Bacteria Hit a Nerve | Bad Neighbors Spur Cancer | Space Beads

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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ OCTOBER 5, 2013

The Soot Solution

Why black carbon and other pollutants may be key to averting climate catastrophe

Poverty Saps Reasoning

Global Warming Hiatus Explained

Parasite vs. Parasite

How to Outsmart a Millionaire

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I wasn't looking for trouble. I sat in a café, sipping my espresso and enjoying the quiet. Then it got noisy. Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his $14,000 watch made it okay for him to be rude. That's when I decided to roll up my sleeves and teach him a lesson.

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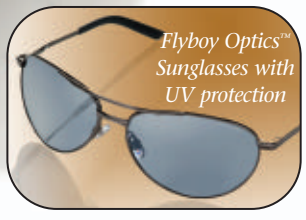

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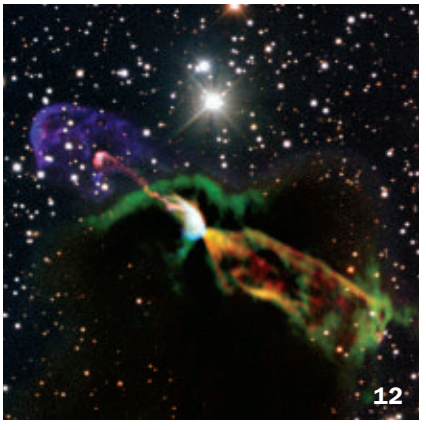

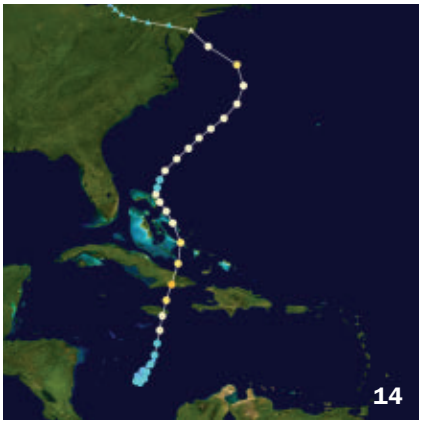

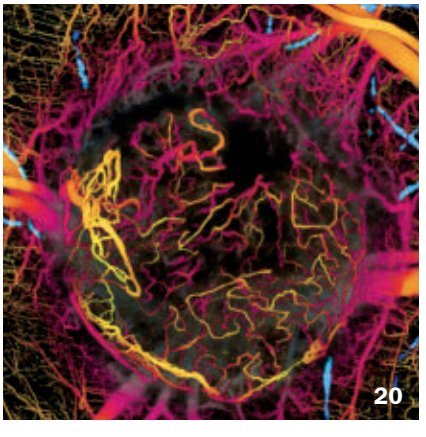

ScienceNews

In The News

Features

Departments

COVER Curbing soot emitted by sources such as this brick kiln in Afghanistan could produce relatively quick reductions in human-caused warming. *Shah Marai/AFP/Getty Images*

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

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

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

FROM THE EDITOR

Coming soon: *Science News* any way you want it

As I mentioned in an earlier letter, change is afoot at *Science News*. Now I have some exciting news for readers: On October 2, we will launch a new and expanded *Science News* website. And starting with the October 19 issue, all print subscribers will have access to a new iPad version of *Science News*, at no additional charge. You'll also notice a smart new look for the magazine, starting with the next issue, that helps align our online, tablet and print editions.

Dubbed "*Science News* any way you want it," this expansion of the ways people can access the magazine will ensure that *Science News* keeps reaching readers whether they prefer paper and ink or a retina-display screen. That's vital to our future, especially given the uncertainties faced by most magazines and newspapers today.

But unlike many other journalistic concerns, we have the benefit of being part of a nonprofit organization, the Society for Science & the Public, that is committed to promoting scientific awareness to the general public. Which brings me to another change: We're inviting our subscribers to become full-fledged members of the Society. Members will get full access to *Science News* as well as regular updates about the Society's education programs and broader efforts to promote public understanding of science. Members will also be helping to support *Science News for Students*, a free, online publication geared toward teens and educators (and edited by *SN*'s own Janet Raloff).

Of special interest to *SN* readers are the new blogs that will debut on the redesigned website. *Context*, by former editor in chief Tom Siegfried, will explore new findings through the lens of science history. *Growth Curve*, by neuroscience writer Laura Sanders, will look at the science of parenthood and child development. Erika Engelhaupt, deputy managing editor, will take readers on tours of the bizarre, gross and creepy in *Gory Details*. Freelance writer Sarah Zielinski will share news from the natural world in the *Wild Things* blog. And web producer Ashley Yeager will provide a constant stream of up-to-the-minute research news in *Science Ticker*. The website's new design means you can easily read news and blogs on your desktop, tablet or smartphone.

We've had an exhilarating experience over the last year, dreaming about all that *Science News* can be. I hope you'll tune in, any way you want to, and see what we've come up with. —*Eva Emerson, Editor in Chief*

SANDY SCHAEFFER

Actual size is 40.6 mm

The LAST 2013 American Silver Dollars?

Minting of 2013 American Silver Eagles Will Cease.

Millions of people collect the American Eagle Silver Dollar. In fact it's been the country's most popular Silver Dollar for over two decades. But there's one "secret" that many people do not know. It's actually against the law for the U.S. government to strike any more 2013 Silver Eagle coins after Dec 31st. That means that sometime in the next few months, the government will issue the order to stop the minting of these magnificent 2013 American Eagle Silver Dollars —and the dies will be destroyed forever!

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Don't wait until it's too late. Today you have the opportunity to secure these massive, hefty one full Troy ounce U.S. Silver Dollars in stunning Brilliant Uncirculated condition while our supplies remain. These legal tender United States Silver Dollars feature a nearly 100-year-old design of Lady Liberty striding confidently forward while draped in a U.S. flag, while the other side depicts a majestic U.S. eagle, thirteen stars, and an American shield. But the clock is ticking. Once production is stopped, no new 2013 American Silver Eagles will ever be struck again!

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Science Stats | SCARING SMOKERS

In 2012 the U.S. Centers for Disease Control and Prevention launched Tips from Former Smokers, the first federally funded, national media campaign promoting smoking cessation. A new study reports that the three-month campaign, which used emotional pleas from real people like the man at left, did prompt people to quit smoking, some long-term. SOURCE: T. MCAFEE *ET AL*/*LANCET* 2013

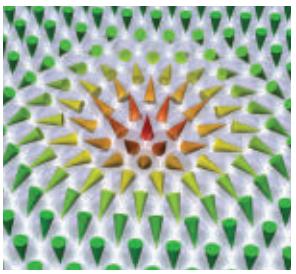
1.64 million — Additional smokers who tried to quit after campaign

220 thousand — Ex-smokers still not smoking at end of campaign

100 thousand — Estimated smokers who will quit long-term

Say What? | SKYRMION *SKIR-mee-on*\ *n.*

A vortex of magnetized atoms. Scientists are interested in using skyrmions to develop faster, more stable information storage, such as next-generation computer hard drives. Now researchers have created and destroyed individual skyrmions in a material for the first time. A team carefully pointed the tip of a scanning tunneling microscope, which can manipulate surfaces at atomic scales, toward a thin magnetic film. The tip applied a small current that twisted atoms on the film into a skyrmion (illustrated, left); reapplying the current erased the nanometer-sized vortex. Eventually new hard drives might store 1s and 0s based on the presence or absence of these tiny magnetic tornadoes, Niklas Romming of the University of Hamburg and colleagues report in the Aug. 9 *Science*. — *Andrew Grant*



50 Years Ago

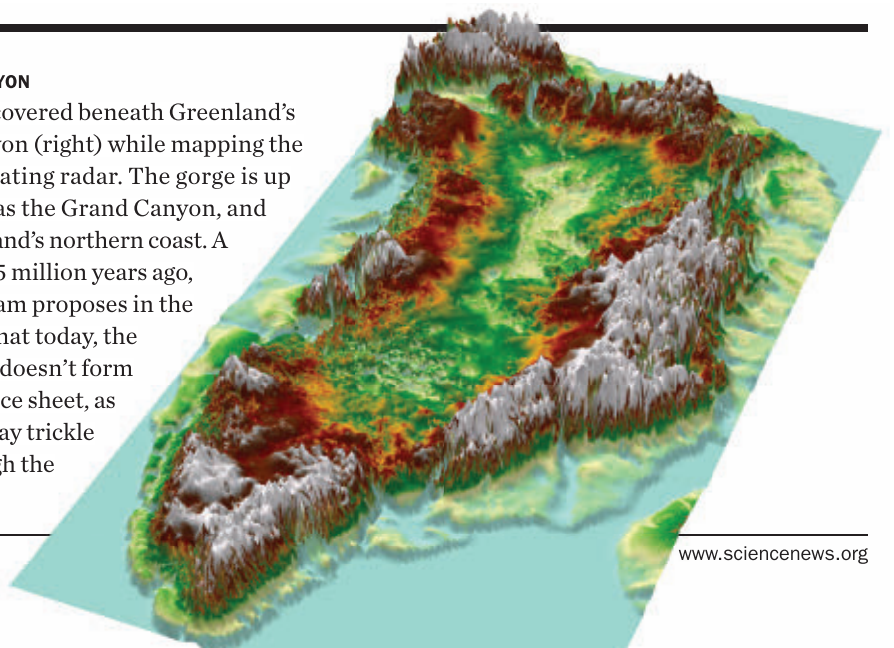
Excerpt from the October 5, 1963, issue of *Science News Letter*

HUGE GALACTIC EXPLOSION The most gigantic explosion ever known in the universe, the tremendous detonation of the heart of a distant galaxy of millions of stars, has been discovered. The galaxy, known to astronomers as M-82, is still in the process of explosion, with material rushing out at velocities up to 20 million miles per hour. Matter equal to five million suns is involved in the cataclysm. The explosion started 1.5 million years ago, about when the Ice Age existed here on earth. Light has just reached earth, for the galaxy is 60 billion billion miles (10 million light-years) away. Captured on a special photograph taken with the world's largest telescope, the 200-inch Hale telescope on Mt. Palomar, Calif., the evidence is that tremendous jets of matter, stretching out 60 million billion miles (10,000 light years), are streaming from the galaxy's nucleus.

UPDATE: Scientists later found a surprising source for the "explosion" at the heart of M-82. It and another galaxy, M-81, once whizzed past each other, compressing gas inside M-82 and creating new stars. Rather than an exploding galaxy, M-82 is now understood to be a starburst galaxy, ejecting plumes of dust and gas as stars form.

Introducing | GREENLAND'S GRAND CANYON

A 750-kilometer-long chasm has been discovered beneath Greenland's thick ice. Glaciologists uncovered the canyon (right) while mapping the island's subglacial terrain with ice-penetrating radar. The gorge is up to 800 meters deep, or about half as deep as the Grand Canyon, and stretches from central Greenland to the island's northern coast. A river probably carved the channel about 3.5 million years ago, before ice spread across Greenland, the team proposes in the Aug. 30 *Science*. The researchers suspect that today, the canyon may be one reason why meltwater doesn't form subglacial lakes at the base of Greenland's ice sheet, as it does in Antarctica. Instead, meltwater may trickle down into the canyon and then flow through the channel to the sea. — *Erin Wayman*



FROM TOP: U.S. CENTERS FOR DISEASE CONTROL AND PREVENTION; COURTESY OF R. WIESENDANGER GROUP/UNIV. OF HAMBURG; J. BAMBER/UNIV. OF BRISTOL

“It’s important because it shows that in order to understand the immune system, you really have to understand the nervous system.” —KEVIN TRACEY, PAGE 16

In the News

FROM LEFT: KAY CHERNUSH/GETTY IMAGES; KUTTELVASEROVA STUCHELOVA/SHUTTERSTOCK

STORY ONE

A gut infection can keep mice lean

Bacteria can invade one rodent from another, preventing both from getting fat

By Meghan Rosen

Mice fed microbes from obese people tend to gain fat. Microbes from lean people protect mice from excessive weight gain, even when animals eat a high-fat, low-fiber diet.

Skinniness could be contagious. Gut bacteria from thin people can invade the intestines of mice carrying microbes from obese people. And these invaders can keep mice from getting tubby.

“It’s very surprising,” says molecular microbiologist Andreas Schwiertz of Giessen University in Germany, who was not involved in the work. “It’s like a beneficial infection.”

But the benefits come with a catch. The invading microbes drop in and get to work only when mice eat healthy food, researchers report in the Sept. 6 *Science*. Even fat-blocking bacteria can’t fight a bad diet, says study leader Jeffrey Gordon, a microbiologist at Washington University in St. Louis.

> “It’s like a beneficial infection.”
> ANDREAS SCHWIERTZ

In recent years, researchers have collected clues suggesting that gut microbes can tweak people’s metabolism. Fat and thin people have different microbes teeming in their intestines, for example. And normal-weight mice given microbes from obese mice pack on extra fat, says coauthor Vanessa Ridaura, also of Washington University.

These and other hints have led researchers to experiment with fecal transplants to flush out pro-obesity gut microbes and dump in lean-promoting ones. The transplants can clear diarrhea and may help some obese people regain insulin sensitivity. But feces can house dangerous as well as friendly microbes.

“We want to make therapies that are more standardized—and more appealing,” says gastroenterologist Josbert Keller of the Haga Teaching Hospital in The Hague, Netherlands.

Scientists are trying to pinpoint helpful gut microbes and figure out how diet guides their role in metabolism. Gordon, Ridaura and colleagues transplanted fecal microbes from obese and lean human twins into mice lacking gut bacteria of their own. Within two weeks, mice that received bacteria from obese people started to put on fat. Mice given bacteria from lean people stayed slim.

Next, the researchers wondered if the microbes could travel between animals and stake out new territory. So the team

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housed mice carrying microbes from lean people with still-thin mice carrying microbes from obese people. "We called it 'the battle of the microbiota,'" Gordon says.

Microbes from lean people won: The organisms claimed space in the guts of mice carrying microbes from obese people. What's more, the invaders kept their new hosts from putting on weight.

The findings sparked a question about humans. If microbes from thin people can jump between animals and prevent pudginess, Gordon asks, "why isn't there an epidemic of leanness? The answer is diet, diet, diet."

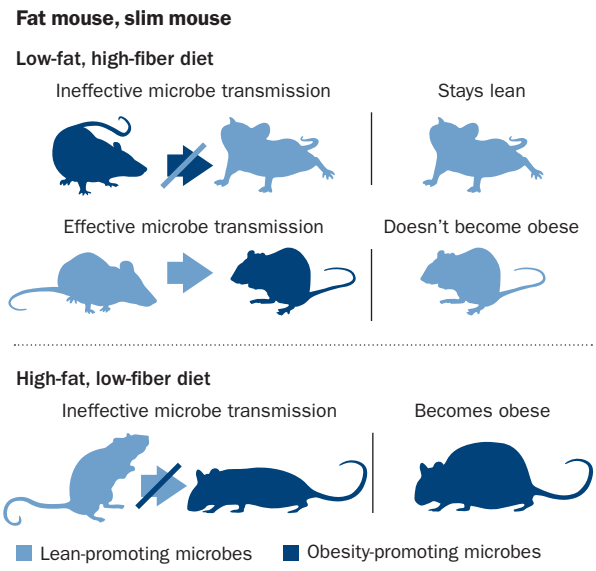
Gordon's team drew that conclusion after repeating the microbiota battle, this time feeding both types of mice a high-fat, low-fiber diet based on American eating habits.

On this diet, lean-people microbes seemed to protect mice from getting chubby: Mice with these bacteria gained less weight than did mice with obesity-associated microbes. But when researchers put the two types of mice together, lean-promoting microbes were no longer able to invade the guts of mice carrying obesity-associated microbes. And without these invaders, mice couldn't stave off excessive fat gain.

