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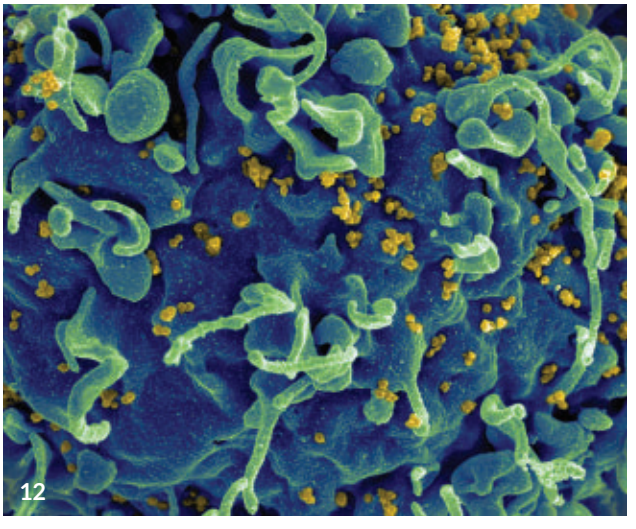
Feature

News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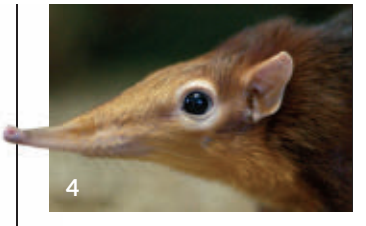
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Departments

COVER A brown tawny owl hunts in a grassland. In one region with declining snow cover, the brown variety has become more common than its gray brethren. *Mike Dowsett, www.wildlife-gallery.com*

Adapting to climate change: Let us consider the ways

In late June, the U.S. Government Accountability Office released an assessment of how the consequences of climate change, from rising temperatures and sea levels to changes in precipitation patterns and sea ice cover, might impact the military. The report recommends that the Pentagon develop a better plan to respond to and mitigate such impacts.

The title of the report, "Climate Change Adaptation," sounded familiar. That's because it was very similar to the working title of this issue's cover story. And although our article deals with the feathered and flowered worlds of plants, animals and other creatures — and not military infrastructure — biologists are similarly concerned with how natural populations might respond to the consequences of climate change. "Quick-change artists" on Page 22 tells an important story about some of the ways that vulnerable organisms might adapt to a changing world.

As freelance writer and *Science News* "Wild Things" blogger Sarah Zielinski reports, many organisms do have tools to deal with sudden environmental changes. Migration, of course, is an option for species that can move and find suitable habitats. Genetic variability may enable others to evolve quickly enough to survive in their existing ranges. And flexible behaviors could also help some organisms adapt to shifting climes. Still, there will be those that are unable to cope. And others might survive only with interventions from people. Although there are still many questions left to answer about the extent organisms can adapt to climate change, the scale of the issue suggests it's a crucial area to investigate.

The politicized nature of climate change means that Congress will probably fight over the GAO recommendations. Some members don't want money spent on anything to do with climate change — even planning options. But it's good to remember that plants and animals can't engage in any debate. Many species are already on the brink (see Page 32 for the latest maps of vulnerable birds). The survival of many more may soon be on the line as well. To them, adapting would probably sound like a wise option.

— Eva Emerson, Editor in Chief

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NEW

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Excerpt from the July 18, 1964, issue of *Science News Letter*

50 YEARS AGO

Study Injuries Produced By Auto Windshields

Investigators will try to measure the potential hazards of brain concussions and lacerations when windshields or side windows are shattered during collisions, the causes of spontaneous glass breakage, and escape methods for trapped drivers and passengers.... Because little scientific information is available on the comparative strength, breakage and other characteristics of ... safety glass, the team [is developing research] techniques and devices.... More complex ... will be the development of life-like scalps, faces, necks and eyes for instrumented dummies.

UPDATE: After years of skyrocketing death rates from automobile accidents, the U.S. National Traffic and Motor Vehicle Safety Act was enacted in 1966. Federal safety standards required seat belts and shatter-resistant windshields. Research also showed that adhesives to keep car windows from popping out during collisions would save lives. Deaths per 100 million miles traveled dropped from around five in 1964 to 1.1 in 2011.

IT'S ALIVE

Elephant shrews actually related to elephants

Elephant shrews — including so-called "giant" species the size of a squirrel — are more closely related to elephants than to shrews. As for their basic lifestyle, elephant shrews may be more like really mixed-up antelopes.

"Take an antelope and an anteater and slap them together," says Galen Rathbun of the California Academy of Sciences in San Francisco.

Elephant shrews, or sengis, are native to Africa and, like antelopes on the

INTRODUCING

Antarctica's new tardigrade

A new species of one of the toughest creatures on Earth has been found on the Antarctic coast. *Mopsechiniscus franciscae* is a tardigrade, or water bear. These microscopic animals can survive nearly any condition, including a vacuum, because of their ability to enter a deep resting state when water is not available. The new species was collected among moss growing on gravel during a 2011 survey of tardigrades along the coast of Victoria Land, which borders the Ross Sea. The reddish creatures are tiny: Males are about a quarter of a millimeter long, and females are about 50 percent bigger than that. They sport four pairs of legs and red-brown eyespots that look like itty-bitty grains of rice. Because water bears have been in Antarctica since it was part of the ancient supercontinent Gondwana, researchers hope to use the tiny beast to better understand how animals reached the far southern continent, says Roberto Guidetti of the University of Modena and Reggio Emilia in Italy. He and his colleagues published their findings in the May *Polar Biology*. — *Sarah Zielinski*

A new species of tardigrade, *Mopsechiniscus franciscae*, found in Antarctic moss has eight legs and is less than half a millimeter long.

FROM TOP: JOSH MORE/FLICKR (CC BY-NC-ND 2.0); R. GUIDETTI

Elephant shrew noses, as on this *Rhynchocyon petersi*, aren't true trunks but wiggle well.

savanna, "run like the wind," Rathbun says. Mated pairs often clear long, straight paths through their territories and bound along them when a hawk looms. Smaller sengi species spend a lot of time clearing twigs or other high hurdles off the potentially lifesaving speedways.

Also like antelopes, baby sengis often don't need a lot of babying. In many species they're up and moving an hour or two after birth. And sengis have high-crowned teeth, common in plant-grazers that grind tough vegetal stuff. Yet the little mammals don't gather in herds and don't even graze, instead snuffling around for small invertebrates, especially ants.

Their long bendy noses look like tiny elephant trunks, but they're less flexible and can't pick things up. To snatch an ant, a sengi shoots out a skinny tongue from its mouth, which lies far back toward the neck. To work around all that nose, sengis sometimes turn their heads and slurp sideways. "They're really sloppy eaters," Rathbun says.

The rest of the body isn't very elephant-like either, Rathbun says. The connection comes from DNA analyses that place elephant shrews in the Afrotheria group with real elephants, sea cows, aardvarks and some other African mammals. "They're not closely related, but they're more closely related to one another than to anything else," he says.

A new DNA analysis by California Academy's John Dumbacher has helped add a new sengi species to the previously known 18. Described in the June *Journal of Mammalogy*, the latest (distant) cousin of an elephant is the smallest sengi yet, weighing in adulthood less than a newborn kitten.

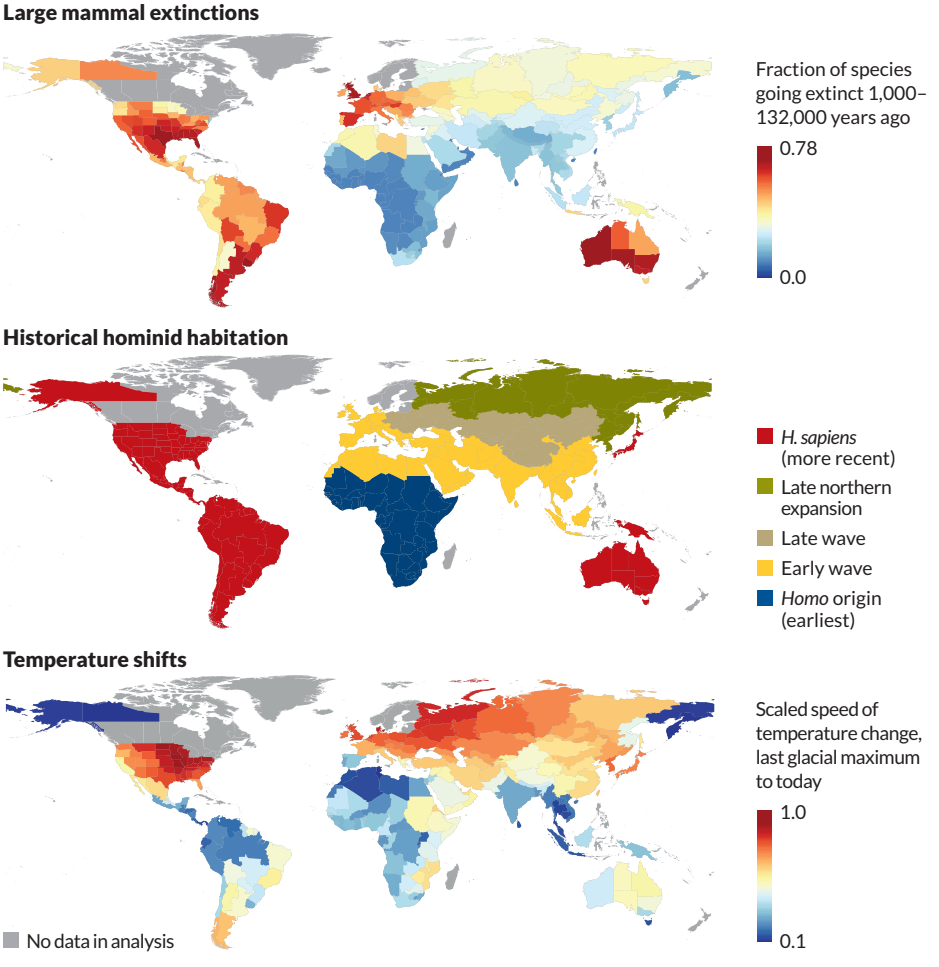
—Susan Milius

The mouse-sized Etendeka round-eared sengi (*Macroscelides micus*) was recently discovered.

SCIENCE STATS

Human history of extinction

Long before causing today's animal losses, people may have been a primary cause of extinctions during the last Ice Age. A study of 177 large mammals (weighing more than 10 kilograms) that went extinct between 1,000 and 132,000 years ago (top) concludes that humans, not changes in climate, may have been the main factor in driving the animals over the brink. Changes in regional temperature (bottom) and precipitation were weakly linked to extinction hot spots, while the presence of modern humans (center) was a stronger predictor of extinction rates. Thirty percent or more of large mammal species disappeared from most areas in which modern humans were the first hominids present, Danish researchers report in the July 22 *Proceedings of the Royal Society B*.



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MATTER & ENERGY

Quantum computer fails challenge

D-Wave Two shows no speed gain over traditional machine

BY ANDREW GRANT

A comprehensive new test reveals that the machine marketed as the first commercially available quantum computer holds no speed advantage over traditional computers in its ability to solve a certain type of problem.

Physicists have long aspired to build a quantum computer. Using quantum bits, or qubits, which can be both 0 and 1 simultaneously, these computers should be capable of performing certain tasks far faster than traditional computers (*SN: 3/10/12, p. 26*).

Due to numerous technical and basic physics challenges, large-scale quantum computing devices are probably decades away. Nonetheless, D-Wave Systems of Burnaby, Canada, decided to build the best quantum computer it could with current technology.

D-Wave One, introduced in 2010, and the recently released D-Wave Two are made up of small superconducting circuits that serve as qubits. The computers perform an algorithm that the company says capitalizes on two properties of quantum mechanics, entanglement and tunneling.

The algorithm should excel at solving a certain class of problems that require picking the best possible solution out of an exhaustive list of potential solutions. Tackling these optimization problems quickly could prove useful in tasks such as image detection, data mining and financial analysis. Google was intrigued enough to team up with NASA and the Universities Space Research Association to buy the roughly $15 million D-Wave Two.

Whether the machine actually exhibits quantum entanglement and tunneling is up for debate; several recent studies provide some evidence that it does. "But those studies don't address whether the computer is actually better," says Matthias Troyer, a computational physicist at ETH Zurich.

So Troyer and his colleagues set up a speed test between a quantum algorithm running on a D-Wave Two computer (owned by Lockheed Martin) at the University of Southern California and a classical version of the same algorithm running on a traditional computer.

The primary goal wasn't to see which solved problems faster — that would depend on factors such as processing speed. Instead, the researchers wanted to know how each computer would do as the problems got harder. Traditional computers take exponentially longer to solve optimization problems as more variables are added. The solving time for a quantum computer, however, should rise much more slowly.

After running multiple iterations of several problems, Troyer and his colleagues found no evidence of a D-Wave Two advantage, they report June 19 in *Science*. While the machine scaled better than the traditional computer for a small fraction of tasks, it actually did worse for the vast majority of problems, says study coauthor Daniel Lidar of USC.

