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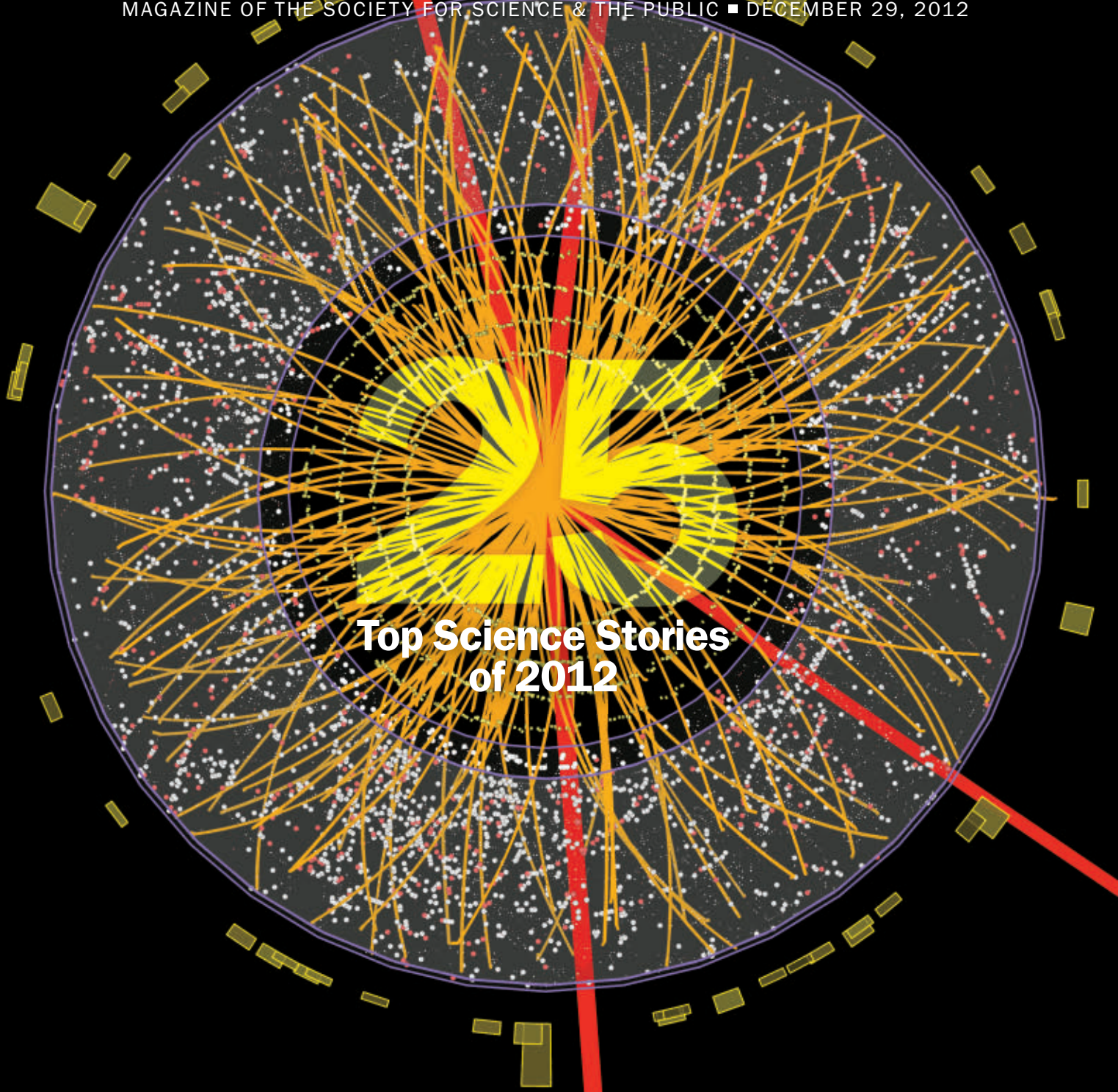
ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 29, 2012



Top Science Stories of 2012

OUR EDITORS' PICKS:

The Higgs boson, a Mars rover, bionic limbs and much more

Chicago Doctor Invents Affordable Hearing Aid

Outperforms Many Expensive Hearing Aids

Reported by J. Page

CHICAGO: A local board-certified Ear, Nose, Throat (ENT) physician, Dr. S. Cherukuri, has just shaken up the hearing aid industry with the invention of a medical-grade, affordable hearing aid. **This revolutionary hearing aid is designed to help millions of people with hearing loss who cannot afford—or do not wish to pay—the much higher cost of traditional hearing aids.**

"Perhaps the best quality-to-price ratio in the hearing aid industry" – Dr. Babu, M.D. Board Certified ENT Physician

Dr. Cherukuri knew that untreated hearing loss could lead to depression, social isolation, anxiety, and symptoms consistent with Alzheimer's dementia. **He could not understand why the cost for hearing aids was so high when the prices on so many consumer electronics like TVs, DVD players, cell phones and digital cameras had fallen.**

Since Medicare and most private insurance do not cover the costs of hearing aids, which traditionally run between $2000-$6000 for a pair, many of the doctor's patients could not afford the expense. Dr. Cherukuri's goal was to find a reasonable solution that would help with the most common types of hearing loss at an affordable price, not unlike the **"one-size-fits-most" reading glasses** available at drug stores.

He evaluated numerous hearing devices and sound amplifiers, including those seen on television. Without fail, almost all of these were found to amplify bass/low frequencies (below 1000 Hz) and not useful in amplifying the frequencies related to the human voice.

Inspiration from a surprising source

The doctor's inspiration to defeat the powers-that-be that kept inexpensive hearing aids out of the hands of the public actually came from a new cell phone he had just purchased. **"I felt that if someone could devise an affordable device like an iPhone® for about $200 that could do all sorts of things, I could create a hearing aid at a similar price."**

Affordable Hearing Aid With Superb Performance

The high cost of hearing aids is a result of layers of middlemen and expensive unneccesary features. Dr. Cherukuri concluded that it would be possible to develop a medical grade hearing aid without sacrificing the quality of components. The result is the MDHearingAid PRO®, starting well under $200. **It has been declared to be the best low-cost hearing aid that amplifies the range of sounds associated with the human voice without overly amplifying background noise.**

Tested By Leading Doctors and Audiologists

The MDHearingAid PRO® has been rigorously tested by leading ENT physicians and audiologists who have unanimously agreed that the **sound quality and output in many cases exceeds more expensive hearing aids.**

DOCTORS AND PATIENTS AGREE:
"BEST QUALITY SOUND"
"LOWEST AFFORDABLE PRICE"

"I have been wearing hearing aids for over 25 years and these are the best behind-the-ear aids I have tried. ***Their sound quality rivals that of my $3,000 custom pair of Phonak Xtra digital ITE"*** —Gerald Levy

"Perhaps the best quality-to-price ratio in the hearing aid industry"
—Dr. S. Babu Board-Certified ENT Physician, National Authority on Hearing Loss

"I have a $2,000 Resound Live hearing aid in my left ear and the MDHearingAid in the right ear. ***I am not able to notice a significant difference in sound quality between the two hearing aids."*** —Dr. May, ENT Physician

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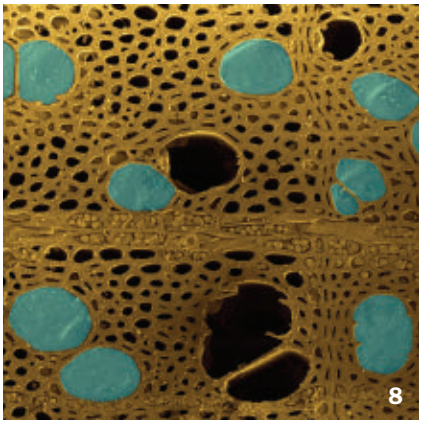

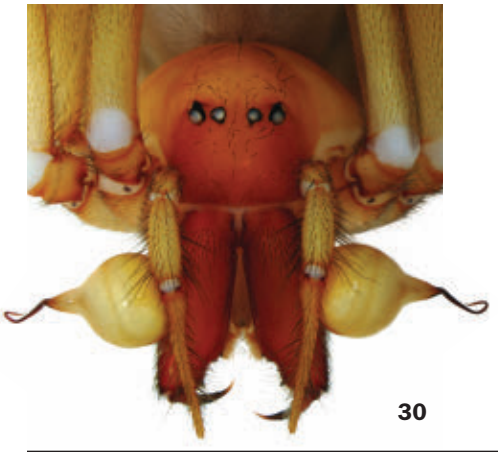

ScienceNews

In The News

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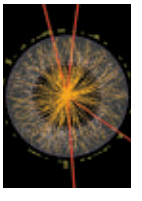

COVER The Higgs boson discovery is *Science News'* pick for top story of 2012. Physicists spotted it by studying decay patterns of subatomic particles (shown). *ATLAS Experiment © 2012 CERN*

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FROM THE EDITOR

2012, when science news got its 15 minutes

While other media outlets focused on the looming fiscal cliff or baby news from the British royal family, the weekly *Science News* staff meeting was abuzz with talk of potential uses for hagfish slime and a renewed interest in the mysterious Casimir force (contributing editor Alexandra Witze expects to fill readers in with a story in the coming year). It's a reminder that though we live on a diet rich in science news, most of the world does not.

Perhaps that was why this summer was so sweet. Suddenly, science aficionados had a lot of company. In July, news of the discovery (all but confirmed) of the Higgs boson hit front pages, the radio waves, even cable news. Then in August, the landing of a robotic explorer on Mars got the bright-lights, big-city treatment: The Curiosity rover's descent to the Red Planet played live on the jumbo screens in Times Square. For a few moments, feats of science and engineering held the attention and stoked the imagination of the world.

The excitement around these stories made them clear choices when it came to picking the top science news of the year (Page 16). Discovery of the Higgs, after years of effort, struck editors here as especially significant. The finding offers crucial experimental support for one of theorists' most powerful constructs: the standard model of physics, which describes the particles that make up the universe and the rules for how they interact. The existence of the Higgs field, shown indirectly by detection of the Higgs particle, helps explain how the cosmos became what it is today. It's hard to think of a more fundamentally important science story.

Except maybe not finding the Higgs. That also would have been huge news — and, to one physicist friend of mine, perhaps more thrilling. It would have required physicists to crack open the standard model, rethink what they thought they knew and come up with alternative explanations for how things work. It would have meant a stranger universe and a new puzzle for physicists — and followers of science — to feast upon.

Not that there's any shortage of scientific puzzles. This year's Top 25 serves up a virtual buffet. You'll find the latest on whether women are born with their lifetime supply of eggs or if they can make new ones (Page 23), using technology to help the paralyzed regain independence (Page 20), a proposal that Alzheimer's is actually caused by an infectious protein similar to what causes mad cow disease (Page 24), and much more. Bon appétit! — *Eva Emerson, Editor in Chief*

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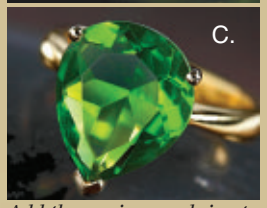

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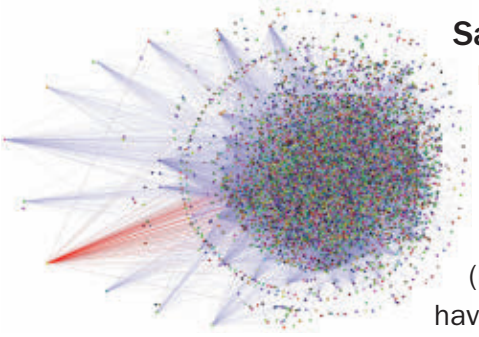

Say What?

Ridiculome *ri-DIK-yu-lohm*\ *n.*

A tongue-in-cheek term used to describe computer simulations of vast numbers of molecular interactions inside cells. Visually, maps of these goings-on resemble hair balls (human protein interactions shown), and critics have contended that the "ridiculous" amount of data in the simulations doesn't reflect what really happens in cells. But applying mathematical logic rules can help untangle the hair balls and build a better artificial representation of a cell, Ion Moraru and Michael Blinov of the University of Connecticut Health Center in Farmington suggest online November 21 in *BMC Biology*. "I think we can tackle what was once ridiculously complicated," Moraru says. — *Tina Hesman Saey*

Science Past | FROM THE ISSUE OF DECEMBER 29, 1962

INSULIN SYNTHESIS SEEN — Synthesis of insulin for the first time may be realized early in 1963.... Dr. Panayotis G. Katsoyannis [of the University of Pittsburgh] is hopeful that the last problems are about to be solved in synthesis of the life-saving protein-hormone important to diabetic patients. Chinese scientists, either in Shanghai or Peking, are believed to be working on the insulin-B chain containing 30 amino acid molecules that when joined with the A chain (containing 21 amino acid molecules) will produce insulin. Spurred by competition, Dr. Katsoyannis is working hard to arrive first at the point of synthesis. Insulin now is obtained from purified material taken from the pancreas glands of slaughtered cattle, sheep and pigs.

Science Future

January 27
Last day to see an exhibit in New York City of mathematician Benoît Mandelbrot's work on fractals and chaos theory, including some of his original drawings and photos. See bit.ly/SFmandelbrot

January 31
Deadline to enter the Neuro Film Festival, in which patients, caregivers or others can submit short videos about neurological disease to promote research funding. Watch past videos and get instructions for entering at bit.ly/SNneurofilm

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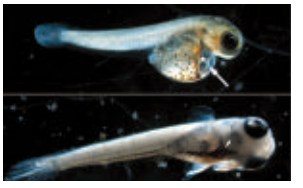
ENVIRONMENT
Lab experiments show that low exposures to oil spills can kill young fish. See "Gulf spill harmed small fish, studies indicate."



MATTER & ENERGY
Underwater landslides are more complex than dry avalanches. Read "Underwater avalanches go with the flow."

GENES & CELLS
Pregnant rodents receiving low doses of radioactivity gave birth to healthier pups than nonirradiated rodents. Read "A little radiation is good for mice."

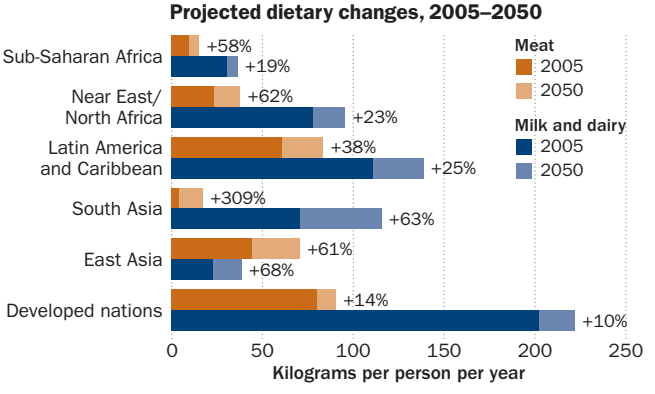
Humans today carry far more rare genetic variants than scientists ever imagined. See "Across 1,000 genomes, rarities abound."

The –est | FARTHEST SUPERNOVA

Two superbright supernovas have been spotted far, far away. One of the stellar explosions, called SN 1000+0216, is the most distant supernova ever detected. The other, SN 2213-1745, was probably around 250 times as massive as the sun when it exploded. Superluminous supernovas (illustrated) are between 10 and 100 times brighter than the average exploding star and are exceedingly rare near Earth. Astronomers discovered these giants in archival images from the Canada-France-Hawaii Telescope Legacy Survey Deep Fields. Both stars exploded when the universe was less than a quarter of its current age and are more than 9 billion light-years from Earth, the team reports in the Nov. 8 *Nature*. — *Nadia Drake*

Science Stats | RICHER DIETS

People in developed nations eat the most meat and dairy per capita, but diets in other parts of the world are shifting to include more animal products. SOURCE: N. ALEXANDRATOS AND J. BRUINSMA/FAO 2012



CLOCKWISE FROM TOP: ANDYTROP79/FLICKR; BENJAMIN DUBANSKY/LSU; ADRIAN MALEC AND MARIE MARTIG/SWINBURNE UNIV.

“It’s hard to speculate on the genetic health of our species when the environment is changing.” —JOSHUA AKEY, PAGE 13

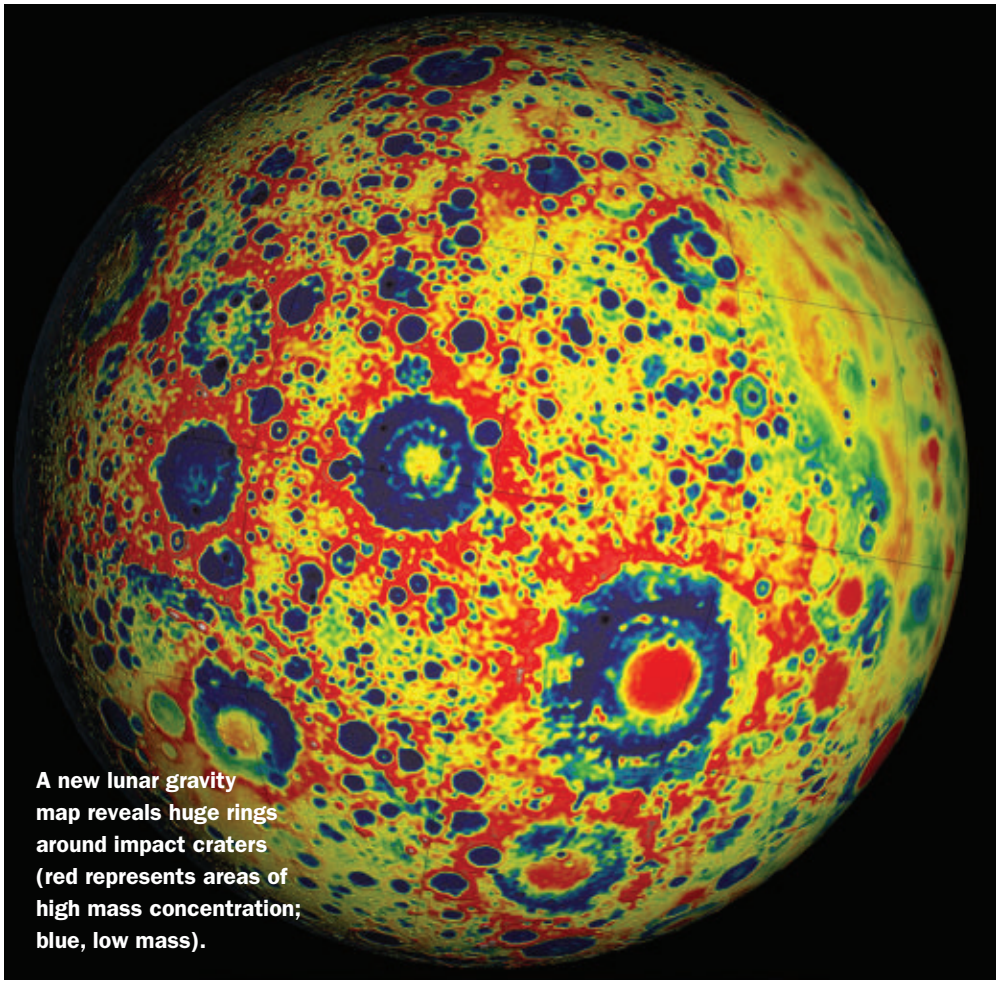
In the News

STORY ONE

Violent history revealed by map of moon’s interior

Gravity probes see jumbled crust beneath lunar surface

By Alexandra Witze



A new lunar gravity map reveals huge rings around impact craters (red represents areas of high mass concentration; blue, low mass).