The findings underscore the gut microbiota's important but limited role in metabolism, Gordon says. "It's not the only cause of obesity, but it is a contributor." And a bad diet can tip the scales, thwarting helpful bacteria from accessing the gut, he says.

Now the team is looking into adding microbes to diets to promote health and possibly even repair poor gut bacterial communities. The team identified one group of invading microbes called Bacteroidetes that could help protect against obesity. Gut microbes such as these, Gordon says, could be the next generation of probiotics — bacteria people consume to improve their health.

"You will never be able to eat everything you want and compensate with fecal transplants or probiotics," Keller says. "But it's very difficult for obese people to lose weight with a normal diet, so we need other therapies to support them." ■



Sharing microbes Gut microbes sometimes move between mice that are housed together. Microbes from obese people don't readily move between animals, while microbes from lean people can take hold in another mouse's gut, keeping the animal slim. A high-fat diet, however, blocks the transfer of lean-promoting microbes and their protective effects.

Back Story | FECES HAPPENS

In 1958, physicians used fecal transplants to treat patients with severely inflamed colons. Since then, the unappealing remedy has lingered on the fringes of mainstream medicine. The idea of pumping one person's feces into another person's intestines makes many people squeamish. Researchers blend feces into a slurry and then deliver the load via enema or nasal tube.

But fecal transplants may be worth the trouble. A 2013 study found that they are better than an antibiotic for some gut infections. And last year, researchers reported that obese people recovered insulin sensitivity after getting dung donations from lean volunteers.

Still, scientists are looking for ways to clean up the procedure and standardize treatment. One option is to identify the microbes that are responsible for the transplants' helpful effects. Members of the phylum Bacteroidetes, for example (one species shown), may protect people from getting fat. Pegging these and other friendly bacteria might let researchers get at the goods without getting their hands dirty. — *Meghan Rosen*

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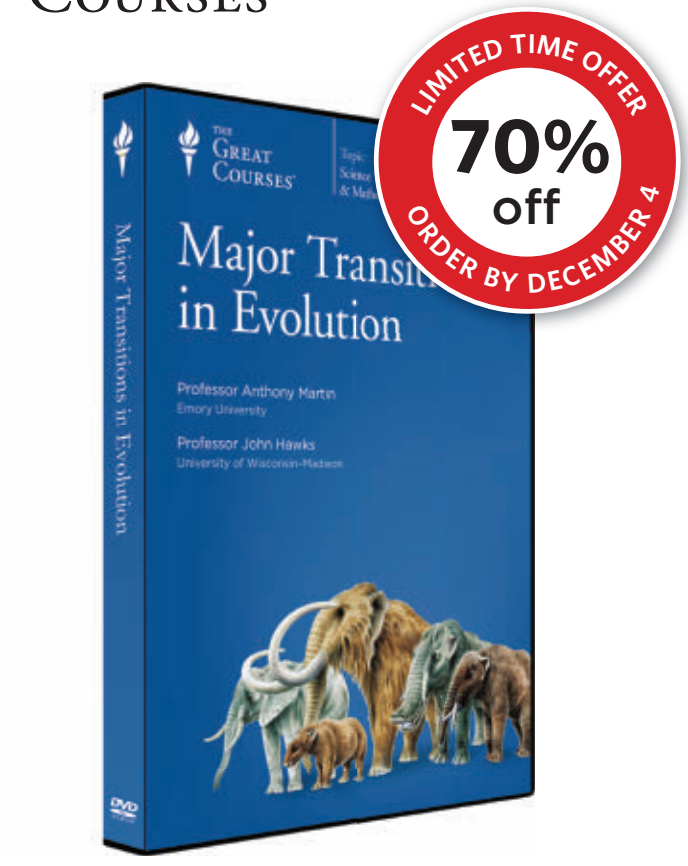

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Life

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For sheep horns, biggest is not best

Trade-offs between studliness and survival help less endowed

By Jessica Shugart

Sometimes it pays to be mediocre. A new study shows that sheep with a 50/50 blend of genes for small and big horns pass along more of their genes than their purely big-horned brethren, who mate more often.

The finding offers rare insight into an enduring evolutionary paradox: why some traits persist despite creating an apparent reproductive disadvantage.

"This is a marvelous combination of using the most modern tools available to confirm classic older views of sexual selection," says evolutionary geneticist Allen Moore of the University of Georgia in Athens.

The results, published online August 21 in *Nature*, reveal that while bigger-horned sheep mated most successfully each season, small-horned sheep survived longer. Rams that inherited one of each type of gene from their parents got the best of both worlds: They lived longer than bigger-horned sheep and mated more successfully than those with the smallest horns.

As a result, middle-of-the-road sheep passed on more of their genes over time. "They're the fittest of them all," says Jon Slate of the University of Sheffield in England, who led the study.

Traits such as bold peacock feathers and giant antlers garner the attention of prospective mates and boost reproductive success. Yet if each generation of females continues to pick the most stellar males, Charles Darwin wondered, how do subpar versions of a trait continue to persist? "It's something that has preoccupied evolutionary biologists ever since," Slate says.

Attempts to untangle the paradox have been confounded by the fact that most physical traits are thought to involve multiple genes. But in a population of sheep living on a chain of isolated Scottish isles, one gene bucks the trend.

"This one gene had such a massive effect on the size of the horns, and that was really unusual," says evolutionary geneticist and coauthor Susan Johnston of the University of Edinburgh. Johnston discovered the gene, called relaxin-like receptor 2 (*RXFP2*), two years ago while analyzing the genetic fingerprints of nearly 500 Soay sheep. Domesticated in the Neolithic era and roaming wild for the last 4,000 years, the Soay sheep weigh just 45 to 80 pounds and stand 2 feet high. Scientists have intensively studied the colony in the St. Kilda archipelago since 1985.

Two versions, or alleles, of the *RXFP2* gene exist. One produces large, curled horns that work well in a fight, and the other produces small horns. Because sheep get a copy of the gene from each parent, males may have two big-horn alleles, two small-horn alleles or one of each.

Sheep with two big-horn versions have the largest horns, whereas sheep with one of each have smaller, yet substantial, horns. Rams cursed with two small-horn alleles develop either small curled horns or stubby protrusions called scurs that are worthless in competition. "They're really quite pathetic," Slate says.

Male Soay sheep with small, or scurred, horns (left) can't compete with larger-horned rams (center and right) for mates, but live longer than their most well-endowed kin.

Slate and his team analyzed samples collected from nearly 6,000 sheep over three decades. The team linked reproductive success and overall survival with the type of horn gene passed down with each generation.

Though it's unclear why small-horned sheep live longer, the authors propose that these sheep may prolong survival by steering clear of confrontation. Rather than attempting to square off with larger-horned males, the sheep stuck with scurs may lie in wait for unattended females. In contrast, the sheep with the largest horns must protect and defend multiple females over the course of a mating season — a violent and energy-consuming endeavor that taxes survival.

The concept of "heterozygote advantage" — when an animal benefits from having two different versions of a gene — isn't new, Johnston says. But it is "quite often overlooked, because there are just so few examples of it." The gene that causes sickle-cell anemia is one such example: People who carry one copy of the disease-associated allele and one healthy allele are resistant to malaria. ■

PETER KORSTEN

"The older birds get, the closer they stick to the straight line." —THOMAS MUELLER

Suspended state induced in rats

Injected compound causes hibernation-like slowdown

By Laura Sanders

Not normally hibernators, rats spent hours in a state of chilly suspended animation after researchers injected a compound into the animals' brains. Each rat's heart rate slowed, brain activity became sluggish and body temperature plummeted.

The research joins a small number of studies that attempt to induce the metabolically lethargic state known as torpor in animals that can't normally slow their metabolism. "It's a breakthrough" in understanding aspects of torpor, says neuroscientist Kelly Drew of the University of Alaska Fairbanks.

Lowering the body temperature of a nonhibernating mammal is really hard, says Domenico Tupone of Oregon Health & Science University in Portland. As temperatures inside the body fall, several failsafe systems spring into action. Blood vessels near the skin squeeze tight to hold warmth in, the body starts to shiver and brown fat, a tissue that's especially plentiful in newborns, starts to produce heat.

But Tupone and colleagues bypassed the rats' defenses against the cold with a compound that's similar to adenosine, a molecule in the body that signals sleepiness. After about an hour in a room chilled to 15° Celsius, the rats' brain waves slowed, their heart rates dropped and their hearts occasionally skipped beats.

The rats' core temperature dropped from about 38° to about 28° C, or from roughly 100° to 82° Fahrenheit, the authors report in the Sept. 4 *Journal of Neuroscience*. In further experiments, rats' core body temperatures reached 15° C, or about 59° F. "That is a pretty amazing temperature," Tupone says. "No one has done this before."

The rats weren't in a coma, nor were they asleep or truly hibernating. Hibernating animals' metabolisms plummet and their temperatures sink much lower; an Arctic ground squirrel, for instance, cools to about –3° C when it hibernates.

In the experiment, loud noises and tail pinches failed to arouse the rats. They didn't eat or drink. Occasionally, one would slither into a corner, but for the most part, the animals stayed still for up to six hours. In unpublished experiments, Tupone has kept the animals in the unresponsive state for 24 hours, he says.

Warming the room coaxed the rats out of their torpor. The recovery process took about 12 hours, during which the animals ate and drank voraciously. After recovering, the animals were alert, moved around their cages normally and slept when tired.

The rat experiment could one day have implications for another nonhibernating mammal, humans. A safe and reversible way to allow people to lower their temperatures would be an important tool for doctors. A safe way to induce torpor in humans is also the dream of people with interstellar aspirations: People would be able to travel much farther in space in a suspended animation state. ■

Elders lead young whooping cranes

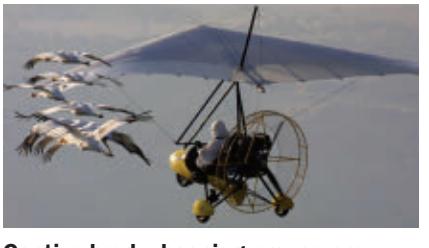
Captive-bred birds get more efficient the more they migrate

By Susan Milius

Here's a lesson on road trips from whooping cranes: For efficient migration, what matters is the age of the oldest crane in the group. More experienced fliers keep youngsters on course during long flights.

"The older birds get, the closer they stick to the straight line," says ecologist Thomas Mueller of the University of Maryland in College Park, who crunched data from 73 *Grus americana* migrating between Wisconsin and Florida.

One-year-olds traveling with other birds of the same age, the analysis says, tend to deviate about 76 kilometers from a direct route. But if they fly in a group with an 8-year-old crane, they stray about 47 kilometers, or 38 percent less, Mueller and his colleagues report in the Aug. 30 *Science*.



Captive-bred whooping cranes are escorted by an ultralight aircraft on their first trip south. On later migrations, youngsters may learn from older birds.

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Eight years of data on these endangered cranes summering in Wisconsin's Necedah National Wildlife Refuge offered a rare chance to parse how birds find their way. Researchers release captive-bred cranes in Wisconsin and lead each class of newbies, just once, with an ultralight aircraft to Florida's Chassahowitzka National Wildlife Refuge for the winter. Cranes navigate back to Wisconsin on their own.

Whether this is a true case of social learning, with young birds picking up migration savvy from flying with older ones, is a question that intrigues behavioral biologist Dora Biro of the University of Oxford in England. Youngsters might not be learning from their flight mates so much as benefiting short-term from the older birds' expertise. The difference is not just semantics, she says, but is important for understanding how generations might be transmitting information.

Science & Society

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Bias seen in behavioral studies

Analysis suggests researchers too often find what they seek

By Bruce Bower

Here's a hard pill to swallow for practitioners of "soft" sciences: Behavioral studies statistically exaggerate findings more often than investigations of biological processes do, especially if U.S. scientists are involved.

The inflated results stem from a lack of consensus about experimental methods and measures in behavioral research, combined with intense publish-or-perish pressure in the United States, say evolutionary biologist Daniele Fanelli of the University of Edinburgh and epidemiologist John Ioannidis of Stanford University. Without clear theories and standardized procedures, behavioral scientists have a lot of leeway to produce results that they expect to find, even if they're not aware of it, the researchers conclude in the Sept. 10 *Proceedings of the National Academy of Sciences*.

"Sadly, the general finding about U.S. science sounds rather plausible," remarks psychologist Hal Pashler of the University of California, San Diego.

Fanelli and Ioannidis examined the primary findings of 1,174 studies that appeared in 82 recently published meta-analyses. A meta-analysis weighs and combines results from related studies to estimate the true effect in a set of reported findings.

The researchers divided the studies into three types. Psychological and other purely behavioral studies examined qualities such as impulsivity using observation-based scales or instruments. Studies in genetics and several other nonbehavioral fields used unambiguous outcomes, such as death. Biobehavioral studies probed a combination of biological and behavioral effects.

The studies' authors primarily came from the United States, Europe and Asia.

Of the study types, individual behavioral studies were most likely to report effects greater than those calculated in associated meta-analyses. Behavioral studies with a lead author in the United States showed an especially strong tendency to find what researchers had predicted before performing the research.

Biobehavioral studies displayed a smaller "U.S. effect." No such tendency characterized nonbehavioral investigations, in which findings differed from those of meta-analyses mostly because samples were unrepresentative of populations being studied, the researchers say.

"U.S. studies in our sample overestimated effects not because of a simple reluctance of researchers to publish nonsignificant findings, but because of how studies were conceived and carried out," Fanelli says.

Poverty may tax thinking abilities

Stress of just getting by seems to hurt performance

By Bruce Bower

Poverty drains brains while it empties pocketbooks, a new study concludes.

Money worries consume poor people's attention, dramatically undermining their performance on IQ-related tests of reasoning and mental control, say economist Anandi Mani of the University of Warwick in England and her colleagues. Among the poor, but not the rich, evoking financial concerns damages reasoning abilities about as much as going a night without sleep or losing 13 IQ points, Mani's team reports in the Aug. 30 *Science*.

Shortly after reaping a financial windfall, poor individuals perform far better on the same mental tests. That improvement may be thanks partly to temporary freedom from money concerns, the scientists propose.

Their findings follow evidence that scarcity of money (or anything else important) promotes short-term thinking, helping to explain why poor people generally save too little and borrow too much (*SN: 12/1/12, p. 17*).

The new results raise a valid concern, although people barely scraping by frequently deal with money in sophisticated ways, says Harvard University sociologist Kathryn Edin, who studies U.S. families subsisting on welfare. "Poverty can lead to better, not just worse, mental functioning."

Many mothers on welfare, for instance, work out complicated family budgets and keep careful spending records, Edin finds.

In one experiment, Mani's group classified more than 300 shoppers at a New Jersey mall as affluent or poor based on self-reported incomes and family size. Participants made easy or hard hypothetical financial decisions before taking nonverbal tests of logical thinking and the ability to control rapid responses to computer images.

Poor people who contemplated tough money problems scored lower on both mental tests than their wealthy counterparts. After easy problems, rich and poor groups scored similarly.

In a second experiment, the researchers administered comparable tests to 464 sugarcane farmers in India. Farmers there eke out a living until harvests yield big pay days.

The researchers gave tests before and after harvests; test scores rose substantially after harvests. Stress reduction, indicated by lower blood pressure and heart rate, partially explained farmers' mental turnaround, Mani says.

Humans

"There is something special about evolutionarily threatening sounds that infants respond to." —NICOLE ERLICH

Early iron beads came from space

Ancient Egyptians worked meteorites into jewelry

By Bruce Bower

Iron beads from jewelry discovered in an ancient Egyptian grave came from meteorite pieces, two new studies find.

