SN
SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC
FEBRUARY 8, 2014

Ancient Microbes Leave Their Mark

Deleting Painful Memories

Calculus at the Speed of Light

IS XINJIANG THE NEXT NAPA?

How climate change will transform the wine industry

EXCLUSIVE RELEASE

Actual size is 40 mm

Smithsonian Authorizes FIRST EVER U.S./China Panda Silver Proof!

Washington D.C.

When the first giant pandas arrived in the United States from China in 1972, their new home became the Smithsonian's National Zoo. Today, more than 40 years later, the National Zoo still houses giant pandas, an endangered species believed to number only about 1,600 in the wild. The National Zoo is part of the Smithsonian Institution,® the largest museum and research complex in the world.

Spectacular World's First

Now, to honor over four decades of Chinese giant pandas at the National Zoo, the China Mint and the Smithsonian Institution are releasing a first-ever special issue Panda Silver Proof exclusively through GovMint.com. Struck in one full ounce of 99.9% pure proof silver—the finest silver available—each Smithsonian Panda Silver Proof features the National Zoo's current panda pair: Mei Xiang and Tian Tian. The obverse of this massive 40mm silver proof depicts the Great Wall of China alongside the iconic Smithsonian Castle on the National Mall in Washington, D.C. It's a **world's first**!

New Baby Panda Makes Headlines

This summer, Mei Xiang gave birth to a new giant panda cub. Mama and baby have already captivated millions through the National Zoo giant panda webcam online. Mei Xiang and Tian Tian, the cub's father, are depicted on the Smithsonian Panda Silver Proof at rest within their National Zoo habitat.

Strictly Limited Edition

The China Mint has been issuing hugely-popular China Silver Pandas for over 30 years. In fact, over 30 million have been issued during the last three decades. But this is the ***first time ever*** that the China Mint has struck a special issue Panda Silver Proof in collaboration with the Smithsonian Institution. And the mintage is strictly limited to only 500,000 for the entire world!

These silver proofs are only available through GovMint.com. Each proof is accompanied by a serial-numbered government certificate of authenticity and the earliest orders will claim the coveted lowest serial numbers. Act quickly to secure yours now! Naturally, your satisfaction is assured with our no-hassle 30-Day Guarantee.

2014 Smithsonian Panda Silver Proof

Your cost 1–4 proofs – $59.95 each + s/h
5–9 proofs – $55.95 each + s/h (Save $20 or more)
10+ proofs – $49.95 each + s/h (Save $100 or MORE)

Call toll-free 24 hours a day

1-888-835-8675

Offer Code SMP166-01
Please mention this code when you call.

Smithsonian Institution®

GovMint.com, 14101 Southcross Dr. W, Burnsville, MN 55337

VOL. 185 | NO. 3

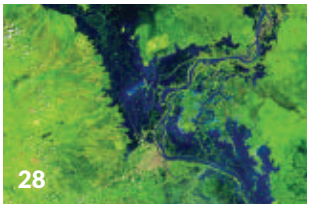
ScienceNews

16

Features

News

10



28

Departments

COVER Warming climate promises to open new wine-making frontiers in places such as China and Great Britain. *1421 Wines*

CLOCKWISE FROM TOP LEFT: PETER HENDRIE/GETTY IMAGES; LANDSAT/USGS, NASA; CYNOCLUB/ISTOCKPHOTO

Dealing with change, climate and otherwise

In December, the *New York Times* published an article about the emergence of English wineries, noting the industry's rapid growth in the last decade as well as the fact that sparkling wines from the region have recently bested French champagnes in competitions. The story ran in the business section, not the science section, but it was really about climate change. And like the article by Susan Gaidos on Page 20 of this issue, it illustrated how changing climate is already changing people's lives and livelihoods.

Warming temperatures in many grape-growing regions have actually helped winemakers in recent years. Longer growing seasons mean grapes produce more sugar, increasing the alcohol content of the wines, Gaidos reports. But the good times for traditional wine-making regions aren't scheduled to last. Simulations of different climate scenarios suggest that by midcentury some of the prime wine regions in California, France and Italy will be too hot for grapes currently grown there. Instead, as this issue's cover hints, future generations may drink wines from China, England and even Canada. Vineyards are already being planted and expanded in cooler locales once thought unsuitable for many mainstream grapes. That some in the wine industry are moving forward to deal with current and future climate shifts shouldn't be a surprise — it's a pragmatic move by players in a multibillion dollar business trying to protect profits. It offers an important lesson in embracing change, a lesson global warming is poised to teach billions of people over the next hundred years.

Technology is another major force of change today, a point highlighted in Science Visualized on Page 32. As the speed of deciphering the chemical DNA letters that make up each organism's genetic blueprint has soared, the cost of such sequencing has dropped equally swiftly. Scientists are now on the verge of an era in which they can regularly sequence individuals' genomes, a feat bound to bring profound changes to medicine and to people's understanding of themselves.

Changes of a more cosmic nature are discussed in our coverage from this year's American Astronomical Society meeting on Pages 6 and 7. Andrew Grant describes a new study pointing to supernovas as a source of the cosmic dust that seeded early star birth and reports on new work showing that gravitational lensing of supernovas might be useful for measuring the continuing expansion of the universe. It's a good reminder that change is constant, whether we are ready for it or not. — *Eva Emerson, Editor in Chief*

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
Audit Bureau of Circulation
1719 N Street NW, Washington, DC 20036
Phone (202) 785-2255
Subscriptions subs@sciencenews.org
Editorial/Letters editors@sciencenews.org
Advertising/Business snsales@sciencenews.org
Texterity Digital edition provided by Texterity, www.texterity.com

Science News (ISSN 0036-8423) is published biweekly by Society for Science & the Public, 1719 N Street NW Washington, DC 20036. Subscriptions are $54.50 for 1 year or $98 for 2 years (International rate $85.50 for 1 year or $161 for 2 years), single copies are $3.99 (plus $1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

Subscription Department: PO Box 1205, Williamsport, PA 17703-1205. For new subscriptions and customer service, call 1-800-552-4412.

Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

SANDY SCHAEFFER

gravity defyer®
ADVANCED FOOTWEAR TECHNOLOGY

G-Defy Benefits

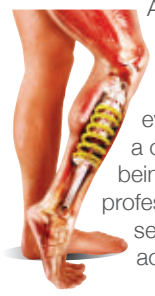
- Absorb harmful impact
- Stay comfortable & active
- Support & protect your body
- Stand & walk with greater ease

G-DEFY **NEXTA**

Scientifically ENGINEERED to DEFY GRAVITY

SHOES THAT WILL CHANGE YOUR LIFE... *GUARANTEED!*

The Ultimate Shock Absorbing Footwear



As featured in hundreds of magazines, on radio and TV nationwide, Gravity Defyer® shoes are changing lives every day. They have become a comfort phenomenon, and are being used and recommended by professionals in hospitals, the food service industry, board rooms across the country and more.

A Decade of Science in Every Pair

The patented VersoShock® system was developed by Impact Research Technology and is found exclusively in Gravity Defyer® footwear. It absorbs harmful impact relieving discomfort from every step before returning energy that propels you forward. Stay more active on your feet and experience unparalleled comfort and performance.

Feel Weightless

Standing, walking, and running are easier as the VersoShock® system's energy return makes you feel lighter, like you're walking on clouds.

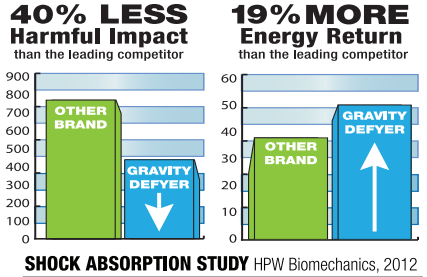
Absorbs Shock on Impact

Energy Return Propels You

"I decided to fulfill a life's dream and go to China… without my Gravity Defyer® [shoes] this would have been impossible." – Eleanor W

"After ordering and wearing your Gravity Defyer® [shoes], I have renewed faith that I will be able to continue my passion for senior softball. Thank you." – Ron B

"I work in a restaurant. Finally found the shoes that don't kill my legs and feet…Gravity Defyer® shoes are awesome!" – Diana B



SHOCK ABSORPTION STUDY HPW Biomechanics, 2012

Shock absorption: Measurement of maximum pressure (KPI).
Energy return: Measurement of energy returned (Joules).

Nexta

Men • Sizes 7-15
$129.95

A. BLUE **TB9001MBU**
B. BLACK **TB9001MBS**
C. GREY **TB9001MGB**
D. YELLOW **TB9001MYB**
E. WHT/BLK **TB9001MWBB**

Women • Sizes 5-11
$129.95

A. WHT/BLU **TB9001FSU**
B. BLACK **TB9001FBS**
C. BLK/GRN **TB9001FGG**
D. BLK/ORG **TB9001FGO**
E. WHT/BLK **TB9001FWP**
F. WHT/GRN **TB9001FGW**
G. BLUE/WHT **TB9001FWUB**

Try a pair FREE for 30 days!

PLUS

FREE SHIPPING

COUPON CODE: MM3BFT5

Call **1 (800) 429-0039**

GravityDefyer.com/MM3BFT5

Once you put on your first pair, you won't ever want to take them off! We guarantee that they will change your life, or simply return them and pay nothing.

Free Returns • Free Exchanges

*Offer valid for new customers only. Deferred billing for 30 days from the date shipped and is an option selection during checkout. Credit card authorization required. See website for details.

Excerpt from the February 15, 1964, issue of *Science News Letter*

50 YEARS AGO

Mars 'Air' Found Thinner

The atmosphere on Mars is as thin as the earthly air 15 miles above the surface, the American Meteorological Society meeting in Los Angeles was told. Martian "air" is mostly nitrogen, with a little carbon dioxide and traces of oxygen and water vapor, unlike that on earth. The Martian atmosphere has now been found to be about a third as dense as previously believed. The finding has forced scientists to revise their designs of capsules that could land on Mars.... A thinner Martian atmosphere means designing a parachute system that will operate at such a low pressure or allowing more weight for retrorockets to slow the capsule.

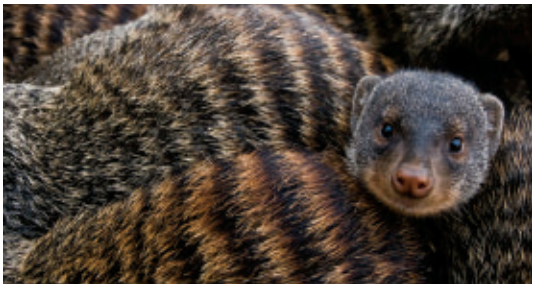
UPDATE: All the probes that have landed on Mars have used parachutes to slow in the thin atmosphere. The Soviet Mars 2 lander was first in 1971, but its parachute did not deploy and it crashed. The Mars Science Laboratory used the largest parachute ever built for extraterrestrial use — with a diameter of more than 15 meters — to land the heavy Curiosity rover in 2012.

Up close, a disco clam native to Indo-Pacific waters flashes bright lines along the top and bottom edges of its mantle.

MYSTERY SOLVED

Synchronous birth

For young banded mongoose moms, there's only one choice for when to give birth — the same day as older, dominant mothers. In communities of these cat-sized animals (below), all females give birth together, no matter when they became pregnant. It's in the subordinate mongoose's best interest to synchronize labor to give her young their best chance at survival, researchers now report. When scientists used contraceptives to manipulate mongoose pregnancy, they found that dominant females would kill any newborn mongoose they knew was not their own. By waiting to give birth on the same day as older moms, a subordinate mongoose can slip her young into the communal litter where they'll be safe, the team reports in the Jan. 7 *Proceedings of the National Academy of Sciences*. — *Sarah Zielinski*



SCIENCE STATS

Smoking equality

A study of tobacco smoking patterns reports that more men than women smoke in every country except Sweden. In some nations, the smoking disparity between the sexes is large (see far right). But smoking is on the rise among women in some countries, especially in the Middle East and Eastern Europe. The biggest increases in smoking among women from 1980 to 2012 were in Saudi Arabia, the United Arab Emirates and Tunisia.

Globally, smoking rates declined over this period, dropping from 41 percent to 31 percent in men and from nearly 11 percent to 6 percent in women. But because of population growth, the total number of daily smokers increased from 721 million to 967 million.

SOURCE: M. NG *ET AL*/*JAMA* 2014

FROM TOP: COURTESY L. DOUGHERTY; ANDY YOUNG/UNIV. OF EXETER

Watch a video of disco clams flashing at **bit.ly/SNdisco**

IT'S ALIVE

Disco clams put on a streak show

Blow a kiss. Then pinch your lips into a thin line. Now alternate kiss and pinch several times a second for a pathetic, low-wattage human attempt at mimicking a disco clam.

Scuba divers call *Ctenoides ales* the disco or electric clam because the restless, curling lips of its mantle flash bright streaks. "It's very vivid and very dramatic," says Lindsey Dougherty of the University of California, Berkeley. She has made progress discovering how the poorly understood clams create a streak show. But that only deepens the puzzle of why.

Dougherty helped bust the myth that the clams bioluminesce, an idea so reasonable and persistent that she makes sure to say it's wrong at least twice in each scientific presentation. The clams don't make light themselves, but unfurl a supremely reflective strip along the lips of the mantle. Reflected light winks off the strip, then the lip rolls up like a window shade, going dark for an instant before unfurling again.

Flashing clams are often found in multiples, like these two fastened in the same crevice.

Since it's reflected light, Dougherty wonders why the clams end up in dimly lit spots. They range as deep as 50 meters and favor crevices within caves. "Holes within holes," she says. And just as puzzling, the clams keep moving their lips at night when there's virtually no light to reflect.

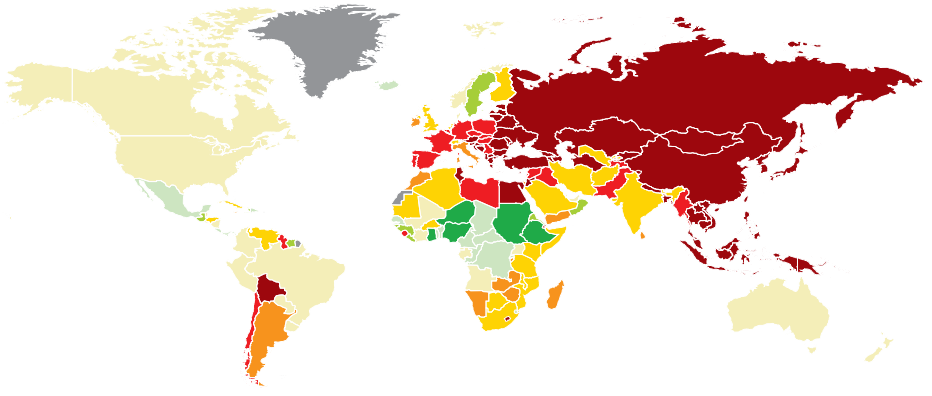
About half the clam crannies that Dougherty visited last summer housed more than one clam, so she wonders whether it's possible that free-floating youngsters are drawn to the flashing beacons of adults. Adult clams have eyes (she has counted up to 40) but scientists haven't seen the youngsters, much less figured out if they can see.

Tiny water creatures that clams eat might also be attracted to the flashing display, Dougherty speculates. "It reminds me of one of those 'Eat Here' signs," she says. If this is molluscan deception, then the disco clam may also be the all-night-diner clam.