NASA GODDARD SPACE FLIGHT CENTER VISUALIZATION STUDIO

SAN FRANCISCO — The moon is cooling and shrinking today, but early in its history it actually got bigger.

As the moon expanded, molten rock rose from its deep interior to cool and solidify into long gashes buried beneath the surface. For billions of years these fiery scars remained hidden, finally revealing themselves to a pair of spacecraft flying overhead.

The probes, named Ebb and Flow, spotted the rock formations by their gravitational pull. And not just that: The NASA mission has revealed a host of other discoveries, both on the moon’s surface and below it. In producing the best gravity map ever compiled of any planet or moon — Earth included — the mission illustrates how violently the moon’s crust was pummeled by meteorites over eons.

“We see now a picture of the moon being far more broken up and shattered than we’ve seen before,” said Maria Zuber, principal investigator for the twin probes, known collectively as the Gravity Recovery and Interior Laboratory, or GRAIL.

Zuber, an MIT geophysicist, described the results December 5 at a meeting of the American Geophysical Union. Three papers on GRAIL’s first findings appeared online the same day in *Science*.

Ebb and Flow chase one another as they orbit the moon. As the spacecraft in front feels the tug of something with a little extra gravity, like a mountain, the probe speeds up a tiny bit. The second spacecraft, following 82 to 218 kilometers behind, also speeds up once it gets close enough to feel the same tug. By precisely measuring the changing distance between the two probes, GRAIL researchers can map gravity bumps caused by changing concentrations of mass at or just below the lunar surface.

Every second, mission scientists can detect changes in the spacecraft distance down to 50 nanometers, or billionths of a meter. That’s at least 1,000 times as precise as any previous study of the moon, allowing GRAIL to generate an incredibly detailed gravity map.

Craters pop dramatically into view

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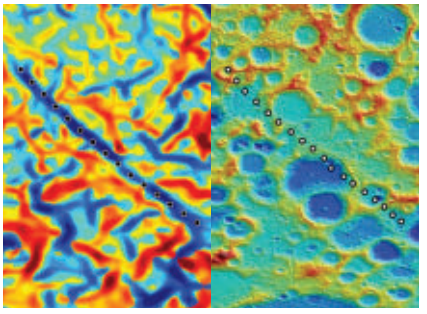
in the new map. Many are surrounded by rings of fractured rock and blankets of debris kicked up by the crash, with a peak dotting the middle of each.

The new map reveals that the moon's crust is between 34 and 43 kilometers thick on average. That's some 10 to 20 kilometers thinner than scientists had thought, said team member Mark Wieczorek of the University of Paris. The lunar crust is also far more fractured by impacts than anyone had suspected; a full 12 percent of the surface layer is nothing but empty space in churned-up rock deposits.

"It really opens a window on what a violent place all terrestrial planets were early in their history," Zuber said.

The lunar crust's relatively high porosity confirms that the moon contains roughly the same amount of aluminum as Earth does. That makes sense, because scientists think the moon was born in a cosmic collision when a Mars-sized object smashed into the early Earth. The material kicked up by that blast settled into orbit around Earth, there to coalesce and form the moon.

During the first 500 million to 1 billion years of its existence, the moon was probably hot on the outside and relatively cool on the inside, said Jeffrey Andrews-Hanna, a planetary scientist at the Colorado School of Mines in Golden. Because of that temperature inversion, the moon ballooned slightly, getting wider by some 1 to 10 kilometers, he and his colleagues have calculated.



The dotted line on the lunar gravity map at left marks a linear rock formation buried at least 10 kilometers beneath the moon's surface. The feature is invisible on the surface map at right.

That period of expansion is when the sheets of molten rock rose from below, penetrating cracks created as the hot moon grew. Only after cooling enough on the outside, some 1 billion years after it was formed, did the moon begin shrinking, Andrews-Hanna said.

In GRAIL's gravity map, the volcanic scars show up as mysterious linear shapes, some over 500 kilometers long. They are buried at least 10 kilometers deep, Andrews-Hanna said, and aren't detectable any other way than with the sensitive gravity measurements.

"We have essentially taken geophysics and are bringing it into the realm of surface geology," Zuber said.

On Earth, such sheetlike volcanic intrusions are known as dikes, but the lunar versions are so large as to perhaps warrant their own name someday, Andrews-Hanna added.

GRAIL has run out of time to make discoveries. The probes finished their main tasks between March and May, then began orbiting ever closer to the lunar surface. By December 6 they had descended to an altitude of just 11 kilometers, Zuber said. As this issue of *Science News* went to press, the probes were expected to crash into the lunar surface on December 17, doomed by the very gravity they studied. ■

Blame it on Theia. That's the name scientists have given a rogue celestial body, about the size of Mars, that is thought to have smashed into Earth 4.5 billion years ago. The cosmic collision (illustrated at left) would have kicked enough debris into orbit to eventually coalesce into the moon.

That scenario is supported by similarities between the moon and Earth in the abundance of aluminum (see main story), oxygen, titanium and other elements. But what happened to Theia? There's no trace of it in the moon's composition.

Two papers in the Nov. 23 *Science* may explain why. In one, Robin Canup of the Southwest Research Institute in Boulder, Colo., simulated what might happen if Theia were much bigger than previously thought, as big as the newborn Earth. If so, the collision could have mixed the two planets well enough that they would have become nearly chemically identical.

In the second paper, Matija Ćuk and Sarah Stewart of Harvard propose how Earth alone could have contributed most of the debris that formed the moon. Earth was spinning far faster at the time, and that high speed would have sent stuff from Earth and not Theia into orbit, the team proposes. —*Alexandra Witze*

FROM TOP: JPL-CALTECH/NASA, GSM; ALLOY PHOTOGRAPHY/VEER

Technology Breakthrough | **Safe, comfortable bathing from Jacuzzi®**

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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. *first*STREET has partnered with Jacuzzi®, the company that perfected hydrotherapy. Together, they've created a walk-in tub that offers more than just safe bathing, peace-of-mind and independence, it can actually help you feel better.

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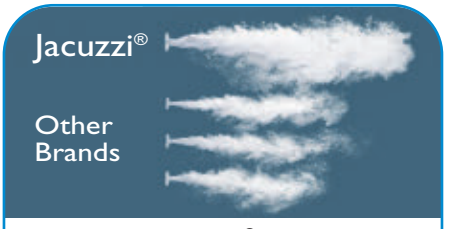

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- **Warranty** - Ask for a lifetime "no leak guarantee." The best tubs offer a lifetime warranty on both the tub and the operating system.
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Life

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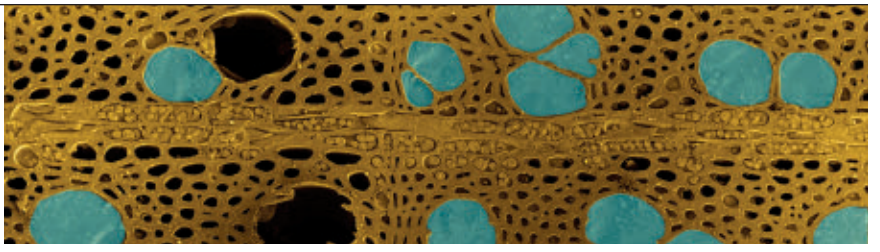
Most trees a sip away from death

Plants' plumbing systems often on the brink of failure

By Susan Milius



In a microscopic cross section of frozen wood, blue indicates channels where water has recently been flowing properly through a tree's plumbing. Empty channels have had their flow interrupted by air bubbles, which can kill a tree.

Trees in most forests, even wet ones, live perilously close to the limits of their inner plumbing systems, a global survey finds.

Seventy percent of 226 woody species in forests around the world routinely function near the point where a serious drought would stop sufficient water transport from their roots to their leaves, says plant physiologist Brendan Choat of the University of Western Sydney in Richmond, Australia. Even trees in moist, lush places operate with only a slim safety margin separating them from a thirsty death.

"This is the first time that we've looked across all forest [types] and seen that there's a convergence on risky behavior," Choat says. He and his colleagues report their findings in the Nov. 29 *Nature*.

"I think this is a really big deal," says David Breshears of the University of Arizona in Tucson. As forest researchers confronting climate change, "we've been trying to be careful as a community not to be alarmist," he says. But the new paper adds yet more worrisome data. "They all keep pointing to: 'Whoa, our forests are really vulnerable.' "

Trees don't have hearts to pump vital fluids. Instead, evaporation from tiny pores in the leaves pulls water up from the roots through masses of microscopic tubes. Called xylem tissue, these marvels of hydraulic transport can develop microscopic air bubbles when water is scarce, which then block individual tubes. Developing too many of these bubbles across the xylem kills the tree.

To judge the state of the forests, Choat and colleagues pieced together information from 81 sites spanning wet tropics to arid shrublands. The team assessed normal water transport in various tree species and the point at which each species fails.

Flowering tree species — such as maples and oaks — proved more vulnerable overall to dry conditions than conifers. But the researchers show that the majority of trees operate with only the slimmest of safety margins.

Trees have to make trade-offs to capture carbon dioxide from the air for growth and metabolism. When a tree opens its pores, it loses about 400 molecules of water to evaporation to snag one molecule of carbon. The new study, Choat says, reveals that trees are maximizing their carbon capture for food even though it strains the plumbing.

Climate threatens bamboo

Scientists have simulated how bamboo species native to central China's Qinling Mountains might move around as climate changes. It's bad news for hungry pandas: All species shrink in range. Mao-Ning Tuanmu, now at Yale University, and his colleagues studied three bamboo species in the Qinling Mountains, home to some 270 pandas, or about 17 percent of the total wild population. The scientists took four widely used climate simulations and calculated how conditions would change throughout the Qinling region. The results suggest that conditions suited to bamboo growth would shift to higher elevations and become more isolated from the surrounding areas. If the plants manage to spread well and temperature increases stay small, then panda habitats will largely remain intact. But more likely are a fragmenting of panda habitat and overall bamboo shortages, the scientists write online November 11 in *Nature Climate Change*. —*Alexandra Witze*

FROM TOP: YUZOU SANO/HOKKAIDO UNIV.; HUNG CHUNG CHIH/SHUTTERSTOCK

Atom & Cosmos

"With this technique, we were able to look more deeply into the data and detect weaker signals." —HUGH JONES

Growth of early universe gauged

Project measures expansion before dark energy hit the gas

By Andrew Grant

New measurements have captured the universe's expansion when it was slowing down 11 billion years ago, before a mysterious entity called dark energy took over and began spurring the cosmos to expand faster and faster. The measurements, reported online November 12 at arXiv.org, are an important step toward understanding what dark energy is and how it works.

About 15 years ago, astronomers discovered that the universe's expansion is accelerating by cataloging spectacular stellar explosions called type 1a supernovas. Because each explosion emits almost exactly the same amount of light, astronomers can use a supernova's observed brightness to determine its distance, and then measure its redshift, or how much its light is stretched, to determine how fast the supernova is moving away from Earth. The technique revealed that the universe's expansion is currently accelerating and has been for the last 5 billion years or so.

But as bright as supernovas are, they are difficult to see deep in the cosmos, at distances corresponding to the time when the universe was only a few billion years old. So an international team of scientists with the Baryon Oscillation Spectroscopic Survey, or BOSS, employs a different method. They use the 2.5-meter Sloan telescope at New Mexico's Apache Point Observatory to collect light produced by feasting supermassive black holes that thrived a few billion years after the dawn of the universe 13.7 billion years ago.

As that light makes its long journey toward Earth, it occasionally runs into clouds of hydrogen gas and gets partially absorbed. BOSS scientists crunched data on the light of almost 50,000 black hole emissions to create a map of where those gas clouds are and, using redshifts, how fast they are receding.

Based on the speeds of the most distant of those clouds, BOSS scientists determined the universe's expansion rate a mere 3 billion years after the Big Bang. The team then compared its measured rate with those from more recent eras to conclude that the universe's expansion was slowing at that time. "The universe was a very different place," says study coauthor and University of Utah physicist Kyle Dawson.

The BOSS finding is consistent with physicists' theories of how the universe's growth rate has changed. Immediately after the Big Bang, the universe ballooned rapidly in a split-second era called inflation. Expansion continued afterward, but like a coasting car, the cosmos had nothing to keep it accelerating. The gravitational attraction of all the matter in the universe was acting like rolling friction, gradually slowing down the expansion.

But as the universe got larger and matter got more diluted, scientists believe something caused expansion to accelerate once more. Scientists don't know exactly what the culprit is, so they call it dark energy. Eleven billion years ago, dark energy made up less than 10 percent of the total content of the universe; today it makes up almost three-quarters.

BOSS and other surveys are allowing scientists to chart the universe's expansion rate over time and determine the evolving role of dark energy. The measurements so far lend support to the leading theory that dark energy is a natural property of empty space: The more the universe expands, the stronger dark energy becomes.

Super-Earth in "sweet spot"

Habitable planet candidate just 42 light-years away

By Tanya Lewis

Astronomers on the prowl for potentially habitable planets have found a new candidate: a world at least seven times as massive as Earth in a nearby solar system.

The planet orbits a star about 42 light-years away in the constellation Pictor. The star, HD 40307, was thought to harbor only three planets, but sensitive data-filtering methods suggested the presence of three more. The farthest out of these lies in a sweet spot, at a distance from its star where liquid water — and thus life — might exist.

"If confirmed, I think it would be a significant discovery, because we don't have many examples of such planets," says astronomer Christophe Lovis of the University of Geneva in Switzerland.

The outermost planet, if it exists, orbits about 90 million kilometers from its sunlike star, close enough to have temperatures in the life-supporting range. Better yet, it's not tidally locked, or always showing one face to its star, in contrast to other potentially habitable planets that hug their stars more tightly. So the new planet should have cycles of day and night, says Hugh Jones, coauthor of a paper on the HD 40307 planets in an upcoming *Astronomy & Astrophysics*.

He and his colleagues found the planets by taking a closer look at data astronomers had collected with the HARPS instrument at the European Southern Observatory's La Silla telescope in Chile. Changes in the star's light indicated that planets were tugging on it gravitationally.

"With this technique, we were able to look more deeply into the data and detect weaker signals," says Jones, of the University of Hertfordshire in England. The newfound planet remains a candidate until other astronomers can confirm it.

Environment

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Polar ice sheets shrinking overall

Greenland and Antarctica both lost mass over two decades

By Erin Wayman

Scientists now have one polar ice study to rule them all. An international team of researchers has compiled 19 years of data from 10 satellite missions to create the most comprehensive assessment to date of Greenland's and Antarctica's shrinking ice sheets.

The verdict: From 1992 to 2011, the Greenland ice sheet lost 2.7 trillion metric tons of ice while the Antarctic ice sheet shed 1.35 trillion metric tons. All that water raised sea level by an average of 11.2 millimeters, accounting for one-fifth of sea level rise over that period, the team reports in the Nov. 30 *Science*.

"Our estimates of ice sheet mass loss are the most reliable to date," says study coleader Andrew Shepherd of the University of Leeds in England.

Many studies suggest that more mass is lost each year through melting ice and calving icebergs than is added by annual snowfall. But some research indicates ice losses and gains actually balance out. The disparities stem from three different satellite methods used to evaluate ice sheet mass. And these studies have looked at different regions of the ice sheets over different, usually brief, intervals, says Richard Alley, a glaciologist at Penn State.

From 1992 to 2011, Greenland (shown) and Antarctica lost 4.05 trillion metric tons of ice through calving icebergs and melting.

The new study combined and compared data from different satellites using uniform time periods and the same geographic areas. The research also factored in how glacial rebound — the rise of a landmass after the weight of an ice sheet has been reduced — influences estimates of ice loss.

The work confirms that melting in Greenland has accelerated: The island lost ice five times as fast in 2005–2010 as it did in 1992–2000. And Antarctica overall is now losing more mass than it's gaining, even though ice in East Antarctica grew slightly during the last decade.

The good news is that the satellite methods do largely agree when compared fairly, says Ian Howat, a glaciologist at Ohio State University. "This will be the benchmark now for observations."

The bad news is that there's so much variability from year to year that scientists can't take the new estimates and simply extrapolate what's going to happen to future sea levels, Howat says.

Drought trends may be inflated

Simple equations exaggerate drying over the last 60 years

By Tanya Lewis

The standard method of assessing drought has exaggerated drying trends over the last 60 years, scientists report in the Nov. 15 *Nature*.

The problem has to do with the way of calculating a quantity called potential evaporation, the amount of evaporation that would occur given an unlimited water supply. Historically, scientists calculated potential evaporation using the Thornthwaite equation, which is based entirely on temperature. The more complete Penman-Monteith equation, by contrast, incorporates the influences of solar radiation, humidity and wind speed. So it gives a much more accurate measure of potential evaporation, says study coauthor Justin Sheffield, a hydroclimatologist at Princeton University.

