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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ JUNE 29, 2013

Invasive Mosquito Brings More Than a Bite

Roaches' Bitter-Sweet Switcheroo

Mars Trip Packs Radiation Wallop

After the Higgs

Monumental discovery fails to point toward new physics

THE REVIEWS ARE IN:

"AMAZING"
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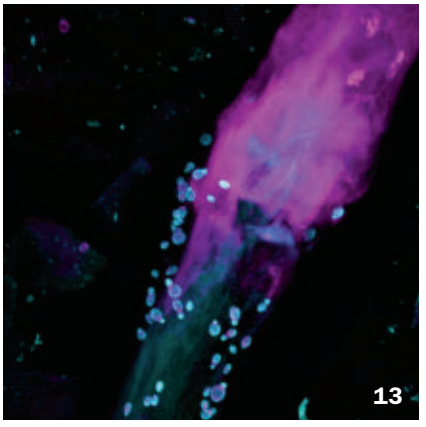

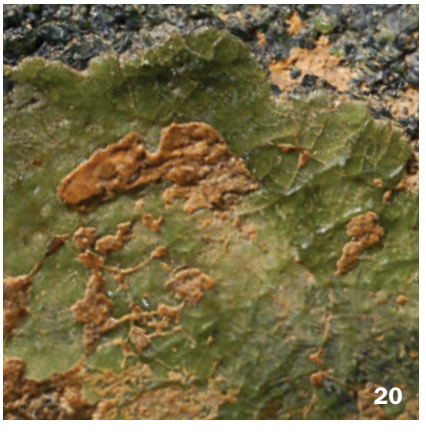

ScienceNews

In The News

Features

Departments

COVER The ATLAS detector is one of two experiments designed to find and study the Higgs boson at the Large Hadron Collider near Geneva. *Peter Ginter*

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FROM THE EDITOR

Be humble in the face of nature's awesomeness

SANDY SCHAEFFER

No one said that figuring out the most basic constituents of the universe — the fundamental particles that make up matter and transmit forces — would be easy. But the Large Hadron Collider seems up to the task: the underground machine shoots two beams of protons in opposite directions around a 27-kilometer ring buried 100 meters below the border region of France and Switzerland. The protons are traveling fast, reaching speeds close to that of light. When the proton beams collide, the smashup converts some of their energy into mass, producing, however fleetingly, a variety of particles. Some of these particles are old school — quarks, electrons. Once in a great while, the collision creates something new and exotic.

In the three years since the LHC began operations, its detectors have found three new particles: the Chi-b(3P), a mix of a quark and an antiquark; the Xi(b)*, a mix of three quarks; and, most celebrated by far, the Higgs boson, the only fundamental particle of the three. Chi-b(3P) and Xi(b)* are composites, made up of other fundamental particles, so while interesting they are not game-changers. It turns out, as physics writer Andrew Grant describes on Page 22, that the Higgs isn't as much of a game-changer as some had hoped. Though a historic discovery, it's clear that the Higgs particle revealed by the LHC experiments doesn't immediately suggest any major revisions to existing descriptions of the universe.

Reporting the story, Grant found himself intrigued by the notion that the LHC's success also contains a kernel of failure. Even when all goes right, as it did with the Higgs boson, new insights are not guaranteed. Now, many scientists are looking toward LHC's next round of experiments, set to begin in 2015, which will notch up the collision energies to levels that physicists hope will reveal something hitherto unknown.

To me, the LHC still counts as a wild success. It would be hubris to think that all unknowns will yield easily and quickly to human probing. At higher energies, the LHC will offer a peek at subatomic realms never before glimpsed. But it's still just a peek. The universe is replete with unknowns. Huge progress has been made in revealing many of those, but some humility in the face of nature's awesomeness is required. We should be energized, not discouraged, if we can't see the entire vista through the lens of just one tool.

— Eva Emerson, Editor in Chief

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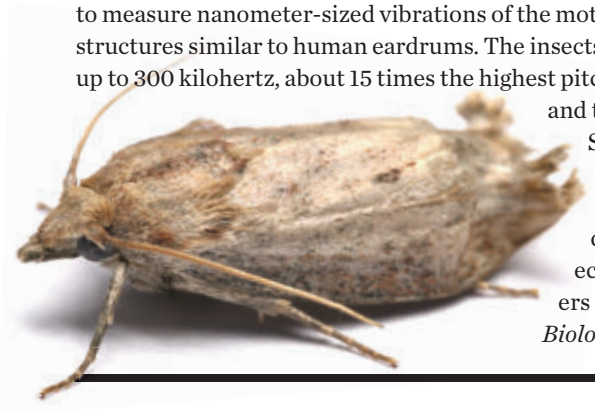
The –est | BEST LISTENING SKILLS

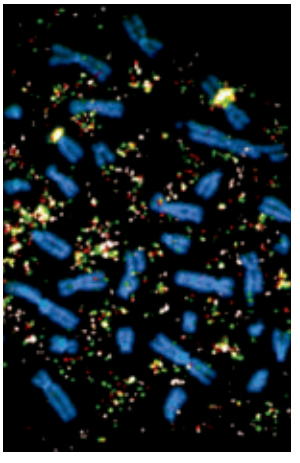
To avoid becoming a snack for bats, one moth species has evolved ears capable of hearing the highest pitched sounds of any animal. Researchers in Scotland played high-pitched tones for greater wax moths (one shown) and used a laser to measure nanometer-sized vibrations of the moths' tympanal membranes, structures similar to human eardrums. The insects could tune into frequencies up to 300 kilohertz, about 15 times the highest pitch detectable by human ears and twice that of some whales. Supersensitive hearing lets wax moths eavesdrop on bats that squeak out calls at frequencies up to 212 kilohertz to echolocate prey, the researchers report in the August 23 *Biology Letters*. — *Allison Bohac*



Say What?

CHROMOTHRIPSIS *KRO-mo-THRIP-sis*\ *n.*

The catastrophic shattering of a chromosome, which can spark cancer development. All or part of a chromosome may break into pieces, some of which reassemble. Leftover fragments can form DNA circles (colored dots, right) that replicate wildly. If the circles contain cancer-causing genes, their proliferation fuels tumor growth. Disintegrating chromosomes may be the cause of many childhood cases of medulloblastoma, an often-deadly brain cancer, researchers in Germany and England report in the March 14 *Cell*. — *Tina Hesman Saey*



50 Years Ago

Excerpt from the June 29, 1963, issue of *Science News Letter*

BALLOON CLEARS ARTERIES

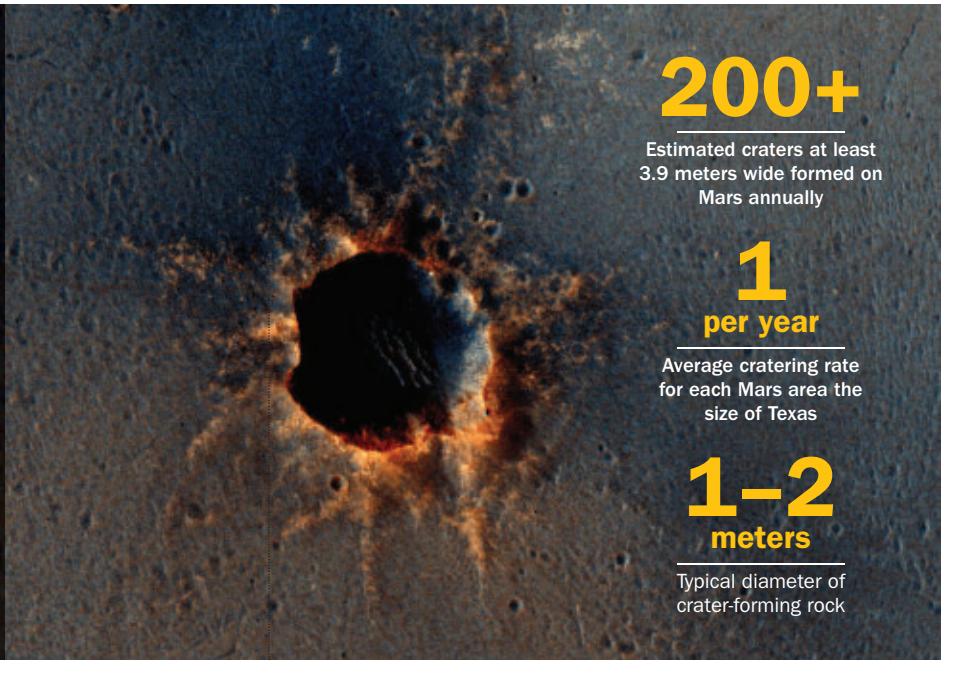
A tiny balloon inserted into dangerously clogged arteries at the tip end of a long tube is saving lives by sweeping away the blood clots. A 29-year-old resident in surgery invented the device.... It has been used on 22 patients at the Good Samaritan Hospital in Cincinnati. Dr. Thomas J. Fogarty, now at the University of Oregon Medical School, originated the new ... balloon-catheter technique.... A small incision is made either in the groin or other location nearest the clot, and the tube is inserted as far as it will go. The balloon inflates and is filled with blood, carrying the clot or clots with it when it is withdrawn.

UPDATE: The balloon catheter became the standard of care for blocked coronary arteries and paved the way for angioplasty and stents. Balloons are also now used to clear sinuses, urinary tracts and more. As for inventor Thomas Fogarty, today he heads a research institute in California and holds 135 surgical patents.

