In 1985, Richard Smalley and colleagues discovered that carbon forms cages of 60 or more atoms. They called the 60-atom shape "buckminsterfullerene," though it was already known to mathematicians as a truncated icosahedron — and to nonscientists as a soccer ball.

Schein came to the cagelike molecules because he was curious about clathrin, a protein that assembles itself in cages. Making physical and computer models of these shapes, he was struck that some of them were, he says, "ugly": If he made the edges equally long, he couldn't get the faces to lie flat. In fact, all fullerenes other than the 20-atom dodecahedron and the 60-atom soccer ball have this defect. Yet pictures of them tend to fudge these distortions. "A lot of people say that fullerenes are convex polyhedra, but from the point of view of a geometer, the faces of a polyhedron must be planar," says Schein. In addition, the faces warp in such a way that the solid cannot be convex.

Schein developed a way of measuring warpedness, called the dihedral angle discrepancy. If you open a greeting card so that the bottom edge opens to an angle of 30 degrees, while the top edge opens to 90 degrees, you must warp the front of the card. The discrepancy, 60 degrees, measures how much warp is necessary. Schein experimented with various fullerenes to see whether the dihedral angle discrepancy could be set to zero.

He was surprised to discover that, for a particular class of fullerenes called Goldberg polyhedra, all of the faces can flatten simultaneously. These solids were discovered in 1937 by mathematician Michael Goldberg. They are the most symmetric fullerenes, with all of the rotational symmetries of a soccer ball or an icosahedron.

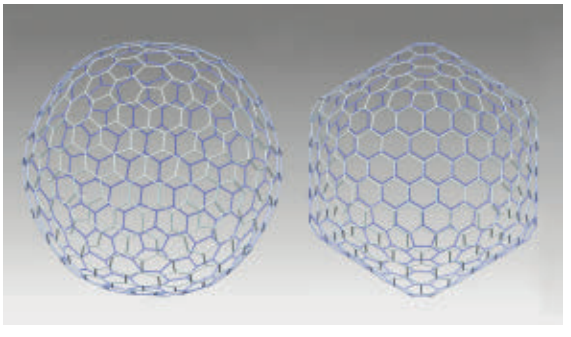
The new Goldberg-type polyhedra have hexagonal faces with sides of equal lengths but unequal angles, as well as pentagonal faces with both equal sides and equal angles. The shapes also retain the 60-fold rotational symmetry of the original Goldberg polyhedra. Using computer software, Schein and Gayed constructed such polyhedra with as many as 980 vertices.

When the number of vertices is large, these polyhedra resemble a sphere. By contrast, conventional fullerenes approach a nonrounded shape. The roundedness of the Goldberg polyhedra might make them useful for applications where a spherical shape matters — say, for designing better patterns of dimples on a golf ball. The flat faces could make them a model for molecular cages with double bonds, Schein says, because such bonds warp less than single bonds.

Though Schein's and Gayed's fields of study venture far from geometry, mathematicians applaud their finding. "It is correct, and the result is new," says mathematician Branko Grünbaum of the University of Washington in Seattle.

Mathematicians have overlooked the equilateral Goldberg polyhedra, says Grünbaum, because they have cared more about the number and pattern of the faces than about concrete questions such as how long the sides are. Geometer Egon Schulte of Northeastern University in Boston agrees. "You have to get your hands dirty to answer those questions," he says.

Now mathematicians may start to look for additional classes of convex polyhedra with equal sides, says Schulte. "It's not even clear that there are only finitely many classes." ■



A new type of molecular cage has sides of equal length and flat faces of pentagons or hexagons (left). A fullerene with the same number of vertices and the same pattern of faces (right) has hexagons with angles that vary in a much narrower range, which forces the faces to warp and the cage to become pointy.

MOLECULAR GRAPHICS PERFORMED WITH THE UCSF CHIMERA PACKAGE. FIGURE PROVIDED BY S. SCHEIN

MATH & TECHNOLOGY

Termitelike robots build structures

Simple guidelines keep machines hauling and placing bricks

BY MEGHAN ROSEN

Human construction crews, meet Robo-Termites. Like the mound-building insects, these squat little robots can erect complicated structures without an instruction manual.

Using just a few preprogrammed rules, some traffic laws and a stack of foam bricks, the bots get busy building towers, pyramids and fortress-like walls, Harvard computer scientist Justin Werfel and colleagues report in the Feb. 14 *Science*.

One day, such robotic builders might be able to take on risky human jobs such as building sandbag levees during floods. And like a termite or ant colony that gets stepped on, Werfel says, "it doesn't matter if some of the robots are lost — the rest will keep going."

Termites are the architects of the insect world. The itty bitty animals paste together dirt and chewed-up bits of wood to build mansion-style mounds, with open chimneys and labyrinths of snaking tunnels.

But perhaps most impressive, Werfel says, is the fact that termites can build at all. "It's frankly amazing," he says. "There's no central brain assigning them tasks, no one coordinating what they do." Instead, millions of insects working side by side each decide their next moves for themselves (*SN: 5/9/09, p. 16*).

Werfel and colleagues created computer programs that let robot construction crews act like independent insects. One program converted a building's blueprints into "traffic laws" for roaming robots to follow. The laws told the robots where they could move from any spot within the construction site, a checkerboard-like grid.

This building robot uses a forklift-style arm to hoist foam bricks onto its back. An onboard computer "brain" helps the bot navigate and make building decisions independently.

Another program gave the bots some basic guidelines to prevent gridlock: Always cruise counterclockwise around the structure, for example, and lay bricks one after another along a row, instead of skipping around. With these rules and traffic laws, the builder bots could construct complicated structures without a plan of action and without knowing what the other robots were up to.

Each machine, about the size of a tissue box, scoops up square bricks one by one with a forklift-style arm that flips bricks onto the robot's back. As the bots haul bricks through the construction site, they use infrared sensors on their bellies to detect navigation cues. Lines on the ground tell the bots where to start, and crosses on the bricks help the little builders figure out their location.

"They count their movement along the grid to keep track of where they are," Werfel says.

Scientists have created multirobot building teams before but relied on navigational aids similar to GPS to track the robots' positions. Werfel's team's robots navigate on their own, says Vijay Kumar, a robotics engineer at the University of Pennsylvania in Philadelphia, who has assembled swarms of robot helicopters. "That's a lot more complicated," he says. ■

LIFE & ENVIRONMENT

In crazy vs. fire, the ant with the detox dance wins

Acid defense helps recent invader stomp out pest

BY SUSAN MILIUS

Tawny crazy ants pick fights with fire ants and win, thanks to a previously unknown way of detoxifying fire ant venom.

When dabbed with the venom, the crazy ants (*Nylanderia fulva*) curl their hind ends up between their legs and secrete droplets of formic acid, says ecologist Edward LeBrun of the University of Texas at Austin. The ants then give themselves vigorous rubdowns, smearing the acid on their bodies, LeBrun and his colleagues report in the Feb. 28 *Science*. Most survive the attack.

This detox trick could help explain why these crazy ants can vanquish the

LIFE & ENVIRONMENT

Windows are major bird killers

Small buildings do much more damage than skyscrapers

BY SUSAN MILIUS

Between 365 million and 988 million birds die from crashing into windows in the United States each year, according to the latest estimate.

That might equal 2 to 10 percent of the (admittedly uncertain) total bird population of the country.

The biggest share of deaths comes not from glass massacres at skyscrapers but from occasional collisions with the nation's many small buildings, says Scott Loss of Oklahoma State University in Stillwater. "It's death by a million nicks."

Low-rise buildings four to 11 stories tall account for about 56 percent of deaths in the new estimate, Loss and his colleagues report in the February

COURTESY OF ELIZA GRINNELL/HARVARD SCHOOL OF ENGINEERING AND APPLIED SCIENCES

Watch a video of robot construction crews at **bit.ly/SNrobotermites**

red imported fire ants *Solenopsis invicta*, which have been spreading across the southern United States since they invaded more than 70 years ago. The fire ants wipe out native ants, disrupt ecosystems, move into people's yards and sting anything within reach.

In 2002, pest control operator Tom Rasberry reported an invader in Texas, what's now called the Rasberry, or tawny, crazy ant. The "crazy" comes from their frenzied, curlicued running.

The crazy ants can take on fire ants. For the first 200 meters or so behind the front line of expanding colonies of crazy ants, fire ants are "just gone," LeBrun says. He finds crazy ants living in what used to be fire ant nests.

Tawny crazy ants don't sting. But in late summer and fall, they can build up in huge numbers, flooding homes with seething ant masses and ruining the insides of electrical devices. "If you're allergic to fire ants, then it's a vast improvement," LeBrun says, but "for the average homeowner, probably not."

The red imported fire ant (left) dabs droplets of potent venom from its rear onto enemies, but its opponent, a tawny crazy ant (right), detoxifies the venom with an acid rubdown.

To see how the two insects compete, LeBrun set out crickets as bait. The fire ants typically found the food first. Then crazy ants charged in, attacking with formic acid sprayed from an opening in their abdomens. Fire ants in turn exuded venom droplets from their rears.

That venom kills many other insects, LeBrun says, but the tawny crazy ant has a combat trick of its own. He noticed crazy ants withdrawing from the fray for vigorous self-smearing and grooming.

Entomologists already knew that formic acid could be used as an attack weapon. In experiments, LeBrun and colleagues discovered that it has detox powers as well. When the researchers blocked the crazy ants' rear opening with nail polish, survivorship after venom smears decreased from 98 to 48 percent. The team tested secretions from two glands that release compounds to that opening and found that formic acid was the crucial ingredient.

Treating ants of another species with formic acid saved their lives after exposure to fire ant venom.

Unlike many North American ants overwhelmed by fire ants, the tawny crazy species has had time to evolve fire ant–fighting techniques, LeBrun says. Its native range in South America overlaps with *S. invicta* fire ants' original range.

The southern United States has eight or 10 species of native *Nylanderia* crazy ants, says John LaPolla of Towson University in Maryland. The native crazy ants, like the rest of their relatives in the group called formicine ants, should wield formic acid too, LaPolla notes. ■

LAWRENCE GILBERT

Condor: Ornithological Applications. Residences that are one to three stories tall make up around 44 percent; skyscrapers represent less than 1 percent.

Any given small residence probably kills far fewer birds each year than the 24 expected to die annually at a single skyscraper. But the United States has about 15.1 million low-rises, 122.9 million small residences and only about 21,000 skyscrapers. Loss applauds efforts to make skyscrapers bird-friendly but cautions that protecting birds takes a broader effort.

56 percent
Fraction of window-related deaths due to low-rise buildings

Some species — many of them Neotropical migrants — appear especially vulnerable to windows, Loss and his colleagues find. Birds on long-haul migrations at night may be at risk of disorientation from artificial lights. Compiling data from all kinds of buildings, the team found that Anna's hummingbirds, black-throated blue warblers, ruby-throated hummingbirds, Townsend's solitaires and golden-winged warblers topped the risk list.

Conservationists have already flagged the golden-winged warbler because of its steep population decline in recent decades. Other troubled species that rank high in vulnerability to window crashes include painted buntings, wood thrushes and Kentucky warblers.

It's these already distressed species that worry Loss the most. For individual species with dwindling numbers, he imagines window kills might affect population trends.

The estimate puts windows just behind cats as the second-largest source of human-related menaces that kill birds directly *(SN: 2/23/13, p. 14)*. From what Loss knows of estimates of direct perils to birds such as wind turbines and vehicle kills, he says, "nothing else comes close."

There's no nationwide reporting of birds thumping into glass or succumbing to a paw, so estimating death tolls has long been difficult and controversial *(SN: 9/21/13, p. 20)*. The new estimate of mortality from windows, based on statistical analysis of 23 local studies, comes close to an old estimate (100 million to 1 billion) that had been derided for its simple, back-of-the-envelope approach. "We were a little surprised," Loss says.

There are plenty of uncertainties in extrapolating from small, diverse, local studies, particularly in trying to estimate overall species vulnerabilities, says Wayne Thogmartin of the U.S. Geological Survey in LaCrosse, Wis. But even such "imperfect science" has value, he says. For one thing, it may inspire people to start filling in gaps in data.

The total for window kills isn't the whole story, though, says ornithologist Daniel Klem Jr. of Muhlenberg College in Allentown, Pa., who did the earlier calculation: "The moral imperative of preventing even one unwanted and unintended death of these utilitarian and aesthetically pleasing creatures is, or should be, compelling enough." ■

Watch a video of tawny crazy ants in battle at **bit.ly/SNcrazyants**

EARTH & ENVIRONMENT

Magma viewed as sludgy mush

Crystals open window into volcanic depths

BY GABRIEL POPKIN

When red-hot magma spews from a volcano, it clearly flows like a liquid. But before erupting, the magma may have spent hundreds of thousands of years in a chunky state resembling cold porridge, a study finds. The discovery suggests that hot, liquid magma pools may be useful as an indicator of impending eruptions.

Volcanic magma, the mix of molten rock and gas below Earth's surface, leads a sort of double life: It spends some time as a hot liquid and some as a colder, rocky "crystal mush." Scientists have long known that magma is mostly liquid only above 750° Celsius, and that in its colder state, it is too viscous to flow. Whether magma spends much of its existence in the hot, largely liquid state or heats up briefly before erupting has been a mystery.

Seeking answers, Kari Cooper of the University of California, Davis and Adam Kent of Oregon State University in Corvallis analyzed crystallized minerals in cooled magma that spewed from the two most recent eruptions of Oregon's Mount Hood, which occurred around 220 and 1,500 years ago. Some of these crystals contain forms of uranium and thorium that radioactively decay to other elements. By measuring the amounts of uranium and thorium in the minerals, the scientists determined that the crystals began growing inside Earth tens of thousands, and possibly hundreds of thousands, of years ago.

Magma that erupted from Oregon's Mount Hood around 220 and 1,500 years ago spent most of its time under the mountain in a relatively cold, semisolid state.

The team then sought to determine how much time the crystals had spent above 750° C. Certain elements, including strontium, diffuse into crystals only at high temperatures, so by measuring the amount of strontium in the crystals the scientists could estimate how long the magma had been that hot. The scientists also measured the crystals' sizes to see how long they had spent growing; the crystals the team studied grow only above 750° C. "We're getting kind of a window into what's happening below the surface," says Cooper.

From the measurements, Cooper and Kent found that the crystals could have been above 750° C for a few thousand years at most; the rest of the time, they were in colder, mushy storage. The scientists conclude in the Feb. 27 *Nature* that the magma was hot and liquid for at most 12 percent of the time it spent under Mount Hood and probably for less than 1 percent.

Cooper and Kent now want to confirm that other volcanoes have cold, mushy magma beneath them. If scientists can use imaging techniques to find liquid magma beneath a volcano, they may then have a clue that the volcano could soon erupt, the authors say. But magma can also heat and cool without the volcano erupting, so just finding a liquid magma pool is not enough to forecast an eruption, says George Bergantz, a geologist at the University of Washington in Seattle.

