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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ SEPTEMBER 7, 2013

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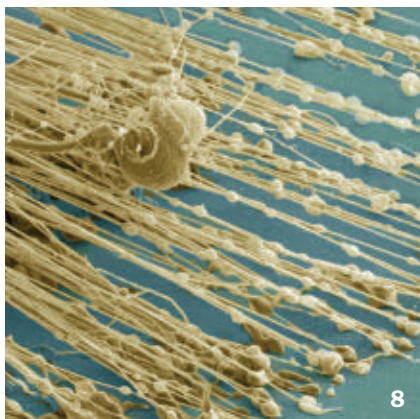
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In The News

5 STORY ONE

- 'Happiness ratio' rests on bad math

8 GENES & CELLS

- DNA profile reveals chaos that famous cancer cell line uses to grow

9 MATTER & ENERGY

- Combining transistors boosts speed, efficiency
- Chip-like device reliably teleports quantum data

10 MIND & BRAIN

- Leaving for lunch derails attention to detail at work
- Natural light shifts sleep-wake schedules

11 ENVIRONMENT

- Sea sponges boom after Antarctic ice shelf busts

12 LIFE

- Evolution of meat eaters attributed to oxygen
- Forest corridors foster genetic diversity in tigers
- Warmer climate may alter animals' behavior
- Noise of the modern world deafens bats to sounds of potential prey

14 HUMANS

- Y chromosome analysis moves Adam closer to Eve

Features

16 FAMILIAR FACES

COVER STORY: People who never forget a mug are teaching scientists about how we know who we've seen before.
By Susan Gaidos

22 EVERLASTING LIGHT

New measures of the faint, remnant glow of ancient stars give astronomers a better view of the history of the universe.
By Alexandra Witze

26 LIFE UNDER ICE

DNA from two miles down suggests that Antarctica's largest subglacial lake could support a full-fledged ecosystem.
By Rachel Ehrenberg

Departments

2 FROM THE EDITOR

4 NOTEBOOK

30 BOOKSHELF

31 FEEDBACK

32 PEOPLE

Harold Harlan regularly gives blood — to bedbugs.



COVER Super recognizers never forget a face. Scientists want to know if their powers are functionally distinct or enhancements of normal abilities.
Toni Guerra Photography, S. Egts

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FROM THE EDITOR

Science News, a gem deserving of discovery



I remember discovering *Science News* in college, more years ago than I care to share. Standing amid rows and rows of magazines and journals in the library, *Science News* was a surprise to me. On almost every one of its admittedly few pages, there was an item that I could not only read and mostly understand but that also fed my insatiable desire

to learn about the world and how it works. Each article was like a little gift, an intellectual present. I hadn't known that such a magazine existed, or that there were people who actually talked and wrote about science for a living.

Later, after working as a tech in a lab for nearly a year and struggling unsuccessfully for months to clone a gene from the retina of a striped bass (that was quite a project back then and I didn't, as they say, have "good hands"), thoughts of *Science News* and its ilk kept bobbing into my consciousness. My favorite part of the week, I came to realize, was Friday lab meeting, and not just because we ate delicious pastries. My lab mates would share tidbits from interesting papers they were reading and discuss results of their experiments, asking for feedback on what they might do next. Every Friday, if only on that day, I loved my job.

It wasn't long before I quit, went on a four-month backpacking trip to Indonesia and Australia, thought a lot and then applied for a graduate program in science writing at my alma mater, UC Santa Cruz. At my interview for the program, when asked what kind of things I wanted to write, I pointed to *Science News*. What interested me then, and what still interests me now, is to learn about and share — in a way that everyone can follow — what we know about how things work and how we know it.

All of this is a preamble of sorts to a number of changes *Science News* will be introducing in the magazine, on the website and to the iPad tablet edition in coming months. I will be sharing more details soon, but know that our efforts are designed to help more people discover and enjoy *Science News*. These days, people are less likely to stumble across it in an actual library. We need to do a better job of letting people know it exists, and once they find it, making sure they can read it on any platform they wish. Still, no matter the packaging, *Science News* will always be most concerned with reporting on science as it happens. And making sure its pages are full of intellectual gems. — *Eva Emerson, Editor in Chief*

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The First The Last The ONLY!



Actual size
is 30.6 mm

50 Years later the 1964 Silver Proof Set still shines bright

On November 25, 1963, just three days after the tragedy in Dallas, the U.S. Mint began work on the 90% Silver Kennedy Half Dollar. It would prove to be one of the most popular half dollar designs in our nation's history. Not surprisingly, when Americans discovered that the brand new Kennedy Half Dollar was the centerpiece of the 1964 U.S. Silver Proof Set, demand immediately soared through the roof!

By January 11th, 1964, the Mint was forced to halt orders for the 1964 Silver Proof Set, and eventually had to reduce the original maximum order of 100 Proof Sets down to just 2 sets per buyer in the face of such staggering demand. Finally, on March 12, even the limit of 2 sets was halted because the Mint received orders for 200,000 Proof Sets in just two days!

Fifty years later, the 1964 Silver Proof Set is still in great demand.

Why? Because this set is chock full of "Firsts", "Lasts" and "Onlys":

1964 Proof Set Firsts, Lasts & Onlys

- ✓ The **FIRST** year Kennedy Half Dollar Proof
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- ✓ The **LAST** Proof Set struck at the Philadelphia Mint
- ✓ The **LAST** year the Roosevelt Dime, Washington Quarter and Kennedy Half Dollar were struck in 90% silver for regular production
- ✓ The **ONLY** 90% Silver Kennedy Half Dollar Proof ever minted for regular production
- ✓ The **ONLY** Kennedy Half Dollar Proof struck at the Philadelphia Mint

As we approach the 50th Anniversary of JFK's 1963 assassination this year, the 1964 U.S. Silver Proof Set is back into the spotlight again. Each set contains the 1964 Lincoln Cent and Jefferson

Nickel, along with three 90% Silver coins: the Silver Roosevelt Dime, Silver Washington Quarter, and the 1964 Silver Kennedy Half Dollar—the only 90% Kennedy Half Dollar ever struck for regular production.

Saved from destruction—but how many sets survived?

Collectors know that the key is to find those sets still preserved in the original U.S. Mint "flat pack" just as issued. And over the past 50 years, that has become more and more difficult! Since this set was issued, silver prices have risen from \$1.29 per ounce to over \$48 per ounce at the silver market's high mark. During that climb, it is impossible to determine how many of these 1964 Proof Sets have been melted for their precious silver content. The packaging on thousands of other sets has been cut apart to remove the silver coins—so there is no way to know for certain how many 1964 U.S. Proof Sets have survived to this day.

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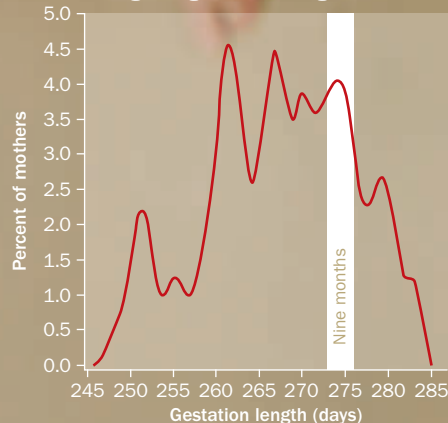
Science Stats

NOT REALLY NINE MONTHS

The length of human pregnancy varies naturally by five weeks, researchers have found. A new study followed 125 women from conception to live single births and found the longest pregnancies in women who were older, had previously had long pregnancies or were themselves heavier at birth.

SOURCE: A.M. JUKIC ET AL/HUMAN REPRODUCTION 2013

Percentage of mothers with given gestation length



50 Years Ago

Excerpt from the
September 7, 1963, issue
of *Science News Letter*

PORPOISES CAN TEACH MAN MARINE DIVING, DETECTION

Cetaceans — the technical term for whales and porpoises — can give scientists a fund of valuable information for developing our mechanical equipment, especially for target detection and identification, and for long-range underwater communication and navigation, stated Dr. Sidney R. Galler, head of the biology branch of the biological sciences division, Office of Naval Research.... The ability of a porpoise to detect and identify targets is highly interesting to the Navy, stated Dr. Galler, as is its accuracy in moving silently and rapidly towards them.... He also noted the porpoise's ability to dive and surface efficiently and silently, as well as to calculate the trajectory of a ball or fish and catch the object.

UPDATE: Today, the U.S. Navy Marine Mammal Program studies and trains bottlenose dolphins and California sea lions. The animals learn to detect underwater mines and help rescue swimmers. Military dolphins (such as K-Dog, shown below wearing a locating device) marked the locations of mines in the Persian Gulf during the Iraq War. The Navy says it “does not now train, nor has it ever trained, its marine mammals to harm or injure humans in any fashion or to carry weapons to destroy ships.”



For Daily Use

MAN'S EMPATHETIC BEST FRIEND

Here's something for dog owners to try: Offer a big yawn and see if Fido yawns back. In humans, contagious yawning activates neural circuits involved in social skills and empathy. Domestic dogs, known for their ability to pick up on human social cues, seem to pick up on human yawns as well. Researchers at the University of Tokyo found that dogs often yawn after a human yawns. What's more, dogs were more likely to yawn in response to their owner's yawn than to a stranger's. This bias toward familiar people suggests that a rudimentary form of empathy may be at work in dog brains, the researchers conclude August 7 in *PLOS ONE*. —Allison Bohac



Say What? | SHERGOTTITE \SHER-goh-tite\ n.

The most common kind of Martian meteorite. First discovered in Shergotty, India, in 1865, these rocks originally come from Martian volcanoes. Shergottites (one shown below) give geologists clues to the composition of Mars' mantle, the layer beneath the crust. Geologists J. Brian Balta and Harry Y. McSween Jr. of the University of Tennessee say that data from shergottites, and from Mars missions such as the Spirit and Opportunity rovers, indicate that the Red Planet's mantle was once wet but lost its water through degassing. Volcanoes may have brought the water to Mars' surface, where it could have weathered rocks to clays and even supported life, the researchers report July 30 in *Geology*. —Sarah Zielinski



“ Being a little less focused could be good or bad, depending on the situation. ” —PAUL ROZIN, PAGE 10

Humans Adam, meet Eve

Matter & Energy Info takes quantum leap

Mind & Brain Long lunch breaks focus

Environment Sponges bloom after ice goes

Life Habits change with warmer climate
Oxygen aided meat eaters' evolution

Genes & Cells HeLa cells' power revealed

In the News

STORY ONE

Ratio for a good life exposed as 'nonsense'

Highly touted measure of emotional health criticized as mathematical disaster

By Bruce Bower

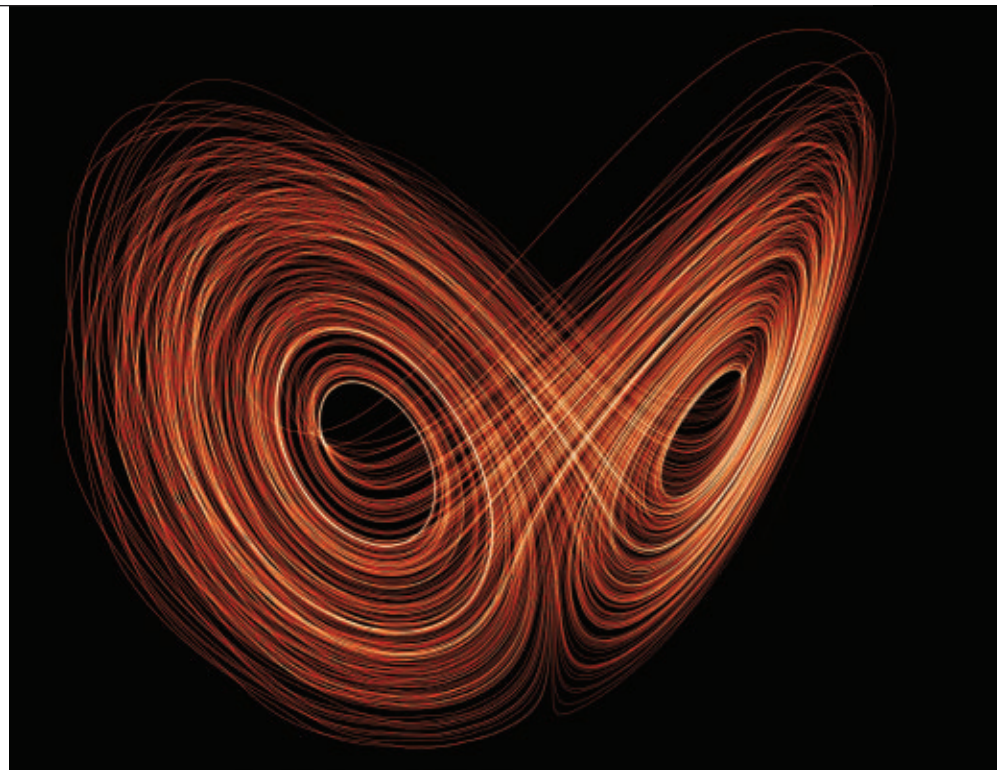
A 52-year-old, part-time graduate student with no previous training in psychology and little math education beyond high school has knocked a celebrated measure of the emotional mix needed to live well off its mathematical pedestal.

Nicholas Brown, who is completing a master's degree in applied positive psychology at the University of East London in England, teamed up with two colleagues to demolish the math at the heart of a widely cited October 2005 *American Psychologist* paper that claimed to identify the precise ratio of positive to negative emotions that enables life success. The researchers' takedown of what's known as the critical positivity ratio appears July 15, also in *American Psychologist*.

"It's slightly worrying to discover that a leading journal could publish an article with so many obvious errors in it," Brown says.

His report joins a movement in psychology to clean up lax research practices (*SN*: 6/1/13, p. 26).