Science Stats

MARS SMACKERS

Using images from NASA's Mars Reconnaissance Orbiter, scientists have found that the Red Planet gets just one-tenth to one-third as many new scars each year as previously thought. Still, far more pieces of debris — mostly bits of asteroids or comets — hit the surface of Mars compared with Earth (see Page 20). Entering objects are less likely to burn up in the thin Martian atmosphere, so more make it to the surface.



200+

Estimated craters at least 3.9 meters wide formed on Mars annually

1 per year

Average cratering rate for each Mars area the size of Texas

1–2 meters

Typical diameter of crater-forming rock

FROM TOP: D. KUCHARSKI K. KUCHARSKA/SHUTTERSTOCK; P. STEPHENS *ET AL*./*CELL* 2011; JPL-CALTECH/NASA, UNIV. OF ARIZONA

“The kinds of radiation that someone going to Mars would experience are different from any radiation that we receive here on Earth.” —DAVID BRENNER, PAGE 8

In the News

STORY ONE

DSM-5 enters the diagnostic fray

Fifth edition of the widely used psychiatric manual focuses attention on how mental disorders should be defined

By Bruce Bower

To a cacophony of boos, so-whats and even a few cheers, the American Psychiatric Association released the fifth edition of its *Diagnostic and Statistical Manual of Mental Disorders, DSM-5,* on May 18 at its annual meeting in San Francisco.

Controversy always flares when psychiatrists redefine which forms of human suffering will count as real and reimbursable by medical insurance. This time, though, the stakes are raised by competing efforts to classify mental disorders.

The World Health Organization plans to release a new version of its own system for identifying mental ailments in 2015 as part of the 11th edition of the *International Classification of Diseases.* It's not clear how much the *ICD* will mirror *DSM-5.*

Some differences have already emerged. Clinicians working on the international classification report in the May 11 *Lancet* that they plan to pare down the number and types of symptoms needed to diagnose posttraumatic stress disorder, or PTSD, and add a severe form of the condition triggered by long-lasting or frequent harrowing events. These departures from *DSM-5* would make it easier for mental health workers to help victims of conflict and natural disasters in poor, non-Western countries, say psychologist Andreas Maercker of the University of Zurich and his colleagues.

Meanwhile, the National Institute of Mental Health in Rockville, Md., has launched the Research Domain Criteria, or RDoC, a 10-year effort to define mental disorders based on behavioral and brain measures. *DSM*'s approach, by contrast, relies on rulings by groups of psychiatrists about which symptoms characterize particular disorders. The approach has yielded imprecise diagnostic labels that advance neither treatment nor research, argued psychiatrist and NIMH director Thomas Insel in an April 29 blog post.

Insel's statement raised hackles at the psychiatric association. On May 13, Insel and American Psychiatric Association president Jeffrey Lieberman together released a conciliatory statement declaring that *DSM-5* and RDoC complement each other on the path to better diagnoses for mental disorders.

RDoC will fund research that examines how lots of factors — fear, attention, parenting styles and neighborhood qualities, to name a few — interact to produce symptoms that may or may not jibe with *DSM-5* categories, said

A thermometer for the psyche The American Psychiatric Association's *Diagnostic and Statistical Manual* has grown from a basic attempt to codify mental illnesses into a complex classification system that is used throughout health care.

Version	*DSM-I*	*DSM-II*	*DSM-III*	*DSM-IV*	*DSM-5*
Year	1952	1968	1980	1994	2013
Number of disorders	102	182	265	297	About 300
Highlight	The first edition relied heavily on the tradition of Sigmund Freud and other proponents of psychodynamic theory.	In 1973, the sixth printing was revised to exclude homosexuality as a mental disorder. A 1974 study found that clinicians using the manual often reached different diagnoses for the same patient.	The term “neurosis” disappeared from the manual, and many diagnoses were divided into multiple subcategories defined by symptom lists.	The increasing scope of the *DSM* led a 2005 study to conclude that roughly half of all Americans will meet the criteria for mental illness at some point during their lives.	Among other changes, the new edition eliminates subtypes such as paranoid and catatonic from the schizophrenia definition; adds gender dysphoria as a diagnostic class and adds several new disorders, including premenstrual dysphoric disorder, hoarding disorder, gambling disorder and excoriation disorder, in which people compulsively pick at themselves.

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the RDoC project's director, psychologist Bruce Cuthbert, at the Association for Psychological Science annual meeting in Washington, D.C., on May 23. Not everyone with, say, autism spectrum disorder or PTSD has the same underlying problems, he says.

"RDoC is about understanding the biology and the psychology of mental illness," Cuthbert says. "*DSM-5* is sloppy on both accounts."

DSM-5 has also gotten hammered — especially by psychiatrist Allen Frances, chair of the task force that produced the previous *DSM* — for allegedly turning some common forms of distress into medical conditions, encouraging physicians to prescribe unneeded psychoactive medications.

Normal grief will become an illness in *DSM-5*, Frances says. Mourning and eventual acceptance of a loss will be replaced, in his view, by "pills and superficial medical ritual."

As with any highly upsetting event, a loved one's death triggers major depression in some people, responds University of Pittsburgh psychiatrist David Kupfer, who chaired the psychiatry association's *DSM-5* task force. The new manual makes clear that in grief, painful feelings come in waves and self-esteem is preserved; in depression, dark moods endure and include feelings of worthlessness and self-loathing. Clinicians should be able to separate grief from depression, Kupfer says.

When the process of developing *DSM-5* started 14 years ago, those involved were optimistic that biological markers of mental disorders were just around the corner. To their disappointment, scientific validation of *DSM-5* categories, from schizophrenia to major depression, remains a distant goal.

"*DSM-5* isn't perfect, but it is the best we can do with the science available," Kupfer says.

Field trials leading up to the final version of *DSM-5* assessed the extent to which 279 clinicians trained in the new manual and prompted by a computerized checklist agreed on diagnoses for nearly 2,000 patients at seven adult and four child psychiatric hospitals. Results were mixed.

Good agreement existed about which patients qualified for conditions such as PTSD, the most severe form of bipolar disorder, borderline personality disorder, autism spectrum disorder and attention-deficit hyperactivity disorder. But discord reigned when the clinicians tried to determine which patients met *DSM-5* criteria for major depression, generalized anxiety disorder, antisocial personality disorder and several other ailments.

> **"*DSM-5* isn't perfect, but it is the best we can do with the science available."**
> **DAVID KUPFER**

Many psychiatric disorders include symptoms of depression and anxiety that can complicate diagnostic and treatment decisions. Fuzzy boundaries separating many mental ailments mean that, as with previous manuals, most people deemed to have one *DSM-5* disorder will also have one or more additional disorders, Kupfer says.

Kupfer and his colleagues faced intense scrutiny for revising how autism and related conditions are diagnosed. A tightened autism definition in *DSM-5* has raised fears among advocacy groups that some children with this condition will go undiagnosed and be denied special school services. *DSM-5* folds four previously separate categories on the autism spectrum, including Asperger syndrome, into an umbrella term, autism spectrum disorder. Under *DSM-5*, individuals with this diagnosis get rated on the severity of their social problems, the restrictiveness of their interests, and the extent to which they engage in repetitive behaviors. Language difficulties can coexist with these symptoms.

No one knows how, or whether, these changes will affect autism rates. ■

Back Story

CHANGING NOTIONS OF AUTISM

As autism rates have climbed, physicians and parents have taken an increasing interest in how the *DSM* defines the condition. Before 1980 the book didn't offer separate criteria for autism, but mentioned it within the entry for childhood schizophrenia.

DSM-I
The final sentence in the entry for "Schizophrenic reaction, childhood type," dictates that "psychotic reactions in children, manifesting primarily autism, will be classified here."

DSM-II
The second edition of the manual takes a similar approach to that of the first. Autism appears in the entry for "Schizophrenia, childhood type," which notes that "the condition may be manifested by autistic, atypical and withdrawn behavior."

DSM-III
Autism is broken out as its own disorder in an entry headed "Infantile Autism." There are six criteria for the diagnosis, including onset before 30 months of age, pervasive lack of responsiveness to other people and gross deficits in language development.

DSM-III-R
Now called autistic disorder, the requirements for diagnosis are much more complex. The manual specifies 16 characteristics grouped into three categories. At least eight of the 16 are required for a diagnosis, with at least two from one category and one from each of the other two.

DSM-IV and DSM-IV-TR
These editions require six or more characteristics from three categories, with at least two from the first and one from each of the second two, for an autism diagnosis. The criteria primarily focus on impairments in social interaction, communication and behavior.

DSM-5
Previous editions identified a number of developmental disorders similar to autism, including Asperger syndrome, childhood disintegrative disorder and pervasive developmental disorder not otherwise specified. This edition largely combines those categories into a single entity labeled autism spectrum disorder, though a separate diagnosis called social communication disorder also exists.