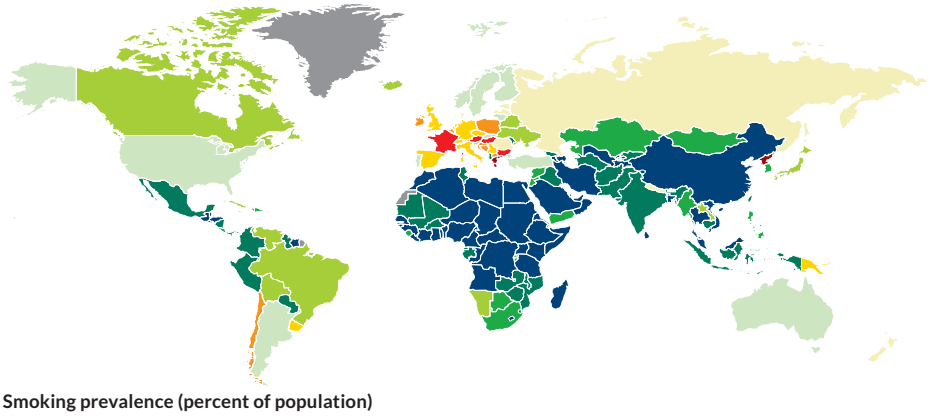
—Susan Milius

FROM TOP: COURTESY L. DOUGHERTY; REDMAL/ISTOCKPHOTO. ADAPTED BY S. EGTS

Smoking prevalence in 2012, men



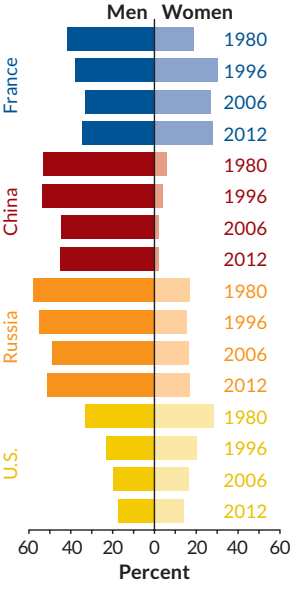
Smoking prevalence in 2012, women



Smoking prevalence (percent of population)

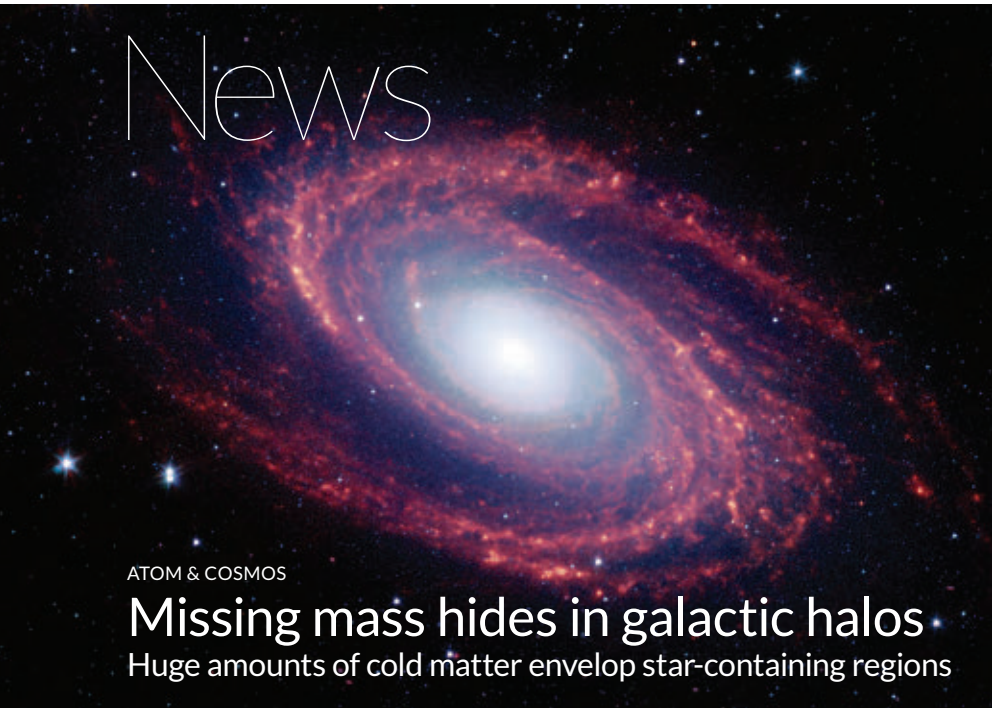
0.5 to <2.6 | 2.6 to <5.6 | 5.6 to <9.8 | 9.8 to <13.3 | 13.3 to <16.5 | 16.5 to <19.7 | 19.7 to <23.4 | 23.4 to <27.5 | 27.5 to <34.7 | 34.7 to <61.1 | No data

Changes in smoking rates by gender



5.7 million

Estimated global deaths from smoking in 2010



Galaxies like Messier 81, a spiral galaxy in the constellation Ursa Major, are surrounded by large quantities of cold, nonluminous gas, a new study finds.

ATOM & COSMOS

Missing mass hides in galactic halos

Huge amounts of cold matter envelop star-containing regions

BY GABRIEL POPKIN

Vast reservoirs of previously undetected gas account for much of galaxies' mass, according to research presented January 7. The finding could explain why earlier studies found far less mass in galaxies than cosmologists' theories had predicted.

For more than a decade, astronomers have wondered about galaxies' missing mass. Baryonic matter — the ordinary, visible stuff of the universe including the protons, neutrons and electrons that make up stars and planets — should account for about 17 percent of a galaxy's matter; the rest is invisible dark matter. But astronomers can find only a third of the baryonic matter that they think galaxies should have in stars and in the 1 million degree Celsius and hotter gas that surrounds galaxies in giant halos.

Recent studies have revealed that galactic halos also contain colder gas with temperatures around 10,000°. Telescopes cannot detect this gas directly because it is diffuse and emits little light. But a few halos are backlit by extremely bright, distant galactic nuclei called quasars that shine with a nearly uniform spectrum of light. When quasar light passes through a gas, the gas's atoms and ions absorb certain wavelengths depending on the amount, temperature and makeup of the gas.

To weigh the cold gas in galactic halos, a team led by Jessica Werk, an astrophysicist at the University of California, Santa Cruz, studied light from 38 quasars using the Hubble Space Telescope. By looking at the spectral fingerprints

ATOM & COSMOS

Galaxy spotlights far-off supernova

Detection method could help measure universe's expansion

BY ANDREW GRANT

An immense cosmic magnifying glass has given astronomers an unprecedented view of a distant exploding star. The discovery demonstrates that scientists can spot supernovas that are seemingly too far away to be detected.

The supernova PS1-10afx, located more than 9 billion light-years away, first appeared in 2010 images from the Pan-STARRS1 sky survey. It shined about 30 times as brightly as a typical supernova at that distance. Last April, a team including astronomer Robert Kirshner from the Harvard-Smithsonian Center for Astrophysics published a study that classified PS1-10afx as a new type of ultrabright supernova.

But Robert Quimby, an astronomer at the Kavli Institute for the Physics and Mathematics of the Universe near Tokyo, was skeptical. He found that nearly every measurable characteristic of the supernova — including its color, temperature and duration of peak brightness — matched the profile of the most commonly found supernova, called type 1a. The only thing that set PS1-10afx apart was its extreme brightness.

Quimby wondered if something had made the supernova appear brighter than it actually was. He knew that the intense gravity of galaxies and other massive objects causes light to bend around them. If such a galaxy is positioned directly between a distant object and Earth, this light-bending effect can make the faraway object appear much brighter, analogous to the way a magnifying glass bends light to enlarge a faint object. This effect is called gravitational lensing.

To test his hypothesis, Quimby used Hawaii's Keck I telescope to take a closer look at the region where PS1-10afx once shined. The telescope detected a large reservoir of gas about 8.5 billion light-years away. The gas suggested the presence of a galaxy lying between PS1-10afx and Earth that probably served as a gravitational lens. Quimby shared his findings January 8.

Kirshner said the results are convincing but not definitive. He wants to see more-detailed observations that demonstrate that the galaxy is massive enough and lined up properly to act as a lens.

Still, Kirshner is excited about the

JPL-CALTECH/NASA , S. WILLNER/HARVARD-SMITHSONIAN CFA

in this light, the team found that galactic halos harbor far larger quantities of cold carbon, silicon and magnesium ions than researchers previously thought. Hydrogen ions do not show up in quasar fingerprints. But after analyzing her ion measurements, Werk estimated that cold hydrogen ions are also plentiful in galactic halos.

Adding up the gases, Werk found that at least 10 times, and possibly up to 100 times, as much cold gas surrounds galaxies as researchers had previously estimated. If her calculation is correct, it would account for the two-thirds of galaxies' baryonic matter that astronomers have been looking for, Werk said. "We were surprised by how much" cold gas there is.

Chris Churchill, an astronomer at New Mexico State University in Las Cruces, would like to understand better how Werk and her team distinguished between hot and cold hydrogen gas. "If she could convince me she's done that correctly," he said, "I would be highly convinced" that much of galaxies' missing matter is hiding in cold gas.

Still, Churchill added, "I think she's probably right." ■

potential significance of Quimby's work. Astronomers already use gravitational lenses to identify objects that would otherwise be too far or too faint to detect; a new Hubble Space Telescope survey is using the technique to find galaxies that formed a mere several hundred million years after the Big Bang. The opportunity to also spot distant supernovas with this technique is enticing, Kirshner said.

Quimby said that finding other distant stellar explosions could help astronomers measure the expanding universe. Type 1a supernovas shine with almost exactly the same brightness, allowing astronomers to pin a precise distance to each one. But a gravitationally lensed supernova's light will travel slightly different distances depending on the path it takes as it bends around the lensing galaxy and thus will get stretched different amounts by the universe's expansion. ■

ATOM & COSMOS

Supernova is a giant dust factory

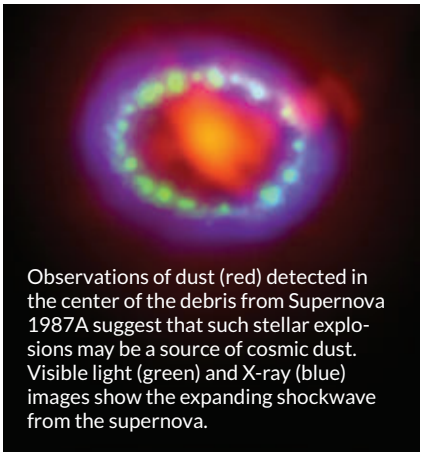
Grains spewed by explosion offer clues to star formation

BY ANDREW GRANT

The remnant of a recent supernova contains nearly a star's mass of dust. The dust's presence provides strong evidence that similar explosions distributed dust that seeded bursts of star formation billions of years ago.

For astronomers, dust is a bit different from the stuff on your dresser. Space dust forms when searing-hot atoms of carbon, oxygen and silicon cool and clump together into solid grains as large as a thousandth of a centimeter across. These grains permeate the cosmos, serving as springboards for star formation and as surfaces on which other atoms combine into complex molecules, including the building blocks of life (*SN: 1/30/10, p. 26*).

Lots of cosmic dust forms in the outer layers of old, bloated stars. Astronomers have strongly suspected that dust also forms after supernovas, the violent explosions of giant stars that send atoms hurtling through space at thousands of kilometers a second. In just a few years, dense clumps of material can cool from more than 700° Celsius to below –200°. But previous telescope surveys looking for a faint glow of cosmic dust grains in the aftermath of a supernova came up empty.



Observations of dust (red) detected in the center of the debris from Supernova 1987A suggest that such stellar explosions may be a source of cosmic dust. Visible light (green) and X-ray (blue) images show the expanding shockwave from the supernova.

ALMA (ESO, NAOJ, NRAO/AUI AND NSF), A. ANGELICH; VISIBLE LIGHT IMAGE: HUBBLE SPACE TELESCOPE/NASA AND ESA; X-RAY IMAGE: NASA CHANDRA X-RAY OBSERVATORY

Astronomer Rémy Indebetouw of the University of Virginia in Charlottesville and colleagues took another stab using a new high-resolution telescope network called the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. They pointed the telescopes at the remnant of a supernova about 168,000 light-years away in the constellation Dorado, whose light first arrived at Earth in 1987. Within the rapidly expanding shockwave from that explosion, the researchers detected the distinct spectral signature of dust-emitted radiation.

The supernova remnant's grains collectively weigh in at about a quarter of the sun's mass, Indebetouw reported January 6. "We found all this dust that had to have been made there," he said.

This first definitive evidence of supernova-produced dust provides a clue to the makeup of the infant universe. Telescopes peering back in time to less than a billion years after the Big Bang have spotted individual galaxies with dust that weighs hundreds of millions of times as much as the sun. Supernovas seemed the logical candidate for supplying all that dust, but the unsuccessful telescope searches had thrown the idea into doubt.

"We had wondered why we didn't see the dust," said Devin Silvia, an astrophysicist at Michigan State University in East Lansing. "That's what makes this such a huge deal."

Astronomers can't officially call the mystery solved. Portions of the shockwave from the explosion have rebounded inward. When the shockwave reaches the newly created dust, much of it may vaporize. If that occurs, then it would suggest that supernovas in general may not be able to distribute the dust they create into their surroundings.

Silvia is optimistic, noting that most of the dust is in the form of large, robust grains. It will take more than 100 years for astronomers to determine the fate of the 1987 supernova's dust, Indebetouw said. But Silvia added that ALMA may be able to probe older supernovas for comparison. ■

GENES & CELLS

Marine microbes shed packets of DNA, nutrients

Bacterial vesicles may offer genetic exchange opportunities, affect carbon cycle

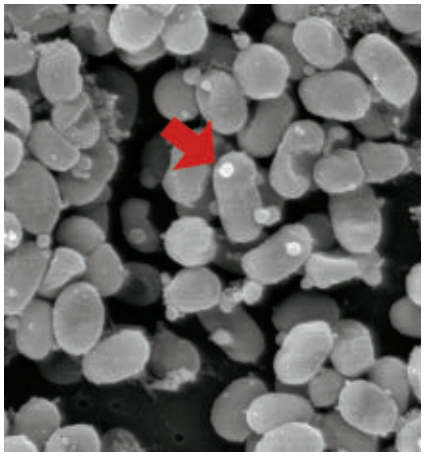
BY TINA HESMAN SAEY

Superabundant bacteria in the ocean routinely sacrifice parts of themselves, scientists have discovered. This sacrifice, in which bacteria pinch off minuscule spheres called vesicles, may influence climate change by affecting how much carbon dioxide the oceans can absorb.

Photosynthetic bacteria in the genus *Prochlorococcus* shed two to five vesicles a day, researchers led by biological oceanographer Sallie Chisholm of MIT report in the Jan. 10 *Science*. Each vesicle is a membrane-wrapped bubble up to about one-sixth the diameter of the bacteria and is packed with lipids, proteins, RNA and DNA. Together, the hordes of bacteria may cast off 10,000 to 100,000 metric tons of organic carbon daily in these parcels, Chisholm's team calculates.

Prochlorococcus, which Chisholm and her colleagues first described in 1988, is the world's most abundant marine microorganism, with an estimated global population of an octillion, or 10^{27}. It and other marine phytoplankton carry out about half of the world's photosynthesis.

At just 600 nanometers across, *Prochlorococcus* cells look like specks under a light microscope, Chisholm says. But in electron micrographs, she and her colleagues noticed "these pimples — we call them 'blebs' — on the surface." MIT microbiologist Steven Biller recognized them as vesicles. The researchers then found vesicles in water samples drawn from Vineyard Sound in Massachusetts and from the Sargasso Sea near Bermuda.



Photosynthetic bacteria called *Prochlorococcus* pinch off bits of themselves to make sacs called vesicles (one indicated by arrow). The vesicles, each about 70 to 100 nanometers across, may affect carbon levels in the oceans.

S. BILLER/CHISHOLM LAB

Prochlorococcus lives in the most nutrient-impoverished parts of the ocean, says David Scanlan, a marine microbiologist at the University of Warwick in Coventry, England. The bacteria have to convert carbon dioxide and sunlight into biologically useful carbon; they also scavenge for important nutrients such as phosphorus and nitrogen.

> *Prochlorococcus* and other marine phytoplankton carry out about half of the world's photosynthesis.

So why would organisms that work so hard to build and scavenge nutrients dump their hard-won resources? The researchers propose several possibilities that may also help explain how carbon moves through the atmosphere and the ocean.

Most exciting to marine microbiologist Julie Huber of the Marine Biological Laboratory in Woods Hole, Mass., is that ocean bacteria might use vesicles to trade DNA. "It's a new way of thinking about genetic exchange," she says.

Prochlorococcus may constantly send out packets of genetic information that other organisms could take up and incorporate into their genomes. Such trading may blur lines between species, Huber says.

The researchers also discovered vesicles carrying DNA from other microbes. In its samples, the team found DNA from a total of 33 phyla from all three domains of life, although bacterial DNA was the most abundant. The finding suggests that lots of marine microbes ship off genetic messages in the tiny bottles.

Another hypothesis is that *Prochlorococcus* may scatter vesicles to distract bacteria-killing viruses known as bacteriophage. The researchers found that bacteriophage can latch onto and inject genetic material into vesicles. If the vesicles are distracters, they could allow the bacteria to thrive and convert carbon dioxide, a greenhouse gas, from the atmosphere into organic carbon. That carbon would eventually drift down to the bottom of the ocean, where it could remain for hundreds to thousands of years — or perhaps even longer, says Suzanne DeLorenzo, a biological oceanographer and microbial ecologist at the Oregon Health & Science University in Portland.

Or *Prochlorococcus* may feed vesicles to other types of bacteria that it needs to flourish. *Prochlorococcus* cannot break down hydrogen peroxide and other molecules that may damage or kill it, so it must rely on other microorganisms to detoxify the chemicals. If such microbes don't do photosynthesis, *Prochlorococcus* could provide them with nutrients in return, the scientists propose. Two types of nonphotosynthetic bacteria could grow in seawater when the researchers fed them with *Prochlorococcus* vesicles as their only source of carbon.

If vesicles are a food source for other microbes, that may help carbon get consumed by larger organisms and eventually get metabolized back to carbon dioxide. Whether they function as a food source or a defense mechanism, the vesicles could affect the concentration of carbon dioxide in the atmosphere, and in turn, the world's climate.

Vesicles may perform all of these functions and perhaps more, Biller says: "They may be the Swiss army knife of the cell." ■

LIFE & EVOLUTION

V-flying birds pick efficient flapping pattern

Timing is everything to catch boosts from neighbors' wings

BY SUSAN MILIUS

A bird migrating with others in a V formation turns out to be a master of the well-timed flap, able to match the up-and-down path traced by the wing tip of the bird in front of it.

Fighter pilots know the benefits of flying in a V formation. Wings create vortices of whooshing air that trail from their tips. A rearward plane that keeps one of its wing tips in a vortex from the plane in front gets a boost from the upwash of air and can save fuel. But birds flap their wings, so the vortices spinning off their rising and falling wing tips swoop up and down. For a bird to catch the benefit of another's wing trail, flap timing has to be right.