Researchers say that techniques employed by Egyptian artisans to make the beads around 5,200 years ago eventually proved essential for making objects out of iron extracted from ore. That practice started roughly 1,500 years later in or near modern-day Turkey and 3,000 years later in Egypt.

Hammering relatively soft metals such as copper and gold into thin sheets, which were rolled up to form cylindrical beads, began about 10,000 years ago in Turkey. To do the same with iron lumps from meteorites required impressive blacksmithing skills, says archaeometallurgist Thilo Rehren, who directs the University College London campus in Doha, Qatar.

Ancient Egyptian beads made of iron from meteorites (left) were strung on necklaces with gold and stones (right).

ROB EAGLE/UCL PETRIE MUSEUM

Chunks of hard, brittle meteorite iron were repeatedly heated to red-hot temperatures and hammered to make tube-shaped beads, Rehren and colleagues report August 20 in the *Journal of Archaeological Science*.

Analyses of three of nine presumably iron beads from Egypt's Gerzeh cemetery found traces of nickel, cobalt, phosphorus and germanium, elements characteristic of meteorites containing iron. Intense heating and hammering destroyed the iron's original crystal structure, the researchers propose.

But planetary scientist Diane Johnson of the Open University in England thinks that preservatives applied by museum curators corroded these beads' internal structure and turned them black. A light-colored bead discovered at Gerzeh, which bears no signs of chemical treatment, retains a crystal structure typical of meteorite iron, Johnson and her colleagues reported in the June *Meteoritics & Planetary Science*.

Ancient Egyptians, or people who traded with them, made space beads via careful hammering and heating at lower temperatures than assumed by Rehren's group, Johnson asserts.

Babies perk up to ancient threats

Snake's hiss, angry voices quickly capture infants' attention

By Bruce Bower

Babies have an ear for primeval dangers, a new study suggests.

By age 9 months, infants pay special attention to sounds that have signaled threats to children's safety and survival throughout human evolution, say psychologist Nicole Erlich of the University of Queensland, Australia, and her colleagues. Those sounds include a snake hissing, adults' angry voices, a crackling fire, thunder claps and — as a possible indicator of a nearby but unseen danger — another infant's cries.

Noises denoting modern dangers, as well as pleasant sounds, failed to attract the same level of interest from 9-month-olds, Erlich and her colleagues report August 27 in *Developmental Science*.

People can learn to fear just about anything. But tens of thousands of years of evolution have primed infants' brains to home in on long-standing perils, the scientists propose.

"There is something special about evolutionarily threatening sounds that infants respond to," Erlich says.

Previous work by psychologist David Rakison of Carnegie Mellon University in Pittsburgh found that 11-month-olds rapidly learn to associate fearful faces with images of snakes and spiders (*SN: 9/26/09, p. 11*). "There is now a coherent argument that infants are biologically prepared in at least two sensory systems to learn quickly which evolutionarily relevant objects to fear," Rakison says.

Further work needs to check an alternate possibility, he adds: that babies learn soon after birth to associate sounds of snakes and other ancient threats with adults' negative reactions.

Erlich suspects that babies are born sensitive to sounds that have denoted threats dating back to the Stone Age. The auditory system, unlike the visual system, is nearly mature at birth.

In the new study, 61 male and female infants sitting in high chairs near a parent briefly heard through speakers a series of long-standing danger sounds, modern danger sounds and pleasant sounds. Modern danger sounds included glass breaking and a siren wailing. Pleasant sounds included classical music and a baby laughing.

In response to ancient danger sounds, infants experienced a bigger drop in heart rate, larger eye blinks as measured by electrodes and increased turning toward the speakers or parent, all indicating that they were paying more attention. Babies didn't cry or otherwise get upset while listening to danger sounds.

Previous studies have found that infants first recognize adults' expressions of fear between 5 and 7 months of age. ■

Atom & Cosmos

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Sun's future, 250 light-years away

Almost twice as ancient, star offers clues to sun's fate

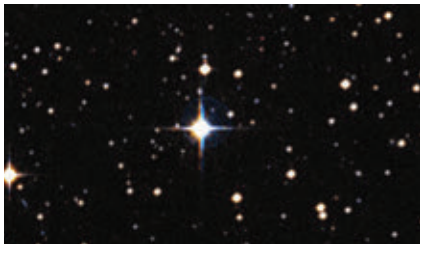
By Andrew Grant

When the sun enters its twilight years, chances are it will look just like HIP 102152.

The star is the closest match to the sun ever found in terms of mass, temperature and chemical composition, a team of astronomers announced August 28. But it's also almost 4 billion years older, providing a tantalizing glimpse of what might happen to our 4.6-billion-year-old sun as it ages.

"Work with solar twins is helping us contextualize the sun as a star," says Gustavo Porto de Mello, an astronomer at the Federal University of Rio de Janeiro who was not involved in the research. "This is another step toward finding stars that represent the sun at various stages of evolution."

HIP 102152 has given the researchers insight on lithium, an element that exists in high amounts in some stars but is virtually absent in the sun. Some astronomers have wondered whether that makes the sun an outlier, Porto de Mello says. But



The star HIP 102152 (center), located 250 light-years from Earth, resembles the sun in almost every way except that it is nearly 4 billion years older.

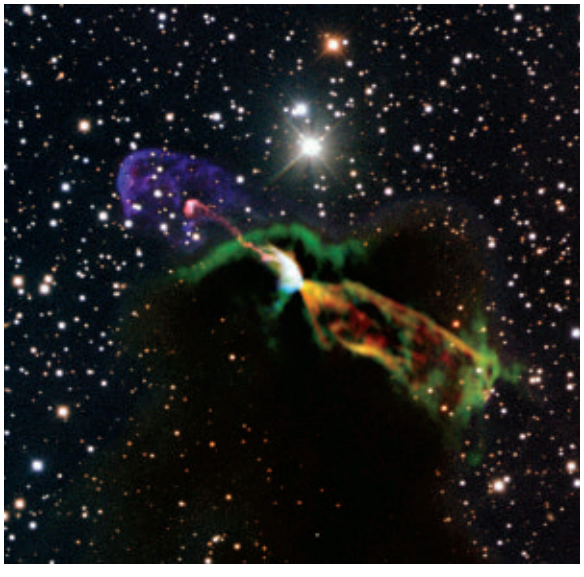
the researchers found that HIP 102152 contains even less lithium than the sun, while a previously identified younger solar twin named 18 Scorpii has more. The findings suggest that the hot, churning interiors of sunlike stars gradually burn through lithium as the stars age.

Like the sun, HIP 102152 has relatively low amounts of iron, magnesium and silicon, elements that tend to make up the bulk of rocky planets such as Earth. That could be a sign that the newly discovered star hosts planets, says study coauthor Iván Ramírez from the University of Texas at Austin. So far, observations with the La Silla 3.6-meter telescope in Chile have ruled out the existence of Jupiter-mass planets, but small rocky ones are still possible.

The international team of astronomers began hunting solar twins with a 2006 sky survey that tagged HIP 102152, which is located about 250 light-years away in the constellation Capricornus.

Now the researchers have used the European Southern Observatory's Very Large Telescope in Chile to perform a detailed analysis of HIP 102152. The analysis appears in the Sept. 10 *Astrophysical Journal Letters*. HIP 102152 is 97 percent as massive as the sun, 54 degrees Celsius cooler and has very similar abundances of more than 20 chemical elements. "It's about as dead-on a twin as you could reasonably hope to find," says David Soderblom, an astronomer at the Space Telescope Science Institute in Baltimore who was not on the research team.

At 8.2 billion years old, HIP 102152 is the oldest solar twin ever found. In less than 2 billion years, the star will run out of hydrogen in its core and start ballooning to hundreds of times its current size. When that happens to our star, the sun will fry Earth and probably engulf it.



In starbirth, molecules zoom

Certain molecules burst from young stars much faster and with more energy than previously thought. As a young star forms, it throws off material at speeds up to 1 million kilometers per hour. When the material collides with surrounding clouds of gas and dust, the space region glows. Observations tracking carbon monoxide molecules in the glowing cloud Herbig-Haro 46/47 (left), which sits about 1,400 light-years away in the southern constellation Vela, show that the molecules flow through the cloud about five times faster than earlier measurements indicated. Calculations based on the new data put the molecules' speed at up to 144,000 kilometers per hour, scientists report in the Aug. 14 *Astrophysical Journal*. The higher speeds increase the calculated energy and momentum of the carbon monoxide outflows. These variables affect the environment in which young stars form and possibly how big they become. Scientists captured the images with the Atacama Large Millimeter/Submillimeter Array (ALMA) and the New Technology Telescope in Chile. —*Ashley Yeager*

FROM TOP: DIGITIZED SKY SURVEY 2/ESO, DAVIDE DE MARTIN; ALMA/ESO, NAOJ, NRAO, H.ARCE, BO REIPURTH

Flicker reveals stars' properties

Brightness measurements help gauge size and age

By Andrew Grant

The key to learning about distant stars is as simple as watching them flicker.

Stellar brightness measurements from NASA's planet-hunting Kepler space telescope can pin down once-elusive physical properties of about 170,000 stars and the planets orbiting them, scientists report in the Aug. 22 *Nature*. The new technique can translate modest fluctuations in starlight over several hours into insights about a star's size, surface gravity and stage of life.

"All this information is encoded in a star's brightness in such a wonderfully simple way," says astrophysicist and study coauthor Keivan Stassun of Vanderbilt University in Nashville.

For four years, the now-moribund Kepler stared at the stars within a patch of sky, looking for eclipsing planets. Kepler homed in on several hundred for meticulous scrutiny. By studying subtle changes in the brightness of these select stars, astronomers have been able to tease out vibrations in the stars' interiors — analogous to seismic waves caused by earthquakes on Earth — and precisely determine a slate of physical properties for each star, including surface gravity.

In contrast, astronomers have only rough estimates of the size, mass and other attributes of most other Kepler stars, and stars in general. "We know [the estimates] are not very good," says Ronald Gilliland, an astronomer at Penn State University in University Park, Pa.

One of the authors of the study, Fabienne Bastien, an astrophysicist at Vanderbilt, was sifting through the brightness data of the carefully studied stars when she noticed a clear-cut connection: The more a star flickered over the course of several hours, the weaker its surface gravity. Surface gravity decreases as a star ages and swells up. "It tells you how evolved the star is and how big it should be," Bastien says.

While no one had noticed the connection between flickering and surface gravity before, Stassun says it makes sense. The surfaces of stars are covered in giant pockets called granules. Granules form as hot gas rises and cooler gas sinks. Some granules are hotter and brighter than others, and their temperatures can change over the course of minutes. As a star swells up later in its life and its surface gravity dips, the volatile granules increase in size, leading to greater variations in surface brightness.

> "All this information is encoded in a star's brightness in such a wonderfully simple way."
> KEIVAN STASSUN

Bastien, Stassun and two colleagues have created a scale that can be applied to any star in Kepler's field of view. By simply knowing how much a star's brightness fluctuates over an eight-hour period, astronomers can determine its surface gravity with an uncertainty of about 20 percent.

The scale will also be a valuable tool for astronomers using Kepler data for finding and describing planets, Gilliland says. The magnitude of the shadow cast by an eclipsing planet reveals only the ratio of a planet's size to that of its star. To determine whether a planet is a giant, a runt or something in between, astronomers first need to know the size of the star. Bastien says her team's new scale will allow astronomers to attain a reliable estimate quickly without having to resort to time-consuming, expensive observations with ground-based telescopes.

Environment

"We can't predict the next move of the equatorial Pacific." —SHANG-PING XIE

Warming hiatus tied to cool Pacific

Air temperature plateau caused by natural variation in oceans

By Erin Wayman

A recent pause in global warming has resulted from cooling in the tropical Pacific Ocean, simulations find. The colder ocean temperatures are a consequence of natural fluctuations in climate; global temperatures will start rising again when warmer conditions return to the Pacific, researchers propose August 28 in *Nature*.

Exactly when that will happen is anyone's guess. "We can't predict the next move of the equatorial Pacific," says study coauthor Shang-Ping Xie of the Scripps Institution of Oceanography in La Jolla, Calif.

Since 1998, average global surface temperatures have remained relatively steady. Some climate change skeptics incorrectly point to the warming hiatus as evidence that humans aren't contributing to climate change.

Various possible explanations for global temperatures' stagnation have been proposed, including increased aerosol production due to rising coal consumption in China and storage of heat in the deep ocean. Other work suggested that the break in surface warming might be tied to La Niña events, when the eastern tropical Pacific is at least half a degree Celsius below average for several months to two years. Since 1998, there have been six La Niñas, which can lead to global cooling.

Now, Xie and Scripps colleague Yu Kosaka have taken a closer look at the tropical Pacific. Simulations of global temperatures that included a cooler Pacific sea surface replicated the current warming pause. Scenarios without a cooler Pacific predicted that global average temperatures should be climbing.

But the work doesn't explain why the tropical Pacific has cooled, says atmospheric scientist Susan Solomon of MIT. "Did the sea-surface temperatures cool on their own or were they forced to do so by, for example, changes in volcanic or pollution aerosols or something else?" she asks.

Climate scientist Gavin Schmidt of NASA's Goddard Institute for Space Studies in New York City says that several factors probably play some role in the global warming pause. His "informal prediction" is that the long-term surface warming trend will resume once the Pacific warms up again.

Although surface temperatures are stalled for now, the hiatus doesn't dramatically alter estimates of how much warming the planet will experience in the 21st century, researchers from the United Kingdom's Met Office concluded in August. The researchers suggest that the warming previously forecast for 2050 will be delayed by only a few years.

Sandy scenario to be less likely

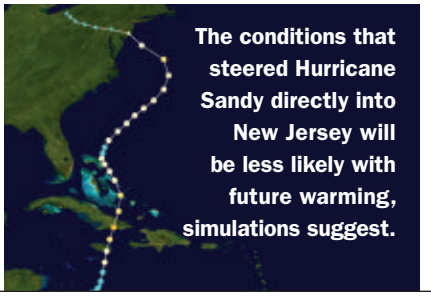
Future climate expected to discourage direct strikes

By Erin Wayman

The unusual circumstances that allowed Hurricane Sandy to slam directly into New Jersey could become even rarer in the future, simulations predict.

North Atlantic hurricanes tend to make landfall on the East Coast from the south. The October 2012 storm was unusual because it took a left turn and approached from the east, smacking into New Jersey at nearly a right angle. The perpendicular angle to the shore intensified Sandy's destructive storm surge.

Several atmospheric conditions converged to drive Sandy down its odd path, says Elizabeth Barnes, an atmospheric scientist at Colorado State University in Fort Collins. Kinks in the jet stream set up a blocking event, which is a high-pressure system that stays stuck in one place for several days to weeks. The blocking event diverted the jet stream south and forced North Atlantic winds to switch direction and blow from east to west. The easterly winds pushed Sandy toward the East Coast; normally, westerly winds guide hurricanes away from North America.



The conditions that steered Hurricane Sandy directly into New Jersey will be less likely with future warming, simulations suggest.

CYCLONEBISKIT/WIKIMEDIA COMMONS

An analysis published in May found that, under current climate conditions, hurricanes like Sandy that hit New Jersey at a right angle occur on average once every 700 years. To understand how climate change might alter atmospheric patterns and change that frequency, Barnes' team ran simulations of an extreme scenario in which carbon dioxide emissions quadruple over the 21st century. The simulations suggest that the jet stream will shift north and blocking events will become less frequent over the western Atlantic, the researchers report September 3 in the *Proceedings of the National Academy of Sciences*. The study doesn't address whether Atlantic hurricanes will change in frequency or intensity.