Sheffield and colleagues calculated global drought trends from 1950 to 2008 using both equations on multiple datasets. They found a much smaller change in drought using the Penman-Monteith equation. The estimated yearly drought increase was only half as severe as that derived from the Thornthwaite equation. Weather records invariably contain some errors, but Sheffield says those errors don't alter the conclusion that the simpler model overestimates rises in global drying.

The finding stands in opposition to the results of several recent studies. "It presented a somewhat different view of the drying trend for the last 60 years," says Aiguo Dai, an atmospheric scientist at the State University of New York at Albany, whose own research suggests that the two equations yield very little difference in drought estimates. Dai says the new study fails to consider trends in soil moisture and other variables. He also claims that the new study relies on outdated weather records and questionable radiation data. However, Sheffield and colleagues attribute the disagreement to inconsistencies in the weather data used by Dai and others.

"I think the jury's still out on why those groups looking at similar metrics come to different conclusions," says paleoclimatologist Kevin Anchukaitis of the Woods Hole Oceanographic Institution in Massachusetts, who was not involved in either study.

COURTESY OF IAN JOUGHIN

Earth

New pathway proposed for ancient flood

Pulse of fresh meltwater may have triggered 1,200-year cold snap

By Erin Wayman

Natural disasters in the Arctic aren't always a sign of global warming. A catastrophic deluge of freshwater pouring into the Arctic Ocean from northwestern Canada might have triggered the planet's last major cold spell nearly 13,000 years ago. That's a different pathway than the standard explanation for this big chill.

New computer simulations indicate that ocean currents would have transported the Arctic floodwaters to the North Atlantic near Greenland, where the freshwater would have disrupted the ocean's circulation of heat. Freshwater flowing into the Atlantic through Canada's Gulf of St. Lawrence — the previously hypothesized source of the flood — would have been carried too far south to disturb heat flow, researchers report in the Dec. 4 *Proceedings of the National Academy of Sciences*.

"We see a more accurate picture of where the water went in the past," says coauthor Alan Condron, a physical oceanographer at the University of Massachusetts Amherst.

The 1,200-year-long cold spell, known as the Younger Dryas, interrupted a warm period 12,900 years ago when the massive ice sheet covering much of Canada was melting. During the cold snap, temperatures in parts of the Northern Hemisphere dropped to about 10 degrees Celsius colder than they are today.

In 1989, Wallace Broecker of Columbia University suggested the Younger Dryas resulted from an abrupt overflow of Lake Agassiz, a colossal pool of meltwater along the southern edge of Canada's ice sheet. Broecker thought the water streamed into the Great Lakes, the St. Lawrence Valley and from there into the Atlantic. The flood would have carried anywhere from a few hundred thousand to a few million cubic meters of water per second. The lighter freshwater sitting on top of the ocean's denser saltwater would have prevented normal ocean mixing in the North Atlantic. This would have shut down the conveyor belt that brings warm waters north, causing temperatures to plummet.

But since Broecker's proposal, geologists haven't found any traces of an ancient flood in the St. Lawrence Valley. And there's no evidence that Lake Agassiz's water levels suddenly dropped prior to the Younger Dryas, says Thomas Lowell, a glacial geologist at the University of Cincinnati.

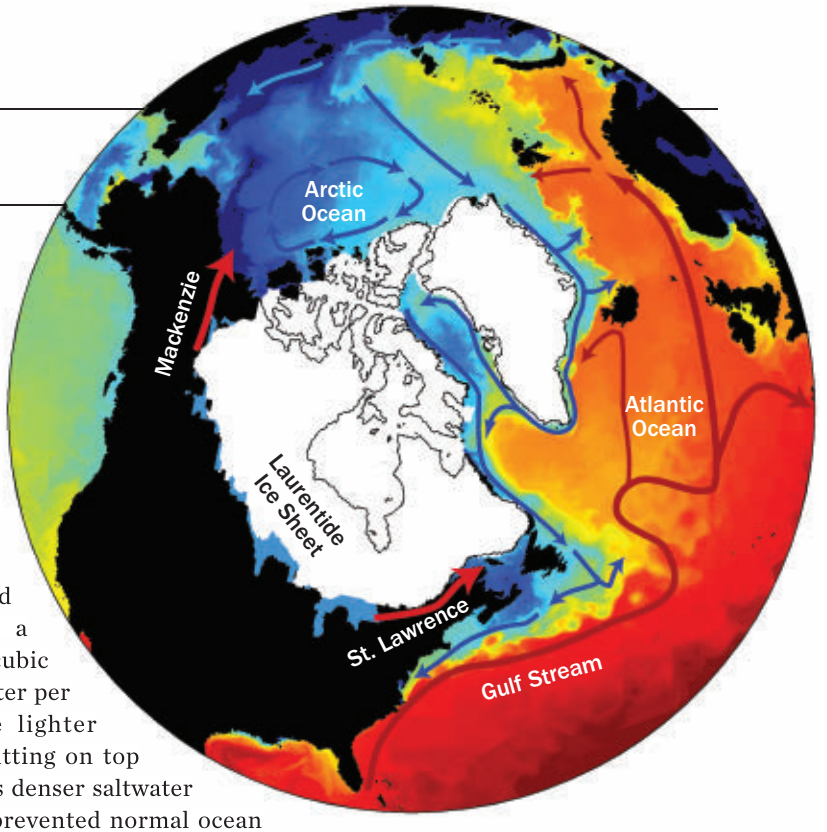
That lack of evidence led some researchers to suggest that the flood might have originated somewhere along the northwestern part of the ice sheet, with water flowing north through the Mackenzie Valley and into the Arctic.

Condron and Peter Winsor of the University of Alaska Fairbanks examined both scenarios. They simulated how currents would move a torrent of freshwater through the ocean. A flood leaving the mouth of the St. Lawrence would have traveled south and met the Gulf Stream, which would have transported the freshwater about 3,000 kilometers too far south to interfere with the ocean's conveyor belt. Such a flood would have slowed heat circulation by just 14 percent.

In contrast, a flood through the Arctic's Mackenzie Valley — taken by currents to the subpolar North Atlantic — would have weakened the ocean's conveyor belt by as much as 32 percent. The result fits with previous findings of boulders and gravels in northwestern Canada that suggest a giant flood happened at the onset of the Younger Dryas. "This whole thing now hangs together beautifully," says W. Richard Peltier, a physicist at the University of Toronto.

But there's still one missing piece of the puzzle. Condron and Winsor assume most of the freshwater came from a melting dome of ice in northwestern Canada. Geologists have yet to find direct evidence that such a large pool of water actually existed, Lowell says. "We need to know whether that load of water was even available or not."

Condron plans to search for more geological clues of a Mackenzie Valley flood. He's also running simulations of what might happen to the ocean's conveyor belt in the future as Greenland's ice sheet melts. ■



Melt from the Laurentide Ice Sheet entered the North Atlantic via the Mackenzie Valley and Arctic Ocean 13,000 years ago, not the St. Lawrence Valley, new research suggests.

A. CONDRON/UNIV. OF MASSACHUSETTS AMHERST

Technology

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Plastic seals in speeding bullets

Layered polymer melts and mixes when hit by projectiles

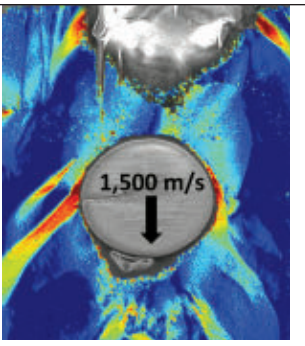
By Rachel Ehrenberg

You don't have to be a caped superhero to stop a speeding bullet. Scientists have created a material that demonstrates how common plastics can bring projectiles traveling faster than a kilometer per second to a screeching halt.

"This may provide a way to make new materials that are more durable," says Catherine Brinson, a specialist in advanced materials at Northwestern University in Evanston, Ill. "There may be applications for anything that is impacted at high speeds — body armor, satellites — anything that you don't want destroyed."

Experiments that shoot projectiles into the new material suggest that it goes through a liquidlike phase that envelops the miniature bullets without cracking the material. The ballistics tests suggest that the material's parallel layers of glassy and rubbery ingredients enhance its bullet-stopping power by 30 percent, a team reports November 6 in *Nature Communications*.

Some polymers such as hardened polyurethane are known for being exceptionally resistant to cracking under fire. Bullets shot into polyurethane disks are frozen in their tracks and sealed in place. But it hasn't been clear how polyurethane captures speeding projectiles without cracking, says Ned Thomas of Rice University in Houston.



A tiny glass bead is halted by a polyurethane composite (cross section shown). Red indicates sites of greatest compression.

"Experimentally it works wonderfully," Thomas says. "But theoretically, nobody knows why."

To better understand the ballistic properties of this common material, Rice research scientist Jae-Hwang Lee created a miniaturized system for studying the effects of impact. The target was a simplified, tidy version of polyurethane: a composite made by alternating orderly nanometers-thick layers of a glassy polymer (polystyrene) and a rubbery polymer (polydimethylsiloxane). Then the researchers used a laser to propel tiny silica beads about 3,700 nanometers in diameter into the target.

Bombarding the composite material with these nanobullets at 1,500 meters per second revealed a strange deformation process. The layers are compressed like a pancake, then kink and start to fragment. But instead of cracking, the layers appear to melt and mix together, liquefied by the energy brought by the bead. The researchers estimate that the energy imparted by a speeding projectile briefly turns the material into a swirling, 3,000° Celsius molten liquid that a millionth of a second later is solid again.

"In the extreme conditions, the material behaves in ways that are unanticipated," Thomas says.

Hydrogen fuel edges a bit closer

Setup mimics photosynthesis to create clean-burning gas

By Rachel Ehrenberg

Making hydrogen gas in water just got a little easier. A new discovery may lead to inexpensive, practical means of harvesting sunlight to create clean-burning hydrogen for powering cars or generating electricity.

Scientists would like to mimic photosynthesis, which harvests sunlight and splits water molecules to create fuel for plants. It sounds simple, but it's a highly orchestrated set of reactions.

The new study, published online November 8 in *Science*, focuses on the light-harvesting side of photosynthesis. Researchers from the University of Rochester in New York created nanocrystals of cadmium and selenium that spit out electrons when hit with light. The team also needed a catalyst to pass those electrons to hydrogen ions, which would combine into the useful gas H_2.

So the team combined water, the nanocrystals (along with little chemical caps to make the crystals soluble in water), a nickel catalyst and a few other ingredients. When light hit the nanocrystals, the system chugged to life, generating hydrogen gas. And it didn't stop. Often the light-absorbing part of such a system starts to degrade; when it breaks down, everything grinds to a halt.

"After two weeks it was still going like a champ," says team member Todd Krauss.

In proper photosynthesis, the hydrogen atoms that receive the electrons would come from splitting water, creating oxygen. The current setup doesn't have a way to split water, so it uses another compound, ascorbic acid, to do water's work.

The new setup overcomes several hurdles that can plague artificial photosynthesis efforts, says Stanford chemist Hemamala Karunadasa. The system is long-lasting and compatible with water, and the chemical players efficiently carry out more than one job. Not only that, she notes, the light-harvesting molecules can be tuned to capture energy from many wavelengths of light.

THOMAS LAB/RICE UNIV.

Genes & Cells

81.4 percent Fraction of genetic variants in European-Americans that arose in last 5,000 years

58.7 percent Fraction of genetic variants in African-Americans that arose in last 5,000 years

Human diversity's recent explosion

Most genetic variation came about in last 5,000 years

By Tina Hesman Saey

A new look at living people's DNA reveals that the human genome just isn't what it was in Neolithic times.

Most of the genetic quirks people carry today popped up within the last 5,000 years or so, researchers report online November 28 in *Nature*. During that time, human populations exploded from no more than several million to 7 billion.

Researchers examined more than 15,000 genes in each of 6,515 people of European-American or African-American ancestry. Of the 709,816 genetic variants found in European-Americans, about 81 percent arose in the last 5,000 years, the researchers determined. African-Americans in the study collectively carried 643,128 genetic variants, more than 58 percent of which are less than 5,000 years old. Five millennia may seem like a long time, but it's only a small fraction of the time humans have existed in modern form, says study coauthor Joshua Akey, a geneticist at the University of Washington in Seattle.

It takes time for a genetic variant to rise to prominence. Common variants — those found in 5 percent or more of the population — tend to be old tweaks that have stuck around, usually because they don't have a big effect on health.

The new study will give scientists a clearer picture of the stamp the recent population explosion has left on human genes, says Sarah Tishkoff, a geneticist at the University of Pennsylvania in Philadelphia. The work may help track down variants that affect people's risk of developing common diseases, she says.

In European-Americans, variants predicted to be harmful tend to be younger than those in African-Americans — 3,000 years old on average in European-Americans versus 6,200 years old in African-Americans. Evolution has not had time to purge the newest harmful changes in either group, and many of them pack a wallop in terms of disease risk.

Even though most of the genetic variants the researchers uncovered are predicted to change the workings of proteins in harmful ways, some of the genetic tweaks might someday give humans an evolutionary advantage, says Akey. Exactly which variants turn out to be good and which will cause trouble is unpredictable. "It's hard to speculate on the genetic health of our species when the environment is changing," he says.

Telomeres linked to birds' life span

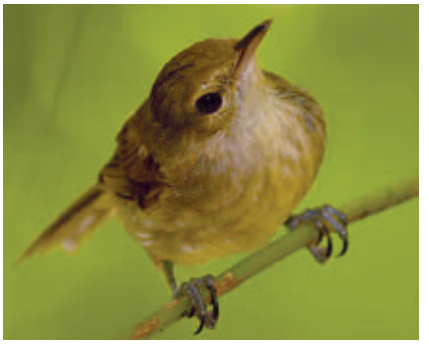
Short chromosome caps tied to mortality in warblers

By Tina Hesman Saey

The long and short of a bird's life may be recorded in the tips of its chromosomes.

A study of Seychelles warblers living on a small island in the Indian Ocean suggests that the length of telomeres — bits of DNA that cap chromosome ends — can predict a bird's chance of dying better than its chronological age can. Warblers with shorter telomeres were less likely to survive another year, especially if the truncation happened rapidly, David S. Richardson, a molecular ecologist at the University of East Anglia in Norwich, England, and colleagues report online November 21 in *Molecular Ecology*.

The study "provides very important evidence that backs up what has been found in the laboratory — changes in telomere length matter a lot," says animal ecologist Pat Monaghan of the University of Glasgow in Scotland.



A study of Seychelles warblers (one shown) suggests that the length of telomeres, protective caps at the ends of chromosomes, is linked to survival.

Increasing age and body mass were also linked to shorter telomeres in the birds. That result stands in contrast to a recent large study of people in northern California that found telomeres generally get shorter with age, but that higher body mass is associated with longer telomeres (*SN Online: 11/11/12*).

Like shoestring aglets, telomeres stop chromosomes from unraveling or being eaten away at the ends. Cells with very short telomeres become decrepit or die, but it has been unclear whether that has any effect on the whole body.

The new study followed birds over the course of their natural lives; on average, Seychelles warblers live about six years, but some have reached age 17.

Young birds start with roughly the same size telomeres, Richardson says. But some warblers' telomeres shorten faster than others as the birds age.

It's not clear whether telomere shortening leads to poor health and death, or if truncated chromosome tips are a side effect of stress and disease. Even if losing a little off the chromosome tips isn't enough to kill outright, "telomeres might be acting as an indicator of the sort of hard life you're going through," Richardson says.

UNIV. OF EAST ANGLIA

Mind & Brain

Spelling out baboons' 'literacy'

Word-detecting monkeys may be cued by letter combinations

By Bruce Bower

Baboons that have learned to tell words from nonwords use the order of regularly appearing letter pairs to make the distinction, new evidence suggests.

Psychologist Jonathan Grainger of the University of Aix-Marseille in France reported earlier this year that baboons can learn to tell real four-letter words from nonsense words (*SN: 5/5/12, p. 5*). But whether these animals detect signature letter combinations that enable their impressive word feats has been tough to demonstrate.

Monkeys that previously learned to excel on this task are more likely to mistake as real nonwords created by reversing two letters of a word they already recognize, much as literate people do, Grainger reported November 16.

"Letters played a role in baboons' word knowledge," he concluded. "This is a starting point for determining how they discriminate words from nonwords."

Grainger's team tested the six baboons from the original investigation. Some of these monkeys had previously learned to recognize many more words than others had. In new trials, the best word identifiers made more errors than their less successful peers when shown nonwords that differed from known words by a reversed letter combination, such as WSAP instead of WASP and KTIE instead of KITE.

Grainger's team fed the same series of words and nonwords into a computer simulation of the experiment. The computer model best reproduced the animals' learning curves when endowed with a capacity for tracking letter combinations.

Psychologist Emmanuel Keuleers of Ghent University in Belgium was skeptical of the findings. His own computer simulations mimicked baboons' word learning in Grainger's experiments without being able to track specific letter combinations.

Keuleers' program calculated the similarity of new words to previously learned four-letter strings based on the number of insertions and deletions of single letters. As with the baboons, this computer system easily learned new nonwords but often stumbled when supplied with new words. That's because, using this single-letter strategy, new words presented to baboons in Grainger's experiments were typically most similar to previously learned nonwords, Keuleers suggested. ■

MEETING NOTES

Gestures have timely impact

People think differently about the passage of time depending on the hand gestures someone else uses, Stanford psychologist Barbara Tversky reported on November 17. In a series of experiments, Tversky's colleague Azadeh Jamalian of Columbia University asked volunteers to diagram progressions of familiar events. While describing these tasks, Jamalian gestured in a straight horizontal line, gestured in a circle or made no gestures. Most individuals drew linear diagrams after seeing linear gestures and circular diagrams after seeing circular gestures. Linear diagrams predominated if no gestures were used, probably because people tend to conceive of time as running on a line, Tversky said. Gestures can subtly alter the notion of how time proceeds, she proposed. — *Bruce Bower*

Memory athletes flex mind power

Top competitors in memory competitions aren't one-trick ponies. Four of the most accomplished memory athletes, including the top-ranked master of recall, scored much higher than groups of college students on a variety of memory and attention tests, psychologist Henry Roediger III of Washington University in St. Louis said on November 17. Memory competitors scored extraordinarily well on tests of list memory, recall of specific numbers from equations that had been mentally solved, and attention control during attempted distractions. Memory athletes use well-known recall strategies on specific challenges, such as remembering hundreds of rapidly presented numbers, but these people possess much broader mental prowess than that, Roediger suggested. It's not known whether recall gurus start out with super memory and attention or gain those skills through practice. — *Bruce Bower*

Humans expect hidden treasures to be clustered in space

Adults and children hide valuables in clumps to make them easy for collaborators to find but scatter goodies widely when hiding them from competitors, psychologist Andreas Wilke of Clarkson University in Potsdam, N.Y., reported November 16. Humans evolved to expect that food and other resources appear in patches, Wilke theorizes (*SN: 2/12/11, p. 26*). In one test, 5- to 8-year-olds hid 20 marbles among 100 boxes on a playground after being told to make it either hard or easy for others to find the toys. Adults did the same in a computer game in which they hid $1 tokens in a grid of 100 squares. In both games, hiders clustered objects if they wanted them easily found. — *Bruce Bower*

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Stories worth losing sleep over

When it came to choosing the year's best stories, the editors of *Science News* applied a simple criterion: We picked the ones that kept us up at night.