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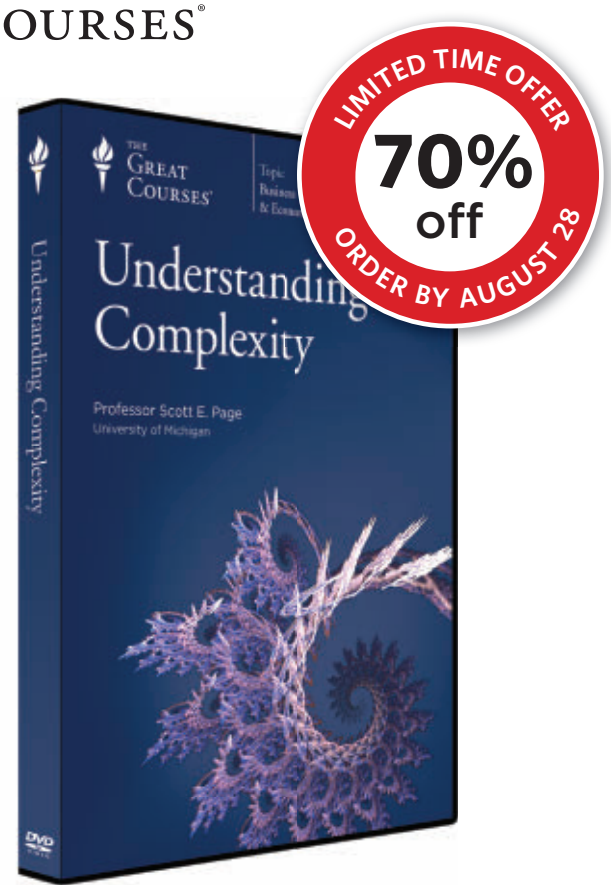

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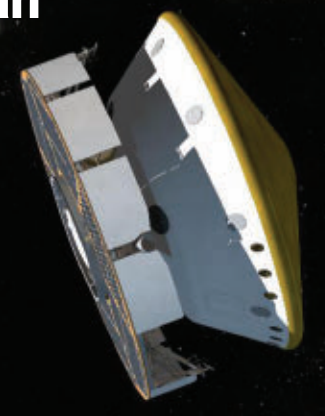
Atom & Cosmos

1 sievert — Typical career radiation limit for astronauts

0.66 sieverts — Estimated in-flight radiation dose on Mars round-trip

Mars trip would mean big radiation dose

Curiosity instrument confirms expectation of major exposures



A detector on the Mars Science Laboratory (illustrated) finds that a round trip to Mars comes with a 0.66-sievert radiation dose.

By Cristy Gelling

Astronauts making the journey to and from Mars would face many new and uncertain dangers. Now the Mars rover Curiosity has reduced uncertainty about one of them: radiation exposure.

Measurements of radiation reaching the shielded interior of the spacecraft that carried Curiosity to Mars indicate that an astronaut on a yearlong round-trip to the planet would be exposed to around two-thirds of the career radiation limit that some space agencies set. Any time spent on the planet and outside the spacecraft would add more exposure.

The radiation dose researchers calculated was 0.66 sieverts, they report in the May 31 *Science*; the agencies' limit for astronauts is 1 sievert.

On Earth, a 1-sievert dose increases cancer risk by about 5 percent. Scientists don't know whether space radiation would have similar effects.

"The kinds of radiation that someone going to Mars would experience are different from any radiation that we receive here on Earth, so we don't have direct experience of what the health risks are," says David Brenner, director of the Center for Radiological Research at Columbia University.

Previous measurements of the radiation in space have been made outside spacecraft. Good luck enabled the new interior measurements, which were conducted with the Radiation Assessment Detector, a coffee-can-sized device attached to the Curiosity rover. Its designers intended the device to measure radiation on the surface of Mars, not inside the spacecraft that ferried it there.

"We realized as we were getting ready to launch that we had this serendipitous opportunity to also measure the radiation environment inside the spacecraft during our cruise," says coauthor Donald Hassler of the Southwest Research Institute in Boulder, Colo.

The measurements confirmed predictions that 95 percent of a Mars-bound astronaut's radiation dose would come from galactic cosmic rays. Humans are normally shielded from such rays by Earth's atmosphere, so their effects on health are uncertain, Brenner says.

Still, he says, the measurements are useful because they were close to theoretical predictions of radiation exposure. ■

Moon's water bears Earth's imprint

Ratio of deuterium to hydrogen suggests a common source

By Andrew Grant

Water trapped deep inside the moon apparently came from the same source as water on Earth. New research suggests that the moon seized a healthy supply of water from Earth when the satellite formed in the aftermath of a cataclysmic collision 4.5 billion years ago.

In the new study, published May 9 in *Science*, Brown University geochemist Alberto Saal and his team analyzed two moon rocks returned by Apollo astronauts in the 1970s. The rocks probably formed from buried magma that was forced to the surface during volcanic eruptions early in the moon's lifetime.

The team measured concentrations of hydrogen and deuterium, a form of hydrogen with an extra neutron. The ratio of these two isotopes reflects the origin of water. Water on most comets that formed in the outer solar system has a higher deuterium-to-hydrogen ratio than terrestrial water does.

The deuterium-to-hydrogen ratio of the Apollo samples is very similar to that of water on Earth and in meteorites, suggesting that water on Earth and the moon originated from the same meteorite impacts billions of years ago. "The reservoir of water for Earth and the moon is the same," Saal says.

Not everyone agrees. Francis Albarede, a geochemist at École Normale Supérieure in Lyon, France, notes that the rocks Saal analyzed are far richer in water and other volatile molecules than other Apollo samples. He says that there is no way to prove they are representative of the infant moon's composition.

"They are rogue samples," Albarede says. "I don't think they represent the interior of the moon, so I don't think we can say anything about the moon's water content."

JPL-CALTECH/NASA

Health & Illness

"When you disrupt your clock, you are more prone to possible infection." —PAOLO SASSONE-CORSI

Timing key in fighting infection

Response to salmonella in mice is more severe before noon

By Meghan Rosen

A run-in with salmonella may be worse at dawn than at dusk, at least for mice.

Mice fed the bacteria in the morning developed more severe infections than mice fed salmonella at night, researchers report May 28 in the *Proceedings of the National Academy of Sciences*.

"This is the first study that has infected mammals with a pathogen and seen this effect," says Laura Roden, a molecular chronobiologist at the University of Cape Town in South Africa, who has found clock-driven immune responses in plants. Other researchers have observed a similar phenomenon in fruit flies.

"We've gone from flies to plants, and now we have mammals," she says.

From plants to humans, almost all organisms use molecular timekeepers called circadian clocks to set daily rhythms. Out-of-sync clocks in people can cause jet lag and have even been linked to depression (*SN: 6/15/13, p. 12*).

Scientists already knew that mammalian clocks set sleep hours, eating patterns and hormone cycling. To find out whether clocks also influence response to infection, a team led by Manuela Raffatellu and Paolo Sassone-Corsi at the University of California, Irvine infected mice with salmonella at either 10 a.m. or 10 p.m., and then compared signs of gut inflammation.

Mice infected at night fared much better than those infected during the day. "Some of them looked like they had never been infected," Raffatellu says. In contrast, morning-infected mice had inflamed large intestines clogged with throngs of bacteria-fighting immune cells.

Because mice are nocturnal, a mid-morning meal for them is like a midnight snack for humans. Shaking up the animals' normal feeding and sleeping patterns might explain the differences in illness. "When you disrupt your clock, you are more prone to possible infection," Sassone-Corsi says.

The team repeated their experiment in mice genetically engineered to have broken clocks. These mice had similar reactions no matter the time of infection, Raffatellu says. Without a working clock, mice can't respond to salmonella infection in quite the same way as mice with functioning timekeepers do.

Human immune systems might also respond to pathogens differently during day and night. If they do, says neurobiologist Alec Davidson of the Morehouse School of Medicine in Atlanta, giving vaccines might be more effective at certain times of day.

Flu spreads via airborne particles

Hand washing goes only so far in retarding transmission

By Tina Hesman Saey

Half of flu cases arise when people inhale tiny particles that float in the air, an international group of researchers reports June 4 in *Nature Communications*. The finding flies in the face of conventional wisdom, which holds that nearly all influenza spreads by large droplets that sick people release when they sneeze or cough. Those large droplets, the theory went, get on people's hands and transmit the virus from there.

While scientists knew that small particles called aerosols represent possible routes of disease spread, many thought that cases almost never arise that way.

Public health officials say that knowing how often flu transmits via the air is important for controlling outbreaks,especially when dealing with pandemic strains for which no vaccine exists.

Benjamin Cowling, an infectious disease epidemiologist at the University of Hong Kong, and his colleagues studied how flu spread among 782 families in Bangkok and Hong Kong during regular outbreaks from 2008 through 2011. Some families received liquid soap and instructions about proper hand hygiene. Some also got surgical masks. Together, washing hands and wearing surgical masks should block transmission of the virus through the large-droplet route.

"What it really says is you can't rule out aerosols." DONALD MILTON

But surgical masks don't block airborne flu. So the researchers assumed that people who got sick even though they wore the masks and washed their hands probably caught the flu by inhaling small particles. And to work out how the families without soap and masks caught the flu, the researchers further assumed, based on previous lab studies, that people who got sick through the airborne route were more likely to develop classic flu symptoms such as fevers and coughs. People who catch flu via large droplets typically get milder symptoms.

Aerosol transmission caused 33 percent to 92 percent of cases in Hong Kong and 55 percent to 98 percent in Bangkok, the team calculated.