Jennifer Francis, an atmospheric scientist at Rutgers University in New Brunswick, N.J., is not convinced, noting that climate models have a tough time simulating blocking events. But Thomas Knutson, a climate scientist at the Geophysical Fluid Dynamics Laboratory in Princeton, N.J., says the results suggest that conditions favoring Sandy-like storms will be less common. ■

Mind & Brain

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Speech learning starts in womb

Brains of newborns react to words heard before birth

By Laura Sanders

Babies can hear specific words in the womb and remember them days after birth, a new study reports. The results add to the understanding of how the early acoustical environment shapes the developing brain.

Earlier studies found that fetuses can hear and learn certain sounds. Nursery rhymes, vowel sounds and mothers' voices can all influence a developing baby. But the new study, published August 26 in the *Proceedings of the National Academy of Sciences*, shows that a fetus can detect and remember discrete words, says study coauthor Eino Partanen of the University of Helsinki.

Partanen and colleagues used a fake word, *tatata*, to test whether a particular word can worm its way into the fetal brain. Five to seven times a week during their third trimester, 17 pregnant Finnish women blasted a recording of a woman saying the word in two bursts of four minutes. Most of the recording was the same delivery of *tatata*, but every so often the pitch in the middle syllable would change, something that rarely happens in spoken Finnish.

Electrodes test whether a newborn learned a fake word during gestation.

About five days after birth, babies heard the recordings again. Electrodes on the babies' heads allowed Partanen and colleagues to look for a specific sign of recognition: An outsized neural jolt, called a mismatch response, tells the brain to pay attention because something is unexpected.

When the recording reached the altered version of *tatata*, babies who had heard the recording in utero showed this mismatch response, while 16 babies who hadn't heard it didn't, the team found. These results suggest that the babies could learn and remember the normal version of *tatata*.

It's not clear how long these word memories last. In the study, babies last heard the recording about five days before the test, but the memory could be older than that.

The study goes beyond earlier work, much of which relied on indirect behavioral changes such as sucking on a pacifier or turning the head, and instead reveals effects in the brain, says psychologist Christine Moon of Pacific Lutheran University in Tacoma, Wash. "We've had quite a bit of research on behavior and not so much on the brain," she says.

Gut-brain link tied to overeating

Treatment to restore communication curbs appetite in mice

By Cristy Gelling

Repairing faulty communication between the gut and brain can quell the urge to overeat, suggests an experiment that cured chubby mice of their junk food addiction. A similar strategy might be used to treat compulsive eating in people.

Some scientists have proposed that, in both mice and humans, overeating can resemble drug addiction; the more food a person consumes, the less responsive the brain becomes to the pleasure of eating. By restoring normal communication between the gut and brain, researchers resensitized overfed rodents to the pleasures of both fatty and healthy foods.

"The therapeutic implications are huge," says neuroscientist Paul Kenny of the Scripps Research Institute in Jupiter, Fla., who was not involved in the study.

In the brain, a chemical called dopamine surges in response to pleasurable experiences like eating, having sex and taking certain drugs. But brain-scanning studies suggest that obese individuals have muted dopamine responses to food. These changes could lead overeaters to seek more and more food to get a pleasurable response, suggests study leader Ivan de Araujo of Yale University.

In previous work, de Araujo and colleagues found that mice get a dopamine rush when fat is introduced directly into the gut via catheters. This shows that the gut communicates with the brain's reward center even when the mouse can't taste food.

De Araujo's team reports in the Aug. 16 *Science* that mice on a high-fat diet for 15 weeks don't experience the normal dopamine surge after a gut infusion of calories.

The team guesses that the disruption in dopamine levels involves a molecule called oleoylethanolamine. Eating normally boosts levels of the molecule in the small intestine, but rodents on a high-fat diet have abnormally low levels. The researchers gave overfed mice oleoylethanolamine injections and found that the mice had a dopamine surge when fat reached the gut, ate less and lost weight.

Oleoylethanolamine treatment seems to repair damaged communication lines between the gut and brain, de Araujo suggests. The researchers do not yet know whether the same approach would work in humans, but his team is planning a collaboration to test whether similar treatments would help people stick to a low-fat diet.

"Maybe it will address obesity and maybe it won't," Kenny says, "but I think it's a wonderful place to start."

COURTESY OF VEIKKO SOMERPURO/UNIV. OF HELSINKI

Health & Illness

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Bacteria inflict pain directly

Infected mice felt discomfort before immune response

By Cristy Gelling

Bacteria can directly trigger the nerves that sense pain, suggesting that the body's own immune reaction is not always to blame for the extra tenderness of an infected wound. In fact, mice with staph-infected paws showed signs of pain even before many immune cells had time to arrive at the site, researchers report in the Sept. 5 *Nature*.

Isaac Chiu of Boston Children's Hospital and Harvard Medical School and his colleagues made this finding after growing immune cells and pain-sensing cells together in a dish. The researchers were trying to activate the immune cells by adding bacteria to the mix but were surprised to see an immediate response in the nerve cells instead. This made them suspect that nerve cells were sensing the bacteria directly.

To take a closer look at a real infection, the team injected the back paws of mice with *Staphylococcus aureus*, a bacterium that causes painful sores in humans. The researchers measured how tender the infected area was by poking it with flexible filaments of plastic. If the mouse didn't like being prodded, it would lift its paw, giving a measure of each infection's ouch factor.

The mice's paws were most sensitive when bacterial cell numbers were at their peak, six hours after infection. By the time the immune response peaked, 48 hours after infection, the pain had largely ebbed away. The researchers identified two protein fragments released by *S. aureus* that could trigger nerve cells in dishes and that were also painful when injected into the mice.

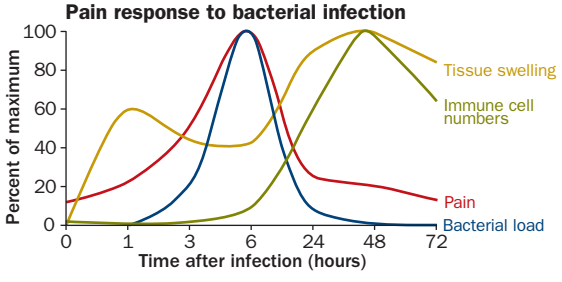
The team guessed that the nerves were helping to alert the immune system to the presence of bacteria, but when they tested this idea, they found the opposite. When the researchers infected mice that lacked pain-sensing nerve cells, even more immune cells rushed to the site of infection than in normal mice. This implies that the nerve cells normally suppress the immune system, Chiu says.

Chiu speculates that when tissue is damaged by injury, an overenthusiastic immune system may need to be held back. Bacteria like *S. aureus* might take advantage of pain's anti-immune effects to avoid detection, he suggests, "but it's an open question."

Kevin Tracey, an immunologist and president of the Feinstein Institute for Medical Research in Manhasset, N.Y., says the results fit with his own studies that show nerve signals can put the brakes on immune responses. "It's a beautiful study," Tracey says. "It's important because it shows that in order to understand the immune system, you really have to understand the nervous system."

Bacteria bring pain Mice with infected paws were most sensitive to being prodded when bacterial numbers were at their highest, not when the immune response was peaking.

SOURCE: I. CHIU *ET AL*/*NATURE* 2013



Device tells brain and tumor apart

New technique might improve accuracy of cancer surgery

By Nathan Seppa

A tiny probe equipped with a laser might reveal what the human eye doesn't always see: the difference between a tumor and healthy tissue. A new study suggests the device might provide brain surgeons with a roadmap as they go about the delicate business of removing tumors.

Surgeons try to excise as much of brain tumors as possible, but they risk harming patients if they remove healthy tissue. "Basically, we do it by feel," says surgeon Daniel Orringer of the University of Michigan in Ann Arbor. In the new study, Orringer and his colleagues used a revved-up version of Raman spectroscopy, a technique that reveals vibrations of specific chemical bonds, to distinguish between proteins and lipids in brain tissue. Since tumors are higher in protein than healthy brain tissue is, the authors designed the technique to present protein signatures as blue images on a screen, and lipids as green.

Using the device, the researchers examined human brain tumor cells that had been implanted in live mice. The device could distinguish where the tumor ended and healthy tissue began. A separate analysis of tissue that had recently been removed from a human brain cancer patient similarly revealed stark differences between the tumor and normal tissue. The findings appear in the Sept. 4 *Science Translational Medicine*.

The study offers "a very exciting advance," says chemist Ji-Xin Cheng of Purdue University in West Lafayette, Ind., by establishing that visualization of the tumor margin using Raman spectroscopy is possible in a living animal.

The researchers estimate it could take five years or more of testing to get regulatory approval to use the technique with patients.

"By treating one thing, we may increase susceptibility to something else." —AARON BLACKWELL

Test for kidney transplant rejection

Assay for immune biomarker could reduce need for biopsies

By Nathan Seppa

A simple test might reveal whether a kidney transplant recipient is at imminent risk of organ rejection. A study finds that the test, which checks urine levels of an immune protein, might lessen the need for kidney biopsies in some patients and pinpoint others who might safely reduce their dose of immune-suppressing drugs.

Increases in urine levels of the immune protein, called CXCL9, often show up in patients a month before an episode of organ rejection, researchers report August 22 in the *American Journal of Transplantation*. "That could be pretty useful," says Kim Solez, a pathologist at the University of Alberta in Edmonton, Canada, who has worked on standards for assessing biopsy data from transplant recipients. "But it depends on how reliable it is," says Solez, who wasn't part of the study team.

A biopsy — surgical removal of a small piece of tissue — is the standard procedure for determining if a transplanted organ is in danger. Doctors do biopsies when blood tests or symptoms show signs of rejection. But even when seemingly necessary, many biopsies find that a patient isn't having an acute rejection episode, says Peter Heeger, a transplant nephrologist at Mount Sinai Hospital in New York City. Sometimes the patient's symptoms come from fighting an infection.

Less invasive and more accurate tests would ease the burden on patients and improve doctors' ability to monitor transplants, he says. Toward that end, Heeger and his colleagues evaluated 258 kidney recipients by testing samples of their urine periodically for up to two years after their surgeries.

During the study, 79 patients underwent a biopsy. Some were indeed in the throes of kidney rejection. Urine tests revealed that patients with high CXCL9 had a tripled likelihood of rejection compared with those with low readings. Having low CXCL9 levels also indicated better blood filtration in the donor kidney.

Transplant recipients routinely get drugs to suppress their immune systems, but these medicines leave the patient susceptible to infection and some, such as steroids, can cause disagreeable side effects. With further testing, Heeger says, the urine test might identify patients who have low CXCL9 levels and thus might require less immune suppression.

Parasite rivalry may benefit host

Worms in gut seem to protect people from *Giardia*

By Jessica Shugart

Parasitic infection may come with perks. For indigenous people at the Amazon's southern edge, infection with the slithering gut hitchhikers may protect against other parasites, a new study shows.

The finding calls into question whether parasitic infections should always receive treatment. "By treating one thing, we may increase susceptibility to something else," says Aaron Blackwell, an anthropologist at the University of California, Santa Barbara, who led the study.

Interactions between worms and other parasites have been studied in animals, but this is the first large-scale study in humans, says Maria Yazdanbakhsh, an immunologist from Leiden University in the Netherlands.

STAN ERLANDSEN/CDC

***Giardia lamblia*, a protozoan parasite (shown in its feeding stage at top and left of photo), uses flagella to swim through contaminated rivers and other waterways. Infection with parasitic worms may decrease a person's odds of being infected with *G. lamblia*.**

Blackwell and his team studied the Tsimane people of northern Bolivia, who subsist by hunting, foraging and growing crops they plant along the Maniqui River. The Tsimane are continually exposed to soil-dwelling parasitic worms called helminths, such as hookworm and roundworm. They also frequently contract waterborne protozoan parasites such as *Giardia lamblia*.

Helminths can cause anemia, delay neuronal development and stunt children's growth. *G. lamblia* causes diarrhea.

Over six years, the researchers collected fecal samples from more than 3,000 Tsimane. Of the samples, 56 percent contained at least one hookworm species, 15 percent harbored the eggs of the giant roundworm *Ascaris lumbricoides* and 30 percent contained *G. lamblia*.

People infected with worms were less than half as likely to contract *G. lamblia* as their worm-free counterparts, the researchers report in the Oct. 22 *Proceedings of the Royal Society B*. To some extent, the protection goes both ways: Compared with people without *G. lamblia*, those infected with the protozoan were only 71 percent as likely to contract a parasitic worm.

The researchers don't yet know how the parasites antagonize each other.

News in Brief

FRANK PASMANS

LIFE

New fungus kills salamanders

The rogue chytrid fungus that has devastated more than 200 kinds of amphibians worldwide has an accomplice: a second species that researchers have discovered attacking fire salamanders. Populations of frogs, salamanders and their relatives have been dwindling worldwide, and in 1999 scientists identified a contributing factor. *Batrachochytrium dendrobatidis* was the first member of a phylum of fungi called chytrids found to attack vertebrates. Now genetic tests have identified a second vertebrate-killing chytrid, the newly named *Batrachochytrium salamandrivorans*. Researchers found the new fungus when volunteers reported a population crash in a yellow-and-black fire salamander, *Salamandra salamandra* (shown), in the Netherlands. Lab tests showed that fungus spores from a sick salamander caused the disease in healthy ones, researchers report September 2 in the *Proceedings of the National Academy of Sciences*. Within days of infection, the fungus eats away the skin of a salamander until scientists need a microscope to see skin remnants. —*Susan Milius*

MIND & BRAIN

Game sharpens elderly brains

Playing a car-racing video game boosted older adults' brainpower, scientists report in the Sept. 5 *Nature*. The results suggest that brain-training games might stave off mental decline that comes with age. Adam Gazzaley of the University of California, San Francisco and colleagues created a video game called NeuroRacer. Participants drove a car on a narrow, winding road while distracting signs popped up. Older people were worse at the game than younger people, the team found. But after playing for 12 hours over a month, volunteers between ages 60 and 85 got so good at the game that they beat 20-year-olds playing it for the first time. The benefits stayed for at least 6 months, even though the older volunteers had stopped playing NeuroRacer. Other mental functions also improved: Participants' working memory increased, as did attention. —*Laura Sanders*

HEALTH & ILLNESS

Antibodies can make flu worse

Some antibodies to flu viruses may actually make patients sicker, a new study of pigs suggests. The finding, published August 28 in *Science Translational Medicine*, may point to problems with catchall influenza vaccines. Pigs vaccinated against a seasonal strain of influenza made antibodies to that strain. Some of the antibodies could also latch on to a different flu virus that caused a pandemic among humans in 2009. Instead of protecting the pigs against the 2009 pandemic flu, the broad-range antibodies actually helped the virus invade lung cells, causing pneumonia and lung damage. Scientists hoping to create a universal flu vaccine need to learn how the pigs' antibodies and viruses interacted to make the disease worse, James Crowe Jr. of Vanderbilt University writes in a commentary in the same issue of the journal. And vaccines aren't the only problem, Crowe says. Natural infections may provoke similar disease-worsening problems. —*Tina Hesman Saey*

Fructose may be key to weight gain

Mice lacking the ability to metabolize fructose don't gain nearly as much weight as normal mice do, researchers report September 10 in *Nature Communications*. Fructose, which some people blame for the obesity epidemic (*SN: 6/1/13, p. 22*), shows up in high-fructose corn syrup and in table sugar, or sucrose. The body also makes fructose by modifying glucose in a process involving an enzyme called aldose reductase. Richard Johnson of the University of Colorado Denver and his colleagues gave mice sugary drinking water that was 10 percent glucose for 14 weeks. Normal mice gained weight and developed fatty liver and insulin resistance, but mice lacking aldose reductase showed less weight gain and less-severe related conditions. The team got similar results when they gave the glucose water to mice engineered to lack fructokinase, an enzyme that trips the chain reaction by which fructose is metabolized. —*Nathan Seppa*