Still, Bergantz says he was "tremendously excited" when he read the paper. ■

BODY & BRAIN

Dog brain areas respond to voices

MRIs hint at how pups understand human communication

BY LAURA SANDERS

By training pooches to lie absolutely still in a brain scanner, scientists have begun revealing the mysterious inner workings of the canine brain. Like their human companions, dogs use certain parts of their brains to detect voices, researchers report in the March 3 *Current Biology*.

What's more, dog brains, like people's, react to emotional cues. A playful yip, pleading whine and aggressive bark elicit varying levels of activity in a certain brain region. Human laughs or cries have similar effects on dogs' brains, functional magnetic resonance imaging shows. The results might help explain how dogs sense their owners' emotions.

"Dogs are really good at tuning into their owners' feelings," says study coauthor Attila Andics of MTA-ELTE Comparative Ethology Research Group in Budapest. But until this study, he adds, "we just had no idea what goes on in their brain."

Andics and colleagues trained six border collies and five golden retrievers to lie still inside an fMRI scanner for more than six minutes at a time (the data were useless if a dog moved more than three millimeters). The dogs actually enjoyed their tedious job. "You should just see how these dogs love to go to the scanner," Andics says. "They just cannot wait to be the next one."

During the scan, the dogs listened to a recording of people crying, laughing and shouting (no speech was included) and dogs barking angrily, whining and yipping playfully. When dogs heard canine vocalizations, regions in the front part of the primary auditory cortex, a swath of neural tissue in the middle of the brain that helps detect sound, became active.

These regions are analogous to brain locales in humans that respond to human voices, the team found by playing the same recording for 22 people

THOMAS SHAHAN 3/FLICKR

BODY & BRAIN

Vitamin C could give chemo a boost

The supplement helped anticancer drugs shrink tumors in mice

BY NATHAN SEPPA

Vitamin C might complement chemotherapy as a cancer treatment. Very high doses of the vitamin injected into mice attacked tumors and showed signs of working in synergy with chemotherapy drugs. Separately, in a safety trial, 13 women with ovarian cancer given chemotherapy plus high doses of vitamin C experienced less toxicity from chemo than did women not getting the vitamin.

The idea dates back at least to 1976, when chemist Linus Pauling reported that high doses of intravenous vitamin C given in addition to standard treatment to patients with advanced cancer seemed to increase their survival time. But Pauling's findings were countered by a study showing that vitamin C taken orally, which resulted in lower levels in the bloodstream, had no effect. While some doctors have continued to use it against cancer, vitamin C fell out of favor.

In the new study, researchers implanted mice with ovarian cancer cells and later gave some mice chemotherapy and others chemo plus injected vitamin C. Tumors shrank substantially more in the mice getting the combination, the scientists report in the Feb. 5 *Science Translational Medicine*.

Vitamin C is an antioxidant that sops up reactive molecules. But in high doses its role can reverse. The study found that vitamin C killed human ovarian tumor cells in lab dishes by acting as a pro-oxidant, damaging DNA, sabotaging a cellular fuel source called ATP and inhibiting mTOR, a cell growth activator. Healthy cells were largely unaffected.

25.5 months
Median time to relapse in patients given vitamin C

16.8 months
Median time to relapse in patients not given vitamin C

Tumor cells may not make the array of proteins necessary to protect themselves from the pro-oxidant assault, says Joseph Cullen, a surgeon at the University of Iowa in Iowa City who wasn't involved in the study. He adds that tumor cells contain excess iron, which may render them susceptible to high doses of vitamin C.

The researchers also gave intravenous vitamin C to 13 women newly diagnosed with ovarian cancer that had spread to the abdominal cavity. "This reached levels [in the blood] that were 10 to 100 times higher than what is achieved with oral vitamin C," says study coauthor Qi Chen, a biochemist at the University of Kansas Medical Center in Kansas City. Those women, along with 12 who did not get the vitamin, also received chemo.

Over five years, compared with women getting chemo alone, the vitamin C group had fewer mild or moderate side effects from the chemo, particularly digestive problems and skin irritation. Just how vitamin C might reduce chemo's side effects is unclear.

Patients getting the vitamin went a median of 25.5 months before relapsing; others relapsed after 16.75 months. But this difference could be due to chance because of the small size of the study.

Chen's coauthor Jeanne Drisko, a physician and researcher also at Kansas, says that the findings set the stage for a larger trial of vitamin C. "It's safe, inexpensive and seems to be working hand in hand with chemotherapy," she says. ■

---

undergoing fMRI scans.

In both dogs and people, other brain regions near the primary auditory cortex were more active when hearing happier noises, regardless of whether the voice belonged to a dog or a person. Laughing and joyful barks elicited greater responses than crying and growling, for instance.

Neuroscientist and psychologist Pascal Belin of the University of Glasgow in Scotland cautions that those areas may respond to acoustical differences in the sounds, not the emotion itself.

Nonetheless, he says, the new results are plausible to anyone with a pooch. "Without even doing science, if you own a dog, you clearly see that a dog is able to recognize your identity and your emotional state," Belin says.

The human-dog comparison also revealed an interesting difference: The vast majority of sound-responsive areas in the human brain react more strongly to human voices than to sounds from the environment, such as a thunderstorm, a ringing phone or a car horn. In dogs, almost half of the analogous areas respond more strongly to nonvocal environmental sounds. That finding highlights how sensitive the human brain is to voices, Andics says.

It would be fascinating to scan the brains of other animals such as wolves or cats, Andics says, but coaxing those animals to lie still for an fMRI scan is a long shot. He and his colleagues plan on running more experiments to see how the dog brain handles smells, sights and speech. ■

By training dogs to lie still for an fMRI scan, researchers were able to identify areas in the canine brain that respond to voices.

BORBALA FERENCZY

EARTH & ENVIRONMENT

Strong winds may have waylaid global warming

Gusts over the Pacific could have stashed heat underwater

BY BETH MOLE

Unusually strong trade winds whooshing over the Pacific may explain the ocean's cool temperatures and a recent hiatus in the rise of global temperatures. Though scientists aren't certain what caused the trades' strength to increase, they are confident that the winds will return to normal and global warming will continue apace.

Using a combination of climate simulations and weather data, researchers show that in the last two decades, forceful Pacific trade winds have pushed warm water westward. In the western Pacific, ocean currents dunk the heat deep in the ocean. The result is cooler water at the surface and a beguiling pause in warming, the team reports February 9 in *Nature Climate Change*.

Since 2001, researchers have noted a plateau in global average air temperature despite the continued surge of greenhouse gases into the atmosphere. Global climate simulations have yet to account for the lull, still predicting a rise in temperature.

"We wanted to understand why the models and the observations were so different," says climate scientist Matthew England of the University of New South Wales in Sydney.

Researchers have proposed a range of explanations for the cool interlude, including increases in volcanic emissions or air pollution, changes in solar radiation and increases in the oceans' heat uptake. Last year, scientists proposed that cooling in the tropical Pacific led to the warming plateau, but it was unclear why the ocean's temperatures had dropped (*SN: 10/5/13, p. 14*).

England and his team found that winds over the Pacific are twice as strong as climate modeling had predicted. When the team included actual wind data in a model, the results came close to matching the measured global temperatures during the pause.

The change in wind strength is still unexplained, England and colleagues say. But it's most likely due to a combination of natural fluctuations in multiyear climate patterns and the other factors suggested as causes for the warming pause, such as air pollution.

Clouding the search is the fact that climate change and naturally fluctuating weather patterns affect each other, says atmospheric scientist Susan Solomon of MIT. "It's very unclear at this point where the chicken is and where the egg is."

Once the winds die down, Solomon says, the submerged heat will return to the sea surface and global warming will resume. The long-term warming trend, she adds, is unaffected by such pauses and "10- or 20-year wiggles." ■

MATTER & ENERGY

Scientists throw crystals a curve

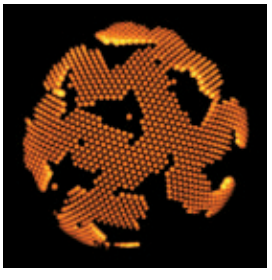
Particles assembled inside a sphere form ordered ribbons

BY BETH MOLE

Scientists don't need a crystal ball to predict how crystalline solids grow on flat planes. But it might come in handy for curved surfaces.

By trapping particles in tiny balls of water, scientists got their first glimpse of crystal formation in rounded environments. Researchers report in the Feb. 7 *Science* that the caged crystals formed arched ribbons inside the sphere rather than the compact clumps seen on flat surfaces.

Curves offer a challenge for crystals, which are solids made of molecules, atoms or other subunits assembled in ordered, symmetrical patterns. Harvard chemical engineer Vinothan Manoharan says that growing crystals around a sphere "is kind of like trying to gift wrap a basketball."



Inside a droplet of water between about 11 and 35 micrometers across, particles (orange) assemble into strips of crystals rather than chunks to avoid stressful bending.

COURTESY OF GUANGNAN MENG AND V. MANOHARAN/HARVARD UNIV.

Scientists knew that curves cause crystals to develop defects, or pattern breaks, but researchers had not found a way to eye a growing crystal as it navigated bends.

Manoharan and colleagues devised a technique using wee water droplets suspended in oil and loaded with polymer particles with diameters of 80 nanometers and 1 micrometer. Using microscopy, the team monitored the enclosed particles, which attract each other, as they crystallized. The particles formed thin, branched crystalline ribbons along the insides of the drops.

On flat surfaces, the particles' attraction to one another would make crystals form in a tight clump. "The behavior on curved surfaces is entirely different," says biophysicist Gerhard Gompper of Forschungszentrum Jülich in Germany.

In this case, Manoharan and colleagues observed that the crystal's shape was dictated by the drop's curvature and by the crystal's aversion to stressed arching shapes. Individual particles may not be affected by a curve, much like a person doesn't feel the Earth's curvature. But as the crystal grew larger, the whole structure felt strain and grew into strips to avoid stretching and forming defects.

"It's a nice piece of work," says physicist William Irvine of the University of Chicago. These observations, he says, may further understanding of how curved structures form in a variety of settings, including coatings on nanoparticles and the outer shells of viruses. ■

When flowers died out in Arctic, so did mammoths

Genetic analysis finds vegetation change around same time as megafauna extinction

BY TINA HESMAN SAEY

For want of mums, woolly mammoths were lost.

A genetic analysis of ancient permafrost suggests that after the Ice Age the Arctic shifted from a landscape dominated by nutritious flowering plants known as forbs to one dominated by hard-to-digest grasses and woody plants. Evolutionary geneticist Eske Willerslev of the University of Copenhagen and colleagues report the finding in the Feb. 6 *Nature*. The shift may have helped drive the extinction of large herbivores such as woolly mammoths and woolly rhinoceroses, Willerslev speculates.

The researchers examined 242 permafrost samples excavated from 21 sites in Siberia, Alaska and Canada. Each sample was carbon dated to determine its age. To identify plants in the samples, the researchers sequenced DNA from chloroplasts, structures in plant cells that carry out photosynthesis.

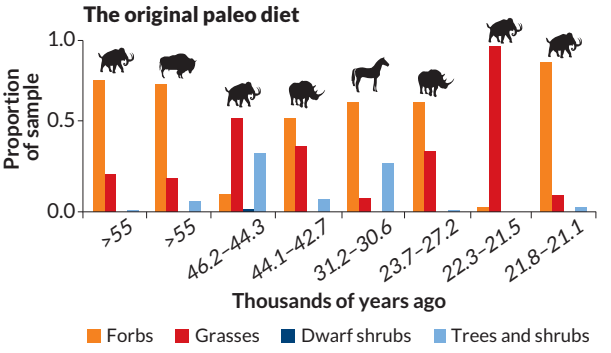
From about 50,000 years ago until around 12,000 years ago, the most abundant plants were forbs that thrived in dry environments. The samples included relatives of plants such as prairie sagewort, yarrow, chrysanthemums and asters, the researchers discovered.

That means mammoth steppes were probably crazy quilts of blooming plants. Previous studies of ancient pollen had instead suggested that the environment was marked by vast grasslands upon which mammoths and other large herbivores grazed.

Between 25,000 and 15,000 years ago, plant diversity plummeted to record lows in the cold, dry climate of the Ice Age. Forbs still ruled the land, but fewer species could make a go of it.

After temperatures climbed and glaciers receded, the Arctic became wetter. Plant diversity rose again, but instead of reviving pre-Ice Age species, moister soils allowed grasses to rise in prominence and new species such as horsetails, cotton grass, willows and other woody plants to invade.

To see what prehistoric animals were eating, Willerslev and his colleagues analyzed plant DNA from the guts or fossilized feces of eight large herbivores that lived between 55,000 and 21,000 years ago: four woolly mammoths, two woolly rhinoceroses, a bison and a horse. None of those animals roam the Arctic today. The ancient herbivores dined largely on forbs, the researchers found. About 63 percent of plant remains in the samples were forbs, with grasses comprising about 27 percent.



Food for thought Researchers extracted DNA from the guts or fossilized feces of eight prehistoric Arctic herbivores and determined the amount of genetic material in the samples that came from different types of plants. The diets varied, but the animals seemed to prefer protein-rich flowering plants called forbs. The data contradict earlier views that mammoths and other extinct grazers dined mainly on grass.

"Our study really questions the whole concept that a grass system was necessary to sustain the megafauna," says Willerslev. "I'm not saying that they weren't eating grasses, but our data suggest the forbs were sustaining them."

Because grasses and shrubs contain fewer nutrients and are harder to digest than forbs, large grazers may have essentially starved to extinction, he speculates. Animals such as reindeer survived by adapting to the vegetation switch, he says.

Missing megafauna may also have led to the decline of the forbs in a vicious cycle, some researchers say.

"All those great big beasts not only ate the vegetation but helped maintain it," says Scott Elias, a paleoecologist at Royal Holloway, University of London. Trampling and grazing would have spurred growth of forbs and kept grasses down.

Other researchers are happy to see a new technique for reconstructing long-gone landscapes but say the conclusion that vegetation changes contributed to mammoth extinction overreaches.

"This is a fantastic dataset, but if you look closer at the data, the story is not as straightforward as they make it," says Michael Hofreiter, an evolutionary biologist at the University of Potsdam in Germany. Vegetation patterns changed most dramatically around 5,000 years ago, after woolly mammoths and other megafauna went extinct, he says. Mammoths were gone from most of the Arctic by 10,000 years ago.

What's more, the gut contents and fecal samples all came from animals that lived before or in the early stages of the Ice Age, which ended about 12,000 years ago. So the researchers don't address what animals ate after the glaciers receded, says Jessica Blois, a paleoecologist of the University of California, Merced.

And an animal's last meal doesn't necessarily represent its usual diet, says Pavel Tarasov, a paleoecologist at the Free University of Berlin. He thinks deep snow may have interfered with the animals' ability to find food.