One of Brown's coauthors is physicist Alan Sokal of New York University. Sokal gained notoriety in 1996 by publishing



Edward Lorenz was studying fluid dynamics 50 years ago when he developed a set of equations that, when graphed, trace out an oscillating pattern that is extremely sensitive to small perturbations. The equations, which became a foundation of chaos theory, were improperly applied in 2005 to research on happiness.

an intentionally nonsensical paper in a leading journal of cultural studies.

Psychologist Barbara Fredrickson of the University of North Carolina at Chapel Hill and psychologist Marcial Losada, head of Losada Line Consulting in Brasilia, Brazil, coauthored the 2005 paper. In a response published alongside the new critique, Fredrickson acknowledges that their paper employed "now questionable mathematics." But she devotes most of her response to shorting up the argument of the 2005 paper by describing evidence that people do best when positive feelings

exceed negative feelings by a factor of about 3 to 1—roughly equivalent to the contested critical positivity ratio.

Responding to a request for comment, Fredrickson told *Science News* that she's "not speculating any further on these issues." Losada, whose firm uses the ratio when advising companies on improving employee productivity, declined to write a response to Brown's paper.

Brown first read Fredrickson and Losada's paper in November 2011 as a class assignment. The study used mathematical equations known as Lorenz equations to calculate how positive



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and negative human emotions change over time. In 1963, mathematician Edward Lorenz published the equations to model how fluids change over time. Fredrickson and Losada used the equations with emotion data from volunteers tracked for 28 days. The researchers determined that creativity, helpfulness to others and other elements of “flourishing” characterized people who displayed a ratio of positive to negative emotions above 2.9013:1 and below 11.6346:1.

People whose balance of emotions fell outside that range “languished” in an unproductive state, the two psychologists concluded. Their report emphasized the lower ratio as the critical threshold to cross in order to flourish in life.

Upon reading the 1963 Lorenz paper “with some difficulty,” Brown realized that the equation Fredrickson and Losada used to calculate the critical positivity ratio had no connection to their emotion data: Regardless of the volunteers’ data points, the equation would simply generate the same, meaningless number.

Brown then asked Sokal and psychologist Harris Friedman of the University

“What’s shocking is not just that this piece of pseudomathematical nonsense received 322 scholarly citations and 164,000 web mentions, but that no one criticized it publicly for eight years, not even supposed experts in the field.” —ALAN SOKAL

of Florida in Gainesville to analyze the 2005 paper more completely.

“What’s shocking is not just that this piece of pseudomathematical nonsense received 322 scholarly citations and 164,000 web mentions, but that no one criticized it publicly for eight years, not even supposed experts in the field,” Sokal says.

Brown and his colleagues’ sacking of the critical positivity ratio is on the mark, comments mathematician Colin Sparrow of the University of Warwick in England, who studies Lorenz equations.

The equations belong to the field of nonlinear dynamics, which describes how small changes in a few variables that evolve independently — mainly in physics and chemistry — can lead to complex consequences.

In the 2005 report, Fredrickson and

Losada failed to show how individuals’ self-reported feelings could be mathematically described as quantities that vary smoothly over time, as the Lorenz equations require, Sokal says. Two earlier papers by Losada that examined emotional changes in groups suffered from the same problem, he adds.

Losada and Fredrickson also plugged into key parts of their calculation values that had been adopted by Lorenz for his fluid analysis, Sokal says. There’s no reason to assume those values also apply to emotional changes, rendering the critical positivity ratio “entirely fanciful,” he concludes.

No retraction of the 2005 paper is planned, says psychologist Norman Anderson, editor in chief of *American Psychologist* and CEO of the American Psychological Association in Washington, D.C. ■

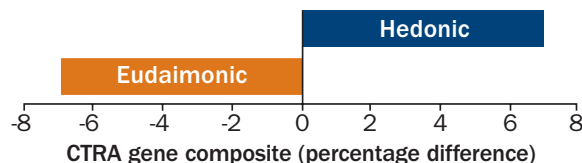
Back Story | THE LATEST RESULTS

People who feel good because they try to achieve noble, meaningful goals display healthy, gene-regulated levels of key immune substances. In contrast, those whose happiness stems from personal indulgences show unhealthy levels of the same immune agents.

That’s the conclusion that psychologist Barbara Fredrickson of the University of North Carolina at Chapel Hill and her colleagues reached July 29 in the *Proceedings of the National Academy of Sciences*. Unlike her 2005 paper on the critical positivity ratio, it took only a week for the new paper to draw fire.

Fredrickson’s group used vague measures of self- and meaning-related happiness that tap into the same mental disposition, argued psychologist James Coyne of the University of Pennsylvania in an August 5 post on his blog, *Mind the Brain*. Any associations of these well-being measures with immune activity “are likely to be artificial and not replicated in future studies,” Coyne wrote. —Bruce Bower

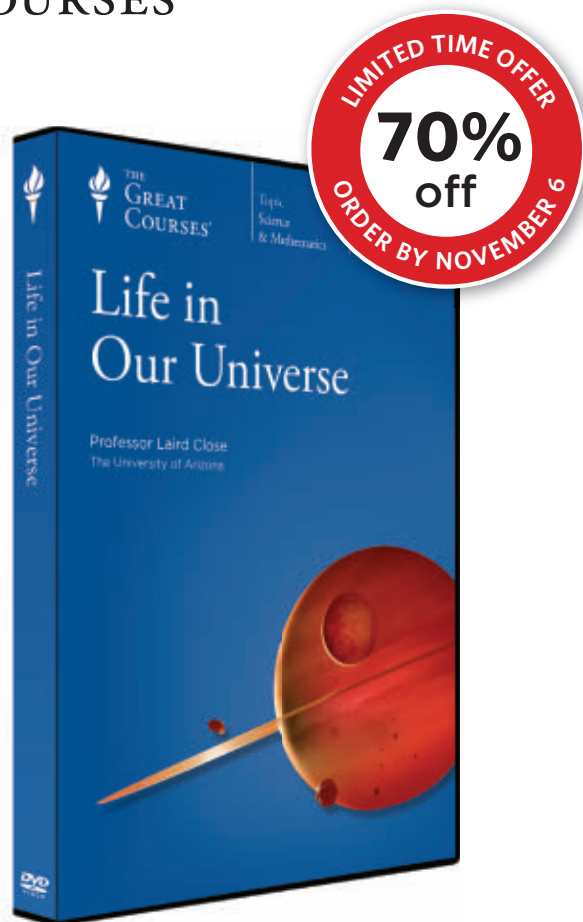
Two study groups: Fredrickson and her colleagues classified 80 happy people into two groups. People were termed “hedonic” if their good feelings generally stemmed from their own pleasant experiences, or “eudaimonic” if their happiness derived from “striving toward meaning and a noble purpose beyond self-gratification.”



The test: Then the researchers measured something called “conserved transcriptional response to adversity,” or CTRA, in both groups. This number reflects the activity of a set of 53 genes that are associated with stress.

The conclusion: People in the eudaimonic group had lower CTRA values than people in the hedonic group, as the graph above illustrates. That pattern suggests that eudaimonic happiness may be much more effective at fostering a long and healthy life, Fredrickson and her colleagues conclude.

SOURCE: B.L. FREDRICKSON ET AL./PNAS 2013



Are We Alone in the Universe?

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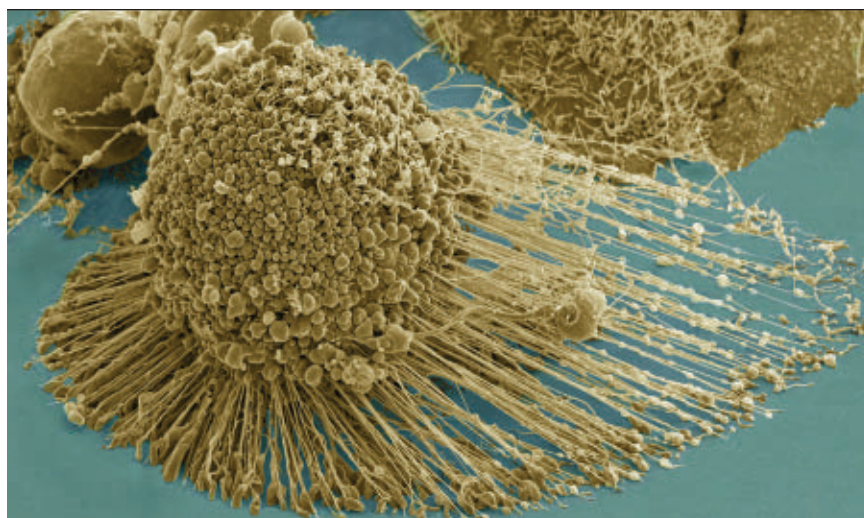
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Genes & Cells

“We no longer have to make assumptions about what the HeLa genome looks like.” —**PETER PARK**



Famed cancer's DNA sorted out

Analysis sheds light on virulence of HeLa cell line

By **Cristy Gelling**

A detailed DNA profile of the world's most widely used cancer cell line sheds light on the genetic chaos the cells use to grow virtually unchecked in the lab. That property may also explain their virulent growth in the woman who unwittingly left them to science.

The famous cells came from a biopsy taken in 1951 from Henrietta Lacks, a woman who was dying from cervical cancer at Johns Hopkins Hospital. Although no one asked Lacks or her family for permission to perform experiments with the cells, they constituted the first immortal human cell line ever successfully grown in the lab. HeLa cells were pivotal in developing a vaccine for polio, among other scientific milestones.

But one problem for researchers using HeLa cells has been that their genome is a scrambled version of a normal human genome. This makes it more difficult to design and interpret experiments using the cells.

The new work, reported by University of Washington researchers in the Aug. 8 *Nature*, will help scientists make better use of HeLa cells by providing information on the arrangement of

HeLa cells, shown in an electron micrograph, grow indefinitely under certain lab conditions. Though collected under dubious ethical circumstances, the cells have been scientifically valuable.

genetic variants on chromosomes.

These details were “long overdue” says Peter Park, a computational biologist at Harvard Medical School. “We no longer have to make assumptions about what the HeLa genome looks like.”

Human cells normally have two copies of each chromosome. Sometimes, a genetic variant differs between the two copies. But standard sequencing methods mix the data together, so it's impossible to figure out which variant is on which chromosome. The University of Washington group overcame that obstacle by using a method that identifies which variants sit together on the same chromosome.

This new level of detail helps reconstruct an event that is thought to have contributed to Lacks' cells becoming cancerous. Scientists already knew that the HeLa genome contained human papillomavirus DNA, which comes from the genome-invading virus that causes nearly all cervical cancers. The virus's

DNA had embedded itself near *MYC*, a human gene that, when erroneously switched on, can cause cells to become cancerous.

The new study found that in chromosomes with viral DNA, the *MYC* gene was turned on. But in matching chromosomes without viral DNA, *MYC* was not active. That meant that the viral DNA probably turns the *MYC* gene on, but only within the same chromosome. The researchers also found that the viral DNA actually touched the *MYC* gene, suggesting it directly causes the different *MYC* activity on the chromosomes. This reveals one of the ways that the invading virus might have enabled Lacks' cancer cells to grow out of control.

“It's a really lovely piece of work,” says geneticist Daniel MacArthur of Massachusetts General Hospital in Boston. “It's a shame that the technical achievements of the authors may be overshadowed by the ethical challenges.”

The HeLa genome sequence was published for the first time in March, by a research group led by Lars Steinmetz at the European Molecular Biology Laboratory in Heidelberg, Germany. These data, published in *G3: Genes, Genomes, Genetics*, mapped out the many rearrangements and mutations that distinguish the HeLa genome from a healthy human genome.

The study sparked a controversy because the sequence was freely available and could potentially be used to infer some of the genetic variants carried by Lacks' family. In response the team withdrew the HeLa sequences from the public database.

The National Institutes of Health has now negotiated an agreement with the Lacks family that restricts access to the HeLa genome and requires future publications based on the data to acknowledge the contribution of Henrietta Lacks and her family. The new arrangement also calls for a panel that includes members of the Lacks family to oversee requests to use the data. ■

Matter & Energy



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Efficiency boosts transistor speed

New device mixes high-performance, low-energy approaches

By Andrew Grant

Combining the engines of a Ferrari and a Honda Civic would not lead to a fast, fuel-efficient car. Yet the simple trick of coupling a power-sipping transistor to a high-speed one has created a transistor that excels in both categories without any obvious weaknesses.

"This is a great advancement," says Adrian Ionescu, a nanoelectronics engineer at the Swiss Federal Institute of Technology in Lausanne. The new transistor could soon find its way into the flash memory chips that store data in computers, tablets and smartphones, Ionescu says.

Transistors, particularly a variety called metal-oxide semiconductor field-effect transistors, or MOSFETs, are building blocks of the electronic

age. They have gates that rapidly open and close to control the flow of electric current within microprocessors and memory chips.

The gates of current MOSFETs are so thin — just several atoms wide — that electrons can burrow through via a phenomenon called quantum tunneling. Scientists have harnessed these tunneling electrons in flash memory chips, but the process requires a lot of energy, most of which goes to waste. "The main showstopper in consumer electronics is power consumption," Ionescu says.

Since 2001, microelectronics engineer Peng-Fei Wang at Fudan University in Shanghai has worked to integrate another type of transistor called a tun-

neling field-effect transistor, or TFET, into mainstream electronics. This relatively new technology cannot compete with MOSFETs for speed, but it can function on very small amounts of energy.

In the Aug. 9 *Science*, Wang and colleagues describe how they built a modified MOSFET with an embedded TFET. Like other MOSFETs used in flash memory, the new transistor exploits quantum tunneling electrons, but the presence of the TFET allows it to run on very little energy. Low power consumption translates to high speed because it takes less time for the circuit to build up to the energy threshold required

for the transistor to work.