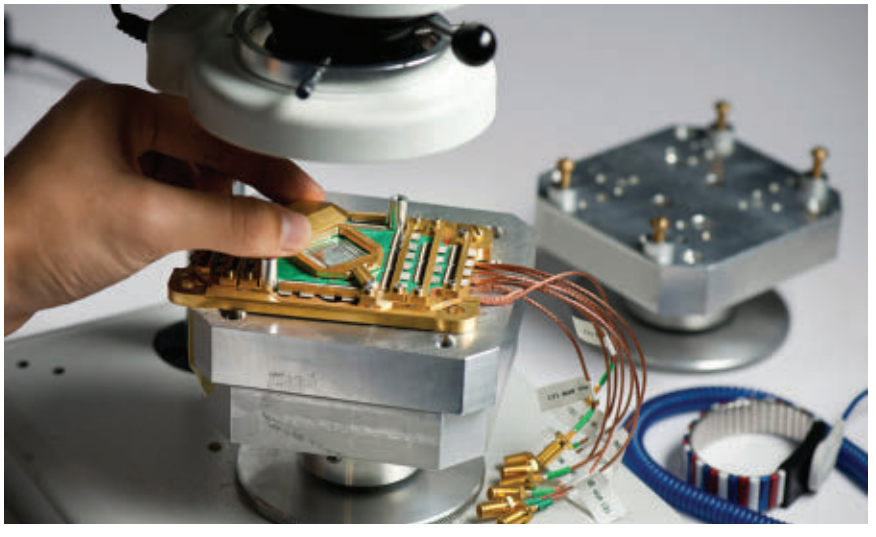
Colin Williams, D-Wave's director of business development and a quantum physicist, says that Troyer's team chose the wrong kinds of problems for the test. "The problems were simply too easy," Williams says. "They didn't allow [the quantum algorithm] to show an advantage."

Lidar acknowledges that in hindsight, he and his colleagues would have chosen a different set of problems. But he says that researchers have yet to find any problem that D-Wave's computer can provably solve faster than a traditional computer as the problem gets harder.

Itay Hen, a USC computer scientist not involved with the new work, is looking for such problems. He says that he has found some intriguing possibilities. He plans to use the methods detailed in the *Science* paper to test the most promising candidates.

The mystery should become easier to solve once D-Wave produces a computer with more qubits and more reliable hardware.

As D-Wave machines become capable of tackling larger problems, any advantage they have should become more easily distinguishable. "We're basically redesigning the chip three to four times a year," Williams says. ■



The D-Wave Two quantum computer solves problems with a processor (seen here) made up of over 500 superconducting circuits chilled to 0.02 degrees Celsius above absolute zero.

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GENES & CELLS

Controversial stem cell papers retracted

Mistakes, misconduct lead to questions about STAP cells

BY TINA HESMAN SAEY

Two discredited papers misrepresented photos (shown) of one embryo as two different embryos, created from a type of stem cell known as STAP cells. The inset shows the embryo without a placenta.

H. OBOKATA *ET AL*/*NATURE* 2014

Rising doubts about easy-to-make stem cells have hit a crescendo: The researchers who claimed to have discovered the cells have pulled their papers from the journal *Nature*. The scientists say that mistakes in the work now make them question the existence of STAP cells, short for stimulus-triggered acquisition of pluripotency cells. The original publications described making the STAP stem cells in mice simply by stressing mature cells with a squeeze or with a brief plunge in acid.

Other scientists worry that the early enthusiasm about the papers quickly followed by revelations of misconduct will mar the reputation of stem cell research.

"We apologize for the mistakes," the authors write in the July 3 *Nature*. "These multiple errors impair the credibility of the study as a whole and we are unable to say without doubt whether the [STAP cell] phenomenon is real."

When they were announced in January, STAP cells were greeted with both hope and skepticism that easy techniques could reset cells to a primordial state rivaling that of embryonic stem cells (*SN: 2/22/14, p. 6*). The cells could purportedly generate any type of tissue in a mouse's body and could even produce placenta, something that other stem cells generally can't do.

Researchers in other labs attempted to replicate the results but were unsuccessful. "Hundreds of postdocs and graduate students have tried to do this in their labs because it was supposed to be so easy. They have had zero success," says Jeanne Loring, a stem cell scientist at the Scripps Research Institute in La Jolla, Calif.

Within days of publication, scientists also noted that images and passages of text appeared to have been copied, sparking an investigation by RIKEN, the research institute in Japan where much of the work was done (*SN Online: 3/10/14*). That investigation found instances of plagiarism and data manipulation, and concluded that the study's lead author, Haruko Obokata, was guilty of misconduct (*SN Online: 4/1/14*).

The institute is still attempting to replicate the work. Japanese media reported that in early July, Obokata began a planned five months of experiments to demonstrate that STAP cells do exist. She is working under close supervision, including video surveillance, the *Japan Times* reported. Loring, however, thinks it is unlikely that anyone would adopt the method now even if RIKEN demonstrates the cells are real.

Study coauthor Charles Vacanti of Brigham and Women's Hospital and Harvard University was one of the originators of the idea that stimuli such as mechanical or chemical stress could reprogram adult cells to form stem cells. Vacanti declined to speak to reporters but stood behind his original idea. He said on his website that the misconduct investigation did not cast doubt on the existence of STAP cells. But he agreed to retract the papers because, he said, "I am concerned that the multiple errors that have been identified impair the credibility of the manuscript as a whole."

While researchers have used cocktails of chemicals to reprogram cells into stem cells (*SN Online: 7/18/13*), Leonard Zon, director of the stem cell program at Boston Children's Hospital, says he always doubted the papers' assertion that a single stressor, like acid, could completely change a cell's fate.

Stem cell scientist Paul Knoepfler of the University of California, Davis School of Medicine in Sacramento agrees. If mild stresses could make mature cells revert to the ultraflexible state of cells in an embryo, he says, "we'd have stem cell tumors sprouting up inside of us all the time."

The evidence to support STAP cells' existence is, if anything, only weakening as scientists look more deeply into the original reports.

In the retraction notice, the authors list five newly identified errors, including pictures of a single cell or embryo labeled as multiple cells or embryos.

Nature contends in a July 3 editorial that its editors and reviewers could not have discovered those and other fatal flaws during the peer review process.

But Loring finds that argument specious. "There has to be some responsibility somewhere," she says.

The incident has tainted the reputation of stem cell research, Loring and Zon say. But scientists are drawing on the experience to educate young researchers. Zon points to a recent session on scientific integrity for junior investigators at the International Society for Stem Cell Research meeting as an example. "We're trying to be responsible as a field," he says.

As for Loring, she's tired of the controversy. The field should move past the incident, she says. "There's enough really excellent work to swamp it out." ■

HUMANS & SOCIETY

Neandertals evolved in fits and starts

Fossil treasure trove shows nuances in hominid family tree

BY RACHEL EHRENBERG

The Neandertal branch of the hominid family tree just got a lot more shrublike. Ancient skulls from a desolate Spanish cave have a hodgepodge of Neandertal and non-Neandertal features, suggesting that the species underwent a long period of evolutionary fits and starts before emerging as full-fledged Neandertals some 200,000 years ago.

A battery of dating techniques indicates that the 17 skulls, seven of which were analyzed for the first time, are roughly 430,000 years old. The age makes the fossils the oldest reliable evidence of recognizable Neandertal features, says paleontologist Juan Luis Arsuaga of Complutense University of Madrid, who led the new analysis. The ancient age also suggests that Neandertals' evolutionary roots reach much farther back in time than that of humans, whose characteristic features don't appear in the fossil record until some 200,000 years ago in Africa.

The skulls' teeth and jaws are Neandertal-esque, with protruding teeth and no chin, hinting that chewing or using the mouth in a grasping, tool-like manner was important in becoming a Neandertal, Arsuaga says. He and an international team of colleagues report the findings in the June 20 *Science*.

But random evolutionary processes might also have led to the suite of traits, says Jean-Jacques Hublin of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. Europe underwent major environmental fluctuations from about 780,000 to 125,000 years ago, during the Middle Pleistocene. "We have dramatic swings between periods of hominids swimming where London is and of reindeer living in Spain," says Hublin, who was not involved with the study.

Small, isolated populations of proto-Neandertals probably crashed and burned repeatedly during this time. Limited genetic diversity in these small groups could have randomly led to the odd mix of facial traits seen in the remains.

None of the skulls have a hefty brain case like that of a proper Neandertal, which means that the big brains of Neandertals and the big brains of humans evolved independently, says Hublin. The origin of larger brain sizes in both hominid species probably resulted from intense selection, he says. And differences between those big brains very

Hominids in Spain some 400,000 years ago had protruding teeth and no chin, as in this fossil, but had not yet evolved the big brain cases seen 200,000 years later in Neandertals.

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BODY & BRAIN

Heart flaw at root of some strokes

Brain attacks tied to undiagnosed atrial fibrillation

BY NATHAN SEPPA

Monitoring stroke patients' heartbeats after they leave the hospital reveals that some have atrial fibrillation that had been undetected, two studies find. Atrial fibrillation, a heartbeat that's occasionally out of rhythm, is itself a risk factor for stroke. Researchers now report that electronic monitors attached to or under the skin can spot the irregularity in people who have had strokes with no apparent trigger, suggesting that this kind of tracking should become a standard part of such patients' care.

Most strokes result when a blood clot lodges in the brain. In atrial fibrillation, the upper chambers of the heart, or atria, beat erratically and cause a disruption of blood flow that can contribute to clot formation. People diagnosed with atrial fibrillation are sometimes put on prescription blood thinners to limit clotting.

Researchers focused on patients with unexplained strokes to see if atrial fibrillation might be present and detectable. In one study, small heart-rhythm monitors implanted under the skin of the chest in 221 survivors of stroke or ministroke revealed that after six months, 8.9 percent of the patients had atrial fibrillation. This number rose to 12.4 percent after a year as more episodes were spotted, says study coauthor Rod Passman, a cardiologist at Northwestern University Feinberg School of Medicine in Chicago.

In the other study, neurologist David Gladstone of the University of Toronto randomly assigned 286 people to wear external heart-rhythm monitors for a month. The people in the study had had a stroke or a ministroke, also known as a transient ischemic attack. Atrial fibrillation turned up in 16.1 percent of the patients. Both studies appear in the June 26 *New England Journal of Medicine*.

The implanted monitor could send a patient's abnormal heart-rhythm signals via cell phone towers to a doctor's office, Passman says. But quite often, little

likely led to humans' success and the Neandertals' demise.

How these incipient Neandertals ended up more than 13 meters deep in a cave shaft in Spain remains a mystery, Arsuaga says. The site, called Sima de los Huesos, the pit of bones, was known to cave explorers from the middle of the 19th century, he says. When paleontologists first examined the hominid fossil assemblage, found beneath a mess of carnivore bones including bears, foxes and a jaguar, they were stunned to discover that the skeletons were not from modern humans, but humans' ancient relatives.

"Someone, some agent had to put them there," Arsuaga says. "It's a problem that is very difficult to solve." Since many of the 28-odd skeletons are complete, the bodies may have been dumped in the shaft as corpses, probably from a more accessible cave entrance that no longer exists. There are no known funeral practices from more than 400,000 years ago. If intentional burials did occur at Sima de los Huesos, it would be the earliest evidence of such symbolic ritualized behavior, Arsuaga says. ■

attention is paid to the heart rhythms of people who survive an unexplained stroke if they have no history of atrial fibrillation, says Hooman Kamel, a neurologist at Weill Cornell Medical College in New York City. He says these findings suggest that monitoring such patients can reveal hidden atrial fibrillation, which doctors would then track and treat with blood thinners or other medications if deemed necessary for that patient.

But questions linger. These patients' atrial fibrillation could have developed after their strokes, says cardiologist Stuart Connolly of McMaster University in Hamilton, Ontario. Because of that, the studies don't establish that atrial fibrillation caused these strokes or ministrokes. ■

EARTH & ENVIRONMENT

Triclosan may spoil wastewater treatment

Antimicrobial could thwart cleanup microbes

BY BETH MOLE

Triclosan, after being flushed down the drain, may muck up sewage treatment. In wastewater treatment plants, the omnipresent antimicrobial may sabotage some sludge-processing microbes and promote drug resistance in others.

About 100 metric tons of the antimicrobial, common in personal care products such as hand soap and toothpaste, wash into U.S. wastewater treatment plants each year. Researchers have now found that concentrations of triclosan present in wastewater can destabilize the microbial communities that help treat sewage solids, which can then be used as fertilizer.

Triclosan may also encourage the growth of microbes immune to drugs, increasing the chances that drug-resistant microbes will spread in the environment, the researchers report June 10 in *Environmental Science & Technology*.

In wastewater treatment plants, the solid waste from sewage is collected in oxygen-free silos. There, bacteria and other microbes called archaea digest the solids into a more compact, better smelling and less infectious sludge. Civil engineers monitor the microscopic workers and their chemical transformations, including how much methane gas the microbes release, which is a measure of sludge breakdown.

The microbes that break down sewage solids in wastewater treatment plants (one shown) may be threatened by triclosan, a ubiquitous antimicrobial agent.

In the lab, civil engineer Patrick McNamara of Marquette University in Milwaukee and colleagues simulated sewage sludge treatment, starting with microbes from a local treatment plant that had been exposed to triclosan. The team then fed triclosan to the microbes at three concentrations, spanning today's median triclosan level found in sewage solids to four times as high as the current maximum found in those solids.

At the low level, the researchers saw no unexpected changes in microbial methane production compared with no-triclosan conditions. But at the medium level, the microbes released wildly variable amounts of gas. At the highest level, methane production crashed to just above half of control levels.