Willerslev and others say that combining DNA analysis with other methods of reconstructing the past will give a more complete picture of how ecosystems vary along with climate. The result could aid in predicting future changes. ■

E. WILLERSLEV *ET AL*/*NATURE* 2014, ADAPTED BY S. EGTS

HUMANS & SOCIETY

Nearly 1-million-year-old hominid footprints found in Europe

Waves cutting away layered sediments on England's southeastern coast revealed rare footprints of human ancestors last year, only to wash the tracks away within weeks. The footprints were discovered in May 2013, researchers report February 7 in *PLOS ONE*. A low tide at the Happisburgh site revealed that heavy seas had worn away layers of hardened silt, exposing footprint-covered sediment. At least five individuals created the prints between 1 million and 780,000 years ago, say Nick Ashton of the British Museum in London and colleagues. Lengths and widths of the ancient footprints corresponded to individuals who stood between 3 and 5.7 feet tall, suggesting that adults and youngsters strolled together. The sizes of the feet are similar to those of possible Neandertal ancestors, whose fossils have been found in Spain and date to at least 800,000 years ago (*SN: 3/29/08, p. 196*). Only 3.6-million-year-old hominid footprints in Tanzania and 1.5-million-year-old footprints in Kenya (*SN: 3/28/09, p. 14*) are older than the Happisburgh discovery. *— Bruce Bower*

BODY & BRAIN

Rise in stress hormone linked to less risky financial decisions

Chronically high levels of the stress hormone cortisol may make people play it safe financially. The finding has real economic implications: When markets reel, people may be less inclined to make the risky investments needed to stop the free fall. Previously, John Coates of the University of Cambridge and a colleague reported that London traders experienced a 68 percent boost in daily cortisol during an eight-day spell of market instability. In the new study, participants took cortisol pills over eight days to get a similar boost. Participants then made choices between pairs of lotteries, one risky and one safe. In one particular choice, for instance, about half the people who received a placebo chose the safer gamble. In contrast, about 80 percent of people who received cortisol chose the safer bet, Coates and colleagues report February 18 in the *Proceedings of the National Academy of Sciences*. During a stressful financial crisis, people's inclination to avoid dicey investments may make the market even worse, the authors write. These shifting risk tolerances may be an ignored source of market instability. *— Laura Sanders*

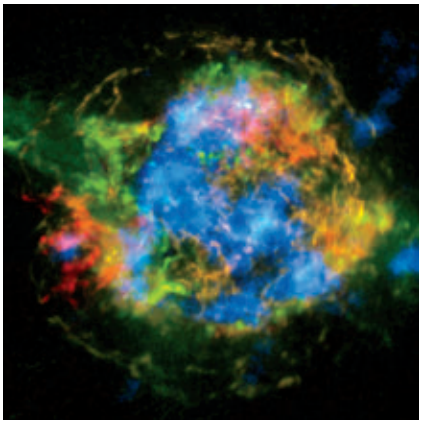
Clot risk lingers after pregnancy

SAN DIEGO — Women spend the 12 weeks after giving birth at an elevated risk of blood clots. Hooman Kamel of Weill Cornell Medical College in New York City and colleagues analyzed medical records of nearly 1.7 million women admitted to California hospitals for labor and delivery from 2005 to 2010. Kamel reported February 13 at the International Stroke Conference and in the *New England Journal of Medicine* that while the risk of clotting in these women afterward was low overall, it increased by a factor of nearly 11 in the first six weeks postpartum and remained at least doubled during weeks seven through 12. Harvard neurologist Lee Schwamm said the low incidence of clotting makes it impractical to preventively treat the huge population of postpartum women. But he said women with pregnancy complications putting them at risk of clots do merit monitoring beyond childbirth. *— Nathan Seppa*

ATOM & COSMOS

Star explosions not spherical

Giant stars are slightly off-kilter as they go kablooey, research in the Feb. 20 *Nature* suggests. When a massive star runs out of elements to fuse in its core, it collapses under its own gravity; the imploding material then bounces off the core and explodes in a bright display known as a core-collapse supernova. But computer simulations indicate that if material collapsed symmetrically, as scientists long assumed, a star would not explode. To address this conundrum, researchers including Caltech astrophysicist Brian Grefenstette pointed NASA's Nuclear Spectroscopic Telescope Array at Cassiopeia A (below), the remnant of a nearby core-collapse supernova whose light first reached Earth about 350 years ago. The researchers plotted the spatial distribution of high-energy X-rays emitted during the decay of radioactive titanium-44, which is forged in the depths of supernova explosions. The X-rays revealed that the titanium is concentrated in several dense clumps, suggesting that the explosion was not symmetrical. The study brings scientists closer to learning exactly how these spectacular cosmic fireworks get set off. *— Andrew Grant*



JPL-CALTECH, CXC/SAO, NASA

LIFE & EVOLUTION

Embryos in eggs move around to get comfortable

The power to cuddle up to warmth or cringe away from overheating may be widespread among reptile and bird embryos still in the egg, researchers say. Earlier studies found two species of turtle embryos moving toward warmth or away from dangerously high heat (*SN: 6/18/11, p. 9*). Now tests of 12 diverse species find active repositioning, says ecologist Wei-Guo Du of the Chinese Academy of Sciences in Beijing. Embryonic Chinese alligators (*Alligator sinensis*) shifted more than a centimeter toward heating pads, Du and his colleagues report in the March *American Naturalist*. Embryos of Pekin ducks (*Anas platyrhynchos domestica*) repositioned almost a centimeter, and those of three other birds on average shifted a few millimeters. Embryos of three kinds of snakes edged several millimeters toward warmth or several millimeters away from excessive heat. Only two lizards failed to budge, as the researchers had predicted due to the species' small eggs. *— Susan Milius*

Technology Breakthrough | Safe, comfortable bathing from Jacuzzi®

Enjoy A Bath Again… Safely and Affordably

The Jacuzzi® Walk-In tub is luxurious, feature-packed and affordable

There is nothing like the simple pleasure of taking a warm bath. The cares of the day seem to fade away, along with the aches and pains of everyday life. Unfortunately for many aging Americans with mobility issues, slipping into a bath can result in slipping onto the floor. The fear of falling has made the simple act of bathing and its therapeutic benefits a thing of the past until now. Jacuzzi®, the company that perfected hydrotherapy, has created a walk-in tub that offers more than just safe bathing, peace-of-mind and independence, it can actually help you feel better.

Unlike traditional bathtubs, this Walk-In Tub features a leak-proof door that allows you to simply step into the tub rather than stepping precariously over the side. It features a state-of-the-art acrylic surface, a raised seat, and the controls are within easy reach. No other Walk-In Tub features the patented Jacuzzi® PointPro® jet system. These high-volume, low-pressure pumps feature a perfectly balanced water to air ratio to massage thoroughly yet gently. Some swirl, some spiral, some deliver large volumes of water and others target specific pressure points. They are all arranged in precise locations designed to deliver a therapeutic massage, yet they are fully adjustable so that your bathing experience can be completely unique.

SEE THE JACUZZI® DIFFERENCE
Laboratory tests clearly show how Jacuzzi® jets outperform other manufacturers' jet systems, producing a deeper and wider plume of revitalizing bubbles. You get the best technology for an affordable price!

Why spend another day wishing you could enjoy the luxury and pain-relieving benefits of a safe, comfortable bath? Call now and you'll get an unsurpassed limited lifetime warranty. Knowledgeable product experts are standing by to help you learn more about this product. Call Today!

What To Look For in a Walk-In Tub:

Five major considerations to help make an informed decision before buying a Walk-In Tub:

- **Quality** - A walk-in tub is a major investment. You want to find a quality tub that will last for decades. Look for one that's 100% leak-proof, mold-resistant, full metal frame construction and one that's American made.
- **Warranty** - Ask for a lifetime "no leak guarantee." The best tubs offer a lifetime warranty on both the tub and the operating system.
- **Pain Relieving Therapy** - Find a tub that has both water and air jet therapy to soak away your aches and pains preferably with a perfectly balanced water to air mix. This tub is the first to offer a specialized foot massage experience. Its unique spinning motion provides optimal therapy to feet and legs. Best of all, you get it at no additional charge.
- **Comfort** - Insist on ergonomic design, easy-to-reach controls.
- **Endorsements** - Only consider tubs that are ETL or UL listed. Also look for a tub tested to IAPMO standards and that's USPC Certified.

New & Improved Jacuzzi® **Walk-In Tub**

For information call:

1-877-475-5829

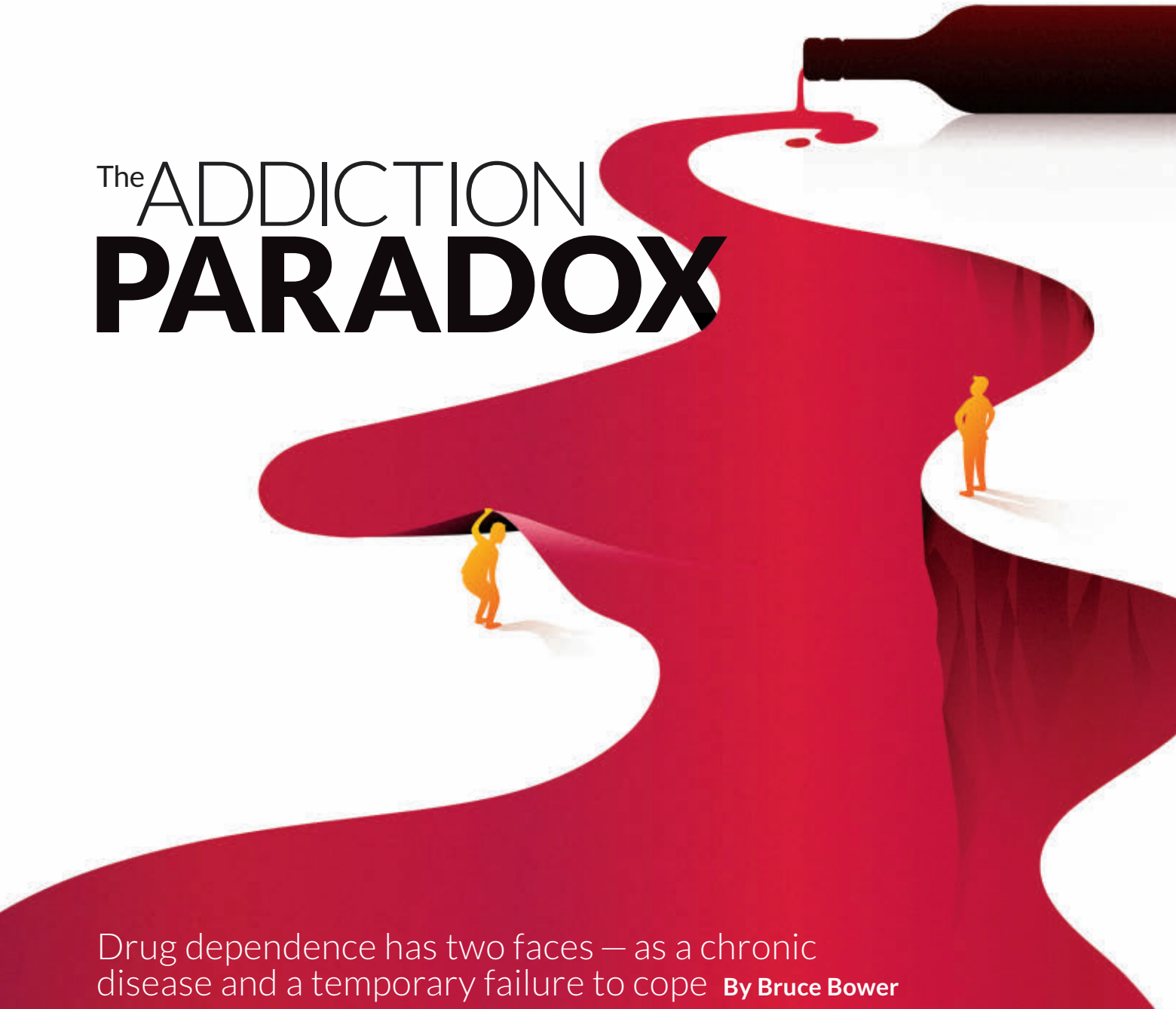
Call now Toll-Free and mention your special promotion code 58248.

Third-party financing available with approved credit.
Aging in the Home Remodelers Inc.
is neither a broker nor a lender.
Not available in Hawaii and Alaska

80973

We are proud to support **Operation Homefront** in their efforts to assist members of the military and their families.

The ADDICTION PARADOX



Drug dependence has two faces — as a chronic disease and a temporary failure to cope

By Bruce Bower

Actor Philip Seymour Hoffman's February death from a drug overdose triggered media reports blaming the terrible disease of addiction for claiming another life. But calling addiction a "disease" may be misguided, according to an alternative view with some scientific basis. Most people who are addicted to cigarette smoking, alcohol or other drugs manage to quit, usually on their own, after experiencing major attitude adjustments. Although relapses occur, successes ultimately outnumber fatalities. People can permanently walk away from addiction.

Evidence that addiction is a solvable coping problem rather than a chronic, recurring disease seems like encouraging news. But it's highly controversial. Neuroscientists and many clinicians regard drug addictions as brain illnesses best vanquished with the help of medications that fight cravings and withdrawal. From this perspective, drug-induced brain changes increase a person's thirst for artificial highs and make quitting progressively more difficult.

This conflict over addiction's nature plays out in two lines of research: studies of remission and relapse among treated substance abusers and long-term studies of the general population.

Follow-up investigations of people who attend treatment programs report that addicts never completely shake an urge to snort, inject, guzzle or otherwise consume their poisons of

TANG YAU HOONG

choice. Ongoing treatment in psychotherapy, rehab centers or 12-step groups encourages temporary runs of sobriety, but it's easier to kick the bucket than to kick the habit.

Surveys and long-term studies of the general population, however, observe that addicts typically spend their youth in a substance-induced haze but drastically cut back or quit using drugs altogether by early adulthood. Most of those who renounce the "high" life do so without formal treatment.

Each research approach has drawbacks. Treatment studies don't include people who overcome addictions without seeking formal help, and thus underestimate overall recovery rates. Community surveys often overlook individuals with especially harsh drug problems, and thus overestimate recovery rates.

"There's clearly disagreement in the field about the natural history of alcohol dependence and other substance use disorders," says psychologist Madeline Meier of Arizona State University in Tempe. "Part of the reason is that clinic-based studies tend to find high rates of relapse but population-based studies don't."

New investigations aim to clarify how alcohol and drug addictions play out across the life span, at least in industrialized nations. A reanalysis of four national surveys in the United States concludes that issues such as getting married, fears of arrest, drug prices and health concerns can prompt individuals to quit drug addictions at any age, a finding at odds with the brain disease model of addiction. Related research suggests that life transitions and personality changes accompany remission from excessive drug use. Studies of New Zealand children tracked into adulthood suggest that individuals who break free of alcoholism suffer relapses less frequently than is often assumed.

Severe substance abusers, on the other hand, appear to face the most challenging future. Recent evidence highlights a near-universal tendency for people with multiple addictions and other mental ailments to relapse at least once within four years of completing treatment.

Scientists trying to untangle the life course of excessive, harmful consumption of mind-altering substances face challenges at every turn.