Wang's team says that the transistors remain reliable for a quadrillion operations, a billion times as efficient as existing technology. ■

"The main showstopper in consumer electronics is power consumption."

ADRIAN IONESCU

Device gives info a quantum leap

Chip allows data signals to teleport reliably and in full

By Andrew Grant

Quantum teleportation is on its way to becoming routine. A new study demonstrates that quantum information can teleport on demand, for the first time using a device that closely resembles a computer chip.

The techniques laid out in the Aug. 15 *Nature* are major steps toward developing quantum computers and ensuring secure communication over quantum networks, says physicist Eugene Polzik of the University of Copenhagen.

Unlike *Star Trek's* transporters, quantum teleportation does not physically transport objects. Instead it shuttles

information about the properties of an object and incorporates those properties into a new object. For a simple particle like a photon, that's just as effective as moving it: A photon that has the same polarization, energy and other attributes as another photon might as well be the same photon.

Quantum teleportation is not easy to accomplish because the properties of quantum particles are so fragile. Physicists have successfully teleported photons over increasing distances through fiber-

An ant provides scale in this false-color micrograph of the first solid-state device capable of quantum teleportation.



optic cables (*SN: 6/30/12, p. 10*), but the process remains inconsistent.

Now physicist Andreas Wallraff at ETH Zurich and his team have created the first solid-state device, similar to a computer chip, that is capable of teleporting quantum information. The chip contains tiny circuits that each behave like an atom. The circuits are connected by millimeters-long transmission lines carrying microwave radiation, which entangles the circuits so that the properties of one affect the other. By programming a bit of quantum information into circuit A, Wallraff and his team changed the signal arriving at circuit B. They could then use that changed signal to determine the original properties of circuit A and transfer them to circuit B.

Most importantly, Wallraff's teleportation system successfully transports information in nearly every attempt, and it can do it roughly 10,000 times per second, an unprecedented rate. ■

Mind & Brain



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Dining out zaps mental focus

Leaving the office for lunch affects detail-oriented tasks

By Jessica Shugart

Lunch at a restaurant with a friend could lessen the brain's aptitude for detailed tasks back at work. If an error-free afternoon is the goal, perhaps workers should consider hastily consuming calories alone at their desks, a new study suggests.

But bosses shouldn't rush to glue workers to their chairs just yet. The research is only a first stab at teasing out how a sociable lunch affects work performance, says study leader Werner Sommer of Humboldt University in Berlin.

Researchers have long thought that dining with others fosters mental well-being, cooperation and creativity. To test

the effects of a midday social hour on the brain's capacity to get through the workday, Sommer and his colleagues gave 32 women lunch in one of two settings and then tested their mental focus. Half of the women enjoyed meals over a leisurely hour with a friend at a casual Italian restaurant. Those in the other group picked up their meals from the same restaurant, but had only 20 minutes to eat alone in a drab office. People who went out to lunch got to choose from a limited vegetarian menu; participants in the office group had meals that matched the choice of a member of the other group.

After lunch, the group that dined in bland solitude performed better on a task that assesses rapid decision making and focus, the researchers report July 30 in *PLOS ONE*. Measurements of brain activity also suggested that the brain's

error-monitoring system could be running at subpar levels in those who ate out.

Sommer acknowledges that several factors besides the meal context could have affected the results. For instance, the people who ate in the office had no choice of food and did not get to socialize, read or surf the web.

And the news is not all bad for diners out, Sommer says. Being less rigidly focused could come in handy when navigating sticky social situations or solving problems creatively. Sommer's lab is testing the effects of social meals on workers' creativity and generosity.

"Being a little less focused could be good or bad, depending on the situation," says psychologist Paul Rozin of the University of Pennsylvania. "If you're running the control tower at the airport you wouldn't want this. But if you're trying to think of a new idea, you might." ■

"Being a little less focused could be good or bad."

PAUL ROZIN

Camping resets internal clock

A week in the wild pushed back volunteers' sleep-wake times

By Meghan Rosen

A short camping trip could help people rise and shine.

After a week living in tents in Colorado's Rockies, volunteers' internal clocks shifted about two hours earlier, transforming night owls into early birds, researchers report in the Aug. 19 *Current Biology*.

"It's a clever study, and it makes a dramatic point," says Katherine Sharkey, a sleep researcher and physician at Brown University. People get much more light outside than they do indoors, and that can reset their internal clocks, she says.

A master clock in the brain controls the release of melatonin, a hormone that prepares the body for sleep. Melatonin levels rise in the early evening and then taper off in the morning before a person wakes up.



After a week of camping (and away from artificial light) in Colorado, volunteers fell asleep and woke up earlier.

But because so many people spend their days indoors and their nights bathed in the glow of electric lights, the body's clock can get out of sync. Melatonin levels ramp up later in the evening and ebb later in the morning — often after a person has woken up. The lingering sleep hormone can make people groggy.

Kenneth Wright Jr., a sleep researcher at the University of Colorado Boulder, and colleagues whisked eight volunteers away from artificial lights for a summer camping trip. After nightfall, the campers used only campfires for illumination — no flashlights (or cellphones) allowed.

While camping, the volunteers soaked up four times as much light as they got indoors. And they went to sleep and naturally woke up more than an hour earlier than they had before the trip. After the trip, the volunteers' melatonin levels climbed around sunset and petered out at sunrise — two hours earlier than they had before camping.

People might not even need to rough it to nudge their internal clocks back. Because typical office lighting is about 500 times dimmer than the light of a midsummer day, even brief stints outside could help.

"Start your day off with a morning walk, and open the shades to expose yourself to sunlight," Wright advises. ■

COURTESY OF K. WRIGHT JR.

Environment

1,500
square kilometers

Area of 1995
Larsen A ice
shelf collapse

3,250
square kilometers

Area of 2002
Larsen B ice
shelf collapse

Ice shelf busts, sponges boom

Creatures emerge in Antarctic after Larsen A collapse

By Jessica Shugart

When a catastrophic ice shelf collapse in Antarctica opened up prime seafloor real estate, enterprising creatures called glass sponges showed up with unprecedented speed to stake their claim. The finding suggests that even in frigid places, sea life may adapt rapidly to climate change.

Cloaked in darkness and cut off from the photosynthetic power of the sun, the waters beneath Antarctic ice shelves generally host sparse signs of life. But when a giant shelf collapses — as Larsen A and B did in 1995 and 2002

(SN 4/29/95, p. 271; 12/21/02, p. 400) — solar-powered plankton production ramps up. Scientists think the increase could jump-start a complex food web of diverse marine life.

A 2007 expedition revealed that sea squirts had taken over the area of the seafloor once shaded by Larsen A. When Claudio Richter of the Alfred Wegener Institute in Bremerhaven, Germany, and his team went to the same spot in 2011 to see how the squirt coup had progressed, they were shocked at what they found instead.

“The sea squirts were gone, and all of a sudden the glass sponges had tripled” in number, Richter says.

The discovery, published in the July 22 *Current Biology*, surprised Richter because scientists had previously seen the vase-shaped sponges, known as hexactinellids, growing at a slow pace that would have them maturing in

Glass sponges, which provide habitat for feather and brittle stars in frigid Antarctic waters, flourished following the collapse of the Larsen A ice shelf.



decades. The signals that triggered the sponge boom remain enigmatic.

“This sudden expansion of a glass sponge is unprecedented,” says Paul Dayton of the Scripps Institution of Oceanography in La Jolla, Calif. But he thinks the boom is only temporary, as other predators will probably take over. ■


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Oxygen aided carnivore evolution

Explosion of animal diversity attributed to rise of predators

By Erin Wayman

A rise in oxygen more than half a billion years ago paved the way for the origin of the first carnivores. The meat eaters in turn triggered the Big Bang of animal evolution, researchers argue.

The major groups of modern animals — everything from insects to creatures with a backbone — popped up 540 million to 500 million years ago in a proliferation known as the Cambrian Explosion. But both fossil and molecular evidence hint that the most primitive animals appeared a couple hundred million years earlier, leading scientists to wonder about the cause of the lag.

Now scientists have stitched together theories to come to a comprehensive explanation. Erik Sperling, an earth scientist at Harvard University, and colleagues say an increase in oxygen in the geologic record at the onset of the Cambrian period allowed carnivores to evolve. The oxygen boost could have accommodated the high energy costs of pursuing and digesting prey, Sperling says.

Once carnivores arrived, an evolutionary arms race broke out between predator and prey, the team suggests July 29 in the *Proceedings of the National Academy of Sciences*. As prey evolved new defenses and predators developed new weapons, new kinds of animals sprung up.

Support for the oxygen-carnivore theory comes from modern polychaetes, tiny earthworm relatives that live on the seafloor and vary in their feeding habits. Combing through data from previous studies on polychaetes, Sperling's team examined 962 worm species from 68 locations worldwide. The researchers found a clear association: The number of carnivorous species was lower in areas with the lowest oxygen levels. In some of these regions, predatory polychaetes were completely absent.

Previously, scientists invoked either an oxygen increase or an arms race to account for the Cambrian Explosion, says Guy Narbonne, a paleobiologist at Queen's University in Kingston, Ontario. Linking oxygen to carnivores provides strong evidence that the two



Polychaetes (one shown) vary in their diet, but carnivorous species are rare or absent in low-oxygen areas.

explanations are “intimately interrelated,” he says.

Paleobiologist Nicholas Butterfield of the University of Cambridge sees the data differently. He thinks the rise of oxygen was actually an effect of the animals on the environment. He contends that shallow marine areas, where early animals most likely lived, were probably well oxygenated and therefore a lack of the gas did not stifle their evolution. It just took a while for a burst of complex animals to arise from simpler ones, he says. “It takes a whole lot of tinkering and experimenting and false starts until you trip over something that works.” ■



Tigers mingle in forest corridors

Endangered tigers' habitats have been carved up in central India, but the cats still prowl through strips of forest that connect these far-flung populations, a new study finds. These corridors enable the estimated 273 tigers in the area to intermingle and stay genetically strong, researchers report July 31 in the *Proceedings of the Royal Society B*.

Using historical data and genetic analyses, Sandeep Sharma of the Smithsonian Conservation Biology Institute in Washington, D.C., and his colleagues illuminated the tigers' story: In recent centuries, as roads, factories, mining operations and railroads started to impinge on wild terrain, India's tiger population splintered into smaller, distinct groups. But several of these groups remain connected by tendrils of pristine forest, the researchers found, allowing the cats to maintain a healthy mix of genes.

Currently, these forest pathways have no legal protection in India. A mining company has just applied for a lease that would sever one corridor in the study, Sharma says. Such a split could be devastating for the tiger population, he says. — Laura Sanders

Climate change may shift habits

In some places, animals are expected to alter lifestyles

By Susan Milius

Warming climate may dramatically change not just where animals live, but how. Solitary sweat bees in northern climes are projected to become builders of social colonies, researchers reported July 31. Closer to the equator, fitful rainfall may drive tree frogs to exchange plants for ponds as their place to lay eggs.

Previously, researchers found that animals confronted by changing climate are likely to alter their timing of migration or shift their ranges poleward or up a mountain slope (*SN*: 6/30/12, p. 16). But a new generation of research is finding that more fundamental changes may occur in animal life history.

In Scotland and Northern Ireland, the sweat bee *Halictus rubicundus* could largely switch from its solitary life to forming small colonies by 2080, said Roger Schürch of the University of Sussex in England.

The bee, which is widespread across the Northern Hemisphere, adopts a distinctly more social lifestyle in the warmer reaches of its range, including the south of England and Ireland. Each queen emerging in spring lays a batch of largely female eggs, feeding and tending them until they mature into a small workforce, which in turn raises the final generation of the year. The warmth, Schürch said, allows bees to move around briskly and make more foraging runs, which in turn allows bees to raise more offspring.

If transplanted north, however, families of the social southerners turn solitary like their new neighbors. And solitary northerners moved south tend to go social.

Using a program that generates hypothetical future weather under various climate scenarios, Schürch found that with high greenhouse gas emissions Belfast, Northern Ireland, should be toasty enough by about 2050 for its now-solitary bees to raise as many workers as counterparts in southern England do today. And a bit farther north, warming should cause bees in Peebles, Scotland, to go social with southern-sized colonies by 2080.

Meanwhile, changing rainfall could affect the lifestyle of a tropical frog, said Justin Touchon of the Smithsonian Tropical Research Institute in Panama. Pantless tree frogs (*Dendropsophus ebraccatus*) there can lay eggs that develop either on land or in water. The frogs were the first species found to produce dual-habitat clutches.

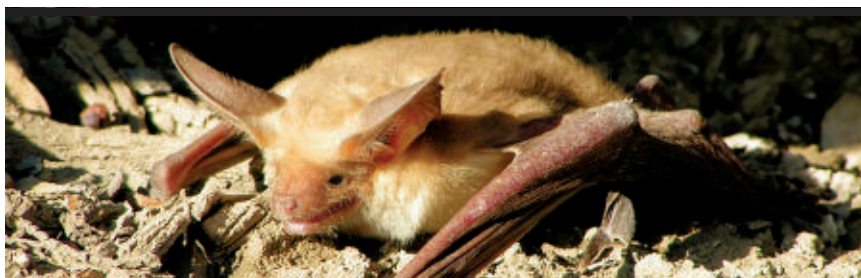
At shady ponds, the tree frogs often attach their eggs to plants on shore. As long as rain moistens the eggs during their first day they can hatch there, safe from voracious predators in the water. If

rain fails to sufficiently wet the eggs on their first day, the clutch usually dies. So around ponds with more open sun beating down, pantless tree frogs often just lay their eggs in the water.

That tendency to take a chance on rainfall generally grows stronger among pantless tree frogs as precipitation rates increase southward from Mexico to Ecuador, Touchon reported.