Sensitive monitoring devices show that northern bald ibises coordinate their wing beats in ways that scientists predict would be efficient, says Steven Portugal of the University of London's Royal Veterinary College in Hatfield. When flying in a V formation, a bird tends to flap so that one of its wing tips follows the route taken by the nearest wing tip of the bird in front.

The wings don't necessarily rise and fall at exactly the same time. But the follower's wing tip chases the leader's along the same path and thus catches the vortex's helpful uprush of air.

In contrast, when a bird flies directly behind another, the follower tends to flap out of phase with the leader, so its wing tip is down where the leader's was up. This disconnect helps the follower dodge the substantial downwash of air directly to the rear of a flying bird, Portugal and his colleagues report in the Jan. 16 *Nature*.

Big birds such as ibises, geese and cranes often fly in a V formation. But scientists' predictions about the efficiency of that formation depend largely on experience with nonflapping wings.

To see whether flapping birds coordinate their wing beats carefully enough to hit the sweet spots in V formations, Portugal and his colleagues worked with Zoo Vienna's project training captive-bred *Geronticus eremita* ibises to migrate from Austria to Italy. The effort to help the critically endangered birds migrate depended on imprinting the newly hatched chicks to treat human volunteers as their parents.

When migration time came, a human parent rode in the back of a microlight aircraft shouting for the youngsters to follow. Researchers attached tiny backpacks to the birds that contained equipment noting the location of a bird and its flapping phase. The researchers then recovered the equipment after a stint of real-world flying.

Northern bald ibises from a captive breeding program offered flight researchers an up-close chance to test the birds' flapping strategies during migration.

The study builds on other researchers' work to develop ways to test how birds coordinate their flaps to get a boost from V-flying. "We still don't know if this actually saves any energy, but the new data are certainly consistent with the theoretical predictions," says comparative physiologist Michael Dickinson of the University of Washington in Seattle.

"My strong suspicion is that the effect does not scale well," adds Dickinson, who focuses on flight in much smaller fliers: insects. Even among small birds, he speculates, the wake left by flying may not be very useful. And taking advantage of a flight formation among fast-flapping little birds, he says, "would require superfast reflexes." ■

MARKUS UNSÖLD

Watch a video of migrating ibises at **bit.ly/SNibis**

Dog paddling is more like an underwater run than a trot, scientists determined in a novel study of the motions of nature's less-efficient swimmers.

LIFE & EVOLUTION

Dog-paddle science debunks notion of underwater trot

From Newfoundlands to Yorkshire terriers, canines swim with similar, distinctive gait

BY SUSAN MILIUS

AUSTIN, TEXAS — A preliminary analysis of dog paddling has already sunk the old idea that swimming dogs just trot in water.

In a trot, a front paw (or hoof or foot) rises and falls in sync with the hind paw on the opposite side, explained Frank Fish of West Chester University in Pennsylvania. Although dog paddling had never been analyzed, he said, even he on occasion had described it as trotting in water.

Underwater videos of the churning paws of six breeds of dog, however, revealed motions more like other kinds of running than an exact trot, Fish reported January 5 at the annual meeting of the Society for Integrative and Comparative Biology.

Diagonally opposite paws didn't stroke with trotlike synchrony, he and a colleague found. Instead, the four legs perform strokes in a pattern that's more complex. The gait is also remarkably consistent across breeds, from galumphing Newfoundlands to a small Jack Russell terrier.

Studying terrestrial mammals' inefficient swimming offers a way to reach back in evolutionary history to understand the pressures that might have driven four-legged land animals struggling in water to streamline into today's marine mammals. "Dogs are beautiful for this," Fish said.

For the study, eight dogs, including a German shepherd, a Labrador retriever and Fish's own Nova Scotia duck tolling retriever, paddled back and forth in a swimming pool or veterinary water-therapy tanks. Meanwhile, Fish, submerged in scuba gear, filmed their legs. The Yorkshire terrier recruited for the study was small enough to paddle in a long aquarium in Fish's lab.

A dog paddle is inefficient, but the gait has its nuances. Dogs extend their legs during the power stroke of sweeping down and back. As they bring that leg forward again, Fish found, they reduce drag in the water by slowing the leg's motion and by tucking it close to the body.

Dogs may not be elegant swimmers, but some legged animals manage quite well without fins, said aquatic chemical ecologist Jeannette Yen of Georgia Tech in Atlanta. Tiny krill, crustaceans that are widespread in the world's oceans, swim marathon migrations with five pairs of legs beautifully coordinated, Yen said. ■

BODY & BRAIN

Bad memories fade with a short jolt

Research illustrates vulnerability of brain's information storage

BY LAURA SANDERS

An electric shock to the brain can muddle a nasty memory. Precisely timed electroconvulsive therapy, a last-ditch treatment for severe depression, interferes with a person's ability to remember a recently learned story, scientists report December 22 in *Nature Neuroscience*.

The ECT results are the latest to highlight that memories are fluid, making them susceptible to manipulation and even to destruction. Scientists hope to ease the burden of diseases such as anxiety and post-traumatic stress disorder by selectively targeting traumatic memories with behavioral therapy, drugs, ECT and milder forms of brain stimulation.

"We are starting to understand the process to some extent," says study coauthor Marijn Kroes of Radboud University Nijmegen in the Netherlands. But, he cautions, "we are a very long way away from treating patients."

Scientists and patients know that ECT is bad for memory in general, but the results show that the therapy, when carefully timed, can knock down specific memories, Kroes says.

He and his colleagues studied 42 people with depression who were receiving ECT, a treatment that briefly jolts the brain with a powerful electric current. Participants saw two series of pictures as they heard a narrator describe two disturbing stories. In the first, a car hits a young boy and severs both of his feet. In the second, an escaped convict

CYNOCLUB/ISTOCKPHOTO

Watch a video of a dog's swimming strokes at **bit.ly/SNdogpaddle**

GENES & CELLS

Celebrity heir of early flowers is a major gene thief

Rare *Amborella* shrub has captured complete genomes from several other species

BY SUSAN MILIUS

A shrub from the most ancient group of flowering plants alive today steals and hoards genes from other species on a staggering scale.

Botanists have been building a case for more than a decade that *Amborella trichopoda* is the only known survivor of a plant lineage that branches off at the very base of the genealogical tree of living flowering plants. Now researchers describe the plant's genes in detail.

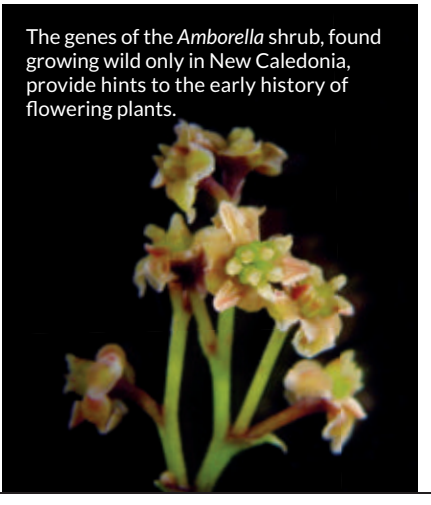
It turns out that this oddity has captured not just pieces but whole loops of DNA from three kinds of green algae and a moss, says Jeffrey Palmer of Indiana University Bloomington. These pilfered genes aren't in *Amborella*'s cell nucleus but in the mitochondria, little powerhouses of the cell that contain their own circular genomes.

The genes that *Amborella* swallowed now outnumber its original mitochondrial ones 6-to-1, Palmer says. Yet so far, tests suggest that little of the hoarded DNA still works, he and his colleagues report in the Dec. 20 *Science*. "It's an anal-retentive genome," as Palmer puts it.

Researchers already knew that plants and other organisms, especially bacteria, kidnap bits of DNA now and then.

For *Amborella*, "what is amazing about this case is the sheer scale of the transfer and the [evolutionary] distance between the species," says Ralph Bock of the Max Planck Institute of Molecular Plant Physiology in Potsdam-Golm, Germany.

Amborella's incorporation of whole genomes suggests a fusion scenario by which mitochondria may manage their heists, Palmer says. Old textbook stereotypes of mitochondria as tidy, self-contained capsules have faded away as modern imaging techniques show them routinely fusing into tubes and branches.



The genes of the *Amborella* shrub, found growing wild only in New Caledonia, provide hints to the early history of flowering plants.

Since the plant's mitochondria can fuse with each other, he reasons, they might also fuse with the mitochondria in algae and moss draping a shrub's branches.

The new work also shows how uneven the results of gene stealing can be. Genes in *Amborella*'s nucleus don't contain such a rich trove of stolen goods. That discrepancy makes it tricky to judge the role of thievery in evolution, says Patrick Keeling, an evolutionary biologist at the University of British Columbia in Vancouver.

A second paper in the same issue of *Science* describes *Amborella*'s nuclear genes, thanks to work by more than 75 researchers. The plant contains repeated genes, which indicates that ancestral flowering plants must have duplicated their whole genomes early in their history, says Douglas Soltis of the University of Florida in Gainesville, one of the project's 14 research leaders.

This doubling may help explain how flowering plants "came to rule the terrestrial landscape," he says. Further genome multiplication is common in the later history of plants as a way that new species form, adds Pamela Soltis of the Florida Museum of Natural History, who is another leader of the work. Multiple genomes can help organisms take advantage of new opportunities: With extra copies around, some genes keep doing their old job while others are repurposed for some brave new world. ■

attacks a woman in an alley.

A week after they encountered these stories, the participants saw a picture from one of the stories and were asked about it. That exercise triggered a process called reconsolidation that is thought to make a memory wobbly as the brain dredges up the information and stores it again. Immediately after recalling the story, the patients were anesthetized and treated with ECT. A day later, participants took multiple-choice tests about the stories.

People performed no better than chance at remembering the details of the story that had been recalled just before ECT, the researchers found. But participants were better at remembering the story that hadn't been recalled just before ECT.

Testing patients soon after ECT instead of waiting a day didn't reveal a memory deficit. That observation shows that it takes time to weaken a memory.

The results "are very elegant," says Daniela Schiller of the Mount Sinai School of Medicine in New York City. But many questions remain, she says. It's unclear whether ECT could interfere with memories created in a person's daily life and not in a lab.

"There is some evidence that older memories and stronger memories are sometimes resistant" to tampering, Schiller says. It's also unclear whether the anesthesia plays a role in the memory loss, or how long the effects would last, she says.

While ECT works well for people suffering from severe depression, it may be too extreme to become a widely used treatment to ease traumatic memories. But for people who are already undergoing ECT for depression, the results suggest a way to preserve memories, Kroes says: If a person could avoid thinking about something right before ECT, that memory might be better protected. ■

SANGTAE KIM

MATH & TECHNOLOGY

Materials' light tricks may soon extend to doing mathematics

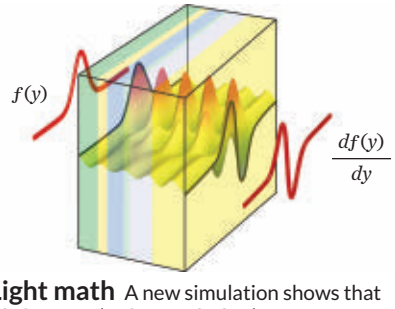
Metamaterials could provide fast pattern recognition

BY GABRIEL POPKIN

Tiny structures that use light waves to perform ultrafast complex mathematical operations could be built from available materials, a new computer simulation suggests.

The study could soon lead to new human-made materials that manipulate light in surprising ways. In previous experiments, scientists have used these metamaterials to create invisibility cloaks that bend light waves around objects (*SN: 8/27/11, p. 16*). Electrical engineer Nader Engheta of the University of Pennsylvania in Philadelphia took metamaterials in a new direction in 2012, when he and colleagues made circuit elements that process light waves the way resistors and capacitors process electric currents. Such elements could be far smaller and faster than current electrical circuit parts.

In the new study, Engheta and colleagues designed materials to use light to do more sophisticated calculations, mathematical operations familiar to anyone who has studied calculus. The researchers' goal was to design a structure that would predictably transform an incoming light wave's shape. In one such computation, the exiting wave would have the shape of the incoming wave's slope, also known as its derivative.



Light math A new simulation shows that a light wave (red squiggle, left) entering into a specially designed structure (cube) can be transformed into the original light wave's derivative (right), a common computation in calculus.

To show how to perform this mathematical wizardry, the researchers built a computer simulation of a structure of alternating blocks, each a few micrometers thick. The blocks were made of pure silicon or of zinc oxide spiked with aluminum.

The scientists chose the materials because of how they interact with infrared light. In their simulations, the researchers varied the widths of the blocks and stacked layers of the structures with different amounts of space between them. They then studied how an infrared light wave changed as it interacted with the materials. The scientists report in the Jan. 10 *Science* that they could precisely control the shape of the outgoing wave.

Structures like those that the team simulated could be used to recognize patterns in images hundreds or even thousands of times faster than the current state-of-the-art technology, Engheta says. In their simulation, the researchers demonstrate this potential by sending through their material a light wave with the shape of the Austin, Texas, skyline. The output is a light wave with sharp spikes where the buildings' edges appear in the original image.

The new study is "a very appealing demonstration of using metamaterials in analog computation," says Massimiliano Di Ventra, a physicist at the University of California, San Diego. A typical computer, which performs digital calculations, would encode a wave as 0s and 1s before doing an operation. Engheta's approach could do the computation much faster by skipping that step. But Di Ventra adds that such technology will complement rather than replace digital logic.

Engheta says that within the next six months, his team will start to build the structures in the simulations. ■

A. SILVA/UNIV. OF PENNSYLVANIA

BODY & BRAIN

Hormone hinders effects of pot

Rodent study could lead to cannabis addiction treatments

BY LAURA SANDERS

A nondescript hormone that moonlights as a potent marijuana blocker in the brain may lead to drugs that help people curb cannabis dependence. The hormone pregnenolone blunts marijuana's effects in rats and mice, scientists report in the Jan. 3 *Science*.

The results are "incredibly exciting, both at a scientific level and at the level of public health," says Margaret Haney of Columbia University Medical Center. Recent laws that legalize marijuana will expand the already popular drug's reach,

Watch a video of caterpillar breath scaring off a spider at **bit.ly/SNhornworm**

LIFE & EVOLUTION

Smoker's breath saves caterpillars

Tobacco-nibbling larvae exhale nicotine at spiders

BY SUSAN MILIUS

Eating wild tobacco plants produces such noxious breath in hornworm caterpillars that predators reel backward and flee upon encountering it.

"I think it's actually the first example of using bad breath as a defense, although I'm sure that everybody has had a personal encounter of something similar," says Ian Baldwin of the Max Planck Institute for Chemical Ecology in Jena, Germany.

As a plant defense, nicotine works by poisoning a variety of creatures. But the plump, striped tobacco hornworm caterpillar (*Manduca sexta*) can repurpose the poison to generate "toxic halitosis," Baldwin says.

Tobacco hornworm caterpillars use some of the nicotine in their food to produce a smoker's breath strong enough to drive away predatory wolf spiders.

When a hornworm feeds on a wild tobacco plant, a touch of the nicotine diverts from the gut into the insect equivalent of a bloodstream and from there wafts out through small respiratory openings along the body. Baldwin and his colleagues identified a gene involved in diverting 0.65 percent of ingested nicotine to create smoker's breath strong enough to fend off attacking wolf spiders, the researchers report December 30 in the *Proceedings of the National Academy of Sciences*.

When they touch the caterpillars, the spiders jump away, Baldwin says. Yet the night-prowling wolf spider *Camptocosa parallela* readily eats hornworms that nibble plants lacking nicotine.

Defense by tobacco takes its toll, though. Nicotine stunts caterpillar growth a bit, Baldwin says. And unlike a cigarette for a human smoker, nicotine turns hornworms sluggish.

Caterpillar smoker's breath is a new insight into an insect that chemical ecologists have been studying for so long that it should be "depressingly familiar," says entomologist May Berenbaum of the University of Illinois at Urbana-Champaign. And the finding "would never have been uncovered in just the lab environment."

Baldwin and his colleagues discovered the hornworms' chemical defenses by putting lab-engineered plants out into natural environments. Such experiments aren't welcome in Germany, so the researchers plant their coyote tobacco (*Nicotiana attentuata*) at a research station in Utah.

On nicotine-free versions of coyote tobacco in Utah, hornworms disappeared in unusual numbers at night. Researchers eventually fingered predatory wolf spiders.

In a series of experiments, researchers shut down a gene, *CYP6B46*, that is normally active in the guts of caterpillars eating the nicotine-producing plants. As the researchers dialed back midgut activity of *CYP6B46*, diversion of nicotine into the "bloodstream" and production of smoker's breath dwindled.

Researchers don't know just how the gut gene might cause diversion, or what's happening to all of the nicotine. Some 45 to 60 percent gets excreted, but researchers don't see signs of the detoxified forms of nicotine that human smokers produce. So that leaves a chunk of caterpillar nicotine still unaccounted for. ■

---

leading to more people who struggle with cannabis addiction, she says. "We have no options to help the substantial number of people who are seeking treatment for that disorder," Haney says. "This looks like a very exciting potential tool for that."

Pregnenolone was thought to be an inert building block for other flashier hormones, such as testosterone, progesterone and estrogen, says study coauthor Pier Vincenzo Piazza of INSERM, the National Institute of Health and Medical Research in France. Instead, the hormone has the unexpected ability to curb marijuana's effects in the brain. "It was really a big surprise," Piazza says.

