Living Transistor Debuts | Brain Laid Bare | Young Earth, Weak Sun

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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ MAY 4, 2013

What Animals Know

And how we can learn from their mental missteps

Hot Times in Old Pangaea

The Imperfect Mammalian Ear

Alzheimer's Protein Has Good Side

Cell Phone Inspires Chicago Doctor to Design Affordable Hearing Aid

Outperforms Most Higher priced Hearing Aids

Reported by J. Page

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

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

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

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

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

Inspiration from a surprising source

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

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Affordable Hearing Aid With Superb Performance

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

Tested By Leading Doctors and Audiologists

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

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Doctors and patients agree: "BEST QUALITY SOUND" "LOWEST AFFORDABLE PRICE"

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

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

"We ordered two hearing aids for my mother on Sunday, and the following Wednesday they were in our mailbox! Unbelievable! Now for the best part—they work so great, my mother says she hasn't heard so good for many years, even with her $2,000 digital! ***It was so great to see the joy on her face.*** *She is 90 years young again."* —Al Peterson

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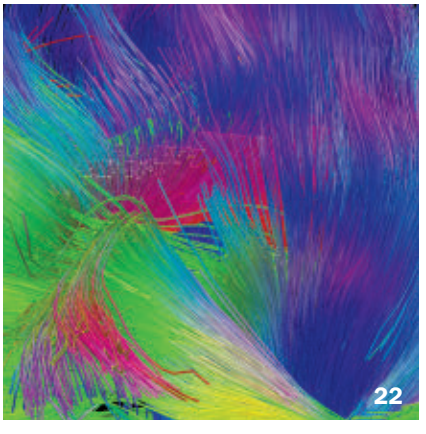

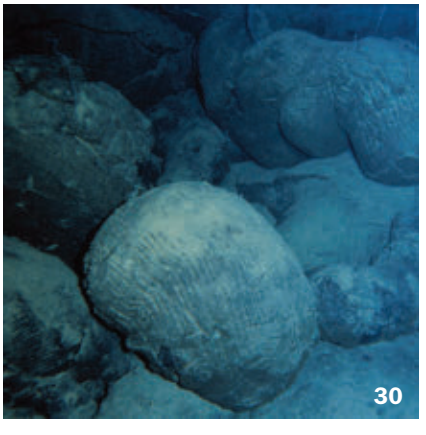

ScienceNews

In The News

Features

Departments

COVER Tests of problem solving by rooks and other animals provide clues to the evolution of intelligence. *Worm: C Joe V/Flickr; String: Barcin/iStockphoto; Birds: Eric Isselee/Shutterstock*

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FROM THE EDITOR

Think about it: Support for brain research is smart

For over 2,500 years, scientists have studied the human brain, examining its intricate physical structure for clues to how it works. Early studies revealed the organ's overall anatomy and its basic parts — the cerebral cortex, the cerebellum, the brainstem. Over a hundred years ago, microscope studies of individual brain cells illuminated the diverse forms neurons could take, their long threadlike extensions hinting at a role in transmitting and processing information. These detailed anatomical views helped usher in an era of intense activity and discovery in cellular neuroscience in the second half of the 20th century, with new insights into the form and function of single cells and even modest cellular networks. At the other end of the scale, advances in brain imaging have enabled panoramic views of the brain at work, highlighting general areas of heightened or depressed activity and thus providing some landmarks on a functional map of the brain.

But we are still unable to say exactly how the brain thinks, reacts or does any of the marvelous things that it does (such as marvel at its own complexity). Similarly, scientists remain baffled by exactly what goes wrong in the brains of people with disorders such as depression, schizophrenia and autism, to name a few. And that is why it's good news that President Obama is putting his weight behind neuroscience research, as *Science News* intern Puneet Kollipara describes on Page 22. The BRAIN project seeks to fill the gap in understanding between cellular and global views of the brain, to define the working circuits thought to produce many of the brain's most treasured functions.

Yes, the initiative is politically motivated and yes, many (hopefully fruitful) disagreements remain about its details, including a clear articulation of its end goal. But what the proposal gets right is the need for a major effort — in the style of the space race or the Human Genome Project — to explore one of the most exciting frontiers in science. And focusing largely on technologies and tools as opposed to data-generating experiments seems an appropriate role for a big government effort, akin to building highway infrastructure. Such tools are foundational to advancement but hold little incentive for researchers eager to publish results. The payoff could be a view of the brain that goes beyond anatomy to its very functions, and eventually new ways to heal disorders. That sounds like something worth investing in. — *Eva Emerson, Editor in Chief*

PHILIP CHANNING

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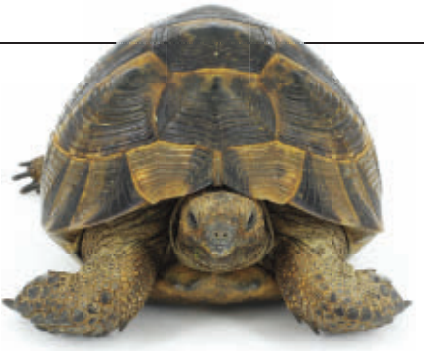
Say What?



Genetic surfing \ ***juh-NET-ick SUHR-fing*** \ ***n.*** A phenomenon in which a genetic variant with no particular evolutionary advantage starts out rare in a population, but swells to prominence as a group carries it into new territories. In this way, a "surfing" variant rides the leading edge of a migratory wave. Until now, genetic surfing has been mostly a theoretical concept. But a recent study found evidence that rare genetic variants in Northern African spur-thighed tortoises (*Testudo graeca*, above) surfed to commonness in Spain after the animals crossed the Mediterranean a few thousand years ago, researchers report in the June 23 *Biology Letters*. Studying how genetic patterns change as a population expands could help scientists better understand the genetic consequences of climate change–induced migration. —*Tina Hesman Saey*

Science Past | FROM THE ISSUE OF MAY 4, 1963

NEW STAR DATING METHOD — The first effective technique for measuring the ages of large numbers of stars like the sun has been developed. Providing a powerful research tool for astronomers, the new dating technique is based on relatively simple measurements of a single chemical element, lithium. The age calculations can be applied to both young and "ordinary" stars, as well as to the sun itself. The new method makes possible spotting very young stars among the myriad stars in the sky. With further development, the technique appears certain to give astronomers important evidence on such problems as the origin of stars, the rate of star formation and the cycle of stellar evolution.

Science Future

May 10
The 2013 Omnifest film festival opens at the Science Museum of Minnesota in St. Paul. Catch daily screenings of five documentaries on the Omnitheater's giant screen. See the schedule at bit.ly/OmniFest

May 18
Learn about the evolution and diversity of frogs around the world at a special exhibit of the American Museum of Natural History in New York City. More information available at bit.ly/AMNHFrogs

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EARTH IN ACTION
Learn about sinkhole science in Alex Witze's column "Geologists develop weapons to combat that sinkhole feeling."

ENVIRONMENT
There's good news for some corals in "Isolated coral reefs can regrow after bleaching."

DELETED SCENES
Several new studies support claims of vitamin D's health benefits. See "Vitamin D doesn't disappoint."

HUMANS
Kids with autism may know more about how others think than previously thought. Read "Competition brings out autism's social side."

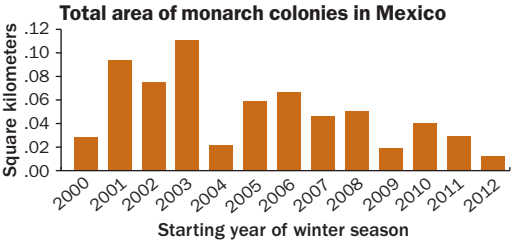
Introducing | NATURAL TOPOLOGICAL INSULATORS

For 30 euros, Pascal Gehring snagged one of the most precious materials in physics. Gehring, a physicist at the Max Planck Institute for Solid State Research in Germany, studies topological insulators, special materials that act as insulators except on their surface, where electrons shuttle along in well-defined lanes. This conducting layer makes the materials valuable for developing future electronics and quantum computers. Gehring and his team bought rocks from a former gold mine that contain kawazulite — a mineral made of bismuth, tellurium, selenium and sulfur — and imaged electron movement on their surfaces. Gehring's team reports February 26 in *Nano Letters* that kawazulite (shown) is nearly as good a topological insulator as synthetics are. —*Andrew Grant*

Science Stats | DECLINING MONARCHS

A survey of monarch butterfly hibernating grounds in Mexico shows a sharp decline this year — nine colonies of insects occupied a total of just 0.01 square kilometers of forest space during the winter season that began in 2012, a 59 percent decrease from the previous winter. Researchers suspect that herbicide use and climate change are to blame.

SOURCE: WWF MEXICO, MONARCH BUTTERFLY BIOSPHERE RESERVE



CLOCKWISE FROM TOP: DOBERMARANER/SHUTTERSTOCK; COURTESY OF N. THAKE; BUTTERFLY: MARCO ULIANA/SHUTTERSTOCK; AMERICAN CHEMICAL SOCIETY

“The way evolution works doesn’t always create the most perfect, engineered structure.” —ABIGAIL TUCKER, PAGE 8

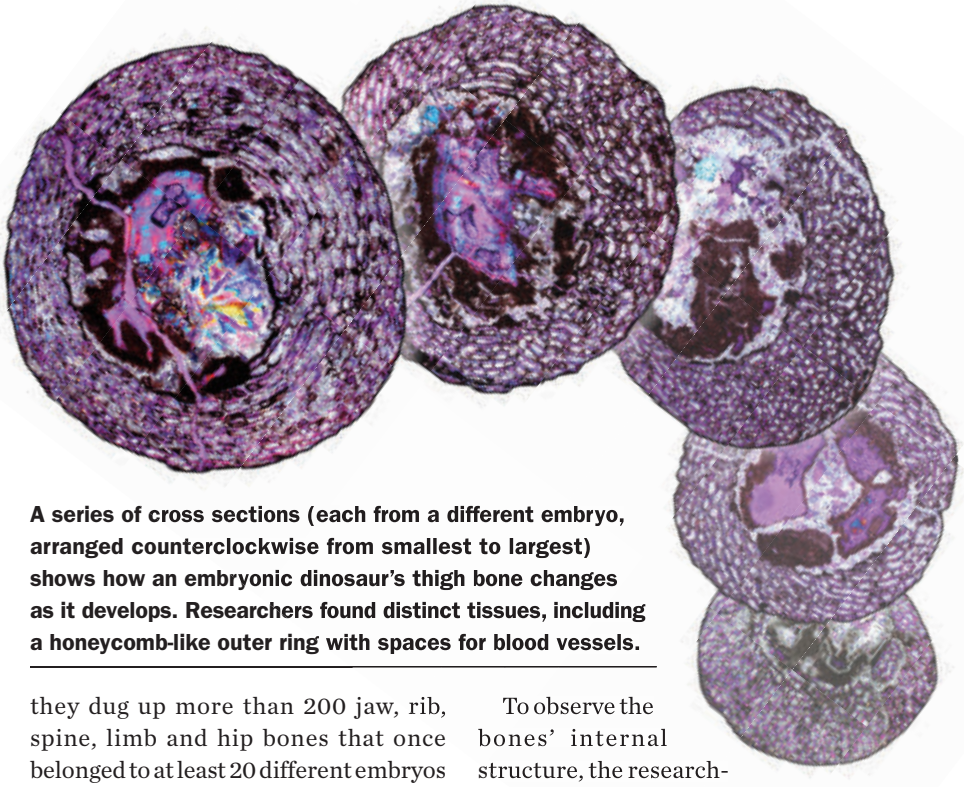
In the News

STORY ONE

Fossil embryos offer glimpse at dinosaur growth

Hundreds of bones found in southwestern China reveal rapid development

By Erin Wayman



A series of cross sections (each from a different embryo, arranged counterclockwise from smallest to largest) shows how an embryonic dinosaur’s thigh bone changes as it develops. Researchers found distinct tissues, including a honeycomb-like outer ring with spaces for blood vessels.

D. MAZIERSKI AND D. SCOTT, FROM PHOTOS BY A. LEBLANC

Dinosaur embryos lived fast and hatched young.

The most ancient dino embryos ever discovered — hundreds of miniature bones dating to nearly 200 million years ago — show that some dinosaurs grew rapidly inside their eggs and probably had brief incubation periods, researchers report in the April 11 *Nature*. The work marks the first time scientists have tracked the development of dinosaur embryos.

“It’s so rare to have a window into the earliest times of dinosaurs’ lives,” says Kristi Curry Rogers, a vertebrate paleontologist at Macalester College in St. Paul, Minn., who wasn’t part of the research team.

The itty-bitty fossils may also retain some of the oldest preserved organic remains found. These compounds may be traces of proteins.

Paleontologist Robert Reisz of the University of Toronto Mississauga and colleagues unearthed the unhatched dinos in southwestern China’s Yunnan Province. Unlike with previous discoveries of dinosaur embryos, the team didn’t recover fully intact skeletons curled up inside fossilized eggs. Instead, they dug up more than 200 jaw, rib, spine, limb and hip bones that once belonged to at least 20 different embryos whose eggs were crushed prior to fossilization, Reisz says. Aspects of the jaws tentatively tie the embryos to the genus *Lufengosaurus*, which lived during the early Jurassic period more than 190 million years ago and was an early relative of the colossal, long-necked sauropods that included *Apatosaurus*.

“It was very clear from the beginning these were little bones from embryonic dinosaurs,” Reisz says. In addition to their tiny size — some bones are shorter than the diameter of a dime — the fossils possess telltale signs of being unhatched. These signs include holes in the vertebrae through which a rod of cells called the notochord ran. Before a dinosaur hatched, the notochord would disappear and the hole would close up.

To observe the bones’ internal structure, the researchers sliced thin cross sections from some of the fossils and placed them under a microscope. When a bone fossilizes, it maintains the microscopic structure of cells and tissue, offering a snapshot of a developing embryo. By looking for differences inside bones of varying sizes, the scientists could piece together how embryos grew over time.

The thigh bones also revealed that the dinosaurs moved around inside their eggs. A knobby growth where muscles attach to bone got progressively bigger during development. In modern animals, this happens over time as the muscles pull the knob. The researchers think the unhatched dinos must have been kicking their legs.

Another feature of the bones also

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The oldest known fossil dinosaur embryos come from southwestern China, where researchers found more than 200 bones (thigh bone shown) dating to nearly 200 million years ago.

stood out: They were all highly perforated. In modern animals, a lot of hollow spaces in a bone means it's growing quickly and allowing plenty of blood vessels to enter and bring nourishment. After dinosaurs hatched, the pockets would fill in with bone, Reisz says. Compared with other known dinosaur embryos, the new ones are more heavily pockmarked. So the embryos probably grew faster than did those of other dinosaurs and faster than embryos of modern birds, the team suggests. But there's not enough information to estimate exactly how long the incubation was.

"The high growth rates were necessary for a large [adult] body size," says Martin Sander, a paleontologist at the University of Bonn in Germany. As hatchlings, the animals were probably about 20 centimeters long, the researchers estimate, but eventually grew to be 9 meters. The only way adults can get that big is if they mature fast, starting as embryos, Sander says.

Other paleontologists are more skeptical of exceptionally speedy growth. "All embryonic dinosaurs grew quite rapidly," says Gregory Erickson, a paleobiologist at Florida State University in Tallahassee. "Whether these were growing more rapidly than other embryonic dinosaurs I don't quite buy."

Among modern birds, he notes, species with a lot of bone perforation can develop at different speeds. So pockmarks may not represent a good way to distinguish growth rates. Rogers suggests that comparing other aspects of the dino embryos with those of birds and crocodiles might help scientists get a better sense of how quickly the embryos matured.