Cloudbursts during the rainy season, when pantless tree frogs breed, may get iffier as the climate changes. Touchon's earlier work suggests that during the past four decades, rainstorms have become more likely to be skimpy or to skip days and leave tree frog eggs to dry out. In response, frog populations may become more likely to lay eggs in water.

These research topics are "very exciting and a new direction," says behavioral ecologist Timothy C. Roth II of Franklin & Marshall College in Lancaster, Pa. Studying how climate change might affect behavior, he says, has been "very underrepresented." ■



Noise may disrupt a bat's dinner

The roar of humankind's machines may make it hard for some bats to hear the tiny footsteps of their prey. Bats that snatch insects off leaves and other surfaces find their targets by listening for the little rustles and scratchings of prey in motion. In the lab, pallid bats (*Antrozous pallidus*, shown) took extra time to locate live insects when speakers blared noise, Jessie Bunkley of Boise State University in Idaho reported July 30. For the test, Bunkley released bats into a darkened chamber with an array of bowls. One held live mealworms, and the others offered freeze-dried mealworms, dead and silent. In a quiet room, pallid bats averaged 3.5 seconds to locate the living mealworms. But when Bunkley played recordings of highway traffic or the noisy compressors found at gas wells, bats took 6 to 8 seconds to locate their meals. Bats operate on a strict energy budget, so small delays for each food item could add up to nutritional stress, Bunkley said. —Susan Milius

Humans



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Y Chromosome Adam gets older

Male and female ancestors were roughly contemporary

By Erin Wayman

Men might need some more pages in their family album.

The largest analyses to date of the human Y chromosome suggest that modern men can trace their family tree further back in time than previously thought. One of the studies, an analysis of 69 men from nine populations worldwide published in the Aug. 2 *Science*, finds that their most recent common ancestor lived 120,000 to 156,000 years ago. That's roughly the same time that the last common ancestor of women is estimated to have lived, researchers report.

The Y chromosome, passed down from father to son, and mitochondrial DNA, passed down from mother to child, are useful in retracing ancestry because they don't undergo genetic reshuffling, as the rest of the genetic instruction book does. Researchers analyze mutations in these parts of the genome to assess when groups split apart. The hypothetical common ancestors of these genetic lineages are sometimes called Y Chromosome Adam and Mitochondrial Eve.

"We're not saying they're exact contemporaries or they actually met or all men and women descended from the same couple," says study coauthor Carlos Bustamante of Stanford University. Y Chromosome Adam and Mitochondrial Eve aren't the first human man and woman either, but they are real people whose Y chromosome and mitochondrial DNA have been passed down with modifications to every living male and female.

The findings may overturn previous results that suggested Y Chromosome Adam was only a half or a third as old as

Mitochondrial Eve. Most previous analyses date the Y chromosome common ancestor to between 50,000 and 115,000 years ago and the mitochondrial DNA common ancestor to between 150,000 and 240,000 years ago.

Bustamante and colleagues also looked at mitochondrial DNA in their study population and found a common female ancestor 99,000 to 148,000 years ago.

Another study in the same issue of *Science* pushes the Y ancestor back even further in time. Paolo Francalacci of the University of Sassari in Italy and colleagues analyzed DNA from 1,204 Sardinian men and determined that Y Chromosome Adam lived 180,000 to 200,000 years ago.

Since the Y chromosome and mitochondrial DNA are inherited separately and have independent evolutionary histories, their trees do not necessarily spread from the same time and place. Still, the apparent lag between the mitochondrial DNA and Y chromosome lineages has been a head-scratcher for researchers, who expected the ancestors to be roughly contemporaneous. "People tied themselves in knots to come up with an explanation," says Rebecca Cann, an evolutionary biologist at the University of Hawaii at Manoa.

One idea implicated mating differences between the sexes. Women bear approximately similar numbers of children, but men can vary widely in their fertility, Bustamante says. One man might leave behind hundreds of descendants, another only one or a few. That variation in the number of offspring of men and women could account for different patterns in the Y chromosome and mitochondrial DNA trees.

The studies look at longer stretches of the Y chromosome than earlier work,

which could help explain why they find an older male ancestor, says Bustamante, whose team sequenced complete Y chromosomes.

But even these studies are missing pertinent data, says Michael Hammer of the University of Arizona in Tucson. In March, Hammer and colleagues reported in the *American Journal of Human Genetics* the discovery of a rare Y chromosome in an African-American. They also found similar Y chromosomes in 11 men from western Cameroon. Hammer's team traced the most recent common ancestor of the Y chromosome back 338,000 years.

In this scenario, the Y chromosome ancestor is much older than the mitochondrial DNA ancestor — and even predates the earliest known fossils of

Homo sapiens by more than 100,000 years. The great antiquity may imply that *H. sapiens* is older than the fossil evidence currently suggests, or that early humans mated with a closely related hominid species that contributed to the Y chromosome gene pool.

The other new studies didn't consider the Cameroonian population,

so they are missing crucial genetic diversity in their analyses, Hammer says. In general, scientists are overlooking lots of Y chromosome diversity because populations in sub-Saharan Africa have been poorly sampled, he says.

Melissa Wilson Sayres, a geneticist at the University of California, Berkeley, agrees there are still a lot of data to collect. Part of the problem has been the complicated nature of the Y chromosome itself. It's highly repetitive and therefore has taken a long time to properly read. In fact, she says, it took almost as long to sequence the Y chromosome as it did to sequence all the rest of the human genome. ■

"We're not saying they're exact contemporaries or they actually met or all men and women descended from the same couple."

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FAMILIAR
FACES

“Super recognizers” never forget a visage, an unusual ability that can be put to good use

By Susan Gaidos

If you're someone who enjoys being recognized, Julian Lim is your kind of waiter. Lim, who's working his way through college waiting tables, remembers the face of everyone that walks through the door of the South Bend, Ind., restaurant where he works. His abilities go beyond making his customers feel special. This spring, when he cut his hand on broken glass, he pegged the emergency room nurse as a fellow student from his grade school days. Though they'd never spoken, and the girl had since undergone changes in appearance, Lim recognized her instantly.

Carrie Shanafelt is good with faces, too. A professor of literature at Grinnell College in Iowa, Shanafelt can spot her students outside the classroom, whether it's the first week of class or years later. And Ajay Jansari, an information technology specialist in London, often has to see a face only once to remember it, even those he meets thousands of miles from home.

While some people say they never forget a face, these folks have scientific studies to back their claims. Called “super recognizers,” they're among a small group of individuals being studied by scientists at Dartmouth College and in England to better understand how some people can recognize almost every face they have ever seen.

Scientists are now putting super recognizers' skills to the test to get a handle on how face-processing areas of the brain work to make a few people so adept at recalling faces. Findings from the studies may advance understanding of how most people categorize faces — a subject that is still poorly understood.

Studies of those with exceptional recognition powers may also influence how police work or other jobs that require identifying people by their faces are carried out. Learning about the variability in people's face-recognition skills may

lead to tests for assessing eyewitness testimony, or ways to evaluate individuals seeking jobs in areas like security, where the ability to remember faces may be important. Studies of super recognizers may also reveal ways to help others improve their face recognition abilities.

“By identifying strategies used by super recognizers, we may find ways to train others who have problems with face recognition, or help people who are in the normal range but have professional demands in which superior face recognition would be beneficial,” says Dartmouth psychologist Bradley Duchaine.

Most super recognizers take their powers for granted, or assume that others share their ability to pick a face out of the crowd. Shanafelt says she knew she was good at recognizing others, but wasn't aware there was anything special about her ability until she was tested three years ago.

“Actually, I've always worried about not being able to recognize someone,” she says. Her fears, she says now, likely stemmed from the fact that she recognized others far more frequently than they recognized her.

The phenomenon of those who excel at recognizing faces emerged from work on people at the opposite extreme — those who can't recognize faces at all. Duchaine, who studies people on both ends of the spectrum, says that face recognition ability may vary much more than previously thought, running along a spectrum from poor or disordered to exceptional.

“Outside the psychological community, it's something that people likely didn't give much thought to,” Duchaine says, because most people assume that “anybody can recognize faces.”

What sets super recognizers apart is their ability to remember people they have seen or met only briefly, says Ashok

Jansari, a psychologist at the University of East London. Claiming to have “very good, but not super” facial recognition skills himself, Jansari set up an experiment at the London Science Museum to test individuals' facial recognition powers. Of the 730 museum visitors who participated in the studies, seven turned out to be super recognizers. One of them was his brother, Ajay.

To date, only two dozen or so super recognizers have been identified, including a group of London police officers who are extremely good at recognizing criminal suspects. Though studies of super recognizers are just getting under way, findings suggest that about 1 percent of people are super recognizers.

Facing facts

Most people can instantly identify their family members, friends and even foes just by looking at their faces. If your aunt Martha cuts her hair or cousin Joe grows a beard, chances are you'll still know them by their visages. For most, the ability to perceive faces is present from birth. Newborn babies prefer to look at pictures of faces compared with other objects, and a baby as young as 3 days old prefers looking at its mother's face over a stranger's.

“Faces are special,” says University of Southern California neuroscientist Irving Biederman, who studies how the brain processes visual information.

“What's unique about faces in terms of our evolutionary history is that it's the only visual stimulus class where we had to make very fine discriminations,” he says. “If you see one tiger versus another tiger, you don't really have to make a distinction whether that's Pammy or Tommy. But for human faces, you do.”

Though early humans had only a small number of faces to individuate — perhaps only the faces in their own cave — they still had the problem of distinguishing one mug from another, Biederman says. Not only are faces similar in appearance, with two eyes, a nose and mouth, but they change over time: People smile, grimace

1
out of
100

People classified as
super recognizers

and frown, and their faces wrinkle with age. Different angles and lighting also influence facial appearance.

“You don’t get the exact same image of a face every time you look at it,” Biederman says. “Yet, most people recognize the features of those they know, even after gaps of 20 years or more.”

How the brain perceives a face remains a mystery. Some scientists say face recognition is a special type of processing that comes with its own dedicated neural machinery. This mechanism may operate differently from those used for object recognition. Whether face-recognition mechanisms are hardwired or constructed from experience also remains unknown.

Early evidence that the ability to distinguish facial features is localized in the brain came from studies of stroke patients and veterans injured in war. People with damage at the back of the brain on the right side in an area called the ventral occipito-temporal cortex often lost the ability to recognize faces.

Such studies gave scientists reason to think that there could be a special region in that vicinity of the brain dedicated to face recognition.

By the late 1990s, researchers were turning to functional magnetic resonance imaging, or fMRI, to get more precise information. By monitoring the blood flow in different regions of the brain as subjects viewed faces and other

objects, scientists could see which brain areas are most active.

In 1997 Nancy Kanwisher, now of MIT, and her colleagues used fMRI to pinpoint an area that appeared to be specialized for detecting faces. This brain area, called the fusiform face area,

would light up with activity when subjects viewed faces, but showed less activity when subjects viewed other objects such as houses. Still, the studies couldn’t tell whether this region was actually required to recognize the face it was seeing.

“Just because you see some part of the brain turn on when you look at faces, it doesn’t mean that it’s necessary for face recognition,” Kanwisher says.

Recently, scientists got more direct confirmation. Kanwisher’s group, along with others, ran experiments using a noninvasive technique known as transcranial magnetic stimulation, or TMS, to interfere with brain activity near the fusiform face area while subjects were viewing faces. The scientists also tested to see what happened in this region when subjects viewed other body parts. TMS works by inducing weak electric currents in the neurons in a selected brain region, causing a temporary interference with normal activity. In this case, the scientists targeted the right occipital face area, located next to the fusiform face area. By messing up the recognition process in this manner, Kanwisher’s group confirmed prior findings that zapping this

region interferes with face recognition.

How much of the face-recognition process happens within this region remains unknown, Kanwisher says. Beyond this area, scientists are working to figure out what other brain structures are required for processing faces.

“There must be *some* other brain regions” involved, Kanwisher says, noting that the fusiform face area on its own probably can’t house a conscious experience of a face. “For that it most likely must talk to lots of other brain areas.”

Scientists curious about how the brain works to make a positive identification have often studied those who have a tough time recognizing faces. Stroke victims or those with autism may have such problems. Another group includes those with an affliction called face blindness, or prosopagnosia. People with this condition may find it nearly impossible to identify their spouses or family members, yet most can easily pick out differences in objects such as cars, tools or landscapes.

Some develop the condition after suffering a stroke or brain injury. Others — about 2 percent of the general population — are born with face blindness. It was from such studies that scientists discovered that some people actually excel at face recognition.

Duchaine, who has studied face blindness for 15 years, says he and his colleagues would hear people say, “I’m not face blind, I’m the opposite.”

“We finally decided to look into it,” he says.

Working with Richard Russell, now of Gettysburg College in Pennsylvania, and Harvard psychologist Ken Nakayama,

“Just because you see some part of the brain turn on when you look at faces, it doesn’t mean that it’s necessary for face recognition.”

NANCY KANWISHER

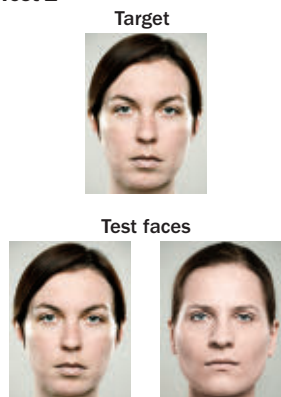


Find that face

Super recognizers are better than average at matching a target face (left) to one of the six shape-adjusted faces on the right. When a similar test is conducted by adjusting the pigmentation of faces, super recognizers still outperform people with average face-recognition ability. This suggests that the face-recognition process in super recognizers integrates information about shape and pigmentation.