The top two stories on our list literally had us working the graveyard shift. In the wee hours of July 4, we tuned in online as physicists in Geneva held a morning (their time) seminar announcing the discovery of the long-sought Higgs boson. The next month found us working in our pj's yet again, this time as NASA's Curiosity rover executed a spectacular touchdown on Mars in the early a.m. of August 6, Eastern time.

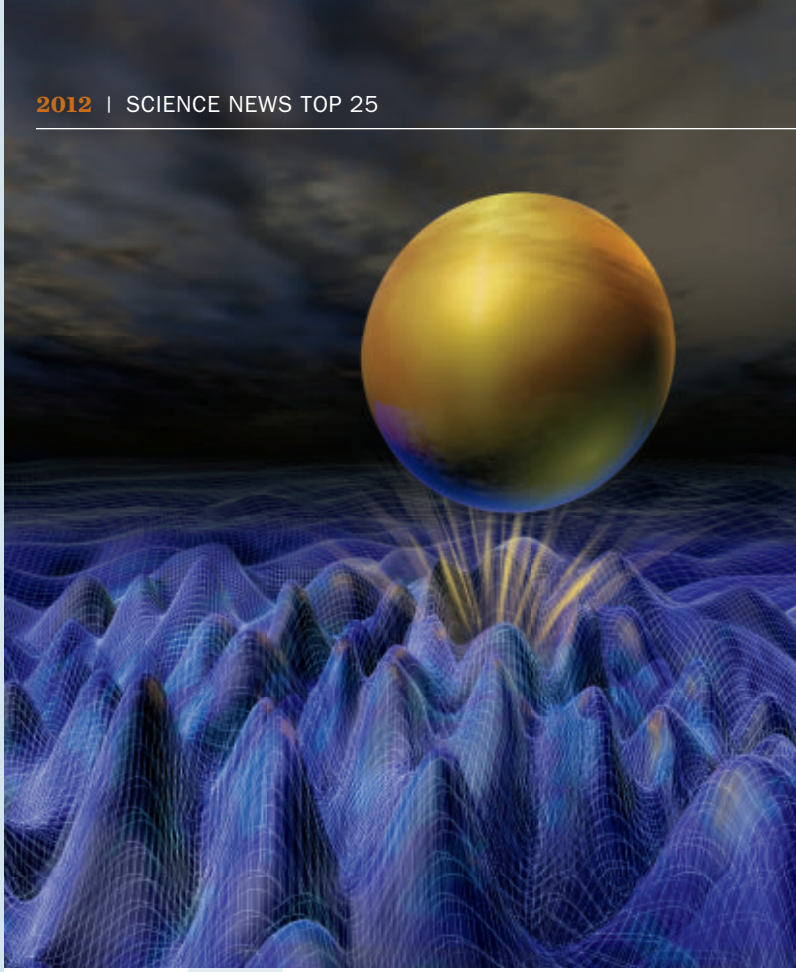
Then there were the stories that thwarted our sleep with their terrifying implications. In June, researchers described in two controversial papers how easily bird flu can be mutated to render it capable of airborne transmission. And if global pandemic flu wasn't enough to keep us staring at the ceiling, we could rest assured that no rest would come from pondering a warming trend that, far from being a theoretical concern for the distant future, is a clear and present danger. Several studies this year pinned recent record heat waves and droughts on human-caused warming, and in September the Arctic Ocean's sea ice cover reached its smallest size on record, surpassing the previous record low by almost 20 percent.

But it wasn't just anxiety and dread that kept us tossing and turning. Other stories made the list because they filled our sleepy heads with fascinating questions: Will we ever visit the planet that has been discovered in the Alpha Centauri system, just a few light-years away? What led humans to meet and mate with Neandertals and even more exotic relatives whose DNA has ended up in the genes of people living today? It's enough to keep you up for days.

There's just one story here that's not worth losing a wink of sleep over. Despite archaeological evidence to the contrary, some modern-day mystics have claimed that the ancient Maya predicted a global apocalypse on December 21, 2012. Now we can put that one to bed for sure.

—Matt Crenson, Managing Editor

On the Web For the complete year-end section with links to the original online news stories, visit www.sciencenews.org/2012



NICOLLE RAGER FULLER

Higgs discovery helps make sense of matter

Long-sought boson completes standard model of physics

By Alexandra Witze

It's hard enough to muster a standing-room-only crowd for a physics talk, let alone an overnight queue. But on the night of July 3, scientists sacrificed sleep to line up outside the main auditorium at CERN, the particle physics laboratory near Geneva. Their goal: get a seat to hear Joe Incandela. It wasn't the laconic, gray-suited scientist they had lined up for, though. Incandela, a particle physicist at the University of California, Santa Barbara, was expected to be the first to unveil the biggest physics news in years.

At 9 o'clock the next morning, with the auditorium packed, Incandela launched into a flood of charts and graphs. Blips in the data represented what happened when proton beams slammed into one another in CERN's mammoth particle collider. Buried in this data was one blip representing a

subatomic celebrity that scientists had been hunting for years — the Higgs boson.

Incandela didn't disappoint. "We're seeing something; it's relatively significant," he told the anxious onlookers.

He clicked to the next slide. The blip grew bigger. There it was: the Higgs. The room erupted in applause.

The next speaker, CERN's Fabiola Gianotti, only strengthened the case when she unveiled her team's evidence.

In many ways, that moment at CERN was the culmination of decades of scientific questing. Finding the Higgs meant that physicists had finally succeeded in explaining why the universe looks the way it does (*SN: 7/28/12, pp. 5, 26 & 28*). Their framework of the universe at the subatomic scale was complete.

Science News
TOP 25
Edited by
Erika Engelhaupt

"When it comes to discovering the ultimate workings of reality, the easy part is now officially over," says Sean Carroll, a theoretical physicist at Caltech. "We've put the finishing touches on a complete theory of the matter we see around us in our everyday lives."

Now that most scientists agree the Higgs is here, they can begin to map uncharted realms, from the possibility of extra dimensions of space and time to massive, secretive particles that shadow those already known.

Ultimately, the Higgs particle is important because it helps explain mass. It and the closely related Higgs field are the reason the universe didn't remain a sea of massless particles after the Big Bang.

Just nanoseconds after the cosmos was born, a field permeating all of space switched on. This was the Higgs field (named, like the particle, after University of Edinburgh physicist Peter Higgs, one of several scientists who dreamed up the idea in the 1960s). Suddenly some of the particles zipping around hit the Higgs field and slowed down, like marbles rolling through honey. That slowdown endowed them with mass. Once they had mass and could properly stick together, particles could combine and congeal into the atoms and molecules that make up everything from stars to people.

Only some of the particles slowed down; others, like photons, can buzz right through the Higgs field and thus still have no mass.

No wonder physicists have been hunting the Higgs for so long. But scientists can't spot the Higgs field directly; they can only deduce its existence by detecting the Higgs boson. A boson is a type of particle often closely linked to a force, and the Higgs boson emerges from the Higgs field (illustrated at left).

And the only way to observe a Higgs boson today, nearly 14 billion years after the Big Bang, is to create one in high-energy smashups at particle accelerators. For decades, nobody had a powerful enough machine to generate the energies required.

Accelerators such as the Tevatron at Fermilab, outside Chicago, took a shot at it. Einstein's equation $E=mc^2$ says that energy and mass are interchangeable. Smash two particles together at high enough energies, say nearly the speed of light, and an even more massive particle can pop into existence.

The Tevatron helped narrow the range of masses the Higgs might have, but it took CERN's bigger Large Hadron Collider to shake the Higgs loose. Out of every trillion collisions between protons, perhaps one created the rare, unstable Higgs — which quickly decayed to other kinds of particles.

Peering into sprays of debris from 500 trillion proton collisions, two detectors independently spotted signatures of Higgs decay. Working backward from the particle debris, scientists calculated that the Higgs has the mass of about 133 protons.

To convince themselves they were seeing true Higgs decays, the CERN physicists set themselves a rigorous statistical standard. They required a level of certainty known as five sigma, which holds that there is a 1-in-3.5-million chance that a statistical fluke could have created a signal of the observed magnitude or greater. At the time of the CERN announcement, both Higgs detectors independently achieved the five-sigma level; the statistical strength has only increased since, with both detectors now between six and seven sigma.

Still, current theories predict a very specific set of behaviors for the Higgs, and it's not yet clear whether the particle found at CERN meets those. The discovery may yet turn out to be a close cousin, rather than an identical twin, to the particle that Peter Higgs predicted. Scientists have been posting papers almost daily at arXiv.org, an online forum for new research not yet in journals, exploring the consequences of what a non–standard model Higgs might mean — from limiting the scope of other theories to raising the possibility of brand-new particles never before dreamed of.

If so, physicists will need new theories to explore what's going on. That may take years: Their best tool, the LHC, is scheduled to shut down in early 2013 for an upgrade that could take up to two years. It will come back with more than 50 percent more energy.

That ultimate energy should be enough for physicists to distinguish between the several Higgs possibilities. There may even turn out to be not one but many kinds of Higgs particles, each with a different mass.

An LHC running at full bore may also be able to answer one of the biggest puzzles about the collider so far: why it hasn't spotted any evidence of supersymmetry, a theory that holds that all the particles in the ordinary world have a heavy partner lurking nearby. Supersymmetry could explain why the mass of the Higgs boson isn't infinite, as standard model math would have it. Supersymmetry could also mean that the Higgs itself has its own massive superpartner particle. Powering up to higher energies will let the LHC probe the possibilities of this shadowy otherworld, if it exists.

"This isn't the end of the story," says Fermilab physicist Rob Roser, "but the beginning of a new chapter in science." ■

Curiosity goes to Mars

NASA's rover looks for life-friendly environments

By Nadia Drake

Curiosity took this self-portrait after landing on the surface of Mars. The rover will spend two years hunting for signs of past life on the Red Planet.

Besieged by budget cuts and diminished by the end of the shuttle era, NASA got a welcome shot in the arm in August as mission controllers at the Jet Propulsion Laboratory in Pasadena, Calif., watched their latest interplanetary emissary guide itself to a safe landing on Mars. Curiosity's arrival on the Red Planet ignited a firestorm of enthusiasm for space sciences, as millions followed the spectacular touchdown online.

The rover's landing included a hypersonic parachute ride, then an acrobatic sky-crane maneuver involving a retrorocket-powered descent stage that lowered the rover to the planet's surface on nylon cables. Christened "Seven Minutes of Terror" by the JPL team, the rover's entry, descent and landing were broadcast live over NASA's TV network — and appeared on the big screen in New York City's Times Square, where cheers erupted when the rover touched Martian soil around 1:30 a.m. on August 6 (*SN: 8/25/12, p. 5*).

Even the mission's scientists and engineers began to attract rock star–like followings. There was "Elvis Guy" — entry, descent and landing lead Adam Steltzner, sporting a shellacked, lofty coif — and "Mohawk Guy" Bobak Ferdowsi, who rocked a star-spangled 'do. In an on-air phone call to mission control, President Barack Obama praised the team for exemplifying the best of "American know-how and ingenuity," and for reaching beyond Earth to explore the vast unknown.

Its harrowing journey completed, Curiosity is now well into its primary mission: to search for evidence of past, and perhaps present, life-friendly environments on Mars.

"What we'd like to do is to begin to characterize habitable environments," says project scientist John Grotzinger of Caltech. That task includes looking for signs of organic carbon and an energy source that could have powered Martian microbes in the distant past. In September, the rover returned evidence that water once flowed on the surface of Gale Crater (*SN Online: 9/27/12*). And in its first complete soil analysis, Curiosity found organic compounds, though it's not clear whether they originated on Mars or were carried there by the rover (*SN Online: 12/3/12*).

Now the rover is en route to a mountain in the middle of Gale Crater. Mount Sharp — also known as Aeolis Mons — is a 5.5-kilometer-high peak built from sediment deposited over billions of years. Eventually, Curiosity will climb the mountain and read the history recorded in its layers.

"The question about habitability goes just beyond the simple observation of water on Mars, to re-creating the environments in greater detail with an understanding of the chemistry that was going on at that time — to ask if this is the kind of place that microorganisms could've lived," Grotzinger says.

An onboard instrument called ChemCam is analyzing the ingredients in rocks littering the Martian surface. These measurements should provide important clues about whether early Mars really was warm, wet and capable of hosting life, as scientists suspect.

Curiosity's investigations are being watched by orbiting spacecraft, which returned images of the rover parachuting to the surface and of the landing site, showing the ejected back shell and retrorocket-scorched dust. The rover is also sending home postcards — some self-portraits, others capturing the strangely familiar and yet alien landscape in the crater.

But the best images may still be from the video captured by Curiosity during its dramatic descent. Starting with the spacecraft's heat shield falling away, the video — shot by a camera on the rover's belly — tracks the swinging, plunging descent until touchdown, an event marked by the welcome sight of swirling Martian sands. ■

JPL-CALTECH/NASA, MALIN SPACE SCIENCE SYSTEMS

Controversial bird flu papers fly

But research freeze holds

By Tina Hesman Saey

Bird flu researchers started the year with a self-imposed moratorium on work deemed too dangerous for public consumption. That ban was supposed to last just 60 days, but as the year ends, the research is still on hold. And scientists have been left debating whether it makes sense in the first place to do research that, in the wrong hands, could spread a deadly disease.

The halt was called in response to two controversial studies in which scientists created mutated versions of the H5N1 avian flu virus. Unlike the original, the engineered versions could pass through the air between ferrets, common stand-ins for humans in influenza research. A U.S. government advisory panel decided there was a danger that terrorists might use information from the studies to create and unleash a deadly flu pandemic.

In the studies, two teams coaxed versions of H5N1 to evolve in the lab by passing them from ferret to ferret until the viruses could spread on their own when the animals sneezed or coughed. Initially it appeared that the virus in one lab was both infectious and deadly, prompting the government advisory panel to recommend that neither of the two papers describing the work be published in full. That ruling was reversed in March, and both papers were published in June, one in *Nature* (*SN Online: 5/2/12*) and the other in *Science* (*SN: 7/14/12, p. 8*).

The decision to allow publication ultimately came down to whether ferrets in Ron Fouchier's lab at Erasmus Medical Center in the Netherlands lived or died when infected with the airborne version of the virus. Perhaps no animal's fate has come under as much scrutiny since Schrödinger's hypothetical cat.

A majority of the 23 panel members concluded that because the ferrets survived, the mutated virus did not pose an immediate threat. Those researchers also thought publishing both papers might give public health officials the tools to more quickly spot burgeoning pandemics and to speed the development of vaccines and antiviral medications.

But six outvoted panel members disagreed. A paper by Yoshihiro Kawaoka's group at the University of Wisconsin–Madison posed no immediate danger, they agreed, but Fouchier's work presented a possibility for abuse. These panel members recommended making available only a redacted version of Fouchier's results that excluded virtually everything but the finding that the virus could become airborne.

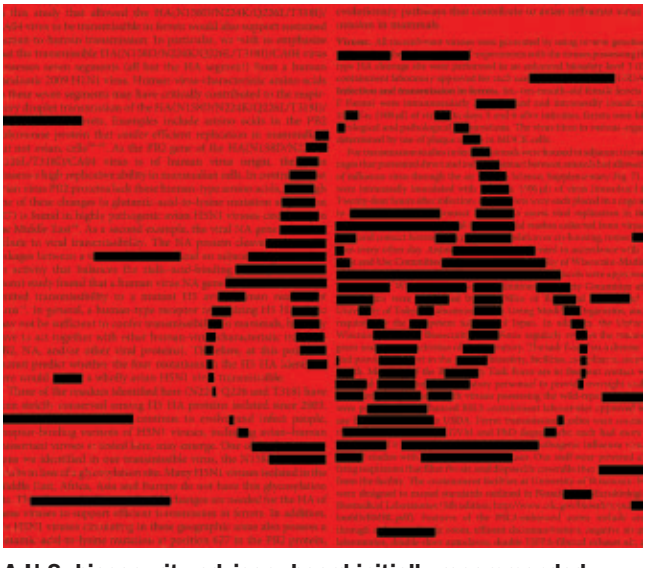
The complexities of working with influenza viruses almost ensure that anyone hoping to create a biological weapon from the flu would need specialized training. But anyone who has the skills to create a deadly airborne avian flu could make their own version without knowing what the two research groups found. And the flu would make an unwieldy weapon, one nearly impossible to control.

The initial concern over the two papers led the U.S. government to revise its policy on dual-use research, which is basic research that could be bent to nefarious purposes. In February, the National Science Advisory Board on Biosecurity made recommendations on ways to strengthen codes of conduct for researchers performing such work.

The moratorium was initiated by 39 influenza researchers, including Fouchier and Kawaoka, and prohibits work that makes H5N1 spread more easily or increases its virulence, called gain-of-function experiments. Such research remains hotly debated among scientists, public health officials, security experts and others. This summer the U.S. government proposed an indefinite continuation of the work stoppage.

As editor of the journal *mBio*, microbiologist Arturo Casadevall of Albert Einstein College of Medicine in New York City commissioned a series of essays about H5N1 research. Fouchier, Kawaoka and a colleague argued in the journal that the research should go forward because it would produce valuable knowledge about how flu viruses adapt to mammals and how to stop their spread. Other researchers weighed in on safety measures to contain the viruses in the laboratory.