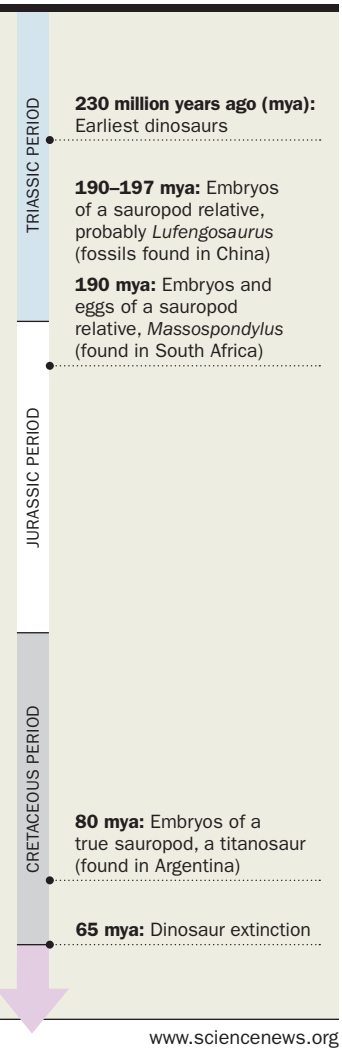
The bones bear witness to more than just developmental patterns. Reisz and colleagues say they've found some of the animals' original organic remains. In the past, researchers have usually searched for ancient proteins by dissolving fossils and looking for organic residues. But critics have questioned whether these samples were contaminated with bacteria or other modern material.

To make a more definitive identification, the researchers studied intact bones, using a technique that measures characteristic patterns of wavelengths of infrared light absorbed by organic compounds. The team reports finding the chemical fingerprint of amino acids, the building blocks of proteins. Reisz says the team plans to compare the compounds with proteins from other animals.

"The authors did a great job incorporating new technologies," says paleobiologist Mary Schweitzer of North Carolina State University in Raleigh, who has recovered protein from a 68-million-year-old *Tyrannosaurus rex* specimen. But the new case isn't a slam dunk, she says. The pattern doesn't quite match what you'd expect for a protein. It's possible, she notes, that decaying proteins might have different chemical signals than pristine ones, which could account for the discrepancy. ■

Back Story | FOSSIL GAP

With all that's known about adult dinosaurs, the discovery of at least 20 fossilized embryos of an early sauropod relative in southwestern China illustrates how little information there is regarding how the creatures developed in the egg. Paleontologists have found embryos and eggs of smaller relatives of the enormous, long-necked sauropods in South Africa (*SN: 7/30/05, p. 68*) dating to about 190 million years ago. Those embryos' anatomy indicates hatchlings were probably awkward walkers and toothless, signs that the babies would have needed help from mom or dad. The next example of prehatchlings in the sauropod lineage doesn't come until about 80 million years ago, with the appearance of embryos and eggs of a true sauropod group, the titanosaurs. Scientists think the huge size difference between adults and hatchlings, as well as the large number of eggs in each nest, means these giants didn't provide much care for their young. How growth, reproduction and parental care evolved in sauropods and their cousins during the more than 100-million-year gap in the embryo fossil record is something of a mystery. The fossils must be somewhere, says Martin Sander of Germany's University of Bonn, but "people just haven't looked hard enough."



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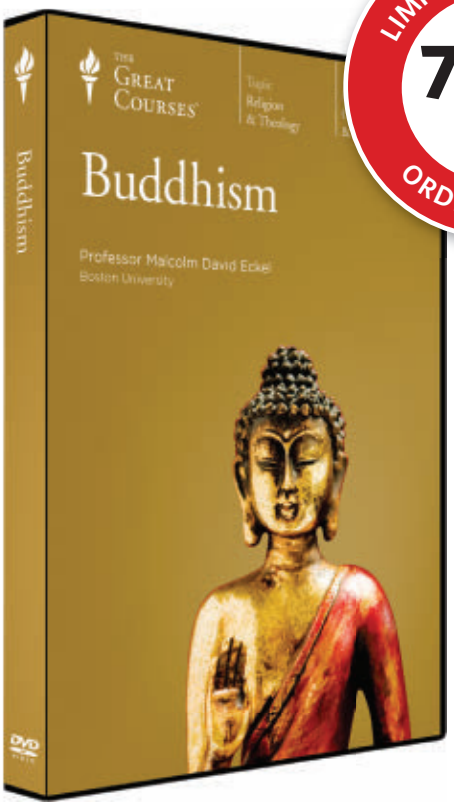

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Life

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Mammals grow ears with a flaw

Rupture-and-repair process may explain infection prevalence

By Susan Milius

Hey evolution, thanks for nothing.

When a mammal embryo develops, its middle ear appears to form in a pop-and-patch way that seals one end with substandard, infection-prone tissue.

"The way evolution works doesn't always create the most perfect, engineered structure," says Abigail Tucker, a developmental biologist at King's College London. "Definitely, it's made an ear that's slightly imperfect."

The mammalian middle ear catches sound and transfers it using three tiny bones — the hammer, anvil and stirrup — a trait that distinguishes mammals from other lineages.

Research in mouse embryos finds that the middle ear begins as a pouch of tissue that then ruptures at one end. The break lets in a different kind of tissue, which forms the tiny bones of the middle ear.

This intruding tissue originates from what's called the embryo's neural crest, a population of cells that gives rise to bone and muscle. Neural crest tissue has never been known before to create a barrier in the body. Yet as the mouse middle ear forms, this tissue creates a swath of lining that patches the rupture, Tucker and colleague Hannah Thompson report in the March 22 *Science*.

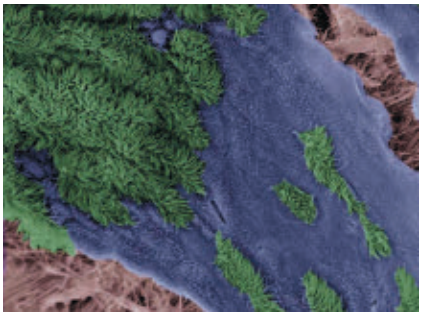
This neural crest tissue isn't great at forming barrier linings. Its patch in the middle ear tends to flake off when infected. And it doesn't form the forest of protective hairlike cilia that sweep away debris in the rest of the middle ear.

The improvisational patch may explain why infections in this bald zone of the middle ear tend to be more severe and frequent than in cilia-covered stretches.

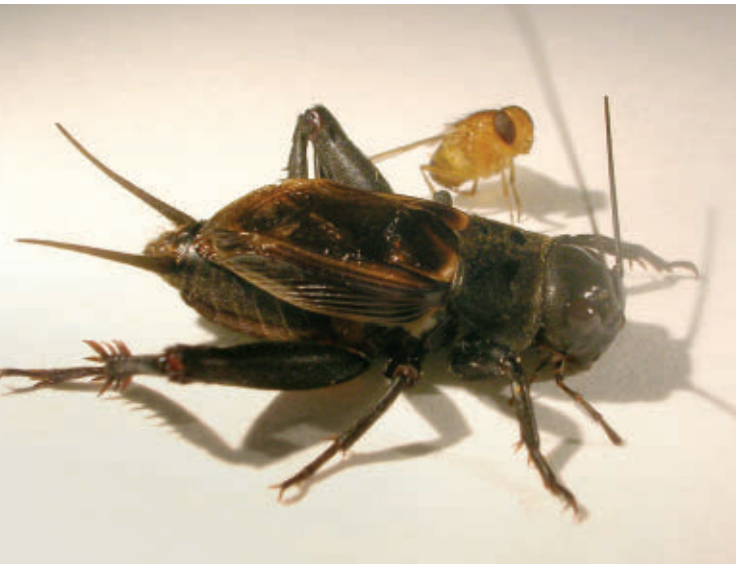
Before this paper, biologists thought the entire lining of the middle ear came from one kind of tissue, endoderm, which can readily form hairs. Tucker says she wondered how that endoderm layer managed to grow a continuous lining despite the middle ear's complicated obstacles of developing bones, along with their tendons and blood supplies.

To trace the process in detail, she and Thompson turned to genetically engineered mice that have labels distinguishing neural crest and endoderm tissues. By staining mouse tissue samples, the researchers revealed these labels and pieced together which parts of the middle ear came from each precursor cell type.

The development process may turn out to be general to all mammals, says Donna Fekete of Purdue University in West Lafayette, Ind. The scenario fits with observations of a lining rupture and a no-cilia zone in both human and rat middle ears. "If I were revising a textbook of human embryology," she says, "I would change the drawings."



A lawn of cilia (green) covers part of the mammalian middle ear. Nearby tissue that has a different developmental history is bald and prone to infection.



Dying crickets less choosy

With parasitic flies gorging on her guts and the end approaching, a variable field cricket may have time to do only one more thing: Find a mate. Usually, female *Gryllus lineaticeps* (shown with adult fly) prefer males with fast chirps. But when being eaten alive by fly larvae, the crickets are willing to settle for slow-chirping sexual partners, evolutionary biologists Oliver Beckers of Indiana University in Bloomington and William Wagner Jr. of the University of Nebraska-Lincoln report in the April *Animal Behaviour*. Infested female crickets have about a week to find a mate and lay eggs before being killed by the fly larvae growing inside them. To find out whether infestation lowered females' mating standards, Beckers and Wagner placed fly larvae on female crickets and then played slow and fast chirp recordings from loudspeakers set in separate corners of a square chamber. Healthy females walked toward the fast chirping sound about 80 percent of the time, while infested females split their devotion about equally. —*Meghan Rosen*

FROM TOP: COURTESY OF H. THOMPSON; COURTESY OF O. BECKERS

800 hertz | Upper frequency limit of hearing for cave-dwelling fish

2,000 hertz | Upper frequency limit of hearing for surface-dwelling fish

Some cave fish partially deaf

Loss may be adaptation to distracting background noise

By Puneet Kollipara

Blind fish that spend their lives in dark, underwater caves have lost a huge chunk of their ability to hear, scientists report in the June 23 *Biology Letters*. Two fish species studied could not hear high-pitched sounds.

"I was really surprised," says study coauthor Daphne Soares of the University of Maryland in College Park. "I expected them to hear much better than the surface fishes."

Cave-dwelling fish can lose their vision and even their eyes over many generations. Without light, eyesight appears to lose its importance to fish survival. Only two previous studies have explored what happens to hearing after fish lose their vision; both found no differences in hearing between cave fish and those that experience daylight.

Soares and colleagues collected fish of two blind cave-dwelling species, *Typhlichthys subterraneus* and *Amblyopsis spelaea*, from lakes in Kentucky caverns. Specimens of a surface-dwelling species, *Forbesichthys agassizii*, which is closely related to the cave dwellers, came from a lake in Tennessee.

At frequencies up to 800 hertz, almost the highest pitch of a trumpet, the two cave-dwelling species could hear just as well as their surface counterparts, the researchers found.

For higher pitches, it was a different story: The surface fish could hear frequencies as high as 2,000 hertz, roughly the highest pitch of a flute. But the cave dwellers were virtually deaf to those sounds.

The researchers returned to the caves to find out whether background noise there may have hurt the animals' ability to hear. The noise was generally far louder at higher ranges — the same frequencies that the cave fish couldn't hear, the researchers found. The high-pitched sounds may come from ripples or water dripping from the caves' ceilings, Soares says.

The process by which cave fish lost their hearing is not yet clear, says Martina Bradic of New York University. The fish could have adapted over time to the noisy environment, or their hearing systems could be highly flexible within a single lifetime.

Soares next hopes to study whether other creatures living without light, such as cave salamanders, also have become partially deaf.

Genes & Cells

For longer versions of these and other Genes & Cells stories, visit **www.sciencenews.org**

Weight loss linked to gut-bug shift

Microbial change may play role in benefits of bariatric surgery

By Tina Hesman Saey

Intestinal bacteria may be responsible for at least part of the fat-shedding effect of a popular weight-loss surgery, a new study in mice suggests. Those naturally occurring bacteria not only trim the tummies of mice that have had the surgery but, when transplanted into mice that have not had surgery, cause them to lose weight as well.

Roux-en-Y, the most common technique for gastric bypass, diverts food around most of the stomach and upper small intestine. Some patients go on to lose large amounts of weight, and the surgery may produce other health benefits such as improving symptoms of type 2 diabetes (*SN: 9/10/11, p. 26*). In mice, those benefits stem from a bacterial blend fostered by bypass surgery, researchers report March 27 in *Science Translational Medicine*.

The finding could be a first step toward "bypassing the bypass" as a means of treating obesity and diabetes, says coauthor Lee Kaplan, a gastroenterologist who heads Massachusetts General Hospital's Weight Center.

Still, the study was done in mice, says Guilherme Campos, a surgeon at the University of Wisconsin School of Medicine and Public Health in Madison, so the role that gut microbes play in humans' weight loss is unknown. "Is it the main driver? Likely not, but it is still likely one of the components that assist gastric bypass patients to lose weight in the long run," he says.

Previous studies of people and rats have found that the natural mix of microbes in the intestines changes after gastric bypass, with some groups growing more prominent and others diminishing. No one knew whether the altered microbial composition was merely a side effect of the surgery, or if shifting bacterial populations could help generate weight loss.

To find out, Kaplan and colleagues fattened up mice and then performed either bypass or a sham surgery on the animals. Mice in the bypass group lost about 29 percent of their body weight within three weeks of the procedure. But the mix of intestinal bacteria changed even earlier, within a week of surgery.

Compared with the sham operation group, the bypass mice had more of certain types of microbes, particularly *Escherichia* species. Some species of *Escherichia* are pathogens, but others help prevent inflammation and maintain intestinal health. Bypass mice also had more *Akkermansia* bacteria, which can feed on mucus lining the intestines, particularly when the host is cutting calories.

The researchers transplanted bacteria from the intestines of bypass mice into mice that had been raised without any bacteria. The formerly germ-free mice slimmed down, dropping about 5 percent of their body weight, even though they started out lean. Germ-free mice that received bacteria from the guts of sham surgery mice actually packed on a bit of fat.

The team is investigating what the bacteria do to cause fat reduction.

MIKE FLIPPO/SHUTTERSTOCK

Longhorn ancestry traced to Asia

Texas longhorn cattle descend from livestock that Christopher Columbus brought to the New World in 1493. Those first bovine immigrants were long thought to be descendants of taurine cattle (*Bos taurus*), which were originally domesticated from wild aurochs in the Middle East about 10,000 years ago. But a new study shows that longhorns (one shown) and two other New World cattle breeds also carry a genetic legacy from indicine cattle (*Bos indicus*), a lineage independently domesticated in what is now Pakistan. David Hillis of the University of Texas at Austin and colleagues analyzed genetic variants in 58 breeds from all over the world, including Texas longhorns, Mexican Corriente and Colombian Romosinuano cattle. Those three breeds had a pattern of variation suggesting that both taurine and indicine cattle contributed to their pedigrees, the researchers report in the April 9 *Proceedings of the National Academy of Sciences*. That could mean that Columbus imported cattle from Northern Africa, where herds often have mixed heritage. Genetic contributions from indicine cattle may account for the longhorns' famed drought tolerance and disease immunity, Hillis and colleagues suggest. —*Tina Hesman Saey*

"You don't need to put a MacBook chip inside a cell to get some really interesting functions." —TIMOTHY LU

Cholesterol tied to vision loss

Lipid could be targeted in macular degeneration

By Tina Hesman Saey

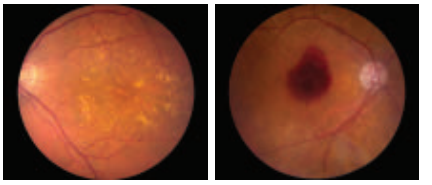
Cholesterol-lowering eye drops may one day help preserve sight in people with a common cause of an age-related eye disease, a new study suggests.