Maturing out

Psychologist Charles Winick grappled with those challenges in a controversial 1962 article titled "Maturing out of narcotic addiction." More than 50 years later, new studies support and expand on key elements of his argument. Winick discovered that about three-quarters of those listed as heroin addicts in an annual federal tally disappeared from the rolls by age 36. He concluded that these young people had "matured out" of opiate dependence as they assumed adult responsibilities and resolved emotional conflicts that had driven them to drugs in the first place.

In line with most mental-health professionals at the time, Winick, affiliated with City University of New York, considered heroin addiction a disease. These findings suggested to him that addictions, like some infections, can be resisted successfully.

Winick assumed that police and hospital data collected by the government included nearly every U.S. heroin addict and that all of those dropped from the list had stopped using heroin. But some may have died without the government knowing, or continued using while managing to avoid the authorities. Today, arguments over Winick's conclusions haven't been fully resolved, says Boston College psychologist Gene Heyman.

Many people addicted to legal and illegal drugs end up quitting without formal treatment, just as Winick concluded, according to Heyman's reanalysis of data from four national surveys of psychiatric disorders conducted in the 1980s, the 1990s and the early 2000s. Heyman's work also indicates that people conquer their addictions at all ages, not just during young adulthood, as Winick thought.

Heyman's findings, published in the 2013 *Annual Review of Clinical Psychology*, build on an argument he made in a 2009 book, *Addiction: A Disorder of Choice*. Everyday decisions influenced by deeply held values and goals push people toward or away from addictions, he wrote.

Heyman rejects the standard premise that alcoholism and drug abuse result either from brain diseases or moral failures.

Marijuana and cocaine addiction mainly afflicted young

Two sides of treatment

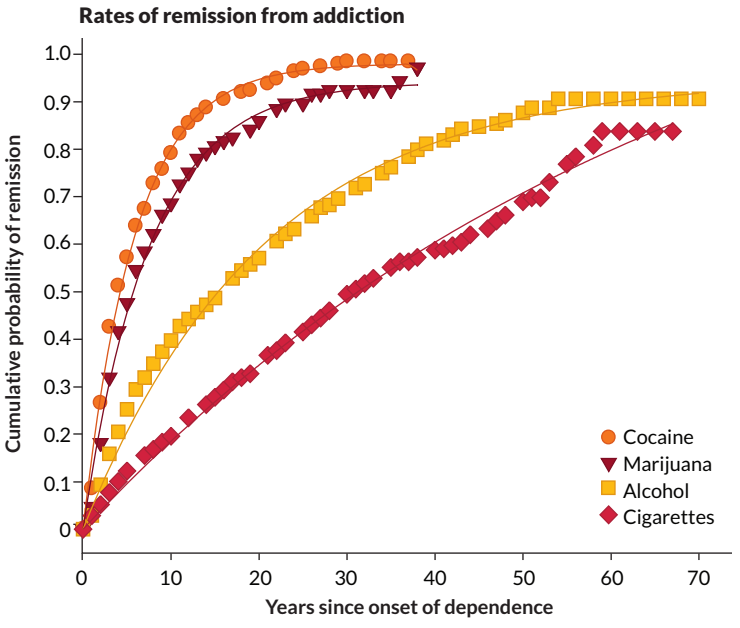
Some treatments for alcoholism and drug addiction assume that addiction is a disease:

- **Twelve-step groups and centers** promote guiding principles that include acknowledging a lack of control over one's addiction and recognizing a higher power that enables one to quit. Total abstinence is the goal.
- **Drugs prescribed by a physician** can substitute for street drugs and prevent or reduce withdrawal symptoms as doses are tapered. The synthetic opiate buprenorphine is used in this way to treat heroin addicts.

Other approaches emphasize coping skills and in some instances reject the disease perspective:

- **Motivational interviewing and cognitive behavioral therapy** engage clients in exploring how they would like to change and in developing healthy ways to deal with stress and daily challenges. SMART Recovery self-help groups — an alternative to 12-step programs — allow for either abstinence or occasional drug use, depending on the client.
- **Therapeutic communities,** which are sometimes affiliated with 12-step programs, are drug-free settings where addicts live together and learn healthy approaches to life with the help of former addicts and therapists.

Aging out It generally takes alcoholics and smokers much longer to quit than cocaine and marijuana users. But national survey data indicate that most people eventually drop their habits. The graph below shows the proportion of people who have stayed off a drug for a year after having been addicted. Half of cocaine users have quit within a few years of starting; it takes 30 years for half of smokers to quit.
SOURCE: G. HEYMAN/*ANN. REV. CLIN. PSYCH.* 2013



people in the national surveys. An average of about three-quarters of those who at some point had heavily consumed either of these two drugs had cut back markedly or stopped using completely by age 30. Just 5 percent of cocaine addicts remained hooked into their 40s and 8 percent of marijuana addicts remained devoted pot smokers into their 50s.

Alcoholics and cigarette smokers held on tighter to their habits. It took an average of 27 years for two-thirds of alcoholics to quit or dramatically curtail their drinking and a whopping 49 years for two-thirds of tobacco users to give up their smokes. Cocaine and marijuana addicts quit sooner; two-thirds had quit within seven years and nine years, respectively.

It's especially tough to break the addictive grip of substances that are glamorized in ads and can be legally purchased at local stores, Heyman suspects.

Never too late

Most provocatively, he calculates that the likelihood of recovery stayed constant over time. A disease that turns the brain into an increasingly insatiable drug-seeker would make aging addicts the least likely to recover. Yet, heavy alcohol users in the study were as likely to give up the bottle or revert to occasional use at age 40 or 50 as at 30. That means that people whose addictions lasted into their 50s and beyond still had the potential to turn their lives around, Heyman concludes.

Being married, having a college degree, fearing arrest, facing high drug prices and developing drug-related health concerns made heavy cocaine, marijuana and alcohol users more apt to quit or substantially cut back.

Heavy smokers took a different road to recovery. Most who gave up nicotine did so after age 75. Government data suggest that antismoking campaigns have influenced increasing numbers of heavy smokers, many of them older, to quit using cigarettes, Heyman argues. From 1965 to 1995, smokers who had graduated from high school or college quit at higher rates than those with less education, apparently in reaction to information about health dangers of their habit, he says. Cigarette sales began a steady downward slide shortly after the 1964 Surgeon General's report on smoking and illness, which was followed by increased cigarette taxes, prohibitions on public smoking and the appearance of warning labels on packs of cigarettes.

"Whether or not drug use persists depends on factors that influence decision making, particularly values related to family, the future and one's reputation," Heyman says.

Short-term, self-focused decisions — such as wanting to numb the emotional pain of childhood abuse — can eventually lead to drug addiction, he argues. Switching to a long-term focus on others — say, choosing to be a better parent and to make family members proud — triggers the hard work of getting sober and improving one's lot in life.

Providers of addiction treatments differ on whether a positive perspective shift banishes bad habits or temporarily controls illnesses that can't be cured. Studies of how people kick addictions on their own are rare. Intensive investigations of addicts who quit without formal treatment would help in designing treatments that produce long-lasting improvement, Heyman suggests.

Sobering changes

Major personal transitions throughout life, as suggested by Heyman's findings, shape the course of alcohol and drug addictions, says psychologist Kenneth Sher of the University of Missouri in Columbia.

"People mature out of addictions at all ages," Sher says, echoing Heyman's expansion of Winick's 1962 proposal.

Sher and his colleagues have analyzed data from one of the U.S. population surveys of alcohol and drug use that Heyman consulted. In that project, more than 34,000 adults, ages 18 and older, completed face-to-face interviews in 2001 or 2002 and again three years later.

At the second interviews, past-year rates of drug dependence and abuse — defined in the survey as full-blown addiction accompanied by painful withdrawal reactions, as well as lesser but still serious drug problems — peaked at 9.3 percent among 18- to 20-year-olds but gradually fell in older age groups, reaching a low of 0.5 percent among those older than 50.

In particular, rates of new drug addictions and relapses among

M. ATATROD

those who had kicked past substance problems declined sharply as participants got older, Sher's group reports in the December 2013 *American Journal of Public Health*. From young adulthood to old age, those who started out with drug problems were most likely to get better over the three-year span if they got married, had children or landed a job after being unemployed, in line with Heyman's results.

Cases of drug dependence and abuse that originated between interviews clustered among people who were at least 34 years old and got divorced in that window of time.

Alcoholics in the sample displayed an intriguing gender difference, Sher's team reported in the May 2012 *Journal of Abnormal Psychology*. Men, but not women, who were at least 38 years old and got jobs or had a child after the first interview displayed marked declines in alcoholism by round two of the interviews. About 50 percent of alcoholic women in that age bracket who had children during the study remained heavy alcohol drinkers after three years, versus 40 percent of alcoholic women who didn't give birth during the study.

Life transitions mean different things to different people, Sher says. For instance, parenthood may more often instill a sense of responsibility in middle-aged men and a sense of despair in middle-aged women.

Just say yes Many people report having ever used alcohol, cigarettes and marijuana, but few have used heroin, according to a 2012 survey of the U.S. population. Usage rates dropped for each substance in the month before the survey, but remained substantial for alcohol and cigarettes. SOURCE: NIDA

Use history for various drugs in adults age 26 or older

Drug	Lifetime	Past month
Alcohol	88.1%	55.6%
Cigarettes (any use)	67.9%	22.4%
Marijuana	44.4%	5.3%
Heroin	1.9%	0.1%

A changeable habit

Sher's team has found in another study that personality changes also contribute to maturing out of alcohol problems. Among 467 men and women tracked from ages 21 to 35, heavy drinking and other booze-related problems declined among those who became more conscientious and more emotionally resilient over time, the researchers reported in the November 2010 *Addictive Behaviors*.

A fine-grained picture of the ways in which people gravitate into and out of alcoholism is emerging in New Zealand.

Interviews with a representative population sample of about 1,000 participants at ages 18, 21, 26, 32 and 38 have probed the extent of imbibing and alcohol-related problems in the previous year. Data on physical and mental health have been obtained every few years since birth for each volunteer.

Findings so far underscore Heyman and Sher's argument that alcoholism often doesn't last a lifetime, or even past middle age, Arizona State's Meier and her colleagues report in the August 2013 *Development and Psychopathology*.

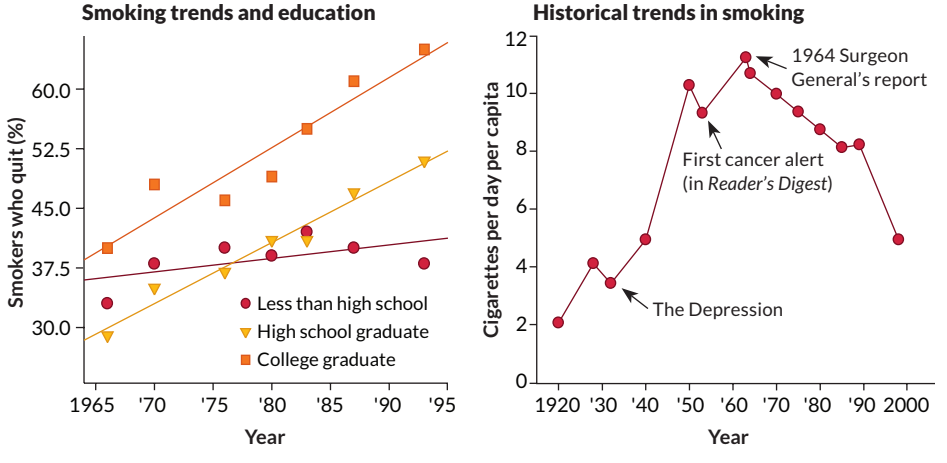
About 13 percent of volunteers were diagnosed as alcohol dependent at age 18 or 21 but no longer drank alcohol excessively when questioned at later ages. Another 4 percent qualified as alcohol dependent only one time, at age 26. Members of these groups had generally grown up in relatively stable families and had brief brushes with delinquency and drug use as teenagers. Young adults' stressful transition to greater independence and responsibility may have evoked temporary booze problems, Sher suggests.

A small minority experienced persistent problems. Alcoholism consistently affected around 3 percent of the sample from ages 18 or 21 onward. These participants displayed the highest rates of alcohol and drug dependence, criminal convictions and psychiatric disorders in their families.

Of the 22 percent of alcoholics who had recovered by age 32, only 14 percent had relapsed into heavy drinking when contacted at age 38.

"Based on our representative sample, relapse does not appear to be as ubiquitous as one might expect based on estimates from clinic samples," Meier says. Nearly everyone tracked by researchers after receiving addiction treatment relapses at some point. A substantially lower relapse rate in Meier's study is consistent with the view that alcoholism, at least in most cases, represents a changeable habit rather than a brain disease. Since the interviews occurred at 3- to 6-year intervals and covered just the previous

Smoke enders U.S. surveys find that college and high school graduates are more likely to quit smoking cigarettes than their less-educated peers (left). Information on smoking's health risks may have influenced that trend. Cigarette sales dropped steadily after the highly publicized 1964 Surgeon General's report describing health dangers of cigarette use (right). SOURCE: G. HEYMAN/*ANN. REV. CLIN. PSYCH.* 2013



M. ATATROD

12 months, however, the researchers can't be sure what happened in the years between interviews.

Chronic urgency

Even if the new studies show that many people beat addictions when they reach critical junctures in their lives, Michael Dennis, a psychologist and addiction researcher, is more concerned about the people with severe addictions who can't go it alone.

Among volunteers recruited from Illinois' largest addiction treatment agency, severe substance abusers qualify for an average of at least five psychiatric disorders, often including depression, anxiety conditions, personality disorders and addictions to two or more drugs, according to research by Dennis and his colleagues at Chestnut Health Systems in Illinois. Most have struggled with addictions for at least 20 consecutive years.

These individuals tend to end up dead or in nursing homes by their early 50s, so it makes no sense to wait for them possibly to find ways to get better on their own, Dennis says.

Quarterly recovery checkups of 446 patients released from state-run addiction centers in Illinois revealed that more than 90 percent needed more treatment at some point over the next four years, Dennis and psychologist Christy Scott of Chestnut Health Systems reported in the February 2012 *Drug and Alcohol Dependence*.

"For those with chronic addictions that last for at least two decades and include multiple psychiatric problems, the odds of recovery are limited without treatment," Dennis says.

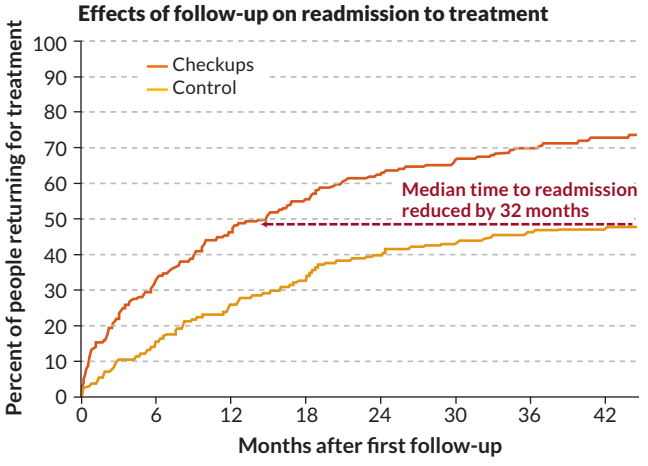
Lasting improvement depends on personal growth after treatment, he adds. Many ex-addicts who manage to stay off drugs long after treatment ends talk about having had spiritual awakenings or jolts of awareness about the destruction wreaked by their drug habits. "I've also seen people who can't stop using drugs even though they desperately want to," Dennis says.