Pregnenolone is normally present in the rodent brain. But in response to a big dose of THC, the active ingredient in marijuana, pregnenolone levels temporarily soared, increasing in some cases by 3,000 percent above baseline levels.

When researchers injected large amounts of the hormone into rodents, the animals became largely immune to several effects of THC. Mice and rats that received pregnenolone minutes before receiving THC didn't get the munchies that come with marijuana use, and mice were better able to remember objects. The hormone also seemed to curb mice's craving for a THC-like molecule. After receiving pregnenolone, the animals were less likely to self-administer the drug.

9
percent
Estimated fraction of marijuana users who become addicted

The results at this early stage have little relevance for people who struggle with drug abuse or dependence, cautions neuroscientist Carl Hart of Columbia University. Studies on rodents can't model the complexities of human addiction, he says. "We as thinking humans have to be careful to understand that what they're doing is a nice first step, but the relevance to the human model is at best unclear."

Pregnenolone itself isn't a viable treatment to curb the effects of marijuana, Piazza says. When taken orally, the hormone isn't easily absorbed by the body and converts into other hormones within minutes. (Those facts cast substantial doubt on claims for pregnenolone supplements, which are marketed as aids for a host of ailments including fatigue, psoriasis, PMS, Alzheimer's and aging.) Piazza and his colleagues are working to develop a family of compounds that work similarly to pregnenolone without these metabolic problems. ■

COURTESY OF PAVAN KUMAR

EARTH & ENVIRONMENT

Florida's mangroves migrate north

Mangrove forests in Florida are on the move. Satellite images from the last three decades reveal that these diverse coastal ecosystems have crept up the state's Atlantic coast thanks to rising winter temperatures. Kyle Cavanaugh, an ecologist at the Smithsonian Institution, and colleagues compared images taken by NASA's Landsat satellites from 1984 to 2011. During this period, the area occupied by mangrove forests south of about 30° N latitude, where St. Augustine sits, grew by about 12 square kilometers. Most of the increase occurred north of 27.5° N latitude, around the city of Vero Beach. The mangroves' gains come mainly at the expense of salt marshes, which thrive in areas historically too cold for mangroves, the researchers report in the Jan. 14 *Proceedings of the National Academy of Sciences*. The team found that mangroves expanded in places where winter lows once fell below 4° Celsius but now rarely do. — *Gabriel Popkin*

GENES & CELLS

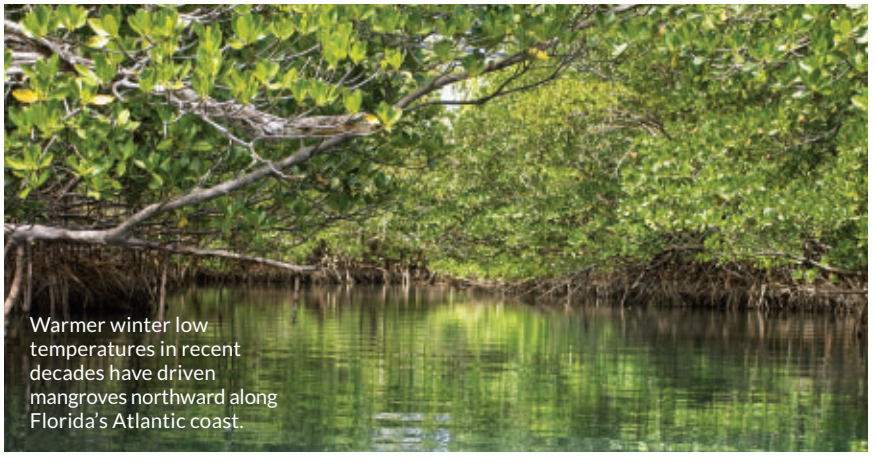
Deadly influenza could strike aboriginal groups hardest

Aboriginal Australians and Alaska Natives may be particularly vulnerable to a bird flu that emerged in China last year. So far, the H7N9 avian influenza virus has infected more than 200 people and killed at least 50. When viruses infect people, immune cells known as T cells can sometimes mount a defense, provided that they've fought off similar invaders in the past. Some genetic variants increase T cells' ability to combat H7N9, and those variants are more prevalent in certain ethnic groups, Katherine Kedzierska of Australia's University of Melbourne and colleagues report January 6 in the *Proceedings of the National Academy of Sciences*. Only about 16 percent of Alaska Natives and Australian Aborigines carry the flu-fighting variants; more than a third of Asians and Africans and 57 percent of people of European descent do. — *Tina Hesman Saey*

BODY & BRAIN

'Good' bacteria prevent colic symptoms in babies

Newborns who take drops containing a beneficial bacterium cry less than babies not given the supplement, researchers report January 13 in *JAMA Pediatrics*. The cause of excessive crying, or colic, is not well understood, but scientists suspect that the microbial mix in infants' intestines is involved. Researchers across Italy randomly assigned 589 newborns to get either a placebo or a probiotic supplement. The supplement contained live *Lactobacillus reuteri*, a microbe shown previously to improve intestinal function. Parents delivered the drops, and 468 families kept detailed diaries of infant health for three months. Newborns getting the microbe were less apt to develop colic symptoms. They cried for an average of 38 minutes per day; infants getting the placebo cried for 71 minutes. The microbe-treated babies also spit up less often. — *Nathan Seppa*



Warmer winter low temperatures in recent decades have driven mangroves northward along Florida's Atlantic coast.

MATTHEW CONNOLLY/SHUTTERSTOCK

Green tea may interfere with blood pressure medication

Green tea chemicals linked to reducing the risk of cancer may thwart a blood pressure medication by preventing it from getting into the bloodstream. In a preliminary study, researchers gave 10 healthy adults the blood pressure medication nadolol after the volunteers drank about two glasses of green tea a day for two weeks and again after they stopped drinking tea for two weeks. Compared with taking the medication after avoiding tea, the volunteers had just 24 percent as much nadolol in their blood after consuming tea, the researchers found. In lab-dish studies, the team, led by Shingen Misaka of Fukushima Medical University in Japan, found that antioxidants in green tea called catechins inhibit the cellular machinery that pumps nadolol into cells. The findings, appearing January 13 in *Clinical Pharmacology & Therapeutics*, suggest that catechins may block uptake of nadolol in the intestines. — *Beth Mole*

MATTER & ENERGY

Battery blueprint promises storage of renewable energy

A new battery that relies on cheap organic molecules could help stockpile energy from intermittent sources such as solar and wind power for use on cloudy or breezeless days. The battery uses quinones, common chemicals in many life-forms that help hold energy for later use, Harvard researchers report in the Jan. 9 *Nature*. In place of quinones, previous designs of similar batteries have used metal compounds, which can be expensive. The device is a type of flow battery, in which two separated liquids pass in and out of a cell with electrodes. A membrane in the middle of the cell prevents the two solutions from mixing but allows ions to travel between them. To charge the battery, electricity causes a quinone-carrying liquid to accept electrons from the current and protons from the other liquid. The liquids then flow out of the cell and into storage containers. To get energy from the battery, the liquids pass back though the cell and undergo the reverse chemical reaction. — *Beth Mole*

Perfect Choice HD™ is simple to use, hard to see and easy to afford…

The invention of the year is great news for your ears.

Over the years, digital electronic technology has made the way we live easier, safer and more convenient. In many cases, it's even made many products more affordable… (remember how much the first VCRs used to cost?). Unfortunately, the cost of many digital products, including the hearing aid never seemed to come down. Now, a new option has been invented… it's called Perfect Choice HD™.

Perfect Choice HD is NOT a hearing aid. It is a Personal Sound Amplification Product (PSAP). Hearing aids can only be sold by an audiologist or a licensed hearing instrument specialist following hearing tests and fitting appointments. Once the audiologist had you tested and fitted, you would have to pay as much as $5000 for the product.

Now, thanks to the efforts of the doctor who leads a renowned hearing institute, there is Perfect Choice HD. It's designed to accurately amplify sounds and deliver them to your ear. Because we've developed an efficient production process, we can make a great product at an affordable price. The unit has been designed to have an easily accessible battery, but it is small and lightweight enough to hide behind your ear… only you'll know you have it on. It's comfortable and won't make you feel like you have something stuck in your ear. It provides high quality audio so sounds and conversations will be easier to hear and understand.

Try it for yourself with our exclusive home trial. Some people need hearing aids but many just want the extra boost in volume that a PSAP gives them. We want you to be happy with Perfect Choice HD, so we are offering to let you try it for yourself. If you are not totally satisfied with this product, simply return it within 60 days for a refund of the full product purchase price. Don't wait… don't miss out on another conversation… call now!

Why Perfect Choice HD is the best choice !	
Lightweight / Inconspicuous	Less than 1 ounce
Sound Quality	Excellent – Optimized for speech
Increased Loudness	Yes
Test and Fitting Required	No
One-on-One Personal Set Up	Free
Friendly Return Policy	60 Days

Are you or a loved one frustrated in these situations?

• Restaurants
• Dinner parties
• Outdoor conversations
• Lectures • Sermons
• Meetings
…and other times where you need to turn up the volume

Perfect Choice HD™

Call now for the lowest price ever.

Please mention promotional code 47646.

1-877-509-2605

Perfect Choice HD is not a hearing aid. If you believe you need a hearing aid, please consult a physician.

81005

FEATURE

Life's Early Traces

New finds help push microbe origins beyond 3.5 billion years ago

By Meghan Rosen

Western Australia's Pilbara region isn't known for its hospitality to life. Dry creek beds carve paths through dusty red earth, and razor-sharp grasses cover the area's low hills. In this place with record-setting heat and months of minimal rainfall, hardy plants and animals eke out an existence.

But the Pilbara may have been prime real estate for the planet's earliest complex life-forms. In the region's 3.5-billion-year-old rocks, geobiologist Nora Noffke has found tiny, subtle patterns that may reflect communities of microorganisms. The patterns look just like those made by moist mats of microbes found along today's shorelines. The markings Noffke spotted in Australia may be the earliest evidence of complex life on Earth.

Other scientists aren't so sure. Early signs of life are hard to interpret, and are famous for stirring up controversy. Taken one at a time, every odd structure, chemical trace or microscopic fossil that is held up as the earliest relic of life is met with skepticism. But together with Noffke's patterns, the combined evidence tells a story about life's origins that scientists can mostly agree on: Microbial ecosystems probably existed around 3.5 billion years ago.

If Noffke's patterns really were created by cells, the subtle sculptures might offer a new way to search for microbes on other planets, and they might help scientists better understand how quickly life developed here on Earth.

A nascent world

When the Earth formed around 4.5 billion years ago, life as we know it didn't stand a chance. Asteroids smashing into the planet left behind oceans of molten rock and probably wiped the planet clean of any potential life. Scientists think the earliest cells emerged sometime after a planet-sized body slammed into Earth, creating the moon.

Since complex life takes time to evolve, those first cells must have existed well before microbial ecosystems appeared about 3.5 billion years ago, scientists reason. If so, Noffke's find and others suggest that, on the timeline of life on Earth, early cells' origins lie quite close to the planet's tumultuous beginnings. "Every time we have a find like this it says to me that the process of life arising on a planet is pretty fast," says geomicrobiologist Penelope Boston of New Mexico Tech in

The Pilbara region in Western Australia, home to Millstream Chichester National Park (left), may hold signs of the planet's earliest complex life.

PETER HENDRIE/GETTY IMAGES

Socorro. "And that's pretty amazing."

Ancient signs of life can be hard to pin down. "It's easy if you find a big old wonkin' dinosaur bone," says Boston. "But most fossils aren't that."

The oldest dinosaur fossils date back to about 230 million years ago. Yet those bones are brand-new compared with Noffke's patterned structures. Time has been tough on tiny, ancient fossils: They rest in rocks that have endured billions of years of Earth's geologic history. Heat and pressure may have long since pulverized any cellular remnants beyond recognition. What's left is often microscopic and wide open to interpretation.

Scientists look for these minuscule clues in different layers of rock. "Think of a layer cake," says astrobiologist Abigail Allwood of NASA's Jet Propulsion Laboratory in Pasadena, Calif. The oldest rock layers sit at the bottom, and younger ones lie on top. Geologists use chemical tests to figure out the age of each rock layer, and consider anything entombed inside to be the same age.

When searching for signs of early life, scientists comb ancient layers of rock for telltale structures, chemicals and fossils. Noffke sometimes has to hunker down close to the rock and peer through a magnifying glass to see her patterned sculptures. But she believes the tiny impressions stamped into ancient rocks match those formed by microbial mats today.

Modern mats lie atop sandy shores and ooze a sticky slime that glues particles together. When waves lap across the mats, the microbes rearrange bits of sand and the slime cements them into place, sculpting recognizable patterns. They're like the grooves worms make as they cut through sandy soil, Noffke says. If the sand solidifies, evidence of the trail becomes set in stone. Microbial mats don't push paths through sand like worms do, but the microbes can form characteristic sculptures, such as chips, crinkles, tufts and rolls. Eventually, the microbes die and their cells break down. But their sedimentary sculptures can stick around.

Noffke has studied microbial mats, and the sculptures they leave behind, in aquatic environments around the world, from tidal flats off the coast of Germany to lagoons in Tunisia. She has seen sculptures just weeks old, in sediments deposited thousands of years ago and in rocks of various ages. Until now, the oldest place Noffke had seen these features, called microbially induced sedimentary structures, or MISS, was in South Africa, in 3.2-billion-year-old rocks.

She thought she might find MISS in even older rocks in the Pilbara, which signs suggest once was home to an ancient sabkha, a kind of microbe-friendly salt flat. During a brief initial visit, Noffke had spotted what she suspected might be MISS. "I thought, 'I have to get back here and take a closer look,' " she says.

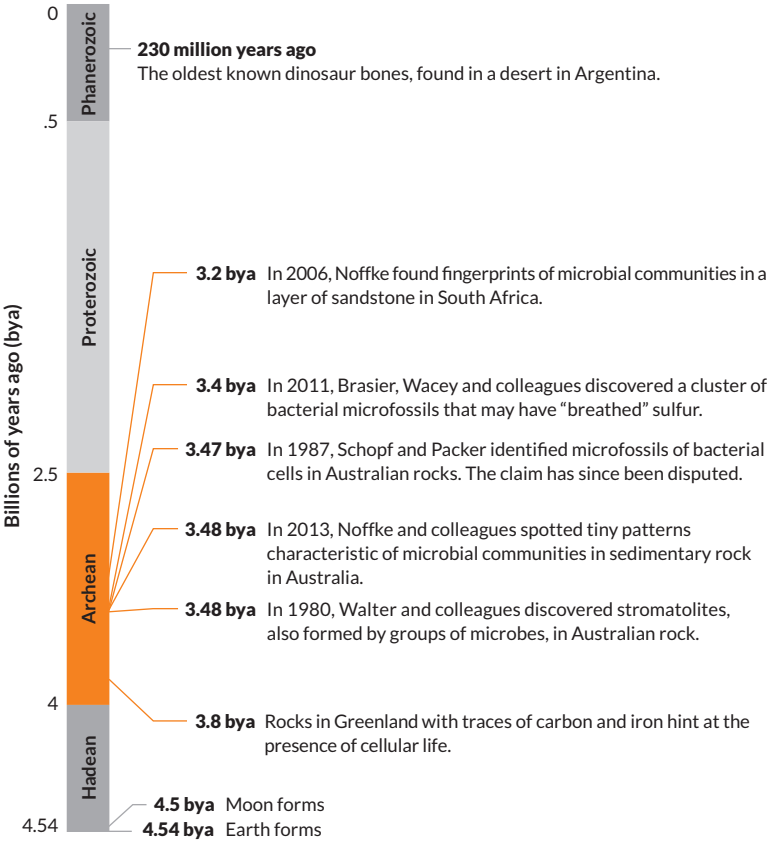
So in 2011, she and graduate student Daniel Christian, both of Old Dominion University in Norfolk, Va., trekked to a part of the Pilbara with 3.5-billion-year-old rocks, hauling in food, water and camping supplies, and settled in for three weeks of fossil hunting. For days, the two scoured the area for fresh outcrops of ancient rocks. Then, the pair searched for rock beds containing MISS.

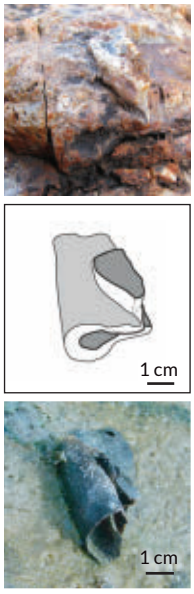
Halfway up a low hill, Noffke first caught sight of the microbial sculptures. "I was so excited that I couldn't stop talking about it for a whole week," she says. Ragged blotches, called chips, freckled the rocks' surfaces. The chips looked just like sculptures made by mats in modern salt flats.

"I was convinced right away," she says.

She collected small samples and brought them back to the lab to inspect them with microscopes.

Signs of life The earliest evidence for life on Earth resides in 3.8-billion-year-old rocks from the Archean eon. This evidence, plus younger traces of life described below, suggest that the first cells may have emerged relatively soon after the planet's birth. In contrast, the earliest dinosaur fossil is from the Triassic period of the Phanerozoic eon, a mere 230 million years ago.