SOURCE: R. RUSSELL ET AL./
NEUROPSYCHOLOGIA 2012

Test 1

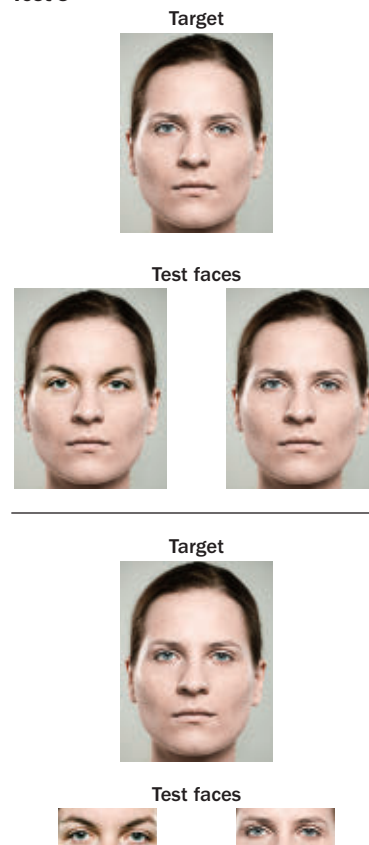


Test 2



Match game Face-matching tasks show that people are good at recognizing faces as a whole but struggle to identify mismatched features or those shown in isolation. Test 1 (left) shows that it's easier to match faces when the images are right-side up rather than upside-down. Test 2 (center) shows that it's easier to tell if two halves of a face belong to the same person when the halves are offset rather than aligned. Test 3 (right) shows it's easier to make a match based on whole faces rather than eyes alone. SOURCE: J. DEGUTIS ET AL/COGNITIVE NEUROPSYCHOLOGY 2012

Test 3



Duchaine published the first report on super recognizers in 2009. These initial findings, published in *Psychonomic Bulletin & Review*, suggested that people with this ability might actually look at faces differently than others do.

Getting the whole story

Super recognizers excel at discriminating among the countless faces they encounter. But faces change over time. People switch hairstyles or glasses, or suddenly shave. Super recognizers are able to see through changes in appearance to recognize near strangers whom they have not seen for years.

Case in point: Two years after visiting a theme park in Florida, Jansari's brother Ajay ran into the woman who had served as a tour guide. Though she now worked as a clerk in a kitchenware store, he immediately recognized her.

How did he do it? One possibility, scientists say, is that super recognizers' brains are better than others at some-

thing called "holistic" processing, or viewing the face as a single unit. Studies of those with face blindness show that people who have difficulty recognizing faces tend to focus on individual parts. By contrast, people with normal face-recognition ability process faces as a "whole." Duchaine says that super recognizers may be able to do this kind of processing even better than others, "though this possibility remains to be tested."

His group and Jansari's are now independently looking to see if there's a difference in the way super recognizers process faces. To isolate holistic processing mechanisms, the researchers are using various face-recognition tests, including one called composite-face effect. In this test, images of faces are split horizontally so that there's a top half and lower half. Researchers then align the top half of one face with the lower halves of several others.

When scientists ask subjects "Are the top halves of those faces the same?"

people have a hard time seeing that the two halves are the same because their brain automatically fuses the top and lower halves to form a new, unfamiliar face, Duchaine says. The more you rely on holistic processing, the harder the task is.

Though researchers don't yet have data on super recognizers' performance at this task, Duchaine anticipates that they may not score highly if they're using a holistic approach to look at faces.

Another test of holistic face processing is the whole-part effect: Here, subjects are shown an unfamiliar face, then asked to identify individual features by looking at images of various eyes, noses or mouths. Most people do better when a feature is presented within the whole face than when it stands on its own, Duchaine says.

"Eyes, and other features, are influenced by rest of the face," he says. "If the rest of the face isn't there, it's more difficult to tell whether a particular pair of



eyes are the same because you're viewing them in a slightly different manner."

Scientists are also looking to see if super recognizers have other exceptional powers, such as superior perception, which is the ability to tell one unfamiliar face from another simultaneously presented face. Such powers might aid or work in addition to recognition, which is remembering a previously seen face.

Joe DeGutis, a fellow at the Harvard Vision Sciences Lab who studies those with face blindness, refers to perception as a "front-end procedure" that allows one to take in visual information about a face and encode it. This skill is routinely used by security agents to match faces on a screen or compare an ID photo against the face of the person presenting it.

Facing up to the task

Police officers also may draw upon perceptual ability to ID suspects. Josh P. Davis, a psychologist at the University of Greenwich in London, is studying a group of police officers in London to see how perceptual ability aids in recognizing faces pulled from closed-circuit camera images. Davis began studying the officers for super recognition abilities after hearing of their near-superhuman perception abilities to match faces from such images.

Only months after setting up his program to study the officers, riots broke out across London. A core group of 20 officers were able to ID more than 600 suspects from grainy and incomplete images collected by security cameras. One officer alone accounted for 190 identifications, pulling from memory faces he had seen before. In many cases, rioters wore heavy

disguises — using scarves, bandannas, and hooded sweatshirts to protect their identities — leaving only the eyes visible.

Tests of the 20 officers confirmed at least five are super recognizers, Davis says. The others scored above control subjects on the test. As a result of the study, the police department has changed its system, giving super-recognizer officers extra time to view images distributed throughout the department.

"If you've never seen someone before, you're not going to recognize them, no matter how good your face-recognition skills are," Davis says. "But super recognizers seem to be able to remember far more faces they've encountered than the rest of us, and to learn new faces far more efficiently."

Davis has teamed up with Jansari to better understand how super recognizers make these associations, and to see if they're related to perception as well as recognition. Writing in an upcoming issue of *Psychologist*, the scientists say super recognizers may be extra efficient at extracting information about a face, especially if viewed in action. Davis says that previous studies have shown that people can extract more information about a face if it's moving, as opposed to looking at a still image. But he says the police officer super recognizers seem to have a disproportionate advantage over others for gleaning information about faces as they scan video images or watch people in motion.

This summer, he began probing the officers' perceptual abilities, using souped-up versions of standard face recognition tests to see how well these super recognizers discriminate between

One London police officer with exceptional recognition powers spotted and arrested a suspect on a busy street 18 months after seeing video of the man committing an armed robbery.

similar faces. He's also running a battery of tests to see if the officers are better than control subjects at feature-by-feature matching.

"A lot of the officers claim that their abilities are down to recognizing specific facial features, or idiosyncratic features such as a tattoo or scar," Davis says. He wants to see whether the police officers are right about their abilities, or if they view faces in the same holistic manner that seems to drive most people's face-recognition process.

Though face recognition may not automatically improve with use, some studies suggest it's a skill that can be honed to some degree. Psychologist Isabel Gauthier of Vanderbilt University in Nashville has shown that the face-processing areas of the brain can be trained to identify other objects, such as cars and birds, holistically. Her findings suggest that if bird-watchers and car buffs can train their brains to specialize, others can, too.

Duchaine wants to identify the strategies used by super recognizers to help those with problems identifying faces. Such strategies might also boost performance among those working jobs that require checking photo IDs. In the future, customs and border patrol agents, as well as TSA agents working in airports, might be tested for their facial recognition abilities and put to work where their ability to super recognize is more than just a curiosity.

Meanwhile, just knowing that face recognition ability runs along a spectrum — with some being exceptional — may give pause to criminals or others looking for mischief.

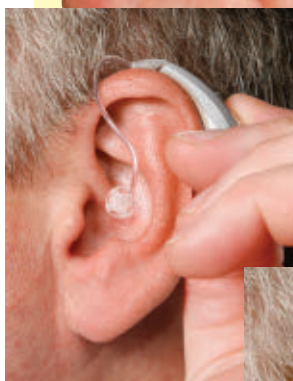
"If I were going to commit some criminal act," Davis says, "I might be deterred by the fact that there might be somebody recognizing me, or who later might see an image of me committing that act." ■

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A superbright galaxy called a blazar sends out a flood of radiation in this illustration. On its way to Earth, some of that radiation slams into vestiges of light from all the stars that have ever existed.

Everlasting Light

Remnant glow of ancient stars offers glimpse of universe's past

By Alexandra Witze

On the next clear night, go outside and look up. If you're away from city lights, you may be amazed by the darkness of the sky between the stars. But what looks like inky black isn't really so. Even the darkest of night skies still contains the light of all the stars that ever shone.

Photons, or particles of light, are born in the nuclear furnaces of stars and then jet outward through the empty depths of space. Still more photons are ejected when stars explode as supernovas and from superheated matter that swirls in its death throes before being

sucked into a black hole.

Some of these journeying photons will slam into other particles and disappear; a minuscule fraction will be captured by telescopes on Earth. But the vast majority of stellar photons continue traversing the cosmos, creating a ubiquitous if faint glow that scientists call extragalactic background light, or EBL.

The cumulative radiation isn't enough to light up the night sky. In fact, this cosmic glow is so dim that it's extremely difficult to spot even with powerful telescopes. But measuring the extragalactic

background light is a challenge researchers are eager to take on. Because the EBL has been rattling around for nearly the entire history of the cosmos, it can help astronomers peel back layers of the universe's history and probe profound questions that other types of observations cannot. "If we can measure all this radiation, we can get fundamental information about the universe," says Alberto Domínguez, an astrophysicist at the University of California, Riverside.

After decades of hunting the EBL, astronomers are finally close to snaring

their quarry. New discoveries are narrowing precisely how much light exists and at what wavelengths, from infrared to visible to ultraviolet. The findings come thanks to a clutch of telescopes that capture energy blazing from the universe's distant reaches.

By figuring out the amount of EBL at different stages of the universe's history, researchers can explore how stars and galaxies formed and evolved over time. The EBL is already offering a glimpse at the first generations of stars. Eventually, the EBL could reveal mysterious objects such as "dark stars" that may have burned fast and furious in the early universe and strange shape-shifting particles flitting through intergalactic space.

"The EBL has so much information," says Eli Dwek, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Md. "You really can see so many different types of physics in it."

Two glows for the price of one

Astronomers knew they had their work cut out for them when they started hunting the cosmic glow of the stars in the 1970s. Calculations revealed that the EBL would be very faint simply because so many stars are extremely far away. The challenge is akin to holding up a 100-watt lightbulb and trying to determine how much of its light reflects off a sheet of paper 10 kilometers away.

Complicating matters is the fact that Earth nestles in a bright celestial neighborhood. Dust along the plane of the solar system scatters sunlight, creating a diffuse glow of its own known as zodiacal light. Plus, the solar system is embedded in the bright Milky Way. "When you look locally, you're swamped with light," says Frank Krennrich, an astrophysicist at Iowa State University in Ames. This flood of nearby light obscures the glow of radiation from all the other stars.

Astronomers first tried to detect the EBL by launching sounding rockets that scanned the sky for minutes at a time before falling back to Earth. Those searches came up empty. In the 1980s, the U.S.-British-Dutch Infrared Astronomical Satellite mapped the sky

in infrared wavelengths. It spotted the bright foreground light from the solar system and the Milky Way but provided only inconclusive evidence of a dim background glow.

Then EBL researchers received a gift in the form of NASA's Cosmic Background Explorer (COBE) satellite, which was launched in 1989 primarily to measure a different type of glow from the universe's past: the cosmic microwave background. This radiation emerged soon after the Big Bang 13.8 billion years ago when a hot, dense soup of primordial matter cooled enough for photons to break free and travel unimpeded through the cosmos. Over time, as the universe expanded, this relict glow stretched and cooled into microwave energies.

To measure this ancient radiation across the sky, COBE was designed to filter out objects in the foreground that might be obscuring a fainter glow behind. That's exactly the approach EBL researchers needed to succeed. And in addition to scanning for microwave photons, COBE had a separate instrument that mapped the entire sky in 10 different infrared wavelengths of light. In 1998, scientists using COBE reported glimpsing the EBL for the first time.

The COBE data confirmed scientists' estimates that most of the EBL would appear as infrared light, because light from stars in distant galaxies gets

shifted to longer wavelengths as the universe expands. Plot the EBL on a chart, and two peaks appear that resemble a double-humped camel. The first peak, at shorter infrared wavelengths, mostly represents light emitted from ordinary stars, extremely bright supernovas and other explosions. The second peak, at slightly longer wavelengths, represents light that interacted with cosmic dust. Stars are usually born in dusty environments, and photons bouncing around warm up some of that dust, which then re-emits the light at longer wavelengths.

COBE proved that astronomers could detect the EBL; the next challenge was measuring it precisely enough to make conclusions about the distant universe. At first astronomers tried to do that by counting the number of galaxies photographed by orbiting telescopes such as Hubble and Spitzer and estimating how many photons those galaxies emit.

But conducting a photon census this way is sure to miss some important contributors and underestimate the EBL intensity. Even the best telescopes can't capture the faintest, most distant galaxies. Plus, such a census would miss any stranger, undiscovered sources of light that may also feed into the EBL.