Tough road ahead

Scientists don't expect that any empirical jolts of insight will clarify lifetime patterns of alcohol and drug addictions to everyone's satisfaction. Because excessive substance use occurs at a crossroads where culture, society, economics, psychology and biology meet, "it's very difficult to study the natural history of drug use," says psychiatrist Wilson Compton, deputy director of the National Institute on Drug Abuse in Bethesda, Md.

NIDA and many medical organizations regard alcoholism and drug addictions as brain diseases. That's not to deny that, in population surveys, many people report having quit addictions without formal treatment, Compton acknowledges. He and his colleagues have examined data from the most recent U.S. survey analyzed by Heyman, which was conducted in 2001 and 2002 and again three years later. Compton's team estimated that nearly half of those who began with mild to moderate drug problems had stopped using drugs at the follow-up interviews. Another 11 percent of problematic drug users had shifted to occasional drug consumption that had no harmful effects on their lives, the researchers reported in the June 2013 *American Journal of Psychiatry*.

Rocky recoveries Though most people can eventually quit without help, those with severe addictions usually require multiple rounds of rehab. In those cases, quarterly checkups run by a case manager seemed to make a big difference in getting people back into treatment when their recoveries were starting to falter. In a study of people released from Illinois treatment centers, half of those in a checkup program re-entered treatment within 13 months; it took 45 months for half of those receiving only brief quarterly interviews to seek treatment.
SOURCE: M.L. DENNIS AND C.K. SCOTT/*DRUG AND ALCOHOL DEPENDENCE* 2012



About 40 percent of drug users cited at least as many drug issues three years later. So there's reason for concern that a substantial minority of problem users are headed for worse, long-lasting drug problems, in Compton's view.

Rehab and other forms of treatment jump-start recovery, even if many people with drug problems eventually get better on their own, Compton says. He compares this situation to flu sufferers, who can return to health without treatment but do so more quickly when prescribed proper medication.

Heyman disagrees. "The data don't tell us that there are two kinds of addicts, one that quits and one that doesn't," he says. Everyone can potentially break free of addictions if their personal options and perspectives on life change — and most do.

Those who don't quit still make choices that are unavailable to those afflicted with physical illnesses, Heyman emphasizes.

That goes for actress Drew Barrymore no less than for Philip Seymour Hoffman, who stayed clean for more than 20 years before he tragically returned to heroin use. Barrymore transitioned from child movie star to teenage alcoholic and drug addict to nonaddicted movie star and producer who occasionally drinks wine from her own winery. In life as in research, that's the paradox of addiction. ■

Explore more

■ G. Heyman. "Quitting drugs: Quantitative and qualitative features." *Annual Review of Clinical Psychology*. 2013. doi:10.1146/annurev-clinpsy-032511-143041.

M. ATATROD

S·P·A·R·K COMPETITION

WHAT WILL SPARK KIDS' LOVE OF EXPLORATION AND DISCOVERY?

Create a SPARK and win up to $50,000.

Decades ago, the chemistry set helped children explore their curiosity and fostered a spirit of discovery. Scientists often attribute their childhood use of chemistry sets as critical fuel for their early interest in science and, ultimately, their pursuit of a career and lifelong engagement in science. Of course, the chemistry set wasn't the only experience that provided entry to the world of science. Children got hooked on science through any number of experiences: taking apart clocks and radios, playing in creeks and collecting bugs.

These sorts of experiences take advantage of children's propensity to play and to ask questions and allow them to tinker and revel in the messiness of exploration. The SPARK competition challenges participants to reimagine the chemistry set for the 21st century to generate a new set of experiences and activities that encourage imagination and interest in science.

To learn more contact spark@societyforscience.org.

GORDON AND BETTY MOORE FOUNDATION

SOCIETY FOR SCIENCE & THE PUBLIC
Inform. Educate. Inspire.

cloudy forecast

The biggest source of climate uncertainty is white and fluffy

By Gabriel Popkin

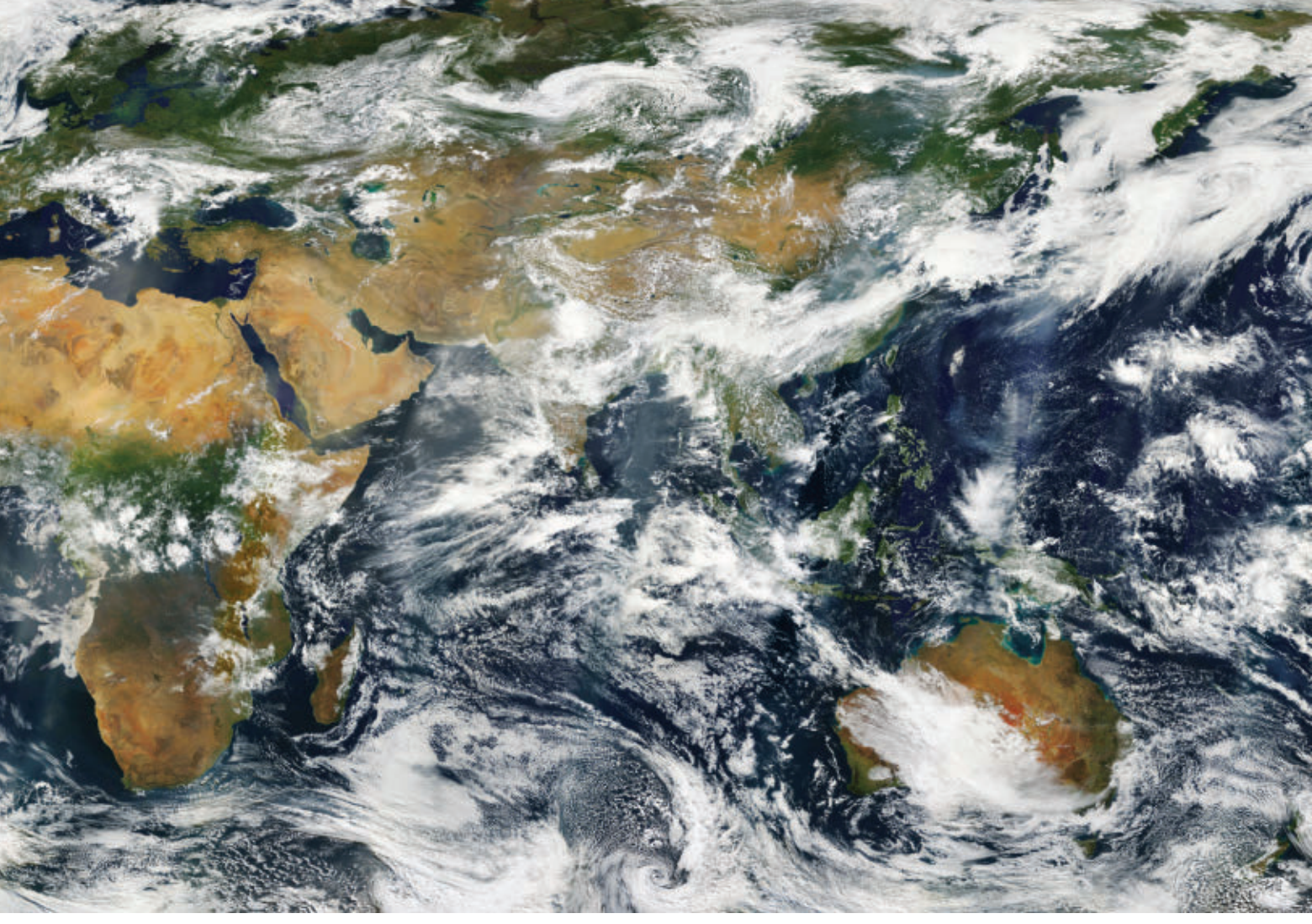
From space, clouds appear to perform an intricate and never-ending ballet. Thin streaks dance at the poles, vast storms plow across the jet streams, spinning cyclones get tossed up in the tropics and deep convecting monsters churn near the equator. Clouds whip and curl and billow, materializing seemingly out of nowhere and dissipating just as mysteriously.

The mystery deepens when scientists try to understand how clouds influence climate. Clouds lead a sort of double life, both trapping and deflecting planet-warming energy. Their molecules, like all water in the atmosphere, contribute to the greenhouse effect by lapping up infrared radiation emitted by Earth and redirecting some of that energy back toward the planet's surface. But clouds' white tops also reflect, collectively, almost a quarter of the solar radiation that reaches them, in effect shading the planet.

All told, clouds cool through reflection far more than they warm through the greenhouse effect. Without them, Earth's surface would be, on average, about 5 degrees Celsius warmer. "Clouds are really at the heart of the climate system," says Sandrine Bony, a climate scientist at the Université Pierre et Marie Curie in Paris.

That clouds both warm and cool is established. But how the global balance between those two effects will shift as the climate heats up is not. Even seemingly minor shifts in clouds' behavior could substantially dampen or accelerate global warming.

NASA



Clouds can both warm and cool the planet. How clouds will respond to global warming is the largest source of uncertainty in climate change predictions.

Early predictions suggested that clouds might work to counteract rising temperatures: As oceans absorb more heat, they add more water vapor to the air. This, the thinking went, would create more sunlight-reflecting clouds, which would help cool the planet. In climate speak, this is known as a negative feedback. Research over the last two decades suggests, however, that the cloud feedback is more complicated and likely to result not in cooling but in added warming.

But no one knows how much additional warming, if any, to expect. The United Nations Intergovernmental Panel on Climate Change, which represents the collective knowledge of the world's climate scientists, considers cloud feedbacks the top source of uncertainty in climate change prediction. This uncertainty is reflected in the reports that the panel releases every five to seven years. In its 2007 report, the panel estimated that if the concentration of carbon dioxide in the atmosphere were to double from its preindustrial level — a likely outcome by the end of this century — global average temperature would rise between 2 and 4.5 degrees Celsius. The panel's latest report, officially published January 30, estimates a temperature rise of 1.5 to 4.5 degrees with carbon dioxide doubling. In other words, seven years later, the uncertainty has actually grown.

Researchers nevertheless insist that they understand clouds much better than they did in 2007. "We've moved from the unknown unknowns to the known unknowns," says Leo Donner, a scientist who develops climate simulations at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory in Princeton, N.J. "I would argue that in fact there has been very significant progress, though [it's] correct that the bottom line is still not changed."

Scientists like Donner are increasingly convinced that cloud feedbacks are not going to diminish greenhouse gas warming. But to really put this issue to bed, they say they need more sophisticated cloud observations extending over decades. Whether researchers will get this crucial data record is far from certain.

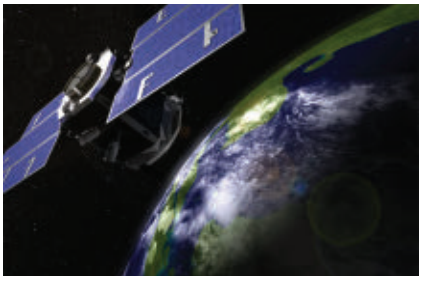
Getting clouds' numbers

Until recently, researchers had no way to monitor clouds on a global scale. Ground-based observatories could see only the bottoms of clouds. And while scientists could send balloons and airplanes through individual clouds to gather more complete profiles, these methods provided only local snapshots. Things improved in 1999 when NASA launched the first of its two MODIS instruments, which circle the planet and look

down on cloud tops. But these data, too, are limited: Clouds and sea ice are nearly indistinguishable from above, and a several-kilometer-thick cloud can hide large variations in its interior.

In 2006, NASA launched the satellites CloudSat and CALIPSO. These sister orbiters fly in close formation and send out beams — radar for CloudSat and lidar (the laser version of radar) for CALIPSO — that penetrate deep into clouds and bounce off water droplets and airborne particles called aerosols before returning to the satellites. Zipping around the planet roughly every hour and a half, the satellites send down a continuous trove of data that scientists can access almost in real time.

CloudSat and CALIPSO are "a revolution in observing technology," says Ulrike Lohmann, a cloud physicist at the Swiss Federal Institute of Technology in Zurich. Previously, scientists didn't always know even basic things such as clouds' altitudes, volume and how often they produce rain. Researchers have been surprised to learn how much of the water in clouds is frozen, says Lohmann. "The amount of ice in the atmosphere seems to exceed the amount of liquid almost everywhere."



Data collected by a new generation of cloud-gazing satellites such as NASA's CloudSat (shown in an artist's conception) are helping researchers pin down the basic properties of clouds and fine-tune climate simulations.

Frozen clouds seem to have a stronger greenhouse effect than liquid clouds, says Graeme Stephens, a researcher at NASA's Jet Propulsion Laboratory in Pasadena, Calif., and chief scientist on the CloudSat mission.

"Active" instruments like radar and lidar provide "the least ambiguous view of clouds," he says. "Everything else gives us just glimpses." He has called the CloudSat-CALIPSO era a "golden age" of cloud observations. And these observations are helping researchers home in on some of the biggest unknowns in climate science.

Modeling the future

The first good satellite observations of clouds showed that the supercomputer-driven climate simulations used to predict future warming got a lot right. But these simulations tended to produce too few clouds and to make them too reflective. The models also produced too many storms and failed to reproduce important weather patterns.

Many of the problems stem from simplifications that scientists have to make when constructing climate models. Modelers start by dividing Earth's surface into squares. Each square becomes the base of a stack of rectangular boxes extending up through the atmosphere. Scientists decide on a set of physical variables to sum up atmospheric conditions, and then use real-world data to assign a starting value for each factor in each box. Modelers then write computer code to make neighboring boxes interact based on the laws of physics and fluid dynamics. Finally, researchers run time forward in discrete steps and study how their digitized planet changes.

Early climate models had grid squares around 500 kilometers on a side. In today's climate models, squares have shrunk to 100 kilometers wide. Vertical and time resolution have also improved. Still higher resolutions are possible, but going to that level of detail for long-term climate simulations would gobble up too much time even on today's fastest computers, says David Randall, an atmospheric scientist at Colorado State University.

Resolution has been a major problem for simulating clouds, which can be as small as tens of meters across. And the processes by which clouds form — water nucleating around aerosol particles — occur at scales of micrometers. The results of models that run at the scale of individual clouds can be fed into climate models. But this means that global climate simulations themselves must approximate or ignore important cloud-related processes.

To get around this limitation, Randall has helped pioneer a technique called superparameterization that embeds small-scale cloud models inside global climate models. The method uses a lot of computing power, but less than trying to shrink global models' grid cells to the size of clouds. "The superparameterization approach is a kind of a compromise," Randall says, that better reproduces certain local processes like day-night rainfall patterns and the annual monsoon cycle in the Indian Ocean. He predicts the technique will become more common.