A 3.48-billion-year-old microbially induced sedimentary structure (top) forms a roll (illustrated at center) that closely resembles one (bottom) made by modern microbial mats.

Tiny patterns, as well as the rock's mineral makeup, matched MISS that Noffke had studied before, she and colleagues reported in 2013 in *Astrobiology*.

Though the structures formed by microbial mats are subtle, Boston, who studies microbes that survive in hostile environments, can see the similarities between ancient and modern MISS. "I'm pretty convinced that what they're seeing is microbial in origin," she says.

Chemical evidence within the MISS also hints at life. Noffke teamed up with paleobiologist David Wacey of the University of Western Australia in Crawley to detect ancient carbon in the rock sculptures. Her samples were loaded with the element — a good sign for scientists looking for life. The carbon might be remnants of cells broken down long ago, Noffke says.

NASA's Allwood, whose research on ancient rocks could aid the search for life on other planets, wants to see more analysis of the chemicals inside Noffke's samples. Different tests could pinpoint other biological hallmarks, such as whether the MISS have a carbon signature indicative of life: a specific ratio of carbon isotopes. Cells tend to stock up on carbon-12, the light version of the element that serves as a building material for living organisms.

Though Noffke's structures are "definitely intriguing," Allwood adds, "it's very difficult to prove that they are absolutely biological."

Scientists tend to rely on a mixture of visible and chemical features when assessing evidence for early life, but "it's quite hard to tick all the boxes," says paleontologist Kathleen Grey, formerly of the Geological Survey of Western Australia in Perth. Researchers rarely see all the features they want to see, she says, which might explain why signs of ancient life can be so controversial.

Layers of life

One sign of ancient life has captivated scientists for decades. In the 1980s, bumpy structures found in 3.5-billion-year-old rocks hinted that groups of bacteria might have lived back then.

These structures, called stromatolites, are built by microbial mats in watery environments rich in carbonate, a chemical building block of limestone and coral reefs. Stromatolites form when carbonate grains, sediment and slimy mat layers stack on top of one another. As the microbes within the mats grow, they alter the temperature and acidity of the surrounding water. These changes can force dissolved minerals to build up on the mats' surface. New mats pile on top, and the process repeats, creating layered structures that can be meters thick.

Modern stromatolites, such as those found in Shark Bay in Australia, are often covered with a thin mat of live cells, but their core has already solidified into rock, says Grey, who has collected stromatolite samples from around the continent. "It's a bit like concrete that's setting from the bottom," she says. By slicing through these structures, scientists can see the distinctive wavy lines of different mat layers. These layers also appear in ancient stromatolites.

Like Noffke's MISS, the stromatolites hint at the sophistication of life 3.5 billion years ago. The cells must have been organizing into communities that shaped their surroundings, says Boston. "That's not what you get from a soup of DNA sloshing around."

But some type of primordial soup evolved into the planet's first cells. And for those cells to develop into communities probably took hundreds of millions of years. Evidence for this timeline resides in 3.8-billion-year-old rocks from another desolate part of the world, Greenland. The carbon isotope signature of these rocks suggests that organisms may have lived some 300 million years before the microbes that formed early stromatolites and MISS.

Marks of life on ancient Greenland also pop up as another element: Red streaks of iron cut through its oldest rocks. The red hue hints that enough oxygen may have been around to produce rust. And if oxygen existed 3.8 billion years ago, photosynthesizing bacteria may have been releasing the gas into the air as they converted sunlight into sugar.

But chemical clues aren't entirely convincing, Wacey says. He's skeptical that the Greenland rocks' carbon traces were actually left behind by living organisms. "There are no structures within these rocks that you could ever say are fossils," he says. What's more, even a shred of modern plant matter can contaminate ancient rock samples with lifelike carbon signatures. These signatures

Stromatolites form in shallow waters in Shark Bay, Australia (left). Slices from both ancient and modern stromatolites (right), reveal evidence of microbes organized into communities that grew one atop another, leaving mineral deposits in layers.

TOP: N. NOFFKE *ET AL/ASTROBIOLOGY* 2013; BOTTOM LEFT: © FRANS LANTING/CORBIS; BOTTOM RIGHT: FRANCOIS GOHIER/SCIENCE SOURCE

can even be forged where no life exists, in volcanoes and hydrothermal environments.

For decades, the field has had trouble establishing criteria for what constitutes solid evidence of early life. Ideally, scientists would like to find fossils shaped like cells and outlined by something that looks like a membrane. For some scientists, that kind of evidence is the keystone for building a convincing case for ancient signs of life. So far, no one has found that evidence within 3.5-billion-year-old stromatolites or MISS.

"Life is enclosed within a cellular membrane," says paleobiologist Martin Brasier of the University of Oxford. "That's the crunch point for me."

Direct evidence

Scientists thought they had found convincing evidence of ancient cells in 1987. J. William Schopf and Bonnie Packer reported in *Science* finding fossilized cells in an Australian rock layer just less than 3.5 billion years old. The team claimed that tiny spheres wrapped in sheaths were microfossils of bacteria.

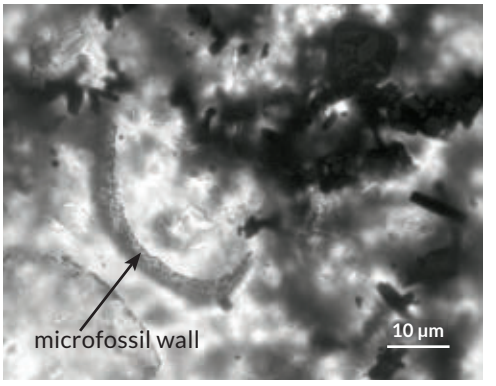
Most scientists accepted the claim until 2002, when Brasier, a veteran at evaluating ancient fossils, shook up the field. He examined the specimens and claimed in *Nature* that the structures weren't fossils at all: They were mineral growths. "People simply looked for funny shapes that reminded them of cells," Brasier says. Shapes are important, he says, but so is sketching out a picture of the ancient cells' environment, and finding evidence of lifelike behaviors. "You put all these things together, and then you've got a story," he says.

> "If we were to find signs of cells in and around these MISS, that would make me very happy."
> **MARTIN BRASIER**

In 2011, Brasier, Wacey and colleagues reported finding stronger evidence for microfossils of cells. Their fossils rest in 3.4-billion-year-old sandstone just 50 kilometers from where Schopf and Packer discovered their specimens.

In the younger rock, the researchers found clumps of rounded cells that look like bunches of grapes and elongated cells connected like sausage links. But these microfossils don't just look like cells; Brasier contends that the clumps acted like cells too. The organisms appear to have stuck themselves to sand grains. And tiny crystals of a mineral called pyrite speckled in and around the microfossils may be a by-product of sulfur metabolism. Like some modern microbes living in low-oxygen environments, these organisms may have "breathed" the element instead of oxygen, the researchers reported in *Nature Geoscience*.

Though Noffke hasn't yet found actual cells within the MISS from the Pilbara, she has seen microscopic textures that resemble filaments, long skinny threads of bacteria. No one has confirmed that these filaments are organic in origin, but Brasier thinks MISS are worth a closer look. "If we were to find signs of cells in and around these MISS, that would make me very happy," he says.



Crystals of pyrite mineral (black specks) that surround microfossils from a 3.4-billion-year-old Australian rock layer may be evidence of early cell metabolism.

All together, the evidence for complex life 3.5 billion years ago is piling up, says geomicrobiologist Maud Walsh of Louisiana State University in Baton Rouge, who has been following the early life debate for years. "It's building more lines of evidence that we had pretty robust ecosystems of bacteria."

Grey, who studies stromatolites, agrees. "It's like putting a detective case together." Again and again, she says, the clues keep hinting at life early in Earth's history. And because MISS are made by such complex ecosystems, cellular life must have existed for millions of years before the structures appear in the fossil record.

The ancient structures embedded within the rocks of the Pilbara may even help scientists searching for life on other planets, says Walsh. Researchers could examine photos snapped by the Mars rovers for both stromatolites and MISS like those nestled in Earth's oldest rocks.

Noffke is hopeful because Earth and Mars both hold evidence of ancient sabkhas. "The likelihood that there are MISS on Mars is very big," she says.

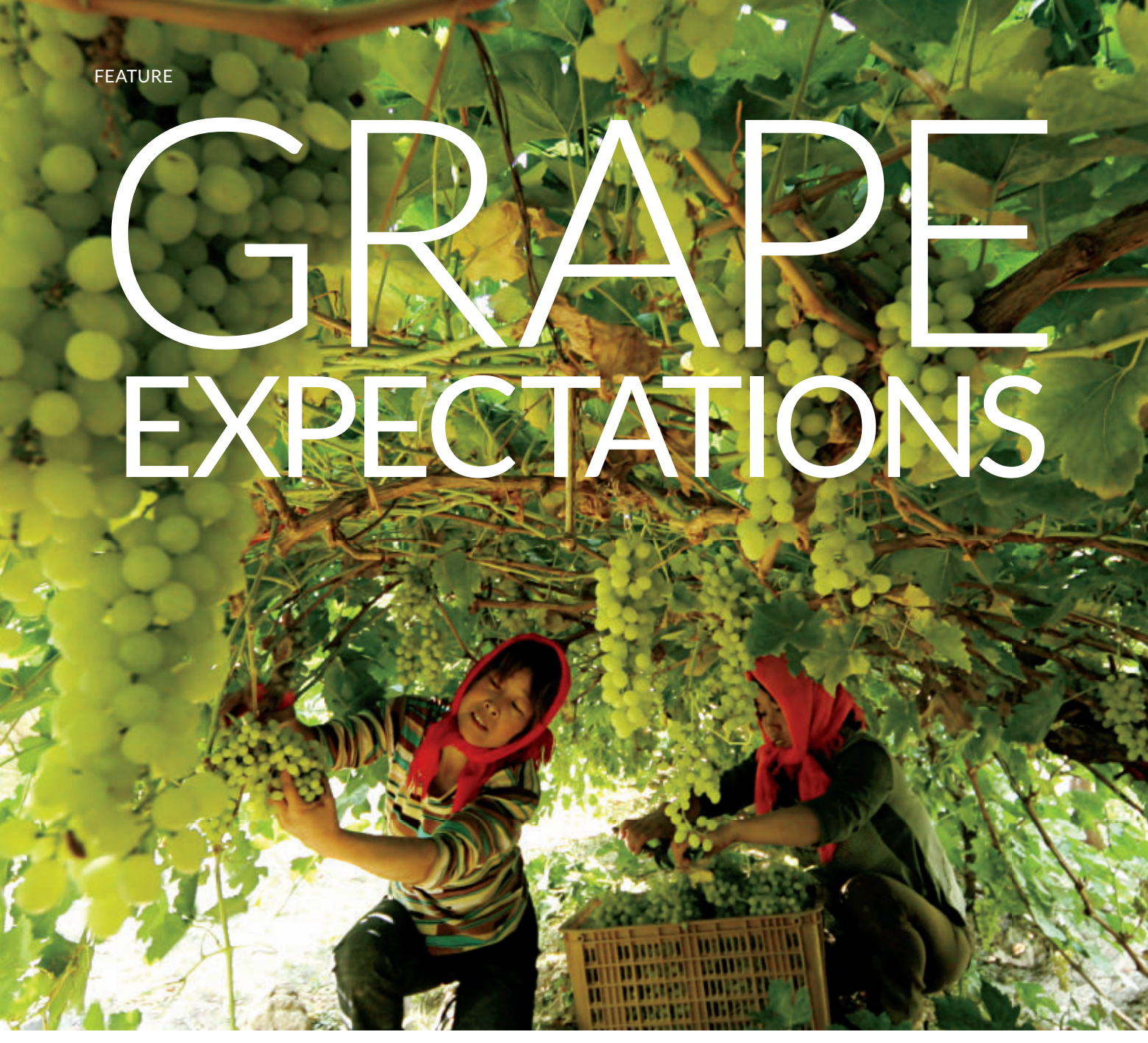
Even if the case for such ancient life falls apart, the vigorous discussion it whips up is healthy, Brasier says. "How terrible it would be if we found life on Mars, and nobody could actually agree," he says. "We've got to rehearse these debates here." ■

Explore more

- Nora Noffke *et al*. "MISS recording an ancient ecosystem in the ca. 3.48 billion-year-old Dresser Formation, Pilbara, Western Australia." *Astrobiology*. December 2013.

D. WACEY *ET AL*/*NATURE GEOSCIENCE* 2011

GRAPE EXPECTATIONS



Climate change is already transforming the wine industry

By Susan Gaidos

Antonio Busalacchi knows quality wine. As a sommelier, his educated palate can discern the oak undertones or mineral accents of a wine — flavors that elude most wine drinkers. He picks up on other nuances too. One sip of deep, inky purple, and he can distinguish the jammy, syrup-ripe fruit flavor of a shiraz grown in a warm climate from the lean olive notes of a syrah, made from the same grape, grown in a cooler region of France.

In his day job, Busalacchi offers another take on his favorite wines. A climatologist at the University of Maryland, he recognizes that he soon may be praising the merits of a fine English — not French — sparkling wine, or discussing the complexity of a world-class Tasmanian cabernet sauvignon.

As famed regions such as Napa and Bordeaux become too warm, wine producers will have to find new places to grow grapes, such as in China's Xinjiang region (shown).

The reason: climate change. Warming temperatures are already affecting vineyards from France to Chile. So far, rising temperatures have been mostly good for wine. Warmer, longer growing seasons have allowed grapes to stay on the vine longer, producing fruit that results in stronger, bolder wines with higher alcohol content.

But as the world continues to warm, conditions in some

STR/AFP/GETTY IMAGES

areas will sour. Signature wines produced in some of the world's most famous regions, such as Champagne or Bordeaux, will probably lose some of their quality and character. And the projected temperature changes will make it increasingly difficult for these renowned regions to grow their famed grapes at all, Busalacchi says.

His prognostications have scientific backing. A 2005 study in *Climatic Change* led by climatologist Gregory Jones of Southern Oregon University found that the average growing-season temperature in 27 prime wine-producing regions had risen in the previous 50 years. Seventeen of the regions showed an average temperature climb of 1.26 degrees Celsius. In the vineyards of Spain, Portugal, southern France and Italy, average temperatures rose even more. By 2049, average temperatures in most wine regions will shoot up another 2 degrees, Jones projected.

According to these projections, by midcentury Bordeaux could reach the upper temperature limits for growing red varieties, and will fall outside the ideal climate for its white grapes. Other areas are threatened too. Last year an international team of scientists showed that by 2050, some of the world's most famous wine-making regions, including Tuscany in Italy, will shrink by nearly 70 percent.

That doesn't mean the end of sauvignon blanc or merlot. But in the not-so-distant future, these well-recognized French wines may not come from France. Some wine producers in Champagne or Bordeaux already are moving north and setting up vineyards in southern England. There the soil is similar to the chalky substrate of Champagne, offering a hospitable environment for growing quality grapes. In other parts of the world, growers are expanding into areas previously not known for wine, setting up vineyards in India, Brazil and China.

These geographic shifts will keep the wine flowing, but may bring new pressures on wildlife and other natural resources such as water, says climatologist Lee Hannah of Conservation International's Moore Center for Ecosystem Science and Economics. When Hannah and his team looked at the conservation implications of the wine industry's geographic overhaul, they were "stunned," he says, by the magnitude of changes that could come over the next few decades.

The Champagne region's chalky soil (shown) adds to the flavor of the sparkling wine made there. Southern England also has chalky soil suitable for growing grapes.

Their study, published last April in the *Proceedings of the National Academy of Sciences*, showed that some of the best places to grow wine grapes in 2050 will overlap with panda habitat in China, as well as regions north of Yellowstone National Park where land is being set aside for bears, antelope, mountain lions and other species.

The potential conflicts are a sign of what's to come. Although wine grapes may seem like a frivolous crop to some, they represent big business: Analysts estimate that U.S. consumers spent over $30 billion on wine in 2012. What's more, scientists say the plant's extraordinary sensitivity to temperature makes the industry a strong early-warning system for problems that all food crops are expected to confront as climates continue to change.

Wine leaders Winemakers produced roughly 28 billion liters of wine in 2013. As the climate changes, some of the top 10 wine-producing countries (below), such as Italy, may lose some grape-growing regions while others, such as Germany, gain new territory. SOURCE: OIV

1. Italy
2. France
3. Spain
4. United States
5. Argentina
6. Australia
7. Chile
8. South Africa
9. Germany
10. Portugal

Because wine grapes are a particularly good bellwether for other crops, similar issues may soon arise for producers of coffee, chocolate, hops and a host of other products, Jones says. "The narrow range in which the crop is most successful from a production and quality standpoint can change quickly in today's climate shifts."