ATOM & COSMOS

Surprising chemicals on meteorite

A space rock that lit up the California sky last year (*SN: 1/26/13, p. 5*) has given scientists an unprecedented look at the complex chemistry that probably took place during the solar system's infancy. Similar meteorites probably delivered the raw materials of life to Earth. When Arizona State University chemist Sandra Pizzarello and colleagues used acid to melt away some minerals from a sample of the meteorite, a plethora of sulfur- and oxygen-containing organic compounds were left behind, several of which have never been identified in meteorites before. The researchers detail their findings September 9 in the *Proceedings of the National Academy of Sciences*. The molecules probably formed several billion years ago in conditions similar to those on early Earth: warm and rich in water. —*Andrew Grant*

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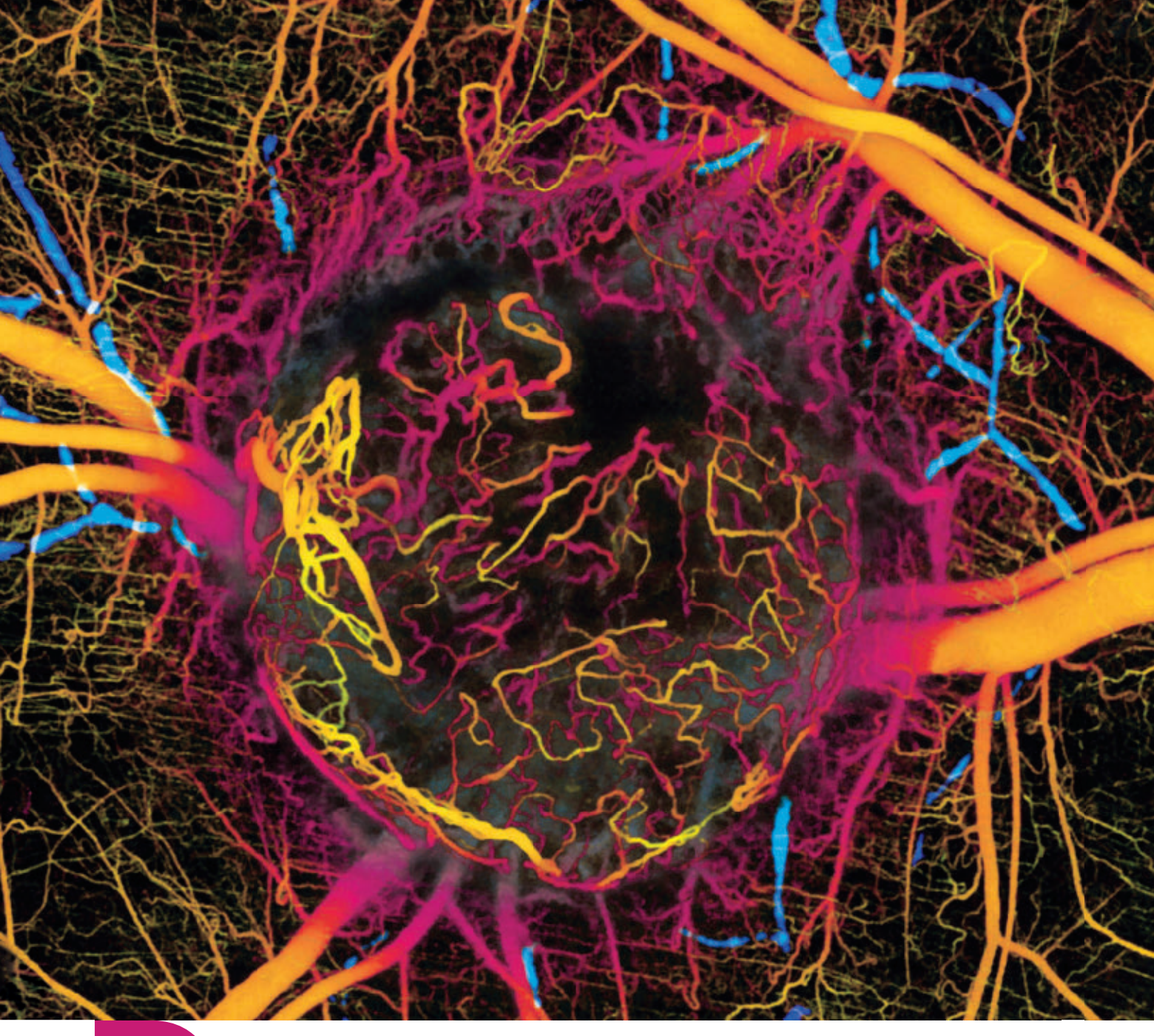


Dangerous DIGS

A cell's surroundings may be instrumental to the development of cancer

By Tina Hesman Saey

B.J. VACOK *ET AL*./*NATURE MEDICINE* 2009

It's what's inside that counts, right? Not so when it comes to cancer, says Mina Bissell.

True, gene mutations inside a cell help determine whether it will become a tumor. But, according to Bissell, a cancer researcher at Lawrence Berkeley National Laboratory in California, the neighborhood immediately surrounding the cell is just as important.

Cells in healthy tissues nestle tightly against each other like row houses. These rows sit on top of, and are surrounded by, a dense scaffolding of proteins known as the extracellular matrix. Blood vessels act like water pipes to bring in nutrients; lymph vessels drain away waste like sewer lines. In thriving neighborhoods, any trash that builds up within a cell doesn't spill out to pollute the rest of the area. If it does, the neighbors clamp down like a strict homeowner's association to contain the problem and bring the cells on the block back into line.

In crumbling localities, however, cells lose touch with their neighbors or run amok after falling in with the wrong crowd.

Bissell's experiments over four decades have repeatedly demonstrated that a cell's neighborhood — its microenvironment — is a key influence on whether cancer will develop and how bad it will get. In the past 5 to 10 years, many other cancer researchers have also found evidence to support that view.

Their research is transforming thinking about cancer and what to do about it. Bissell and others are convinced that by properly managing a tumor cell's microenvironment, they can make cancer something people live with, not die from.

"We really should be able to keep cancer as dormant disease," Bissell says.

Her ideas are the antithesis of what most people have come to believe about cancer: Genes determine how nasty a tumor will be and the only way to deal with the disease is to eradicate it. Many cancer researchers have focused on the mutations that turn upstanding cells into cancerous thugs. Some even view those genetic changes as the sole determinant of cancer.

The view of genetics as cancer fate made headlines earlier this year when Angelina Jolie announced that she had her breasts removed because she carries a mutation in the breast cancer associated gene 1, or *BRCA1*. The odds are clearly against women with Jolie's family history (her mother died of breast cancer) and genetic makeup. On average, about 8 of every 100 women will develop breast cancer by age 70. But 50 to 70 of every 100 women with *BRCA1* mutations will get the disease before age 70, and usually at much younger ages.

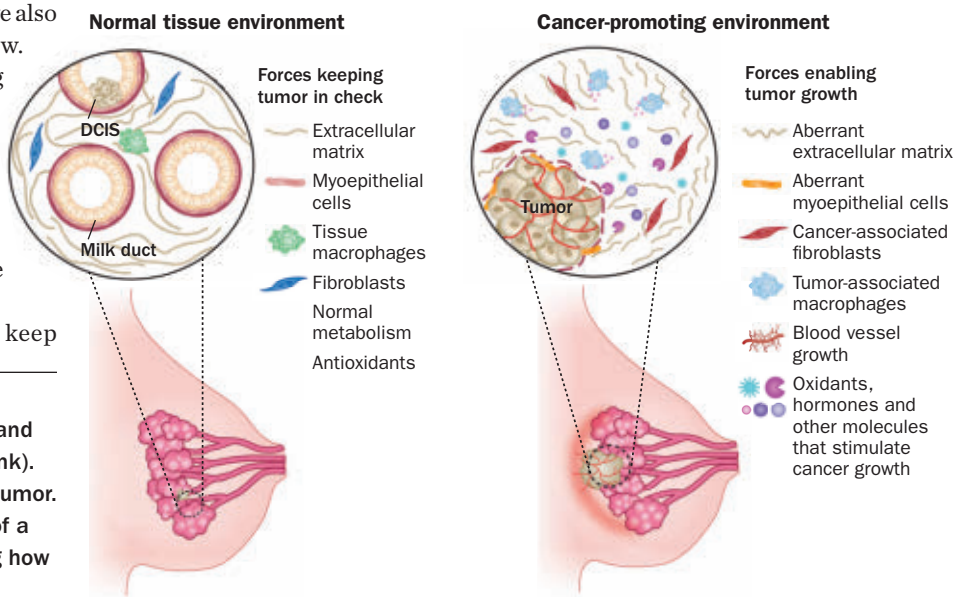
Bissell sees a different story in those numbers. She points to all the women with a *BRCA1* mutation who never develop cancer. Plus, she adds, the gene is instrumental for helping repair damaged DNA in every cell of the body. Yet most carriers of the faulty gene develop either breast or ovarian tumors. "So why don't you get pancreatic cancer or brain cancer?" Bissell asks. For that matter, "why doesn't the entire breast or the entire body turn into a tumor?"

The answer, she and a growing cadre of researchers contend, is that mutations aren't alone in determining whether breast or other cancers will arise, spread and kill. Controlling cancer is a community effort, with nearly every denizen in a cancer cell's neighborhood playing a part.

Missing protection

Breast cancer often starts when mutations hit the epithelial cells that line the milk ducts in the breast. Varieties of epithelial cells are found in other organs, too, such as the lining of the intestines, kidney, stomach and pancreas. They are in ducts and glands, line the air sacs of the lungs and form skin. They are also the type of cell from which most cancers arise. In the breast, those mutations initially cause a noninvasive

Meet the neighbors In a healthy breast (left), the milieu around ductal carcinoma in situ, or DCIS (inset) can keep a tumor from breaking out. Normal fibroblasts and myoepithelial cells help maintain healthy structure, while immune cells called macrophages patrol the area and kill wayward cells. In invasive cancer (right), fibroblasts and macrophages are corrupted (inset), promoting instead of suppressing cancer. Changes in the extracellular matrix along with oxidants and other molecules made by surrounding cells can promote cancer growth.



A breast tumor grown in a mouse (facing page) is lined with twisted and leaky blood vessels (orange and pink). Lymph vessels (blue) surround the tumor. New studies show the importance of a tumor's environment in determining how aggressive a cancer will become.

M.J. BISSELL AND W.C. HINES/*NATURE MEDICINE* 2011, ADAPTED BY E. OTWELL

precancerous state known as ductal carcinoma in situ, or DCIS. About 20 to 30 percent of women with DCIS will develop invasive breast cancer.

Kornelia Polyak of the Dana-Farber Cancer Institute in Boston and her colleagues thought that the epithelial cells that produce DCIS must be fundamentally different from the ones that would break out of the duct and become dangerous invasive breast cancers. But close examination showed that DCIS cells and invasive cancer cells carry the same sorts of mutations and grow similarly in laboratory dishes, she says. What changes between not-yet-cancer and cancer is the behavior of neighboring cells, Polyak and others have found.

She has evidence that myoepithelial cells, which form a layer next to the epithelial cells, are important for keeping DCIS inside the ducts. If those myoepithelial cells fall down on the job, the cancer cells can break out and form dangerous tumors.

About half the cells that make up most solid tumors are a mix of noncancerous cells known collectively as stroma. (In pancreatic cancer, stromal cells can make up about 90 percent of the tumor.) The stroma of a breast tumor includes blood vessels, a wide variety of immune cells, fat cells, cells called fibroblasts and the mesh of proteins called the extracellular matrix that give tissues their shape.

Delicate strands of extracellular matrix proteins such as collagen and elastin are barely visible on mammograms of healthy breasts, says Thea Tlsty, a molecular pathologist at the University of California, San Francisco.

But in some women's breasts, collagen, elastin and other extracellular matrix proteins form thick ropes of connective tissue that appear as stringy white material on a mammogram. Those women are said to have dense breasts and are at increased risk of developing breast cancer.

Tlsty and her colleagues discovered that a protein that helps strike a balance between making fat and producing connective tissue is partly responsible. The protein, called CD36, exists on many types of cells. CD36 is a busy molecule, regularly making contact with a wide variety of proteins in the extracellular matrix and on neighboring cells. Among its many roles, CD36 controls processes that can promote healthy breast tissue. When missing, it leaves behind an environment that allows cancer to grow, Tlsty and her colleagues reported last year in *Cancer Discovery*.

Rosa Anna DeFilippis from Tlsty's team studied breast tissue fibroblasts from women who had undergone breast reduction surgery or who had had tumors removed. Fibroblasts are cells that help construct connective tissue, and are some of the main builders of the extracellular matrix components that contribute to breast density.

Women with low breast density (more fat than connective tissue) had more CD36 on their fibroblasts than women with high breast density. Fibroblasts with low levels of CD36 pump out more of the stuff, like collagen, that creates the whiteness on mammograms, Tlsty says. Lower levels of the protein also spark other cancer-stimulating changes. Immune cells that don't make CD36 transform from tumor fighters into cancer promoters. And wiping out CD36 from blood vessel cells removes the brakes that normally keep vessel growth in check, the researchers found.

Tlsty's group has seen these procancer changes in the stroma occur before there's a tumor. "That's amazing," she says. It suggests that the stroma goads tumor growth. Everybody else thought that the tumor itself caused the abnormal growth of connective tissue, she says. Perhaps correcting the CD36 levels could eventually be both therapy and prevention for breast cancer, she says.

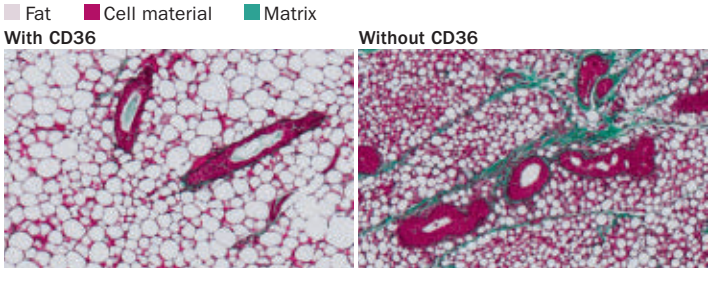
No place like home

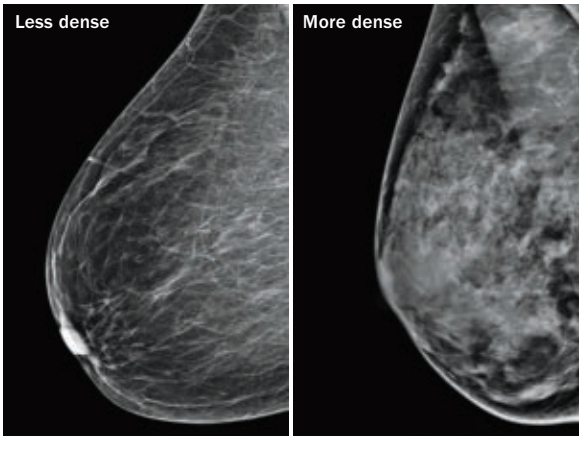
This sort of data comes as no surprise to Bissell.

After all, her lab demonstrated that placing breast cells in a laboratory setting that reminds them of home is enough to get the cells to remember how to do one of their primary jobs: producing the proteins that go into milk. And altering the way breast cancer cells interact with some proteins in the extracellular matrix coaxes cancer cells to behave like normal cells, her team showed in 1997.

Since then, her lab has piled up dozens of papers that detail how cancer cells interact with different aspects of the microenvironment. The complexity

Matrix overload Women whose breasts appear less dense on mammograms have more fat cells and less extracellular matrix. Women with dense breasts, on the other hand, have less fat and more extracellular matrix, yielding a cloudier mammogram image (right). That change in density (shown below in mouse mammary glands viewed under a microscope) increases cancer risk and may be caused by loss of a protein called CD36.