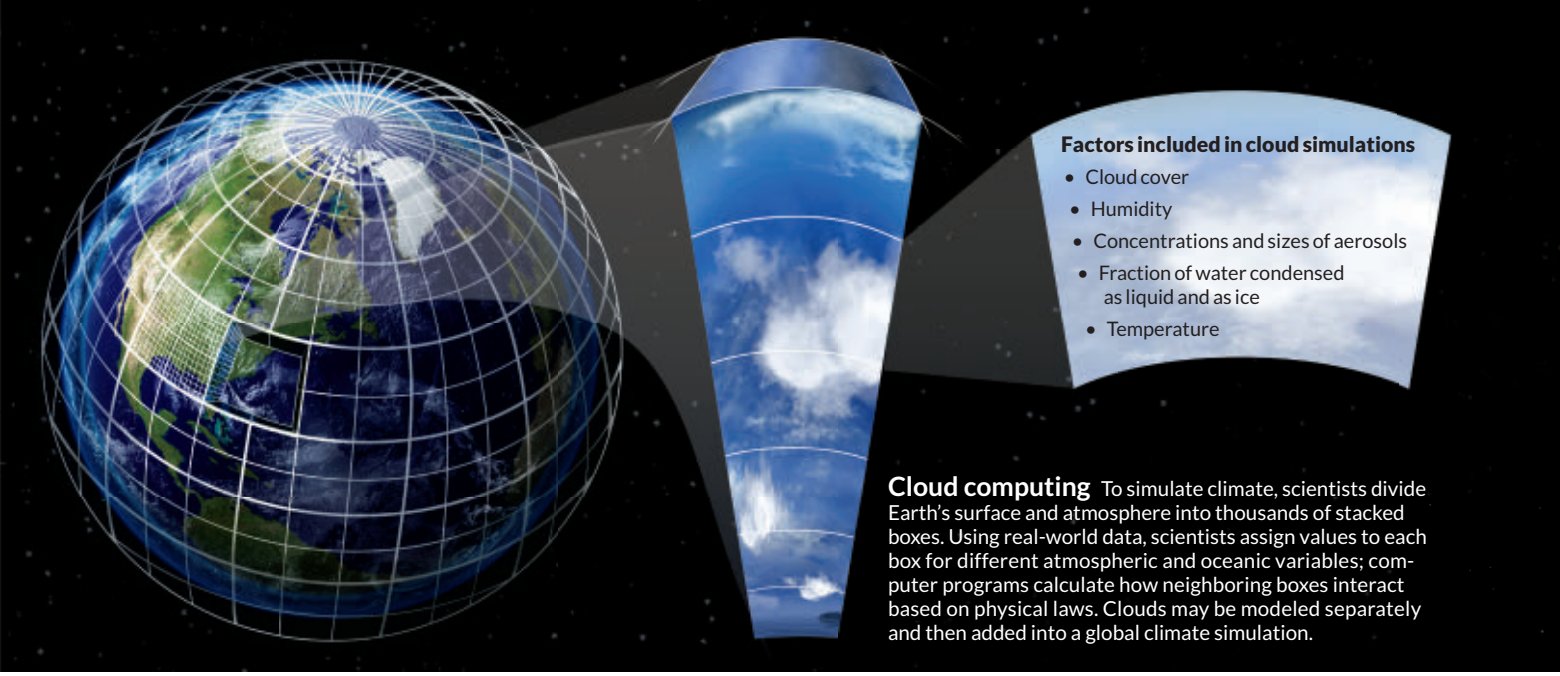
Higher resolution helps, says Anthony Del Genio, who develops simulations for NASA's Goddard Institute for Space Studies in New York City. But it is not the only, or even the best way to make more realistic models. "In terms of the big issues in climate change, resolution is not necessarily the answer," he says. "Better physics is the answer."

Today's climate models represent cloud-related processes with dozens of variables, including humidity, amount of water condensed as water and as ice, number of droplets falling at different speeds and concentrations and sizes of various aerosol particles. Models that used to ignore or drastically oversimplify aerosols now allow them to interact with water and form droplets. Also more nuanced are climate models' simulations of convection, the complex physical process that moves water upward in the atmosphere, causing much of the planet's rainfall.

These improvements, notes cloud physicist Lohmann, give a more realistic representation of nature's complexity, but not necessarily better predictive power. "It tends to be that the more we know, the larger the uncertainty gets," she says.

Bjorn Stevens of the Max Planck Institute for Meteorology in Hamburg, who works on a model called ECHAM, emphasizes how crucial it is for climate simulations to get what is known about clouds right. He recently found that ECHAM was representing clouds in an unrealistically crude way: Instead of allowing cloudiness to vary smoothly from 0 (perfectly clear) to 1 (overcast), the value was forced to occupy one of

JPL/NASA



Cloud computing To simulate climate, scientists divide Earth's surface and atmosphere into thousands of stacked boxes. Using real-world data, scientists assign values to each box for different atmospheric and oceanic variables; computer programs calculate how neighboring boxes interact based on physical laws. Clouds may be modeled separately and then added into a global climate simulation.

the extremes. When Stevens changed his computer code to allow fractional cloudiness, the model's prediction for future temperature rise doubled.

Closing in on the cloud feedback

Before every IPCC report, the world's 20 or so major climate modeling groups run simulations of the future climate assuming various greenhouse gas emissions projections, from an uncontrolled increase to a stabilization or decrease. Scientists then compare the simulations' outputs to see where models agree and where they diverge. The most recent comparison showed, among other things, that nearly all models predict that as the world warms, clouds will change in ways that further increase warming. "I don't think anybody's really constructed a full model with a significantly negative cloud feedback," says Andrew Gettelman, a scientist at the National Center for Atmospheric Research in Boulder, Colo. "If you discovered that you had a negative feedback and could build a self-consistent model of that, you'd become famous."

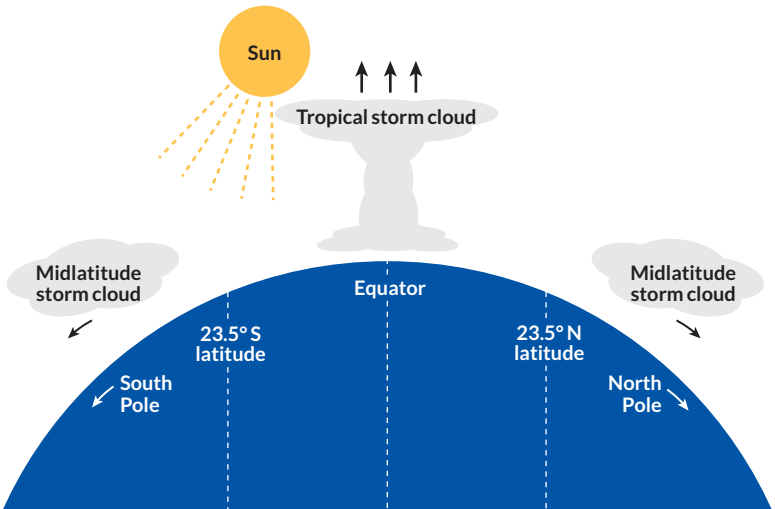
Gettelman stresses that he and his colleagues aren't just relying on models. They also have reasons based on established physics to think that clouds will amplify, or at least not dampen, global warming. One of these mechanisms results from the fact that the atmosphere's lowest layer, the troposphere, is becoming taller as the climate warms. Many clouds extend to the top of the troposphere, meaning their tops are also rising. This makes the clouds' tops colder, so they radiate less energy into space.

A related pro-warming effect results as warming at the equator expands the rotating cells of dry air that maintain Earth's low-latitude deserts. Scientists expect these expanding cells to push midlatitude storm tracks toward the poles, widening the low-latitude cloudfree belts where most planet-warming sunlight strikes. "Your cloud is essentially giving you less bang for your buck," explains Mark Zelinka, who studies cloud feedbacks at the Lawrence Livermore National Laboratory in California. A recent analysis of more than 30 years of weather data by Zelinka's colleagues Kate Marvel and Céline Bonfils provided evidence that storm tracks are in fact moving poleward (*SN Online: 11/11/13*).

Low-altitude clouds create the most headaches for researchers trying to pin down the total cloud impact. Many scientists once thought that evaporating water in the tropics would form more highly reflective low clouds, which would act as a brake on climate change. But as scientists have come to better understand convection processes near the ocean surface, their view has changed. Most now suspect that low clouds will decrease as temperatures warm.

Using global satellite data, scientists are beginning to directly measure cloud feedbacks. In 2010, Texas A&M University climate researcher Andrew Dessler analyzed radiation data collected by satellites over the previous decade and found that the way clouds responded to natural temperature fluctuations tended to increase warming (*SN Online: 12/9/10*). Although he acknowledges his data series was too short to show a trend from human-caused climate change, Dessler thinks scientists already have enough evidence to rule out a

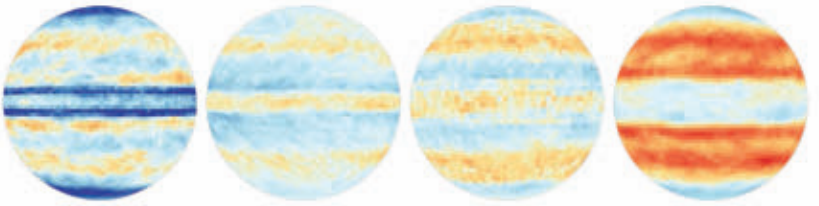
Under a cloud Climate change may produce positive cloud feedbacks, further driving global warming. The tops of clouds are expected to rise to a colder part of the atmosphere, where they will release less heat. And as warming pushes storm tracks toward the poles, more sunlight will reach the surface in midlatitude regions.



FROM TOP: NICOLLE RAGER FULLER, NSF; E. OTWELL

large climate-saving effect from clouds. "We don't see any evidence ... that clouds are this big negative stabilizing feedback that acts to prevent warming."

Not all scientists are ready to concede that the cloud feedback is positive, though. Stephens thinks climate models still vary too much among themselves to allow scientists to make a definitive statement. "There's agreement that of the feedbacks that they know, those feedbacks are most likely to be positive," he says. "It does not mean that the feedbacks overall should be positive." Partly due to Stephens' influence, the IPCC report states that the total cloud feedback is "*likely* positive" (emphasis original), leaving room for a neutral or slightly negative effect.



When it comes to cloud impacts, climate simulations vary widely. Modeling a 4-degree-Celsius increase in temperature, four climate models came to different conclusions on whether clouds on a simplified planet would have a warming (red) or cooling (blue) effect.

The key to nailing the cloud feedback, everybody agrees, is extending the data record. But this record is in jeopardy. CloudSat has already lost its nighttime observing capability because of battery problems, and failing energy supplies will cause CALIPSO to start to depart from its orbit over the next few years. The European Space Agency's EarthCARE satellite, which will also beam radar and lidar at clouds, may temporarily fill the gap. But EarthCARE is slated to fly only from 2015 to 2018, and no one has announced a follow-on mission that could keep the data coming.

Losing the opportunity to compile a long-term record on clouds could severely hamper scientists' attempts to observe and predict climate change, Gettelman says. The CloudSat and CALIPSO series, though valuable, are far too short to show the effects of global warming. Scientists say they need at least 20 to 30 years of data to average out natural fluctuations and determine whether clouds respond to global warming the way simulations predict. And Gettelman says he is frustrated that NASA has no plan for gathering this record. "It's a political and bureaucratic failure to take the observations we have and make sure they continue."

Scientists say they need at least 20 to 30 years of data to determine whether clouds respond to global warming the way simulations predict.

Clouds on the horizon

In January 2014, scientists analyzed how climate models simulate convection and found that many simulations get the process wrong. As a result, the team reported in *Nature*, these simulations produce too many low, sunlight-reflecting clouds. Models that get convection right predict, on average, substantially more warming over the next century. The study authors, who include Bony, concluded that doubling carbon dioxide should raise temperatures by 3 to 4.5 degrees, the upper half of the IPCC's current range.

But not all evidence points in that direction. Since 1998, Earth's surface temperature has remained roughly constant, a substantial shift after three decades of rapid warming (*SN: 10/5/13, p. 14*). If the climate were really as sensitive to greenhouse gases as Bony and her colleagues think, warming should have continued apace, or even accelerated. Studies of past climate changes also hint that greenhouse gases may have less impact on global temperature than many models predict. Reconciling this evidence with scientists' latest findings on clouds is one of the main challenges facing the field today.

Aerosols could also play a joker in the climate game. In pre-industrial times, clouds nucleated around natural aerosols like salt from sea spray, volcanic sulfates and desert dust. These days, however, human-caused emissions from power plants, factory chimneys and wood stoves supplement the natural aerosol load. With more particles in the air, cloud droplets become smaller and more numerous, and therefore reflect more sunlight. So clouds are almost certainly cooling the planet a bit more — and possibly a lot more — than they would without human-made aerosols.

Pinpointing how clouds have adjusted to the changing aerosol potpourri is a major unsolved problem that scientists are furiously working to solve. Writing in *Science* in January, Donner and other climate scientists called for a new satellite-based instrument that would measure not only the amounts of aerosols, as CALIPSO does, but also the weather patterns that move aerosols through the atmosphere. The team argues that such observations are crucial for removing remaining uncertainties from global warming predictions.

Even with those satellite measurements, however, it will be at least a couple of decades before long-term datasets and enhanced computing power allow scientists to elucidate how cloud feedbacks and cloud-aerosol interactions influence climate. If governments haven't acted to reduce greenhouse gas emissions by then, the world will be committed to what almost all scientists consider a dangerous amount of warming. "The models aren't perfect," says Steven Sherwood, a climate researcher at the University of New South Wales in Sydney and a coauthor on both the January *Nature* and *Science* papers. But, he says, "it never makes sense to use uncertainty as an excuse not to do anything. You certainly wouldn't do that if you were running a business ... or in any other aspect of your life." ■

Explore more

■ IPCC Working Group I. "Climate change 2013: The physical science basis." Posted January 30, 2014. www.ipcc.ch/report/ar5/wg1/

B. STEVENS AND S. BONY/*SCIENCE* 2013

No Contract

NEW

"My friends all hate their cell phones… I love mine!" Here's why.

FREE Car Charger

Better Sound and Longer Battery Life

Say good-bye to everything you hate about cell phones. Say hello to Jitterbug.

"Cell phones have gotten so small, I can barely dial mine"
Not Jitterbug®, it features a larger keypad for easier dialing. It even has an oversized display so you can actually see it.

"I had to get my son to program it"
Your Jitterbug set-up process is simple. We'll even pre-program it with your favorite numbers.

"I tried my sister's cell phone… I couldn't hear it"
Jitterbug is designed with an improved speaker. There's an adjustable volume control, and Jitterbug is hearing-aid compatible.

"I don't need stock quotes, Internet sites or games on my phone, I just want to talk with my family and friends"
Life is complicated enough… Jitterbug is simple.

"What if I don't remember a number?"
Friendly, helpful Jitterbug operators are available 24 hours a day and will even greet you by name when you call.

"I'd like a cell phone to use in an emergency, but I don't want a high monthly bill"
Jitterbug has a plan to fit your needs… and your budget.

Available in Silver and Red.