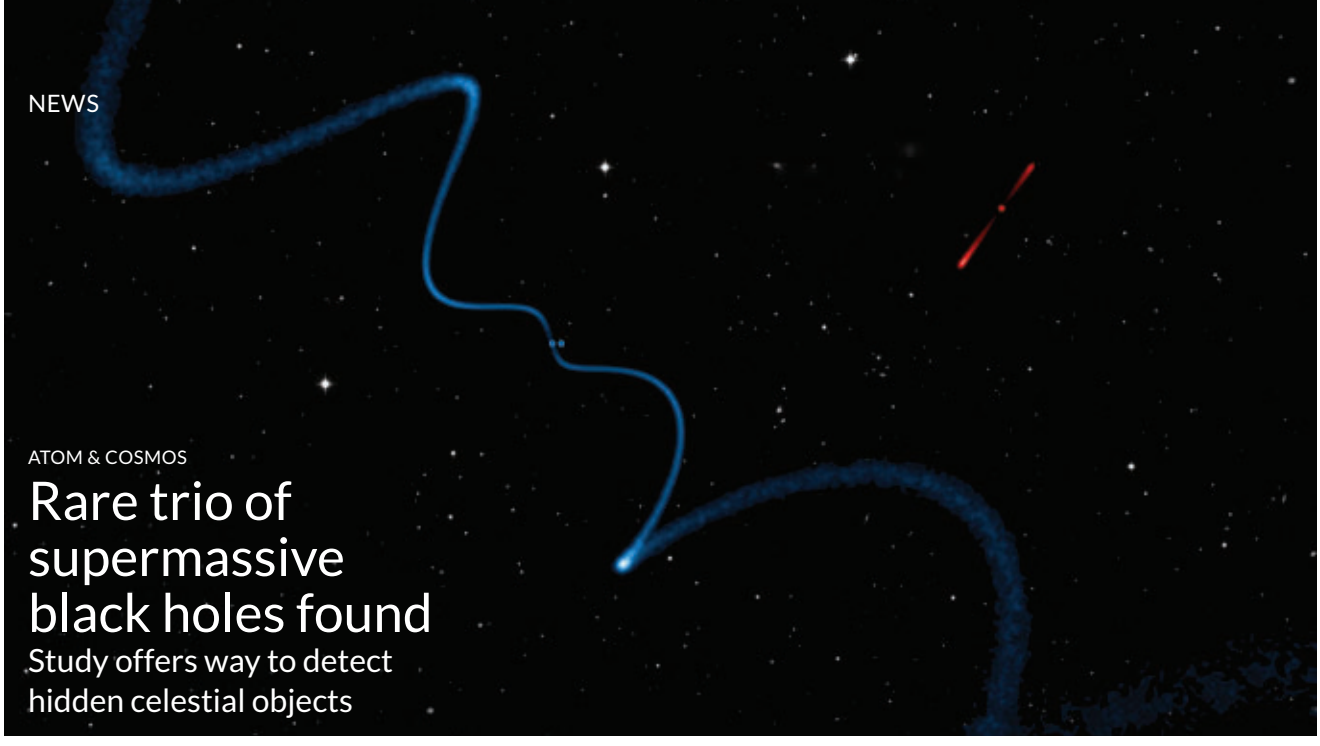
McNamara speculates that the medium triclosan level represents a tipping point before the microbes' sludge-processing power goes down the drain.

The finding alarmed but did not surprise McNamara. Triclosan is intended to disrupt microbes in people's homes, he says, and it can have the same impacts in treatment plants.

In a separate test using microbes that had never been exposed to triclosan, the team found that treatment with high levels of the antimicrobial caused a spike in the amount of a particular gene present in the microbial community, called *mexB*. The gene makes microbes resistant to triclosan as well as to antibiotics such as ciprofloxacin, McNamara says. Though the researchers don't yet understand exactly what caused the rise in the gene's prevalence, it may mean that nonresistant microbes died out, leaving behind resistant bugs, or that some microbes transferred *mexB* to others, or both.

The U.S. Food and Drug Administration is reviewing the use of triclosan in consumer products. Currently, the only way to reduce wastewater levels of triclosan is if consumers use less of it.

Civil engineer Rolf Halden of Arizona State University in Tempe says the finding warrants attention. "Regulating antimicrobials in wastewater should be a priority for the nation," he says. ■



ATOM & COSMOS

Rare trio of supermassive black holes found

Study offers way to detect hidden celestial objects

BY CHRISTOPHER CROCKETT

Where two distant galaxies collide, three supermassive black holes engage in a gravitational dance. Two of the black holes embrace in a tight orbit, spinning out jets of gas, while the third waits off to the side. Observations of the trio demonstrate that swirling jets can help astronomers find hidden black hole pairs. The finding also suggests that these tight pairs may be more common than previously thought.

Every large galaxy appears to harbor a central supermassive black hole. These black holes, which can weigh well over a billion suns, appear to build up over time from collisions between galaxies. As two galaxies merge, their central black holes find one another, spiral together and eventually combine into one giant black hole.

Roger Deane, an astrophysicist at the University of Cape Town in South Africa, and colleagues stumbled upon the black hole trio while studying galaxies that emit a lot of radio waves. The researchers knew of a galaxy that holds two black holes, which were first discovered three years ago and are separated by about 24,000 light-years. What Deane's team figured out is that one of those black holes is actually two black holes, separated by a mere 450 light-years, the researchers report June 25 in *Nature*.

To distinguish between the two black holes huddled together, Deane's team used the European Very Long Baseline Interferometry Network, which spans the globe. When used together, EVN's 18 telescopes behave like a powerful antenna with roughly the diameter of Earth. The network provides astronomers with the resolution needed to pick out the separate blasts of radio waves from two black holes hundreds of light-years apart in a galaxy nearly 5 billion light-years away.

By combining the new observations with old data, Deane and colleagues also saw a spiraling jet of electrons coming from one of the black holes in the closely bound pair. The gravity of one of the black holes appears to be yanking around the other's jet.

Scientists have seen twirling jets before and thought that they might come from two supermassive black holes orbiting each other, says Hai Fu, an astrophysicist at the University of Iowa in Iowa City, who was part of the team that originally discovered the black holes. But this is the first time astronomers have seen both a spiraling jet and independent evidence of a black hole binary. Now researchers can use spinning jets to look for black hole pairs that they couldn't otherwise see.

"I'm quite excited to see that our system has turned out be a triple," Fu says.

A trio of supermassive black holes, seen in an illustration, includes two that are 450 light-years apart (blue dots), with spiral electron jets streaming out. The third black hole (red dot) is 24,000 light-years away and emits straight jets.

Finding dual black holes is difficult, he adds. "We spent many years looking at many sources, and this was the only pair we found."

But the new findings suggest that close black hole pairs are prevalent, since the team found one after looking at only six galaxies. "Either we got incredibly lucky and won the lottery," Deane says, "or they're more common than previously anticipated."

Researchers think that this type of supermassive black hole duo may be a strong source of gravitational waves. As they orbit each other, the black holes radiate gravitational energy, which should send out ripples in the fabric of space. In principle, these gravitational waves may be detectable by instruments on Earth, like the European Pulsar Timing Array, but physicists have not directly detected any. Direct observations of gravitational waves would confirm a prediction of Einstein's general theory of relativity. They would also provide a way to explore the many phenomena that emit almost no light, such as pairs of neutron stars. A collection of compact black hole pairs could help researchers know where to look. ■

R. DEANE

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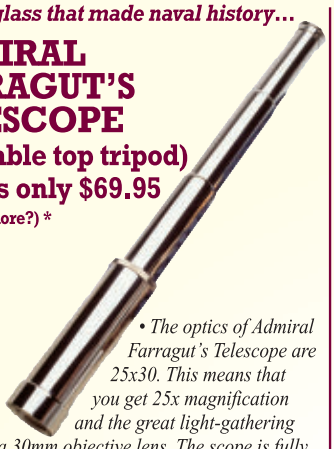

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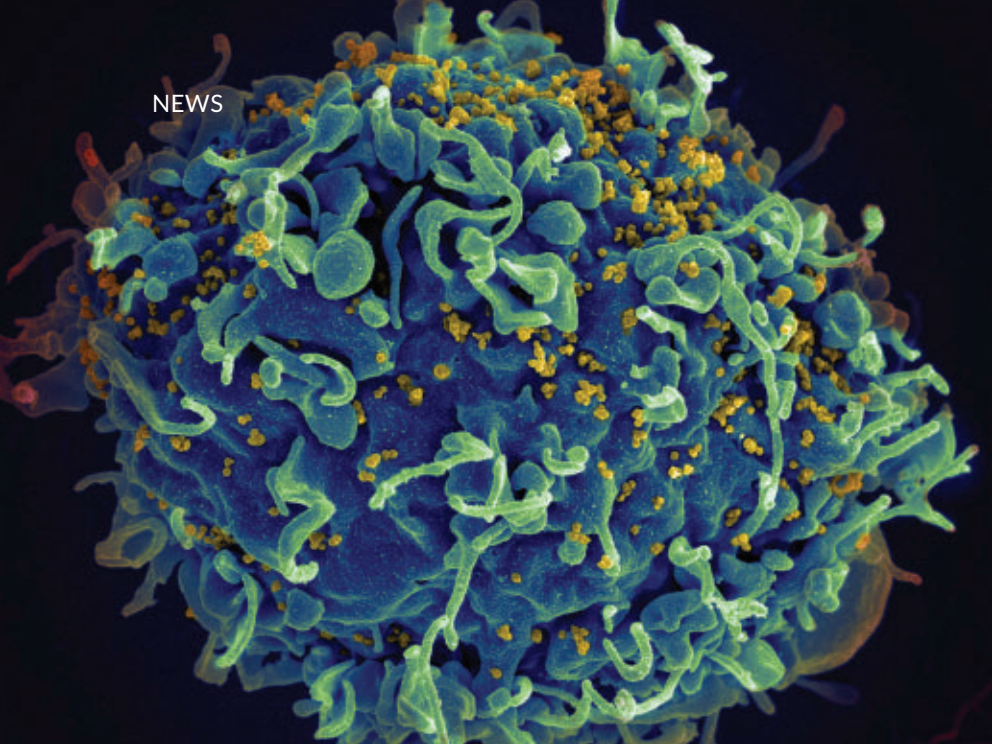


The discovery that HIV (yellow, shown infecting a T cell in a scanning electron micrograph) can trigger an infected cell to replicate may help explain how the virus persists in the body.

NIAID

GENES & CELLS

HIV hides in growth-promoting genes

By spurring cells to divide, virus creates long-term reservoirs

BY TINA HESMAN SAEY

HIV can sometimes create a self-replicating hideout that allows the virus to stay dormant in the body for a decade or more, a new study suggests.

The virus, which causes AIDS, infects immune cells called CD4+ T cells and inserts itself into host cells' DNA. The virus can lurk in these cells for decades as a latent infection. When patients stop antiviral therapy, the virus can rebound. But no one knew why certain T cells serve as the reservoir or how many of these viral hideouts survive in the body. Also a mystery was whether the virus persists within long-lived cells or continually infects new ones, says Charles Bangham, an immunologist and virologist at Imperial College London.

Now, it appears that HIV's longevity in the body depends on where in the DNA the virus inserts itself. When HIV lands in a gene involved in cell growth, it can spur the cell to divide, replicating the cell and the virus buried in the cell's DNA. Such clonal expansion — the duplication of cells — can produce populations of infected cells that last for at least a decade, virologist Stephen Hughes of the National Cancer Institute in Frederick, Md., and colleagues report June 26 in *Science*.

The finding may mean that an HIV cure not only must halt the virus from replicating, but it also has to stop infected cells from dividing, says Bangham, who was not involved in the work.

Hughes and his colleagues examined white blood cells from five HIV-infected people who had taken antiviral drugs for different lengths of time. The researchers mapped where the virus had embedded into the people's DNA.

In total, the team found 2,410 insertion places. Most locations, about 58 percent, were found only once. But the remaining 1,022 sites popped up again and again in different cells, indicating that multiple cells carried identical insertions. That result suggests that the original infected cell had divided many times, giving rise to infected clones. In one person, 58 percent of infected cells were clones of one cell.

Closer examination revealed that in many of the clones, HIV had ended up in genes that help control cell survival and growth. In one patient, the virus landed in a gene called *MKL2* 15 times. About half of the originally infected cells with insertions in this gene expanded into clones. The virus also landed in the *BACH2* gene at least 15 times. Mutations in both genes have been linked to cancer.

That's concerning, says Andrew Rice, an HIV molecular virologist at Baylor College of Medicine in Houston. If the virus inserts into a gene involved in cell growth and fosters the growth of cloned cells, it could lead to unchecked growth and cancer, he says.

However, there is no strong evidence that HIV directly causes cancer. Most of the cancers seen in HIV patients result from other viruses that run amok when patients' immune systems are weakened.

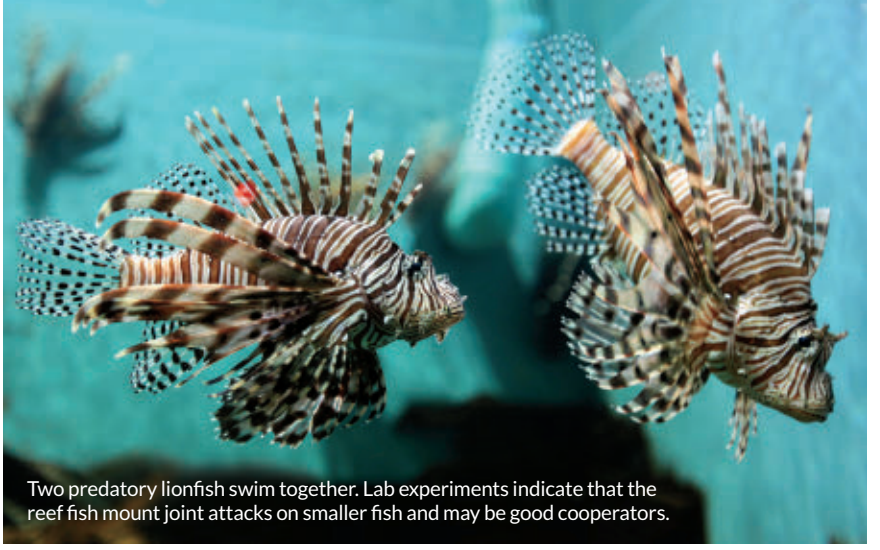
The discovery that HIV can cause clonal expansion could also have implications for gene therapy, says Angela Ciuffi, a virologist at the University of Lausanne in Switzerland. Researchers have used a type of retrovirus to introduce healthy copies of defective genes into children with immune disorders. Although the procedure was successful, some of the children later developed leukemia because the retrovirus insertions caused mutations in cancer-related genes. Now some scientists are attempting gene therapy using lentiviruses, modified versions of HIV, to deliver genes to patients' cells (*SN: 8/10/13, p. 19*). Because HIV is a retrovirus that has now been shown to stimulate cell growth when it hops into cancer-linked genes, researchers may need to be even more vigilant in monitoring gene therapy patients for cancer, Ciuffi says.