In old mice, eye drops that stimulate cells to shed cholesterol rejuvenated immune cells to fight off blood vessels encroaching into the retina, a hallmark of advanced age-related macular degeneration. The finding suggests that cholesterol buildup in the eye helps promote the condition, a leading cause of vision loss in people 50 and older.

In past research, Rajendra Apte of the Washington University School of Medicine in St. Louis and colleagues showed that immune cells called macrophages halt or encourage blood vessel growth into the eye. In the new study, published April 2 in *Cell Metabolism*, Apte's team collected macrophages from young and old mice and people. Then the researchers counted cholesterol-pumping proteins called ABC transporters on the cells' surfaces. Old macrophages had fewer pumps than young ones did. The old cells, particularly those with low amounts of a protein called ABCA1, couldn't combat blood vessel growth as well as the young ones could.

The team traced the diminished cholesterol-pumping ability to a small piece of genetic material called a microRNA. The microRNA *miR-33* builds up as cells age, the researchers found. Because *miR-33* puts the brakes on production of the ABCA1 pump, older macrophages can't jettison cholesterol the way they once did.

Mice given injections of either a microRNA blocker or drugs that stimulate other cholesterol-shedding mechanisms had fewer encroaching blood vessels in their eyes than placebo-treated animals did. And eye drops that stimulate cells in the eye to dump cholesterol worked as well as the injections. That may mean that doctors could treat just people's eyes, potentially avoiding side effects that might accompany whole-body therapies.



Yellow cholesterol deposits in the retina (left) can lead to blood vessel proliferation that destroys a patch of cells in the light-responsive surface (right).

COURTESY OF R. APTE

Apte's group has shown that cholesterol is involved, says Anand Swaroop, a geneticist who studies eye diseases at the National Eye Institute in Bethesda, Md. But Swaroop doubts it is the underlying cause of the disease. How well cells dump cholesterol is just one of many factors that add up to produce macular degeneration, he says.

Transistor built for living computers

DNA-based switches could diagnose and treat diseases

By Meghan Rosen

Save the clunky tricorders for *Star Trek*. One day, tiny computers with DNA-based circuitry could diagnose diseases.

Using DNA and DNA-clipping chemicals, researchers have created a biological version of the transistor. Dubbed a transcriptor, the bioswitch could be connected with other biological devices in DNA-based computers, researchers report March 28 in *Science*.

With these switches, researchers might be able to program probiotic bacteria — the kind in yogurt — to detect colon cancer and then spit out warning signals, says study coauthor Jerome Bonnet of Stanford University. "The bacteria could actually travel through your gut and make a color in your poop," he says.

Inside every smartphone, television and iPod, a computer chip holds circuits loaded with millions of transistors. By flipping on or off, the tiny switches direct electrical current to different parts of the chip. Inside cells, even just a few linked-up switches could be powerful, says synthetic biologist Timothy Lu of MIT. The simple circuits "probably wouldn't be able to compute square roots," he says, "but you don't need to put a MacBook chip inside a cell to get some really interesting functions." And genetic computers can go places conventional electronics can't.

Instead of controlling the flow of electrons in semiconductors, the biological switches control the flow of a protein along a "wire" of DNA in living bacteria. As the protein chugs along the DNA, it sends out messages telling the cell to make specific molecules.

Bonnet and his team toggled the switch on and off with DNA-clipping enzymes that can snip out a section of DNA and flip it backward. The message-making protein could move forward only when DNA faces the right direction. By linking together different switches and DNA clippers, the researchers were able to program a cell's behavior. They could make bacteria glow green only when sugar was around, for example.

Even this simple logic is useful, Bonnet says, because it lets researchers program cells to react to specific chemical cues.

Now bioengineers are working on scaling up biological devices by plugging together different components and linking individual computers to form a multicellular "Internet."

Health & Illness

150 million Cases worldwide of chronic hepatitis C

350,000 Annual deaths worldwide from hepatitis C–related liver disease

Hep C drug goes after patients' RNA

Compound targets genetic material virus uses to replicate

By Nathan Seppa

No matter what medications doctors throw at hepatitis C, it continues to defy treatment in some patients. But a new compound offers an approach quite apart from the rest: It assaults a kind of RNA in the patients that allows the virus to gain a foothold.

In most of a small group of people who took the experimental drug, virus levels fell, sometimes below the threshold of detection. The drug candidate does this by targeting genetic material in the liver called *microRNA-122*. The hepatitis C virus normally attaches to this RNA, gaining the stability it needs to propagate while hiding from the immune system.

The experimental drug, miravirsen, binds to *miRNA-122*, sequesters it and indirectly thwarts viral replication, says study coauthor Harry Janssen, a hepatologist at the University of Toronto. Janssen and colleagues report the findings March 27 in the *New England Journal of Medicine*.

The technique could have broad applicability because microRNAs — genetic snippets that regulate some gene activity — can play roles in cancer and other ailments. The strategy is "a whole new approach to the treatment of serious disease," says Phillip Sharp, a molecular biologist at MIT who earned a 1993 Nobel Prize for work on RNA. "This is an additional treatment that looks quite interesting and almost certainly will be used at some level."

Researchers randomly assigned 36 people with hepatitis C to get five weekly injections. Nine were given placebo shots while 27 got varying doses of miravirsen. None had received any hepatitis drugs beforehand. The scientists monitored the patients for 18 weeks.

While those given the placebo showed little or no improvement, most who received the experimental drug experienced a drop in virus levels. The 18 patients at the two highest dose levels showed profound reductions in viral RNA during the study period. Five of those 18 patients had undetectable virus levels at some point after treatment.

A few patients in each subgroup also received interferon — a standard treatment for hepatitis C — during the trial. At the end of the study, 14 weeks after the last shot, four patients getting both drugs and one getting miravirsen alone still showed no detectable virus.

Alzheimer's bane may help in MS

Plaque components counter inflammation in mice

By Nathan Seppa

Components of amyloid plaques, the notorious protein clumps found littering the brains of people with Alzheimer's disease, might fight inflammation. Researchers report that several of these protein fragments, or peptides, glom onto inflammatory compounds and reverse paralysis in mice that have a condition similar to multiple sclerosis.

When tested on blood taken from three MS patients, one such fragment, the tau peptide, weeded out some inflammatory culprits there, too, researchers report in the April 3 *Science Translational Medicine*.

"This is a seriously good study," says Jian-Guo Geng, a cell biologist at the University of Michigan in Ann Arbor who wasn't part of the research team. "But I don't think we're anywhere close to using these peptides for treatments."

Amyloid is a broad term for clusters of protein in the brain, including those arising with the aid of misfolded versions of tau or another protein implicated in brain disease called a prion. Study coauthor Lawrence Steinman, a neurologist at Stanford University, suggests that the tiny peptides holding the plaques together might have an alternative, useful role in the body.

> **"Most molecules are nuanced in function. In certain circumstances, they can cause harm or benefit."**
>
> LAWRENCE STEINMAN

"Most molecules are nuanced in function. In certain circumstances, they can cause harm or benefit," Steinman says.

His team has shown that injecting mice with amyloid improves symptoms in animals with the MS-like condition (*SN: 9/22/12, p. 14*). Separately, Geng reported in 2012 that mice genetically engineered to make extra amyloid could fend off the MS-like disease, and that knocking out the amyloid-making capacity worsened their symptoms.

The new study goes a step further. Steinman's team identified several peptides, each only six amino acids in length, that seem to knock down inflammation when they twist to form sticky structures called fibrils. Steinman likens the peptide fibrils to sponges, because of their ability to bind to and contain compounds that trigger inflammation.

The researchers injected various peptides that can form amyloid into mice disabled by the MS-like condition. Several reversed the animals' paralysis during treatment. The effect later faded.

When the scientists cultured blood from MS patients with the tau fibril, the peptide bound dozens of molecules, including many involved in inflammation.

Environment

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Fungi pull carbon into forest floor

Organisms work with trees to trap organic material in soil

By Meghan Rosen

Sequestration may be questionable fiscal policy, but it's good news for the carbon cycle. Vast underground networks of fungi may sequester heaps of carbon in boreal forest soil, a study suggests. By holding onto the element, the fungi do the environment a favor by preventing carbon dioxide from escaping into the atmosphere and warming the planet.

Mycorrhizal fungi growing in and on tree roots hold 50 to 70 percent of the total carbon stored in leaf litter and soil on forested islands in Sweden, researchers report in the March 29 *Science*. The finding pokes holes in a long-held idea that carbon in boreal forests accumulates mainly above ground in a litter of pine needles, mosses and leaves. The researchers suggest instead that trees direct carbon deeper into the soil via their root systems.

"It's hard to quantify how important mycorrhizal fungi are in ecosystems," says ecologist Erik Hobbie of the University of New Hampshire, who was not involved in the study. "This paper presents hard evidence about their importance."

Because photosynthesis makes trees so good at capturing carbon from the atmosphere, ecosystems stash loads of the element in forests. Cold boreal forests stow away nearly a quarter of all the carbon stocked in the Earth's land surfaces.

Where exactly trees put their carbon becomes important when researchers build simulations that track carbon cycling. "People talk about how plants shuttle half their carbon to the belowground root system, but it has kind of been neglected in carbon storage models," says study coauthor Karina Clemmensen, a fungal ecologist at the Swedish University of Agricultural Sciences in Uppsala.

Clemmensen and colleagues measured the age and accumulation of carbon in soil samples from 30 islands sprinkled across two lakes in northern Sweden. At each island, Clemmensen's team plunged hollow tubes with sharpened ends into the ground to extract soil cores.

Since new, carbon-rich litter settles layer by layer on forest floors, prevailing wisdom suggested the scientists would find only older carbon as they went down. But instead, researchers found stores of young carbon deep beneath the surface. Only sugars shipped down tree roots could explain the young carbon's presence at depth, says Clemmensen.

Atom & Cosmos

25 billion | Number of particles detected by AMS in 1.5 years

The Alpha Magnetic Spectrometer sits aboard the International Space Station. New results from the detector confirm previous observations that could point to the identity of dark matter.

Cosmic rays hint at dark matter

Space station–based instrument confirms past experiments

By Andrew Grant

A $2-billion experiment on the International Space Station has released the first data from its unprecedented census of the charged subatomic particles whizzing by Earth. Although the results largely confirm previous observations, researchers hope they will point to the identity of dark matter, an invisible form of matter that outweighs normal matter in the universe by more than 5 to 1. Scientists presented the new data April 3 in a seminar at the CERN physics lab outside Geneva.

The Alpha Magnetic Spectrometer is the latest and most ambitious attempt to uncover the identity of dark matter by looking at cosmic rays, which are charged subatomic particles cruising through space. Theoretical physicists have proposed that dark matter could consist of exotic particles that can slam into and annihilate each other, creating detectable cosmic rays such as electrons and their antimatter partners, positrons. An abundance of these particles, particularly the more exotic positrons, could be a signature of dark matter.

This first batch of AMS results, published April 3 in *Physical Review Letters*, encompasses about 25 billion particles detected over the course of a year and a half, including 6.8 million measurements of electrons and positrons that could have come from dark matter. AMS improved the precision of earlier data, detected particles at higher energies than previous instruments and found that the particles arrive in equal amounts from all directions.

But none of the data give clues to the positrons' source, said Katherine Freese, a theoretical astrophysicist at the University of Michigan in Ann Arbor. The trajectories of these charged particles can change as they move through magnetic fields, she said, making it difficult to determine their origins. Her bet is that spinning stars called pulsars produce positrons and fling them across the galaxy using extremely strong magnetic fields. "It will take a while to sort this out," she said.

Physicists first got a peek at cosmic rays that could have resulted from dark matter annihilation in the mid-1990s. The High Energy Antimatter Telescope, a cosmic ray detector attached to a high-altitude balloon, found an unexpected abundance of positrons, a result that seemed to jibe with the idea that dark matter annihilation creates these charged particles. In the last five years, two space-based detectors, PAMELA and the Fermi Gamma-ray Space Telescope, have found even more decisive evidence of excess positrons.

But the specifics of the probes' observations do not match well with theoretical predictions. Along with electrons and positrons, dark matter annihilation should produce other signals like extra antiprotons, gamma rays and radio waves. But detectors have found no evidence of any of those signals.

Researchers hope that AMS can bring clarity to this debate because of its leg up on other cosmic ray detectors. Among other strengths, its perch aboard the International Space Station means it can sample the full spectrum of cosmic rays above Earth's atmosphere, which filters out most cosmic rays before they reach the ground. AMS also sports a strong magnet and precise sensors that allow researchers to easily distinguish between particles that behave similarly, such as protons and positrons.

Samuel Ting, a Nobel laureate from MIT who leads the AMS experiment, is optimistic about the project's prospects for finding the positrons' origins. "I think there is no question we are going to solve this problem," he said. One clue comes from studying the abundance of positrons at very high energies, which AMS is the first to explore. In a graph showing the distribution of positrons at various energy levels, the number of positrons generally increases as their energies rise. But the new AMS data show that at a certain point that increase tails off.

If the number of positrons seen at high energies were to abruptly plummet, Ting said, it would suggest dark matter as a source. He said it would take at least several more months for AMS to detect enough of these high-energy particles to come to a definitive conclusion.

NASA

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– Carol K., Benbrook, TX

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Mind & Brain

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Dream contents revealed by MRI

Brain patterns of sleeping people echo waking state

By Rachel Ehrenberg

A computer can decode the stuff of dreams. By comparing brain activity during sleep with activity patterns collected while study participants looked at certain objects, a computer learned to identify some contents of people's unconscious reveries.

"It's striking work," says cognitive psychologist Frank Tong of Vanderbilt University in Nashville, who was not involved in the research. "It's a demonstration that brain activity during dreaming is very similar to activity during wakefulness."

The work, reported April 4 in *Science* by a team of Japanese researchers led by Yukiyasu Kamitani of Advanced Telecommunications Research Institute International, adds to somewhat scant knowledge of how the brain constructs dreams, Tong says.

The researchers used functional MRI to record brain activity in three adult male volunteers during the early stages of sleep. After the subjects had dozed off, they were repeatedly awakened and asked for detailed reports on what they had seen while sleeping. In one example, a participant stated: "Well, there were persons, about three persons, inside some sort of hall. There was a male, a female and maybe like a child. Ah, it was like a boy, a girl and a mother. I don't think that there was any color."

After gathering at least 200 such reports from the three men, the researchers used a lexical database to group the dreamed objects in coarse categories, such as street, furniture and girl. Then the study participants looked at images of things in those categories, while their brains were again scanned. Computer algorithms sorted through these patterns of brain activity, linking particular patterns with objects.

When the computer went back to the brain scans taken during dreaming, it did a pretty good job of distinguishing some of the signals, such as whether a dream contained a book or a girl. On average, the computer could pick which of two objects had appeared in a dream 70 percent of the time, a rate that is much better than would be expected by chance.

"To be able to get enough data to do this kind of analysis is really impressive," says Russell Poldrack, a neuroimaging expert at the University of Texas at Austin.

The study bolsters the notion that the vivid imagery of dreams, no matter how fantastic, is as real as waking life, Kamitani says, at least from the brain's perspective. Further research may reveal if the same is true of other dreamed phenomena such as sounds or emotions.

Cocaine addiction comes to light

Lasers stimulate neurons to ease drug compulsion in rats

By Puneet Kollipara

Rats that will go to great lengths to get a cocaine fix might blame a group of sluggish neurons. Stimulating those brain cells with lasers reduces the addicted rats' cocaine use, researchers report April 3 in *Nature*.

The findings could help researchers better understand the role of neural circuitry in human drug addiction, says neuroscientist A.J. Robison of Michigan State University, who wasn't involved in the study.