Scanning the fog

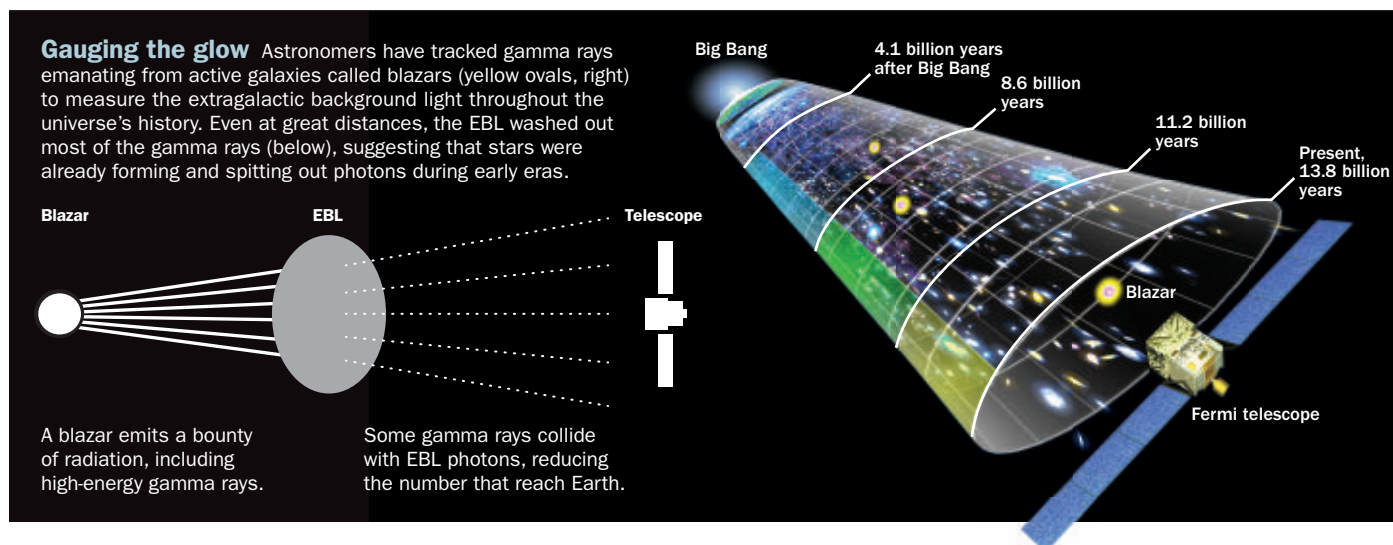
That's why astronomers developed another approach to measuring the

10¹⁵
times

The sun is a million billion times as bright as the extragalactic background light, as viewed from Earth.

1,000
times

Zodiacal light, the visible glow created when sunlight hits dust in the solar system, is 1,000 times as bright as the extragalactic background light.



EBL. The method relies on studying very high-energy gamma rays that begin their lives in a cloud of gas swirling around a monstrous black hole. As it circles the cosmic drain, the gas heats up furiously and produces gamma rays. A galaxy that happens to emit this powerful radiation directly toward Earth is called a blazar.

Not every gamma ray enjoys a clear path to our planet. Every so often, one of them smashes into a photon from the EBL and breaks apart into a pair of particles — an electron and its antimatter counterpart, a positron. The gamma ray is no more. This annihilation happens to quite a few gamma rays as they travel the billions of light-years from the blazar through the EBL.

These collisions mean that by the time the gamma rays reach Earth, the signal is fainter than scientists might expect. It's as if a dense fog dimmed the beacon of a lighthouse in the distance. If you knew how bright the beacon was on clear nights, you could look at it on a foggy night and calculate just how much fog there was between it and you. "If we could somehow infer the light that comes out from the blazar, we can infer what was lost on the way to us because of the EBL," says Domínguez.

It turns out that lower-energy photons aren't absorbed by the EBL, a fact that allows astronomers to estimate an object's intrinsic brightness. By seeing how many of those low-energy photons arrive at Earth from a particular blazar,

scientists can calculate how many high-energy gamma rays also set sail from the same blazar. In 1992, astrophysicist Floyd Stecker of NASA Goddard and his colleagues suggested using this drop-off between the expected and observed gamma rays to measure how much extragalactic background light exists between the blazar and Earth.

Astronomers accordingly turned a suite of powerful ground-based telescopes to the sky. These Cherenkov telescopes search for showers of particles created when a high-energy gamma ray slams into a particle in the Earth's atmosphere, triggering a flash of bluish light. Then scientists can trace the evidence back to the general region of the sky that sent the gamma rays this way.

By the 2000s Cherenkov telescopes in Arizona, the Canary Islands and Africa had detected very energetic gamma rays from powerful blazars. But the telescopes also revealed one big problem: They couldn't probe very

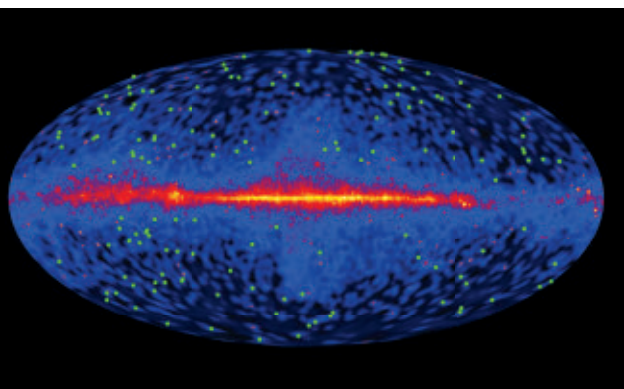
distant gamma-ray sources, because the extragalactic background light absorbs so many of their gamma rays en route to Earth.

The Fermi era begins

To extend their reach in the universe, astronomers turned to the Fermi Gamma-ray Space Telescope. NASA launched the spacecraft in 2008 to study blazars and other violent objects. Because Fermi orbits Earth, it sits well above the atmospheric interference that foils gamma-ray measurements.

Last November in *Science*, an international team of astronomers reported Fermi observations of 150 blazars dating back to about 4 billion years after the Big Bang (*SN: 12/15/12, p. 8*). The team measured the drop-off in gamma rays — presumably due to the EBL absorbing that radiation — at different distance ranges from Earth. In a cosmic sense, distance represents a sort of time travel into the past: The farther an object is from Earth,

A map of high-energy radiation from the Fermi Gamma-ray Space Telescope pinpoints the blazars (green dots) that scientists used to measure the EBL. The orange band is the plane of our galaxy.



the longer its light has been traveling to reach us, and so the object appears to observers as it did in an earlier era.

By calculating the intensity of the EBL at various distances from Earth, the researchers came up with snapshots of how many stars were giving off light during each era. "It's like having many experiments back in time," says team member Marco Ajello, an astrophysicist at the University of California, Berkeley.

Ajello's team lumped the blazars, depending on their distance from Earth, into three separate periods in the past. After measuring how many gamma rays survived their journey from each blazar, the astronomers confirmed earlier work suggesting that star formation has steadily declined since its peak about 3 billion years after the Big Bang.

Although Ajello could not peer back any farther in time directly, his team was able to extrapolate the intensity of the EBL during the era of the very first stars that lit up the universe. These monstrous stars, some 100 times as massive as the sun, probably formed within the first few hundred million years after the Big Bang when vast pockets of hydrogen atoms coalesced and ignited in nuclear fusion.

Despite burning through that nuclear fuel within a few million years, these stars probably played a major role in the universe's history by sending out photons that collided with hydrogen atoms and imparted an electric charge. This crucial process, called reionization, allowed stars to continue lighting up the universe, sparing the cosmos a cold, dark and featureless fate.

Knowing how many photons were around in this early era could help astronomers better understand how reionization happened. Ajello and his colleagues found that the EBL at these great distances was fainter than suspected, which hints that the first stars formed much more slowly than astronomers had thought. "We're doing our best to clear out the fog and nail down the numbers about star formation in the very early universe," Ajello says.



Observing the universe's first stars (illustrated here) remains difficult, but some of their photons traverse the cosmos as extragalactic background light.

Faint glow, powerful probe

Clearing out the fog may solve other long-standing mysteries of the universe. Dwek hopes that scientists can study the portion of the EBL that has bounced off cosmic dust to better understand the role dust plays in absorbing and re-radiating light.

Studying the EBL may also lead scientists into the realm of exotic physics. Some theories, for instance, suggest that dark stars powered by dark matter — a mysterious, invisible form of matter — might have lurked in the early universe. These stars may have accreted dark matter particles and burned quickly, leaving a signal that should be visible today in the EBL. Recent studies have ruled out the existence of dark stars up to about 100 times the mass of the sun, but heavier ones are still possible.

And then there's the possibility of axion-like particles, or ALPs, which are lightweight particles no one has ever seen. If they exist, ALPs would have the weird property of being able to shape-shift into a photon and back again. Some physicists have proposed that gamma rays flooding from a blazar could turn into ALPs and travel through the universe unimpeded by the extragalactic background light. The ALPs could then reconvert to an ordinary photon before reaching Earth, and so astronomers observing them would never know the change had happened.

In theory, ALPs disguised as photons could make up a significant percentage of the EBL. Astronomers are searching for fingerprints of ALPs in the spectra of light coming from blazars and other

gamma-ray sources.

The EBL is likely to lead to more discoveries soon, even if they are not of the exotic variety. Ajello's team is digging through Fermi data for more blazars; the satellite has detected at least 1,000 so far, many at great distances that will help reveal star formation in the distant past. The ground-based Cherenkov telescopes are also working busily; HESS, in Africa, was recently expanded and the VERITAS telescope in Arizona has a new upgrade as well.

Observations from these telescopes, cross-checked with photon counts from Hubble and Spitzer, should allow astronomers to pin down precise measurements of the EBL intensity throughout history. "We're not quite converging yet, but we're getting close," says Krennrich.

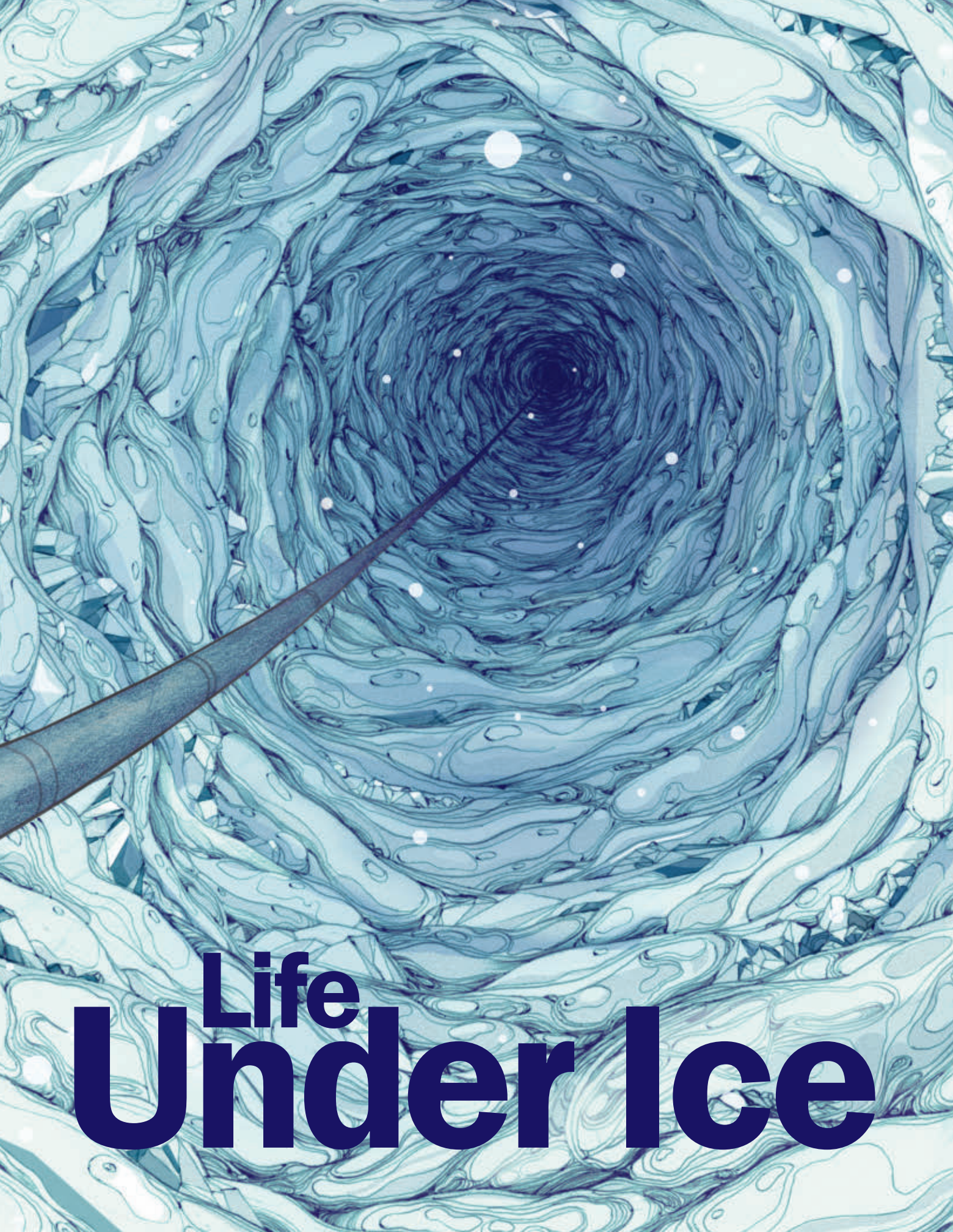
In a study in the June *Astrophysical Journal*, Domínguez and colleague Francisco Prada found that EBL estimates obtained from blazars match up closely with those from sky surveys. The study suggests that there aren't any weird or unusual sources of EBL, like odd stars or faint galaxies, that got missed during the cosmic census. "That means our galaxy surveys are actually detecting most of the light in the EBL," Domínguez says.

Farther off, new generations of instruments will make unprecedented measurements of the EBL. A planned Cherenkov Telescope Array would consist of dozens of telescopes, far more than the handful used in current Cherenkov systems, to detect more gamma rays disintegrating in the atmosphere. And in space, the James Webb Space Telescope — planned for a 2018 launch — will study very faint, very distant stars and galaxies to help pin down their contributions.

Soon, astronomers say, all the light from all the stars will be measured. "It is curiosity that drives us all," says Dwek. "By measuring that light we can actually find out what stars were doing over time." ■

Explore more

■ E. Dwek, F. Krennrich. "The extragalactic background light and the gamma-ray opacity of the universe." Posted Oct. 10, 2012. arxiv.org/abs/1209.4661.



Life **Under Ice**

Lake Vostok may harbor ingredients for a complex subglacial ecosystem

By Rachel Ehrenberg

Even by Antarctic standards, the Lake Vostok research station is inhospitable. The outpost at the heart of the frozen continent holds the record for the lowest naturally occurring temperature ever observed on Earth. Scientists commonly describe the place as punishing, unforgiving, the most desolate place on the planet.