Nature of terroir

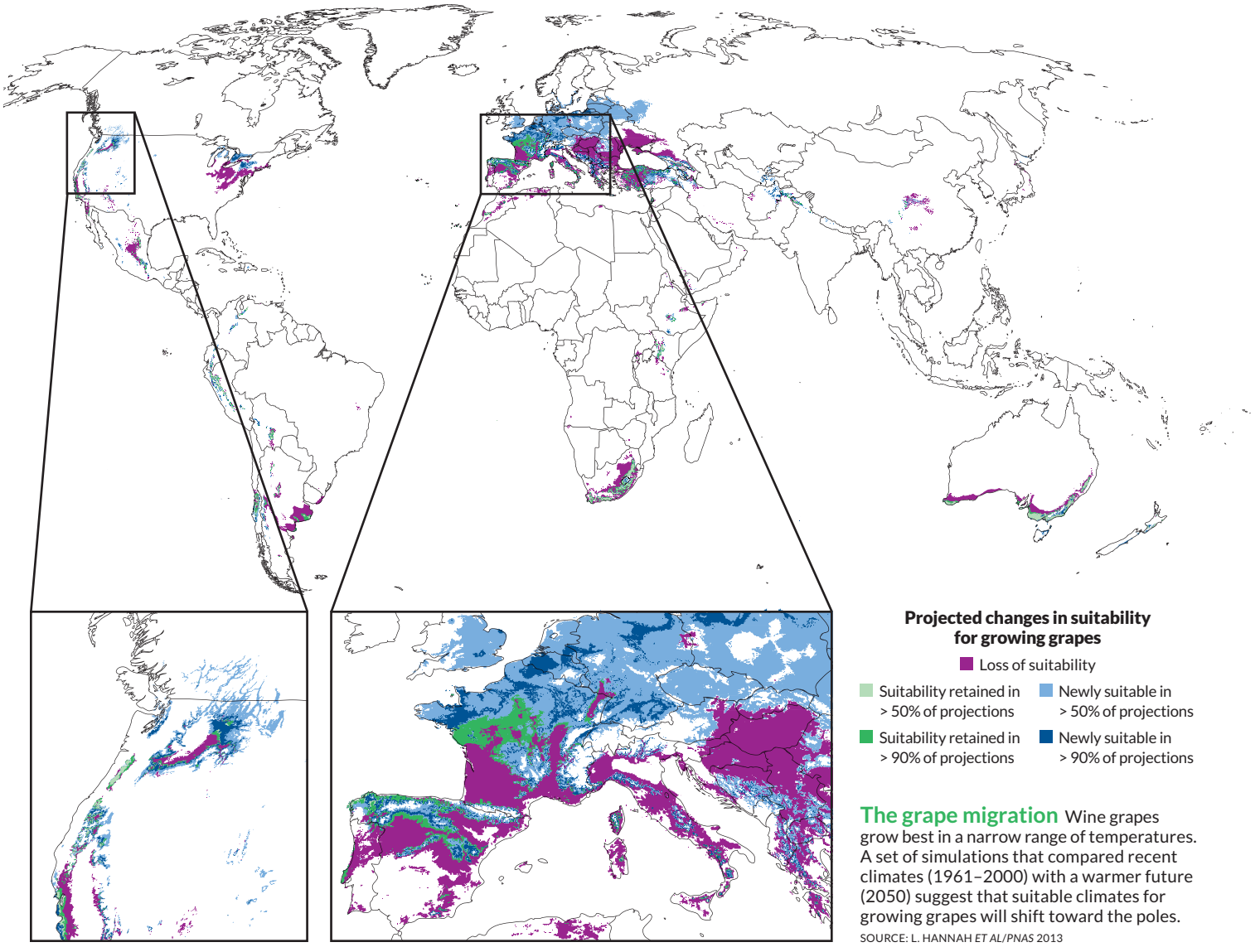
Even with changes afoot to keep wine production and quality consistent as climate changes, wine lovers may detect some differences in their vino. Because the local geology and landscape play a vital role in shaping a wine's taste, transporting grapes to new regions could result in different flavors.

"One of the unique attributes of the Champagne region in France is the chalky soil," Busalacchi says. "That limestone soil is an important attribute, giving wine grapes the drainage and acid backbone needed to produce dazzling champagne wines."

In fact, those local differences have conspired to turn a single species of grape, *Vitis vinifera*, into the source of the vast array of premium wines popular today. Most of the world's wine production comes from just a few *vinifera* varieties, including chardonnay, sauvignon blanc, cabernet sauvignon, merlot, pinot noir and Johannisberg riesling. These grapes are extremely responsive to their physical environment. Soil composition, moisture, hours of exposure to sunlight — even the way that the leaves drape over the fruit — all affect the overall quality and taste of the final product, wine. Such factors get at the nature of terroir, a word that ascribes a wine's uniqueness to the physical environment where grapes grow.

Creating the ideal conditions for growing quality wine grapes is, as Jones puts it, a multibillion dollar issue. Though

GAYLE KECK



The grape migration Wine grapes grow best in a narrow range of temperatures. A set of simulations that compared recent climates (1961–2000) with a warmer future (2050) suggest that suitable climates for growing grapes will shift toward the poles.

SOURCE: L. HANNAH *ET AL*/*PNAS* 2013

there's not one perfect environment for grapes, there is a well-known range of characteristics that growers look for. Grapevines hate wet feet and do best in arid areas where temperatures don't dip below 12° or 13° Celsius during the growing season, or spike above 22° C. Sunlight is important too. As a vine's leaves soak up sunshine, the light fuels photosynthesis, which fills the grapes with sugars. After fermentation, these sugars become alcohol.

The combination of arid land, temperature and sunlight makes places such as California and southern Italy a paradise for growing wine grapes — at least for now.

The good problem

Of all the climate influences on grapes, temperature is the most influential. Jones says heat can enhance ripening, allowing grapes to develop sweeter, bolder flavors.

That's why recent warming has been a boon for wine producers. Rising temperatures have allowed growers to keep the fruit on the vine longer — a strategy that would not have worked 30 or 50 years ago when fall frosts occurred earlier.

As the heat rises, so does the resulting wine's alcohol content. A warmer growing season or longer hang time on the vine produces more sugar in the grapes. Later, during fermentation, the sugars are converted by yeast into alcohol. So the greater the grapes' sugar concentration, the higher the wine's potential alcohol level. For example, the cool conditions of the Champagne region produce low-sugar, high-acid grapes that are well suited for champagne, which is about 13 percent alcohol by volume. Wines from warmer regions — say, a shiraz from Australia's Barossa Valley or a zinfandel from California's Central Valley — often have up to 15.5 percent alcohol by volume.

Wine growers have already started to see sweeter grapes and higher alcohol levels. In Germany's Franconia region, the

MAP: NIGHTSTALLION/WIKIMEDIA COMMONS, ADAPTED BY S. EGTS

sugar content of pressed grape juice that's used to make wine rose some 20 grams per liter each decade from 1962 to 2010, researchers reported July 23 in *PLOS ONE*. The team concluded that changes in growing-season temperature account for more than 40 percent of the increase.

Elsewhere, research has shown that potential alcohol levels of riesling at harvest in Alsace, France, have increased by 2.5 percent over the last 30 years. For Napa wines, average alcohol levels rose from 12.5 to 14.8 percent from 1971 to 2001.

"Some may argue that this trend is driven by economics, catering to consumers' taste for bigger, bolder wines," Jones says. "But our research shows that climate variability and change has clearly helped boost the alcohol levels."

Busalacchi agrees, noting that the warming trend to date has also helped wine production flourish. Higher temperatures have opened, or reopened, wine regions in places such as southern England. Thirty years ago, growers there could produce only a few, lesser varieties of grapes. Today, growers in Sussex, Surrey and Kent are growing a number of premier varietals, including chardonnay and pinot noir.

"A number of wine regions around the world are in the sweet spot right now," Busalacchi says. "We have been seeing places like Bordeaux, Germany and northern Italy, even California, putting together a string of very good and very consistent vintages as a result of climate."

In some areas of France, Busalacchi says, wine producers refer to climate change as *le bon problème*, or the good problem.

Tipping a delicate balance

That may change as temperatures continue to rise. In a warmer than ideal environment, grapes may ripen too rapidly, altering the all-important balance of sugar, acid and potential alcohol content.

"Acid is a very important component of the wine," Busalacchi says. "It's that acid together with the tannins in the wine that cut through the fats in a steak or other foods and gives you that mouth-cleansing effect that helps boost your appetite."

If temperature shoots too high, the heat can shut down photosynthesis altogether. Because photosynthesis helps activate the genes needed to develop color and flavor compounds in the fruit, a shutdown will wash out the grapes' color and alter the acid and sugar content, resulting in the loss of some flavor and aroma.

These changes will be especially noticeable in high-quality wines that generally get "better" with age, Busalacchi says. Such wines are usually made with premium grapes of a specific type to produce a consistent taste, whereas everyday table wines are often blended from grapes of different regions.

That's why some famed regions are in danger of extinction. Before the end of the century, for instance, Western Australia may no longer be known for its cabernet sauvignon or shiraz. Using climate simulations, Australian researchers found that by 2070, the acidity and concentration of a compound that gives red wine its color could dip below thresholds needed to maintain high-quality wine. The team reported the bad news in September in the *International Journal of Biometeorology*.

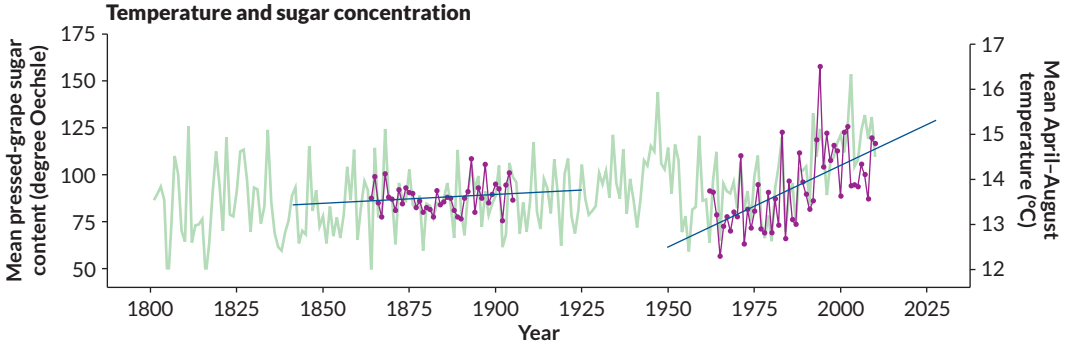
> "A number of wine regions around the world are in the sweet spot right now."
>
> ANTONIO BUSALACCHI

Warming will bring other headaches too. The changing climate will enhance the wide variations in weather that mid-latitude regions already experience from year to year and bring an increased number of extreme events such as heat waves and hailstorms, Busalacchi says. Heat waves can shut down photosynthesis, and hailstorms can damage grapes, ruining a season's production in minutes. This past growing season, a tremendous hailstorm hit widespread parts of France. The storm devastated harvests in Bordeaux, Champagne and other regions.

"By next year, it could be back to normal," Busalacchi says. "However, that is illustrative of what we expect more of in the future."

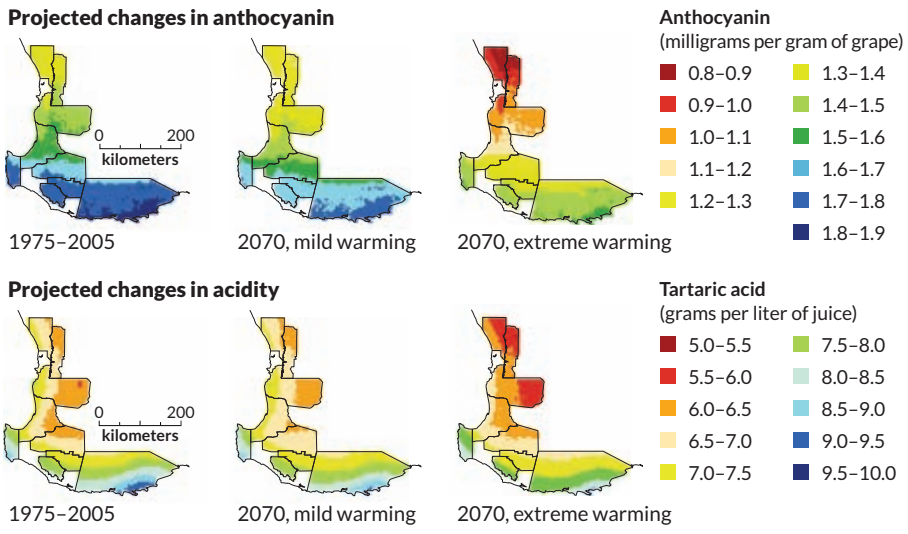
Changes in temperature and humidity may also leave grapes more susceptible to fungal diseases or other microbial invaders.

And, by changing the grapes' resident microbes, such shifts may more directly alter wine. In a study led by scientists at the University of California, Davis, researchers collected 273 samples of pressed grapes from California wineries in Napa, Sonoma and San Joaquin counties as well as from along the Central Coast. The researchers analyzed DNA fragments in



Sweet as wine
In Germany's Franconia region, where wine has been made since the eighth century, the sugar concentration of pressed grapes (purple) has risen over the last few decades as growing-season temperatures have climbed (green). Sweeter grapes lead to higher alcohol levels. SOURCE: A. BOCK *ET AL*/*PLOS ONE* 2013

Sour grapes Climate researchers simulated how the quality of cabernet sauvignon grown in Western Australia will change by 2070. Using low- and high-warming scenarios, the team predicted declines in acidity and the concentration of a compound called anthocyanin, which gives red wine color.
SOURCE: N.N. BARNUUD *ET AL/INT. J. BIOMETEOROL.* 2013



the samples to show that the microbial populations varied from region to region, even on the same variety of grape. The findings, published in the Jan. 7 *Proceedings of the National Academy of Sciences*, showed that factors such as heat and humidity had an important influence on the type of microbes that colonize a grape's surface.

Microbiologist David Mills, who directed the study, says that ultimately, these microbes help in the fermentation process, but they can also affect the wine's taste. Weather-related events are probably driving some of the year-to-year changes in the grapes' microbial communities seen in the study, Mills says. Though the team did not set out to look at climate change, "I would argue that climate change itself is going to have an impact" on the quality of wine grapes, he says. Exactly what that impact might be is still unclear.

Toasting the future

Some vineyard managers are finding ways to adapt to the warmer climate. In many areas producers are making modifications to trellises or to grapevines themselves to deflect rising temperatures. For example, by changing the vine's orientation so that it faces a more northerly direction, managers can limit direct exposure to the sun and keep grapes cooler as temperatures rise.

Some vineyards that are already in relatively cool places will be less affected by climate change. Vineyards planted at higher altitudes or near the ocean — such as those in Oregon and Washington and in Argentina's Mendoza Province — will be less affected by rising temperatures and may continue to benefit from the warming trend. Still, even growers in these areas will likely have to swap in new varietals to keep up with climbing temperatures, Jones says.

In the laboratory, scientists are experimenting with genetically modified grape varietals to help growers find more high-tech ways to adapt. At the University of Florida, biotechnology researcher Dennis Gray is developing methods to genetically alter premium grape varieties to make them more disease resistant.

It's not an easy task. Although scientists have developed fungus-resistant varieties using traditional plant-breeding techniques, cross-breeding compromises the quality of the grape. "If you make a cross using traditional breeding techniques, you don't get anything that resembles the original parent grape in terms of flavor or taste," Gray says.

To get around this obstacle, he uses precision breeding: Instead of mixing entire sets of the DNA from two parents, he selects the gene needed for a specific trait such as resistance to a disease and inserts it into a recipient grape. By transferring only the genes necessary for disease resistance, Gray says the technique may leave the vine's other traits intact.

Whether this strategy can boost disease resistance in grapes is not known. Even if proven successful, the genetically modified varieties may not be accepted by producers. In many European countries, including France and Italy, wine production is governed by strict appellation systems that tie specific wines to their geographic locations. This practice, which dates back hundreds of years, dictates the grape varieties that producers can grow and is meant to preserve a wine's characteristics, which are influenced by a region's special growing conditions. In many regions, appellation rules also govern wine-making practices, such as whether or not growers can irrigate or add ingredients to adjust alcohol or acid levels in the final product.

> "The truth now is that the Earth's climate is changing much faster than the wine business."
> GREGORY JONES

As climate change unfolds, local appellation laws may have to change to permit irrigation or to allow for grape varietals that can tolerate warmer climates, scientists say.

"The Romans said, 'in wine there is truth,'" Jones says. "The truth now is that the Earth's climate is changing much faster than the wine business, and it is advantageous for the wine industry to be proactive in assessing the impacts." ■

Explore more

■ Lee Hannah *et al*. "Climate change, wine, and conservation." *Proceedings of the National Academy of Sciences*. April 23, 2013.

Forty finalists selected in 2014 Intel Science Talent Search

Teen researchers from 14 states have made it to the final phase of the 2014 Intel Science Talent Search, securing a chance to earn a grand prize of $100,000 and share in awards totaling $630,000.

The 40 young scientists will visit Washington, D.C., March 6–12 to tour the White House and other national landmarks, present their research to judges and the public in a poster session at the headquarters of the National Geographic Society and attend a black-tie awards gala at the National Building Museum.

"We are inspired by the knowledge, determination and passion of this year's Intel Science Talent Search finalists," says Rick Bates, interim CEO and chief advancement officer of Society for Science & the Public. "With Intel, we share great excitement in the promise of their future, not only at the finals in March, but as they dig deeper into their particular research and into the challenges society faces."

Finalists' projects this year include innovative stem cell research, a mathematical model that can replicate cardiac arrhythmias and a fast-charging, low-cost supercapacitor for energy storage.

"We celebrate these 40 students because their contributions to the world of science will help solve some of our most pressing challenges," says Wendy Hawkins, executive director of the Intel Foundation. "The Intel Science Talent Search encourages hands-on experience in math and science, which is imperative in enabling young people to think critically, solve problems and understand the world around them."