Before worrying too much that infected clones could rise up and cause an HIV rebound, scientists need to determine whether the cloned cells are actually sources of infectious viruses. Researchers have previously found that many HIV insertions are defective and can't produce infectious viruses, says Janet Siliciano, a biochemist and virologist at Johns Hopkins University School of Medicine. "If they're defective you don't need to worry about them" infecting other cells, she says. ■

LIFE & EVOLUTION

Lionfish dance to signal 'let's hunt'

Special tail and fin moves may start cooperative attack



Two predatory lionfish swim together. Lab experiments indicate that the reef fish mount joint attacks on smaller fish and may be good cooperators.

BY SUSAN MILIUS

Lionfish may be surprisingly sophisticated at hunting with partners. They shimmy their tails and fan out their fins in a signal that can recruit a buddy, and they might even take turns gulping prey.

Divers have reported venomous, leafy-looking lionfish seeming to work together while corralling littler fish. But behavioral ecologist Oona Lönnstedt says that she and her colleagues are the first to test the behavior experimentally.

In a lab, *Dendrochirus zebra* lionfish from Australia's Great Barrier Reef reacted to the sight of prey by swimming away and approaching another lionfish, which was caged and couldn't see the prey. Hovering just in front of the second fish, the one that had seen the prey performed a distinctive sequence of gestures as if to say, "C'mon! Let's go get 'em." When researchers loosed the two lionfish on the prey, each attacker caught a bigger dinner than would a typical lionfish alone.

And the lionfish didn't fight over this bounty, instead striking one at a time, Lönnstedt, of James Cook University in Townsville, Australia, and colleagues report June 25 in *Biology Letters*.

The study adds to growing evidence "that fish social behavior is much more complex than previously assumed," says Redouan Bshary of the University of Neuchâtel in Switzerland.

Fish don't often get credit for having the smarts needed for cooperation, Lönnstedt says. Yet a report from more than 20 years ago indicated that a different lionfish species teamed up to corner smaller fish. And Bshary and his colleagues have proposed that roving coralgroupers signal partners to hunt: The fish frenetically shake their heads in front of giant moray eel hideouts and start a two-species joint hunting expedition.

In the new study, Lönnstedt allowed a lionfish to explore a lab setup and then added six little fish to a compartment as prey. The lionfish typically swam away from the prey and displayed what may be a signal to kick off a hunt. The signaler faced downward and undulated its tail, as lionfish often do when hunting, and then spread out and waved one pectoral fin and then the other. *D. zebra* lionfish performed the routine for potential partners of its own species and for another lionfish species from its home reef. Lönnstedt never saw the display without prey or a potential partner in the arena, she says.

When she allowed the lionfish to hunt together in the test arena, eight times out of 10, the fish that had initiated the display took the first strike and then backed off as the second fish rushed in. A lionfish doesn't back off because it needs time for dinner to slide down the gullet, Lönnstedt says. When feeding alone, lionfish swallow prey fast. Instead, she says, the hunters in pairs "seemed to be almost polite."

Bshary muses over explanations of the apparent turn-taking: The first strike could drive prey into new positions, so that a neighbor gains the best angle. The most remarkable reason would be that this behavior really is tit-for-tat cooperation that evolved as a trade of favors. That would really shake up old prejudices about the mental powers of fish. ■

JUST THE FACTS

Deforestation in Indonesia

6,020,000

hectares

Primary forest cleared in Indonesia between 2000 and 2012

6,230,000

hectares

Area of West Virginia

SOURCE: B.A. MARGONO *ET AL*/*NATURE CLIMATE CHANGE* 2014, U.S. CENSUS BUREAU

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BODY & BRAIN

Hubs go awry in brain disorders

Schizophrenia, Alzheimer's target connection centers

BY LAURA SANDERS

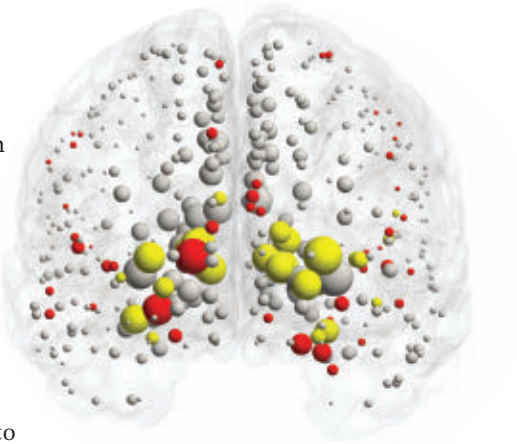
In the brain, a handful of bustling hubs routinely handle heavy volumes of messages. In many cases, these key transit centers are the same areas affected by brain disorders, scientists report June 19 in *Brain*.

The results highlight the importance of studying connections between nerve cells as well as discrete brain regions, an approach that may reveal a deeper understanding of the human mind (*SN: 2/22/14, p. 22*), says Nicolas Crossley, a neuroscientist at King's College London.

With message-sending fibrils called axons, nerve cells in the brain form a complex web of connections that scientists call the connectome. Some parts of this web, called hubs, are especially rich in axons, both coming in and going out.

Computer simulations have suggested that these hubs are mission critical. When certain hubs or their connections are damaged in the simulations, the results are catastrophic for the entire brain (*SN Online: 2/17/14*).

Crossley and colleagues wanted to know whether people with brain disorders might also show signs of damaged hubs. To find brain regions implicated in brain maladies, the researchers analyzed published data that included nearly 10,000 patients with 26 brain disorders including Alzheimer's disease, depression, autism and schizophrenia. Crossley and colleagues then compared the regions associated with these disorders with a composite map of a healthy brain's connections, which the team created from diffusion tensor imaging scans of 56 volunteers. Diffusion tensor imaging indicates the strength and shape of bundles of axons in the brain.



Some of the brain's most highly connected hubs (large spheres) may malfunction in brain disorders, a new study suggests. Yellow and red show hubs associated with disorders.

Overall, regions implicated in brain disorders were more likely to be highly connected hubs than sleepier, out-of-the-way regions, the researchers found. Disorders didn't all affect the same set of hubs. Most regions implicated in Alzheimer's disease were distinct from the hubs implicated in schizophrenia, for instance.

Hubs may have an outsized role in brain disorders for any of several reasons. Because of their high workload, hubs may require more energy than other brain

LIFE & EVOLUTION

Ants evolved swimming several times

Multiple species can rescue themselves after falling from trees

BY SUSAN MILIUS

In the tropics, some ants living high in trees can swim well if an accident — or a scientist — drops them into water.

Some form of swimming has evolved independently several times in ants, says Steve Yanoviak of the University of Louisville in Kentucky. In swim tests, the champs powered across the water at more than three body lengths per second, he and Dana Frederick of the University of Arkansas at Little Rock report in the June 15 *Journal of Experimental Biology*.

Tropical ants have plenty of water to worry about, especially where rivers flood acres of Amazonian forest so deeply that fish swim among the trees for months each year. Ants that plummet from their treetop homes may drown, get gulped by aquatic predators or, just as fatally, be swept downstream far enough that they can't find their colony again. "If you're a wingless animal living high in a canopy, then you have to deal with what happens when you fall," Yanoviak says.

Some ants can glide through the air to a tree trunk, Yanoviak discovered in earlier research that involved dropping ants out of trees (*SN: 2/12/05, p. 101*). Still musing about falls, Yanoviak took ants to a wooden footbridge over swampy pools in Peru. "I dropped a couple of ants and totally expected them to just struggle at the water surface and become fish food." Many did. But ants in a few species "basically stood up and ran across the water surface and climbed out — no problem."

The tropical ant *Pachycondyla villosa* will rescue itself from a splashdown by moving deftly through the water toward shore.

The ants that appeared to run on water did have their feet sink a little, and some ants' legs sank more deeply but could still row along. To see if ants might have natural tendencies to rush toward tree trunks while swimming, the researchers got a vinyl Winnie the Pooh kiddie pool and set a white or black pole in the water against the perimeter. In a species known to swim, ants put into the pool with a white pole oriented in random directions overall as they swam looking for escape. But 87 percent of the ants dropped in the pool with the black pole swam toward it and escaped safely, as if heading for a dark tree. These ants' behavior reminds Yanoviak of "a Labrador retriever chasing a stick in a pond, making a beeline straight towards it, totally determined."

FROM TOP: N.A. CROSSLEY *ET AL/BRAIN* 2014; S. YANOVIAK

See video of ants swimming in slow motion at **bit.ly/SN_ant**

regions. Hubs also have longer connections. These features may render hubs susceptible to damage, the authors suggest. Alternatively, damage to a hub might cause more problems than damage elsewhere, resulting in brain impairment.

The new study has "direct relevance to our understanding of major brain disorders," says neuroscientist John Van Horn of the University of Southern California in Los Angeles. The link between disorders and highly connected hubs may help explain why some brain injuries appear small but have big consequences, while other injuries appear disastrous but prove relatively benign.

Still, Van Horn cautions that the dataset used to compile the brain areas associated with disorders may be biased. The data are based on published results, and scientists are more likely to publish results that pinpoint a connection between a disorder and a brain area than results that fail to find one. That effect might overestimate the importance of certain brain regions, Van Horn says. ■

Of 35 common tropical ant species examined in various tests, 10 proved to be strong swimmers; another 10 showed some signs of directed movement. Biologists already knew that some ants can swim, Yanoviak says. Now he is suggesting that the ability could be widespread. The ants he and Frederick identified as aquatic-capable were scattered among nonswimmers in several lineages in the genealogical tree, suggesting that the ability evolved independently each time.

Benefits of swimming extend beyond the flooded Amazon, says Walter Federle of the University of Cambridge. He has done some ant-dropping tests in Malaysia and found that ants living in the watery mangrove forests were better swimmers than ants living elsewhere.

Just how many ant species can swim remains to be seen, says Corrie Moreau of the Field Museum of Natural History in Chicago. "I suspect you will soon have ant biologists all over the world dropping ants in buckets of water to find out." ■

GENES & CELLS

Autoimmune diseases blocked in mice

Experimental T cell treatment thwarted diabetes, halted MS

BY TINA HESMAN SAEY

A new strategy to rebalance out-of-control immune systems could one day stop autoimmune diseases. The method, tested in mice, preserves the body's ability to fight off bacteria and viruses.

Autoimmune diseases result when the immune system mistakes some of the body's proteins for invaders and attacks organs. Doctors usually treat such disorders — including type 1 diabetes, multiple sclerosis, lupus and rheumatoid arthritis — with immune-suppressing drugs. The drugs calm the attacks but damage the ability to fight infections and cancer.

But the immune system can relearn that the body's proteins are friends, not foes, scientists report in the June 18 *Science Translational Medicine*. They broke down and rebuilt the immune systems of mice with diseases that mimic type 1 diabetes and MS, stopping the progress of diabetes in four out of five mice. Animals with a disease similar to MS went into remission.

The treatment works by depleting the faulty immune cells and stimulating the formation of new ones called regulatory T cells, or T-regs. T-regs are akin to military police that watch over the immune system's soldier cells to make sure they kill only foes and don't damage the body's own cells with friendly fire, says immunologist WanJun Chen of the National Institute of Dental and Craniofacial Research in Bethesda, Md., who led the study. Autoimmune diseases occur in part because T-regs aren't doing their job.

Chen's T-reg strategy may allow researchers to fix wayward immune systems instead of just quashing them. "Conceptually, these findings have broken the bottleneck in manipulating T-regs for the treatment of human diseases, especially autoimmune diseases," he says.

Before new T-regs could form, the researchers had to eliminate old, corrupted immune cells. The team dosed sick mice with enough radiation to cause 60 to 80 percent of their immune cells to commit a form of programmed suicide known as apoptosis. Next, the team injected immune cells called macrophages from the spleens of other mice into the sick animals to gobble up the dying cells. Gorging on dying cells causes macrophages to secrete a chemical called TGF-beta, which stimulates the immune system to produce new T-regs.

To ensure that the new T-regs would prevent autoimmune attacks, the researchers had to program the cells to distinguish self from outsiders. So along with the macrophages, Chen and colleagues injected the mice with the previously attacked body proteins, called autoantigens. The autoantigen boost produced T-regs that were on the lookout for those proteins. When these T-regs found tissues where the autoantigen proteins were made, the cells stopped other immune cells from attacking, Chen says.

The treatment still allowed immune cells to attack bacterial proteins, suggesting that the mice are still able to fend off infectious diseases.

Chen's team demonstrated that both the macrophages and the autoantigens are necessary for the treatment to work. Irradiated mice lacking either didn't go into remission from MS.

In other experiments, the researchers showed a way to possibly avoid the radiation. Targeted antibodies that slate certain immune cells for death can generate enough suicidal cells for macrophages to gorge on. Since the antibodies don't kill macrophages, the mice had plenty of those cells to produce the TGF-beta needed to nurture new T-regs. With humans, antibodies would probably be used instead of radiation, Chen says.

It's not clear whether the human body could sustain production of the T-regs to provide lasting relief from autoimmune attacks, writes immunologist Lucienne Chatenoud of Paris Descartes University in a commentary in the June 20 *Science*. ■

HUMANS & SOCIETY

Young kids can negotiate turn-taking

At a surprisingly early age, children opt to share sacrifices

BY BRUCE BOWER

BERLIN — From supermarket checkout lines to merge lanes on highways, adults often resolve social dilemmas by taking turns. Pairs of 5-year-old preschoolers can do it too, a new study finds. Children frequently work out deals to take turns when their interests collide, suggesting that this sophisticated strategy emerges surprisingly early in life.