	Basic 14	Basic 19
Monthly Minutes	50	was ~~100~~ NOW 200
Monthly Rate	$14.99	$19.99
Operator Assistance	24/7	24/7
911 Access	FREE	FREE
Long Distance Calls	No add'l charge	No add'l charge
Voice Dial	FREE	FREE
Nationwide Coverage	YES	YES
Friendly Return Policy[1]	30 days	30 days

More minute plans available. Ask your Jitterbug expert for details.

"My cell phone company wants to lock me in on a two-year contract!"
Not Jitterbug, there's no contract to sign and no penalty if you discontinue your service.

"I'll be paying for minutes I'll never use!"
Not with Jitterbug, unused minutes carry over to the next month, there's no roaming fee and no additional charge for long distance.

"My phone's battery only lasts a couple of days"
The Jitterbug's battery lasts for up to 25 days.

Enough talk. Isn't it time you found out more about the cell phone that's changing all the rules? Call now, Jitterbug product experts are standing by.

Order now and receive a **FREE Car Charger** for your Jitterbug – a $24.99 value. Call now!

jitterbug plus

firstSTREET for Boomers and Beyond®
1998 Ruffin Mill Road
Colonial Heights, VA 23834

100% U.S. Based Customer Service

Jitterbug Plus Cell Phone

Call today to get your own Jitterbug Plus.

Please mention promotional code 47831.

1-877-725-6452

www.jitterbugdirect.com

We proudly accept the following credit cards.

47592

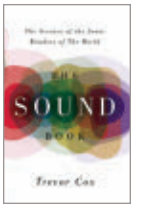
IMPORTANT CONSUMER INFORMATION: Jitterbug is owned by GreatCall, Inc. Your invoices will come from GreatCall. All rate plans and service require the purchase of a Jitterbug phone and a one-time set up fee of $35. Coverage and service is not available everywhere. Other charges and restrictions may apply. Screen images simulated. There are no additional fees to call Jitterbug's 24-hour U.S. Based Customer Service. However, for calls to an Operator in which a service is completed, minutes will be deducted from your monthly balance equal to the length of the call and any call connected by the Operator, plus an additional 5 minutes. Monthly minutes carry over and are available for 60 days. If you exceed the minute balance on your account, you will be billed at 35¢ for each minute used over the balance. Monthly rate plans do not include government taxes or assessment surcharges. Prices and fees subject to change. 1We will refund the full price of the GreatCall phone and the activation fee (or set-up fee) if it is returned within 30 days of purchase in like-new condition. We will also refund your first monthly service charge if you have less than 30 minutes of usage. If you have more than 30 minutes of usage, a per minute charge of 35 cents will be deducted from your refund for each minute over 30 minutes. You will be charged a $10 restocking fee. The shipping charges are not refundable. Jitterbug and GreatCall are registered trademarks of GreatCall, Inc. Samsung is a registered trademark of Samsung Electronics Co., Ltd.

SCREENTIME

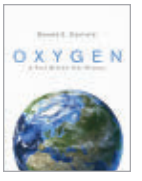
Do your bit for bumblebees

Bumblebee populations are in decline, but scientists don't have enough data on which bee species live where to target conservation efforts. People throughout North America, armed with smartphones and cameras, can now help find the bumblebees. The Xerces Society for Invertebrate Conservation and its partners have launched the Bumble Bee Watch website to track sightings. When you see a bee bumbling around, snap a photo. Head to bumblebeewatch.org and create a free account, then upload your photo and click the map to log your sighting. After that, the website will lead you through questions to help ID your bee. The data will be open to anyone and will help conservationists and scientists in the Xerces Society, Wildlife Preservation Canada, the University of Ottawa and other groups target local efforts and study bee decline. — *Bethany Brookshire*

Bitter Roots
Abena Dove Osseo-Asare
In a fascinating look at modern and traditional medicine, the author tells the stories of efforts to commercialize pharmaceuticals from six African plants.
Univ. of Chicago, $35



The Sound Book
Trevor Cox
An expert in acoustics explores how sounds are made in the natural environment, from creaking glaciers to humming sand dunes.
W.W. Norton & Co., $26.95



Oxygen
Donald E. Canfield
Journey through time with a geoscientist to learn how Earth became an oxygen-rich home for life.
Princeton Univ., $27.95

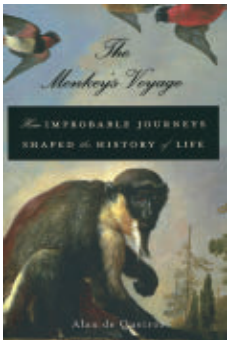
Buy Books Reviews on the *Science News* website include Amazon.com links that generate funds for Society for Science & the Public programs.

BOOKSHELF

The Monkey's Voyage

How Improbable Journeys Shaped the History of Life

Alan de Queiroz



By 26 million years ago, the ancestors of today's New World monkeys had arrived in South America. How those primates reached the continent is something of a conundrum. The leading explanation has the animals floating across the Atlantic Ocean from Africa aboard a giant raft of vegetation.

The scenario may sound preposterous. But de Queiroz, an evolutionary biologist, uses fossil, genetic and geologic evidence to make a compelling case that a variety of plants and animals have dispersed on long-distance ocean voyages throughout evolutionary history.

The idea is not new: Charles Darwin and Alfred Russel Wallace were convinced that ocean voyages played a role in evolution. But by the mid-20th century, when geologists had verified plate tectonics and realized that continents are not stationary, the theory fell out of favor. Many biologists thought that sea level changes and continental breakups better explain how closely related organisms can end up on opposite sides of an ocean. Proponents of the vicariance hypothesis, in which a barrier divides a species' range, were dogmatic — they "seemed a bit like an unruly cult," de Queiroz writes — and ridiculed those who thought creatures could sail on the high seas and survive.

But in example after example — from amphibians to flightless birds — de Queiroz challenges the vicariance camp's dogma. Over the last several decades, evidence of ocean journeys has piled up. For instance, the fossil record and genetic analyses that estimate when lineages diverged indicate that New World monkeys split from Old World monkeys and apes at least 50 million years after South America and Africa broke apart. That leaves a transatlantic trip as the only reasonable way primates could have migrated to the New World.

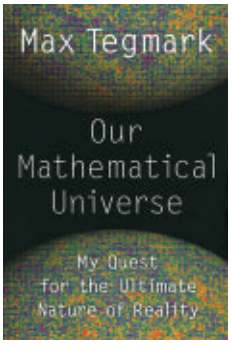
Although de Queiroz is unlikely to persuade staunch vicariance advocates, *The Monkey's Voyage* is a captivating look at one of biogeography's most puzzling problems, with just the right balance between science and scientific drama. — *Erin Wayman*
Basic Books, $27.99

BOOKSHELF

Our Mathematical Universe

My Quest for the Ultimate Nature of Reality

Max Tegmark



Math is everywhere: medicine, sports, banking, gambling, National Security Agency espionage.

And then there's science, which has adopted math as the preferred method of description for life, nonlife and the entire physical universe. Math does a decent enough job at this to inspire wonder among physicists about why it works so well. The answer isn't obvious, but Tegmark thinks he knows: It's because reality *is* math. In fact, he contends, all mathematical structures are real. The internal reality of human perceptions is merely a pale approximation of the true external reality embodied in one of those mathematical structures.

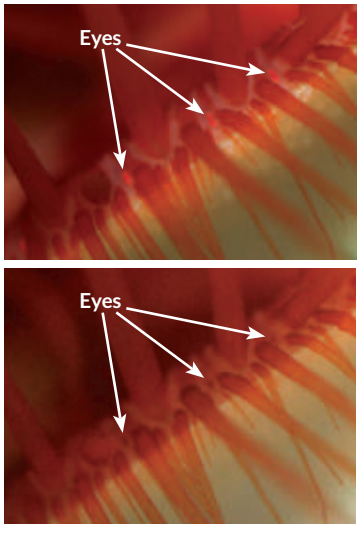
It's fascinating speculation, presented engagingly. But it's unfortunately more than 200 pages into the book before he actually begins to discuss his point. The first half of the book is a semiautobiographical crash course in modern cosmology, of which Tegmark is a prominent practitioner. And the last chapter veers into a rant about ways human civilization could self-destruct, having virtually nothing to do with the rest of the book at all.

Tegmark's case is not entirely convincing. To believe, you need to accept the "block universe" view of spacetime, in which time and change are illusions because all spacetime already exists, just sitting there. He further requires doing away with infinity, as math with infinities is subject to the Gödel undecidability theorem, which demonstrates that mathematical systems of sufficient complexity cannot be completely consistent. So in some way the "real" underlying mathematical reality must somehow be simpler than most of the math that scientists actually use.

Of course, the math now in use hasn't succeeded in answering all of science's big questions either. So perhaps it will turn out that there's a sense in which Tegmark is right about all this. But if so, he's a century ahead of his time. Or three or four. — *Tom Siegfried*
Knopf, $30

FEBRUARY 8, 2014

Bright eyes



A disco clam's eyes are as showy as its lips. The clam's eyes light up when photographed with a flash (top image) but go dim without it (bottom). Special reflective pigments in the eyes may be responsible for this display.

Join the conversation

E-MAIL editors@sciencenews.org

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

Connect with us

Clams light up the deep

*Disco clams produce flashy displays by bouncing light off reflective strips located on their lips. **Susan Milius** described marine biologist **Lindsey Dougherty's** research on these aquatic spectacles, which might help clams lure in small prey, in "Disco clams put on a streak show"* (SN: 2/8/14, p. 5).

"The display is striking and it's astounding that it's not bioluminescence," online reader **Brian Howells** wrote. "Most puzzling is that these clams seem to prefer darker areas. What would the display look like under conditions of very low light? When divers bring high-output lights close to the clams the display looks like lightning. My feeling is that the display looks very different to the target animal."

Dougherty, who took some time away from her clams to answer questions in the comments section of the story online, responds: "Much of the filming I did this summer was in natural lighting (without a dive light).... The clams can be found very deep (up to 50 meters), so I'm very interested in examining physiological and structural differences between the shallow and deep organisms. It is very interesting how bright the display is even at dusk, when there is very low light. The display is likely visible to many sharp-eyed fish, crustaceans and cephalopods."

Birds in sync

***Susan Milius** reported that northern bald ibises time their wing flaps to catch a little lift from the birds flying in front of them in "V-flying birds pick efficient flapping pattern"* (SN: 2/8/14, p. 9).

Gary Nielsen wonders if the birds' efficient coordination is a deliberate choice. "Ask any cyclist who has ridden in a pace line and they will tell you the spot close behind another rider uses less energy," he wrote in an e-mail. "The wind can vary from directly in front of the line of cyclists or from the side, but that sweet spot is easily found by adjusting your position in relation to the leading rider and feeling for the spot that offers the easiest pedaling. A tired cyclist doesn't need to be smart or well-coordinated, just aware of that spot in the line that uses the least energy ... just like an ibis."

Milius thinks that a tired cyclist makes a fine analogy. While the story doesn't suggest that birds are actually calculating the advantages of flight patterns as they fly along, she says, "let's not take evolutionary marvels for granted. It would be great to know more about how that perception of a sweet spot works and how a body maintains energy-saving rhythms."

How pot changes the brain

*The hormone pregnenolone can put a damper on the effects of cannabis on the rodent brain, as **Laura Sanders** mentioned in "Hormone hinders effect of pot"* (SN: 2/8/14, p. 12).

Some online readers questioned whether the word "addiction" can apply to habitual marijuana use. "Cannabis was proven to be nonaddictive, quite a long time ago," commented **owlsmail@gmail.com** on the *Science News* website. "This article uses two terms interchangeably: 'addiction' and 'dependence,' " added **Jan Steinman**. "I agree that pot is not physically addictive. But I have known many people who were dependent to the point that they couldn't get through a day without several joints."

The effects of marijuana may not be as severe as those of other mind-altering substances, says **Sanders**, but the drug does come with some biological baggage, particularly for young people. "While people still debate the difference between 'addiction' and 'dependence,' research suggests both can apply to some habitual marijuana users. Bodies and brains become accustomed to THC, the psychoactive substance in cannabis. Withdrawal symptoms can include anxiety, irritability and sleep problems. And some people have trouble limiting their marijuana intake and keep using it despite the desire to quit — hallmarks of addiction."

COURTESY OF L. DOUGHERTY

The Commander™: Without doubt - the most advanced chronograph watch ever!

With its sophisticated synthesis of high technology and contemporary styling, The Commander Watch is the acme of horological achievement. It can be yours for only ~~$80~~ or perhaps even less. Read on!

A Marvel of Technology

The COMMANDER™ is the most advanced example of analog and digital technology. In its normal mode it shows the time in conventional manner. The analog movement is made by Seiko, which is universally recognized as the maker of the finest watch movements in the world. It won't be off by more than 3 seconds per month.

It's in its sophisticated digital movement where the COMMANDER™ really shines. First, there is the digital readout of hours, minutes; also months, dates, and days of the week. You can select and switch to 12 hrs. or 24 hrs. format. A daily alarm and an hourly chime are available. There is also a snooze function for those who need an extra 10 minutes. For sports enthusiasts, there is a 1/100 sec. chrono- graph stopwatch with split function. To top it off, you can light up the entire dial at the push of a button. With the COMMANDER™ you can read the time in the pitchest dark.

The COMMANDER™ is powered by a tiny mercury cell. It should last you about two years. After that you can easily have it replaced. It shouldn't cost you more than $5.

Like To Dive?

The COMMANDER™ is guaranteed water-resistant to 100 ft (3 atm.). You don't really want to go that deep, do you?

An Exceptional Offer

You may have seen similar watches advertised. Most of them have limited functions. Some claim that they have been reduced from $395 or some such price. That is nonsense, of course, and we don't expect you to fall for such claims. The COMMANDER™ is made to sell for $99. But because of our very large purchases, we are able to bring it to you for just $59.40. But wait, it gets even better. With our trademark 3-for-the-price-of 2 deal we can let you have it for only $39.60 per watch. It's hard to believe - isn't it?!

Keep in mind that a fine watch is a lifetime investment. The COMMANDER™ is that watch.

You may buy it in confidence, it comes with a 3-year limited warranty.

Short On Cash?

With your credit card, you can buy three COMMANDER™ Watches for the price of two - in two equal monthly installments. Shipping/insurance of $12.95 plus $10 for additional processing and billing will be added to the first installment.

The COMMANDER™ Watch

From Us Only ~~$99~~
(why pay more?) $59.40

* BUT READ THIS AD AND SEE HOW IT CAN BE YOURS FOR JUST $39.60!

But, that (as they say on TV) isn't all: Buy three COMMANDER Watches (for the price of two) and we'll send you this splendid Faux Fabergé Egg Pendant with our compliments - absolutely FREE!

The egg measures 1-5/8" x 7/8" and comes with a 22 kt. gold-plated chain. It is adorned with 22 kt. gold-plated filigree and Swarovski crystals – about the closest thing to real diamonds!