Society for Science & the Public, a nonprofit membership organization dedicated to public engagement in scientific research and education, publishes *Science News* and has owned and administered the Science Talent Search since its inception in 1942. Intel assumed title sponsorship of the program in 1998, and has since increased annual awards and scholarships from $207,000 to $1.25 million.

Past STS participants have gone on to distinguished research careers, earning more than 100 of the world's most coveted scientific accolades. Among those honors are eight Nobel prizes, two Fields Medals (for outstanding discoveries in mathematics), five National Medals of Science and 11 MacArthur Foundation Fellowships.

This year's finalists — 15 girls and 25 boys representing 33 high schools from coast to coast — were chosen from 1,794 entries in 45 states, the District of Columbia and seven overseas schools. Nineteen of the finalists — almost half — come from California and New York.

Last year's top prize went to Sara Volz of Colorado Springs, Colo., who conducted an experiment that coaxed algae into boosting their production of oil for use in biofuels. Also honored were Jonah Kallenbach, from Ambler, Pa., who figured out a way to better predict how drug molecules latch onto proteins, and Adam Joseph Bowman, of Brentwood, Tenn., who spent several years designing, building and fine-tuning a plasma gun in his family's garage. — *Sid Perkins*

2014 Finalists

CALIFORNIA **Kathy Camenzind,** San Ramon, California High School; **Eric Chen**, San Diego, Canyon Crest Academy; **Angela Kong**, San Jose, Lynbrook High School; **Kevin Lee**, Irvine, University High School; **Charles Liu**, Palo Alto, Henry M. Gunn High School; **Esha Maiti**, San Ramon, California High School; **Sreyas Misra**, Cupertino, The Harker School; **Natalie Ng**, Cupertino, Monta Vista High School; **Emily Pang**, San Ramon, Dougherty Valley High School; **Jiho Park,** Irvine, University High School; **Vishnu Shankar**, Cupertino, Monta Vista High School

CONNECTICUT **Anne Merrill**, Greenwich, Greenwich High School

GEORGIA **Anand Srinivasan**, Roswell, Roswell High School

HAWAII **Viola Mocz**, Mililani, Mililani High School

ILLINOIS **Rahul Mehta**, Chicago, The University of Chicago Laboratory High School

INDIANA **Yushi Homma**, Carmel, Carmel High School

MARYLAND **Shaun Datta**, North Potomac, Montgomery Blair High School; **Neil Davey**, Gaithersburg, Montgomery Blair High School; **Benjamin Freed**, Frederick, Governor Thomas Johnson High School; **Jessica Shi**, Rockville, Montgomery Blair High School

MASSACHUSETTS **William Kuszmaul**, Lexington, Lexington High School; **Ajay Saini**, Acton, Acton-Boxborough Regional High School; **David Seong**, Lexington, Lexington High School

NEW JERSEY **Joshua Meier**, Teaneck, Academy for the Advancement of Science and Technology; **Brianna Pereira**, Fort Lee, Academy for Medical Science Technology

NEW YORK **John Clarke**, Syosset, Regis High School; **Aron Coraor**, Huntington, Huntington High School; **Soham Daga**, Forest Hills, Stuyvesant High School; **Anubhav Guha**, Chappaqua, Horace Greeley High School; **Preeti Kakani**, Jericho, Jericho Senior High School; **Ivan Paskov**, Scarsdale, Edgemont High School; **Sara Sakowitz**, New York, The Brearley School; **Kaitlyn Shin**, Jericho, Jericho Senior High School

NORTH CAROLINA **Alec Arshavsky**, Chapel Hill, East Chapel Hill High School; **Parth Thakker**, Charlotte, North Carolina School of Science and Mathematics

SOUTH DAKOTA **Zarin Rahman**, Brookings, Brookings High School

TENNESSEE **Joyce Kang**, Brentwood, Brentwood High School

TEXAS **Steven Chen**, Austin, Westwood High School; **Lisa Michaels**, Plano, Plano West Senior High School; **Thabit Pulak**, Richardson, Richardson High School

Finalists are listed by state, name, city and high school.

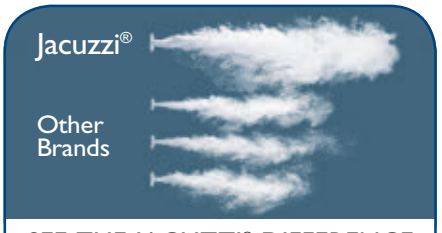
Technology Breakthrough | Safe, comfortable bathing from Jacuzzi®

Enjoy A Bath Again… Safely and Affordably

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

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

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



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

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

What To Look For in a Walk-In Tub:

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

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

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

For information call:

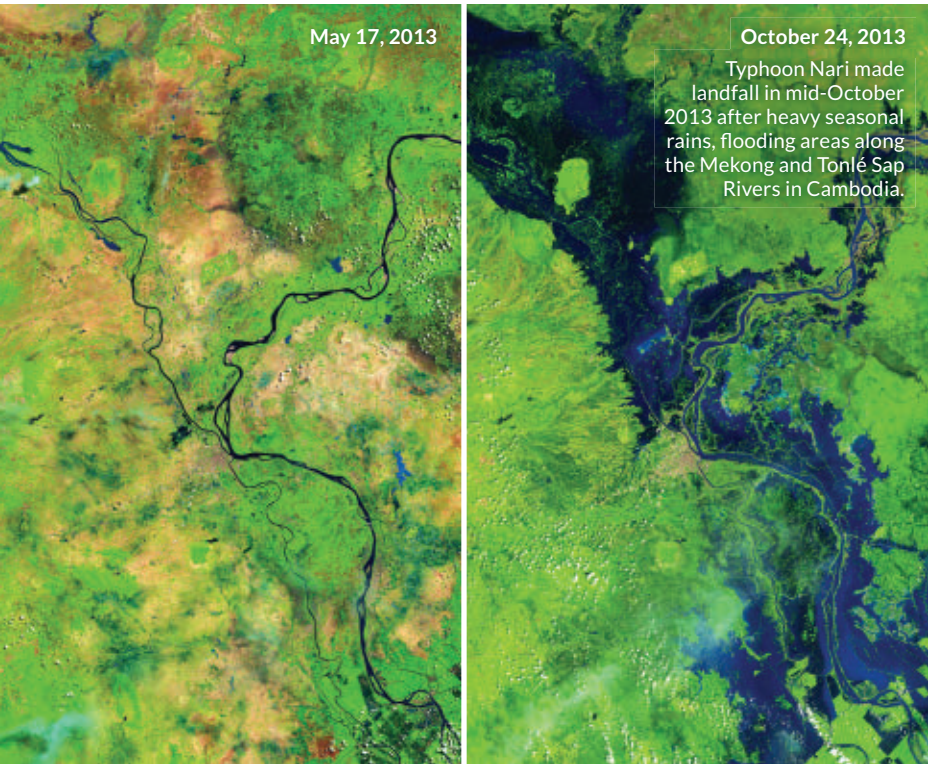
1-888-960-3145

Call now Toll-Free and mention your special promotion code 51143.

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

80973

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



SCREENTIME

Eye in the sky

NASA images show before-and-after scenes of Earth

As many a medieval castle-builder knew, the view from above is a privileged one. Now, with its free Images of Change iPad app and online gallery, NASA makes the aerial perspective available to all, with results both stunning and disturbing. For several decades, the agency's Earth-observing satellites have been capturing dramatic views of land-changing events such as fires, tornadoes and mudslides. To see individual glaciers receding, however, the app's ground-based photos showing green meadows replacing icebergs make the point best. Urban change proves equally profound: An 1830s map alongside a satellite view of modern Boston shows that some of the country's most expensive real estate occupies land that, until fairly recently, was underwater. Only some images are categorized as "human impact," but nearly all of the changes on land — forest fire, glacier melt, flooding — clearly have a human component. NASA does not explicitly make this point, but upon even a casual wander through the gallery, it makes itself. — *Gabriel Popkin*

A lush meadow grows (bottom, summer 2005) where icebergs calved a century earlier in Alaska (top, summer 1917).

FROM TOP: LANDSAT/USGS, NASA; LOUIS H. PEDERSEN, NSIDC; BRUCE F. MOLNIA, NSIDC

BOOKSHELF

From Dust to Life

The Origin and Evolution of Our Solar System

John Chambers and Jacqueline Mitton

In about 300 pages, this book sums up the history of all that matters — or at least everything made of matter — from the Big Bang to life on Earth.

This wild ride across the cosmos and through time covers a lot of territory, but isn't merely a laundry list of observations. Instead, readers will find one lucid explanation piggybacked onto another. Chapters show how energetic particles first organized into atoms, then molecular clouds (the star factories), then protoplanetary disks and eventually the diverse residents of our planetary neighborhood including asteroids, Pluto and its plutino neighbors.

The authors, a planetary scientist and a space sciences writer, make celestial mechanics comprehensible even to readers with more curiosity than scientific background. Yet there are still insights for those who regularly pore over the astronomy stories in *Science News*. Best of all, the authors help readers glimpse the why of it all.

If you've ever wondered, for instance, why the inner solar system harbors rocky planets with perhaps a moon or two while the outer reaches nurture giants, each towing more than a dozen satellites, you'll find the provocative answer here (it involves an embryo planet's gravitational "reach"). Particularly striking is imagery describing the structure of the gas and ice giants (Jupiter through Neptune), such as droplets of helium and neon forming "a continuing drizzle" as they descend through storm eddies toward the Jovian interior.

But breadth comes at a price: This isn't a page-turner. I would have sacrificed some of the book's fine explanations for a glimpse of the personalities of those who advanced our understanding of the universe's origins, sometimes against prevailing views of the times. — *Janet Raloff*
Princeton Univ., $29.95

See more NASA images at **bit.ly/SNnasachange**

HARBOR FREIGHT TOOLS

Quality Tools at Ridiculously Low Prices

LIFETIME WARRANTY ON ALL HAND TOOLS!

FACTORY DIRECT SAVINGS

How does Harbor Freight sell great quality tools at the lowest prices? We buy direct from the same factories who supply the expensive brands and pass the savings on to you. It's just that simple! Come in and see for yourself why over 25 million satisfied customers and leading automotive and consumer magazines keep talking about our great quality and unbeatable prices. Visit one of our 500 Stores Nationwide and use this 25% Off Coupon on one of over 7,000 products*, plus pick up a Free 6 Piece Screwdriver Set, a $4.99 value.

- We Will Beat Any Competitor's Price Within 1 Year Of Purchase
- No Hassle Return Policy
- 100% Satisfaction Guaranteed

NOBODY BEATS OUR QUALITY, SERVICE AND PRICE!

SUPER COUPON!

25% OFF

ANY SINGLE ITEM!

LIMIT 1 - Save 25% on any one item purchased at our stores or HarborFreight.com or by calling 800-423-2567. *Cannot be used with other discount, coupon, gift cards, Inside Track Club membership, extended service plans or on any of the following: compressors, generators, tool storage or carts, welders, floor jacks, Towable Ride-On Trencher (Item 65162), open box items, in-store event or parking lot sale items. Not valid on prior purchases after 30 days from original purchase date with original receipt. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

97063074

SUPER COUPON!

FREE

PITTSBURGH 6 PIECE SCREWDRIVER SET

ITEM 47770/61313

Item 47770 shown

$4.99 VALUE

WITH ANY PURCHASE

LIMIT 1 - Cannot be used with other discount, coupon or prior purchase. Coupon good at our stores, HarborFreight.com or by calling 800-423-2567. Offer good while supplies last. Shipping & Handling charges may apply if not picked up in-store. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

43291286

SUPER COUPON!

PITTSBURGH AUTOMOTIVE

LOT NO. 68048/69227

RAPID PUMP® 3 TON HEAVY DUTY STEEL FLOOR JACK

SAVE $90

- Weighs 74 lbs.

Item 68048 shown

$69.99

REG. PRICE $159.99

45622704

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

580 LB. CAPACITY FOUR DRAWER TOOL CART US★GENERAL

SAVE $160

LOT NO. 95659/61634/61952

★WINNER★ Silver Medal Truckin' Magazine

Item 95659 shown

$99.99

$154.99

REG. PRICE $259.99

48659665

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

- 70 dB Noise Level

SUPER QUIET!

PREDATOR GENERATORS

4000 PEAK/3200 RUNNING WATTS 6.5 HP (212 CC) GAS GENERATORS

LOT NO. 68528/69676/69729

LOT NO. 69675/69728 CALIFORNIA ONLY

Item 68528 shown

SAVE $200

$299.99

REG. PRICE $499.99

62710956

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

29 PIECE TITANIUM NITRIDE COATED DRILL BIT SET

drill master

SAVE 60%

LOT NO. 5889/61637

Item 5889 shown

$9.99 REG. PRICE $24.99

70399473

LIMIT 8 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

3-IN-1 PORTABLE POWER PACK WITH JUMP STARTER

CENTECH

- 900 Peak Amps

SAVE 33%

LOT NO. 38391/60657

Item 60657 shown

$39.99

REG. PRICE $59.99

68883670

LIMIT 5 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

2.5 HP, 21 GALLON, 125 PSI VERTICAL AIR COMPRESSOR

"The Perfect Compressor with Powerful, Quiet and Consistent Airflow… Plus we Love the Low Price" – Street Trucks Magazine

SAVE $70

$149.99

REG. PRICE $219.99

Item 67847 shown

CENTRALPNEUMATIC

LOT NO. 67847/61454/61693

46180484

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

2.4" COLOR LCD DIGITAL INSPECTION CAMERA

CENTECH

LOT NO. 67979

SAVE $60

Requires four AA batteries (included).

$69.99 REG. PRICE $129.99

80201558

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

17 FT. TYPE 1A MULTI-TASK LADDER

LOT NO. 67646

SAVE $82

- 300 lb. Capacity
- 23 Configurations

$117.99 REG. PRICE $199.99

19764217

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

AUTO-DARKENING WELDING HELMET WITH BLUE FLAME DESIGN

Item 91214 shown

LOT NO. 91214/61610

SAVE 53%

$41.99

$59.99 REG. PRICE $89.99

CHICAGO ELECTRIC WELDING

30910267

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

9" x 6 FT. 2 PIECE STEEL LOADING RAMPS

Haul Master

LOT NO. 44649/69591/69646

Item 44649 shown

$39.99

SAVE 50%

$59.99 REG. PRICE $79.99

- 1000 lb. Capacity

60518556

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

NEW!

CENTRALPNEUMATIC

3/8" x 50 FT. HEAVY DUTY PREMIUM RUBBER AIR HOSE

SAVE 38%

LOT NO. 69580

$18.49

REG. PRICE $29.99

14245676

LIMIT 5 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

SUPER COUPON!

- 9060 GPH

2" CLEAR WATER PUMP WITH 6 HP GAS ENGINE (212 CC)

Item 68375 shown

PACIFIC HYDROSTAR

LOT NO. 69774/68375/61986

SAVE $90

$159.99

REG. PRICE $249.99

65936639

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 6/8/14. Limit one coupon per customer per day.

Order at HarborFreight.com or 800-423-2567

We FedEx Most Orders in 24 Hours for $6.99

500 Stores Nationwide

DECEMBER 28, 2013

"From the centerpiece of God's creation to a shelter for bacteria and fungi.... Oh, how the proud human has fallen. Good thing, too."

MIKE O'BRIEN, ONLINE COMMENT, "YOUR BODY IS MOSTLY MICROBES"

Counting up microbes

The *Science News* top story of 2013 was reported in "Your body is mostly microbes" by **Tina Hesman Saey** (*SN: 12/28/13, p. 18*). The article noted that "only about 10 percent of a person's cells are human; microbes make up the other 90 percent." Several readers noted that although microbes make up 90 percent of a person's total number of cells, most of a person's mass is quite human. "The unsuspecting reader of this article may be led to believe that the human body consists of 90 percent bacteria by weight," **Dietrich Marcuse** e-mailed. But microbial cells are smaller, and lighter, than human cells on average.

Calvino Rabeni suggested online that the percentage of a human's biomass composed of microbes would be a more telling number, to which **Scott Linford** replied, "More telling in what way? True, our little friends are little. So is the 90/10 ratio misleading, just hype? No. Because those little guys have millions of active genes. Millions of distinct proteins inside us and yet not human. And that ratio will blow 90/10 out of the water."

Hesman Saey responds: "While it's true that microbes account for only 1 to 3 percent (perhaps a couple kilograms) of an adult human's body weight, there are at least 150 bacterial genes for each of the 22,000 or so human genes in the body. A 2010 study in *Nature* found 3.3 million different bacterial genes in human intestines alone, many of which enable microbes to make nutrients and break down foods that humans can't on their own."

Wonders of engineered parts

The year's No. 2 story was "Bioengineers make headway on human body parts" by **Meghan Rosen** (*SN: 12/28/13, p. 20*). Scientists have more work to do to make artificial organs truly functional, **bf1x@comcast.net** noted online. "To think, after all the work getting the structures, the researchers will need to consider re-creating any beneficial epigenetic changes in a natural organ. They also might need to consider bathing these organs in the same organic stew real ones grow in, not just the nutrients, but immunological factors and others. These are exciting times, with much progress to be made."