"There's a lot of uncertainty in that data," says Donald Milton, an environmental health scientist at the University of Maryland's School of Public Health in College Park. But the exact proportion of cases due to airborne spread doesn't matter as much as the evidence that aerosols are an important route of transmission, he says. "What it really says is you can't rule out aerosols." ■

Life

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How roaches lost taste for sugar

Molecular tweak makes glucose-baited traps bitter to bugs

By Susan Milius

Cockroaches that don't fall for traps' sweet poisons have evolved taste cells that register sugar as bitter.

In certain groups of the widespread German cockroach (*Blattella germanica*), nerve cells that normally detect bitter, potentially toxic compounds now also respond to glucose, says entomologist Coby Schal of North Carolina State University in Raleigh. The "bitter" reaction suppresses the "sweet" response from other nerve cells, and the roach stops eating, Schal and his colleagues report in the May 24 *Science*.

This quirk of roach taste explains why glucose-baited poison traps stopped working among certain roaches, Schal says. Such bait traps combining a pesticide with something delicious became popular during the mid-1980s. But in 1993, Jules Silverman, also a coauthor on the new paper, reported roaches avoiding these once-appealing baits.

"This is a fascinating piece of work because it shows how quickly, and how simply, the sense of taste can evolve," says neurobiologist Richard Benton of the University of Lausanne in Switzerland.

Roaches don't detect taste with tongues, as people do, but instead use hairlike structures. Coauthor Ayako Wada-Katsumata presented various flavors and measured the responses from two types of the hairs' nerve cells, the GRN1 cells, which detect sugars, and the GRN2 cells, which normally warn of bitter compounds such as caffeine.

In roaches that shied away from glucose, the sweet-detecting cells kept firing when exposed to glucose and other sugars. What differed in these roaches were the bitter-detecting GRN2 cells, which responded to glucose as well as to bitter compounds. In these insects, the bitter signal overwhelmed that of the sweet detector.

Schal imagines the glucose aversion arising from scenarios such as a chance mating with some as-yet-unidentified roach species that doesn't eat glucose. Or maybe the bait traps triggered the spread of rare genetic variations in roach taste cells left over from before the species moved in with people. Those outdoor ancestors might have evolved a distaste for glucose because so many plants defend themselves with compounds called glucosides, blends of sweetness and something noxious.

An aversion to glucose doesn't mean distaste for all sugars. The new study found roach enthusiasm for fructose, although Schal has heard that other roaches may be averse to it.

What pest-control manufacturers put in their roach baits now, and whether some still use glucose, isn't public, Schal says. But humankind's arms race with cockroaches could have started long ago, "in the caves," he says. In this back-and-forth struggle, it's important "to understand what the cockroach is doing from a molecular basis."

Fossil stokes bird-origin feud

Specimen may be first avian or just another feathered dino

By Rachel Ehrenberg

A birdlike fossil that dates to roughly 155 million years ago is ruffling the feathers of some paleontologists. At issue is whether the fossil is a dinosaur, an early bird or something in between.

"This new animal is the most primitive bird in the world," says paleontologist Pascal Godefroit of the Royal Belgian Institute of Natural Sciences. He and an international team of colleagues describe the new specimen May 29 in *Nature*. The fossil comes from northeastern China's Tiaojishan formation and is named *Aurornis xui*.

Not everyone agrees with Godefroit's interpretation. "This is very birdlike, but it is not yet a bird," says paleontologist Luis Chiappe of the Natural History Museum of Los Angeles County.

If *Aurornis* is in fact a bird, the specimen may have implications for scientists' view of *Archaeopteryx*, the most famous birdlike dinosaur (or dinosaur-like bird). A controversial 2011 paper argued that *Archaeopteryx* and two other specimens were feathered dinosaurs, not birds. But the family tree that Godefroit's team built suggests that *Archaeopteryx* is evolutionarily younger than *Aurornis*. So if *Aurornis* is a bird, as Godefroit argues, then *Archaeopteryx* is too.

There isn't any well-preserved plumage on the new specimen, but Godefroit says that the shapes of bones in the fossil's pelvic region are part of what make him think the animal was a bird.

Still, the fossil's forelimb is much shorter than that of true birds, Chiappe says. That detail, he says, along with the fossil's longish reptilian tail and several skull features, suggest it is a dinosaur. ■

A fossil from China may represent the oldest known member of the avian line.

FROM TOP: SARAH2/SHUTTERSTOCK; THIERRY HUBIN/IRSNB

Imported frogs spread disease

African species implicated in amphibian fungal pandemic

By Susan Milius

Frogs once imported to the United States for pregnancy testing could have spread a fungus deadly to many native amphibian species, new evidence suggests.

From about the 1940s into the 1970s, medical labs tested for pregnancy-associated hormonal changes by injecting human urine into African clawed frogs. If a woman was pregnant, traces of hormones in her urine would accelerate egg development in the frog. These lab animals sometimes escaped or were set free, allowing African clawed frogs to get a toehold in North America.

A new study using preserved museum specimens of free-living African clawed frogs (*Xenopus laevis*) collected in California finds that three out of 23 carried the fungus *Batrachochytrium dendrobatidis*. The frogs don't succumb themselves, but they can spread the fungus to their more vulnerable neighbors.

The fungus also showed up in about 3 percent of 178 specimens of six *Xenopus* species collected in Africa as far back as the 1930s, Vance Vredenburg of San Francisco State University and colleagues reported May 15 in *PLOS ONE*. But researchers don't know whether the strain in the African specimens matches that in the California frogs.

The fungus is now blamed for wiping out or causing declines in about 200 amphibian species. The trade in African clawed frogs has clearly helped move the fungus around the world, says Matthew Fisher of the Imperial College School of Public Health in London. He and colleagues have shown that African *Xenopus* frogs in a zoo breeding facility passed the infection to other animals that were later released on the island of Majorca.

Imported African clawed frogs (shown) may have spread a fungal disease among amphibians in North America.

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Genes & Cells

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Genes may be associated with education level

Significance of tiny effect is debated by geneticists

By Tina Hesman Saey

Genetic factors may exert a tiny influence on how much schooling a person ends up with, a new study suggests.

But the main lesson of the research, experts say, should be that attributing cultural and socioeconomic traits to genes is a dicey enterprise.

"If there is a policy implication, it's that there's even more reason to be skeptical of genetic determinism," says sociologist Jeremy Freese of Northwestern University in Evanston, Ill.

Published May 30 in *Science* by a group of more than 200 researchers, the study does mark the first time genetic factors have been reproducibly associated with a social trait, says Richard Ebstein, a behavioral geneticist at the National University of Singapore. "It announces to social scientists that some things they've been studying that make a difference to health and life success do have a base in genetics."

But even if the study does survive further inspection — and many similar links between genes and social characteristics have not — the results account for no more than 2 percent of whatever it is that makes one person continue school while someone in similar circumstances chooses to move on to something else.

Previous studies comparing twins and family members have suggested that not-yet-identified genetic factors can explain 40 percent of people's educational attainment; factors such as social groups, economic status and access to education would explain the other 60 percent. That percentage attributed to genetics is similar to the heritability of physical and medical characteristics such as weight and risk of heart disease. That makes a hunt for the genetic factors underlying educational attainment an attractive prospect.

Researchers from the Social Science Genetic Association Consortium set up an experiment that searched 2 million variable locations known as SNPs in the DNA of 101,069 people for variants that appeared to be linked to educational attainment. They found only one that was associated with years of education. Two more SNPs were associated with whether a person had finished college. The researchers then replicated the findings by doing the same sort of analysis on another 25,490 people's DNA and finding that the same three SNPs popped up.

> "This tiny, tiny, tiny signal is completely pointless and will be misinterpreted."
> DAVID GOLDSTEIN

Considering the apparent effect of all 2 million SNPs, the analysis can account for only about 2 percent of the difference between those with the highest and lowest levels of education. The single SNP with the strongest effect explains just 0.022 percent of the variation in educational attainment in the people sampled. The SNP most strongly associated with finishing college gives people about a 1.8 percentage point difference in the odds of completing a degree.

It's common for genetic variants to have only weak influences on whether someone will develop a particular trait: Variants associated with height, for instance, exert about a 0.4 percent influence. But even scientists used to tiny effects have expressed disappointment at the small contribution of these variants. "It's not even like a cup half full," says Robert Plomin, a behavioral geneticist at Kings College London. "It's a cup that is less than 1 percent full."

Critics of the study don't quibble with the way it was done. Their concern — one the authors share — is that there is no gene "for" going to college. The scientists used educational attainment because data on it are available for large numbers of people. But it is a proxy for something else — perhaps differences in the way peoples' brains work or in personality traits like perseverance that could help people get through school. That means it is impossible to know what the researchers are really measuring.

The researchers caution that they have not identified specific genes, but merely found variants implicating some regions of the genome in educational attainment. Even if they had pinpointed a particular gene, "it doesn't tell you the mechanism by which the gene is having a relationship with education," says study coauthor Daniel Benjamin, an economist at Cornell University.

At best, the study may set an upper limit of effects scientists can expect to find in genetic studies of social traits, says Anna Need, a neuropsychiatric geneticist at Imperial College London. If a study of so many people can find only marginal genetic associations, smaller studies claiming to have uncovered genes strongly linked to political views or other social values are probably nonsense, she says. She fears that people will misinterpret the study to mean that genes determine education levels.

It is a fear shared by Duke University geneticist David Goldstein. "This tiny, tiny, tiny signal is completely pointless and will be misinterpreted," he says. "Now we're beating the poor methodology to a point that it will confess to pretty darn near anything."