That's nothing. Nearly 4,000 meters below the station, beneath the crushing East Antarctic ice sheet, sits an enormous body of water. Lake Vostok has existed for millennia in dark, frigid isolation, presumably harboring nothing but the toughest microbes.

But now a Russian team has drilled through the ice, breaching Lake Vostok for the first time in 15 million years. Bits of genetic material in ice core samples of frozen lake water include DNA not just from microbes, an analysis published in July contends, but hints of much more complex life: a water flea, a mollusk, maybe something related to a sea anemone. Even more intriguing, some genetic sequences appear similar to bacteria and parasites typically found living inside fish, lobsters and shrimp.

Many researchers find the claim hard to believe. Lake Vostok just seems too deep, too cold, too dark for complex life. Maybe the researchers who discovered the DNA accidentally contaminated their samples with genetic material from the surface, some microbiologists suggest. Or maybe the researchers are just pushing the genetic data too far, seeing similarities to complex life in what are really just scraps of bacterial DNA.

But unlike other recent claims for the existence of life in otherworldly environments, most notably the now-debunked discovery of arsenic-based life in California's Mono Lake (*SN*: 2/25/12, p. 10), the case for complex life in Lake Vostok doesn't require rewriting basic rules of biochemistry. It does require creating

an intricate ecosystem in the absence of sunlight and photosynthesis, but there is nothing to rule out the possibility that a strange and otherworldly collection of creatures is waiting to be discovered deep beneath one of the most remote places on Earth.

Antarctica's Great Lake

Lake Vostok is a behemoth, and not just by Antarctic standards. It is nearly as big as Lake Ontario and much deeper—estimated to be more than 900 meters in some places. By volume, Vostok is the seventh largest lake in the world. While there were clues that a large body of water lay beneath Vostok station, the lake's existence wasn't confirmed until the mid-1990s. Almost as soon as its existence was confirmed, murmurs began that the buried lake might harbor life (*SN*: 10/2/99, p. 216).

At that time, a team of Russian, French and American scientists had already begun drilling through the ice sheet. But drilling stopped in 1999, about 130 meters above the lake. The research community was worried that the kerosene-freon mix used in drilling might contaminate Vostok's untouched waters. More than five years later, a plan had been approved to protect the lake and drilling resumed. After several seasons and several fits and starts, the Russians penetrated the lake in February 2012.

Russian members of the team now have samples of lake water that gushed up into the borehole, and they expect to publish an analysis of it this fall. But Scott Rogers, an expert in ancient DNA at Bowling Green State University in Ohio, got his hands on some of the American

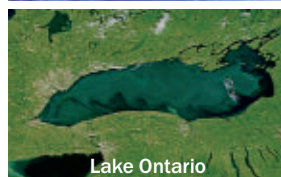
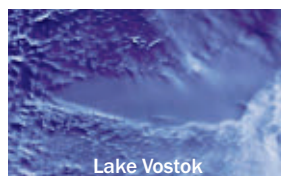
share of the core, which is stored at the National Ice Core Laboratory in Denver. More than 3,000 meters long, the core is mostly glacier ice. But near its bottom, the core contains lake ice that has frozen to the bottom of the overlying glacier as it crawls across eastern Antarctica.

Rogers and colleagues, including his student Yuri Shtarkman, took more than two years to analyze their samples of this "accretion ice." As expected, they found genetic material indicating bacterial life (*SN*: 3/9/13, p. 12). The team had samples from two parts of the lake: In one, about 77 percent of the identifiable genetic sequences were from bacteria, with most of the rest from fungi. In the other, about 95 percent of what the researchers could identify was bacterial.

And then there were the standouts: The researchers detected DNA similar to that of small water animals called tardigrades, or water bears, which are known for withstanding extreme environments. Some genetic material was nearly identical to the little swimmers called rotifers.

Other sequences suggested a whole mess of algae (yellow-green, green, red). The real surprise was sequences indicating larger organisms like clams and jellyfish. Strangest of all were genetic signatures resembling parasites or symbiotic partners of large aquatic organisms: a rainbow trout intestinal bacterium, a sponge symbiont, a lobster gut bacterium.

Finding those DNA sequences doesn't mean that those exact organisms are swimming around kilometers under the Antarctic ice. But the mix of genetic signatures is suggestive of a functioning rudimentary ecosystem: There are what ecologists call primary producers—bacteria and other critters that extract nitrogen and carbon from the environment and make it usable for other organisms. There are also consumers—various amoebae, zooplankton



Lake Vostok is nearly the size of Lake Ontario, and estimated to be at least twice as deep.

and perhaps others living off them. And completing the loop are decomposers, including fungi, that make a living breaking dead things down. Many of the DNA sequences are similar to those of organisms with a high tolerance for extremes, be it cold, salt or pressure.

In the July report, published in *PLOS ONE*, Rogers and his colleagues present a Vostok scenario that goes something like this: About 35 million years ago, much of Antarctica was green and free of ice. Sea levels were higher, so Lake Vostok may have been connected to the Southern Ocean. It could have been a saltwater bay that had reverted to brackish. Bring in a glacier, and the top of the lake becomes freshwater, says Rogers. This scenario might lead to a variety of distinct zones within the lake. At different depths and locations there may be vastly different temperatures, salinities and other chemical concentrations. “You could have organisms surviving there and possibly evolving into different niches in the lake,” he says.

Hard to fathom

Even so, some scientists cannot wrap their minds around the idea of a thriving Vostokian ecosystem.

“Here’s probably the most extreme ecosystem on the planet and it’s teeming with life? And we can go to other less extreme environments and these fauna are absent?” says microbiologist Brent Christner of Louisiana State

University in Baton Rouge.

It’s not just the numbing cold of Lake Vostok, which at its surface hovers around 0°Celsius. Nor is it the crushing pressure exerted on a lake beneath almost 4,000 meters of ice. The problem is energy, without which life can’t exist. Lake Vostok sits in permanent darkness, far beyond the reach of any photons.

“If you put all these organisms in a lake, they have to eat something. What do they eat?” Christner says. “I’m not saying it’s impossible that more than a bacterium lives in these lakes. Maybe you have a nematode, but that would be an apex predator.”

Earlier this year, Christner and his colleagues reported finding cells containing DNA in Lake Whillans, which lies beneath a mere 800 meters of ice in West Antarctica (*SN*: 3/9/13, p. 12). But unlike Lake Whillans and many of the continent’s other subglacial lakes, there aren’t known streams and rivers feeding into Vostok that might bring life or nutrients from afar.

“On the extreme-o-meter, Vostok is an order of magnitude more extreme than these other lakes,” says Christner. “It’s a lot to ask of a multicellular organism to be living like that.”

But if Lake Vostok does harbor an energy source, then the existence of multicellular life seems much less far-fetched.

Data from ice-penetrating radar and laser altimetry suggest that Lake Vostok sits on a major geological boundary.

“Recent minor tectonic activity could have the potential to introduce small, but significant amounts of thermal energy into the lake,” a team of geoscientists wrote in 2003 in *Earth and Planetary Science Letters*. In 2006, a research team that included microbial geneticist Sergey Bulat of the Petersburg Nuclear Physics Institute in Russia, one of the more vocal critics of the current study, reported DNA from Vostok ice cores closely resembling that of microbes thriving in the high temperatures and strange chemistry of volcanic vents and hot springs.

For extremophile microbes like those, Lake Vostok might even seem cushy. After all, there are bacteria that live in the Earth’s upper atmosphere, a freezing place with little oxygen that’s bombarded with UV radiation. Other microbes, like *Picrophilus torridus*, live in highly acidic volcanic vents that spit out scalding-hot gases. And there are fish that survive just fine in toxic, hydrogen sulfide-laden waters inside permanently dark caves.

If those fish can do it, perhaps others can in an Antarctic lake, says Jack Gilbert, an environmental microbiologist at the University of Chicago and the Argonne National Laboratory in Lemont, Ill. “Complex eukaryotic life is unlikely but not impossible. Perhaps maybe even fish,” he says.

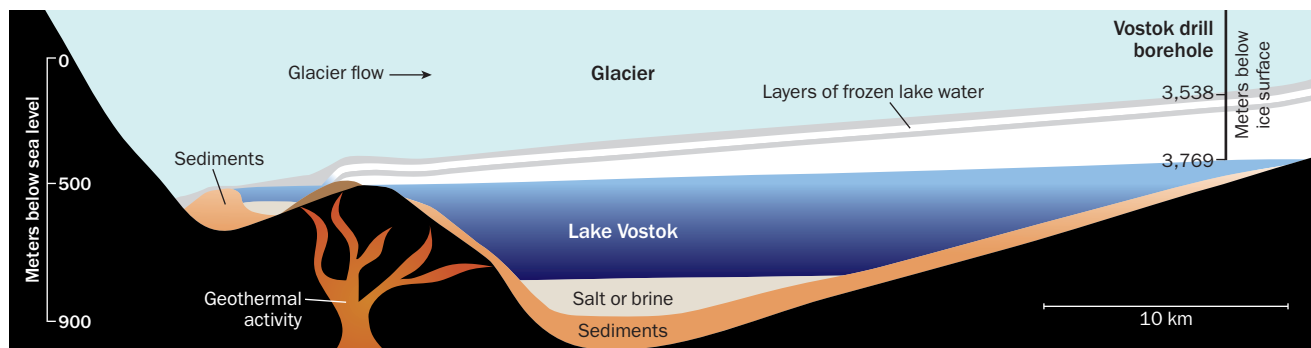
Rogers thinks the tectonic activity and other data suggest a hydrothermal vent, probably near a sediment-rich embayment in the southwestern portion of the lake. The most colorful mix of organisms in his analysis came from that area. “I’d really like to see what’s on

3,769
meters

Depth beneath ice sheet
of Lake Vostok surface

SOURCE: Y. SHTARKMAN ET AL/
PLOS ONE 2013

Going to extremes A drilling team finally reached Lake Vostok in February 2012 after years of trying. As the drill neared its target, it collected lake ice that froze to the overriding glacier millennia ago and has been carried along by it.



Y. SHTARKMAN ET AL./PLOS ONE 2013, ADAPTED BY M. ATAROD

the southwestern side,” he says. “I think that’s where all the biological action is.”

On the seafloor such vents often support a motley crew of organisms. A 2010 expedition found a hot-water vent near Antarctica crawling with a recently discovered crab species and other creatures, including barnacles, anemones, sea spiders, snails and a predatory starfish (*SN*: 1/28/12, p. 5). It’s hard to imagine that similar marine creatures could survive 15 million years sealed off from the ocean and the atmosphere, says Alex Rogers, a deep-sea ecologist at the University of Oxford in England who led the Antarctic expedition (and is unrelated to Scott Rogers). “If there’s anything associated with the lake, I would expect it to be microbial.”

Bulat expresses his skepticism more directly: “It is completely contamination,” he says.

When dealing with fragile, ancient DNA, Scott Rogers acknowledges, some contaminating genetic sequences are to be expected. But as a molecular biologist who has been investigating mummified and hard-to-find DNA for more than three decades, he has learned to take every precaution. His team compared the genetic sequences from their Vostok samples with species on a list of organisms found in the drilling fluids used to extract the ice core, for example. There wasn’t any crossover between the two. The researchers also tested water in their lab and discarded all genetic sequences from the ice that matched anything in their lab water. His lab spent four years, he says, ironing out the best way to extract samples from ice cores, including creating cores in the lab with small amounts of known DNA inside them, coating the cores with contaminating genetic material and then developing a treatment to eliminate the unwanted material (a process that includes washing with Clorox bleach seems to do the trick).

Gene trees

There’s been some additional skepticism from scientists concerned about linking the genetic sequences reported in the paper to familiar organisms. Much of

the genetic material pointing to multicellular life was just short little bits, 200 to a few thousand letters of genetic code long. The researchers reported the percent similarity of their samples to genetic sequences that have been deposited in public databases. But depending on the stretch of DNA examined, percent similarity can be a lousy way to determine what creature the DNA came from; a very short string of letters from, say, a fly and a human might be very similar if there has been little change in that region of the genome since the two species diverged from their last common ancestor.

In other words, says Jonathan Eisen, an expert on the evolution of microbes and genomes at the University of California, Davis, “you want to make sure you’re not looking at weird, spurious crap.” For a good, quick estimate of relatedness, Eisen says, use sequences of DNA letters to build a family tree that roughly approximates the one evolution has created in the real world. If purported insect DNA, for example, fits best on an insect branch of the tree of life, it’s a much stronger case that the DNA truly came from an insect.

Eisen has done just that. While initially skeptical about the claims of genetic similarity, his analysis, performed at the request of *Science News*, finds that many of the purported bits of animal DNA actually do nestle in the appropriate animal branches of reconstructed genetic trees.

“The trees look good,” Eisen says. “I’m not finding anything that I would say is weird.”

That doesn’t mean there are lobsters in Lake Vostok. The genetic sequences that are similar to those of known microbes and parasites associated with larger organisms could indeed be relatives, but ones that abandoned the parasitic lifestyle long ago. Such evolutionary reversals are not uncommon, and can’t be discerned from genes alone. And Eisen’s analysis says nothing about the source of the DNA; it could be contamination.

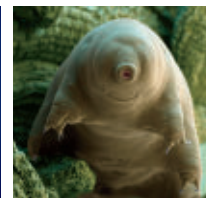
Bulat’s team is now analyzing samples from the 2012 expedition that captured liquid water from Lake Vostok. It isn’t

Cast of characters Researchers isolated DNA from Lake Vostok ice and compared it with genetic sequences from known organisms. Many of the Vostok samples were strikingly similar to sequences from common aquatic invertebrates.



Daphnia

Named for the insects they resemble, water fleas are crustaceans that usually filter feed.