Billy Chen, then of the National Institutes of Health, and colleagues trained rats to take cocaine. The rats learned to press levers to receive a dose of the drug through an IV. After about two months, the scientists started giving the rats shocks roughly one-third of the time when the animals pressed the levers. Most of the rats stopped taking cocaine, but about 30 percent continued. These were compulsive cocaine users, says coauthor Antonello Bonci, a neuroscientist at the NIH's National Institute on Drug Abuse.

Then the researchers sent electric current through neurons in an area of the rats' prelimbic cortex that links to other brain areas involved in drug-seeking behaviors. Neurons in all cocaine-using rats were less likely to fire in response to the currents than cells in rats that hadn't taken cocaine. And compared with noncompulsive cocaine users, the compulsive users' neurons needed almost twice as much current to fire. That suggests that long-term cocaine use reduced neuron firing, especially in the compulsive users.

To find out whether those sluggish neurons in turn caused the compulsive behavior, the scientists injected the rats with viruses that inserted light-responsive molecules into the lazy neurons. When the researchers used lasers to stimulate the neurons in the compulsive rats, the rats pushed the cocaine levers one-third as often. The same experiment on rats that hadn't been shocked had no effect.

The researchers then reversed that experiment, using lasers again but this time turning off the neurons in the noncompulsive users. Those rats started pushing the levers for cocaine almost as frequently as the other rats had.

The study doesn't explain why some rats become compulsive users and others don't, Bonci says. Still, researchers could use the findings to generate new treatments for compulsive drug use.

Humans

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Emotions underlie babies' blather

Communication in early months tied to language learning

By Bruce Bower

Babies take a crucial step toward learning to speak before they can say a word or even babble. By 3 months, infants flexibly use three types of sounds — squeals, growls and vowel-like utterances — to express a range of emotions, from positive to neutral to negative, researchers say.

Attaching sounds freely to different emotions is a building block of spoken language, say psycholinguist D. Kimbrough Oller of the University of Memphis in Tennessee and his colleagues. Any word or phrase can signal any mental state, depending on context and pronunciation. Infants' flexible manipulation of sounds to signal how they feel lays the groundwork for word learning, the scientists conclude April 2 in the *Proceedings of the National Academy of Sciences*.

Language evolution took off once this ability emerged in human babies, Oller proposes. Ape and monkey researchers have mainly studied vocalizations that have one meaning, such as distress calls.

Oller's group videotaped infants playing and interacting with their parents in a lab room equipped with toys and furniture. Acoustic analyses identified nearly 7,000 utterances made by infants up to 1 year of age that qualified as laughs, cries, squeals, growls or vowel-like sounds.

Experimenters judged whether each sound an infant made, and the expression accompanying it, was positive, negative or neutral.

Overall, infants produced the flexible trio of emotion sounds much more often than laughs or cries.

Neuroscientists previously reported that monkeys, apes and humans share an ancient brain pathway linked to emotional sounds such as laughing and crying. In the new study, babies' laughs overwhelmingly expressed positive feelings and cries usually conveyed negative ones.

Ancient humans must have evolved neural connections that supported early voluntary control of sounds other than laughing or crying to communicate emotions, says psychologist Michael Owren of Georgia State University in Atlanta.

"This groundbreaking work shows that, from the beginning, human infants have flexible vocal chops that put them on a very different developmental course than found in monkeys and apes," Owren says.

Earth

For longer versions of these and other Earth stories, visit **www.sciencenews.org**

Kansas was once unbearably hot

Permian temperatures climbed to nearly 74° Celsius

By Erin Wayman

The Permian period was hot, hot, hot: Around 270 million years ago, air temperatures near the equator may have soared to almost 74° Celsius (165° Fahrenheit), scientists report March 18 in *Geology*. That's far hotter than anywhere on Earth today.

"I can't even imagine what it would have been like," says Neil Tabor, a sedimentary geochemist at Southern Methodist University in Dallas who wasn't involved in the research. The intense heat may explain why plants and animals vanished from parts of the tropics at that time, he says, a disappearance preceding the mass extinction that ended the Permian 252 million years ago. Only microbes that thrive under extreme conditions could have survived such temperatures.

Evidence for the sweltering heat comes from sediments in Kansas, which was near the equator during the Permian when the continents fused to form Pangaea. At that time, western Kansas was a desert where lakes of brine repeatedly formed, evaporated and left behind salt deposits. Geologist Kathleen Benison of West Virginia University in Morgantown and a colleague had determined that air temperatures there reached 50° C, no hotter than California's Death Valley today.

Benison and Jay Zambito, also of West Virginia, were surprised to find evidence of even hotter temperatures while investigating another site in western Kansas. They looked at crystals of halite, or rock salt, which act as natural thermometers. As the crystals grow in evaporating lakes of brine, they trap microscopic bubbles of saltwater. In the lab, scientists can estimate the temperature at which the bubbles formed, thereby taking the temperature of the ancient brine itself.

Each bubble, Benison says, "is a very specific snapshot for a single time and place." Since the pools were only tens of centimeters deep, the bubbles are good proxies for air temperature, she adds.

The team collected almost 400 temperature readings from 15 layers in sediments roughly 600 to 800 meters deep. The whole record corresponds to about 270 million years ago, but how much time elapsed across the layers is unknown.

Near the beginning and end of the record, average air temperatures were in the 20s and 30s Celsius. Temperatures spiked in the middle layers to an average of almost 45° C, with daytime temperatures ranging from about 25° C to almost 74° C. Benison and Zambito plan to investigate temperatures over a larger geographic area to see whether the sizzling heat was a regional phenomenon.

But some researchers are not convinced that the team actually found such extreme temperatures. "It's a question of whether or not they've measured the air temperature," says geochemist Ron Spencer of the University of Calgary in Canada. In some modern deserts, he says, even shallow brine can be much hotter than the air because it retains heat better.

If the air temperatures are valid, they create a mystery. "It's unclear at the moment how we could get such extreme conditions at this place," Tabor says. Climate simulations can't yet reconcile how the area could be that hot and still have liquid water at the surface. ■

ACARO/WIKIMEDIA COMMONS

Melting makes more ice

Melting ice shelves may actually spur the growth of sea ice in Antarctica. While Arctic sea ice has dwindled, the extent of Antarctic sea ice has expanded nearly 2 percent per decade since 1985. As the oceans have warmed over the same period, currents have carried heat to the deep waters surrounding Antarctica. The warmth may be melting the base of ice shelves, sections of Antarctica's ice sheet that float over the ocean. That melting floods the ocean with cold freshwater that stays on the surface and easily freezes, suggest Richard Bintanja of the Royal Netherlands Meteorological Institute and colleagues. Climate and ocean simulations confirm that the melting of ice shelves is a plausible mechanism for the growth of sea ice, the researchers report March 31 in *Nature Geoscience*. And the explanation accounts for more sea ice growth than another possible explanation, that stronger winds around the continent have cooled the sea surface, Bintanja says. —*Erin Wayman*

"It's a major change in how we view the tectonic history of North America." — DON FORSYTH

Western terrain a two-step job

North America's tectonic history gets more jumbled

By Erin Wayman

The building of western North America wasn't a simple construction project. Multiple sections of seafloor slid beneath the continent and each other like conveyor belts, researchers suggest, bringing islands in from different directions and pasting them to the western edge of North America in a jumble of rugged terrain.

"It's a major change in how we view the tectonic history of North America," says geophysicist Don Forsyth of Brown University in Providence, R.I., who wasn't involved in the work. "It's a minirevolution."

North America west of the Rockies is a patchwork of crustal fragments that the continent accumulated over the last 200 million years. The accumulation began shortly before North America broke free from Pangaea and started drifting west.

During this time, geologists had thought, a section of seafloor crust known as the Farallon plate dove beneath North America's western edge and into the mantle. Like a bulldozer, the continent scooped up islands sitting on top of the subducting Farallon plate that were too buoyant to sink into the mantle.

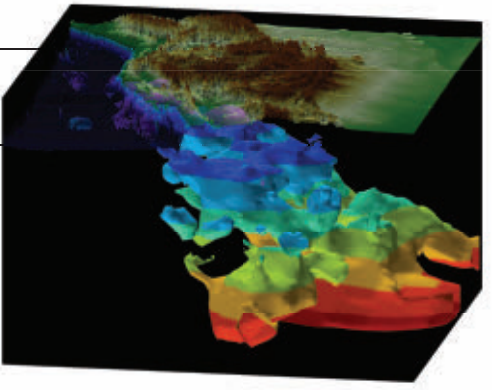
Three-dimensional pictures of Earth's interior expose a more complicated geological history, say Karin Sigloch of Ludwig Maximilians University in Munich and Mitchell Mihalynuk of the British Columbia Geological Survey in Canada. The pair describes the new scenario in the April 4 *Nature*.

Because an earthquake's seismic waves travel faster through remnant slabs of subducted crust than the surrounding mantle, Sigloch could use the vibrations to create images of slabs extending about 2,000 kilometers beneath North America. The pictures reveal that two cycles of subduction helped stitch together the western part of the continent.

Sigloch and Mihalynuk noticed that the shape of one slab, previously interpreted from fuzzier images as the eastern section of the Farallon plate, doesn't match what you'd expect to find if it had simply subducted beneath North America. Instead, the researchers say, this slab is the remains of two newly discovered sections of seafloor crust that once extended off the west coast of North America.

As North America drifted westward, these seafloor sections plunged beneath the Farallon plate and perhaps other plates to the west, the researchers propose. Islands began accumulating around that subduction zone. Once these seafloor slabs completely disappeared into the mantle, the Farallon plate began sliding east beneath North America. First the islands from the initial period of subduction were pasted to the continent, then islands on the Farallon plate began piling up along its edge.

Only further testing, Forsyth says, will determine whether the new hypothesis better explains all of western North America's complex geologic features than the traditional view.



Scientists used seismic waves to make this 3-D image of the Farallon plate extending 1,800 kilometers under North America (each color represents a 200-kilometer change in depth).

K. SIGLOCH

Microbes flourish in deepest ocean

Bacteria prosper despite crushing pressure, isolation

By Puneet Kollipara

In the darkest, deepest part of the ocean, microscopic life thrives under extreme pressures and isolation from the world above. Surprisingly, bacteria in the West Pacific's Challenger Deep gobble up more oxygen than does the life in a nearby shallower area, researchers report March 17 in *Nature Geoscience*.

The study shows that some microbial life can make the most of a difficult environment, says Tim Shank of Woods Hole Oceanographic Institution in Massachusetts, who was not involved in the study.

Pressures at the ocean's deepest points are more than 1,000 times those at sea level. Scientists didn't know what kinds of life could survive in those conditions and how metabolically active it could be.

In 2010, researchers led by Ronnie Glud of the University of Southern Denmark sent a remotely operated deep-sea lander to the western Pacific Ocean to explore the Mariana Trench's Challenger Deep — at 11 kilometers down, the deepest seafloor on Earth. It also visited a nearby site 6 kilometers down.

The lander gauged microbial activity in the sediments by studying how much oxygen the microbes used up while digesting food. Oxygen consumption rates were two times and microbial density seven times those in the shallower area, the researchers found.

Another surprise was that the trench's residents receive a healthy supply of food. Scientists had believed that, compared with shallow parts of the ocean, deep areas get far less organic carbon. But the Challenger Deep had about 25 percent more organic carbon in its sediments than shallower areas did. The carbon-rich material, likely dead organisms such as fish and algae, had floated down from above, Glud says.

News in Brief

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HUMANS

Possible human ancestor in *Australopithecus sediba*

A mix of apelike and humanlike features supports the controversial contention that a 2-million-year-old member of the human evolutionary family gave rise to the genus *Homo*, an international team of researchers reports April 12 in *Science*. In 2008, anthropologist Lee Berger of the University of the Witwatersrand in Johannesburg and his colleagues assigned two partial skeletons and other fossils found in a South African cave to a species they named *Australopithecus sediba*. Among the group's latest findings: *A. sediba's* teeth suggest that this hominid evolved into a *Homo* species, but had no links to earlier East African hominids often regarded as *Homo* ancestors. Though *A. sediba's* relatively long arms were suited to hanging out in trees, these hominids also had narrow, humanlike lower rib cages and lower backs that were longer and more flexible than those of people today. *A. sediba* probably walked awkwardly with its feet rolling inward and slightly pigeon-toed. —*Bruce Bower*

ENVIRONMENT

Cutting certain greenhouse gases could slow sea level rise

A quick way to stave off impending sea level rise is to cut emissions of short-lived climate warmers such as methane and soot, researchers suggest. Carbon dioxide, the main cause of anthropogenic climate change, can linger in the atmosphere for more than a century. So slashing CO_2 output will not immediately halt global warming and its consequences. A faster way may be to limit methane, ozone, hydrofluorocarbons and soot, also known as black carbon. These greenhouse gases and particles stay aloft only weeks to years. Recent work shows that this approach may decrease the expected rise in global temperatures by about 0.6 degrees C by 2050. A team led by Veerabhadran Ramanathan of the Scripps Institution of Oceanography in La Jolla, Calif., wondered whether cutting these four climate pollutants would also slow warming-associated sea level rise. The researchers ran climate simulations in which emissions of these pollutants—or gases that ultimately produce the pollutants—shrank by 30 to 50 percent over the next few decades. Sea level rise dropped 10 percent by 2050 and 22 percent by 2100 compared with simulations without these cuts, the team reports April 14 in *Nature Climate Change*. —*Erin Wayman*

Rising carbon dioxide means more air turbulence

As carbon dioxide emissions increase, so too will the prevalence and power of the turbulence that strikes fear in the hearts of airline passengers, a new computer simulation suggests. English researchers simulated air turbulence at cruising altitudes for transatlantic flights between North America and Europe during winter. Moderate to severe turbulence would be 40 to 170 percent more frequent in a world that had twice the atmospheric CO_2 of preindustrial times, the researchers report April 8 in *Nature Climate Change*. That's a threshold that could be surpassed by 2050. Changes in turbulence are probably linked to alterations in the fast-moving air currents known as the jet streams, the researchers say. Previous work suggests that the jet streams should shift north and strengthen as the climate warms in response to rising greenhouse gas concentrations. —*Erin Wayman*

HEALTH & ILLNESS

New method for making malaria drug

Researchers have come up with a shortcut to making artemisinin, a front-line drug against malaria. Christopher Paddon of Amyris Inc. of Emeryville, Calif., and his colleagues describe their process April 10 in *Nature*. Last year the team reported that they could ferment bioengineered yeast to make amorphadiene, a precursor of artemisinic acid. In the new study, they improve the yield of the precursor and then spell out a process for converting artemisinic acid to artemisinin itself. Artemisinin, which the sweet wormwood plant produces in its leaves, is an ancient malaria remedy. Current artemisinin production requires growing the plants for months, removing and drying the leaves and extracting the artemisinin. But a combination of problems that include fluctuations in raw material prices and too few manufacturers has led to supply uncertainties and price volatility. The authors of the new study say their findings "pave the way for an industrial process capable of supplementing the world supply of artemisinin from a second source independent of the uncertainties associated with botanical production." —*Nathan Seppa*

Statins help breast cancer patients

Cholesterol-lowering drugs might limit the lethality of breast cancer. Although these drugs, called statins, can kill breast cancer cells in laboratory tests (*SN: 5/5/12, p. 30*), scientists don't know whether they can prevent the disease in people or help breast cancer patients. Teemu Murtola, a physician and epidemiologist at Johns Hopkins University, and colleagues analyzed records of more than 31,000 women in Finland who received a first-time diagnosis of breast cancer between 1995 and 2003. Women who started statins after being diagnosed with localized breast cancer were one-third as likely to die from the cancer by the end of 2003 as those not getting the drugs, Murtola reported in Washington, D.C., April 7 at the American Association for Cancer Research annual meeting. Among women whose breast cancer had already spread to other organs by the time of diagnosis, those who subsequently took statins were half as likely to die from the cancer as those not getting the drugs. —*Nathan Seppa*