The study barely clears a widely accepted statistical hurdle for ruling out apparent associations that actually occur by chance. Some studies that skim that hurdle turn out not to be true when later repeated, especially when the trait is not clearly genetic. "This is literally right on the border," Goldstein says, and "has a real good chance of being wrong." ■

2 million Number of DNA points sampled in educational attainment study

2 percent Maximum share of variance in education level explained

How twins go their own ways

Genetically identical mice diverged based on experience

By Puneet Kollipara

Same genes, same environment, different behavior.

Identical twin mice sharing the same mazelike environment developed distinct personalities based on how much they explore their surroundings, researchers report in the May 10 *Science*. Those differences were reflected in the animals' brains after they died.

Twins become more and more different as life goes on, even when they grow up together. Scientists have recognized that having distinct experiences within the same environment might boost such personality differences, but that's difficult to test in humans.

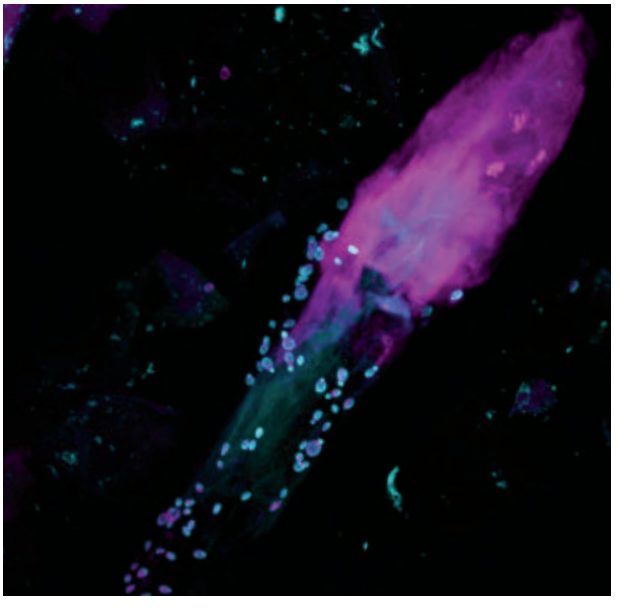
Researchers led by Gerd Kempermann of the Center for Regenerative Therapies Dresden in Germany put 40 genetically identical female mice in an elaborate cage and observed their behavior. The cage had multiple levels linked together by tubes and contained toys and other features that the animals could explore. The researchers equipped each mouse with a microchip that tracked its location, using the animals' movements as a measure of exploratory behavior. Initially, the mice differed only slightly in their tendency to roam. As they grew older, all tended to explore more often, but the differences among the mice grew more pronounced.

After three months, the researchers removed and cross-sectioned the animals' brains, counting how many neurons had been spawned in the hippocampus, a brain region important in navigation and memory. As a control, researchers did the same experiment on mice in a cage that had fewer toys, twists and turns. On average, mice in the richer experimental environment generated about three times as many neurons in their hippocampi as the control mice did. That suggested that the complex environment itself could promote neuron generation.

Within the test group, some of the mice explored a wider area than others did. The more the mice explored, the more new neurons they generated on average, the researchers found. While it's not clear that the exploring was what caused the boost in neurons, Kempermann says, further experiments in which researchers manipulate mouse behavior and observe neuron generation, or vice versa, could demonstrate cause and effect.

Despite being genetically identical, the mice weren't behaviorally identical to begin with: They almost certainly had subtle brain differences that made some explore more than others, says Fred Gage, a neuroscientist at the Salk Institute for Biological Studies in La Jolla, Calif. "What's interesting for me is, what is that initiating event that contributes to the differences?" he says.

Kempermann and colleagues say a whole host of factors could produce these differences, but they don't know which are the most important. Among the possibilities are gene mutations arising after conception, differences in feeding, position in the uterus and epigenetic effects — the environment's influence on gene activity through chemical modifications that don't change the genes themselves.



ALEX VALM, NHGRI

Feet a fungal hotbed

More than 80 types of fungi make human feet home, researchers report May 22 in *Nature*. The tiny organisms (green and blue specks, shown on a hair follicle) grow all over a person's skin, but only feet carry such a diverse population. Researchers from the National Human Genome Research Institute and the National Cancer Institute swabbed 13 skin sites (and clipped toenails) on 10 healthy volunteers, and analyzed the DNA in each sample to figure out which types of fungi live where. Across all areas but the feet, one fungal genus, *Malassezia*, tends to dominate. But on the feet, researchers found about 40 different types of fungi packed on the toenails, 60 wedged between the toes and 80 nestled at the bottom of the heel. Heels and toes may host such hearty fungal gardens because feet are cooler than other body parts, and fungi don't like it hot. Feet also rub against fungus-friendly surfaces such as sweaty socks and locker room floors. Healthy fungal carpets probably prevent dangerous fungi from gaining a toehold on feet. —*Meghan Rosen*

Humans

Fossil sheds light on early primates

Partial skeleton near root of monkey, ape and human line

By Bruce Bower

A palm-sized creature sporting a tail longer than its body has given scientists an unprecedented look at one of the earliest phases of primate evolution.

An international team led by paleontologist Xijun Ni of the Chinese Academy of Sciences in Beijing analyzed this animal's 55-million-year-old remains, the oldest known primate skeleton. Discovered 10 years ago along an ancient lake bed in central China, the fossil comes from a previously unknown genus and species, *Archicebus achilles*, the scientists report June 6 in *Nature*.

Over the past decade, digital scanning of the find with X-rays enabled the scientists to assemble a 3-D reconstruction of the fragile skeleton.

Archicebus was the earliest member of a group that eventually evolved into tarsiers, small primates that now live in Southeast Asia, Ni says. The skeleton includes some unexpected features, however, that look less like tarsiers and more like ancient anthropoids, the primate precursors of monkeys, apes and humans. These traits include small eyes and monkeylike feet.

"*Archicebus* marks the first time that we have a reasonably complete picture of a primate close to the evolutionary divergence of tarsiers and anthropoids," Ni says. That split probably occurred between 60 million and 55 million years ago, he estimates.

Researchers suspect that primates first evolved sometime between 85 million and 65 million years ago, around the time of the dinosaurs' demise. Whatever the exact timing, the new Chinese find bolsters the idea that primates started out in Asia, Ni says.

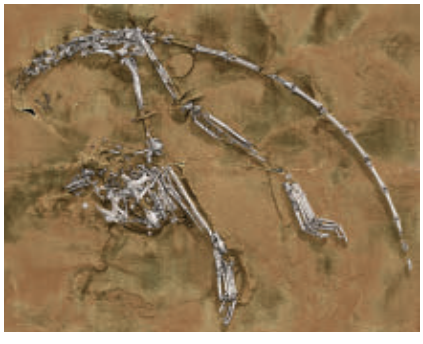
Paleontologist Erik Seiffert of Stony Brook University in New York agrees that primates likely have Asian roots. But the skull and teeth of another creature from around 55 million years ago, *Teilhardina* (*SN: 1/3/04, p. 4*), display traits suggesting that it was the oldest relative of tarsiers, Seiffert holds. Whether *Archicebus* or *Teilhardina* prevails as the earliest tarsier ancestor, this line of research will help clarify the timing of the evolutionary split that led to rise of monkeys, apes and ultimately people.

Ni's team uncovered *Archicebus* by splitting apart two thin layers of rock encasing about half of a skeleton. Each layer contains fossilized bones as well as impressions of bones from the other side.

Weighing in at about 1 ounce, *Archicebus* was slightly smaller than the tiniest living primates, Madagascar's pygmy mouse lemurs, the researchers report. Other early primates, including the common ancestor of tarsiers and anthropoids, must also have been minuscule, Ni says.

Given its small eyes, *Archicebus* was probably active during the day, unlike today's big-eyed tarsiers and lemurs. ■

The oldest known primate specimen, a 55-million-year-old partial skeleton of a 1-ounce creature, was analyzed using a digital 3-D reconstruction (below).



PAUL TAFFOREAU/ESRF; X. NI/CHINESE ACADEMY OF SCIENCES

Hominid diet trended to grass

Tooth chemistry tracks rising reliance on savanna plants

By Rachel Ehrenberg

The salad days of human evolution saw a dietary shift toward grasses and probably grass-fed animals, new analyses of more than 100 fossilized teeth from eight species of ancient hominids indicate.

"These changes in diet have been predicted," says paleoanthropologist Richard Klein of Stanford University. "But it's very nice to have some data, and these data support it very strongly."

Changes in the size and shape of jaws and teeth in hominids and their ape relatives point to changes in diet. The new research adds to this anatomical evidence chemical analyses of different forms of carbon in the fossilized teeth.

The ratio of two types of carbon in tooth enamel reflects diet, says geochemist Thure Cerling of the University of Utah, who spent weeks in a vault in the National Museums of Kenya collecting a few milligrams of enamel per tooth for the analyses.

Grasses, grasslike sedges and many other plants in hot, arid environments have evolved a trick that helps prevent water loss. The metabolic adjustment results in taking up more of a heavier form of carbon, known as carbon-13, than most trees and shrubs do.