How to map the universe

In the No. 3 story of the year, "Planck refines cosmic history" (*SN: 12/28/13, p. 21*), **Andrew Grant** wrote about measurements of radiation left over from the Big Bang. Science Visualized on Page 40 of the same issue showed data collected by the Planck space telescope at a variety of microwave and infrared frequencies. **Jesse Stoner** e-mailed to ask about the layout of such maps. "These so-called maps never have any reference as to what direction the radiation is coming from," Stoner writes. "What causes the maps to be oval? If they represent a view from Earth in all directions, shouldn't they be round? And what is the band across the center of the oval?"

Grant says that the maps' oval shape is a way to depict a 3-D universe in two dimensions, just as atlases include various 2-D projections of the spherical Earth. The band across the center of each map is the plane of the Milky Way, including the galaxy's dust.

Online reader **John Landwehr** had another question spurred by Planck's view of the universe. If, as stated in Grant's story, "the universe began as a smooth ball of energy that then expanded uniformly in all directions," Landwehr wrote, why haven't scientists found the origin point in the universe where the Big Bang occurred?

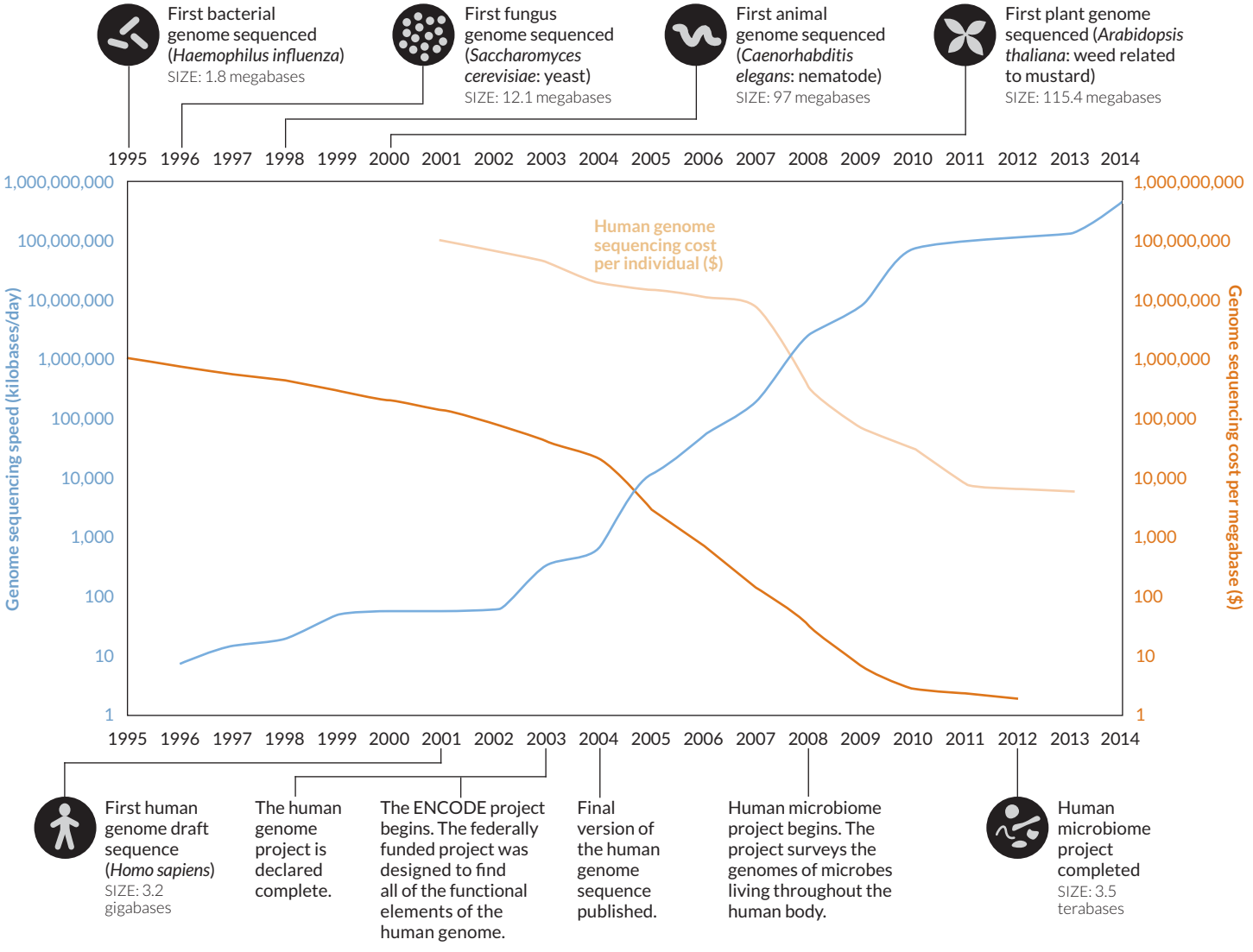
Grant replies that it's important to remember that there is no space outside the universe. "The universe is expanding because the distance between objects within it is increasing," he says. "Space itself is getting stretched out. Extrapolate backward and those distances go to zero. That brings us to the moment of the Big Bang. Since then each point in the universe has spread apart from the others, with no central origin point. No matter your location in the universe, distant objects appear to be moving away in all directions."

Join the conversation

E-MAIL editors@sciencenews.org

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

Connect with us



The gene sequencing future is here

As recently as the 1980s, scientists collected genetic data by laboriously tracking the migration of DNA molecules through slabs of gel. Now researchers stand by as machines gush billions of letters, or bases, of DNA code a day. In the last two decades, the speed of sequencing has leapt from around 10,000 bases per day per machine to more than 1 billion (blue). Since the introduction of high-throughput machines in the mid-2000s, costs have plummeted (orange) and the price of sequencing a person's genome (gold) is tumbling toward the long-anticipated figure of $1,000. The biggest expense in sequencing a human genome now is the cost of storing the information, says Scott Kahn, vice president of commercial enterprise informatics at Illumina, a San Diego biotech company specializing in high-throughput sequencing. Someday soon, he says, it may be cheaper to resequence a person's genome each time the data are needed than to store the information as 1s and 0s. — *Beth Mole*

DNA FIRE HOSE

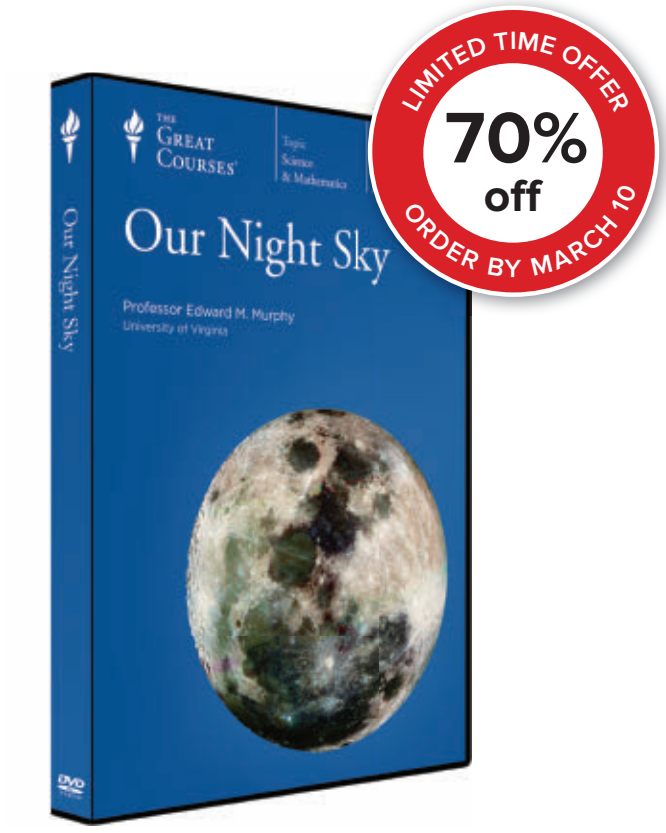
36,000

streaming HD movies

Equivalent raw data flow of one Life Technologies Ion Proton P2 sequencing machine

FROM TOP: E. OTWELL; LIFE TECHNOLOGIES

THE GREAT COURSES®



Learn How to Become an Expert Stargazer

For thousands of years, the star-filled sky has been a source of wonder, discovery, entertainment, and instruction. All you need to feel at home in its limitless expanse is **Our Night Sky**, a richly illustrated 12-lecture course that gives you an unrivaled tour around the sky—all while teaching you about the science, technology, and pure pleasure of stargazing. With award-winning astronomer and professor Edward M. Murphy, you'll learn how to use a star map to orient yourself at any date and time; how to read coordinates to locate planets, constellations, and other objects; how to select the best equipment; and more.

From asteroids to the zodiac, from the Big Dipper to variable stars, **Our Night Sky** provides a comprehensive overview of what there is to see and the best way to see it, whether you are a novice observer or an old hand at astronomy.

Offer expires 03/10/14

1-800-832-2412

WWW.THEGREATCOURSES.COM/5SN

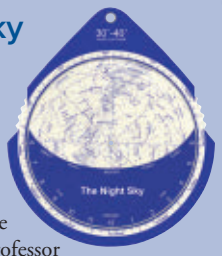
Our Night Sky

Taught by Professor Edward M. Murphy
UNIVERSITY OF VIRGINIA

LECTURE TITLES

1. The Constellations and Their Stars
2. Seeing and Navigating the Sky
3. Using Binoculars and Backyard Telescopes
4. Observing the Moon and the Sun
5. Observing the Planets with a Telescope
6. Meteor Showers, Comets, Eclipses, and More
7. The Northern Sky and the North Celestial Pole
8. The Fall Sky
9. The Winter Sky
10. The Spring Sky
11. The Summer Sky
12. The Southern Sky and the Milky Way

The Night Sky Planisphere included FREE!



Along with this course, you will receive the same Night Sky Planisphere Star Chart used by Professor Murphy throughout his lectures. This sturdy, easy-to-use star finder is an invaluable aid for locating major constellations and stars visible in the Northern Hemisphere.

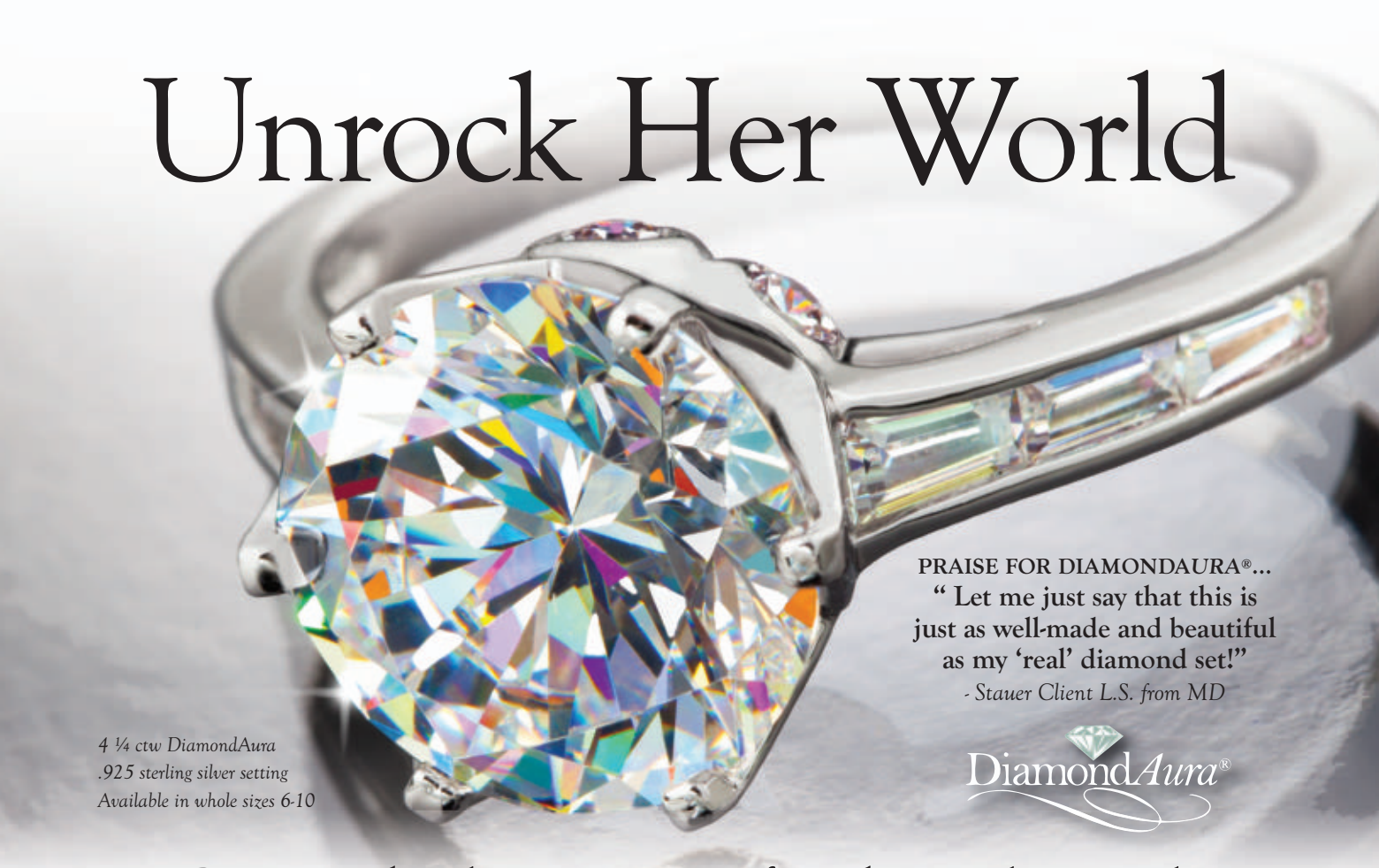
Our Night Sky
Course no. 1846 | 12 lectures (30 minutes/lecture)

SAVE $155

DVD ~~$199.95~~ NOW $44.95
+$5 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 95515

Designed to meet the demand for lifelong learning, The Great Courses is a highly popular series of audio and video lectures led by top professors and experts. Each of our nearly 500 courses is an intellectually engaging experience that will change how you think about the world. Since 1990, over 14 million courses have been sold.

Unrock Her World



4 ¼ ctw DiamondAura
.925 sterling silver setting
Available in whole sizes 6-10

PRAISE FOR DIAMONDAURA®...
" Let me just say that this is just as well-made and beautiful as my 'real' diamond set!"
- Stauer Client L.S. from MD

DiamondAura®

Because she deserves more fire than a diamond.

You want to impress the woman of your dreams. You want her to see you as romantic, thoughtful and smart. But you don't want to fork over a fortune for a microscopic piece of "forever." Thankfully, the ***Ziara Ring*** shows that there's a better, bigger and bolder way to win her heart and "unrock" her world. And it's all yours for **ONLY $99!**

Diamonds are history. Bypass the mines. Ignore the price-controlling cartels. Forget the overpriced shops along Fifth Avenue. The Diamond Myth dominated the 20th-century, but now there is cold, hard scientific proof that Stauer's exclusive lab-created Diamond*Aura*® is the brightest jewelry idea in the last 100 years. Gem experts agree that the centerpiece of our 4¼-carat ***Ziara Ring*** doesn't just visually compare to the rarest, most expensive mined white diamonds on the planet... it surpasses them!

EXCLUSIVE BONUS OFFER!
Order today to get these ***FREE*** *1-Carat DiamondAura® sterling-silver studs* ***PLUS*** *$300 in Stauer Gift Coupons!**

Science, not fiction. Thanks to Diamond*Aura*, you can experience superior clarity and larger carat weights without the outrageous cost of natural diamonds. The Diamond*Aura* process starts with rare minerals heated to high temperatures of nearly 5000°F. After cutting and polishing, scientists create a faultless marvel that's optically brighter and clearer with even more color and fire than a "D" flawless diamond... for a fraction of the price!

Not available in stores. Our ***Ziara Ring*** features a spectacular 4-carat, lab-created Diamond*Aura* brilliant with baguettes set in .925 sterling silver. If you'd rather have a mined diamond, we found a 4-carat D flawless online for $370,467. Ridiculous? We think so.

Your satisfaction is 100% guaranteed. No words or pictures do Diamond*Aura* justice. You need to experience the sparkle up close. If for any reason you don't fall in love with your ***Ziara Ring,*** simply send it back it within 30 days for a full refund of your $99 purchase price.

Exclusive DOUBLE BONUS Offer! While supplies last, we'll also send you our 1-ctw sterling silver Diamond*Aura* Studs ($99 value) for **FREE**! * Plus, when you call today, you'll also get $300 in Stauer Gift Coupons ($25 to use every month for 12 months with no minimum purchase required)! Even if you return the ring, you're welcome to keep the **FREE** studs (and coupons)! There's never been a better time to unrock her world!

Stauer®
14101 Southcross Drive W.,
Dept. ZDR207-01
Burnsville, Minnesota 55337
www.stauer.com

ACCREDITED BUSINESS
Rating of A+

Call now to take advantage of this fantastic offer.
1-800-806-1648
Promotional Code ZDR207-01
Please mention this code when you call.

DiamondAura® Ziara Ring
(4 1/4 ctw) **$99**
Include $99 Stud Earrings
(1 ctw) ~~$198~~
NOW BOTH ONLY — **$99** + S&P

Smart Luxuries—Surprising Prices™