GLAND SECTIONS: ROSA ANNA DEFILIPPIS; MAMMOGRAMS: AMERICAN SOCIETY OF RADIOLOGY/AP IMAGES

she revealed is part of the reason it took some scientists time to appreciate Bissell's argument, she says. "What I was saying was not so easy to demonstrate in one paper."

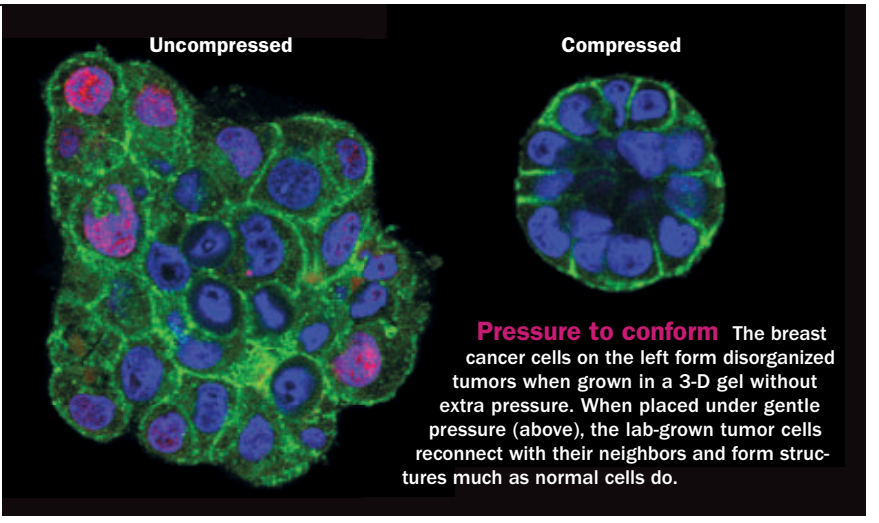
What's helped her move the work forward is growing human cells in three-dimensional gels that mimic growth in a real tissue. Many researchers grow mouse cells in two-dimensional dishes that produce less realistic conditions.

The 3-D system has revealed that mechanical forces exerted by cells pressing up against each other can have a calming effect on cancer. Bissell and collaborators at the University of California, Berkeley demonstrated last year that putting breast cancer cells under gentle pressure, akin to what they might encounter growing in a healthy breast, causes them to reconnect with their neighbors and behave like noncancerous cells (*SN: 1/26/13, p. 8*). That does not mean that squeezing breasts will prevent breast cancer. It just shows that cells get many different types of cues from their environment about how to behave.

Once a cancer cell has migrated to a new location in the body, it can nestle against blood vessels and lay dormant for years, Bissell and colleagues have found. If the blood vessels remain as they are, the cancer will continue to snooze. But when new blood vessels sprout, dormant cancer cells wake up and new tumors grow, Bissell's group reports in the July *Nature Cell Biology*.

"I argue that cancer is not a problem with growth, as the entire field believes," Bissell says. Instead, it's a matter of context. Like small-town kids who get lost in the glitz and glam of the big city, cancer cells can find themselves disoriented when their surroundings change. Soon, they are running amok, behaving in ways they never would at home, where their neighbors help keep them grounded. Incubating cancer cells with components of the extracellular matrix puts the cells in a familiar setting so they can remember their identities and job responsibilities, Bissell says. "This is so obvious. Why don't people get it?"

The message is sinking in, says Suresh Mohla, who heads the Tumor Microenvironment Network at the National Cancer Institute in Bethesda, Md. The institute launched the microenvironment initiative in 2006. By that time, data collected by Bissell and others had become far too compelling to ignore. Now researchers realize that the tumor microenvironment isn't just one thing, says Mohla. "A tumor is just like an organ," he says, "It's a complete functioning unit."



Pressure to conform The breast cancer cells on the left form disorganized tumors when grown in a 3-D gel without extra pressure. When placed under gentle pressure (above), the lab-grown tumor cells reconnect with their neighbors and form structures much as normal cells do.

G. VANUGOPALAN/UC BERKELEY

Emergency responders

Like other cells in the body, a tumor has to find ways to deal with stresses, such as physical pressures, chemical signals and changes in blood sugar and oxygen levels.

The most common response to stress involves making chemicals called reactive oxygen species, which are molecules that bash DNA, proteins, lipids and other components of a cell. Unchecked, these molecules — also known as "oxidants" or "free radicals" — can severely harm or even kill a cell. Most of the time, spillover from stressed cells is mopped up, says Tlsty, but sometimes a small amount can get away and cause damage. Scientists have known for a long time that having too many oxidants raises cancer risks, but the exact mechanism has been murky.

Tlsty and her colleagues are closer to understanding how the process works. Oxidant damage triggers a molecule called Activin A to go to work, the researchers reported last year in *Breast Cancer Research*. Activin A makes the molecular equivalent of a 911 call, Tlsty says. "It says, 'we've got a problem here, folks. Gather around. Help.'"

Among the first to respond to Activin A's distress call are molecules involved in promoting inflammation, the team found. The responders, such as COX-2 (the molecule inhibited by the anti-inflammatory drug Celebrex), unleash a flurry of messages to rival Twitter spikes following a riot. Those messages trigger an avalanche of changes conducive to cancer.

Shutting down inflammation entirely is not the answer. Inflammation is a necessary part of the body's ability to heal wounds. When the immune system detects injuries or aberrations such as cancer cells, it sends in immune cells to clean up the mess and stitch broken tissue back together. "That we don't all walk around with big tumors is proof that the immune system works most of the time," says Lisa Coussens, a cancer biologist at Oregon Health & Science University in Portland.

The problem comes when the clean-up crew encounters rapidly growing cells that won't die on command — in short, cancer. The nascent tumor essentially becomes a wound that will not heal. Inflammation becomes a chronic condition and the tumor feeds on chemicals released by immune cells. Cancer also seduces immune cells into acting as escorts, helping it spread throughout the body.

Coussens and her colleagues found that immune cells called macrophages are attracted to tumors under attack from chemotherapy drugs. The macrophages toughen up the tumor, making it less sensitive to the cancer drugs, the researchers reported in the June 2011 *Cancer Discovery*. Drugs that blocked the macrophages from reinforcing tumors under siege helped restore chemotherapy's cancer-killing ability.

Researchers are testing other drugs that manipulate the immune-cell component of the microenvironment to see if they can halt cancer in patients. Some medications such as aspirin or other anti-inflammatory drugs could reduce the amount of cancer-stimulating inflammation in tissues. Coussens and colleagues argue in the Jan. 18 *Science* that combinations of therapies, maybe even including vaccines or fasting, will probably be needed to restore proper immune system balance.

Calming angry tumors

Researchers realized long ago that the blood supply is one aspect of the tumor microenvironment that might be easy to manipulate. Tumors need oxygen and other nutrients to grow, so it makes sense to choke off a tumor's blood supply and starve it. To that end, drug companies have developed medications that interfere with molecules that stimulate blood vessel growth. Several have been approved for use in various advanced cancers and a few are being tested in patients with breast and other cancers.

Many of the drugs, known as angiogenesis inhibitors, block one of the most potent blood vessel stimulators, a protein called VEGF. But their impact in clinical trials has been mixed. Rakesh Jain, a chemical engineer turned cancer researcher, has been thinking about flow problems for a long time; he did a master's thesis on water flow in the Delaware River before turning his attention to cancer. "While everyone was working on anti-angiogenesis, I was scratching my head saying, 'It's not going to help.'" Instead, in 2001, Jain proposed doing the opposite: increasing a tumor's blood supply and repairing leaky blood vessels with anti-VEGF drugs used in judicious doses.

Open the spigot and feed a tumor — with tumor-starving drugs? "It was not easily embraced," Jain says of his idea. Many scientists still don't buy it. But Jain, of Harvard Medical School and Massachusetts General Hospital, isn't daunted. He lays out the unusual strategy and his rationale in the June 10 *Journal of Clinical Oncology*.

It's a matter of balance, he says. His team's studies show that stromal cells, not just cancer cells, make VEGF. The protein produces vessels that feed the tumor, but the vessels are twisted, leaky and often dead-end unexpectedly. The cancer and stromal cells can crush delicate blood and lymph vessels. The effect is similar to kinking a garden hose or poking holes in it; not much fluid flows through. That makes for an angry, low-oxygen tumor. And lack of oxygen, Jain says, turns on some processes and switches off others to make the tumor resistant to chemotherapy and radiation. It also stimulates abnormal blood vessels.

While some studies have shown that anti-VEGF drugs restrict blood and oxygen supplies — think angry tumor — others indicate that anti-VEGF drugs can plug leaks in blood vessels. Jain hypothesized that, at the right levels, anti-VEGF drugs should restore blood flow and allow chemotherapy drugs to penetrate the tumors.

Jain and his colleagues looked carefully at the data from studies in brain cancer patients in which one anti-VEGF drug had no apparent effect on survival. Blood flow stayed the same or decreased in some patients, while others had increased blood flow to their tumors. The people whose blood flow increased lived about six to nine months longer. The drug, produced by a company that Jain has consulted for, has not received approval for widespread use. Jain is hopeful that a cocktail of drugs that open up squished blood vessels and stop leaks could improve cancer therapy in the future.

Seeing the microenvironment as a key player in cancer is finally gaining traction, says Mohla of the National Cancer Institute. And Bissell says she's close to figuring out what separates a healthy neighborhood from one that would let cancer run wild. She's already certain of one thing: The answers won't be neat or simple. "Biology is not clean," she says. But solving the puzzle of the cancer microenvironment is worth the effort. One day, doctors and patients may be able to transform cancer from a threatening thug to a well-behaved neighbor. ■

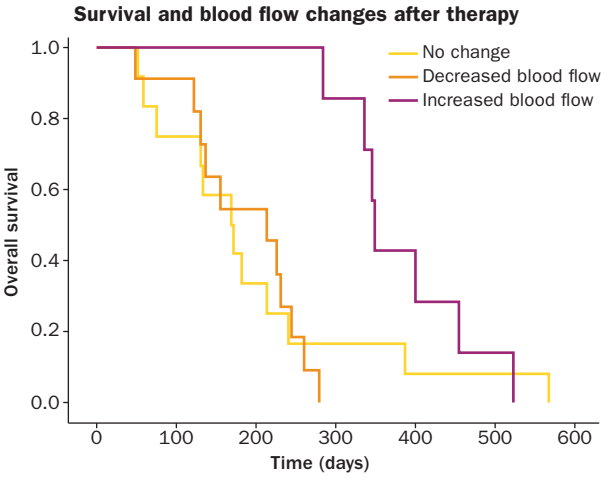
Explore more

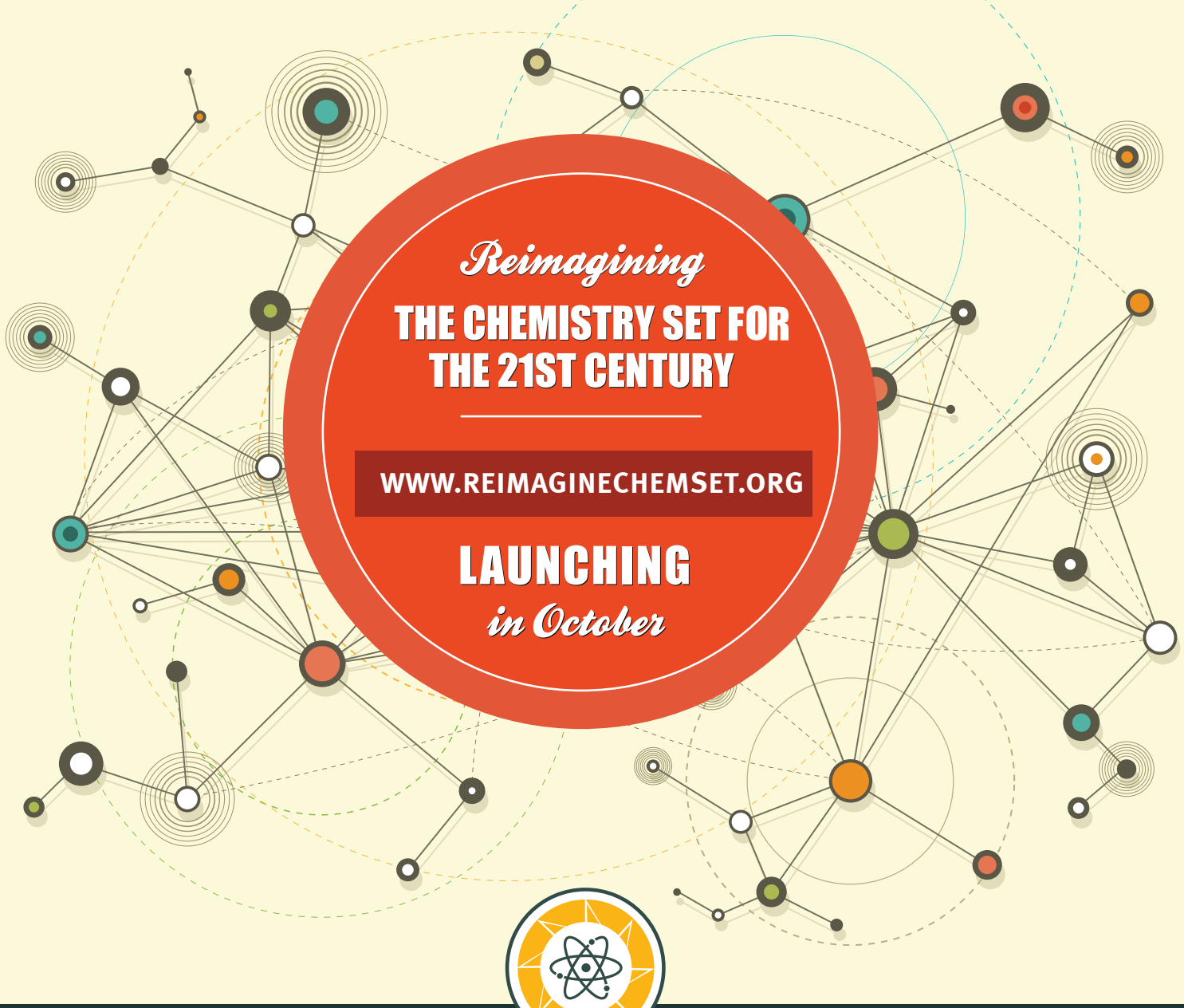
■ M.J. Bissell and W.C. Hines. "Why don't we get more cancer? A proposed role of the microenvironment in restraining cancer progression." *Nature Medicine*. March 2011.

Unclog the pipes

When patients with recurrent brain tumors were treated with a drug that affects blood vessels, an anti-VEGF drug, those who experienced increased blood flow (purple) lived an average of six months longer than those who experienced decreased blood flow to their tumors (orange) or no change in blood flow (yellow).

SOURCE: A.G. SORENSEN *ET AL*/ *CANCER RESEARCH* 2012





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Cool Idea

While nations concede a pressing need for attacking carbon dioxide emissions, other pollutants offer quicker paybacks

By Erin Wayman

Two degrees Celsius: the point of no return. Once average global temperatures exceed preindustrial levels by this amount, scientists warn, a climate catastrophe could become inevitable. Current projections indicate that it would be too late to prevent sea ice from disappearing, ice sheets from collapsing and rising seas from swallowing heavily populated coastlines.

A whole new climate would emerge. Lasting millennia, this hotter world would be humankind's most enduring legacy, perhaps outlasting our species. Fears over this new climate order spurred more than 100 nations to sign the Copenhagen Accord, drafted in 2009. Although nonbinding, the signatories agree that actions are needed to hold global warming to no more than 2 degrees Celsius (3.6 degrees Fahrenheit).