The tooth studies, which cover more than 3 million years and include specimens from southern, eastern and central Africa, found greater quantities of this heavier carbon in hominids that are closer to humans on the evolutionary tree. This pattern suggests that, compared with humans' more ancient relatives, recent ones were eating more grass or more grass-feeding animals, like zebras. The analyses appear June 3 in the *Proceedings of the National Academy of Sciences*. ■

"They are discovering a cornerstone of Western civilization." —BRENDAN FOLEY

Italians taught French to make wine

Archaeology suggests Etruscans brought the grape to Gaul

By Cristy Gelling

French winemakers learned their art after developing a taste for wines made in Italy, a new study suggests.

Archaeologists have found traces of grapes on a stone platform (right) dated to 425 to 400 B.C. from a site in southern France. The traces suggest that people used the platform for stomping on the fruit to make wine. The researchers also found wine traces at the same site in older, imported amphorae, the pottery shipping containers of the ancient Mediterranean.

The wine press provides the earliest molecular evidence for wine-making in France and the traces in the amphorae support the idea that local wine-making was inspired by trade with Etruscans from Italy, researchers report June 3 in the *Proceedings of the National Academy of Sciences*.

Researchers think the first wine industries in France started in the sixth century B.C., but did not have chemical evidence for ancient wine production.

So Patrick McGovern of the University of Pennsylvania Museum of Archaeology and Anthropology and colleagues analyzed samples from merchant quarters in the ancient French port of Lattara, south of Montpellier, where researchers previously found grape seeds. The samples came from Etruscan amphorae dated to around 525 to 475 B.C. The team detected tartaric acid, a molecular fingerprint of grapes, in the samples.

The French taste for imported wine eventually led to a local industry, McGovern and his colleagues think. The team tested a limestone platform from a fifth century B.C. courtyard. The platform has a spout, resembles wine presses depicted on Greek vases and could have held a basket in which a person stomped on grapes. The researchers detected tartaric acid on the platform as well.

Because wine played such a central role in the religion, politics, medicine and art of the ancient world, the researchers' work is important, says Brendan Foley, an archaeologist at Woods Hole Oceanographic Institution in Massachusetts. "They are not merely tracing the introduction of an agricultural product in Italy and France," he says. "They are discovering a cornerstone of Western civilization."

PLATFORM: © L'UNITÉ DE FOUILLES ET DE RECHERCHES ARCHÉOLOGIQUES DE LATTES

Matter & Energy

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Time cloak may prove useful

Method could hide messages without sender's knowledge

By Andrew Grant

A device that manipulates light to open up small gaps in time has crept toward implementation outside the lab. Detailed June 5 in *Nature*, it could soon improve security over fiber-optic lines or improve data streaming rates.

"It's exciting to see this exotic manipulation of light and its applications for communications and data processing," says Alexander Gaeta, a Cornell University physicist who demonstrated the first time cloak two years ago (*SN: 8/13/11, p. 12*).

The term "cloak" can bring to mind *Harry Potter*-esque materials that hide an object at a specific point in space. These cloaks, a hot area of research since they were proposed in 2006, manipulate light so that an observer cannot see a stationary object.

But in physics, what goes for space may also hold for time. Gaeta's team showcased that truism by developing a cloak that hides events during a fixed time interval. A specially designed lens split light beams passing through a fiber into two segments. The trailing segment of light lagged behind the leading one by up to 50 trillionths of a second, creating a gap of total darkness between them. When Gaeta fired a laser at the fiber, the laser shot was undetectable because it had passed through the 50-picosecond interval of invisibility. Finally, Gaeta set up another lens to stitch the light segments back together, ensuring that the light beam emerging from the fiber looked exactly as it did at the start.

After reading Gaeta's study, Joseph Lukens at Purdue University realized he could improve the technique. He designed an apparatus using off-the-shelf equipment that forced light to interfere and create repeating gaps of darkness at fixed temporal intervals. Each 40-picosecond gap was sandwiched between about 40 picoseconds of light, meaning that the time cloak was on roughly half the time.

Lukens' study demonstrates how a time-cloaking device might eventually allow law enforcement or the military to prevent a nefarious person from communicating without the person's realizing it. Just as the time gap in Gaeta's experiment made the laser undetectable, the gaps created by Lukens' cloak can conceal digital data. Lukens' team tried to inject an electrical signal of 1s and 0s into the fiber, a task that would be no problem without a cloak, but the message never got encoded into the light beam. The receiver of such a signal would assume that no message had been sent. ■

Electric plug-in laser leaps forward

Semiconductor-based device has commercial potential

By Andrew Grant

A low-energy alternative to traditional lasers is finally available in plug-in form, a crucial step toward developing a practical alternative to the comparatively inefficient devices in use today.

The lasers now used in telecom, medicine, manufacturing and consumer electronics all function through a process called stimulated emission. A burst of light or electricity injects energy into a sea of atoms, causing the atoms' electrons to jump up in energy as they swirl around the nucleus. When those electrons drop back to lower energies, they release photons. Those photons interact with and stimulate other atoms, causing them to emit more photons. All these photons have the same energy and direction, creating a focused, monochromatic beam of light.

Since 1996, some physicists have studied a different lasing technique that makes use of semiconductors such as gallium arsenide, which have a special arrangement of electrons. When electrons within the semiconductor jump to a higher energy level, they leave behind a positively charged hole.

The holes and the energetic, negatively charged electrons get attracted to one another, creating particle-like units called excitons. Excitons then interact with photons to form exotic light-matter hybrids called polaritons, which in turn decay and release photons with the same energy and direction. These polariton lasers require far less energy than conventional lasers to boost their electrons to higher energy levels and start emitting light.

Previous polariton lasers required researchers to shine light on the semiconductor to inject energy and create the electron-hole pairs. A laser that requires another laser to function is pretty useless, says physicist Sven Höfling at the University of Würzburg in Germany. So he and his team developed a polariton laser that runs on electricity.

Their device, detailed in the May 16 *Nature*, has titanium and gold electrodes that send current through the semiconductor and spark the formation of polaritons that emit a beam of infrared light.

The next step toward a practical device is to raise the operating temperature of Höfling's laser from near absolute zero to around room temperature. That challenge is actually minor compared with getting a polariton laser to run on electricity, says Alexey Kavokin, a physicist at Saint Petersburg State University in Russia. Kavokin says he expects the demonstration of an electrical polariton laser functioning at room temperature within a year or two, with commercial applications soon after.

Technology Simplified

"Now with my simple-to-use WOW Computer, I don't have to miss a thing."

George Bernard Shaw once said "Youth is wasted on the young." Were he alive today, he might well say that computers and the Internet are wasted on the young. The very people who can benefit most from the digital revolution are the ones who are least likely to take advantage of it. Computers seem to be designed for teenagers, and many older folks are intimidated by the complex operating systems and complicated navigation. It's gotten so bad that some people have to pay for instructional videos or go to classes just to use their computer. Now, the leader in developing products for Boomers and Beyond™ has introduced a computer that's designed just for people like you. It's helping thousands of people get back into life by keeping them connected.

Let's start with the computer itself. It features the latest touchscreen technology, so if you can dial a phone, you can use this computer. If you'd rather use a keyboard and a mouse, we've included those too. The keyboard features large lettering and the trackball mouse is easy to use. The speakers enable you to turn up the volume if you have trouble hearing, and there is even a built-in camera for taking photographs of yourself and for video chat.

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Mind & Brain

"We may be able to prevent OCD before it starts." —SUSANNE AHMARI

Brain switch linked to compulsion

In mice, obsessive grooming behavior is flipped on and off

By Rachel Ehrenberg

Two research teams have figured out how to flip a switch in the brain circuits of mice that compels the animals to groom themselves over and over. The results may yield new ways to reduce compulsive behaviors in humans, such as repetitive hand-washing, a feature of obsessive-compulsive disorder, and diseases such as autism and Tourette syndrome.

In one set of experiments, researchers stimulated a particular neural pathway, generating repetitive, excessive grooming in the mice. A second set of experiments with mutant mice targeted the same pathway to eliminate the compulsive behavior. The studies are published in the June 7 *Science*.

"In tandem, this is really a leap forward toward a refined understanding of the circuitry underlying these behaviors," says psychiatrist Scott Rauch of McLean Hospital in Belmont, Mass.

An uptick in the activity of two brain regions, the orbitofrontal cortex and ventromedial striatum, had previously been identified in brain scans of people with obsessive-compulsive disorder, which afflicts roughly 1 percent of the population worldwide. People with OCD have obsessive thoughts, such as worrying that they forgot to turn off the stove, and then perform compulsive behaviors in response, such as repeatedly checking the stove's dials.

While those general brain regions had been implicated, there's little understanding of the causal relationship between faulty brain wiring and the behaviors. So scientists led by psychiatric neuroscientist Susanne Ahmari of Columbia University targeted the implicated brain regions by injecting a virus into nerves that run between them, enabling the nerves to respond to light.

After five minutes of laser stimulation per day for about five days, the mice started compulsively grooming with their paws. Surprisingly, the repetitive grooming continued for two weeks after the stimulation stopped.

"This is really important," says Ahmari. "If we can figure out triggers that make the brain more likely to be hyperactive, we may be able to prevent OCD before it starts." Such triggers might include genetic factors predisposing the nerves to hyperactivity or environmental factors such as traumatic events or stress, she speculates.