By agreeing that each person will alternate in passing up a reward to avoid worse outcomes, duos of preschoolers earned a couple more colorful stickers than they would have otherwise, said psychology graduate student Sebastian Grüneisen of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

Grüneisen presented his preliminary findings June 10 at the Summer Institute on Bounded Rationality, a weeklong set of seminars and workshops for young scientists, at the Max Planck Institute for Human Development.

"Five-year-olds can coordinate decisions with others in a fair way, even when each child has conflicting interests," Grüneisen said.

Until now, researchers had not examined whether preschoolers are capable of forging and enforcing turn-taking agreements when competing for rewards, remarked psychologist Monika Keller of the human development institute. Researchers suspected that preschool children might not arrange and abide by equitable strategies, she said.

Grüneisen and psychologist Michael Tomasello, also of the Leipzig facility, asked 10 pairs of 5-year-old boys and 10 pairs of 5-year-old girls to play a game in which each child steered a toy train carrying three marbles. The marbles could be exchanged for stickers at the end of the game. The trains moved in opposite directions toward a junction where they could collide. Each child had the option to swerve his or her train onto a ramp to avoid a crash that would cause both children to lose their marbles. A child who swerved kept only one marble; the child's partner, who was able to drive straight through, still had all three marbles.

A screen between players blocked their view of each other, although they could talk freely. Each pair of kids played the game 12 times.

Half of the duos took turns swerving. In those pairs, turns were taken on five to 12 trials. Most remaining pairs played a form of "chicken," in which both players said they would drive straight through but one consistently swerved. Boys and girls displayed comparable tendencies to choose a turn-taking approach to the game.

Turn-taking pairs earned an average of about 40 stickers, versus approximately 38 stickers for pairs that didn't agree to take turns.

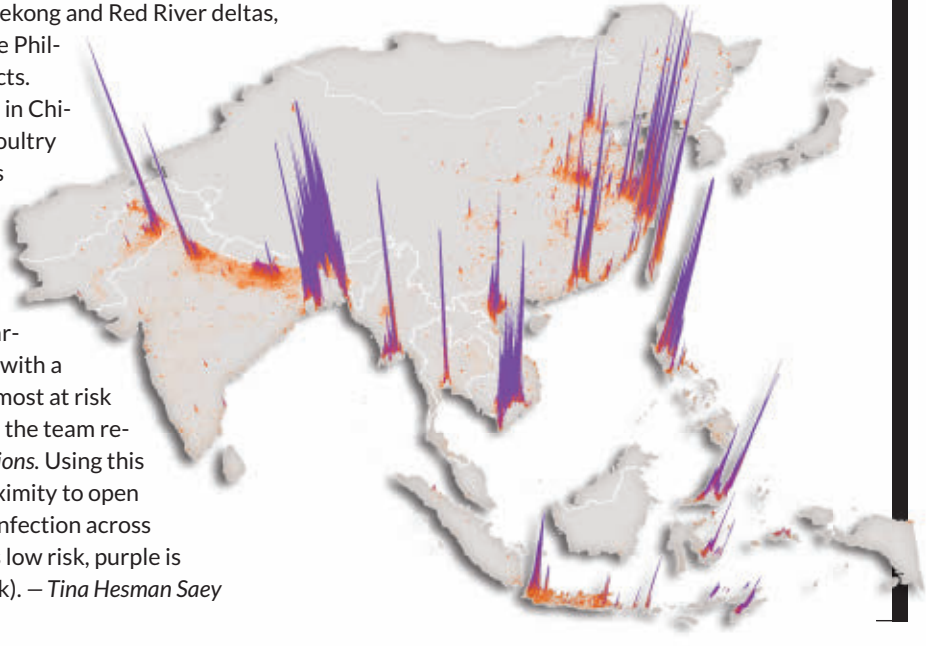
Grüneisen is now looking at whether individual 5-year-olds can work out turn-taking strategies with a revolving cast of three partners in a version of the train game. He also wants to examine how 5-year-olds use promises or protests to ensure that a partner abides by a turn-taking agreement. ■

GENES & CELLS

Avian flu could strike Asian poultry markets

If it spreads beyond China's borders, the H7N9 avian influenza virus could take hold in Vietnam's Mekong and Red River deltas, India's Bengal region and parts of the Philippines and Indonesia, a study predicts.

The virus has infected 451 people in China, many of whom had visited live-poultry markets. Marius Gilbert of Belgium's Université Libre de Bruxelles and colleagues analyzed environmental conditions at 8,943 poultry markets in China to determine which conditions are shared by the 263 markets linked with H7N9 cases. Places with a high density of poultry markets are most at risk of having the virus spread to people, the team reports June 17 in *Nature Communications*. Using this and other risk factors, including proximity to open water, the team mapped the risk of infection across Asia (map shown, orange represents low risk, purple is high; taller spikes indicate higher risk). — *Tina Hesman Saey*



M. GILBERT *ET AL/NAT. COMMUN.* 2014

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ATOM & COSMOS

Magnets could shield spacecraft

Radiation deflectors would safeguard astronauts

BY MEGHAN ROSEN

Deflector shields aren't just for the starship *Enterprise*. One day, giant magnetic bubbles could protect spacecraft on long voyages.

By gathering charged particles floating through space, the bubbles could form a force field that flicks away radiation. If successful, the idea could offer a solution to one of NASA's stickiest problems: how to shield astronauts from harmful cosmic rays and solar eruptions.

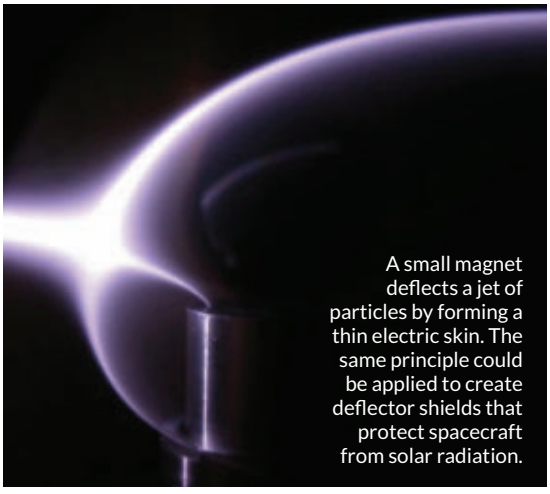
Storms on the sun catapult charged particles into space at tremendous speeds, says Ruth Bamford, a plasma physicist at the Rutherford Appleton Laboratory in Didcot, England. "If you're on a spaceship in transit to Mars," she says, "these charged particles can smash through the hull and smash your DNA."

There are two ways to protect astronauts: shield them or shorten their travel times, says Robert Winglee, a physicist at the University of Washington in Seattle. In the 1960s and 1970s, Apollo astronauts avoided danger because their short missions occurred when the sun was relatively quiet. But Mars is hundreds of times farther away than the moon is. Juicing up spacecraft propulsion systems would speed space trips but that's still a long way off, says Winglee, so scientists are trying to tackle shielding.

Two years ago, Bamford and her team proposed that magnetic bubbles protect swatches of the moon's surface from streams of solar particles (*SN: 8/11/12, p. 8*). The bubbles help generate an electric field that deflects the streams. The researchers thought bubbles could protect spacecraft too. They envisioned ships fitted with onboard electromagnets to generate magnetic fields. In space, a sparse smattering of peppy particles, or plasma, loosely fills the void, like a handful of sand strewn through an ocean. As a ship journeyed to Mars, these particles would smack into the magnetic bubble.

"It's like hitting a wall," says plasma physicist Daniel Spicer of Drexel University in Philadelphia. Heavy particles such as protons lodge within the wall, while lighter electrons bounce off it, he says. A protective electric field would form as the wall separated plasma's positive particles from its negative ones, Bamford's team calculated.

And releasing a cloud of particles from the spacecraft — before radiation from a solar storm arrived — could offer even more protection, the researchers propose in a paper posted June 4 at arXiv.org.



A small magnet deflects a jet of particles by forming a thin electric skin. The same principle could be applied to create deflector shields that protect spacecraft from solar radiation.

Testing the idea is tricky because mimicking the sun's storms in the lab is nearly impossible. So Bamford's team used a computer simulation.

According to the simulation, the electric shell formed by the duo of magnetic field and plasma could deflect 95 percent of the speediest solar particles.

"It's a promising approach," Spicer says, "but a lot of things could go wrong." And Winglee notes that the paper doesn't address the magnetic field's effects on the astronauts.

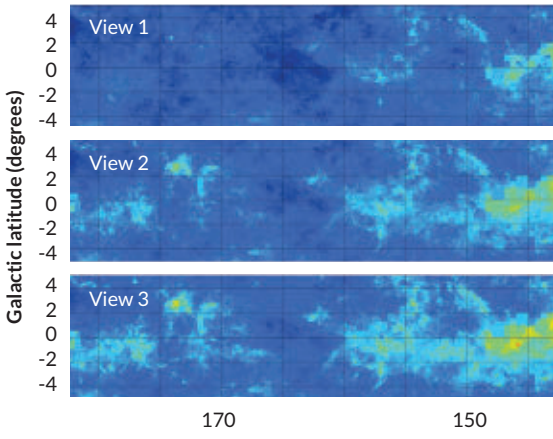
Bamford wants to gather experimental evidence to test the idea and envisions trying to protect unmanned satellites orbiting the Earth. "This could be a relatively cheap mission that we could pull together in about five years," she says. ■

FROM TOP: R.A. BAMFORD *ET AL*/ARXIV.ORG 2014; S.E. SALE *ET AL*., IPHAS

ATOM & COSMOS

Galaxy's dust clouds shown in 3-D

The ashes of dying stars collect in clumps around the Milky Way, as seen in a new 3-D map (right) of the galaxy's interstellar dust. The atlas, presented June 23 at the Royal Astronomical Society National Astronomy Meeting in Portsmouth, England, focuses on a nearly 180° view of the plane of the galaxy. View 1 shows the total amount of dust out to roughly 3,300 light-years from Earth. View 2 adds another approximately 3,300 light-years and View 3 adds still another. Stuart Sale of the University of Oxford and colleagues measured the brightness of more than 38 million stars at three wavelengths of light to make the map, which reveals where dust clumps (red is the most dust, blue the least). That information can tell researchers about the life cycle of atoms and molecules in the galaxy and may allow for better measurements of stars, whose light gets filtered by dust. — *Christopher Crockett*



Sunbathing may boost endorphins in the body and brain

Mice produce feel-good molecule in response to regular exposure to ultraviolet light

BY LAURA SANDERS

When bronzed sun worshippers bask on the beach they may get more than a tan. Ultraviolet light causes mice to churn out an opiate-like molecule, scientists report in the June 19 *Cell*. This feel-good molecule, called beta-endorphin, may explain why some people seem addicted to tanning.

The results may also explain why people are generally drawn to sunny spots, says Steven Feldman, a public health scientist at Wake Forest University School of Medicine in Winston-Salem, N.C. "Do you know why people go to the beach on vacation? Why they put Disney World in Florida and not in Minnesota, where it's cooler? Why caves are not more popular as a tourist destination? It's all because of what these guys studied," he says.

The project began with a puzzle, says study coauthor David Fisher, an oncologist at Massachusetts General Hospital. He and his colleagues wanted to understand why skin cancer rates were increasing, even though the culprit, UV radiation from the sun and tanning booths, had been known for years.

Fisher and colleagues exposed mice with shaved backs to a moderate amount of UV radiation for five days a week for six weeks. The exposure was comparable to what a fair-skinned person would receive from 20 to 30 minutes of summer sun in Florida.

After about a week, the UV-exposed mice had higher levels of a beta-endorphin, which acts similarly to morphine and heroin in the body. Seven days after the mice stopped the UV treatment, beta-endorphin levels fell to baseline. The endorphin boost was found in the mice's blood, not just in skin as earlier work had suggested. Endorphins circulating in the blood carry the feel-good messages to the brain.

> This feel-good molecule may explain why some people seem addicted to tanning.

As beta-endorphin levels rose, so did the mice's ability to withstand pain. After UV treatment, mice tolerated a stronger poke to the paw and kept their paw on a hot plate longer. Mice bred so that they could not produce beta-endorphins did not respond to UV light in the same way.

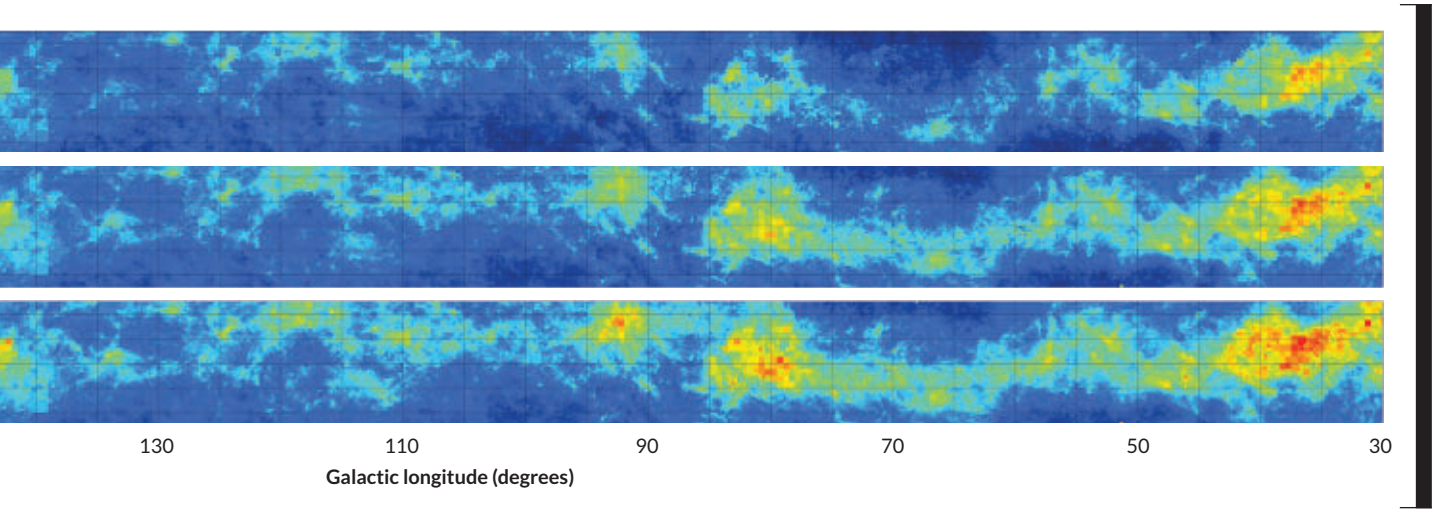
Blocking the effects of beta-endorphin with naloxone, the same drug used to treat heroin overdoses, also blocked the boost in the mice's pain threshold, the researchers found. That suggests that these UV effects depend on endorphins.