"We need to ask the scientists a question that hasn't really been answered yet," Casadevall says. "Is the information we get from gain-of-function experiments critical for moving forward? If so, can we get the information any other way?" ■



A U.S. biosecurity advisory board initially recommended against publishing two papers detailing how to create a more transmissible form of H5N1 bird flu (text of one paper in illustration). The board later reversed its decision.

DAN PAGE

Bionic women (and men) get closer

Prosthetics and new therapies restore abilities to move, see, walk

By Rachel Ehrenberg

Outfitted with a bionic eye, arm, legs and fantastic '70s hair, Steve Austin was a cyborg whose implants allowed him to recover stolen atomic weapons, fight aliens and protect cryptographers in distress. Finally, real life is starting to catch up with the *Six Million Dollar Man*. In one of this year's bionic breakthroughs, a paralyzed woman carried out her own superhuman feat: Using an implanted brain chip, she controlled a robotic arm with her mind (*SN: 6/16/12, p. 5*). She used the arm to grasp a cuppa joe and take a long, satisfying sip of coffee through a straw, an act she hadn't done on her own for nearly 15 years.

"We're entering a really exciting area where we can develop all sorts of very complicated technologies that can actually have biomedical applications and improve the quality of life for people," says bioengineer Grégoire Courtine of the Swiss Federal Institute of Technology in Lausanne. "It's a revolution."

After her groundbreaking sip, Cathy Hutchinson, who had been paralyzed years earlier by a stroke, smiled and then laughed. A roomful of scientists burst into applause.

This was a big year for prosthetic parts, both in and out of the lab. Athletes in London for the Paralympics and the Olympics sprinted on high-tech carbon blades and hurled javelins while balancing on the microprocessor-controlled C-Leg. People in wheelchairs used battery-powered robotic suits to keep their lower limbs in shape. A young man who lost his right leg in a motorcycle accident climbed the 103 flights of stairs in Chicago's Willis Tower with a thought-controlled limb. That technology is still in development. But some bionic add-ons are starting to come out of the lab and into the clinic for the first time, though costs remain prohibitive for many potential users.

The brain-machine interface that allowed Hutchinson to direct a robotic arm (right) with her thoughts, called BrainGate, was created by building upon decades of studies. Monkey experiments in the 1960s, for example, first linked arm movements to the firing of particular neurons in the brain. In 2008 scientists reported that a thought-controlled prosthetic arm had allowed a monkey to feed itself.

Another new prosthetic may restore partial sight to people suffering from macular degeneration or retinitis pigmentosa (*SN: 6/16/12, p. 12*). In existing retinal prosthetics, already on the market in Europe, wiring and coils are implanted along with chips that get slipped into the back of the eyes. The new retinal implant, now being tested in rats, implants only slender photovoltaic chips that go beneath the retinas. The rest of the hardware is incorporated into high-tech goggles with a miniature video camera that sends information to a portable computer about the size of a smartphone. Lasers inside the goggle lenses then project the images into the eyes, where the photovoltaic chip sends signals along to the brain.

"Thinking back to papers from the 1960s, people were

Climate change goes to extremes

Some recent weird weather tied to warming **By Janet Raloff**

Welcome to the new climate; it's keeping those Weather Channel reporters pretty busy with field reports on everything from a crop-slaying U.S. drought to windy deluges and coastal floods. Without question, 2012 ushered in wild and worrisome weather across the planet. The year was among the 10 hottest on record and included a surprising number of record-hot days. Climatologists refer to such events as extremes, and new analyses show that global warming is behind an uptick in some, albeit not all, kinds of extreme events.

The strongest evidence has emerged in Earth's surface temperatures. Two analyses published this summer documented a shift toward hotter temperatures that seemed to kick off around 1981 (*SN: 9/8/12, p. 10*). Neither of those studies attempted to prove a link to global warming, but other analyses looking at notable 2011 events did probe for such a connection — and in July 2012 indicted climate change for exaggerating most of these events (*SN: 8/11/12, p. 14*), including Texas' epic heat wave (shown). The heat had been aggravated by the state's worst drought in recorded history (*SN: 11/17/12, p. 22*).

In 2012, most of the rest of North America began desiccating. By the end of August, moderate to extreme drought savaged almost two-thirds of the contiguous United States.

From January through early December,

TOP: J. DONOGHUE *ET AL*; BOTTOM: SCOTT OLSON/GETTY IMAGES

to reality

building and soldering simple devices by hand," says James Loudin, a researcher at Stanford who was part of the retinal implant team. "Now 50 years later, it's night and day."

Work by Courtine and colleagues has hinted at a different kind of sci-fi–like future — one with no need for bionics. Their research showed the potential of restoring function to limbs without using prosthetics at all. Rats paralyzed by spinal cord injuries were able to walk, run and even climb stairs after weeks of treatment combining drugs and electric shocks to the spine with physical therapy on treadmills (*SN: 6/30/12, p. 5*). But it wasn't just technology that made the feat possible; the research showed the importance of that intangible thing called motivation. The rats who learned to walk were the ones that really wanted it; those trained without a tempting treat never learned to walk.

"We motivated the rats with chocolate," says Courtine. "That's when the miracle happened."

A microchip that impressive is still a long way off. ■

the United States saw nearly 33,000 new record high temperatures. A stable climate sets as many record highs as lows in a typical year. But record hot days outnumbered record cold ones by about 5 to 1 during that period, in line with a trend of increasing highs relative to lows that has been going on since the 1980s.

And then there was the unprecedented melting of the Arctic Ocean's ice cover. Since 1979, the extent of sea ice at summer's end has fallen by 13 percent per decade. What remains is also getting thinner (*SN: 10/6/12, p. 5*). This year's September minimum plummeted to 3.41 million square kilometers (1.32 million square miles) — about 20 percent below the previous record, set in 2007.

As for Hurricane Sandy, it's not clear whether global warming helped fuel the storm's power or set up the high-pressure system over Greenland that turned it landward. Despite maxing out as only a Category 2, Sandy devastated Haiti and part of the eastern U.S. seaboard. Data indicated that rare meteorological conditions in the Caribbean and eastern Atlantic combined to spawn a once-in-a-lifetime hybrid superstorm: part hurricane and part nor'easter (*SN Online: 10/31/12*). ■

Your social brain

Nerve cells notice mistakes and learn from others' desires

By Laura Sanders

Some nerve cells snicker at mistakes. Others compel a person to want someone else's stuff. By studying these phenomena, scientists are learning more than just where schadenfreude and jealousy lie in the brain; they're gaining an unprecedented view of how social influences can worm into a person's head.

Such new results carry researchers beyond studying the brain in isolation to studying it as a social actor. Ultimately, this work could help forge a deeper understanding of how the brain learns by using the behavior of others as a guide.

Earlier this year, Japanese researchers uncovered a small group of nerve cells that fire when a macaque witnesses another monkey making a mistake. These cells, located in the front of the brain, remained silent when a monkey made an error itself, but howled when the monkey saw a partner screw up (*SN: 9/8/12, p. 12*). Humans probably have similar cells, says study coauthor Masaki Isoda, now at Kansai Medical University in Osaka, Japan.

Finding cells that respond to another animal's error but not to the monkey's own mistakes was a surprise, showing that the cells behave distinctly from those in the brain's mirror neuron system. A collection of nerve cells that are active while a subject is both doing and observing another doing, the mirror neuron system has been proposed as a way for the brain to make sense of the actions of others. But these new results, and others like them, paint a more complex picture.

Other research reveals more about how the mirror neuron system helps the brain learn from others. In a different social setting, mirror neurons team up with another system in the brain — the bean-counting system — to make an object in someone else's possession automatically more desirable (*SN: 6/30/12, p. 12*). French researchers found that candy, tools and clothes in someone else's hands held more allure than an untouched object, a copycat phenomenon called "mimetic desire" by the philosopher René Girard.

This automatic upgrade happens in two steps, the researchers found: Initially, the mirror neuron system detects that someone else has something of interest. Then, that information gets sent to the brain's value-assigning system, which adjusts the value of the object upward.

Although these traits — coveting possessions and nitpicking mistakes — are things parents teach their children not to do, they may serve an important function, researchers say. Watching what other people do wrong and what they acquire can yield valuable information about how to get along in this world. ■

Scientists take on Twitter

Social media comes into its own as a tool and a subject for study

By Rachel Ehrenberg

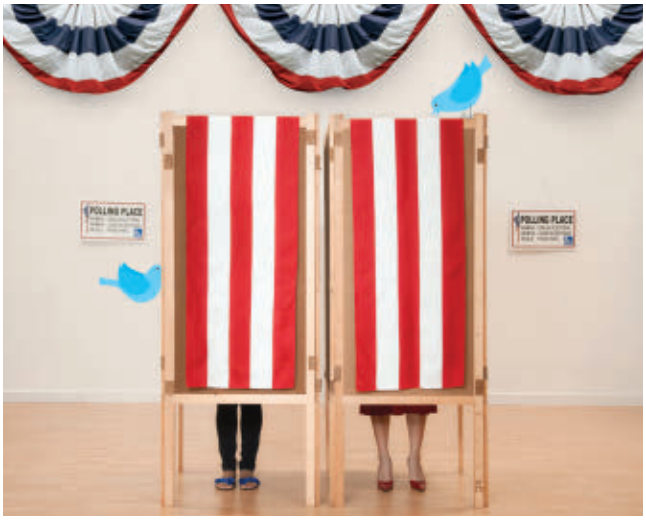
You might say science "friended" social media this year. But like many friendships, this one has its ups and downs.

On the one hand, platforms such as Twitter proved useful tools for tracking particular events in real time. Scientists at Harvard Medical School and Children's Hospital Boston found, for example, that tweets about the 2010 cholera outbreak in Haiti tracked closely with official health reports (*SN: 2/25/12, p. 16*). Twitter chatter about the flu also closely matched the spread of the disease. And tapping into earthquake-related tweets allowed U.S. Geological Survey researchers to create a rough map of the shakiest spots in California's 2009 Morgan Hill earthquake.

In addition to exploring social media's value as a proxy for on-the-ground data, scientists also scrutinized the outlets for their intrinsic power in shaping behavior. Facebook stepped up: A massive experiment during the 2010 U.S. congressional elections found that people who received a message that a friend had voted were more likely to vote themselves (*SN: 10/20/12, p. 12*). Social media also played an important role in informing citizens about goings-on during the protests and uprisings collectively known as the Arab Spring (*SN: 3/10/12, p. 9*).

But scientists also documented how social media can spread misleading and acrimonious political information (*SN: 10/20/12, p. 22*). While the effects of propagating false claims in the lead-up to elections isn't clear, scientists worry about the potential for the social platforms to be used deceitfully to influence behavior at the voting booth.

These studies are meaningful not only for their particular findings, but also because they had findings at all. "We've undergone a transformation in the last five to six years," says Sinan Aral of New York University, who studies the role, spread and influence of information. "There's been an explosion of digital signals that people are exposed to."



That explosion probably has big implications, but working out the specifics isn't easy. Scientists are still figuring out what methods do and don't work for studying social media. Setting up a control group, for example, to narrow down what's causing an effect is relatively straightforward in a lab experiment. Not so for social media, where information can easily "leak" and influence a control group. And compared with molecules or proteins, human players in social media studies are diverse, dynamic and hard to pin down. Sigh. #itscomplicated. ■

Online reader favorites

The editors of *Science News* keep weekly tabs on Web traffic, and sometimes the stories that draw lots of eyes surprise us. Here's a selection of highly clicked stories that didn't make it into this year's Top 25.

Marshmallow test A study put a new twist on a classic test of willpower, in which kids are asked to forgo a marshmallow now for two later. It turns out that kids who have learned to trust the marshmallow-giver are more likely to hold out than those who have reason to think the experimenter unreliable (*SN: 11/17/12, p. 10*).

Moon swirls Mysterious designs on the lunar surface might be created by magnetic bubbles that protect some areas from the darkening effect of solar wind. When the wind hits the magnetic bubbles, an electric field is generated that creates a shield (*SN: 8/11/12, p. 8*).

Music evolves Inspired by natural selection in bacteria, an online experiment finds that cacophonous sounds can become musical within just 500 "generations." People chose pleasing sounds from a set of random noises, allowing those sounds to mutate and move to the next round (*SN: 7/28/12, p. 12*).

Other dimensions didn't make it It doesn't make string theory any easier to follow, but theorists find that at least six of string theory's extra spatial dimensions would have become stunted in the early universe, leaving the familiar three (*SN Online: 1/13/12*).

Synesthetic superchimp A chimp that's freakishly good at recalling numbers may have an unfair advantage: synesthesia, which allows him to see numbers in colors (*SN: 7/28/12, p. 9*).

PHOTO: HILL STREET STUDIOS; BIRDS: E. FELICIANO; BUNTING: DNY59/ISTOCKPHOTO

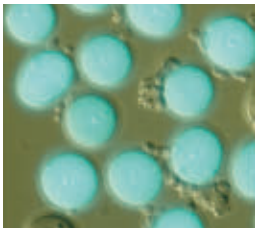
Women may make new eggs

If true, finding could lead to new fertility treatments

By Tina Hesman Saey

For more than 50 years the matter had been considered settled: A woman grows all the eggs she will ever have before she is even born. But a study published this year, and then contested, suggests that this long-accepted fact may not be true.

Stem cells in the ovaries of both women and mice replenish egg supplies throughout adulthood (*SN: 4/7/12, p. 8*), reported a team led by Jonathan Tilly, a reproductive and developmental biologist at Massachusetts General Hospital. With aging, the stem cells' capacity to make eggs diminishes, eventually petering out at menopause, Tilly says.



Many people hailed the news because it raises the possibility of growing eggs in laboratory dishes for use in fertility treatments. That possibility came a bit closer to reality when Japanese scientists announced that they had grown viable mouse egg cells (some shown below), or oocytes, in the lab from embryonic stem cells and from reprogrammed stem cells (*SN: 11/3/12, p. 14*).

Tilly says harnessing the stem cells he and his team found may not only be a boon for those with fertility problems, but also might help delay menopause.

But a follow-up study called Tilly's results into question. Kui Liu of the University of Gothenburg in Sweden and colleagues reported that they had found ovarian cells that might be mistaken for stem cells but produce no eggs (*SN Online: 7/9/12*). Other scientists familiar with Tilly's work say that the Swedish group isolated a different type of cell, and failed to find the stem cells.

Some scientists doubt that stem cells, even though probably real, would actively produce oocytes in the body. Evelyn Telfer of the University of Edinburgh has worked with Tilly's stem cells and says that she thinks the cells may spring into action if the ovary is damaged, but otherwise sit quietly.

While the scientific debate continues, Tilly has formed a start-up company, OvaScience, that is using his work on egg precursor cells to develop treatments for infertility. ■

Earth's new neighbor looks familiar

Planet discovered in Alpha Centauri, just a few light-years away

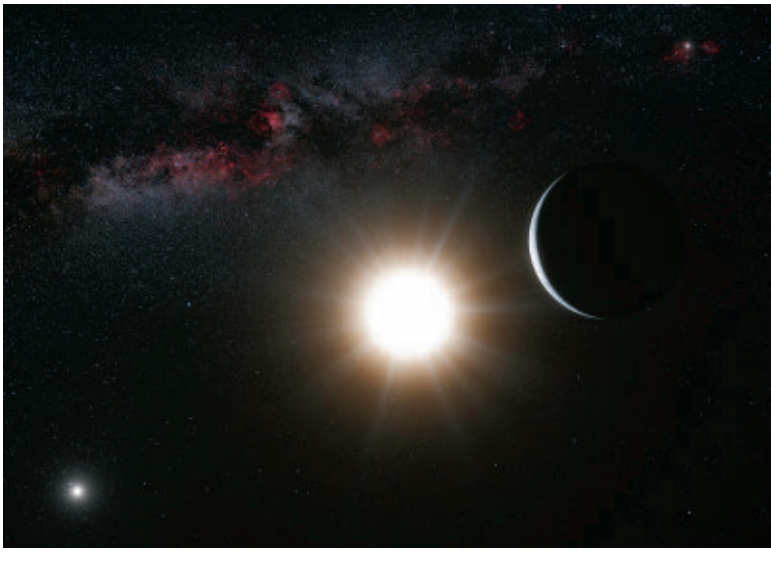
By Nadia Drake

For exoplanets, size does matter. That's why an Earth-sized planet just 4.4 light-years away proved to be one of the most exciting astronomical discoveries of 2012. The planet (artist's depiction shown) circles a sunlike star in the Alpha Centauri system — the nearest stellar system to Earth and a favored target for future interstellar expeditions.

Finding a rocky planet in the Alpha Centauri system settled a decades-long debate about whether the system's three stars hosted planets. The region appeared deserted until the most powerful planet-finding instrument on Earth — the High Accuracy Radial Velocity Planet Searcher — took a four-year-long look. Now scientists are eager to confirm the finding (*SN: 11/3/12, p. 5*) with further observations.

Just a bit more massive than Earth, the planet, unofficially named Alpha Centauri Bb, is so close to its parent star that it completes its orbit in just over three days. That superclose orbit probably means that one side always faces the star, and that side is burnt to a 1,200° Celsius crisp. The other side of the planet could be prime real estate for landing an interstellar space probe, but is probably frigid and similarly unfriendly to life.

But don't count Alpha Centauri out yet. Astronomers are betting there are more planets in the triple-star system, perhaps farther out and in their stars' life-friendly zones. ■



FROM TOP: COURTESY OF KATSUHIKO HAYASHI/KYOTO UNIV.; L. CALÇADA, NICK RISINGR, ESO

Prions may cause Alzheimer's

Similarity found with destructive protein behind mad cow

By Laura Sanders

An infectious, self-replicating protein might be at the heart of Alzheimer's disease, a growing number of studies suggest. If correct, this idea could change how scientists view the condition, which affects 5.4 million Americans.

A tiny seed of a dangerous protein could corrupt other harmless proteins, the theory goes, creating and unleashing a destructive army in the brain. And this process might not be restricted to Alzheimer's. Some researchers believe the spread of such proteins in the brain could explain other devastating disorders such as Parkinson's, Huntington's disease and amyotrophic lateral sclerosis.