Another study led by Eric Burguière and Ann Graybiel at MIT examined the same circuitry in normal mice and in mice engineered both to groom compulsively and to respond to light. The two sets of mice were trained to groom when they heard a tone followed by a drop of water on the nose. The water drop isn't pleasant; the mice soon learned to groom when they heard just the tone. While the normal mice waited to groom until right before the drop hit, the mutant mice groomed right at the tone.

"They get hooked on this external stimulus," says Graybiel. "It's compulsive."

But when the scientists stimulated the designated brain circuit with light, it stopped the compulsive behavior in the mutant mice and they groomed as the normal mice did.

Rauch notes that the two studies not only offer promise for future research and treatments in humans, but they validate that experiments with mice are a legitimate means of investigating compulsive disorders. ■

Less is more for smart perception

High-IQ people more readily ignore less relevant features

By Bruce Bower

People with high IQs see the world in their own way, seamlessly separating the visual wheat from the chaff to home in on the most relevant information.

Using a simple exercise, a team led by psychologist Duje Tadin of the University of Rochester in New York found that high-IQ volunteers excelled at detecting the direction in which small objects moved.

That's a useful trait, the scientists report in the June 3 *Current Biology*. In many situations, small moving objects in the foreground are more important to track than background activity. Whether driving a car, walking down a street or working in an open office, a person's visual field usually includes distracting background activity.

Among participants in the new study, the lower the IQ, the less able a person was to spot movements of small objects, but the better able he or she was to monitor large objects.

The new findings fit with evidence that people with high IQs and expertise in particular activities have more efficient brains than other people, says psychologist and intelligence researcher Richard Haier of the University of California, Irvine.

Tadin's group asked 65 volunteers, with IQs ranging from around 80 to 140, to watch videos in which moving black and white bars repeatedly flashed on the screen. The goal was to identify, as quickly as possible, whether the bars were moving right or left. The bars appeared in three sizes.

Researchers have long reported a modest tendency of high-IQ individuals to perform well on simple visual and other sensory tasks. In Tadin's study, conducting separate tests with small and large moving objects produced much stronger associations.

News in Brief

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LIFE

Frog once thought extinct resurfaces

A frog species formerly considered extinct hasn't actually croaked. The discovery of living, breathing Hula painted frogs has allowed the amphibians to hop back onto scientists' radar, and revealed that the orange-speckled animal (above) isn't quite what researchers thought it was. When scientists first spotted the painted frog in the 1940s in Israel's Hula Valley, they classified it as *Discoglossus nigriventer* for its disklike tongue and unusual black belly. Then between 1955 and 2011, there were no other confirmed sightings. In the last two years, scientists have found 11 of the frogs in the valley. After analyzing the frogs' physical features and DNA, Sarig Gafny of the Ruppin Academic Center in Michmoret, Israel, and colleagues conclude that the painted frog is not a member of the *Discoglossus* genus after all. Instead, the frog has jumped into the genus *Latonia*, researchers report June 4 in *Nature Communications*. —*Meghan Rosen*

SCIENCE & SOCIETY

Marriages born online just as stable

Cupid's arrow flies as true for online daters as it does for partners who meet through more traditional venues, a new survey of nearly 20,000 people who married between 2005 and 2012 finds. Regardless of how they met, the couples who met in the virtual and material worlds reported similar levels of satisfaction with their marriages, a team reports June 3 in the *Proceedings of the National Academy of Sciences*. The number of marriage breakups was also similar between the two groups. Of the people who met offline, couples who met in places of worship reported more satisfaction with their marriages than did people who met in bars or clubs. The study was funded by the online dating website eHarmony. —*Rachel Ehrenberg*

HEALTH & ILLNESS

Sluggish thyroid ups pregnancy risk

An underperforming thyroid can lead to pregnancy complications, a review of thousands of medical records suggests. The thyroid produces a hormone that regulates how the body uses energy. Underachieving thyroids in pregnancy have been linked to preterm birth, but the full risk is unknown. Researchers at the National Institute of Child Health and Human Development in Rockville, Md., analyzed records of more than 220,000 pregnancies. Among them were more than 3,000 from women with low levels of thyroid hormone. Women with the condition were more likely to have gestational diabetes, a cesarean section delivery, a preterm birth, admission to the intensive care unit or a complication called preeclampsia. The findings appear June 6 in the *Journal of Clinical Endocrinology & Metabolism*. —*Nathan Seppa*

Easy steps limit antibiotic-resistant infections in hospitals

A low-tech approach appears to prevent antibiotic-resistant bacterial infections in hospitals better than the current one, scientists report May 29 in the *New England Journal of Medicine*. Hospitals often screen patients as they are admitted to an intensive care unit by testing nasal swabs for methicillin-resistant *Staphylococcus aureus*, or MRSA, a common, dangerous infection. But this technique for catching the bug, treating it and preventing it from spreading within the hospital is far from foolproof. An alternative method entails bathing patients who are headed for the ICU with antimicrobial soap and water and dabbing their nasal cavities twice a day with antibiotic ointment. Researchers call this "decolonization" because it wipes out many microbes that colonize a patient's skin or mucus-lined nasal passages. In the study, researchers assigned more than 74,000 ICU patients to get one of three treatments: decolonization, screening for MRSA or screening and then decolonizing only patients who tested positive for MRSA. The group in which everyone received soap, swabbing and nasal ointment developed fewer bloodstream infections than did either of the screening-recipient groups, report physician Susan Huang of the University of California, Irvine and colleagues. —*Nathan Seppa*

GENES & CELLS

Analog circuits boost power in living computers

Using a molecular dimmer switch that smoothly dials up glowing lights in bacteria, researchers can make calculators in living cells that add, subtract, divide and even do logarithms. These analog computations are much more powerful than digital biological devices, says study author Timothy Lu, a synthetic biologist at MIT. In biology and electronics, digital computers rely on simple on/off switches to perform calculations. More switches mean more computing power. "Digital is great for electronics because we can put billions of switches together on a single chip," Lu says. "But it's not so easy to do that in a cell." So Lu and his team designed a DNA-based circuit that can respond to gradual changes in a cell's environment, rather than all-or-nothing signals. By making bacteria glow more or less brightly depending on the number of different chemicals around, the new circuit can compute answers to math problems, Lu's team reports May 15 in *Nature*. To add 1 plus 1, for example, the circuit would detect two chemicals and crank up the bacteria's glow to "2." —*Meghan Rosen*

Mystery Meteorite

The case for (and against) a rock from Mercury

By Alexandra Witze

There are rocks from the moon, rocks from Mars — and now, just maybe, a rock from Mercury.

In early 2012, a nomad in the western Sahara spotted some green stones scattered on the sand. Knowing that the empty desert was a good place to find rocks from space, and that meteorite dealers would pay good money for them, he picked up about three dozen that looked related.

By spring all 345 grams of them were for sale in Erfoud, Morocco. Stefan Ralew, a meteorite dealer from Germany who was cruising the markets, spotted the stones and asked about them. The seller said he thought they were from a Martian meteorite. But Ralew argued that they couldn't be from a meteorite of any type because of their bizarre, lustrous, emerald color.

Thus began a scientific detective story to unravel the mystery of NWA (for North West Africa) 7325. And while the story isn't finished yet, one thing is clear: The main character is a very interesting something. It may be the first meteorite ever to hail from the planet closest to the sun.

Unearthly green rocks (one shown) found in the western Sahara last year may hail from Mercury.

S. RALEW

To have any meteorite formally classified, a dealer must donate 20 grams or 20 percent of the sample to a scientific institution. Ralew had worked before with Anthony Irving, a meteorite expert at the University of Washington in Seattle. So Ralew shipped some stones to Irving, who got to work studying their mineralogy and sharing samples with scientists for other tests.

NWA 7325 has several curious characteristics. It contains lots of magnesium, which most meteorites don't have, and almost no iron, which most meteorites do. Its pale hue — different from the dark gray or black of many meteorites — suggests it came from the outer portion of a celestial body that separated into layers the way planets do, with a dense, hot core surrounded by a much lighter crust.

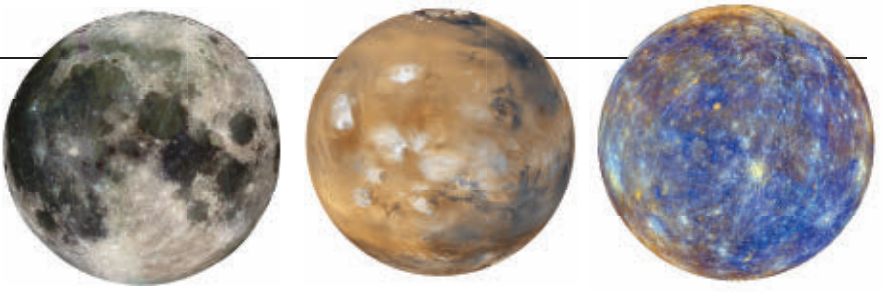
Likely candidates would be rocky planets Mercury, Venus or Mars. Scientists rule Venus out because its thick atmosphere burns up any incoming (or outgoing) rocks. Mars is also out of the running. Researchers know of 67 meteorites from Mars, but NWA 7325's ratio of oxygen isotopes, each with varying numbers of neutrons in its atomic nucleus, is nothing like the oxygen ratios from known Martian meteorites.

"We're dealing with a place that we didn't know about before," says Irving. "It's not any of the usual suspects."