Industrial activities and urbanization since the late 19th century have already spewed enough greenhouse gases to elevate average global temperature by 0.8 degrees Celsius. And because carbon dioxide lingers in the atmosphere for a century or longer, it will take many decades before benefits from any future CO_2 cuts are felt. Even if the world slashed CO_2 emissions in half within the next few decades — a herculean feat — some climate projections suggest Earth would still surpass the 2-degree benchmark before the end of this century.

But CO_2 isn't the only culprit in global warming. Over the last several decades, researchers have identified a substantial supporting cast of co-conspirators. Four pollutants that make a relatively brief but powerful appearance in the atmosphere are known as the short-lived climate warmers: methane, near-surface ozone, a class of industrial chemicals called hydrofluorocarbons and the black-carbon component of soot. These typically stick around the atmosphere for no more than a week to roughly a decade.

A growing number of climate scientists say the quickest way to stall Earth's slowly rising fever in the short term is to reduce the output of these more ephemeral warmers. In fact, some studies indicate, clearing them from the atmosphere might drastically shrink the rate of climate change in a mere 10 to 20 years and help the world avoid as much as 0.5 degrees Celsius of warming by 2050. Such cuts could buy nations a little time to tackle the more challenging problem of weaning themselves from CO_2-producing fossil fuels, the only way to prevent catastrophic warming in the long run.

Cleaning up methane, black carbon and other short-lived warmers requires no new technology and would improve air quality, an added benefit that could save millions of lives annually while boosting agricultural productivity. As a result, countries are joining the short-lived-warmers bandwagon. In 2011, the European Parliament passed a resolution urging its 28 member nations to adopt climate policies that target these pollutants. Last year, the United States partnered with several other countries to found the Climate and Clean Air Coalition, which promotes initiatives to cut emissions of short-lived warmers. In September, the United States, China and dozens of other countries took a more concrete step and agreed to reduce the use of hydrofluorocarbons, also known as HFCs.

But some critics argue that these fleeting climate warmers may offer more hype than hope. Scientific uncertainty still surrounds some of them, especially black carbon. Depending on the conditions, it can either warm or cool the climate. It also enters the atmosphere along with a mix of climate-cooling pollutants. So targeting soot may not control near-term

LI MING LZ/AP IMAGES

warming as reliably as researchers have claimed. Worse, some scientists worry, eliminating it might actually aggravate global warming.

With the climate doomsday clock ticking away, viable options that offer even a smidgen of relief can't be ignored. "Dealing with these [warmers] doesn't get you off the hook of dealing with carbon dioxide," says climate scientist Drew Shindell of the NASA Goddard Institute for Space Studies in New York City. But they "at least offer a way to make some progress."

A motley crew

Without a doubt, CO_2 is the chief driver of human-caused climate change. People have flooded the atmosphere with so much CO_2 that it's responsible for more than half of the extra energy humans have trapped around the planet. So focusing on ways to chop its emissions is "a sensible thing," Shindell says.

But it's not the only greenhouse gas humans unleash into the air. Like CO_2, methane absorbs heat emitted from the Earth. Fossil fuel production releases methane to the atmosphere. So do landfills and wastewater treatment plants, where microbes generate the gas. Cows and other livestock also belch out a substantial amount.

Although atmospheric CO_2 is more than 200 times as plentiful, methane is actually the more potent heat-trapper: Over 100 years, a kilogram of methane emitted into the atmosphere will absorb 25 times as much heat as a kilogram of CO_2.

Methane is one of the main gases that contribute to the formation of another short-term warmer: ground-level ozone. Way up in the stratosphere, ozone filters out much of the sun's biologically harmful ultraviolet light. Closer to the ground, ozone isn't helpful. In the troposphere, it absorbs heat, creates smog and interferes with plant growth. Over the last century, near-ground ozone concentrations in the Northern Hemisphere have more than doubled.

Hydrofluorocarbons are a more recent concern. Companies are increasingly turning to these organic compounds as greener replacements for stratospheric-ozone-destroying chlorofluorocarbons in refrigeration, air conditioning and foam production. Although HFC emissions currently are very low, one molecule of these chemicals can soak up hundreds of times more heat than a molecule of CO_2. And their releases are expected to double within seven years.

Many recent climate simulations have largely overlooked the advantages of cutting HFCs because their emissions are still so small. "The benefit you gain is by preventing them from growing," Shindell explains. Given the pace of growth in HFC emissions, researchers have started giving them a closer look.

Unchecked, HFC emissions could contribute nearly as much to global warming by 2100 as black carbon does today, concludes Veerabhadran Ramanathan, an atmospheric scientist at the Scripps Institution of Oceanography in La Jolla, Calif. Replacing HFCs with any of several available substitutes could shave a half-degree from global warming by century's end, he and several colleagues report June 26 in *Atmospheric Chemistry and Physics*.

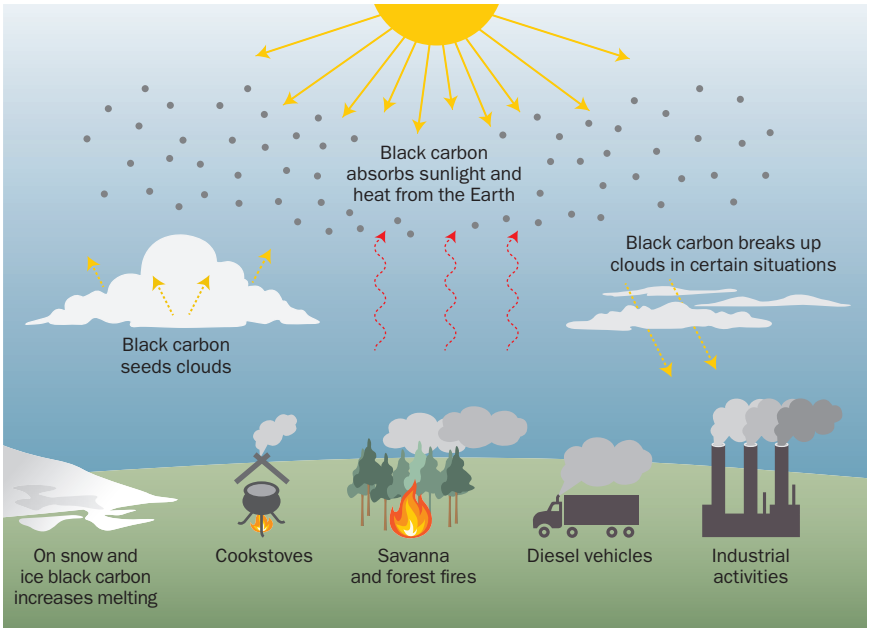
Black sheep of quick warmers

Among short-term warmers, black carbon is the most concerning and complicated. Produced by incomplete combustion, it is one among many tiny solid particles called aerosols that enter the atmosphere in the exhaust of diesel-fueled trucks, the smoke from charcoal-burning cookstoves and the haze from forest fires. In general, aerosol particles produced by combustion cool the planet by scattering sunlight. Not black carbon. In the early 2000s, atmospheric scientist Mark Jacobson of Stanford University demonstrated that black carbon delivers a warming double-whammy. Unlike greenhouse gases, these particles both absorb incoming sunlight and trap outgoing heat.

As if that weren't bad enough, these particles also can boost temperatures by breaking up light-reflecting clouds. And even after it settles back to Earth, black carbon can continue to foster warming. Particles that land in the Arctic or the Himalayas darken ice and snow, boosting heat absorption and melting.

In the past, many climate simulations have failed to include all of these varied

The power of soot Produced by diesel trucks, forest fires, wood-burning stoves and some industrial activities, black carbon warms the atmosphere by absorbing sunlight and by capturing heat radiated from the Earth. It also enhances warming by breaking up clouds, but in other conditions counteracts warming by seeding clouds. After settling on the ground, black carbon also encourages the melting of snow and ice. SOURCE: T. BOND *ET AL/J. OF GEOPHYS. RES.: ATMOSPHERES* 2013



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climate effects, leading some scientists to underestimate soot's warming potential, notes Tami Bond, an engineer and atmospheric scientist at the University of Illinois at Urbana-Champaign. In the June 16 *Journal of Geophysical Research: Atmospheres*, she and her colleagues offer the most comprehensive soot assessment to date. It pegs black carbon's direct effect on warming — not counting cloud- or ice-related impacts — at double some estimates. It's the second-largest contributor to human-driven warming, causing almost two-thirds as much over the past two centuries as CO_2. But in contrast to CO_2's century-long life span, black-carbon particles typically settle out of the atmosphere within a few days to weeks.

The potency and short life span associated with non-CO_2 greenhouse pollutants is giving climate-mitigation analysts some much-needed optimism. Last year a team led by NASA's Shindell reported in *Science* that adopting 14 tactics to curb emissions of black carbon and methane (and by extension tropospheric ozone) could reduce global warming by roughly half a degree Celsius within the next 35 years or so. These reductions would come through activities such as capturing the methane that currently escapes from oil and natural-gas wells and pipelines, adding soot filters to diesel vehicles and switching to cleaner-burning cookstoves in developing countries. For this simulation, the researchers assumed that cuts began in 2010 and only gradually reached full implementation by 2030.

These reductions would do more than just fight global warming, Shindell's group adds. By trimming black carbon and other aerosols that make up particulate matter, as well as ground-level ozone, the pollution cuts would prevent up to 4.7 million deaths annually. And at the same time, global crop yields would grow by as much as 135 million metric tons a year.

Cuts in short-lived warmers would have their biggest impacts on the Arctic. Temperatures there are rising at about twice the global average. At that rate, summer sea ice could disappear within the next 10 to 30 years, says Stanford's Jacobson. "If you control all the CO_2 in the world, it's not going to save the Arctic sea ice because of the long lifetime of CO_2." Controlling the shorter-lifetime pollutants is the only way to do it, he argues.

In 2010, Jacobson demonstrated exactly how much influence black carbon alone has on the Arctic. Over just a 15-year span, controlling soot emissions by installing filters and replacing dirty cookstoves would slash Arctic warming by 1.7 degrees, he reported in the *Journal of Geophysical Research: Atmospheres*. Removing sooty emissions from fossil-fuel burning alone dropped average air temperatures in the Arctic by 1.2 degrees over that period.

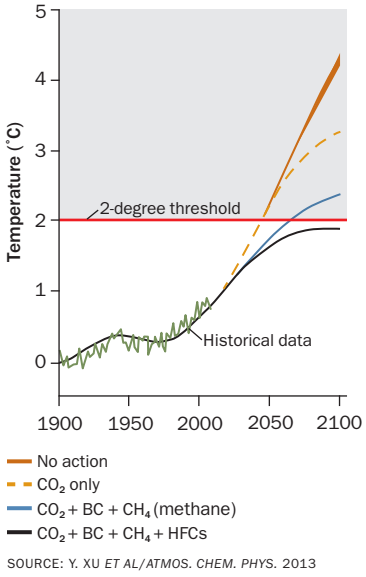
A cool idea, but . . .

Cutting emissions of ephemeral warmers could also dampen sea level rise. Without cuts to these pollutants, the ocean could swell an average of 112 centimeters during this century, Ramanathan and colleagues conclude in the August *Nature Climate Change*. This estimate reflects both the expected melting of glaciers and ice sheets and the thermal expansion of seawater. If reductions in short-lived pollutants began within the next two years, however, their impact on temperature could help shave 25 centimeters — 22 percent — from the sea level rise expected by 2100, the new simulations project.

Climate benefits might extend to rainfall as well. Soot doesn't disperse evenly across the globe, so its warming effect isn't evenly distributed. This patchy warming creates temperature gradients in the atmosphere that can alter wind

Weighing the options Reducing different greenhouse pollutants will produce warming reductions that vary in both magnitude and timing (graph, left). These projections are based on the fact that some gases are more potent warmers, and some are relatively short-lived (table, right). That means reducing their emissions will bear fruit sooner compared with cuts in pollutants like CO_2, which persists in the atmosphere for a century or more.

Climate effects of cuts



SOURCE: Y. XU *ET AL/ATMOS. CHEM. PHYS.* 2013

Greenhouse pollutants compared

	Black carbon	HFCs	Methane	Near-surface ozone	CO_2
Atmospheric lifetime	Days to weeks	1–50 years, (average is 15)	12 years	1 month	100 years or longer
Warming potential*	900	133–4,180	25	2–25	1
Radiative forcing** (Watts/m^2)	+1.1	Less than +0.1	+0.48	+0.35	+1.66
Main sources of pollutant	Diesel engines, charcoal- or wood-burning cookstoves, forest and grassland fires	Refrigeration, air conditioning, foam-blowing agents	Oil and natural gas production, coal mining, agriculture, landfills, wastewater treatment plants	Forms through reactions between sunlight and methane, volatile organic compounds, carbon monoxide or nitrogen oxides	Fossil fuel burning

* Global warming potential is the total energy a gas or particle will add to the atmosphere over 100 years compared with the same amount of carbon dioxide.

** Radiative forcing indicates how much a pollutant alters Earth's energy balance over time. Positive values mean a pollutant adds energy. The values reported here are for 2005 relative to 1750.

SOURCE: EPA, IPCC, T. BOND *ET AL/JOURNAL OF GEOPHYSICAL RESEARCH: ATMOSPHERES* 2013

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and rain patterns, Shindell says. In his team's 2012 study, black carbon reductions were projected to reduce recent shifts in South Asia's monsoon patterns and to lower drought risk in parts of Europe and Africa.

To some climate scientists, the potential benefits from targeting ephemeral warmers sound too good to be true.

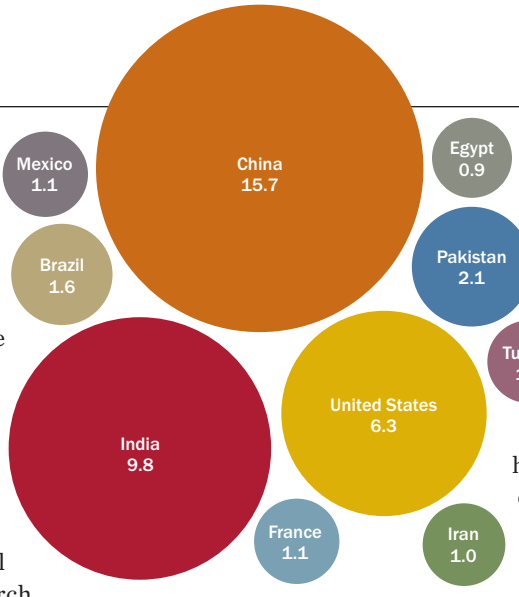
"Black carbon has gotten a bit too much emphasis lately," argues Gunnar Myhre, an atmospheric scientist at the Center for International Climate and Environmental Research in Oslo. "The uncertainties are really large and much larger than for the greenhouse gases."

For instance, although technologies are readily available to address many sources of the pollution, that doesn't mean implementing them will be a cinch. Replacing the cookstoves used by 3 billion people in India, China and other developing countries, for example, is a monumental task. In reality, change may not come soon enough to reap all of the near-term benefits promised by climate simulations, says climate scientist Steven Smith of the Joint Global Change Research Institute in College Park, Md.

Part of the problem, notes Smith, is that black carbon isn't emitted on its own. It enters the atmosphere with an assortment of other aerosols — and "aerosols are the big wildcard."

Taken as a whole, aerosols should cool the planet, but by how much remains unclear. Since there aren't ways to separate black carbon from other particles in soot, cutting black carbon could actually lead to warming if the other lost aerosols would have had a cooling effect.

That's why targeted cuts are key, Bond says. "You shouldn't go blindly reducing emissions from a source because it happens to emit black carbon." The smartest move would be to focus on sooty sources that cough out more black carbon relative to other particles. Removing diesel engines from the road or adding particle traps to diesel vehicles is a better bet than, say, trying to limit agricultural burning or control forest fires.