In Alzheimer's, the possible infectious agent under scrutiny is a protein called amyloid-beta, best known as the main ingredient in the hulking, sticky gobs of plaque found in the brains of people with the disease. It turns out that A-beta probably causes damage long before it accumulates into these plaques. Smaller arrangements of A-beta, called oligomers, scramble brain messages and eventually kill nerve cells.

These oligomers, some scientists now believe, are infectious agents known as prions. Such self-replicating proteins, discovered 30 years ago by Stanley Prusiner of the University of California, San Francisco, are responsible for the brain-wasting Creutzfeldt-Jakob disease in people, scrapie in sheep and bovine spongiform encephalopathy in cattle. Over 20 years ago, Prusiner argued that something similar could be happening in Alzheimer's and other brain diseases. In the last few years, he and others have turned up some evidence that his hunch could be right, and now more people are paying attention.

A-beta injected into half of a mouse's brain slowly incites other A-beta molecules to accumulate, Prusiner and colleagues reported earlier this year (*SN: 7/14/12, p. 5*). And Swedish scientists caught A-beta jumping directly from nerve cell to nerve cell in rat and human cells in a dish, suggesting that the protein can follow neural connections in the brain.

Finding new ways to spell L-I-F-E

XNA molecules join DNA and RNA in the genetic catalog

By Rachel Ehrenberg

Life's menagerie of hereditary molecules got a little bigger this year. By replacing the sugars in the backbone of a DNA strand with other molecules, scientists created ANA, TNA, HNA, FANA, CeNA and LNA (*SN: 5/19/12, p. 10*). Each of these synthetic genetic molecules, collectively known as XNAs (xenonucleic acids), also got its own designer enzymes that allow the molecule to be "read" and then replicated, an advance that could help shed light on how life on Earth got its start.

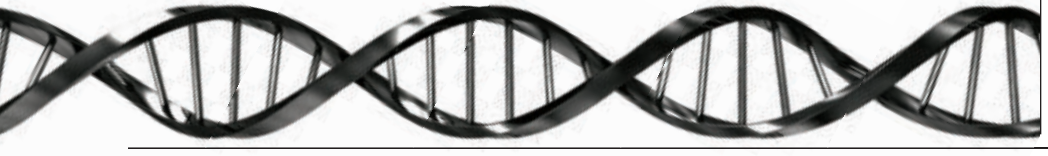
XNAs can make new generations of themselves, though they need an assist from good old DNA. By selecting for a particular trait, such as the ability to attach to another molecule, researchers also coaxed the XNAs to change over time. That covers two biggies: heredity and evolution, now demonstrated to be the purview of not just DNA and RNA.

The work suggests that life, on the early Earth or somewhere else in the universe, could have emerged from other breeds of molecules.

There are also potential biomedical applications: Because researchers can direct the molecules' evolution, designer XNAs could be made with specialized traits for delivering drugs. The newcomers might also provide replication machinery for new organisms constructed from scratch.

"We only know this one example of life — it's what's been on Earth for 4 billion years," says biochemist Gerald Joyce of the Scripps Research Institute in La Jolla, Calif. "Maybe we'll find evidence of some kind of life on Europa [a moon of Jupiter] or fossilized life on Mars. Or maybe we'll just make it." ■

GECKO753/ISTOCKPHOTO



Quantum hops

A little closer to teleportation and new computers

By Alexandra Witze

The future is calling. In a step toward hacker-proof messaging, physicists this year sent quantum-encoded information zipping over a greater distance than ever before. They also spotted a long-sought particle whose quantum properties could one day be used to develop a superfast futuristic computer.

There's still no "beam me up" machine, but when it comes to sending information, even instant messaging can't hold a candle to quantum teleportation. Researchers beam information using a pair of particles "entangled" such that measuring a particular property of one determines that property for the other, even if they are far apart. The information about that property is thus teleported instantaneously between the two.

One research team, based in China, entangled groups of photons 97 kilometers

Still more evidence comes from a study on a particularly dangerous form of A-beta. In "vanishingly small" quantities, this form, called pyroglutamylated A-beta, can cause normal versions of A-beta to turn deadly, says study coauthor George Bloom of the University of Virginia. These proteins needed just 24 hours to kill half of mouse nerve cells tested in a dish (*SN: 6/2/12, p. 18*).

If the prion idea is right, then over many years a small, dangerous A-beta seed may cause harmless forms of A-beta to shape-shift into a destructive form of the protein. So far, there's no direct evidence of this shift in people, but scientists are looking.

Thinking of Alzheimer's as a prion disease could have big implications for how to slow its progress or even prevent it. New approaches might aim either to keep destructive forms of A-beta out of the brain or to interrupt their spread. ■

apart in the air above a Chinese lake. The scientists then teleported information from one group of photons to the other. A second team, based at the University of Vienna, soon broke that record by reporting teleportation across 143 kilometers, between La Palma and Tenerife in the Canary Islands (*SN: 6/30/12, p. 10*).

Scientists' next step is to set up a permanent quantum teleportation experiment involving satellites or the International Space Station. Beaming information into orbit will mean sending it three times farther than ever before. Because fewer molecules exist high in the atmosphere to interfere, physicists think the feat is possible within the next few years.

Another dream is to build a quantum computer, which would rely on the quantum properties of particles to run certain types of calculations blazingly fast. One step toward this goal came this year when physicists apparently glimpsed a long-sought particle known as the Majorana fermion (*SN: 5/19/12, p. 11*).

First predicted in the 1930s, Majorana fermions do not have an antimatter partner like other particles do. Because of this, they might form the basis of a more stable storage unit in quantum computers, one barely influenced by the outside world. ■

SERGEY URYADNIKOV/SHUTTERSTOCK

Polar bears have seen hard times

Two genetic studies extend the Arctic icon's lineage way back

By Susan Milius

The polar bear, furry face of wildlife at risk from climate change, now looks as if it may have been around long enough to have survived past warm spells. Just how long remains to be seen, but two genetic studies published this year push the species' origins back beyond the start of the most recent ice age.

That's a big rewrite of polar bear history that has people thinking about the bears' future; even if the bears survived several past warm periods, that's no guarantee they will survive this one.

Until the genetic analyses this year, polar bears' history as a species was thought to be short. A fossil jawbone and tooth from Norway, the oldest well-documented polar bear remnants, date back only 110,000 to 130,000 years. And preliminary genetic studies by Charlotte Lindqvist of the University at Buffalo and her colleagues traced the female polar bear line back only about 150,000 years to a junction with the brown bear lineage.

If polar bears had really evolved as a species that quickly, it would be "a miracle of rapid adaptation," says evolutionary biologist Frank Hailer of the Biodiversity and Climate Research Centre in Frankfurt.

But this year, two independent teams (one including Hailer, the other with Lindqvist) got the first good look at DNA from the nuclei of polar bear cells. Lindqvist's previous estimate had come from DNA in mitochondria, which traces only the maternal lineage.

Hailer and his team pushed the split from brown bears back to about 600,000 years ago (*SN: 5/19/12, p. 12*), and Lindqvist *et al* to a much more ancient 4 million to 5 million years (*SN: 8/25/12, p. 15*). Dating back 600,000 years would mean the species survived a warm spell around 400,000 years ago, says paleoclimatologist Gifford Miller of the University of Colorado Boulder. The older estimate would put the bears into a different world that may not have had winter sea ice.

The two teams have many ideas about why their dates differ. But they agree that a greater age does not mean polar bears, now listed as threatened, will be just fine as their specialized sea ice habitat continues to melt.

For one thing, today's polar bears are not those of yesteryear. The early ancestors in the polar bear lineage may not have been quite the specialized sea ice predators of today. And as Hailer points out, "The studies focus on the past." With human-caused warming, the planet could heat faster and further than the bears have experienced before.

This is also the first time polar bears have shared a planet with billions of humans during a warm-up. Add in the stresses of hunting and pollution, which thanks to atmospheric circulation patterns tend to accumulate in the Arctic, and the balance might tip against the bears. ■

14

Kissing, and missing, human cousins

DNA paints a contested picture of Stone Age interbreeding

By Bruce Bower

The scientific paparazzi who followed long-gone evolutionary celebrities this year exposed plenty of hanky-panky between early humans and closely related species. These new findings (inexplicably ignored by supermarket tabloids) raise questions about how much genetic swapping happened in the *Homo* genus tens of thousands of years ago. What's more, the mixed-up family tree is uprooting the popular view that modern humans evolved in Africa and spread from there, edging out close relatives such as Neandertals.

In one revealing report, an international team unveiled a largely complete genetic library extracted from the finger fossil of a Stone Age girl (*SN: 9/22/12, p. 5*). Her DNA suggests that she came from a small Siberian population — called Denisovans — that moved through East Asia tens of thousands of years ago. Today's Papua New Guineans inherited 6 percent of their genes from Denisovans, the study found.

Researchers don't have enough fossils to say whether the Siberian girl or other Denisovans represent a new *Homo* species. DNA from one ancient individual, as opposed to a representative sample from a population, isn't up to the task of nailing down a new species.

Neandertals, on the other hand, are generally thought to have been a separate species even if they occasionally interbred with *Homo sapiens*. Recent stone tool finds suggest Neandertals trekked from Europe to East Asia starting 75,000 years ago, giving them the chance to interbreed with ancient humans over a huge geographic expanse (*SN: 8/25/12, p. 22*). The study of Denisovans also found that today's East Asians share more genes with Neandertals than South Americans or Europeans do.

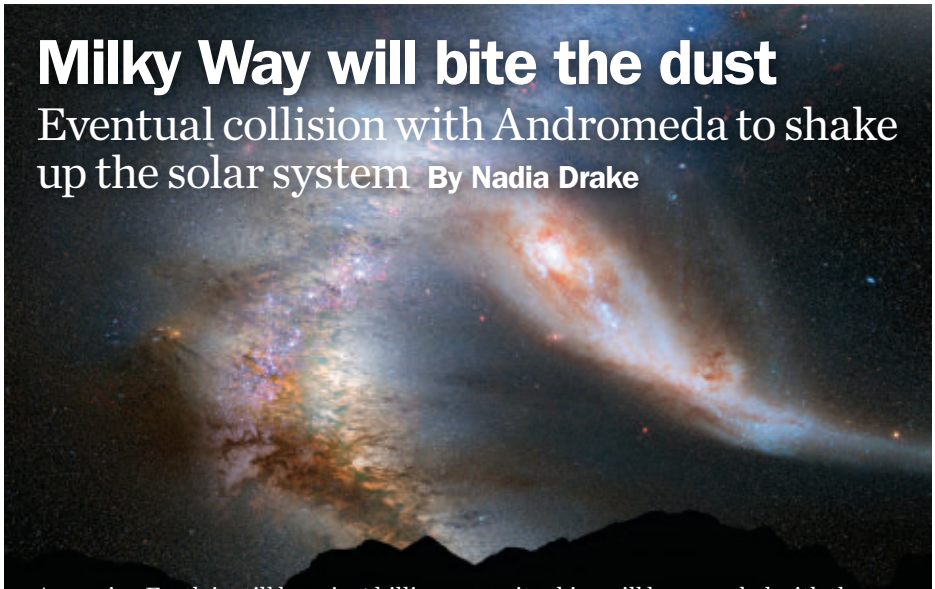
Yet despite shared DNA, it's unclear whether, or how much, interbreeding actually occurred. Some scientists say that African populations ancestral to both humans and Neandertals may have carried genes that became part of both species' genomes. Others estimate that at least low levels of interbreeding must have taken place (*SN: 11/3/12, p. 8*). Whatever the case, evidence suggests that Europeans today carry an average of 2.5 percent Neandertal DNA, versus 3 percent in Chinese people and less than 1 percent in Africans.

Researchers are all over the map when it comes to saying what such genetic clues mean. Some suspect there was even more Stone Age interbreeding than these numbers suggest, shaping the genetic evolution of *H. sapiens*. Others regard Neandertals and Denisovans as having mated so infrequently with *H. sapiens* that interbreeding had little or no effect on human evolution.

15

Milky Way will bite the dust

Eventual collision with Andromeda to shake up the solar system **By Nadia Drake**



NASA, ESA, Z. LEVAY AND R. VAN DER MAREL/STSCI, T. HALLAS AND A. MELLINGER

Assuming Earth is still here in 4 billion years, its skies will be spangled with the glowing shards of an epic cosmic collision. The Milky Way galaxy and its nearest neighbor, the enormous Andromeda galaxy, will plow right into one another (photo illustration, above, shows a view of Earth's night sky during an early stage of the predicted galactic smashup). Earth's solar system will be punted from its perch in the Milky Way's Orion spur, drift for a while and probably end up orbiting much farther from the new galactic core, scientists from the Space Telescope Science Institute in Baltimore and colleagues reported in May (*SN: 7/14/12, p. 10*). Using the Hubble Space Telescope to measure the movement of stars in Andromeda, the team determined that the galaxy is heading straight for the Milky Way — at nearly 400,000 kilometers per hour. Though the galaxies are still 2.5 million light-years apart, gravitational attraction is pulling them together. The researchers speculate that another nearby galaxy — M33, the Triangulum — may get dragged into the pileup. Either way, the merger should be a spectacular sight for cosmic rubberneckers. ■

16

Year's weirdest

Some science stories deserve attention just because they are so mind-bendingly strange. Science didn't hold out on the bizarre this year; here are a few of the weirdest stories that didn't make the Top 25.

Or maybe, some say, Neandertals and Denisovans are part of a single species, *H. sapiens*, that featured more genetic variety in the Stone Age than it does now.

The groups could share plenty of genes with little or no interbreeding if small bands of *Homo* species in Europe and Asia hid out in isolation during ice ages (*SN: 4/7/12, p. 5*). Populations secluded for extended periods in relatively mild areas could have kept many of the same genes but evolved into different species such as Neandertals and, possibly, Denisovans. When conditions warmed, the groups might then have ranged widely and crossed paths, resulting in occasional cross-species couplings.

Mixing things up more, ancient humans could have had other kissing cousins as well. Fossils from two Chinese caves might be a previously unknown *Homo* species that lived near humans between 14,300 and 11,500 years ago. Or these ancient Asians — who looked like a mix of people today and 100,000-year-old African *Homo* fossils — might have been *H. sapiens* with a dash of Denisovan ancestry, or full-on humans who lived in isolation long enough to evolve an unusual appearance (*SN: 4/7/12, p. 5*).

Africa may hold yet more human relatives. DNA from modern African hunter-gatherers shows signs of interbreeding with an unknown *Homo* species between 70,000 and 30,000 years ago (*SN: 9/8/12, p. 9*). Hunter-gatherer DNA also suggests that humans in a far-flung network across Africa have mated with each other over at least the last 100,000 years.

Maybe the exploits of some of these African cousins will land on front pages next year — or maybe others will make their debut as scientists sort through humans' ancient DNA. ■

Out on a limb

Fossils suggest early bipedal hominids still climbed

By Erin Wayman

More than 3 million years ago, a chimp-sized creature climbed a tree to take a nap. Later, she clambered back down, stood up on two legs and strolled off to find some food, or maybe a mate. Or maybe another tree to scale.

That's a controversial view of how the famous human ancestor Lucy and her kind, *Australopithecus afarensis*, maneuvered about the landscape. Scientists have debated whether the early hominid climbed trees. New fossil evidence announced this year suggests the species did spend some time in the treetops even though it mainly walked upright on the ground. This fossil find and others from 2012 challenge the idea that human evolution involved ever more humanlike species replacing more primitive brutes. Instead, the hominid family tree was a tangled bush of motley species.

"This last year has really solidified the idea of diversity in anatomy and behavior in our earliest ancestors," says biological anthropologist Brian Richmond of George Washington University in Washington, D.C.

The insight into Lucy's travel habits came from an *A. afarensis* child that lived in Ethiopia 3.3 million years ago. After comparing the child's shoulder blades with those of other ancient hominids, modern humans and apes, researchers determined that *A. afarensis*' shoulders (one shown) underwent the same developmental changes seen in ape shoulders, with size and shape affected by climbing during childhood. The similarities imply that *A. afarensis* spent at least some time scaling trees, too (*SN: 12/1/12, p. 16*).

Lucy wasn't alone in the canopy. Scientists dug up a 3.4-million-year-old hominid foot in Ethiopia that, unlike that of *A. afarensis*, still had a grasping big toe like a chimpanzee's (*SN: 5/5/12, p. 18*). This suggests the foot belonged to a different species that had superior climbing abilities.

"The experiment of bipedalism played out in a number of different ways," says Jeremy DeSilva, a biological anthropologist at Boston University. Some species were better bipedal walkers, while others spent more time climbing, he says. One anatomical oddity was *Australopithecus sediba*, a nearly 2-million-year-old species from South Africa with a flexible foot that twisted inward (*SN: 5/19/12, p. 14*).

Experiments in hominid diversity weren't limited to the ankles. Some anthropologists think that at least two separate species of *Homo* lived some 2 million years ago after the genus emerged in Africa; others say there was just one species with males much bigger than females. Fossils unearthed in Kenya from this time — the partial face of a child and two jaws — are too different from some other early *Homo* fossils for them all to be one species (*SN: 9/8/12, p. 8*), researchers say, providing the best evidence yet of multiple species of early *Homo*.

All of the discoveries from this year, DeSilva says, are "forcing us to really think about variation." ■

COURTESY OF ZERESENAY ALEMSEGED/DIKIKA RESEARCH PROJECT

Time crystals
A physicist describes mathematically how an object could loop endlessly in time, forming a crystallike structure (*SN: 3/24/12, p. 8*).

***Jurassic Park* plant**
A 31,800-year-old fruit found buried in Siberian permafrost is revived; it sprouts in the laboratory and grows flowers (*SN: 4/7/12, p. 15*).

Walking on water
Particle compaction explains the YouTube party trick of running across a pool containing a cornstarch/water mix (*SN: 8/25/12, p. 13*).

Virgin snake birth
Copperhead and cottonmouth moms are found pregnant with babies conceived without sex, a first in the wild (*SN: 10/20/12, p. 16*).

Rain-riding bugs
Mosquitoes avoid getting splatted by riding raindrops down, then breaking away before hitting the ground (*SN: 7/14/12, p. 9*).

You really can learn while you sleep

Brain stays busy during lights-out

By Laura Sanders

You may think of sleep as a time of repose. But scientists discovered this year that, under the right circumstances, your slumbering brain can sign on for the night shift.