From frogs to cavemen, from eavesdropping birds to the climate, from cotton to Batman…

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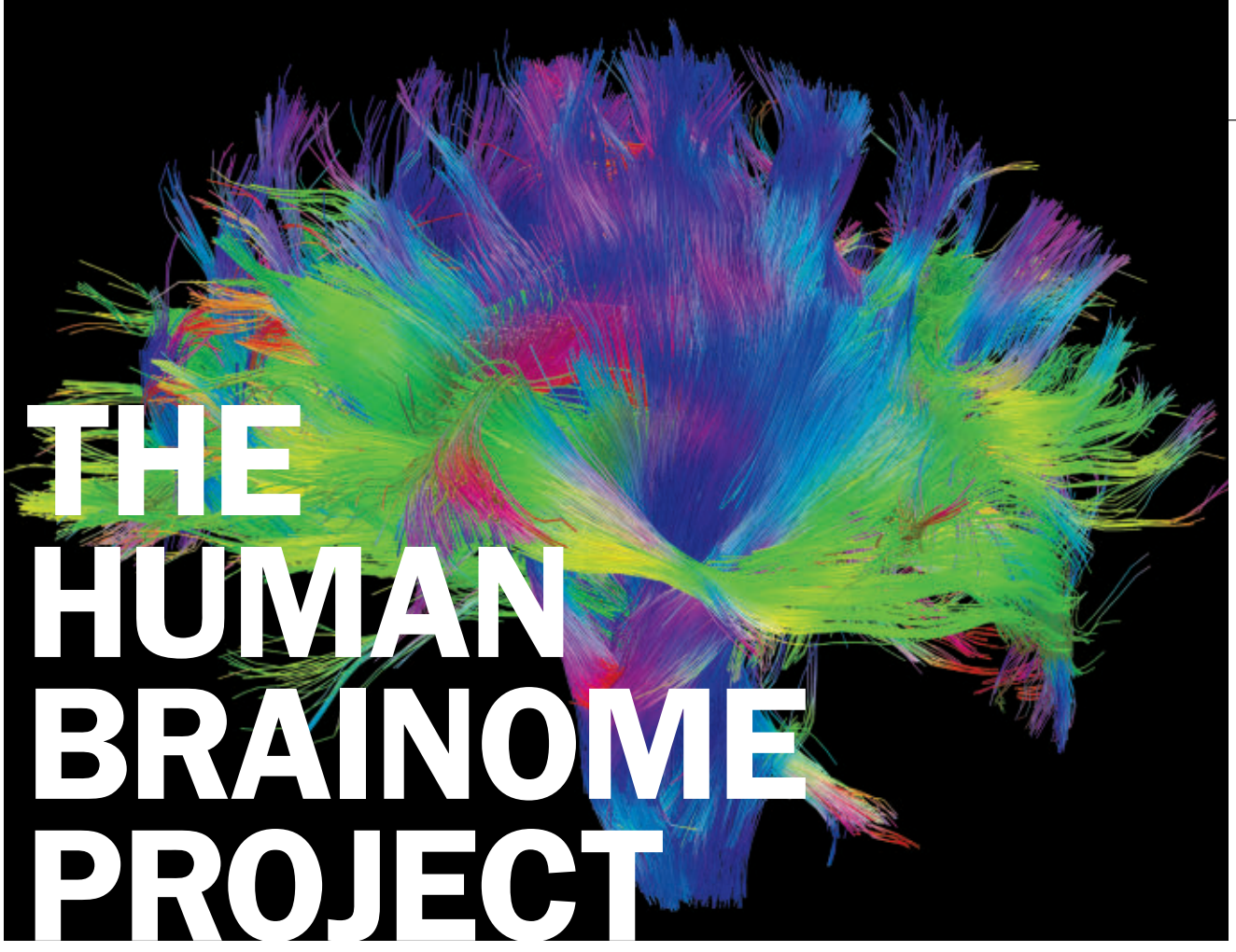


THE HUMAN BRAINOME PROJECT

Obama announces ambitious plan to develop new tools for exploring neural circuitry

By Puneet Kollipara

Brain research has been on a lot of minds lately in the nation's capital. After offering a brief shout-out to Alzheimer's research in his February State of the Union address, President Barack Obama went a step further in April by announcing a decade-long effort to develop advanced tools for tracking human brain activity. The administration dubbed it the Brain Research through Advancing Innovative Neurotechnologies initiative, and proposed spending $100 million on the program in the 2014 fiscal year.

Scientists have discussed such an endeavor for years, and pushed hard for it in the past few months. Writing March 15 in *Science*, researchers say the project would develop technologies to probe brain activity on a far greater scale and with higher resolution than is now possible.

Current tools can monitor only small numbers of individual neurons at a time or capture blurry, bird's-eye views of brain activity. The new tools would enable real-time mapping of how the thousands or millions of neurons in coordinated groups, known as circuits, work together. Brain functions — and, in many cases, dysfunctions — are thought to emerge from this still poorly described circuit level.

"There's no way to build a map until you develop the tools," says Rafael Yuste, a neuroscientist at Columbia University's Kavli Institute for Brain Science and one of the project's proponents.

Researchers call for developing three sets of tools to better understand brain circuits. One focus is on the creation of tools to measure the activities of all the individual neurons in a circuit. Another is on technologies to experimentally manipulate these neurons. The third tool set would store, analyze and make the data accessible to all researchers.

Scientists today can directly probe individual neurons to examine the main currency of neuronal communication, electrical signals known as action potentials. But the existing tools are generally invasive, making them tough to use in humans, or have crude resolution. New technologies, some already emerging, would be nanoscale, proponents of the effort write March 26 in *ACS Nano,* or they would measure voltage indirectly through an indicator. Other possible targets include chemical messengers known as neurotransmitters, which relay action potentials between neurons via synapses.

For instance, researchers already use laser microscopes to measure calcium ions, an indicator of voltage. One recent

LABORATORY OF NEURO IMAGING/UCLA

Recent advances in neuroscience, such as the ability to map neural connections throughout the brain (left), have encouraged researchers to propose an effort to develop a new generation of tools.

study used a special laser microscope that emits a "light sheet" to detect calcium ions and map the activity of 80 percent of a larval zebra fish's roughly 100,000-neuron brain. Coauthor Misha Ahrens of the Howard Hughes Medical Institute in Ashburn, Va., likens the method to shining a thin sheet of light instead of a lamp in a foggy area; the thin layer would be scattered far less by the fog than the diffuse lamplight would.

The map, described March 18 in *Nature Methods*, shows activity once a second. It may be the first time vertebrate brain activity has ever been revealed in such detail. To go further and capture the brain's workings at a rate of 1,000 times a second, as scientists would like, will require major changes in microscope technology, Ahrens says.

Another exciting prospect is the use of quantum dots, nanoscale semiconducting spheres that can be engineered to glow a different color or brightness depending on voltage or neurotransmitter levels.

Researchers even envision artificial cells that could serve as liaisons between measurement tools and neurons, says George Church, a Harvard University geneticist who helped plan the initiative and was a leading figure in the Human Genome Project.

Flipping switches

While imaging and measurement tools would enable researchers to link neuron activity or neurotransmitter levels with certain functions or dysfunctions of the brain, manipulating individual neurons could lead to even more powerful experiments. It also could lead to clinical applications.

In the burgeoning field of optogenetics, neurons are engineered to turn on or off in response to light. "We can selectively activate individual neurons. By doing that, you can really get at issues of causality," says Clay Reid, a neurobiologist at the Allen Institute for Brain Science in Seattle.

Reporting April 3 in *Nature*, researchers at the National Institute on Drug Abuse in Baltimore and the University of California, San Francisco used optogenetics to produce or diminish compulsive cocaine use in rats by manipulating the activity of a specific group of neurons (see Page 16).

Researchers hope the findings lead to new therapies for drug addiction, but the road to clinical application is a difficult one and requires a sustained investment. "The evolution of optogenetics or similar techniques needs a lot of help, because the benefits are going to far, far outweigh the costs," says coauthor Antonello Bonci of NIDA.

A huge advantage of optogenetics, he says, is that it can manipulate neurons almost in real time. But it can't be used for long periods. In his lab, Bonci complements optogenetics with another promising technique that has lower time resolution but can be used for longer. It involves implanting neurons engineered to respond to certain compounds. Injecting those compounds can activate or silence the cells.

Preparing for the data flood

Monitoring and manipulating individual cells is only part of the challenge; tracking a million neurons a thousand times a second will produce a lot of data. Software, databases and hardware will be needed to store and distribute that information, and to process and analyze it. Project proponents met at Caltech in January to discuss how to address the data needs — roughly a gigabyte a second for a million neurons simultaneously, or 30 million gigabytes a year.

Researchers could compress the data by a factor of 10 without sacrificing crucial details, according to a report from the meeting. Ultimately, the data problem shouldn't be insurmountable, Yuste says. Another proposed big science project, the Large Synoptic Survey Telescope, would produce around 10 million gigabytes of astronomical data annually starting in the early 2020s — right when million-neuron tools could come online, he notes.

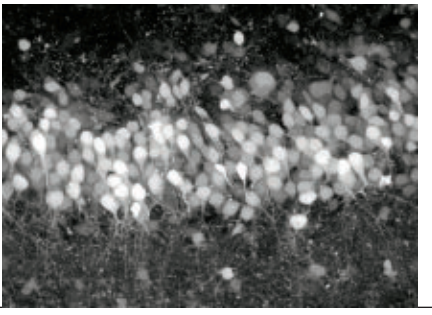
Technical obstacles aren't the only worry Yuste and his colleagues have. The recurring state of fiscal crisis in Washington makes it difficult to get any big project off the ground. Uncertainty over funding has fueled skepticism among scientists, who wonder whether money would be taken from other research to fund a "Big Science" project that lacks a concrete final goal.

National Institutes of Health Director Francis Collins notes that his agency has formed a workgroup of neuroscientists and some nanoscientists — supportive and skeptical alike — to guide the project's timetable and scientific goals. One of the cochairs is Cori Bargmann, a Rockefeller University neuroscientist who previously raised concerns that the project could take funding from other neuroscience work.

Gary Marcus, a neuroscientist at New York University, says he is concerned that the project focuses too much on tool development, but notes that the administration's proposal may be flexible enough to fund projects in other areas of neuroscience.

He fears what will happen if the tools are developed but don't yield all the promised insights. "We will surely learn something," Marcus says. "Whether we learn everything we want to know is another question." ■

A technology that tracks calcium can already measure the activity of small groups of neurons (shown).



R. YUSTE/COLUMBIA UNIV.

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A different KIND OF SMART

Animals' cognitive shortcomings are as revealing as their genius

By Susan Milius

MICK SIBLEY/UNIV. OF AUCKLAND

New Caledonian crows, sometimes called the second most sophisticated toolmaking species on the planet, work wonders with twigs and leaf strips. But certain simple tasks (as people see it) baffle them.

Zola the crow is about to face a test that has baffled animals from canaries to dogs.

She's a wild New Caledonian crow, and for the first time, she's seeing a tidbit of meat dangling on a long string tied to a stick. She perches on the stick, bends down, grabs the string with her beak and pulls. But the string is too long. The meat still hangs out of reach.

In similar tests, dogs, pigeons and many other species routinely falter. Some nibble at the string or keep tugging and dropping the same segment. Some pull at a string that's not connected to food just as readily as a string that is. Eventually many get the hang of reeling in the tidbit, but they seem to learn by trial and error.

Zola, however, does not fumble. On her first attempt, she anchors the first length of string by stepping on it and

immediately bends down again for the next segment. With several more pulls and steps, Zola reels in the treat.

Watching the crow, says Russell Gray, one of the researchers behind the string-pulling experiment, "people say, 'Wow, it had a flash of insight.' " At first glance it seems Zola mentally worked through the problem as a human might, devising a solution in an aha moment.

But Gray, of the University of Auckland in New Zealand, has had enough of such supposed animal geniuses. Asking whether the crow solves problems in the same way a human would isn't a useful question, he says. He warns of a roller coaster that scientists and animal lovers alike can get stuck on: first getting excited and romanticizing a clever animal's accomplishments, then crashing into disappointment when some killjoy comes up with a mundane explanation that's not humanlike at all.

Gray is looking for a way to get off the roller coaster. In Zola's case, he and his colleagues devised several different variations on the string-pulling test that would never trip up a human, and the crow's smooth performances fell apart. Whatever Zola was doing to solve the puzzle, Gray says, it's not full, humanlike insight.

That may disappoint some people, but not Gray. "Often we learn the most when we see what we can change that makes the apparently impressive performance collapse," he says.

He and a handful of other researchers are studying not only what animals can do, but also what they can't. Forget the animal Einsteins — give Gray the not-so-miraculous beasts that ace one version of a test but flunk another.

After all, seeing an animal succeed at a mental challenge reveals little about how it evolved that capacity. Evolution doesn't proceed by astonishing leaps, but by baby steps. "I'm interested in halfway scenarios, intermediate scenarios," Gray says. These modest capabilities, he argues, offer the richest inspiration for understanding the small steps that build up into the rich diversity of animals' mental powers.

> "We somehow want to prove they are as 'smart' as people."
>
> SARA SHETTLEWORTH

Clever creatures

That's not to say that scientists haven't been looking for signs that animals have humanlike thought processes. Recent decades have seen a flood of reports that animals share some degree of capabilities once assumed to be uniquely human. Recently hatched chicks manage simple addition and subtraction, correctly keeping track of which of two hidden groups of familiar objects is larger. Foraging rock ants look as if they're among the very few animals to show true teaching behavior. Sheep have sophisticated powers of facial recognition and can remember 50 of their fellows for two years. Black bears can learn to sort images into categories, such as bears versus humans. Dolphins can use tools, carrying sponges that protect their sensitive snouts while foraging.

None other than Charles Darwin noted many examples of humanlike cleverness in animals, which he celebrated as support for evolution's tenet of shared deep ancestry, says Sara Shettleworth of the University of Toronto.

The unintended result of Darwin's remarks was such uncritical enthusiasm for anecdotes about clever animals, however, that a backlash struck as early as 1894. That year, British psychologist C. Lloyd Morgan published what's called Morgan's canon, the principle that suggestions of humanlike mental processes behind an animal's behavior should be rejected if a simpler explanation will do.

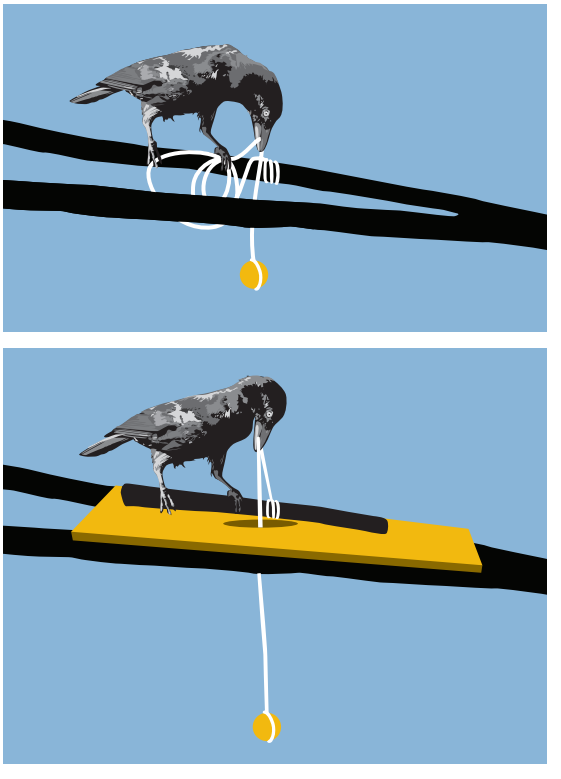
Still, people seem to maintain certain expectations, especially when it comes to birds and mammals. "We somehow want to prove they are as 'smart' as people," Shettleworth says. We want a bird that masters a vexing string to be employing human-style insight.