Added benefits Many countries would see boosts in crop yields (values in millions of metric tons) from the reduction of ozone that would result from cutting black carbon and methane emissions. Cuts using existing technologies could thus have benefits beyond climate. SOURCE: D. SHINDELL *ET AL*/*SCIENCE* 2012

Of even greater uncertainty is what black carbon does to clouds. In general, aerosols, including soot particles, help seed clouds, serving as surfaces on which cloud droplets can form. With more cloud droplets, clouds can grow bigger and brighter — and reflect more sunlight away from Earth. Yet if too much black carbon builds within clouds, its heating could end up burning the clouds away. This is why black carbon's relationship with clouds is so complicated. Depending on where soot is released, its altitude and the type of cloud it encounters, a black-carbon particle can either help build or destroy clouds, says Dorothy Koch, who until recently studied black carbon's interactions with clouds at Columbia University. It's difficult to sort out these cloud interactions because it's hard to trace where black-carbon particles go in the atmosphere and how they change over time as they bump into other aerosols.

The June assessment of black carbon by Bond's team tried to tally all of its influences on clouds. In the end, the researchers found a slight net warming of the atmosphere. But that's not a given; Bond acknowledges that uncertainties surrounding this result are so big that soot's interactions with clouds might actually end up being a net source of climate cooling.

Still, any cooling from cloud effects is probably insignificant, Shindell says, and unlikely to completely offset black carbon's warming influence. "There's very little chance you'd have a negative consequence in terms of climate change" if you cut black carbon. Moreover, he adds, even if the climate benefits prove smaller than anticipated, the health benefits alone would be reason enough to curb black carbon.

Smith agrees: "It's definitely a win-win." But he doubts the climate benefit from cutting back on short-lived warming pollutants will prove as robust as some proponents tout. In a new climate simulation, he and Andrew Mizrahi, also at the Joint Global Change Research Institute, assumed that between 2015 and 2035, nations begin phasing in all "maximally feasible" cuts to short-lived warmers. The result: Global temperatures will drop only 0.16 degree by 2050 relative to current projections. Their findings appeared August 12 in the *Proceedings of the National Academy of Sciences*.

Smith says there are several reasons that his calculations predict a much smaller benefit than previous studies. In addition to differences in computing emission reductions, he and Mizrahi used a more complex climate simulation that integrates a larger number of factors than typical models. In their scenario, the climate didn't respond as quickly to declines in short-lived warmers, resulting in a smaller temperature change.

Other researchers may quibble with the pair's calculations, but all agree that any major climate policy must address all warmers. "There's no need for them to compete with each other," Shindell contends. In fact, the 2012 simulation by his team suggests the world will surpass the 2-degree warming benchmark by the end of the century if CO_2 isn't also regulated. Ultimately, Shindell says, limiting short-lived warmers can slow the rate of climate change — but not stop it. ■

Explore more

- Climate and Clean Air Coalition website: www.unep.org/ccac

M. ATAROD

Cat Sense: How the New Feline Science Can Make You a Better Friend to Your Pet

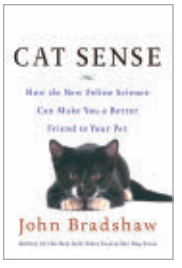
John Bradshaw

Anyone who has ever owned a cat knows that these animals are not quite tame. Each fuzzy, purring companion shows an independent streak in any number of ways, whether it's the mouse left at the doorstep or the refusal to come when called. Now Bradshaw, an animal behavior scientist, deftly sums up the latest science that attempts to discover what's going on inside the kitty brain.

Bradshaw begins with an in-depth look at how the cat ended up in our homes over thousands of years, evolving from wild to — mostly — domestic. "Full domestication," he notes, "means that humankind has complete control over what an animal eats, where it goes, and most crucially, which individuals are allowed to breed." While true for many house cats, large populations of feral cats remain largely untended.

The rest of the book examines the biology and behavior of cats, both owned and feral. Kittenhood gets a lot of attention. Young cats not only have to learn skills such as communicating and hunting but also how to live with humans. Genetics plays a part in how friendly a cat becomes, but so does the experience of human handling.

Bradshaw, who lives in England,



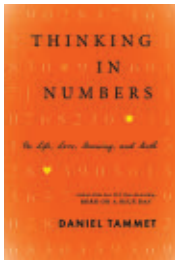
draws overwhelmingly on British examples and research, making the book slightly less relevant for an American audience. Though his prose is technical at times, Bradshaw largely delivers on his promise to help cat owners better understand their pets. A careful read can help a cat owner understand why cats don't get along, guide efforts in training and even reveal what's behind kitty's favorite toy. — *Sarah Zielinski*

Basic Books, 2013, 307 p., $27.99

Thinking in Numbers: On Life, Love, Meaning and Math

Daniel Tammet

As an autistic savant, writer Daniel Tammet approaches numbers in a brilliantly oblique way. He sees math everywhere, from the geometrical grids of city streets to the predictable patterns of his mother's daily chores. *Thinking in Numbers* is his effort to draw the rest of us into seeing that beauty.

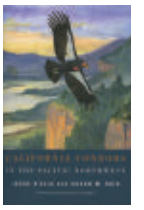


One example of a puzzle he finds pretty: The universe is finite, yet the numbers used to describe it can go on infinitely. Archimedes tackled this paradox in the third century B.C. when he calculated how many sand grains it would take to fill all of space. Next, he envisioned multiplying 10,000 objects — the highest number the ancient Greeks thought worth counting — by 10,000 again and again. "I thought it is not inappropriate for you, too, to contemplate these things," Archimedes told his stunned audience.

Modern readers may feel their jaws similarly dropping at this book's many mathematical whimsies. Among other topics, Tammet explores the many challenges of counting, from how Anne Boleyn might have coped with the decimal system if she had an extra finger, as was rumored, to how Icelanders have a raft of different words for enumerating one to four, depending on what exactly is being counted. Less successfully, Tammet tries to link mathematics to social issues, such as the finances of economic inequality and the calculus of Tolstoy's novels.

In his most lyrical essay, Tammet describes memorizing 22,514 decimal places of pi and reciting them to a university audience for five hours and nine minutes. The moment, like the book, is a transcendent glimpse at a numerate world. — *Alexandra Witze*

Little, Brown and Co., 2013, 272 p., $26



California Condors

Jesse D'Elia and Susan M. Haig

An investigation of condor history examines why the birds disappeared from much of the Pacific Northwest and considers the chances of bringing them back. *Oregon State Univ., 2013, 208 p., $19.95*

Magnificent *Principia*

Colin Pask

A mathematician provides an in-depth tour of Newton's influential 1687 works, in which he first proposed his laws of motion. *Prometheus, 2013, 528 p., $26*

All the Right Angles

Joel Levy

This packed visual guide explores the math behind sports, from billiard geometry to the aerodynamics of a perfect football pass. *Firefly, 2013, 224 p., $29.95*

Giraffe Reflections

Dale Peterson

Striking full-page photographs are highlights in this comprehensive text on the biology and behavior of giraffes. *Univ. of California, 2013, 221 p., $39.95*

My Brief History

Stephen Hawking

The famous cosmologist's memoir recounts both his professional and personal journeys, including his diagnosis with amyotrophic lateral sclerosis at the age of 21. *Bantam, 2013, 144 p., $22*

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Sleepless on schedule

The article "Full moon may mean less sleep" (*SN: 8/24/13, p. 15*) brought up a very interesting hypothesis that besides a 24-hour circadian clock, we may also have a lunar clock. To me that makes sense. Just like our bodies can store fat to use when food sources run low, I imagine over the eons our bodies prepared subtly to use the extra light to do more if needed. Taking advantage of extra light on a fixed schedule no doubt evolved in our ancestors and remains with us to this day.

Linda McBride, Boynton Beach, Fla.

Edison's rubbery discovery

How could everyone forget Edison ("On the rebound," *SN: 8/24/13, p. 26*)? When the price of rubber soared in the late 1920s, Thomas Edison, Henry Ford and Harvey Firestone combined their efforts, talents and finances in search of a natural source for rubber. Together they established the Edison Botanic Research Corp. Extensive research proved goldenrod, a common weed growing to an average height of 3 to 4 feet, produced a 5 percent yield of latex. Through hybridization, Edison produced goldenrod in excess of 12 feet tall, yielding 12 percent latex.

Harlan Howard, Sunnyvale, Calif.

Monogamy not just for men

Two teams of men disagree about why males sometimes choose to bond with a female for life in "Roots of monogamy feed scientific spat" (*SN: 8/24/13, p. 5*). Lots of men commented, but a woman might ask why females sometimes choose to bond with a male. Both sets of data seem plausible: A woman might want a steady partner to keep men from killing her children, or with the alternate hypothesis (females live apart), a woman might want another adult's help. Anyone else consider monogamy a female as well as a male choice?

Kathleen Stassen Berger, New York City

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

The Science Life

"Lakes are my little time machines." —NATHALIE CABROL


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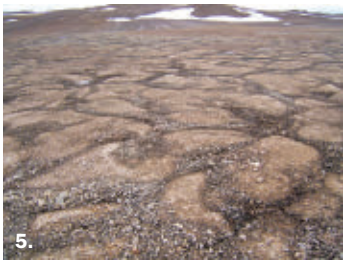
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Exploring Earth's alien spaces

When Nathalie Cabrol was little, her grandfather gave her a pair of binoculars he had picked up as a soldier in Germany after the liberation of France. It was her first real glimpse at the wonders of the moon and stars. "Later," Cabrol says with a laugh, "my toys became more elaborate and complex."

Today she uses robots to hunt for alien life. Cabrol (below) is a planetary geologist and astrobiologist at the SETI Institute's Carl Sagan Center and NASA's Ames Research Center, both in Mountain View, Calif. When she's not using autonomous robots to explore extreme environments, she's jumping into mountaintop lakes herself using specialized scuba gear. Her goal is to understand the conditions under which life on Earth can exist and apply them to searches for life on other worlds, such as Mars or Saturn's moon Titan.

Right now, Cabrol is receiving e-mails from a boatlike robot that floats on a lake in the high Chilean Andes. The Planetary Lake Lander is a NASA-funded probe that is testing technology that could be used to explore environmental conditions in Titan's methane seas. At a lake called Laguna Negra, 2,700 meters above sea level, the lander is now hunkered down for the southern winter but still monitors passing storms.

If the lander notices storm conditions, it starts probing the lake's depths more frequently and e-mails data on physical and chemical changes in the water back to Cabrol and her team. "We've made a substantial leap toward robotic awareness," she says. If a mission to a place like Titan happens, "that will substantially improve the science we can do and the meaning of the science data."

To Cabrol, mountain lakes offer clues to life on other planets; the higher the altitude, the more they resemble alien environments. She holds several world records for scuba and free diving at elevations approaching 6,000 meters. "Lakes are my little time machines," she says, "to travel to the past of other planets or to look toward the future."

Her beloved lakes are also bellwethers of climate change on this planet, with water levels, chemistry and biodiversity fluctuating as snow and rainfall patterns shift. "What we are trying to develop to explore Mars and Titan helps us understand our own Earth," she says. "That's the journey." —*Alexandra Witze*

Spaceflight not needed

Researchers are developing analogs for other worlds right here at home. These studies mimic the conditions of other planets and can help to prepare for future interplanetary missions.

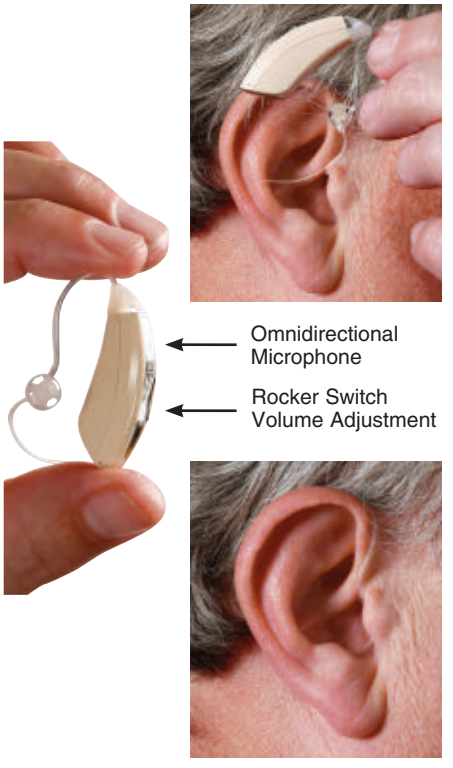
1. A floating robot maps a mountain lake, **Chile's Laguna Negra**, as part of possible plans to send an aquatic robot to Titan in the future.
2. Six volunteers emerged in August from a four-month stay in a habitat on the slopes of **Mauna Loa, Hawaii**, called the Hawai'i Space Exploration Analog and Simulation. Their goal: to develop recipes and meal plans for hungry astronauts on long journeys.
3. The Mars Society, which advocates human exploration of the Red Planet, runs the Mars Desert Research Station in the **Utah** canyonlands where 'marsonauts' have overwintered since 2001. Crews rotate every week or two.
4. NASA frequently tests rovers in the **Mojave Desert**. Members of the team driving Curiosity, the newest rover on Mars, tested their mettle here in navigating rocks, sand and other terrain.
5. The Mars Society has also run simulation missions on **Canada's Devon Island**. Empty since 2009, the Mars Arctic 365 facility is now being fixed up in hopes of a yearlong mission in the near future.

TOP (CLOCKWISE FROM TOP LEFT): COURTESY N. CABROL; KANU101/FLICKR; JIRKA MATOUSEK/FLICKR; ANTHONARES/WIKIMEDIA COMMONS; L. RICHARD MARTIN JR./FLICKR; BOTTOM: VICTOR ROBLES/CAMPOALTO, PLL PROJECT

Personal Sound Amplification breakthrough

Our sound engineers understand acoustics so you can understand conversations.

Perfect Choice HD™ features world-class processors for natural sound quality in a wide spectrum of listening situations.



If you are considering personal sound amplification, you probably know that louder isn't always better. If it were, you could just get one of those ear horns that were popular back in the 19th Century... as long as you weren't concerned with your appearance. Fact is, human conversation- the main reason people get amplification, occupies a relatively small range in the overall sound spectrum. Sound quality and speech intelligibility are much more important than sheer volume. That's why the sound engineers behind the Perfect Choice HD™ focus on optimal listening in challenging situations. The latest algorithms are running on advanced processors that are super small, yet super powerful. Best of all, Perfect Choice HD™ is comfortable and discreet. The lightweight case (you can choose between Silver and Beige) nestles in behind your ear. The clear hearing tube (good luck spotting it in the picture to the right... look closely, it's there) is connected to a flexible tip that fits comfortably into your ear canal. No one needs to know you are using it, and no one needs to know it didn't cost you thousands of dollars. The unit comes pre-programmed and is ready to use right out of the box, so it's the hassle-free choice that you can begin enjoying immediately.

Superior engineering makes it better

- Mosaic™ multi-layered noise reduction accentuates voices and seeks to lower general background noise from the environment.

- Advanced adaptive feedback suppression delivers high-quality sound even in demanding situations. Reducing feedback while delivering high-frequency gain is the hallmark of a professional grade personal amplifier.

- Expansion feature automatically acts to further reduce low-level noise while in particularly quiet environments.

- Wide Dynamic Range Compression brings soft voices into focus and reduces unexpected loud sounds so it can be worn all day long. It automatically changes, in real time to optimally fit your environment.

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

Are you or a loved one frustrated in these situations?

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

Affordable, Simple to use, Virtually impossible to see

Why spend another day wondering if amplification is right for you. Perfect Choice HD™ comes with our exclusive home trial- if you are not completely satisfied simply return it for a refund of the product purchase price. Call now, you'll be glad you did... and so will your friends and family.

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Personal Sound Amplification Product

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Please mention promotional code 47196.

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

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