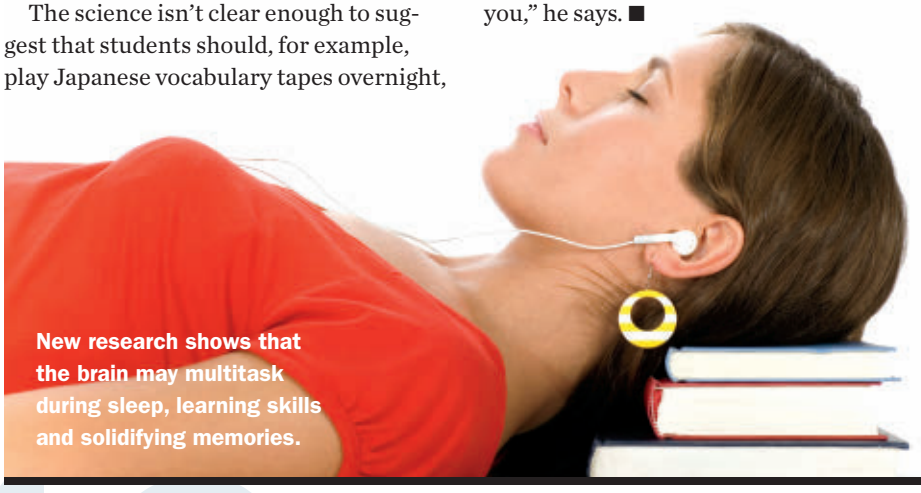
While visiting the Land of Nod, people might improve their musical abilities (*SN: 7/28/12, p. 10*), learn to associate a smell with a sound (*SN: 10/6/12, p. 9*) or solidify negative feelings (*SN: 2/25/12, p. 8*). These results, and others like them, are pushing the boundaries of what scientists think the sleeping brain accomplishes.

"We want to understand where the borders lie between what we can and cannot learn during sleep," says Anat Arzi of the Weizmann Institute of Science in Israel. This year, her team described the brain's ability to learn to associate a particular tone with the smell of rotting fish while fast asleep. Another study found that people can also sharpen existing skills during a nap. After listening to a nap-time song, volunteers were better at hitting the right notes on a keyboard.

The science isn't clear enough to suggest that students should, for example, play Japanese vocabulary tapes overnight, but the results do show that the sleeping brain assimilates information. And the implications go beyond cramming for a test.

Sleeping after a painful experience may lock negative memories into the brain, for instance. Staying awake during a crucial window may help lessen a trauma's emotional impact. A study in mice accomplished the same thing without them losing sleep: A drug injected into the animals' brains lessened a painful memory's effect while the animals dozed (*SN: 11/17/12, p. 14*).

Because scientists still don't understand why humans need to spend a big chunk of their lives asleep, some question the wisdom of giving the brain more work. Perhaps the brain ought to be left alone during the night and given time to do whatever it needs to do, says sleep researcher Robert Stickgold of Harvard Medical School. "I would argue that sleep might be smarter than you," he says. ■



New research shows that the brain may multitask during sleep, learning skills and solidifying memories.

PIKSEL/ISTOCKPHOTO

Obesity research gets weightier

Findings are filling out the story behind the fat

By Nathan Seppa

As obesity expands the world's collective waistline, researchers keep finding new reasons why we are getting fatter, and more consequences of the added pounds.

In 2012, scientists found that hormones such as oxytocin and testosterone seem to help protect against gaining weight, or at least against a runaway appetite (*SN Online: 6/26/12; SN: 7/28/12, p. 11*). Other work offered counterintuitive results, finding that diet soda might not help much (*SN: 7/14/12, p. 14*), and that worries about junk food access in schools may be overrated (*SN: 2/25/12, p. 9*).

It's a mishmash, but this much is clear: More than one-third of people in the United States are already obese, and another third are overweight. In one generation, obesity has gone from a medical and social issue to a public health disaster.

Obesity contributes to atherosclerosis, metabolic problems and other chronic diseases. "If you can tone all that down, you'll probably be better off, and losing weight is a good way to do it," says biochemist Russell Tracy of the University of Vermont.

Obesity comes from more than just overeating, and researchers tracking down the underpinnings of unhealthy behaviors often find their way to the nervous system. Such efforts are revealing that commonly consumed soybean and corn oils can confuse calorie-sensing networks in the

'Good' cholesterol may be overrated

Surprise result questions heart protection from HDL

By Nathan Seppa

Sometimes new research makes us reconsider what we know. One example this year was cholesterol, which has long been divided into black-and-white simplicity — good and bad, HDL and LDL. Because people with higher HDL tend to have fewer heart attacks (and those with high LDL have more of them), it has been a fair distinction.

Or has it? An international team looked at medical data from thousands of people with and without a history of heart attacks, a collection that included some who had genetic variants resulting in higher-than-average HDL.

Surprisingly, the researchers found that having naturally higher HDL imparted no added protection against heart attacks (*SN: 6/16/12, p. 14*).

The very activities that can increase

body. The body taps components in some vegetable oils to make endocannabinoids, homegrown appetite stimulants similar to compounds in marijuana. What's more, certain brain areas get hyperactive in overeaters, particularly areas associated with food-reward sensations (*SN: 10/6/12, p. 24*).

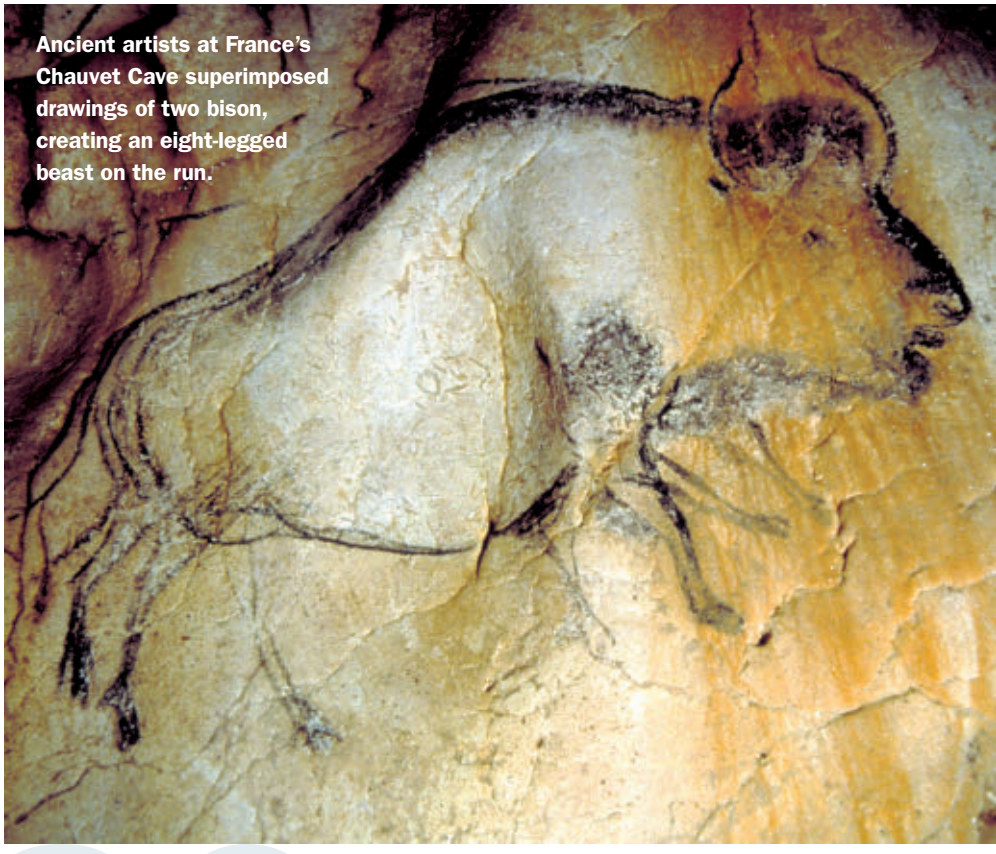
While these findings may help scientists unravel the complexities of appetite, other obesity contributors might be more straightforward. Exposure to secondhand smoke in adulthood is linked to diabetes and obesity (*SN Online: 6/26/12*), suggesting that smoking bans, which are running far ahead of junk food bans, may be the first legislative acts to fight the obesity epidemic.

Another exposure, to antibiotics in infancy, seems to contribute to excess weight by age 3 (*SN Online: 8/22/12*). Work in mice suggests this antibiotic effect might stem from altering the intestinal mix of beneficial bacteria (*SN Online: 6/26/12*).

Even your neighborhood can be risky. Children living in areas with ample green space and a nearby grocery store are roughly half as likely to be obese as kids growing up without such amenities, even after accounting for other differences. The new findings draw attention to what scientists call the "built environment" — a risk factor that is modifiable (*SN: 6/2/12, p. 17*).

There's good news, too. People able to take off weight disrupt a dangerous triad of obesity, inflammation and possibly cancer. New data show that women losing just 5 percent of their body weight experience a drop in inflammatory proteins and cells (*SN: 6/2/12, p. 16*). "Anything you can do to decrease your inflammatory status is probably a good thing," says Tracy. As is often the case in medicine today, obesity is at the top of that to-do list. ■

HDL — exercising, losing weight and stopping smoking — also do their part to protect against heart attacks, which has made it hard to discern how much protection HDL actually provides on its own. The new findings, reported in August, question whether HDL delivers much benefit at all and raise the possibility that having high HDL might simply be a sign of something else that is going right in the body. ■



Ancient artists at France's Chauvet Cave superimposed drawings of two bison, creating an eight-legged beast on the run.

M. AZÉMA, J. CLOTTES, CHAUVET CAVE SCIENTIFIC TEAM

Avant-garde cave art

Paintings and animation date way back

By Bruce Bower

Someone was painting on the walls of European caves nearly 41,000 years ago, several thousand years before researchers had thought. The creators of many of those ancient drawings also used cartoonlike effects to make bison and other creatures appear as if they were moving across the walls. But who the artists were remains an open question.

Findings reported this year show that red disks, hand stencils and other drawings in several Spanish caves are of an age that Neandertals might have crafted them (*SN: 7/28/12, p. 15*).

But some researchers suspect that *Homo sapiens*, not Neandertals, were the artists. People could have started painting on cave walls as early as 45,000 years ago, either before or shortly after entering Europe. Many of the cave drawings in the study were made after Neandertals went extinct, the researchers reported, so they must have been created by people.

Many questions hinge on the paintings' ages, but Stone Age cave art has long resisted efforts at precise dating. A method used in the Spanish caves estimates minimum and maximum ages by analyzing mineral deposits.

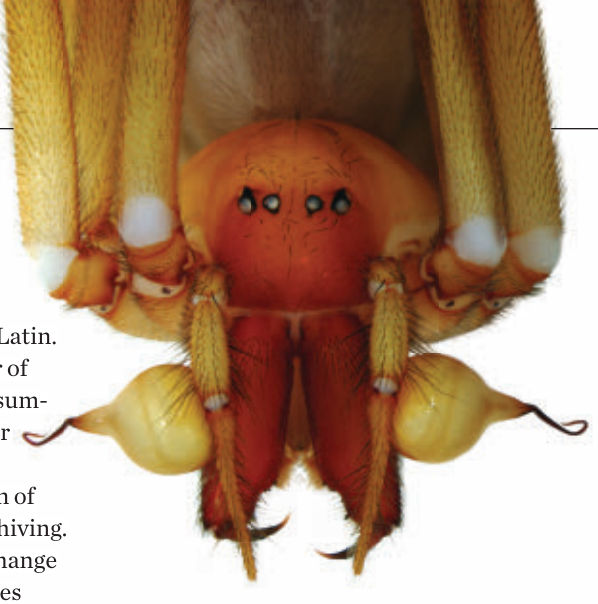
Whoever painted ancient caves, some of the artists took care to create the illusion of live-action scenes (*SN: 6/30/12, p. 12*). In France, dozens of figures superimpose two or more images of the same creature, perhaps to represent running, head tossing and tail shaking. A hunting scene in one cave shows a pride of lions, some drawn smaller than others as if farther away, lunging toward fleeing bison.

Experiments by French researchers suggest that ancient artists also engraved animals on disks that, when spun rapidly, made the creatures seem to move. ■

21 New species of the year

More creatures, less Latin used to describe them

By Susan Milius



A monkey with a blond mane and sky blue rear end was introduced to science this year. So was the first bacterium with calcium structures a bit like bones (*SN: 6/2/12, p. 14*), the world's smallest fly (*SN: 12/15/12, p. 32*), a sponge shaped like a harp, a "cave robber" spider with fold-up claws (right) and a new species of priapiumfish, which sprout long mating structures underneath males' chins. By the end of 2012, biologists will have described somewhere between 16,000 and 20,000 new species for the year.

Of all these, one of the most remarkable was the description of *Solanum umtuma*, a prickly South African shrub related to eggplant. Anyone about to argue that, say, this year's dragon millipedes trump a vegetable should read the *Solanum* paper's diagnosis section, distinguishing the new species from old ones. It's in English, marking the end of a requirement that a new plant, fungus or alga name was legitimate only if its diagnosis was in Latin.

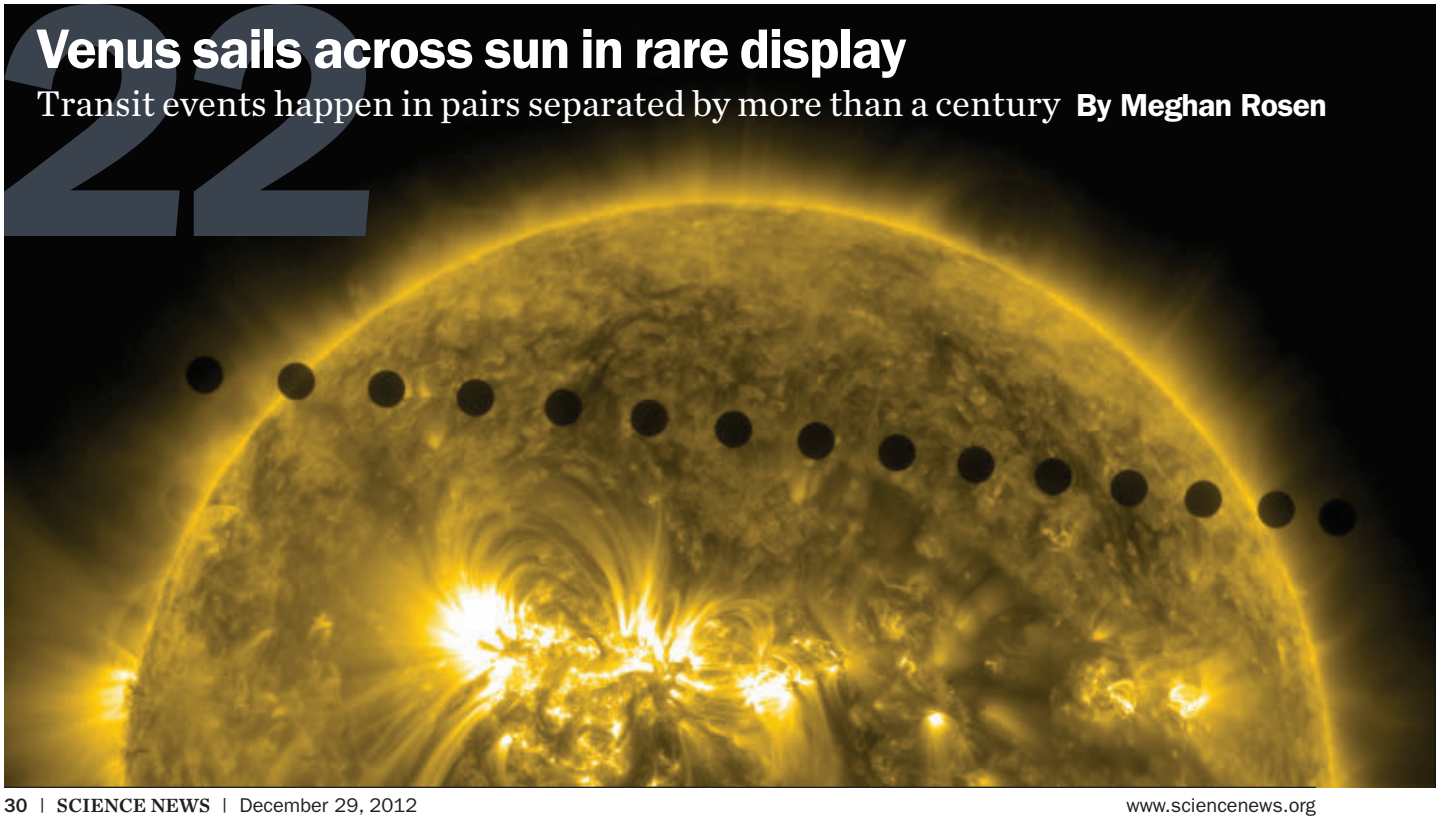
Scientific names will still be in Latin. But starting in the brave new year of 2012, botanists can publish their summaries of distinctive traits in either Latin or English. And botanists will now accept online publication of names, as long as there's deep archiving. Making paper optional is a bold change for scientists who expect the names they create to last for centuries.

Animal descriptions are going digital too, according to a September decision by the International Commission on Zoological Nomenclature. These drastic changes grow out of consternation over how slowly scientists are describing the backlog of species already found, much less those yet to be discovered. Studying anything about living organisms — their medicinal or ecosystem uses, threats they face or pose, the clues they hold to evolutionary processes — totters on the brink of nonsense without clear-cut descriptions of who's who. Meanwhile, a study in *PLOS ONE* in May showed that the rate of discovery of new local organisms has yet to slow down in Europe, even though the area has long been picked over by biologists.

Taxonomists have described about 1.9 million living species so far (not counting bacteria and archaea). But a recent estimate predicts 6.8 million more to discover. At the current pace, it will take another 400 years to name them all. If a higher estimate is right, the job could take 1,653 years, assuming species don't go extinct before scientists notice them. ■

22 Venus sails across sun in rare display

Transit events happen in pairs separated by more than a century **By Meghan Rosen**



FROM TOP: C.E. GRISWOLD *ET AL./ZOOKEYS* 2012; SDO/GSFC/NASA

Evolving *E. coli*

25-year experiment sees real-time natural selection

By Tina Hesman Saey

A simple flask of bacteria has given scientists a glimpse of evolution in action.