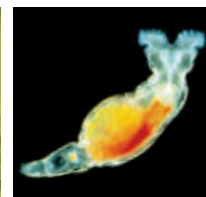
Tardigrade

These aquatic animals are known for their ability to withstand extreme conditions.



Entomobryidae

Relatives of insects, slender springtails can be terrestrial or aquatic.



Rotifer

These zooplankton play an important role at the base of aquatic food chains.

clear what those samples will reveal, especially since they come from the uppermost zone of the lake at a location far from the region that is suspected of harboring volcanic vents. There aren’t any plans to drill into that portion of Lake Vostok anytime soon. In the absence of sending video cameras or similar devices down into the water, the possibility of contamination is likely to remain an issue for any samples that are collected.

“The half-empty side of me says contamination,” says sea vent specialist Alex Rogers. “But who knows? The half-full side of me says, wow, I really hope there is perhaps diverse life. I would be prepared to be delighted; it would provide an environment for all kinds of scientific discoveries.” ■

Explore more

■ Y. M. Shtarkman *et al.* “Subglacial Lake Vostok (Antarctica) accretion ice contains a diverse set of sequences from aquatic, marine and sediment-inhabiting bacteria and eukarya.”

PLOS ONE. July 3, 2013.

How We Do It: The Evolution and Future of Human Reproduction

Robert Martin

Many parents have questions about how to raise children “naturally.” When is the natural time to wean a baby? Is early toilet training natural? What about suggestions to eat the placenta?

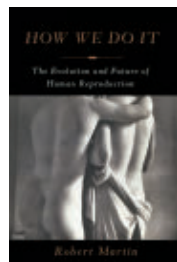
Martin, a primatologist, looks to evolutionary history for clues to how humans have parented through time. He leads a dizzying tour through evolutionary aspects of human reproduction, starting with sperm and egg, winding through pregnancy and parental care, to reach the decidedly unnatural topics of contraception and in vitro fertilization.

The book is a gold mine of cocktail party trivia. Humans, for instance, have the fattest babies of all primates, and our disdain for dirty diapers is something of an evolutionary anomaly. Most mammals, including our closest relatives, deal with their infant’s waste by swallowing it.

Martin often touches on practical issues. He devotes an entire chapter to

breast-feeding and marshals evidence that humans evolved with a normal weaning time greater than three years. But he never makes clear whether he thinks modern mothers would benefit from breast-feeding as the ancients did.

He also discusses more controversial questions, such as whether environmental toxins are harming male



fertility or whether the rhythm method leads to more miscarriages. Although Martin clearly suspects the answer to both questions is yes, he acknowledges that only more research can settle such matters. That should be a warning to anyone seeking a practical, rather than intellectual, guide. People who are fascinated by humans’ past should read this book. Those looking for advice would be better off talking to their doctors.

—Cristy Gelling

Basic Books, 2013, 304 p., \$27.99

What Makes a Hero? The Surprising Science of Selflessness

Elizabeth Svoboda

Stories of heroes are all over the news: First responders and even concerned passersby put themselves in harm’s way to help others, going against every instinct for self-preservation. What could explain such selfless acts? Even Charles Darwin struggled to understand the evolutionary upside of self-sacrifice.



Svoboda, a science writer, takes an in-depth look at some of the scientists who study altruism and what they are finding. Brain scans (including one of Svoboda) reveal that people who envision themselves giving to charity show neurological responses similar to the effects of taking an addictive drug. It’s ironic, Svoboda writes, that acts of selflessness can stem from

such self-centered motivations.

Svoboda also chronicles tales of ordinary people who give of themselves regularly. These inspiring case studies show how selfless attitudes can be developed or strengthened.

Not everyone comes through when the opportunity for altruism calls. But research shows that, as in many endeavors, practice increases the likelihood of success. By starting out with small acts of altruism — donating small amounts to charity or mentoring at-risk youth an hour or two each week — people can become more comfortable with the idea of stepping up to a major challenge.

Studies also suggest that by helping other people, altruists not only get pleasure and enhance their mood, but also boost their health and maybe even extend their lives. In that sense, this could be the ultimate self-help book. You’ve just got to put it down and help someone else first. —Sid Perkins

Current, 2013, 225 p., \$27.95



Seaweeds

Ole G. Mouritsen

A biophysicist with a penchant for Japanese cuisine promotes algae’s nutritional and industrial value

while describing seaweed biology and ecology. *Univ. of Chicago*, 2013, 287 p., \$35



The Space Book

Jim Bell

Learn about 250 astronomical achievements in this compendium organized as a timeline of discoveries.

Sterling, 2013, 527 p., \$29.95



The Joy of Pain

Richard H. Smith

A psychologist examines *schadenfreude*, or pleasure taken from the misfortune of others, and how it

plays out from the workplace to sports rivalries to reality TV. *Oxford Univ.*, 2013, 238 p., \$24.95



On Gaia

Toby Tyrrell

An earth scientist argues that the Gaia hypothesis, which suggests that life on Earth helps regulate

its environment, is flawed and has set back environmental action.

Princeton Univ., 2013, 311 p., \$35



Pterosaurs

Mark P. Witton

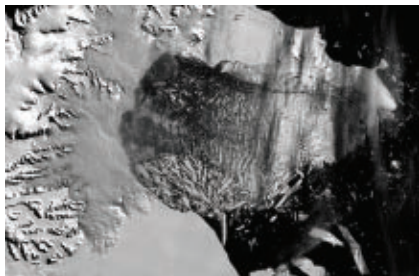
Learn all about flying reptiles in this artfully illustrated overview of pterosaur research,

written by a paleontologist/artist.

Princeton Univ., 2013, 291 p., \$35

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FEEDBACK

**Seeing ice**

In the photo series shown in “Taking Antarctica’s temperature” (*SN*: 7/27/13, p. 18), the ice appears to be increasing from January to April as one would expect in the Southern Hemisphere. How does this demonstrate the rapid collapse of the Larsen B Ice Shelf?

William Meadows, Dripping Springs, Texas

The satellite images show a large area of the Antarctic Peninsula; the Larsen B Ice Shelf is a small area near the center. A closer view of Larsen B (above) from March 7, 2002, reveals that what looks like a solid sheet of ice in the wider view is actually composed of thousands of icebergs that have broken free. — Editors

Musical minds

When contemplating Erich Jarvis’ research on the roots of speech (“Finding the brain’s common language,” *SN*: 7/27/13, p. 32), the existence of nonspeaking deaf humans with Ph.D.s brings me up short. It might make sense to separate the concept of vocal/aural learning from that of detailed social signaling. Perhaps what Jarvis is discovering is part of the biological roots not of language but of music, and

spoken language might arise as a confluence of musical ability with complex social signaling and culture. This might fit with accidental experiments such as 19th century Martha’s Vineyard, where sign language was roughly equal with speech for over a century.

Matthew H. Fields, via e-mail

Mammoth meat-eating

“Siberians rarely ate mammoths” (*SN*: 7/27/13, p. 10) fails to live up to its premise that Stone Age Siberians killed mammoths only for their tusks (for tool-making). The article says that “meaty parts of the animals were probably consumed.” As the saying goes, there’s a lot of meat on the hoof. Subsistence hunters, today as in the past, use almost every part of the animals they harvest.

John Smelcer, Kirksville, Mo.

Mineral mix-up

“Atomic ant sand” (*SN*: 8/10/13, p. 32) referred to Trinitite as a mineral, but the composition of Trinitite is feldspar, quartz and clay; those are minerals. Trinitite is a fused glass mixture. Also, there are plenty of samples of Trinitite in the collections of the Smithsonian Institution; all the researcher has to do is write to us.

Paul W. Pohwat, via e-mail

The reader is the collection manager for minerals at the National Museum of Natural History in Washington, D.C.

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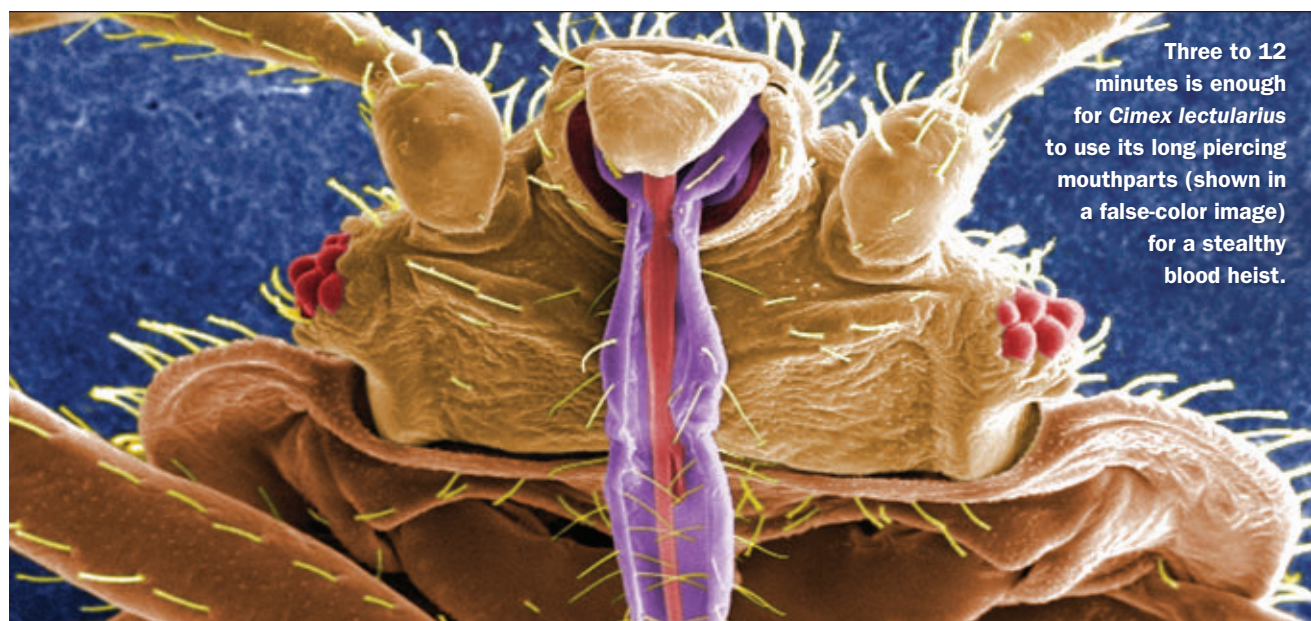
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Three to 12 minutes is enough for *Cimex lectularius* to use its long piercing mouthparts (shown in a false-color image) for a stealthy blood heist.

Let the bedbugs bite

Harold Harlan has been feeding bedbugs, intentionally, on his own blood since 1973. He keeps pint or quart jars in his home containing at least 4,000 bugs. And now Harlan's self-sacrifice is helping other researchers studying the recent resurgence of bedbugs in the United States and other parts of the world.



For most of the first 25 years of this enterprise, Harlan (left) worked as a commissioned U.S. Army entomologist, and bedbugs were a pet project. Then the bugs made a comeback, and other researchers needed advice on care and feeding as they set up laboratory colonies. They also needed a bedbug source.

"I ask them to pay for shipping," says Harlan, now working for the Armed Forces Pest Management Board. He has provided his blood for free, in the course of rearing 6,000-plus bedbugs (so far) for the starter kits he sends out. A fair number have been restarter kits and re-restarters, as other researchers struggled to get bedbug husbandry right. One team, attempting to avoid the need for human feeders, lost its bedbugs after inadvertently exposing them to an anti-parasite drug in slaughterhouse blood from chickens.

"My bugs are wimpier than most," Harlan says. Decades of protecting his colony from pesticides, plus inbreeding, have rendered Harlan's bedbugs a point of comparison for today's many pesticide-resistant forms. So far, authors of at least 45 scientific articles by researchers coast to coast have used his strain.

The Harlan strain started with bedbugs he collected at Fort Dix, N.J., where he had been called in to deal with a mysterious infestation. To study them, he would have to feed them. "I was so fascinated by them, that wasn't an issue," he says. As an entomology student, he had been expected to feed mosquitoes in the lab.

Harlan has learned to be as careful about protecting his bugs from people as vice versa. One jarful succumbed to the wafting mist of a cleaning aerosol that his wife, Norma, spritzed on a duster. When his children were young, he kept the containers hidden away, and when the family moved — as military families often do — he transferred the bedbugs himself. "It's no more difficult than taking care of your china or glassware," he says. Which is one way of looking at it. —*Susan Milius*



Feeling the itch

On weekends a couple times per month, entomologist Harold Harlan feeds about half a dozen jars of bedbugs for roughly half an hour each. He rears the bugs in wide-mouthed jars topped with fine mesh, and to feed them he presses the mesh against the skin on his leg (jar shown above) and tries to distract himself with a book or TV.

Bedbugs can draw blood from most people without even waking them. Unfortunately, Harlan is one of the rare people who can feel the initial bites. After repeated exposure, the human immune system mounts an itching, swelling allergic reaction, Harlan says. About half an hour after a feeding session, the area around the bites reddens, and a day or so later a secondary, intensely itchy swelling reaction occurs.

Harlan has heard that, in theory, people repeatedly exposed to bedbug saliva could reach a point where bites no longer cause skin reactions. But for him, 40 years has not been long enough to eliminate the itch caused by his research bugs. "I just put up with it, because if I didn't they wouldn't stay alive," Harlan says.

CLOCKWISE FROM TOP: JANICE HANEY CARR/CDC; H. HARLAN; PHIL COLLINS/WRAIR

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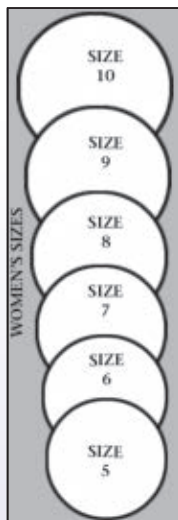
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