Aha moments

New Caledonian crows face the high end of these expectations, as possibly the second-best toolmakers on the planet.

Their tools are hooked sticks or strips made from spike-edged leaves, and they use them in the wild to winkle grubs out of crevices. Gray first saw the process on a cold morning in a mountain forest in New Caledonia, an island chain east of Australia. Over the course of days, he and crow researcher Gavin Hunt had gotten wild crows used to finding meat tidbits in holes in a log. Once the birds were checking the log reliably, the researchers placed a spiky tropical pandanus plant

Pull-ups In a classic puzzle for testing problem solving, a treat dangles from a string too long for a bird or other animal to haul up in one go. Some birds solve it the first time, stepping on the string to anchor it after each pull until the treat hangs within reach (top). But if the birds have to pull the string through a slot in a platform (bottom), they fumble.



S. EGTS

beside the log and hid behind a blind.

A crow arrived. It hopped onto the pandanus plant, grabbed the spiked edge of one of the long straplike leaves and began a series of ripping motions. Instead of just tearing away one long strip, the bird ripped and nipped in a sequence to create a slanting stair-step edge on a leaf segment with a narrow point and a wide base. The process took only seconds. Then the bird dipped the narrow end of its leaf strip into a hole in the log, fished up the meat with the leaf-edge spikes, swallowed its prize and flew off.

"That was my 'oh wow' moment," Gray says. After the crow had vanished, he picked up the tool the bird had left behind. "I had a go, and I couldn't do it," he recalls. Fishing the meat out was tricky. It turned out that Gray was moving the leaf shard too forcefully instead of gently stroking the spines against the treat.

The crows' deft physical manipulation was what inspired Gray and Auckland colleague Alex Taylor to test Zola and other wild crows to see if they employed the seemingly insightful string-pulling solutions that some ravens, kea parrots and other brainiac birds are known to employ. Three of four crows passed that test on the first try, so next the researchers set out to test the crows' limits.

Gray and Taylor set up a platform instead of a perch, which limited what the crows could see while pulling the string. The birds could investigate the string and the dangling meat from the sides but had to hop onto the platform and pull the string up through a slot. The supposedly insightful toolmakers had a terrible time. Out of four birds that had never confronted a dangling tidbit, only one hauled in the treat, and that was on the fifth try. Another bird failed at 10 opportunities, pulling at the string 188 times but never stepping on it.

Zola had solved the first test not by insight, but through an enhanced ability to pay attention.

In another test, researchers laid the string on a table in S-curve loops. The birds could see the meat, but they wouldn't see it moving closer until they'd pulled enough times to reach the last segment of string.

An animal with true insight, in theory, would recognize that continuing to pull the string would eventually pull in the meat. But in this setup, the birds "completely fail," Gray says. Some gave the string a tug at first, but only one kept hauling. And that bird was just as happy to pull on a string not connected to meat as on one that was, Gray, Taylor and their colleagues reported in the *Proceedings of the Royal Society B* in a 2012 paper titled "An end to insight?"

After seeing all this, the researchers proposed that Zola and the other crows had solved the first test — the perch with the hanging string — not by insight in the human sense, but through an enhanced ability to pay attention. New Caledonian crows, which do have relatively large brains for their body size, may be able to notice and absorb in detail the consequences of what they're doing. Reaching down to grab the dangling string isn't a big change from normal poking and exploring. And when the meat rises a bit, the birds absorb the positive feedback and take another step-pull.

As mental prowess goes, Gray says, "that's not a miracle, just a small tweak in cognition."

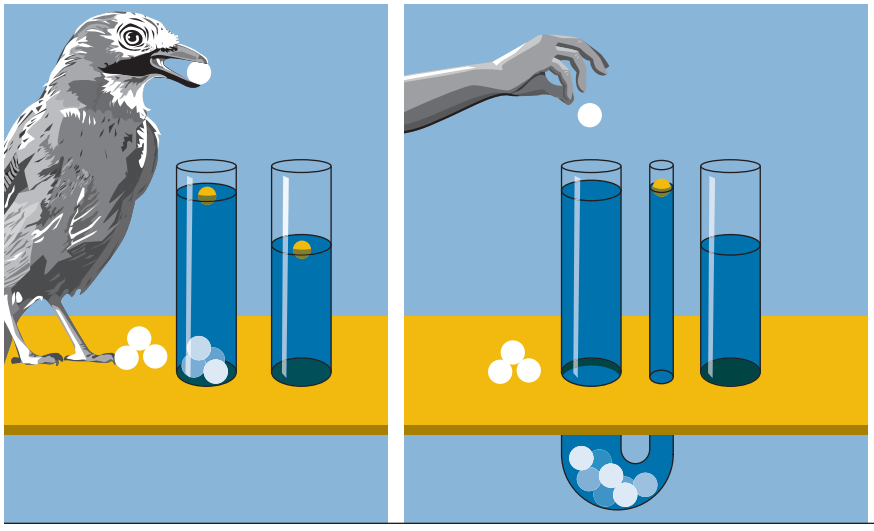
Physics test

Researchers have done a similar kind of tweaking using experiments based on Aesop's fables. In one of the old tales, a thirsty crow finds a jug partly full of water but can't reach down far enough for a drink. So the bird plops stones into the jug until the water level rises.

Nathan Emery and Chris Bird of Queen Mary, University of London taught real-life rooks a version of this trick. The researchers gave birds a tube partly filled with water and a waxworm bobbing on the water's surface. The rooks readily dropped stones into the water until they could grab the treat. (Orangutans in lab tests have solved the problem in their own way, taking mouthfuls of water from their drinking supply and spitting into the tube to raise the water level.)

To see if the behavior extended to a related group of birds, Nicola Clayton and her colleagues tested Eurasian jays. "The birds often walk around the tubes having a good look first," says Clayton, who studies the evolution of animal cognition at the University of Cambridge in England. Soon two of five jays began

Aesop with a twist Like the thirsty crow in Aesop's fable, birds or children in a lab test get a treat from a tube by dropping in stones to raise the water level (left). In a tougher version, the tube with the treat is too narrow for stones but shares a secret connection with one of two larger tubes (right). Human children, but not birds, learned to drop stones in the connected tube.



S. EGTS

to drop stones into the water to score a waxworm. Those two also learned a preference for dropping in pieces of rubber that sink instead of foam chunks that float uselessly on the surface. "This is especially striking because when we tested children, the children don't pass this version of the task until quite late in development," Clayton says. One 5-year-old grasped the value of sinking objects, but overall the successful children averaged more than 8 years of age.

Then researchers devised a counterintuitive set-up, offering three tubes partly filled with water. The treat floated in the middle one, but that tube was too narrow for a stone. The only way a jay or child could score the treat (kids got tokens to exchange for stickers instead of waxworms) was to drop stones into one of the outer tubes that had a hidden connection to the narrow middle tube. Jays just didn't get it, but a substantial number of 8- to 10-year-olds did, although "most of them didn't understand why the setup worked," Clayton says. "They attributed it to magic."

Neither the jays nor the kids managed the trickiest tasks the way an adult human would. But like Gray, Clayton is intrigued by the partial successes. In the last test, she speculates, children may be better able than jays to accept the counterintuitive quirk of the secretly connected tube. "Without a belief in magic," she says, "jays fail to figure it out."

Blurring the boundaries

New studies suggest that a variety of animals may have some version of the fancy mental powers once ascribed only to humans. It's not easy to discern what's going through another species' mind, so these bold claims will need big proof. At the same time, a growing body of research suggests that humans share a number of largely unconscious, so-called irrational processes with other animals. —*Susan Milius*

Honeybees | ABSTRACT CONCEPTS

The miniature brains of honeybees may be able to learn abstract concepts such as "same versus different" or "above versus below." In experiments, researchers teach bees these notions by training them to fly toward a symbol that represents a concept, for example illustrating the idea of "above" with an icon sitting above a line. Researchers show the bees symbols that look different but have the same meaning of "above," and eventually bees tend to make the right choice when they see a new symbol. The insects seem to be learning something beyond mere association of a specific symbol with a reward, and in one recent experiment were even able to learn two abstract concepts, left/right and above/below, simultaneously, Martin Giurfa of Paul Sabatier University in France and colleagues reported in 2012.

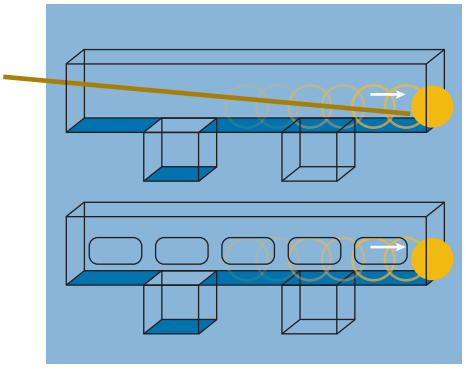
Dolphins | SYNTAX

Language may be one of humankind's most glorious achievements, but decades of experiments suggest that bottle-nosed dolphins can learn sophisticated communication. Louis Herman of the University of Hawaii and his colleagues taught dolphins an invented sign language that requires an understanding of syntax—a way to string together words and phrases to create meaning. The dolphins could distinguish between commands such as "person surfboard fetch" to bring a surfboard to a person and "surfboard person fetch" to tow a person riding a surfboard. Now, Vincent Janik of the University of St. Andrews in Scotland has used microphones to eavesdrop on dolphin talk in the wild. Individual dolphins develop distinctive whistles that they use when meeting at sea, he and a colleague reported in 2012.

Primates | FUZZY MATH

Chimps are natural accountants, says Michael Beran of Georgia State University in Atlanta. They can roughly track how a group of objects changes as objects are added and subtracted, like in a bank account. And in a new test, Elizabeth Brannon of Duke University and her colleagues found that rhesus monkeys and college students do about equally well on a test of adding without being allowed to explicitly count objects. When she and a colleague gave both kinds of primates mere glimpses of two sets of dots—not visible long enough for the humans to actually count them—both did pretty well at selecting a picture that represented the sum of glimpsed sets. This shared ability to do approximate arithmetic in a flash probably reflects the evolution of cognitive abilities in the animal family tree, Brannon says.

FROM LEFT: TOBIKATRINA/ISTOCKPHOTO; ZZOOM/ISTOCKPHOTO; GLOBALP/ISTOCKPHOTO



Mind the gap In puzzle containers with open ends, an animal scores a tempting treat by pushing the food (shown as a ball) away from the center in the correct direction: toward the side where the trap in the bottom is covered instead of open. Chimps flub this using a stick (top), but succeed if they can poke their fingers through holes (bottom).

Reading minds

Besides studying how birds solve physical problems, Clayton has tested the notion that a bird can imagine, in some sense, what's going on in another animal's head. People have this ability, called theory of mind, but proposing, as Clayton does, that the Western scrub-jay can infer what another bird is thinking is a striking conclusion.

Scrub-jays cache food, and possess prodigious powers for remembering where. They also steal from each others' caches, with higher-ranking birds tending to steal from lower-ranked birds. Clayton has found that if a bird with a larcenous past knows it's being watched as it stashes a tidbit, it's likely to later shift the cache to an unobserved location. This suggests that the birds have something like a theory of mind, Clayton says, because they understand that the bird watching them may come steal their stores. Yet nonthieves aren't as likely to recache the food. So jays that steal may project their own behavior onto other birds that are watching them.

Elske van der Vaart of the University of Amsterdam has been looking for a simpler explanation. Maybe the birds are not relying on something even close to a human's theory of mind, she and her colleagues suggested in *PLOS ONE* in 2012. Maybe all the hiding and rehiding is just a side-effect of something as simple as stress. Being watched is stressful, the researchers say, as is failing to find a cache. In experiments with virtual birds in a computer simulation, flustered individuals that were being watched and following a simple rule (they cached as far away as possible from observers) hid and rehid their hoard much as real scrub-jays do.

But real birds don't behave like simulated birds, Clayton and Cambridge colleague James Thom reported in January in *PLOS ONE*. Given a chance to hide peanuts in ice cube trays, birds cached about the same number of treats in both more and less stressful conditions. "Sometimes the simplest explanation is not the best," Clayton says.

So the debate about theory of mind continues. Van der Vaart says the supposedly serene ice cube–tray situations might have held hidden stresses that confounded the results. And other predictions from computer simulations still need testing. "I certainly do think it's possible that [crows and related species] could have something like a theory of mind, and it would be very exciting if they did," she says. "But right now, I don't think we know enough to be able to say one way or the other."

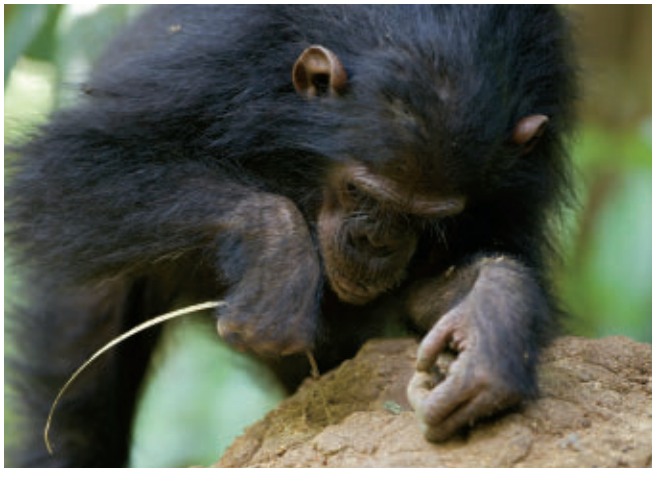
Flub factor

Research on elephant insight and chimps' understanding of the physical world has approached the question of limits from the other direction, with scientists tweaking tests that animals normally flub to discover what specific factors let them improve.

Chimps may not understand how the physical world works well enough to attribute phenomena to underlying causes such as gravity, solidity and other such qualities — or at least that's been a long-standing proposal. Amanda Seed of the University of St. Andrews in Scotland isn't so sure. "The difference between human and ape folk physics may not be as clear-cut as that," she says.

In a classic lab test, chimps seem not to grasp basic cause and effect. To coax a treat out of a device called a trap tube,

Tool use has long been touted as one of the powers that makes people special — incorrectly, it now seems. Chimps (left, fishing for termites), New Caledonian crows (right, with tool shaped from a pandanus leaf) and other animals use tools, too.



CLOCKWISE FROM TOP LEFT: S. EGTS; MICK SIBLEY/UNIV. OF AUCKLAND; INGO ARNDT/GETTY IMAGES

an animal has to use a stick to poke the treat to one end. If nudged in the wrong direction, the food tumbles irretrievably into a hole. "Chimps appeared not very good at telling that their food would fall into a trap," Seed says.

In one of Seed's first chimp experiments, she redesigned the trap so the chimps could poke with their fingers instead of a stick. In a video of the new experiment, a chimp stands in front of a clear plastic box and without much ado, pokes a finger through a series of little holes, working a tidbit along in the correct direction and safely out of the box.

The problem may have been the same one faced by floundering human pool players who spend too much time watching the cue instead of the ball. Chimps may not have a different conception of surfaces and holes than people do, but rather a different capacity to focus attention or remember. Without the tool to distract them, they may absorb more of what poking around in the tube is actually doing.