How to Order

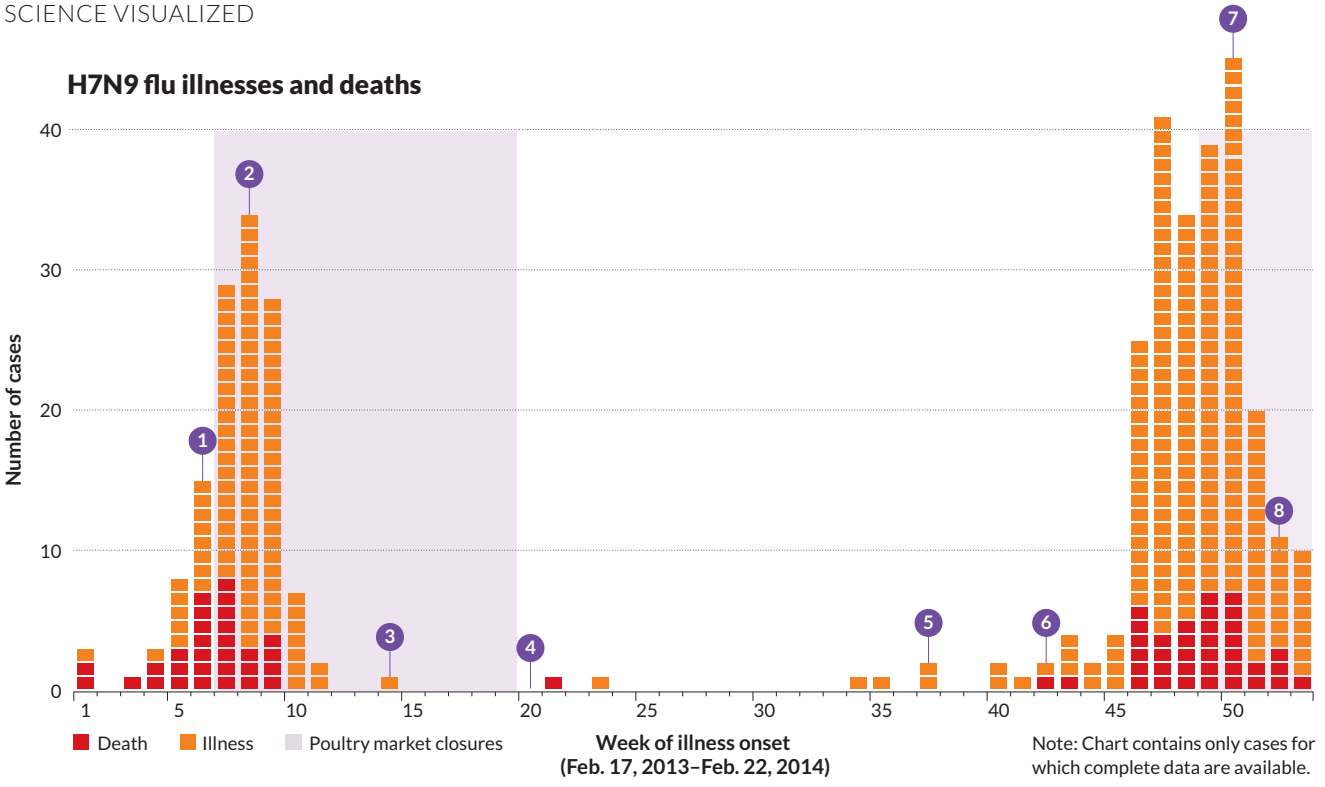
You may order by toll-free phone, by mail or by fax and pay by check or AmEx/Visa/MasterCard. Please give order code shown below. Add $6.95 for one, $12.95 for three watches for shipping/ insurance (and sales tax for CA delivery only). You have thirty days refund and three-year warranty. We do not refund postage. For customer service or wholesale information, please call 415/356-7801. **Please give order code Z457xxxxxx.**

jomira

division of jomira/advance

470 3rd St., #211, San Francisco, CA 94107

Order by toll-free phone: 1-800/600-2777, or (fastest!) by fax: 1-415/356-7804.
Visit our website at www.jomira.com



Second bird flu wave ups pandemic worries

A new type of flu began making people sick in China in 2013. Researchers quickly discovered that the virus was a type of avian influenza, known as H7N9, never before seen in humans. In one year the virus has surged twice, sickening 370 people in China and killing 115 (according to data available as of February 28).

As with seasonal flu, infections tapered off during the summer of 2013 but reappeared with colder weather. The second wave of H7N9 started earlier in the flu season and has sickened more people than the first wave did.

At least for now, H7N9 doesn't spread easily from person to person. Only four families have multiple sick members that may have passed the virus through close contact. Scientists worry that if the virus infects many people, it may gain the ability to readily jump between humans, creating a pandemic.

Exposure to live poultry is the main infection route, with 82 percent of sick people in the first wave reporting recent contact with live animals, especially chickens. — *Tina Hesman Saey*

Outbreak timeline

1 March 29, 2013
Six weeks into the outbreak, China's Center for Disease Control and Prevention identifies H7N9.

2 April 11, 2013
The H7N9 virus includes genes recombined from three other viruses, scientists report.

3 May 23, 2013
H7N9 flu can be transmitted between ferrets through the air, researchers report.

4 July 3, 2013
H7N9 can infect human lung cells, researchers report, helping explain why it causes pneumonia.

5 Oct. 31, 2013
Closing live poultry markets is an effective way to limit H7N9 spread, a study concludes.

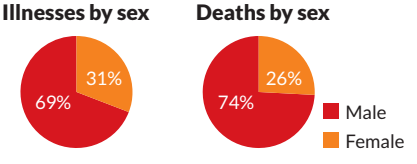
6 Dec. 1, 2013
As of this date, 34 percent of the 139 people who have been infected have died.

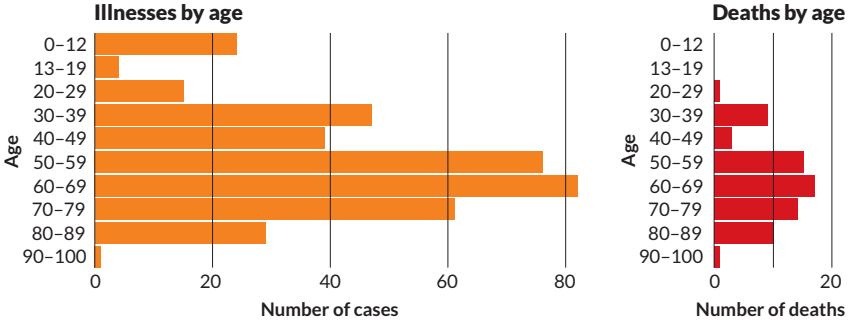
7 Jan. 27, 2014
After infected birds are found in a market, Hong Kong suspends the sale of live chickens and kills 20,000 birds to prevent the spread of the virus.

8 Feb. 13, 2014
Vietnam bans the importation of Chinese poultry.

Men and elderly at most risk

More men than women have become sick with H7N9 flu for reasons that are unknown. People over age 50, particularly older men, have also been more likely to die of the new bird flu. Children tend to have mild cases of the disease, and none are known to have died.

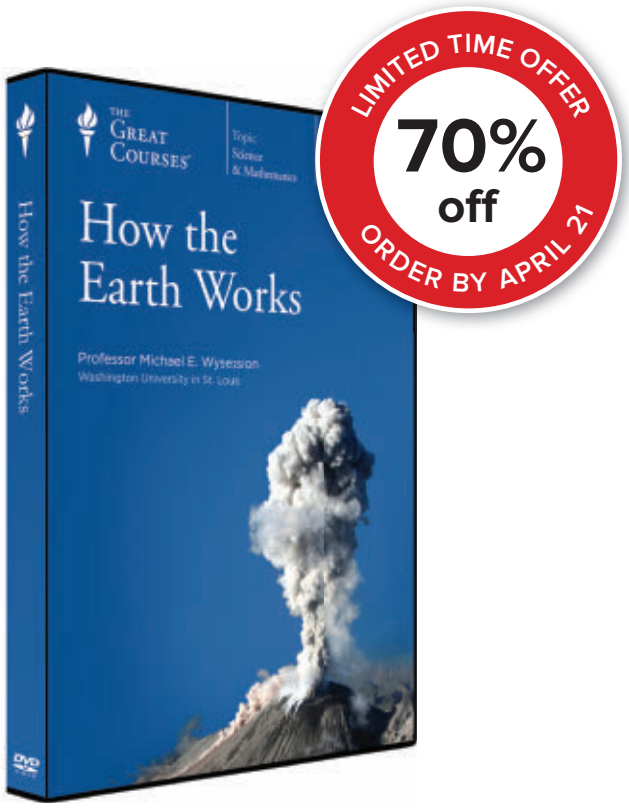




S. EGTS, SOURCES: WHO, FLUTRACKERS.COM

See interactive data at bit.ly/SN_h7n9

THE GREAT COURSES®



Four Billion Years in the Making...

Continents move. Glacial cycles come and go. Mountains form and erode. We live on a planet constantly in motion—except it's usually extremely slow motion. In the 48 exciting lectures of **How the Earth Works**, speed up the action and witness the entire history of our planet unfold in spectacular detail, learning what the Earth is made of, where it came from, and, above all, how it works.

This unforgettable course is an astonishing journey through time and space. From the big bang to small geological forces, you explore the fascinating processes involved in our planet's daily life. You also discover insights into volcanoes, the rock cycle, tsunamis, the ocean seafloor, and other fascinating natural phenomena. An international innovator in seismology and geophysical education, award-winning Professor Michael E. Wysession provides you with a breathtaking, comprehensive picture of our remarkable home.

Offer expires 04/21/14

1-800-832-2412

WWW.THEGREATCOURSES.COM/8SN

How the Earth Works

Taught by Professor Michael E. Wysession
WASHINGTON UNIVERSITY IN ST. LOUIS

LECTURE TITLES

1. Geology's Impact on History
2. Geologic History—Dating the Earth
3. Earth's Structure—Journey to the Center
4. Earth's Heat—Conduction and Convection
5. The Basics of Plate Tectonics
6. Making Matter—The Big Bang and Big Bangs
7. Creating Earth—Recipe for a Planet
8. The Rock Cycle—Matter in Motion
9. Minerals—The Building Blocks of Rocks
10. Magma—The Building Mush of Rocks
11. Crystallization—The Rock Cycle Starts
12. Volcanoes—Lava and Ash
13. Folding—Bending Blocks, Flowing Rocks
14. Earthquakes—Examining Earth's Faults
15. Plate Tectonics—Why Continents Move
16. The Ocean Seafloor—Unseen Lands
17. Rifts and Ridges—The Creation of Plates
18. Transform Faults—Tears of a Crust
19. Subduction Zones—Recycling Oceans
20. Continents Collide and Mountains Are Made
21. Intraplate Volcanoes—Finding the Hot Spots
22. Destruction from Volcanoes and Earthquakes
23. Predicting Natural Disasters
24. Anatomy of a Volcano—Mount St. Helens
25. Anatomy of an Earthquake—Sumatra
26. History of Plate Motions—Where and Why
27. Assembling North America
28. The Sun-Driven Hydrologic Cycle
29. Water on Earth—The Blue Planet
30. Earth's Atmosphere—Air and Weather
31. Erosion—Weathering and Land Removal
32. Jungles and Deserts—Feast or Famine
33. Mass Wasting—Rocks Fall Downhill
34. Streams—Shaping the Land
35. Groundwater—The Invisible Reservoir
36. Shorelines—Factories of Sedimentary Rocks
37. Glaciers—The Power of Ice
38. Planetary Wobbles and the Last Ice Age
39. Long-Term Climate Change
40. Short-Term Climate Change
41. Climate Change and Human History
42. Plate Tectonics and Natural Resources
43. Nonrenewable Energy Sources
44. Renewable Energy Sources
45. Humans—Dominating Geologic Change
46. History of Life—Complexity and Diversity
47. The Solar System—Earth's Neighborhood
48. The Lonely Planet—Fermi's Paradox

How the Earth Works
Course no. 1750 | 48 lectures (30 minutes/lecture)

SAVE $390

DVD ~~$519.95~~ NOW $129.95
+$20 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 95521

For 24 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free mobile apps for iPad, iPhone, or Android. Nearly 500 courses available at www.thegreatcourses.com.

Become a Member of the "Fortunate 500"

Boost your purple portfolio with this stunning 500-carat genuine amethyst necklace for $149!

NEW YORK—Wall Street insiders are buzzing over Stauer's latest IPO (Impressive Purple Offer). The launch of the ***Fortunate 500 Amethyst Necklace*** is a gorgeous game-changer that has Fifth Avenue crying foul because stunning gemstone necklaces of this carat weight usually come with a price tag just as hefty. That's the way high-end jewelers like it. But the company that pioneered "Luxury for Less," thinks differently. Today Stauer shocked the luxury market by offering 500 carats of genuine amethyst for **only $149!**

Massive amethyst acquisition. There's never been a better time to diversify your jewelry box. The impressive ***Fortunate 500 Amethyst Necklace*** makes a fashion statement without ruining your bank statement. You get the same expensive big, bold genuine gemstones that turn heads on the Hollywood red carpets for a fraction of the price. Each necklace showcases a spectacular collection of translucent orchid hued gemstones that dazzle with soft facets and swirls in THE official fashion color of 2014. And for a limited time, when you order the necklace, Stauer will include the magnificent 90 carat amethyst earrings absolutely **FREE!**

Amethyst is the royal stone of history. Worn by every royal from Cleopatra and Catherine the Great to maharajahs and British royalty, amethyst is royalty's most respected violet stone. Stauer's gem hunters scoured three continents, from Africa to Asia to South America, seeking the finest orchid colored amethyst on the planet. With more than a dozen ovals set between gleaming, gold-finished spacers, this necklace is a spectacular display of your stylish net worth.

Your satisfaction is GUARANTEED! Our resident fashion experts promise immediate dividends. However, if for any reason you aren't completely invested in the ***Fortunate 500 Amethyst Necklace***, send it back within 30 days for a full refund of your purchase price. But according to our crack financial fashion advisor, as long as you "buy low and wear high," you'll find this necklace is too big to fail!

FREE
earrings with necklace purchase !
(a $99 value)

Fortunate 500 Amethyst Necklace ~~$399~~

Promotional Code Price *Only* **$149** + S&P *Save $250*

You must use the insider promotional code to get the lowest price and ***FREE*** *Earrings.*

1-800-859-6625

Your Promotional Code: FFA137-01
Please use this code when you order to receive your discount.

Stauer®

ACCREDITED BUSINESS BBB Rating of A+

14101 Southcross Drive W., Dept. FFA137-01, Burnsville, Minnesota 55337 www.stauer.com

** For more information concerning the appraisal, visit* ***http://www.stauer.com/appraisedvalues.asp****.*

TAKE 63% OFF INSTANTLY!
When you use your INSIDER PROMOTIONAL CODE

NECKLACE & EARRINGS INDEPENDENTLY APPRAISED AT $550*

Necklace enlarged to show luxurious detail.

500 carats of genuine amethyst • Gold-finished spacers • 18"+2" length necklace

Smart Luxuries—Surprising Prices™