Escherichia coli bacteria that were part of a 25-year evolution experiment acquired a new ability at some point during the study. They can now eat a chemical called citrate in the presence of oxygen. *E. coli* lost that trait more than 13 million years ago, so when bacteria in one flask — designated Ara-3 (shown below) — started gorging on the chemical, scientists were fascinated. Because they had saved samples of multiple generations from the flask, the researchers were able to trace the genetic changes that led the microbes to redevelop citrate-eating capabilities.

The feat required several genetic changes that took place in three phases over thousands of generations, Zachary Blount and Richard Lenski of Michigan State University in East Lansing and their colleagues reported this year (*SN: 10/20/12, p. 8*).

Untangling the bacteria's genetic contortions may help scientists explain gaps in the fossil record, says Paul Rainey of Massey University in Auckland, New Zealand. Evolutionary geneticists have long claimed that altering a species' appearance or metabolism requires many incremental changes in DNA. But the fossil record doesn't contain all the intermediate forms that might be expected in such a scenario, suggesting instead that major new innovations may pop up suddenly.

The story of Ara-3 shows how both can be true. Many genetic changes — some still unknown — had to happen over several years to allow the bacteria to consume citrate, but the ability seemed to appear virtually overnight. With such laboratory evolution experiments, says Rainey, "One can really get at the inner workings of evolution." ■

Millions of eyes followed Venus' steady June voyage across the sun's surface, the coal-black dot sailing in front of a blazing golden orb (*SN: 6/30/12, p. 11*). The spectacle was the second in the recent pair of Venus transits; the first was in 2004.

At the beginning and tail end of Venus' six-hour journey in 2004 — before and after the planet was completely silhouetted by the sun — astronomers saw something they had been hoping for: Faint wisps of Venus' upper atmosphere winked clearly into view. This year's event handed scientists another opportunity to learn about Venus' gaseous clouds, like why they spin faster than the planet itself. "We got a second chance, and we tried to make the best of it," says Jay Pasachoff, director of the Hopkins Observatory at Williams College in Williamstown, Mass.

Pasachoff's team at Maui's Haleakala Observatory snapped some 660,000 images of the transit using a coronagraph, a special telescope that blocks part of the sun's brightness. In the next year, scientists will compare data from Haleakala with images from spacecraft, ground-based telescopes and several other coronagraphs positioned at different sites around the world. The Hubble Space Telescope even got in on the action, gathering light reflected off the moon's surface during the transit to test a possible technique for detecting the atmospheres of faraway Earthlike planets. Pasachoff says he feels a strong obligation to future Venus-viewing astronomers. "They'll be looking at our observations the way we looked back at observations from the 19th century."

Those data were gathered the last times Venus crossed the sun, in 1882 and 1874, when observers focused on triangulating the Earth-sun distance. The planet's next pair of transits won't occur for another 105 years, in 2117 and 2125. ■

Debunked science

Some exciting finds from years past fell by the wayside in 2012, as new studies disproved some ideas and poked major holes in others.

No arsenic life When researchers claimed two years ago to have found a bacterium that could survive on arsenic in place of phosphorus, other scientists had trouble replicating the results. New work put nails in the coffin, showing the bug is great at tolerating arsenic but, like all other life, needs phosphorus (*SN: 2/25/12, p. 10*).

Not-so-speedy neutrinos A loose cable served as an embarrassing end to an exciting tale: that neutrinos could travel faster than light, violating the theory of special relativity. Faulty wiring to a GPS unit made the trip appear shorter than it actually was (*SN: 4/7/12, p. 9*).

Chronic fatigue not from virus The 2011 retraction of a key finding linking XMRV virus to chronic fatigue syndrome took most of the life out of this proposal. This year a large study funded by the National Institutes of Health concluded that the theory is truly dead.

Supersolidity not solid Findings of "supersolidity," in which atoms in solid helium slosh around without friction, appear to have been wrong. Instead, researchers may have just observed the normal stiffening of a material (*SN Online: 10/12/12*).

Death still hard to cheat Go ahead, have a pat of butter. A study found that rhesus monkeys live no longer than normal on a very low-calorie diet. Evidence so far suggests that calorie restriction can benefit health, but effects on human longevity are still unknown (*SN: 10/6/12, p. 8*).

BRIAN BAER AND NEERJA HAJELA

24 Big drain on groundwater

Overuse of freshwater supplies poses risks

By Alexandra Witze

Everyone needs fresh water, but sometimes need trumps wise use. Humankind's thirst is draining many aquifers faster than they can be replenished, with some disastrous effects. A new global map of nations' varying "groundwater footprints" showed the world's water supplies being sucked up, much of them used to water crops (*SN: 9/8/12, p. 10*). By the study's measure, India, Pakistan and Saudi Arabia are among the thirstiest countries.

The possibility of running out of water isn't the only threat. Pumping groundwater, whether for irrigation or drinking, turns out to contribute more to global sea level rise than scientists had thought (*SN Online: 5/21/12*). Taking water out of the ground means it eventually runs off into the sea. Many scientists had assumed that the water added from aquifers would be roughly balanced by the amount impounded behind dams, but two studies conclude that that's not the case.

Finally, groundwater extraction can literally kill people. Geologists found this year that pumping aquifers shifted the stresses on faults in southeastern Spain. The scientists concluded after the fact that a magnitude 5.1 quake that killed nine people in the region in May 2011 had happened earlier than it otherwise would have because of water being drained out of the ground (*SN: 12/1/12, p. 13*). ■

25 Maya apocalypse goes boom

World doesn't end, ancient astronomy gets a boost

By Bruce Bower

If you're reading this story, the day the ancient Maya supposedly had the world scheduled to end has come and gone. Whew.

It's no shock that December 21, 2012, fizzled as the end of days. Earlier this year, anthropologists working at Maya ruins in Guatemala uncovered a written mention of the 2012 date that concerned political maneuvering way back in the day, not a prediction of Judgment Day (*SN: 8/11/12, p. 15*).

A team led by Marcello Canuto of Tulane University in New Orleans discovered and deciphered the 2012 allusion in hieroglyphs (above) carved on 22 staircase steps at an ancient Maya site called La Corona. The 1,300-year-old inscription describes two centuries of political activity.

Writing on one staircase block commemorated a visit to La Corona in 696 by the powerful ruler of a nearby Maya city. Although long thought by scholars to have been killed or captured in a 695 battle, the neighboring king — known as Jaguar Paw — apparently kept his position and dropped in on his allies in La Corona to demonstrate that he was still in charge. In the inscriptions, the beleaguered king refers to himself with a title denoting that he presided over the end of a key Maya calendar cycle in 692. Perhaps to further bolster his status, Jaguar Paw links himself to a distant date when the next calendar cycle would end — December 21, 2012.

Scientists excavating another Maya site in Guatemala found astronomical tables charting lunar and possible planetary cycles painted on the walls of a 1,200-year-old room (*SN: 6/16/12, p. 10*). This discovery provides the first direct evidence of astronomical information from ancient Maya civilization. Although the hieroglyphs and numbers aren't apocalyptic, they're certainly stellar. ■

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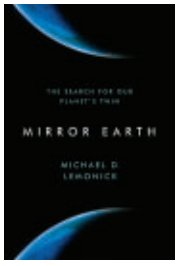
Mirror Earth: The Search for Our Planet's Twin

Michael D. Lemonick

According to one popular notion, everyone has a twin somewhere. Who knows, maybe the same is true for planets. Maybe there's even a doppelgänger Earth orbiting at just the right distance from a sunlike star to support life. In his latest book, science writer Lemonick



provides a behind-the-scenes look at the decades-long search for just such a planet. The endeavor, long considered a scientific backwater with little chance of success, is now one of the hottest fields in astronomy.

Like any nascent field of science, the search for exoplanets poses a challenge that has lured both established researchers and ambitious students. These pioneers aim to detect planets too distant to see directly, by discerning the subtle wobbles of stars being tugged back and forth by the planets, as well as slight dimmings that result when planets pass in front of their parent stars.

In a fascinating chronicle of camaraderie and competition, Lemonick profiles the prominent researchers in an astronomical discipline that is coming of age. He follows the twists and turns in their careers as well as the towering hurdles they faced and ultimately solved — including oft-denied funding requests and the equally daunting search for respect among scientific peers.

At first, researchers could discern only exceptionally large planets closely orbiting small stars. But techniques used to detect exoplanets are becoming more and more sensitive, and scientists may be getting close to discovering a mirror Earth — a find that might be revealed within months, not years, Lemonick contends. — *Sid Perkins*

Walker & Co., 2012, 294 p., $26

Lynn Margulis

Dorion Sagan, ed.

Friends and colleagues reflect on the contributions of one of the 20th century's most influential biologists.

Chelsea Green, 2012, 205 p., $27.95

Edge of the Universe

Paul Halpern

A physicist tackles what is now known about the universe and how scientists are striving to explain concepts such as dark matter, dark energy and wormholes. *Wiley, 2012, 236 p., $27.95*

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Trust no one

"Trust affects kids' patience" (*SN: 11/17/12, p. 10*) refers only to children. But based on my own experience, I'd expect it to apply to adults as well. If you tell me I can have $100 now or $200 in an hour, what I do will depend on whether or not I trust you to come through with the $200 in an hour. I'd expect this to apply to anyone who is old enough to have a concept of the future and has had experience with trustworthy and untrustworthy people.

Ted Grinthal, Berkeley Heights, N.J.

Updated writing tips

Thanks for the reprint of the 1950 "Hints for writing science" mentioned in the letter from the editor (*SN: 12/1/12, p. 2*). The list of "stories that should be handled with care" has to be updated; quite a few concepts previously thought wacky are now mainstream. Here are a few, with updates:

- *Long-range weather forecasts in general:* global warming.
- *Animals that "think" or "read minds":* *Science News* has printed many articles on animal consciousness and perception.
- *Any absolute cure of any disease:* eradication of smallpox.
- *"Marking" of children by experiences of mother before birth:* methylation.
- *Determining or controlling of sex before birth:* ultrasound and in vitro fertilization.
- *Engine-stopping rays:* electromagnetic pulses.
- *Gigantic snakes in temperate zones:* Does Miami count? They have this python problem...
- *Hybrids between unlike plants or animals:* genetically engineered chimeras.
- *Discovery of prehistoric men of gigantic or dwarfed size:* "hobbits" in Southeast Asia.

Keep up the good work; who knows how many more of ones I didn't list will become true in 2074.

Al Pergande, Orlando, Fla.

Twitter and Twain

Rachel Ehrenberg's review of the use of Twitter analysis in American politics ("Social media sway," *SN: 10/20/12, p. 22*) points out how difficult it is to correct misinformation once it has gotten out. It is remarkable how prescient Mark Twain was when he penned his witticism, "A lie can travel halfway around the world while the truth is putting on its shoes."

Robert Fiske, Long Beach, Calif.

To the new editor in chief

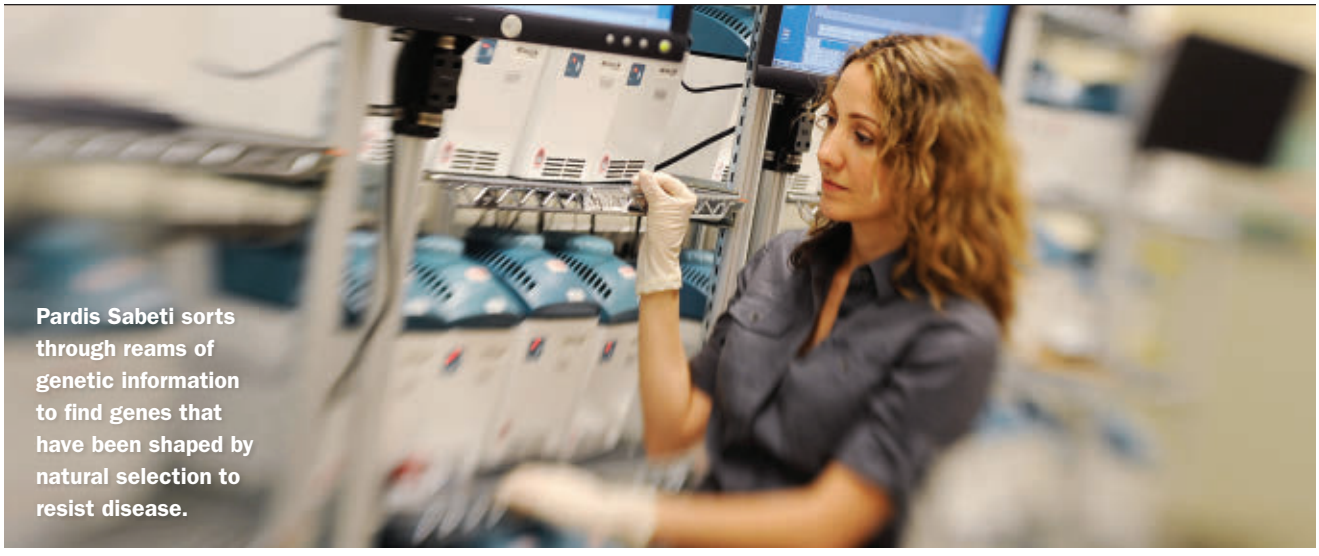
Sincerest congratulations to Eva Emerson for her promotion to editor in chief. Since Tom Siegfried's departure, she has overseen the magazine with grace and aplomb. I am sure *Science News* will be in good hands under Eva's management.

Loring Wirbel, via e-mail

Send communications to: Editor, Science News, 1719 N Street, NW, Washington, D.C. 20036 or **editors@sciencenews.org**. Letters subject to editing.

The Science Life

To watch a video of Pardis Sabeti's music, visit **www.sciencenews.org/sabeti**



Pardis Sabeti sorts through reams of genetic information to find genes that have been shaped by natural selection to resist disease.

Alt science

After a day of computer programming and poring over genetic data, Pardis Sabeti relaxes her brain by writing rock songs.

Born in Tehran, Sabeti is a computational biologist at Harvard and the Broad Institute of Harvard and MIT. She studies human evolution — past, current and future. Her cutting-edge work on the adaptations of humans and the microbes that infect them placed her among the World Economic Forum's Young Global Leaders for 2012. And when she's not in the lab, she's the lead singer of an alternative rock band in Boston called Thousand Days.

"When my brain is most active in science, I'm also most musically creative," she says. It's not that either music or science fuels the other, she explains, but rather that at times her brain enters a creative mode where both just flow.

If her publication record is any indication — Sabeti and her colleagues have already pushed out 13 scientific papers this year — her brain keeps busy by innovating.

Sabeti's team has crafted computer programs to find human genes that have been shaped by natural selection. Much of her work focuses on how humans have adapted to infectious organisms, so she looks for genes that have been altered to confer resistance to certain diseases. These kinds of genes offer a big survival advantage and tend to spread rapidly through human populations.

She has found hundreds of such genetic variants in people living in places where diseases such as tuberculosis, leprosy and malaria are common. Understanding how these genes help fend off illness may eventually benefit people who were not born with such a genetic endowment, by helping to develop new drugs or other therapies.

In her newest work, Sabeti is also investigating the possibility that some variants in genes that affect hair follicle and sweat gland development might have given certain people some sort of evolutionary edge.

Her music is no less novel. From the beginning, Sabeti and her bandmates performed original music. "We didn't do covers so no one would know how bad we were," she says of a band she and two friends started in graduate school. "If you do your own stuff, no one knows how it is supposed to sound."

Making music may sound like the more glamorous of her pursuits, but Sabeti says research also has its attractions. "For me, it really is a hunt," she says. "It's thrilling."
— *Tina Hesman Saey*

Soundtrack of a science life

Alternative rock music has played an important role in the life of computational biologist and rocker Pardis Sabeti. Here's some of the music that has moved her:

- ***Substance* by New Order** Sabeti says she first fell in love with alternative rock in the car on the way to tennis practice in seventh grade.
- ***Sixteen Stone* by Bush** The album "really got me through my senior year at college."
- **Fischerspooner** The band will forever be associated with studying for medical board exams, Sabeti says.
- ***Pretty Hate Machine* by Nine Inch Nails** When everyone else had left the lab for the evening, Sabeti cranked up Nine Inch Nails and collected the experimental data needed to finish her Ph.D.
- ***Rokstarr* by Taio Cruz and *F.A.M.E.* by Chris Brown** Sabeti says these albums and other "really good hip-hop" put her in the right frame of mind to respond to criticism in reviews of her scientific papers: "You feel good about yourself, but you're ready to fight."

FROM TOP: OLIVIER DOULIERY; CINDY QUEZADA

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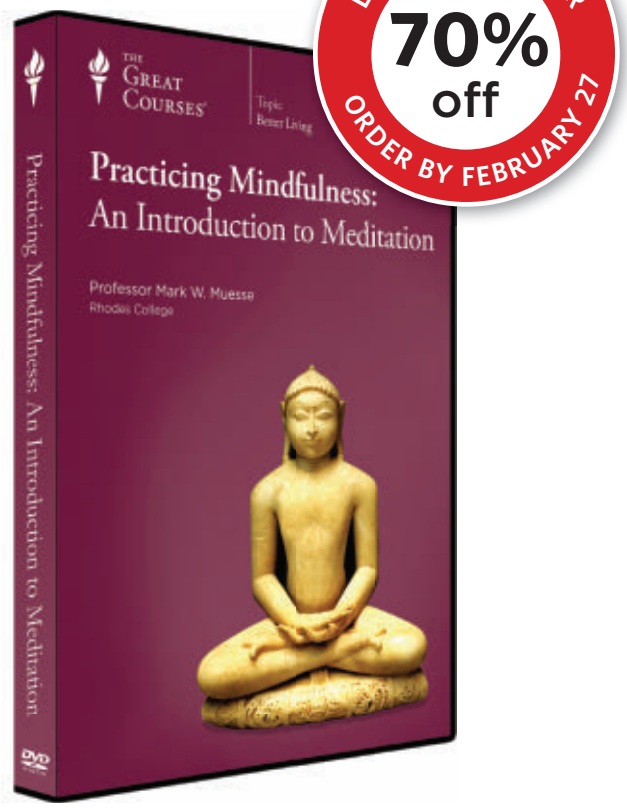

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