What's more, mice seemed to get hooked on the high levels of beta-endorphin. After getting regular doses of UV light, mice showed signs of withdrawal when their endorphins were silenced with naloxone: The animals' paws trembled, their teeth chattered and they shook like wet dogs. Mice that weren't exposed to UV light didn't seem to go through naloxone-related withdrawal.

The results mimic those from research on people. In previous work by Feldman, frequent tanners chose between two tanning beds that looked identical, one that delivered UV light and one that filtered it. After trying out both beds, subjects almost always picked the UV-active bed.

This UV light–seeking behavior seemed to hinge on endorphins: When people's endorphins were blocked with a different drug called naltrexone, they no longer distinguished between the real and fake tanning beds, a failure that suggests they had become immune to the rewards of UV light.

The mice don't reflect the complexities of human addiction, says Bryon Adinoff of the University of Texas Southwestern Medical Center in Dallas. Still, he says, the same beta-endorphin production described in mice may well be part of what compels some people to tan. ■



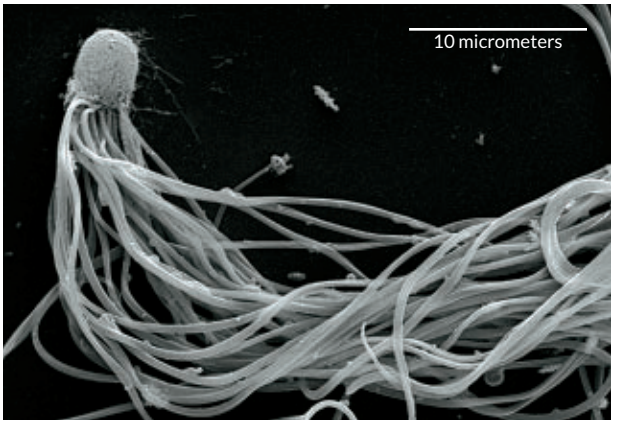
LIFE & EVOLUTION

One type of lichen is actually 126 species and counting

A kind of lichen that biologists thought they knew well has turned out to consist of at least 126 distinct species — and maybe more than 400 — lumped under a single name. The neotropical lichen *Dictyonema glabratum* often grows in curly masses about the size of a fist. It can vary in color as well as in other traits, but other single species vary naturally, so biologists didn't suspect its extreme underlying variation. Manuela Dal-Forno of George Mason University in Fairfax, Va., and colleagues analyzed DNA in a highly variable region of the lichen's fungal component. (Lichens combine a fungus and at least one kind of photosynthetic pal from another kingdom.) At first the researchers detected 16 hidden species. When more DNA analysis revealed over 100 species, "we were totally stunned," says coauthor Robert Lücking of the Field Museum in Chicago. A computer analysis Lücking developed estimates that the total could top 400 unrecognized species, he reports with Dal-Forno and colleagues June 30 in the *Proceedings of the National Academy of Sciences*. — *Susan Milius*

Ant sperm swim as a team

A sperm swim team could make a desert ant a reproductive winner. A study published June 11 in *Biology Letters* finds that binding sperm together in many-cell masses makes them swim faster, with possibly better reproductive results. Reproduction is tough for the male desert ant *Cataglyphis savignyi*. He dies soon after mating, and the female he mates with will quickly take many other partners. After mating, the female stashes sperm from several males in a specialized organ called a spermatheca before using some of the stored sperm to fertilize her eggs. To compete, the male desert ant releases sperm in bundles (one shown, below) of about 50 to 90 bound together at the head with caps of sticky proteins, Morgan Pearcy and others from Belgium's Université Libre de Bruxelles found. Sperm bound together swam 51 percent faster than the few that voyaged alone. Slower sperm may not make it into the spermatheca, blowing their chance of fertilization. The researchers hypothesize that the swim team strategy may have evolved to take advantage of the extra speed. — *Bethany Brookshire*



D. MONTEYNE, D. PEREZ-MORGA, M. PEARCY *ET AL*/*BIOLOGY LETTERS* 2014

GENES & CELLS

Ulcer microbe changes quickly to avoid immune attack

The bacterium that causes stomach ulcers morphs at a breakneck pace when it first infects a person, apparently to dodge immune attack, researchers report June 13 in *Nature Communications*. *Helicobacter pylori* can reside in the human stomach for years or decades. Barry Marshall of the University of Western Australia and an international team obtained samples of *H. pylori* from two volunteers infected with the microbe and then wiped out the infections with antibiotics. Three months later, the team reinfected both people with their own *H. pylori*. During the early weeks of the new infection, the bacteria mutated 40 to 50 times faster than did earlier chronic infection samples. The bacteria's outer membrane proteins, which may be recognized by key players of the immune system, seemed particularly prone to change. That suggests that genes encoding those proteins come under intense selection pressure by the immune system during initial acute infection. — *Nathan Seppa*

BODY & BRAIN

Simple blood test detects heart transplant rejection

Heart transplant recipients whose bodies are starting to reject the new organ might carry genetic warning signs. A new test of recipients' blood appears as accurate in catching signs of rejection as a heart biopsy, the gold standard for monitoring donated hearts, a team led by Stephen Quake and Kiran Khush of Stanford University report in the June 18 *Science Translational Medicine*. The scientists scoured 65 heart recipients' blood for free-floating donor DNA. They distinguished recipient DNA from donor DNA by tracking naturally occurring genetic variants. Donor variants are common in blood the day after transplant, the team found, but decline within a week. After that, increases in donor DNA serve as a sign of rejection. Over two years, three transplant recipients experienced moderate to severe rejection at some point, with one requiring a second heart transplant. The new test revealed these episodes as much as five months before heart biopsies did. The test might enable doctors to treat impending rejection earlier. — *Nathan Seppa*

Crayfish get anxious too

Crayfish under duress show signs of anxiety, scientists report in the June 13 *Science*. Pascal Fossat of France's University of Bordeaux and colleagues watched the crustaceans explore a cross-shaped tank that had two dark arms and two lit ones. Crayfish preferred the safety afforded by the dark but occasionally explored the illuminated arms. However, compared with normal crayfish, animals subjected to stressful shocks before entering the tank spent less time exploring lit areas and more time in the dark. Anxious behavior lessened after researchers treated the crayfish with chlordiazepoxide, an anti-anxiety drug used in people. An injection of serotonin, a mood-regulating chemical messenger, induced anxious behavior in unstressed crayfish. Crayfish join rodents and other animals that possess the ability to be anxious. The growing tally suggests that anxiety evolved long ago to help animals survive. — *Laura Sanders*

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Quick CHANGE ARTISTS

Some animals are managing to respond to climate change. In Finland, the ratio of gray (left) and reddish-brown (right) tawny owls, like these two rescued in the Czech Republic, has changed as winters have warmed.

LIBOR ŠEJNA, WWW.MAKOV.CZ

Researchers simulate climate change to predict which species can adapt and find ways to help some survive

By Sarah Zielinski

High in the Rocky Mountains of Colorado, mustard plants slumber through the winter in snow-covered meadows. When spring finally reveals these hardy perennials, the plants reach for the sky, unveiling tiny pink or white flowers.

This annual rebirth is timed to the snowmelt, and as warmer temperatures have moved melting earlier and earlier in the year, this particular mustard, known as Drummond's rock cress (*Boechera stricta*), has followed. The herb's trumpetlike flowers now bloom about 13 days earlier than they did four decades ago. For a plant that flowers for at most 30 days a year, says University of South Carolina plant ecologist Jill Anderson, "that's an enormous change."

Drummond's rock cress also responded to warming temperatures around 20,000 years ago, pushing its way north and up the sides of mountains after glaciers began retreating. In a relatively

short time, geologically speaking, this little flower spread and adapted to a wide variety of landscapes and elevations.

But with climate expected to change 10 to 100 times faster than in the recent geological past, Anderson wonders if the little plant can adjust again. Last September and October, she began an experiment at the Rocky Mountain Biological Lab in Colorado, collecting thousands of seeds and small mustard plants from up and down the mountain and replanting them at different elevations. As spring approached in April, Anderson's assistant began shoveling snow from the surface of half the gardens to simulate the earlier snowmelts expected with climate change; the team will repeat the process over the next several years.

Anderson wants to know if the plants have the genetic capacity to deal with the environmental conditions of the future.

Concerns about the impact of a changing climate go beyond this single flowering plant, of course. Scientists want to know if the world's organisms will be able to move to new habitats or adapt to new conditions fast enough to cope with the warmer temperatures, earlier springs, altered precipitation patterns and acidifying oceans that will come with climate change.

Most ecologists and evolutionary biologists say that they're not ready to make sweeping generalizations about what might survive. They will say, however, that the survivors will probably use multiple tactics — such as migration and adaptation — to persist in a rapidly changing world.

Hundreds of species are already moving toward the poles, up the sides of mountains and down to deeper ocean depths (*SN: 6/30/12, p. 16*). But often there's no suitable habitat for species to relocate, or there's no room, says evolutionary biologist Ary Hoffmann of the University of Melbourne in Australia. Migration takes time and requires open corridors, which are scarce in nations jammed with cities, agricultural fields and roads. And then there are physical limits to how fast species can migrate.

For species that can't move, adapting to new conditions will have to be part of their survival. Even those that can move will have to adapt, since relocating will require a change of relationships. In a new location, a plant could encounter a fungal disease to which it has no prior resistance. Some will adapt fast enough, while others will buy time, for example, with flexible behaviors — adjusting when to give birth or what food to eat.

Identifying how species might change in response to shifts in the environment is more than just an intellectual enterprise. Scientists and conservationists won't be able to save every species threatened by climate change. But they may be able to use the knowledge of how organisms adapt to help some important ones — such as plants that feed many animals — as well as crops and other species that humans depend on for survival.

Evolution on overdrive

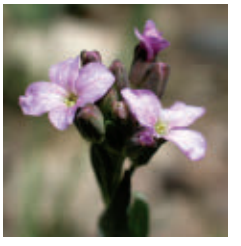
The conventional view of evolution was that it progresses slowly, over the course of thousands to millions of years. "Natural selection will always act with extreme slowness," Charles Darwin wrote in his 1859 book *On the Origin of Species*.

But Darwin was studying a world that moved at a much more leisurely pace than today's. Perhaps more important, he didn't have the tools that allow scientists to see minute changes in DNA. And humans are now driving organisms to adapt to new surroundings and new lifestyles — to evolve — faster than Darwin ever suspected possible.

Climate change is creating even more of these opportunities. The first concrete evidence of global warming altering natural selection and resulting in an evolutionary response came from tawny owls (*Strix aluco*) in Finland. In a study published in *Nature Communications* in 2011, scientists tied climate change to a genetic change in plumage color, which may help the birds survive.

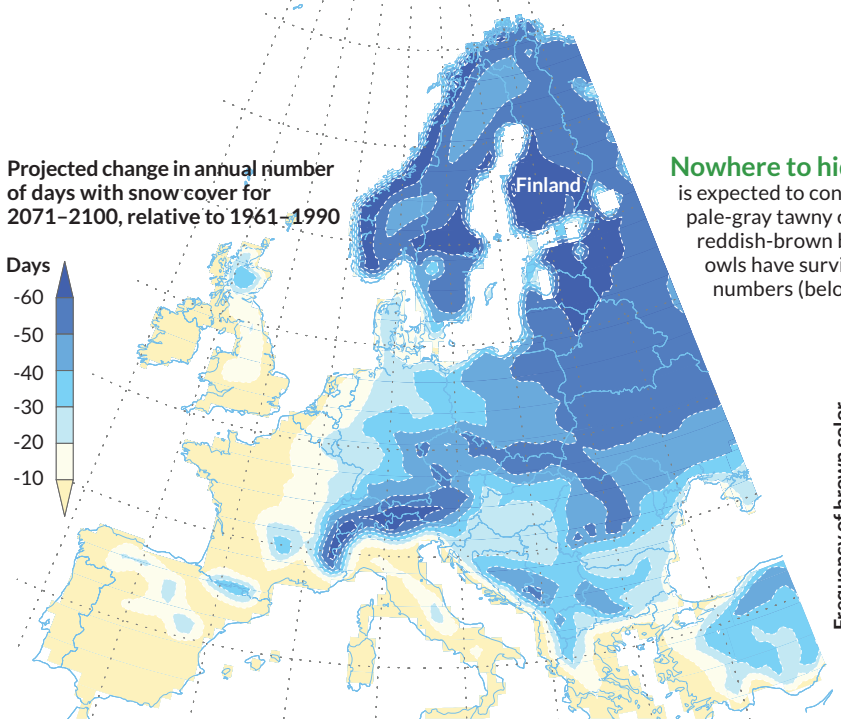
The owls come in two colors, pale gray and reddish-brown. Until recently, selection favored the pale gray shade; those owls were more likely to survive in the snowy Finland landscape. The reddish-brown color persisted, though, because the responsible gene is dominant — when a brown owl mates with a gray bird, about half of their offspring will be brown.

Drummond's rock cress is blooming almost two weeks sooner than it did just 40 years ago.