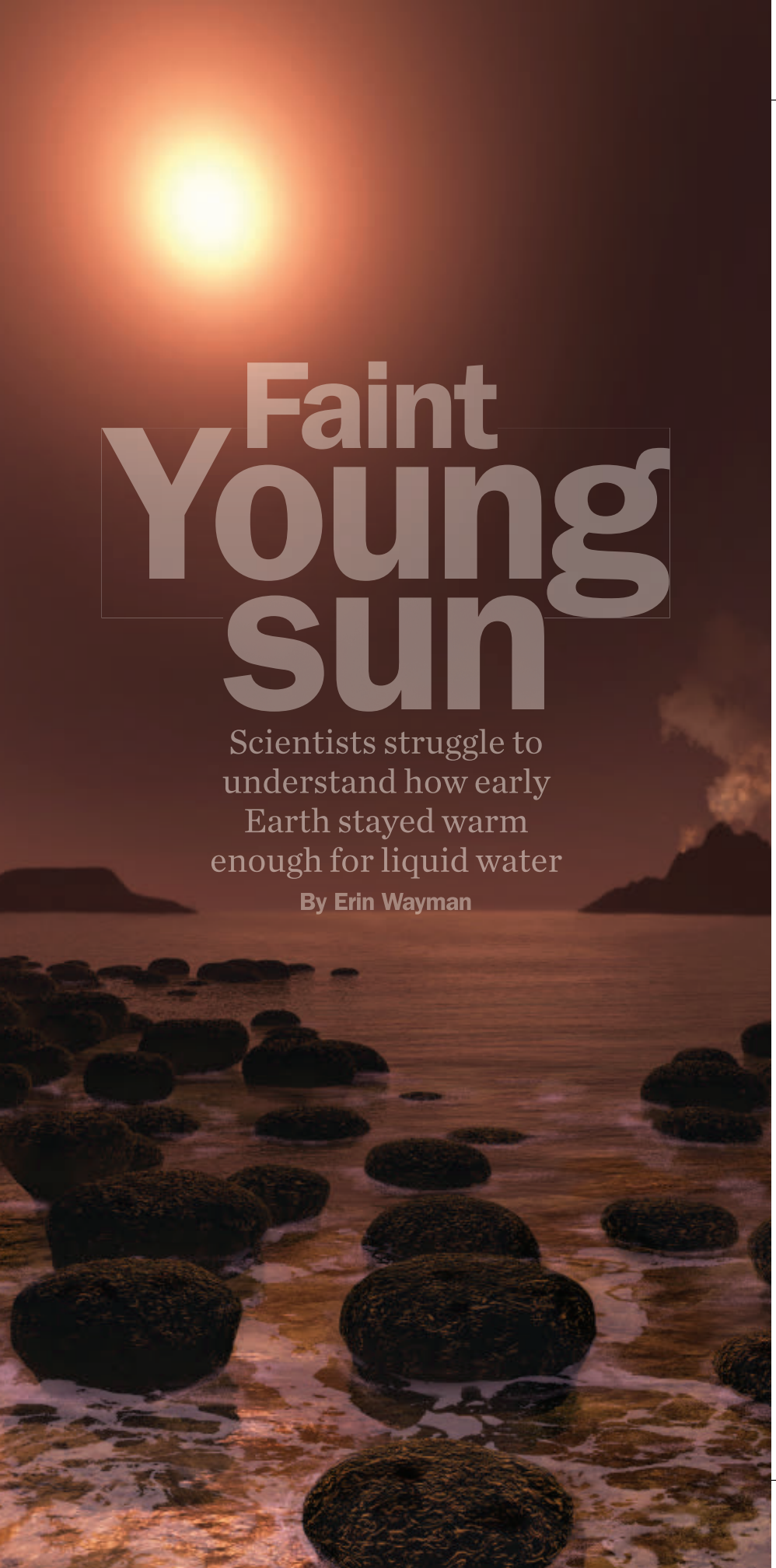
Revealing such hidden animal talents requires devising the right kind of test, which often takes a bit of ingenuity. Preston Foerder of the University of Tennessee at Chattanooga was testing for insight in elephants, for instance, by putting food out of reach and providing a stick as a tool for getting it. Working with three elephants at the Smithsonian National Zoological Park in Washington, D.C., Foerder found that they readily picked up a stick. But instead of pointing it at hard-to-reach food, they banged the walls, scratched themselves and threw it around. "This was about three months of research off and on, and I was commuting from New York City to do it," he says. "Then I had my own insight."

Foerder moved the food and sticks outdoors and provided a cube or tub that could be moved over to the food if an elephant wanted to stand on it. In its seventh session of straining toward the food, 7-year-old elephant Kandula moved the cube into position as a stepstool and snagged some fruit (*SN Online: 8/24/11*). "Elephants are more olfactory than visual," Foerder says, and sniff with their trunks. When holding a stick, their trunks face the wrong direction for detecting what the stick is poking, and the trunk openings may even be closed. The experience points out that people may have to step outside their primate biases to get an idea of what another animal can do, Foerder says.

In the end, experiments that test animals' cognition by determining when they succeed and when they fail may reveal more about human minds than other species'. Whether humankind truly wants to find all it looks for isn't so clear. *Homo sapiens* is hardly modest about its brainpower, perhaps wanting to discover a bit of mental kinship while remaining mental kings. ■

Explore more

- Sara J. Shettleworth. "Clever animals and killjoy explanations in comparative psychology." *Trends in Cognitive Sciences.* November 2010.



Faint Young sun

Scientists struggle to understand how early Earth stayed warm enough for liquid water

By Erin Wayman

Here's a climate puzzle — one that goes back to Earth's infancy some 4.5 billion to 2.5 billion years ago. The sun was much dimmer back then. Far less solar radiation reached the planet. Earth should have been a frozen wasteland. But all geologic signs point to a young planet awash in liquid water, with the first life-forms emerging. Scientists call this conundrum the "faint young sun paradox."

Carl Sagan and George Mullen identified the paradox in 1972. By then, researchers had determined that a newborn star's brightness gradually increases over time as hydrogen atoms in the star's core fuse into helium. Working backward, researchers estimated that the sun generated 20 to 30 percent less energy during the first half of Earth's history than it does now.

Evidence of the paradox comes from clues in the rock record that indicate the presence of flowing water as far back as the Archean eon, 3.8 billion to 2.5 billion years ago. Geologists have found ancient pillow lavas — knobby volcanic rocks that form only when lava erupts under water — and ripple marks etched by waves on sedimentary rocks. No such rocks are known from the earlier Hadean eon *(SN: 5/29/12, p. 22)* 4.5 billion to 3.8 billion years ago, but the chemistry of Hadean-aged zircon minerals recycled into younger rocks suggests that liquid water must have been present by at least 4.2 billion years ago.

By this time, much of the heat from Earth's formation would have dissipated, so it couldn't account for the warm temperatures. The only explanation is that some unknown factor helped warm the planet. The dilemma seems impossible to resolve because data on fundamental climate factors are missing for this primordial period, says planetary scientist Robin Wordsworth of the University of Chicago. "The Earth has such an active system that the evidence gets erased quickly."

Billions of years ago, a dimmer sun shone down on a young Earth. But instead of a frozen planet, evidence reveals a watery past with signs of life.

NICOLLE RAGER FULLER

There has been no dearth of theories, however. Over the last 40 years, climate scientists have offered a range of explanations — everything from high concentrations of insulating greenhouse gases in the atmosphere to changes in Earth's proximity to the sun. Some ideas are more plausible than others, but even the most probable hypotheses present roadblocks for scientists.

Still, as researchers continue to mine the ground for more geologic clues and refine their simulations of early Earth's climate, they inch closer to answers. "I'm rather confident that we can have a much clearer picture of what can solve the faint young sun problem in the next few years," says Georg Feulner, a paleoclimate scientist at Germany's Potsdam Institute for Climate Impact Research.

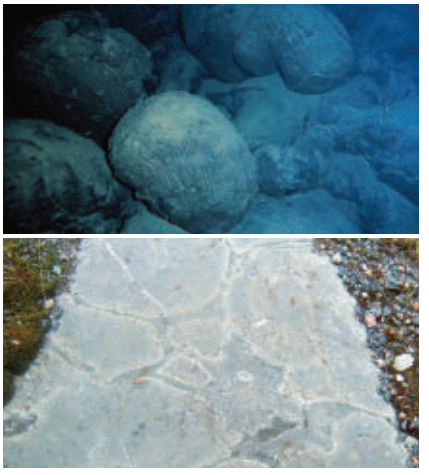
That solution, and scientists' efforts to reach it, may shed light not just on early Earth but on the potential habitability of distant extrasolar planets.

A super greenhouse

Climate scientists acknowledge that the faint young sun paradox probably doesn't have one simple solution. The Hadean and Archean stretch over 2 billion years. Multiple factors probably worked together to make Earth mild over that time, Feulner says.

Given the Hadean's sparse geologic record, climate scientists tend to focus on ways to explain the paradox during the better understood Archean. The work is complicated by the fact that researchers don't really know what global temperatures were like back then, only that they were warm enough for oceans of water to exist. "That's the most frustrating thing," says James Kasting, a planetary scientist at Penn State University in University Park.

With those limitations, the goal is to develop a scenario in which Earth's average global temperature was at least above water's freezing point — or else one with temperatures closer to today's. Many climate scientists agree that some sort of enhanced greenhouse effect probably contributed to heating the planet. Greenhouse gases such as carbon dioxide allow sunlight to pass through the atmosphere and then trap heat bouncing back from the planet's surface. If concentrations were high enough, greenhouse gases could have kept Earth temperate. The thorny part is figuring out which greenhouse gases were interacting.



Pillow lavas (top) form when volcanoes erupt underwater, so finding eroded pillow lavas (bottom) is a sign liquid water was present on ancient Earth.

Back in 1972, Sagan and Mullen thought ammonia was key. An abundance of ammonia seemed feasible based on now-outdated thinking about the chemical makeup of early Earth's atmosphere and the gas's supposed role in forming molecular precursors to life as lightning struck it. Although ammonia could have had a strong warming effect, other researchers in the 1970s and '80s recognized a fundamental flaw in that hypothesis: The sun's ultraviolet radiation would have broken down ammonia, reducing levels below those needed to insulate Earth's atmosphere within a decade. For the ammonia idea to work, volcanoes would have had to continuously burp up hefty supplies of the gas, which is unlikely.

What's more likely, some scientists argue now, is that early Earth had a large, stable supply of CO_2 through a balance between volcanic eruptions and weathering. (Weathering removes the gas from the atmosphere through chemical reactions, and the carbon eventually gets stored in seafloor sediments.) But that's a lot of CO_2. Kasting and others have calculated that Earth would have needed as much as 1,000 times preindustrial levels of atmospheric CO_2 to compensate for low solar output during the early Archean. By the end of the Archean, as solar radiation grew, only up to 300 times preindustrial CO_2 would have been needed.

But as with the ammonia hypothesis, there are hitches. Geochemical clues indicate CO_2 levels probably weren't high enough during the Archean. Most recently, geologist Nathan Sheldon of the University of Michigan in Ann Arbor and colleagues analyzed fossilized soil from Minnesota dating to 2.69 billion years ago. By comparing the chemical makeup of the ancient soil with that of the bedrock below, the researchers estimated how much weathering had occurred in the soil and thereby inferred how much CO_2 must have been in the atmosphere at the time. The most likely answer is about 40 times preindustrial CO_2 levels, Sheldon and colleagues reported in 2011 in *Precambrian Research*. "That's not enough to overcome the faint young sun on its own," Sheldon says.

Sheldon and Kasting agree that CO_2 probably had a little help from methane. Methane is a potent greenhouse gas — about 20 times as efficient as CO_2 in trapping heat. In an atmosphere with little oxygen to break down methane — as was the case during the Archean — it lasts thousands of years. So a little goes a long way.

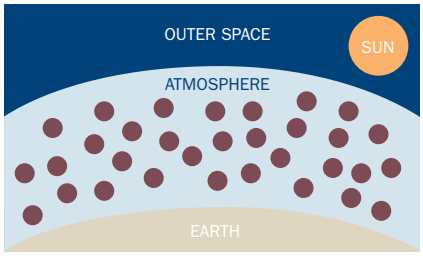
Kasting calculates that the atmosphere needed 1,000 parts per million by volume of methane — combined with as much as 100 times preindustrial levels of CO_2 — to achieve temperatures during the middle Archean that would be equivalent to today's, he reported in 2008 in *Astrobiology*. High levels of CO_2 would have been necessary to prevent the methane from forming a thick haze that would have blocked sunlight and chilled the planet.

Today's methane concentration is in the parts per billion range because of interactions with oxygen. It's hard to verify whether more methane was present 2.7 billion years ago. "We have OK ways

FROM TOP: OAR/NATIONAL UNDERSEA RESEARCH PROGRAM; BLACK TUSK/WIKIMEDIA COMMONS

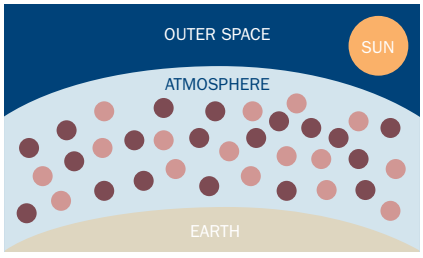
Balancing a weak sun Climate scientists have created various scenarios of the composition of infant Earth's atmosphere to figure out which atmospheric gases, and at what levels, may have been present to keep the planet warm under a faint young sun.

Atmospheric gases
CO_2 N_2
CH_4 H_2–N_2



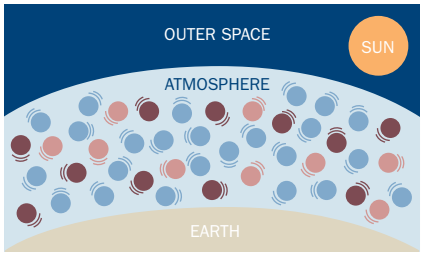
More carbon dioxide
Higher concentrations of CO_2 could have created a greenhouse effect stronger than today's.

Drawbacks:
Earth would have needed as much as 1,000 times preindustrial levels of atmospheric CO_2 to keep the planet warm under conditions of low solar output. Researchers estimate, however, that levels were only about 40 times preindustrial levels, not enough for CO_2 by itself to compensate for the fainter sun.



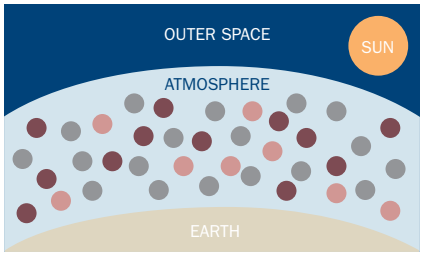
More carbon dioxide and methane
Higher concentrations of both CO_2 and methane (CH_4), an even more potent heat-trapper, could have created a greenhouse effect stronger than today's.

Drawbacks:
Methane can't explain the earliest warmth since the gas wouldn't have been abundant before methane-making microbes emerged. If methane concentrations got too high, a thick haze would have reflected sunlight and cooled the planet.



More nitrogen
Higher concentrations of nitrogen (N_2) could have led to more collisions among greenhouse gas molecules in ways that allowed them to absorb more heat.

Drawbacks:
Geologic evidence suggests atmospheric pressure was probably not high enough to accommodate nitrogen levels much greater than today's. Too much nitrogen could have scattered incoming sunlight and cooled the planet.



More nitrogen and more hydrogen
Higher concentrations of nitrogen and hydrogen could have allowed for the formation of hydrogen-nitrogen molecules (H_2–N_2) that act as greenhouse gases.

Drawbacks:
There's no geochemical evidence that early Earth had an abundance of hydrogen. Any hydrogen in the atmosphere would have been consumed by methane-making microbes once they evolved in the early Archean.

to get at CO_2," Sheldon says, "but there's no clear proxy for how much methane was around." However, the microbes that generate most of today's methane had probably evolved by this time. In the absence of oxygen, if these organisms churned out as much methane as they do today, Kasting says, that would have led to 1,000 times today's methane levels — enough to help offset the dimmer sun. There is one indication that a lot of methane was present: glaciations at the end of the Archean. The rise of oxygen at the end of the eon would have removed significant amounts of methane from the atmosphere, a plausible explanation for why temperatures plummeted.

Greenhouse gas helpers

Some scientists think there must be more to the solution than just CO_2 and methane. In the last few years, these researchers have been looking at other gases that could have contributed to warming. That's where nitrogen and hydrogen come in.

Nitrogen is the most abundant gas in today's atmosphere, accounting for more than three-fourths of the gas in air. Although it's not a greenhouse gas, at higher levels than today's, nitrogen would have enhanced the effects of greenhouse gases, says Colin Goldblatt, an earth scientist at the University of Victoria in Canada. With extra nitrogen, liquid water could have existed with lower levels of greenhouse gases, he says. That could help overcome some of the hurdles set by the geochemical evidence.

Adding more nitrogen to the atmosphere would have enhanced the greenhouse effect by causing more collisions between gas molecules. Ramming into a greenhouse gas molecule changes the way it wobbles, which controls how it absorbs radiation. With enough bumping, Goldblatt says, a molecule of greenhouse gas will start trapping radiation over a greater range of wavelengths. The general result: greenhouse gases that can suck up more heat overall.

"What nitrogen will do is give you more bang for your buck out of any greenhouse gases you've got," Goldblatt says. At about 2.5 billion years ago, with an amount of CO_2 estimated from the geologic record along with some extra methane, a doubling of nitrogen relative to today would be enough to resolve the faint young sun paradox, Goldblatt and colleagues suggested in 2009 in *Nature Geoscience*. (But if the atmosphere built up too much nitrogen, he notes, the gas would have scattered incoming sunlight, ultimately cooling the planet.)

Hydrogen might have helped as well. If nitrogen and hydrogen levels were both higher in the past, collisions between the two would have created a lot of hydrogen-nitrogen molecules that would have stuck together for a little while, Wordsworth says. The way these molecules wobble makes them effective greenhouse gases, even though hydrogen and nitrogen on their own are not. And the molecules would have absorbed wavelengths of radiation not usually taken up by CO_2 or methane, Wordsworth and Raymond Pierrehumbert, also of the University of Chicago, reported in January in *Science*. Depending on the exact quantities of each gas, hydrogen-nitrogen pairings might have contributed several degrees Celsius of warming.

E. FELICIANO

As with CO_2 and methane, however, it's hard to assess how much nitrogen and hydrogen were actually in the atmosphere in the Archean. Goldblatt says the supply of nitrogen now stored in Earth's crust and mantle is big enough that it's possible the gas could have been twice as abundant in the past atmosphere as it is today. Hydrogen, meanwhile, might have been more of a player in the Hadean, before the arrival of methane-making microbes, Kasting says. Once these organisms evolved sometime near the onset of the Archean, they would have gobbled up most of the atmosphere's hydrogen to make methane.

To really assess all of the various explanations, some sort of paleobarometer is needed, Goldblatt says. If scientists had a record of the Archean's total atmospheric pressure, they could figure out whether adding vast amounts of gas to the models — which would increase pressure — is a viable way to solve the faint young sun paradox.

Last year, researchers came up with a way to estimate pressure: fossil raindrops. Sanjoy Som, now at the NASA Ames Research Center in Moffett Field, Calif., and colleagues studied imprints left by raindrops on volcanic ash 2.7 billion years ago to estimate atmospheric pressure. The two are related through a long chain of inferences.

The shape of raindrop splatter depends in part on how fast the rain fell through the air. How fast rain falls, in turn, depends on air density, which exerts drag on the drops.

After analyzing how raindrops leave imprints in lab experiments, Som's team concluded in 2012 in *Nature* that atmospheric density in the late Archean was probably no more than double today's.

Since atmospheric density is proportional to air pressure, the assessment, if correct, puts an upper limit on how much gas climate scientists can add to models of the later Archean's atmosphere. That might not be much of a barrier to hypotheses that rely on increasing concentrations of CO_2 or methane, which are currently at very small concentrations, Wordsworth says. But it's more problematic for explanations that assume nitrogen was more abundant in the past.

With just one snapshot of what Archean atmospheric density might have been like, he says, "it's still too early to definitively say how the atmospheric density changed that long ago."

Fossilized imprints of raindrops help determine the density of Earth's atmosphere during the Archean.

S.M. SOM ET AL/NATURE 2012

Climate in 3-D

Potential solutions to the faint young sun paradox have been investigated almost exclusively with one-dimensional climate simulations. The next step is to look at more complex, three-dimensional simulations to really understand what early Earth's climate was like.

A one-dimensional simulation slices the atmosphere horizontally to see how sunlight travels down through its layers and how radiation reflected from Earth bounces back up. They're useful in assessing the strength of a greenhouse effect, Wordsworth says. But "you're getting a very, very idealized picture of what the climate would actually be like."

Three-dimensional simulations add in how heat travels across Earth's surface. They also take into account other factors, such as wind and clouds. "It gets pretty messy to do this problem right in 3-D," Kasting says.

In December, Feulner and colleagues published the results of the first comprehensive three-dimensional simulation of Archean climate in *Geophysical Research Letters*. Feulner says researchers have been wary of 3-D simulations because so many factors are unknown. Some of the unknowns don't really affect the results too much, but, Feulner says, two factors that aren't accounted for in one-dimensional simulations make a big difference: Earth's rotation and the presence of sea ice.

Because the moon was closer to Earth in the Archean, Earth probably rotated faster, with days that were perhaps only 15 hours long. Faster rotation changes how the air and oceans transport heat from the tropics to the poles. Sea ice influences warming because it reflects more sunlight back into space than land or liquid water, cooling the planet.

By accounting for these factors, the simulation's results indicate early Earth might have needed seven times as much CO_2 to stay warm than simpler simulations have predicted, which is difficult to reconcile with current geochemical evidence. That's just one result from one study, though. As others begin working with 3-D simulations, Feulner hopes researchers will get a better sense of how these studies change scientists' understanding of the faint young sun paradox.

Expanding habitability

By thinking up new ways Earth could have stayed warm during the sun's dim days, climate scientists have also inadvertently expanded the definition of what makes a planet habitable.

The search for life-sustaining planets outside the solar system is guided by the existence of a theoretical habitable zone, the area around a star where liquid water could exist. "You might be able to extend the outer edge of the habitable zone farther," Goldblatt says, if some planets have vast quantities of nitrogen or hydrogen in their atmospheres, making greenhouse effects stronger than expected. Even free-floating planets that don't appear to orbit any star could possess liquid water if their chemistries were just right, Wordsworth adds.

Right now, this is all conjecture. Planet hunters will need to do some detailed calculations to see whether the solutions to the faint young sun paradox also help solve the mystery of whether life exists somewhere else in the universe. ■

Explore more

- G. Feulner. "The faint young sun problem." *Reviews of Geophysics*. June 2012.

My Beloved Brontosaurus

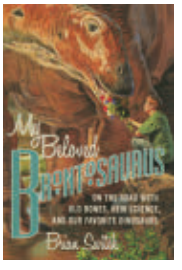
Brian Switek

Poor *Brontosaurus*. First named in 1879 when a paleontologist mistook an *Apatosaurus* skeleton for a new type of long-necked sauropod, *Brontosaurus* may be the most well-known dinosaur that never existed. Though the error was corrected in scientific circles as early as 1903, the iconic behemoth lingered in museums, movies and the public imagination for decades.

Despite their pop-culture status, dinosaur species aren't set in stone, says Switek, a science writer with his own fond memories of *Brontosaurus*. Their identities are constantly being updated and revised as modern technology and new discoveries change the way paleontologists see them. With that in mind, Switek's book is a lifeline for the dinosaur enthusiast — an entertaining guide to the latest science of dinosaurs.

Switek hits the road to visit dig sites and interview paleontologists. His travels produce in-depth discussions of current research on dinosaur biology, from how dinos grew up to what they sounded like to what diseases they may have carried. He even speculates on long-standing mysteries surrounding dinosaur sex, a tricky proposition for animals with large tails to work around.

Switek also presents overwhelming evidence that many — maybe all — dinosaurs sported fluffy coats of protofeather fuzz. "I can almost hear the scaly-tyrannosaur fans weeping," he writes.



Switek doesn't mourn the loss of *Brontosaurus*. The dopey, lumbering dinosaurs of the past, he says, are just a reminder that what scientists know about these much-loved beasts is always evolving.

—Allison Bohac

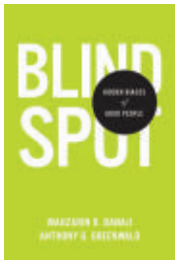
Scientific American/Farrar, Straus and Giroux, 2013, 256 p., $26

Blindspot

Mahzarin Banaji and Anthony Greenwald

In the 1970s, most classical musicians were men. Nobody thought much of it until some orchestras started concealing applicants' gender. As such blind auditions became more common over the next 20 years, the proportion of women hired into major symphony orchestras doubled from 20 percent to 40 percent.

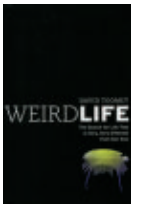
Banaji and Greenwald have made careers of ferreting out bias, cautioning that the mind doesn't operate in a vacuum but rather proceeds from a starting point. Borrowing on their own and others' research, the authors tackle group stereotyping. In one study, test-takers selected a hypothetical person to be on their quiz competition team. The participants naturally accounted for education level, IQ and so on. But the researchers had craftily inserted information on people's weight. Sure enough, the authors note, the test-takers "traded nine honest-to-goodness IQ points for a partner who was thinner than the smarter alternative."



Such hidden tilt is pervasive, and the authors argue that it is detectable with testing. But while psychologists generally agree that implicit bias is widespread, there is less unanimity regarding whether tests can spot it (*SN: 4/22/06, p. 250*). While many of the experiments in this book are fascinating, the main test designed to expose hidden preferences is unconvincing.

The authors explore a host of implicit biases that people carry around like so much loose change. While it's not clear whether *Blindspot* will awaken readers to their own shortcomings, the book is good at exposing the white lies and cognitive dissonance used to get around them. *—Nathan Seppa*

Delacorte Press, 2013, 254 p., $27



Weird Life

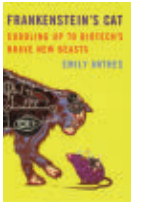
David Toomey

Organisms in extreme environments — from bacteria deep under the ocean floor to imagined creatures on distant moons — challenge definitions of life. *W.W. Norton & Co., 2013, 268 p., $25.95*

Heart of Darkness

Jeremiah P. Ostriker and Simon Mitton

An astrophysicist and a science historian describe the search for the universe's unseen dark matter and dark energy. *Princeton Univ., 2013, 299 p., $27.95*



Frankenstein's Cat

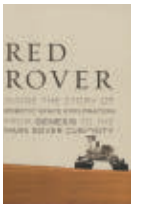
Emily Anthes

This exploration of genetic engineering's promise envisions a world in which pets are cloned and endangered species can be saved. *Scientific American/Farrar, Straus and Giroux, 2013, 241 p., $26*

Ginkgo

Peter Crane

An ancient tree lineage has survived and made its way into humans' lives through medicine, art and as a popular street tree, yet is now endangered in the wild. *Yale Univ., 2013, 384 p., $40*



Red Rover

Roger Wiens

The scientist in charge of Curiosity's ChemCam instrument gives a behind-the-scenes tour of the Mars robot. *Basic Books, 2013, 233 p., $25.99*

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Faux pas on fashion

In "Students honored for research," (*SN: 4/6/13, p. 28*), the female winner got singled out as "decked out in a lavender satin dress." Didn't Hillary Clinton recently point out to an interviewer that he asked her about her clothes, whereas he wouldn't ask a man that? What are you trying to convey?

Irena Swanson, Portland, Ore.

While editing this story, we did ask ourselves whether we might mention the first-place winner's tuxedo were he a young man. Our answer, and the reason we kept the phrase in the story, was yes. The writer was trying to use detail to convey the formality of the event and the sense that these young scientists were being feted. It's unfortunate that it seemed that the winner's gender was being emphasized over her cerebral achievements. As we move forward, we will be sure to think more carefully about our portrayal of women in science. —Eva Emerson

Mouselike men

It's interesting to read in "It matters whether you're a man or a mouse" (*SN: 3/23/13, p. 10*) about how mice can be cured of cancer, sepsis and other conditions, yet the same cures do not work in humans. I support the effort to make a mouse that is more like a human for research purposes. But aren't we missing the biggest potential gain here? We should be trying to discover how humans can be more like mice. Of all the scientists mentioned in the story, only Derry Roopenian of the Jackson Laboratory appears to be thinking this way.

Tom DuBois, Keene, N.Y.

Slow-motion warning

Regarding "Quakes in slo-mo" (*SN: 3/23/13, p. 26*): Since mechanisms triggering earthquakes are mathematically chaotic, we are unlikely to be able to predict them anytime soon, if ever. But it's clear that hot, deep creep can only put more strain on the colder, locked rocks above. Thus creep is a better-than-average warning for The Big One. These slo-mo quakes should therefore be used to save lives through preparedness. When a deep creep starts, local officials along the Cascadia subduction zone (and others like it) should get on TV and the Internet and educate the public about what's going on, order earthquake preparedness drills, and in general remind the public to prepare and think about what to do in the event of an earthquake.

Jeff Barry, Acton, Mass.

Clarification

The article "Ignition failed" (*SN: 4/20/13, p. 26*) neglected to mention Mike Dunne's title. He is the National Ignition Facility's director for laser fusion energy.

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

For more of The Science Life, visit People at **www.sciencenews.org/people**

High school students in Panama learned engineering skills and helped install a water purification and storage system at their school.

Spreading a scientific way of life

Give a man a fish and he'll have a seafood supper. Teach a man engineering principles and he could start an aquafarm, devise a better net or fishing pole or maybe even come up with an entirely new way to combat chronic fishlessness.

That's the premise behind a nonprofit organization called Future Scientist that teaches people to use basic science and engineering to solve problems — and then encourages them to teach others to do the same.

The group is the brainchild of biological engineers Gautham Venugopalan (near left) of the University of California, Berkeley and Richard Novak (far left) of UC Berkeley and UC San Francisco. "Science is not just for scientists," Venugopalan says.

Among its projects, Future Scientist has staged an expedition to Haiti to help set up solar panels and is leading an ongoing effort to clean up water supplies in Portobelo, Panama. Anyone can get involved: Volunteers who cover their own trip expenses can contribute their skills to projects and learn to work with communities abroad.

While traveling in Peru, Venugopalan and Novak met villagers who had been given a generator. When the generator broke, no one knew how to fix it, and the gasoline was too expensive anyway. So now, unlike many aid groups, Future Scientist tries to work with the resources and expertise already in a community.

In Portobelo, the team asked residents of the Caribbean coastal community what problems plague their town. Doctors said they see many patients with waterborne illnesses. Community leaders showed the scientists a drinking water tank in which silt collected after heavy rains, turning the water as dark as coffee.

Last year, Venugopalan, Novak and five UC Berkeley students helped design a dam to control storm runoff. Then in January, another Future Scientist team returned to Portobelo and worked with local high school students to build a filtration system that removes bacteria from their school's drinking water. Not all of the group's ideas work out. "There's lots of error," Venugopalan says. But, as it is in science, that's all right, he says; what's important is trying and learning. — *Tina Hesman Saey*

Future Scientist members worked with a student group from Tufts University to train people in Balan, Haiti, to use and maintain solar panels. Balan's school now has electricity to power computers and, for the first time, public lighting in the town of 20,000 people.

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