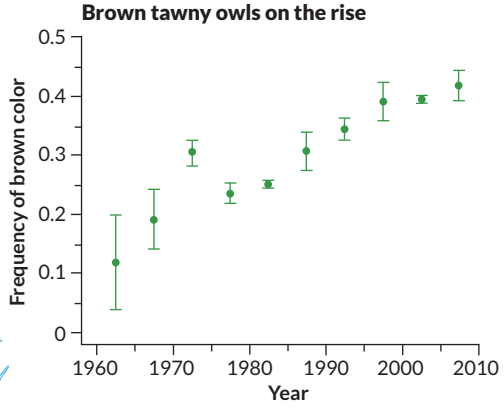


Now that they've planted thousands of Drummond's rock cress plants at various elevations at Colorado's Rocky Mountain Biological Lab, researchers will simulate the earlier springs expected with climate change by shoveling snow off some plants.

FROM TOP: DAVID INOUYE; J. ANDERSON/UNIV. OF SOUTH CAROLINA



Nowhere to hide The trend of decreasing snow throughout Europe is expected to continue through the 21st century (left). Finland's pale-gray tawny owls have had a survival advantage over their reddish-brown brethren. But with warmer winters, more brown owls have survived and passed on their genes, boosting their numbers (below). SOURCE: P. KARELL *ET AL*/*NATURE COMM.* 2011



But ornithologists tracking Finland's owl population have noticed a change over the last few decades: a steady increase in the proportion of reddish-brown owls coinciding with a decrease in snow depth during the country's milder winters. With less snow and warmer temperatures, more of the reddish-brown birds have been able to survive, mate and pass on that dominant gene, ultimately resulting in more brown owls.

Adaptation in nature is rarely so straightforward, however. To adapt to climate change, a species needs two characteristics. Some members must carry the genetic capacity for dealing with the new conditions. And they must be able to pass those genes to future generations. This makes species that have shorter life spans and lots of offspring more likely to evolve quickly.

Morgan Kelly, a marine ecologist at Louisiana State University in Baton Rouge, finds lessons in two marine invertebrates: tide pool copepods and sea urchins. The copepod *Tigriopus californicus* would appear to be well adapted to a wide range of water temperatures since it is found along the western coast of North America from Alaska to Mexico. Its various populations should therefore have a lot of genetic variability for natural selection to act upon, which would help the shrimplike copepods adapt in response to warming.

When Kelly was a graduate student at the University of California, Davis, she and her colleagues attempted to force the tiny invertebrates to evolve. The researchers gathered copepods from eight coastal locations and brought them into the laboratory, where they exposed the creatures to warmer water temperatures through up to 10 generations.

For the first half degree Celsius above what they were used to, the copepods tolerated the heat. Higher than that, the copepods died.

Although the species as a whole has a lot of genetic variation, each local population is only well adapted to the narrow range of temperatures it experiences, Kelly and her colleagues concluded in 2012 in *Proceedings of the Royal Society B*. For the species to adapt to warmer waters, there would need to be intermingling between populations, so that copepods from warmer regions could pass on the genes that let them live in warmer waters to copepods from cooler places. That doesn't happen, however, because the copepods don't live well outside of their tide pool homes; even the young don't travel very far.

This copepod is a coastal invertebrate that couldn't adapt to warmer waters in laboratory tests.

The floating larvae of purple sea urchins (*Strongylocentrotus purpuratus*), however, can travel for hundreds of kilometers. That may help the spiky animals adapt to another aspect of climate change, ocean acidification, Kelly says.

Rising acidity from increasing atmospheric carbon dioxide undermines the chemical reactions that sea urchins and many other marine organisms rely on to build their skeletons and other structures with calcium carbonate. Sea urchin

FROM TOP: FINNISH METEOROLOGICAL INSTITUTE; WALDO NELL/FLICKR

larvae tend to be smaller and fewer reach adulthood when water pH is lower (acidity is stronger).

But some parts of the ocean are more acidic than others, and sea urchins can be found in waters that span a wide range of pH. Kelly and Jacqueline Padilla-Gamiño, while working in Gretchen Hofmann's lab at the University of California, Santa Barbara, collected sea urchins from two sites — one with higher acidity and one lower — and bred them in the lab. They found that the urchins' ability to live in more acidic waters was a genetic trait that could be inherited. Like the copepods, they have a genetic capacity to deal with the changes expected in the future. But unlike the copepods, urchin populations intermingle, so acidity-tolerant genes could move from one location to another. That should help the species adapt to acidifying waters in the future, Kelly says.

"We know that species are going to evolve. That's a given, with both temperature and pH," says Jennifer Sunday, a climate change ecologist at Simon Fraser University in Barnaby, British Columbia, who has found similar results for another sea urchin species. "We know that there's variation out there. There [are] going to be changes in the genetic makeup of populations. And that's evolution."

But evolution isn't the only way that species can change in the face of global warming. Some display an innate resilience to environmental changes that on the surface can look similar to genetic adaptation.

Behavioral flexibility

Across Eurasia, from Scandinavia to North Africa, and from Portugal to China, small yellow-and-black birds about the size of a house sparrow nest in the cavities of forest trees. These birds, called great tits (*Parus major*), have short life spans, about three years typically. They reproduce quickly and have lots of offspring. Each of these conditions allow for faster evolution.

In Wytham Woods, near Oxford, England, however, the great tits are handling environmental changes by changing their behavior.

The birds in these woods have been monitored since 1947, when Oxford researchers erected nesting boxes for the great tits to track the population from year to year. Eventually, researchers began recording the "half-fall date," the date by which about half of the winter moth caterpillars — which the great tits feed to nestlings — had fallen to the ground to begin their next stage of life.

The timing of when the birds lay their eggs is tied to that caterpillar half-fall date and to climate change, reported Oxford ornithologist Ben Sheldon and his colleagues in *Science* in 2008. The availability of caterpillars depends on spring temperatures. In warmer springs, there are more caterpillars earlier in the year. The birds, the researchers found, can shift the date they lay eggs so there will be lots of food for their nestlings. In warmer springs, they lay their eggs earlier.

This behavioral change was not due to genetics, because individual birds changed their behavior from year to year. If this were a genetic response, Sheldon says, the average laying date would be decreasing smoothly and the birds would be laying eggs earlier and earlier.

Instead, the birds rely on a phenomenon called phenotypic plasticity, the ability of an organism to change its behaviors or features in response to the environmental factors it experiences during its lifetime. This is how identical twins end up looking different as adults. It's also how something like a bird or a mustard plant can appear to adapt to climate change without going through much, if any, underlying genetic change.

Purple sea urchins may adapt to the ocean's rising acidity because populations can intermingle and can pass on genes to tolerate acidity.

Phenotypic plasticity can actually be more useful than genetic change in some cases, Sheldon says. If the great tits, for example, were to lay their eggs slightly earlier every year, there would inevitably be mismatches between when nestlings are born and when food is available, since local weather varies and the region will certainly experience above- and below-average spring temperatures.

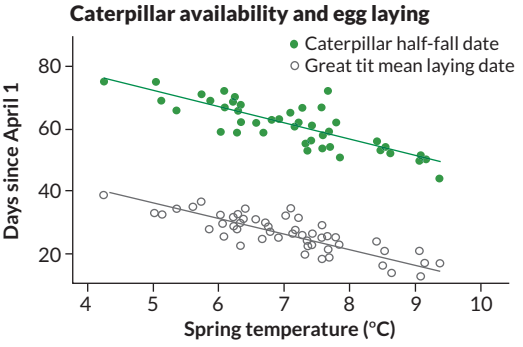
The ability to adjust behavior may provide some organisms with time to allow natural selection to act. "If you're sensitive to the right parts of the environment," Sheldon says, "then even long-lived, slow-reproducing species can survive."

The path to survival for any species will likely be a complex mix of strategies. "The most successful species that are capable of surviving through climate change," Anderson says, "migrate, adapt to new conditions and use phenotypic plasticity."

Even if some species or populations appear to be coping with climate change for now, that doesn't mean that they're in the clear for the future. "Climate change is a moving target," Anderson

DAVID WROBEL/GETTY IMAGES

Food for nestlings Great tits (left) feed winter moth caterpillars to their nestlings. The birds time the laying of their eggs to caterpillar availability. In warmer springs, when caterpillars drop to the ground earlier, the great tits lay their eggs earlier as well.
SOURCE: O. VEDDER *ET AL/PLOS BIOLOGY* 2013



says. "Populations are going to be running behind it, trying to catch up."

Many species just won't be able to manage it. John Wiens, an evolutionary ecologist and herpetologist at the University of Arizona in Tucson, and Ignacio Quintero, a graduate student at Yale University, recently looked at past evolution in 540 vertebrate species, including amphibians, birds, mammals and reptiles. The researchers compared sister species — two species that diverged from a recent common ancestor — and calculated how long it took them to evolve to fit into their current environmental habitats.

Most vertebrate species won't be able to evolve fast enough to adapt to the climatic changes expected over the next century.

Based on past rates of evolution, most vertebrate species won't be able to evolve fast enough to adapt to the climatic changes expected over the next century, Wiens and Quintero concluded in *Ecology Letters* in 2013. To keep up with the changing climate, most species would have to evolve 10,000 to 100,000 times faster than they have in the past.

Many will be able to use a combination of adaptation and migration to persist, Wiens says, but "we may have lots of extinctions and declines before we ever get to adapting to climate change."

Assisted migration

Some scientists, though, are beginning to think about how they can actually help species along. "If you're trying to conserve species, you may have to think about intervention in a radical way," says Melbourne's Hoffmann.

Researchers may be able to identify not only the most threatened organisms but also the ones most important for conserving, such as the keystone species that keep ecosystems working. These are species like sea otters that keep sea urchins in check and prevent them from destroying kelp forests, and prairie dogs, whose burrows provide homes for many other critters. What's more, Hoffmann says, scientists may even be able to assist in the process of adaptive evolution, by transplanting individuals with desired traits from one part of a species range into another, providing diversity that natural selection can act upon.

Researchers from the British Columbia Ministry of Forests are testing the idea. They've taken seeds from trees in the United States and Canada and planted them in new sites, hoping their actions will better prepare forests for a warmer future. Others have succeeded with similar efforts that are unrelated to climate. After the Florida panther population dropped to fewer than 30 cats in the 1990s, eight female pumas were shipped in from Texas. The cats were from a different subspecies, but they provided enough genetic variation to boost the Florida population, which was suffering from inbreeding. Today, there are some 100 to 160 adult Florida panthers.

This idea of shuffling genes between populations and even species in the name of conservation is becoming more acceptable. It "might seem a little bit out there, but certainly there are plenty of people thinking about it," Hoffmann says. "To secure the future, when we know there's this massive change in climate happening ... we know we have to do something fairly dramatic." ■

Explore more

■ A.A. Hoffmann and C.M. Sgrò. "Climate change and evolutionary adaptation." *Nature*. Feb. 24, 2011.

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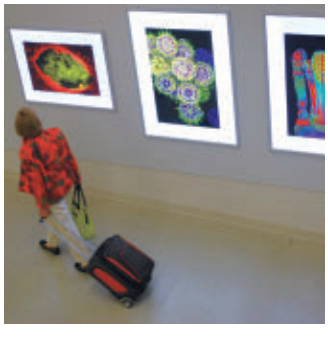
EXHIBIT

Microscapes take off at D.C.'s Dulles airport

By his own admission, Stefano Bertuzzi is a frequent and grumpy traveler. His trips often take him to the United Airlines terminal at Dulles International Airport outside Washington, D.C. There, Bertuzzi, executive director of the American Society for Cell Biology, long grumbled that the pictures of local landmarks lining the hallways ought to be replaced with pictures of cells.

The spectacular images that cell biologists capture in their microscopes could "really wow people and make them say, 'Science is cool,'" he thought.

"One day my flight was delayed, and I said, 'I'm going to do this,'" Bertuzzi recalls. He asked his staff to call the airport and find out how to mount an exhibit.



See cell images at Dulles airport's Gateway Gallery (Concourse C) through November.

The result is "Life: Magnified," a display of microscope images depicting cells, microorganisms and details of life invisible to the naked eye, which runs from June to November. Some of the subjects have been magnified up to 50,000 times.

Images in the "Life: Magnified" exhibit include bubonic plague bacteria (yellow) in a rat flea.

Cell scientists sent in about 600 images and a committee selected 46 based on visual appeal, Bertuzzi says. Microscope manufacturer Zeiss sponsored the exhibit, organized by the cell biology society and the National Institute of General Medical Sciences.

Airports draw people from many demographics, so they are the perfect place to reach a new audience with science, Bertuzzi says. He hopes the exhibit will inspire children and maybe even a few members of Congress traveling to their districts. He's also dreaming of similar projects to reach subway commuters and other unsuspecting audiences.

When the exhibit ends, Bertuzzi says, "I'll be very, very sad and have to go back to looking at pictures of the Washington Monument when I travel."

— Tina Hesman Saey

CLOCKWISE FROM TOP: B. JOSEPH HINNEBUSCH, ELIZABETH FISCHER AND AUSTIN ATHMAN/NIAID/NIH; JOHN FLEISCHMAN, ASCB; YI-LIANG LIU/FLICKR (CC BY-NC-ND 2.0)

Science on the fly

Travelers can get a science fix with current displays at these airports:

SAN: On display at San Diego International Airport are 20 microscope images in Terminal 2, a quilt depicting cells and larger-than-life resin sculptures (above) of bacteria that feed on airplane exhaust.

ORD: Near Terminal 3 at Chicago O'Hare International Airport, fliers will find plant cell walls, bee brains and other "Art of Science" images from the Institute for Genomic Biology.

See more from the "Life: Magnified" exhibit at **bit.ly/SN_LifeMagnified**

BOOKSHELF

Kidding Ourselves

Joseph T. Hallinan

People believe the darnedest things — despite doubts, common sense and even evidence to the contrary. For example, a large majority of people are convinced that they drive better than others do, which of course isn't possible. We can't all be above average, no matter what Garrison Keillor says.

Hallinan, a Pulitzer Prize–winning journalist, argues that all manner of strange beliefs distort people's perceptions and give rise to strong expectations, overconfidence, superstitions or just a rosy view of oneself. These beliefs are not all bad. Take, for instance, the placebo effect. When researchers gave some people fake acupuncture with toothpicks and poked others with real needles, the groups reported about equal improvement in back pain. They expected to feel better and did.

And in other ways, believing is perceiving. In surveys, many people who say they have never used a government social program are in fact on Medicare or Social Security. Cornell University researchers found that one-fourth of people who had been on food stamps claimed they had never received government assistance. They perceived themselves as self-supporting even when they weren't.

It feels better to be in charge. "We all want to believe that we control the direction of life's pinball," Hallinan says. It puts us a little more at ease. As an example, he offers superstition.

People keep superstitions in a back pocket, hiding them from the rational mind. These beliefs provide an edge, some tiny degree of control. Barack Obama played basketball on election days because it "worked." Some baseball players tap their helmets before hitting, and back on the bench they never *ever* talk to a pitcher who's throwing a no-hitter. Even though grown-ups rule the world, elevators manufacturers rarely build in a 13 button, because most buildings have no 13th floor.

A smidgen of extra control is a good thing, and having too little carries a real downside. British researchers discovered that civil servants who were low in the power structure had more job stress. They lacked control and ultimately died younger on average than higher-ups.

So a dose of self-deception might work to our advantage. At the high end of the job ladder, powerful people flood themselves with optimism, bold action and bullishness. It drives them to leadership positions and helps them achieve goals.

But too much of even this good thing carries the risk of becoming slightly poisoned by power. It's common for such high achievers to adopt an attitude best summed up as, "I won't get caught." Cases in point include John Edwards, Lance Armstrong and Richard Nixon. They had power and lots of control and surely assumed bad things would happen to others, not them. They were, in effect, kidding themselves. — *Nathan Seppa*
Random House, $25

BOOKSHELF

Tambora

Gillen D'arcy Wood

For many residents of the Northern Hemisphere, 1816 was known as the "year without a summer." In Europe, summer heat waves were replaced by freezing temperatures while New England saw snowstorms in June. The ruined crops, hunger and social turmoil that followed the next year led many others to remember 1817 as the "year of the beggar."

Those several years of bizarre weather seemed to signal the end of the world. But in an age before the Internet, telephone or even the telegraph, few people realized that the year before the chaos started, a mighty Indonesian volcano had blown its top. In his new book, Wood, an English professor, argues that many of the dramatic events between then and the end of the decade were linked to the 1815 eruption of Tambora.

To make his case, Wood examines recent geologic research as well as historical evidence, particularly relying on the colorful accounts of Mary and Percy Shelley and Lord Byron. Wood concludes that Tambora was responsible for much more than bad weather and famine; among other things, he connects the eruption to a global pandemic, changes in art and literature, the birth of meteorology and the rise of China's opium trade.

The Tambora eruption was one of the largest in recorded history. Scientists now estimate that the volcano belched out as much as 50 cubic kilometers of ash and gas, darkening the sky for days. The finest ash particles hung around the atmosphere for several years, eventually covering a million square kilometers of sky. The ash blocked sunlight and disrupted atmospheric circulation patterns.

In India, for example, the ash cloud interfered with the region's monsoon cycle — first drying up life-sustaining rains and later ushering in biblical floods. The messed-up monsoon set the stage for an outbreak of a particularly virulent form of cholera that eventually spread around the world.

In example after example, Wood expertly explains the volcano's effects on climate and agriculture, though at times, his arguments for Tambora's direct influence on the political realm feel a bit weak. Still, Wood leaves no doubt how sensitive and far-reaching Earth's climate system is — and how vulnerable humans are to the natural world. — *Erin Wayman*
Princeton Univ., $29.95

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JUNE 14, 2014

"Well done for your article on marijuana in your June 14 issue. It was well balanced, something often difficult to do on controversial topics."

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Cannabis highs and lows

Marijuana can tweak the brain's normal functions, and young people may be particularly vulnerable. ***Laura Sanders*** *delved into the science behind pot's neurological effects in "High times"* (SN: 6/14/14,p. 16).

Legalization is a hot issue, and *Science News*' website, Facebook page and Twitter feed exploded with opinions from readers, many of whom argued for laxer laws on cannabis use. Even those with a pro-pot outlook, however, agreed that marijuana should be treated with the same caution as any other drug, particularly when children are involved. "Few substances, if any, can be truly regarded as harmless," wrote online commenter **mjverite**. "We know, for example, that approximately 150 people per year die from acetaminophen. Those with serious underlying health conditions would do well to do their research and speak with their medical provider before using cannabis." **Dan** added, "Keep it out of minors' hands until they have developed enough to make smart choices."

Thomas Ostwald summed up the discussion succinctly: "What the feature made clear is that the research is in its infancy, and we know very little for sure."

Practicing responsible science

Male lizards lose a little swagger in the presence of predators, as ***Meghan Rosen*** *reported in "Lizards may scale back head bobbing to avoid predators"* (SN: 6/14/14, p. 14). *Brown anoles toned down the flashy display they use to attract females when researchers added carnivorous lizards to their island habitats.*

Some readers were appalled that researchers loosed predators on an unsuspecting ecosystem. "Who thought it was a good idea to introduce 'carnivorous curly-tailed lizards' to an island population?" asked **Rebecca L. Walker-Sands** by e-mail. "Disruption of ecosystems to study sexual selection seems a bit extreme." **John Day** offered a suggestion for a new study: "What say we introduce hungry tigers into the authors' lab to see if it reduces their swaggering, head-bobbing behavior?"

The researchers didn't remove the carnivorous lizards, *Leiocephalus carinatus*, after introducing them to the islands, but the experiment was on a small scale, says **Rosen**. "The small islands used in the study host only about 280 square meters of vegetated area, on average — about the size of a big house. And they're naturally prone to colonization by *L. carinatus* living on larger islands nearby."

The perverted spiral

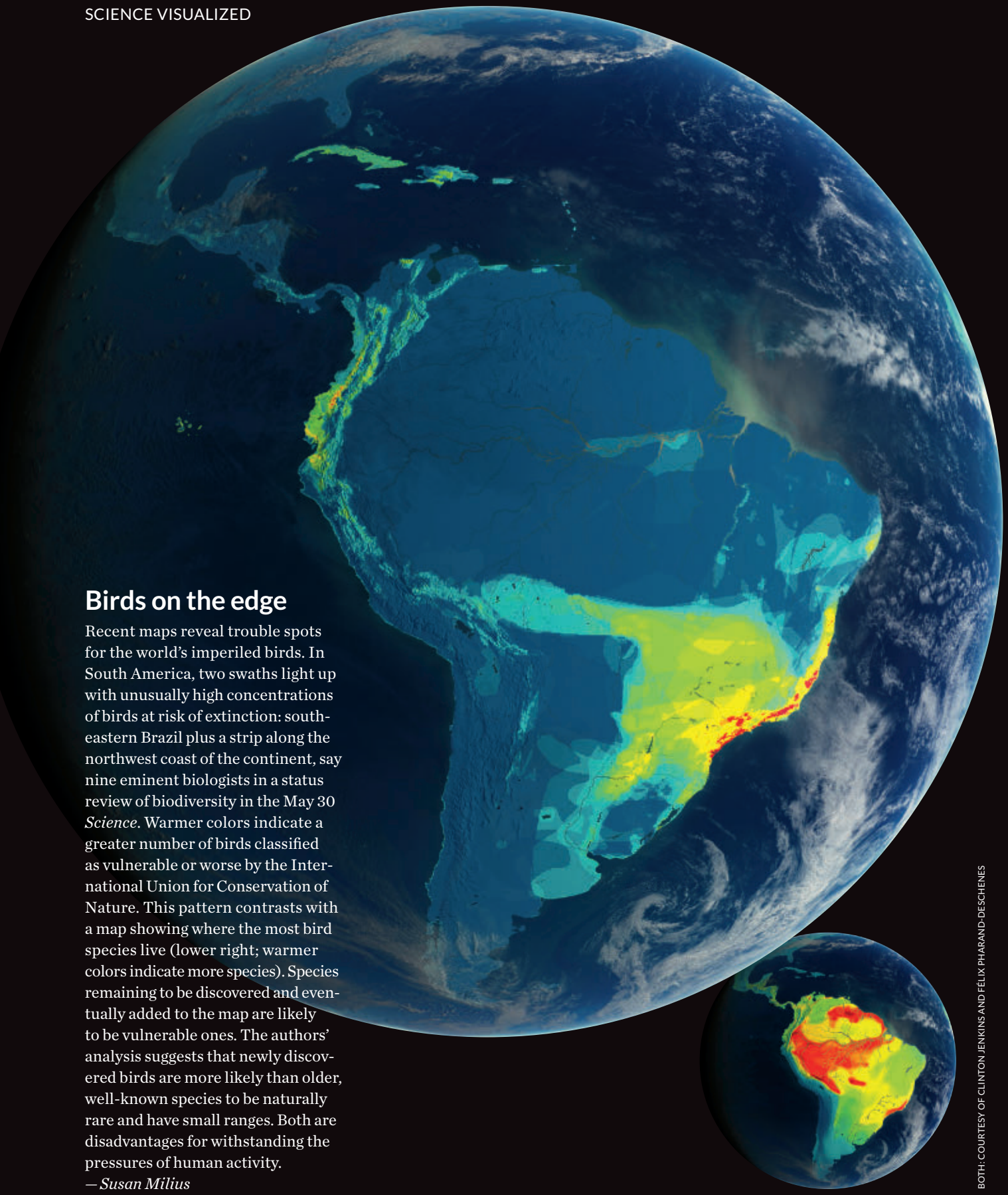
In "A new twist on a twist" (SN: 6/14/14, p. 32) ***Rachel Courtland*** *described how researchers are striving to create an imperfect helix. A change in a normal coil's rotational direction, called a perversion, produces a shape known as a hemihelix.*

"Also known as 'the thing that happens to every Slinky, ever,'" joked **Jake Nielsen**. Readers' familiarity with the twisted twists didn't end with toys. "To think, all these years the secret to DNA structure was right there as we tried to unwind our old phone cords," wrote **Scott McCain**. "The longer the cord, the worse it was — I wonder if long DNA strands suffer the same fate?"

Frogs' fancy footwork

"Indian frogs kick up their heels" (SN: 6/14/14, p. 5) *announced the discovery of a handful of new species in which some males catch a female's attention with a toe-tapping, high-kicking routine.*

The frogs reminded **Jean Mann**, and some *Science News* editors, of another well-known dancing amphibian: "This behavior was surmised by Warner Brothers as early as the mid-1950s, and aptly illustrated in the depiction of the character Michigan J. Frog. Michigan's repertoire, of course, included not only leg-kicking behavior, but also involved top hat–wearing, cane-twirling and singing. Only time will tell if these additional mating behaviors predicted by Warner Brothers are ever observed in the wild."



Birds on the edge

Recent maps reveal trouble spots for the world's imperiled birds. In South America, two swaths light up with unusually high concentrations of birds at risk of extinction: southeastern Brazil plus a strip along the northwest coast of the continent, say nine eminent biologists in a status review of biodiversity in the May 30 *Science*. Warmer colors indicate a greater number of birds classified as vulnerable or worse by the International Union for Conservation of Nature. This pattern contrasts with a map showing where the most bird species live (lower right; warmer colors indicate more species). Species remaining to be discovered and eventually added to the map are likely to be vulnerable ones. The authors' analysis suggests that newly discovered birds are more likely than older, well-known species to be naturally rare and have small ranges. Both are disadvantages for withstanding the pressures of human activity.

—Susan Milius

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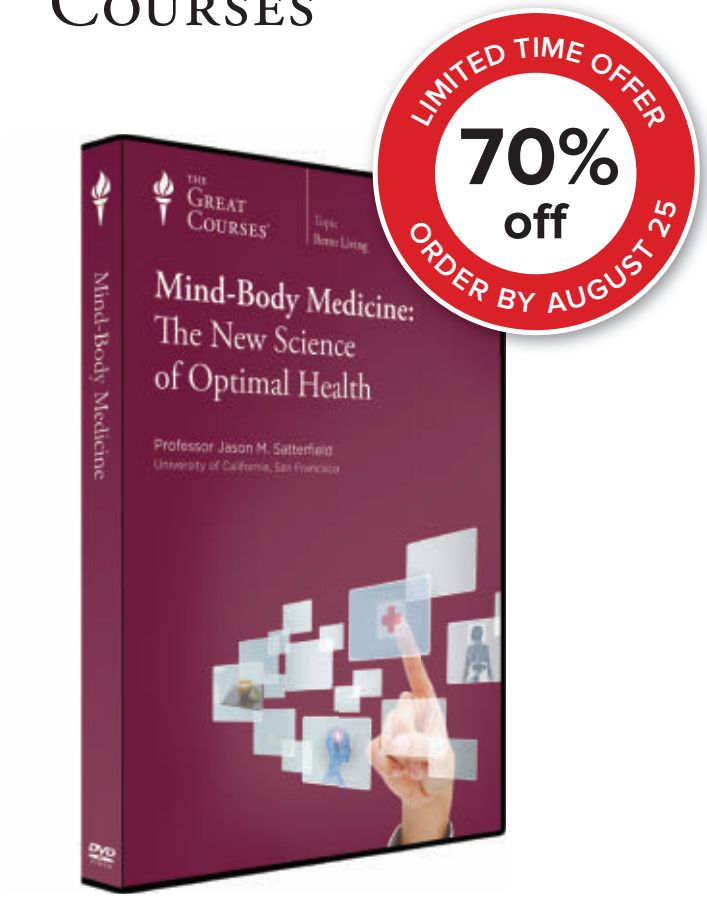

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