Suspect Mercury

In theory, it would be tough to get a rock from Mercury to Earth because the rock would have to spiral outward in the solar system, away from the sun's immense gravitational pull. (Mercury is 58 million kilometers from the sun; Earth is 150 million kilometers from the sun.) But in 2009, a pair of Canadian researchers did some recalculating. They found that because of the sun's strong pull, rocks smashing into Mercury would be moving very fast. So fast, in fact, that debris kicked up from their impact might also be moving fast enough to sail all the way to Earth. The scientists say that roughly 2 to 5 percent of rocks leaving Mercury at high speeds (faster than 9 kilometers per second) might reach Earth within 30 million years, an estimate about 10 to 100 times higher than previously thought.

Tests on the weird green rock also support the idea that it may have made



177
Confirmed meteorites from the moon

67
Confirmed meteorites from Mars

1
Possible meteorites from Mercury

the trip from Mercury, says Irving, who presented his theory in March at the Lunar and Planetary Science Conference in The Woodlands, Texas. Irving lent his samples to Benjamin Weiss, a magnetics expert at the Massachusetts Institute of Technology in Cambridge. In a stroke of bad luck, the intrinsic magnetic fields of all of the rocks except one had been erased by the common kitchen magnets that Moroccan meteorite hunters carry around. But Weiss was able to test the one unaltered rock, and it turned out to have the lowest magnetic intensity ever measured in any meteorite—a magnetism that matches Mercury's modern field almost exactly, Irving says.

The magnetism, the low iron content and the high magnesium content all suggest that Mercury is the meteorite's original home. But other scientists aren't nearly as confident as Irving. They point to other problems with NWA 7325's chemistry. First, NASA's MESSENGER spacecraft recently discovered that Mercury has quite a bit of sulfur on its surface, but NWA 7325 doesn't contain sulfur-rich minerals to the degree that would be expected were it from Mercury, says Shoshana Weider, a geochemist at the Carnegie Institution for Science in Washington, D.C. The rock also has different levels of titanium and calcium than Mercury has, plus large amounts of a chromium-rich version of the mineral pyroxene.

The chemical evidence doesn't quite add up, says Timothy McCoy, a meteorite expert at the Smithsonian's National Museum of Natural History in Washington, D.C. He thinks NWA 7325 could belong to a class of meteorites known as primitive achondrites, which contain chromium-rich pyroxene and are low in iron. These meteorites are thought to be the remains of protoplanets that formed in the early solar system, separated out a crust and core, and then were shattered into oblivion by some impact.

Another potential problem: NWA 7325 is ancient. Geochemists at Australian National University in Canberra, working with Irving, tested lead isotopes left behind in the rock by the radioactive decay of uranium. From that they could back-calculate how long it had been since the meteorite formed, and they came up with an age of 4.56 billion years. That would have been almost immediately after the solar system sprang from the swirling disk of gas and dust around the newborn sun. The tight time frame means that the proto-Mercury would have had only 8 million years to form, melt inside and separate into core and crust before another impact knocked off a chunk of its outer layer. That's not an impossible scenario, says Yuri Amelin of ANU, who will report on the dating work in July at the Meteoritical Society meeting in Edmonton, Canada.

But the timing also opens the possibility that NWA 7325 could have come from a small asteroid that cooled off quickly in the early solar system, says Richard Carlson, a meteorite expert at Carnegie. It would not necessarily have had to come from something quite as large as Mercury, he says.

Irving has a comeback for arguments about the rock's age; he points out that the famous Martian meteorite ALH84001 may be as old or even older. "If you can do it on Mars, you can do it on Mercury," he says.

Further studies might help scientists choose among the possibilities. Thomas Sharp, a geochemist at Arizona State University in Tempe, is looking for physical evidence that NWA 7325 was shocked by an impact at some point in its past. Research has not yet turned up a mineral called maskelynite, a glassy substance that forms in rocks that have been shocked by high pressures and high temperatures, Sharp says. But the meteorite does show hints in some places of having melted and recrystallized, which could indicate more about the conditions under which it was knocked off from its parent body.

In the end, there may be no way to tell definitively whether or not NWA 7325 is from Mercury. At least not yet. When scientists find a rock that they think is from the moon, they can test it against the lunar rocks brought back by Apollo astronauts. Possible Martian meteorites can be tested against ones known to be from Mars because of the air trapped within them. But an equivalent test for Mercury could only be done if a spacecraft were to bring back a sample from the planet's surface.

For his part, Irving doesn't care exactly what NWA 7325 ends up being. "It's an unsolved mystery," he says. "That's the fascination with meteorites, which is why I like doing this." ■

Laying out the case

Evidence for a Mercury origin

- Likely from a rocky planet or mature asteroid with both crust and core
- Low iron and high magnesium content match Mercury's composition
- Weak magnetism matches planet's

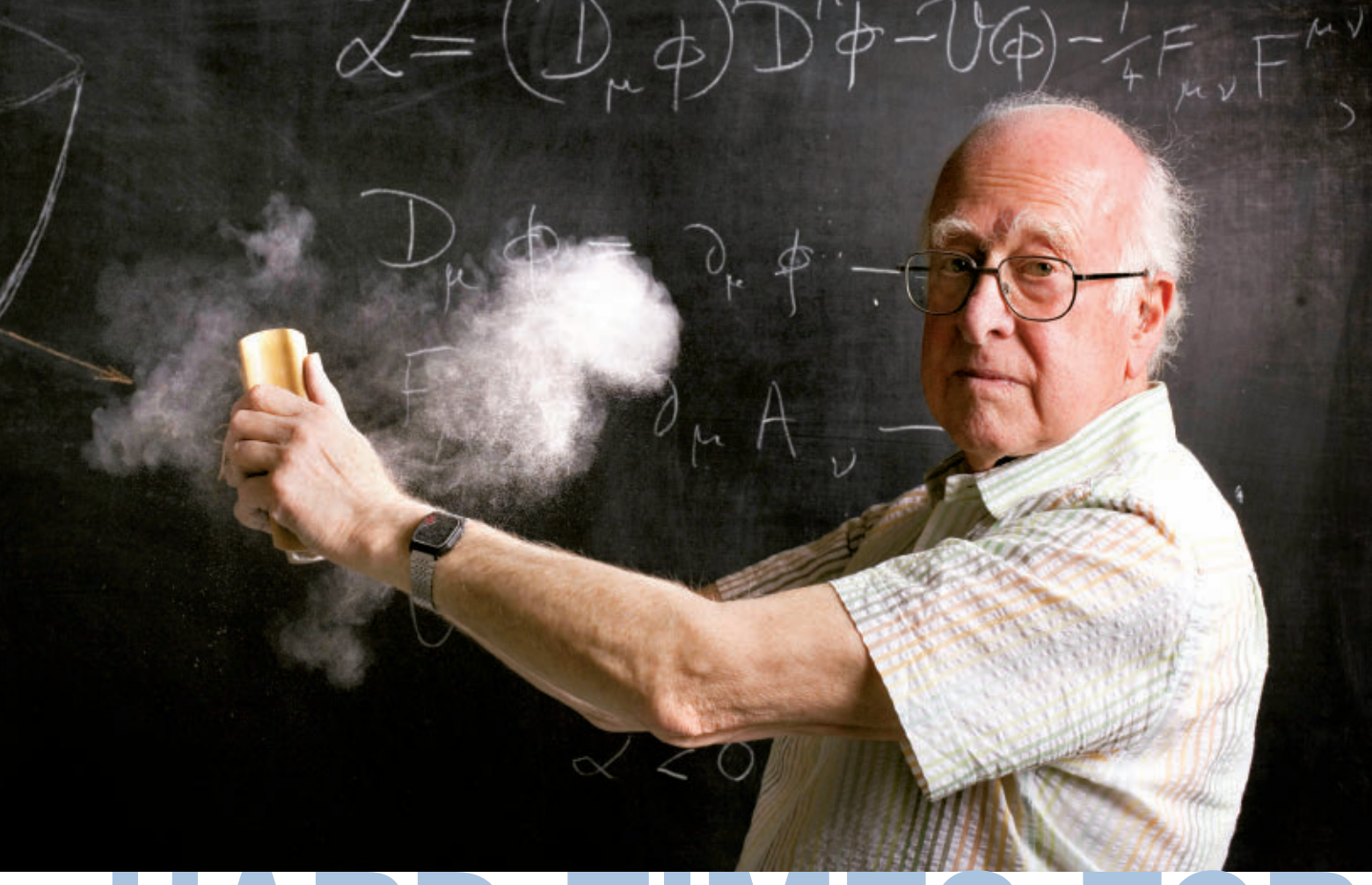
Evidence against a Mercury origin

- Rocks appear very old—may date to just after the solar system formed
- Rocks contain little sulfur, which is abundant on Mercury's surface, and large amounts of chromium-rich pyroxene, thought to be rare on the planet

Explore more

- Meteorite info from Washington University: http://meteorites.wustl.edu

FROM TOP LEFT: JPL/NASA; JPL/NASA; JHU-APL/NASA, CARNEGIE INSTITUTION FOR SCIENCE



HARD TIMES FOR IN A POST-HIGGS WORLD

The Large Hadron Collider's big success leaves no clear avenue for new physics

By Andrew Grant

At 5 a.m. last Fourth of July, Flip Tanedo rolled out of bed after an hour of repeatedly smacking his alarm clock's snooze button. Rousting himself at dawn would be worth it, he hoped, because what he was about to hear was likely to have a huge bearing on the course of his career.

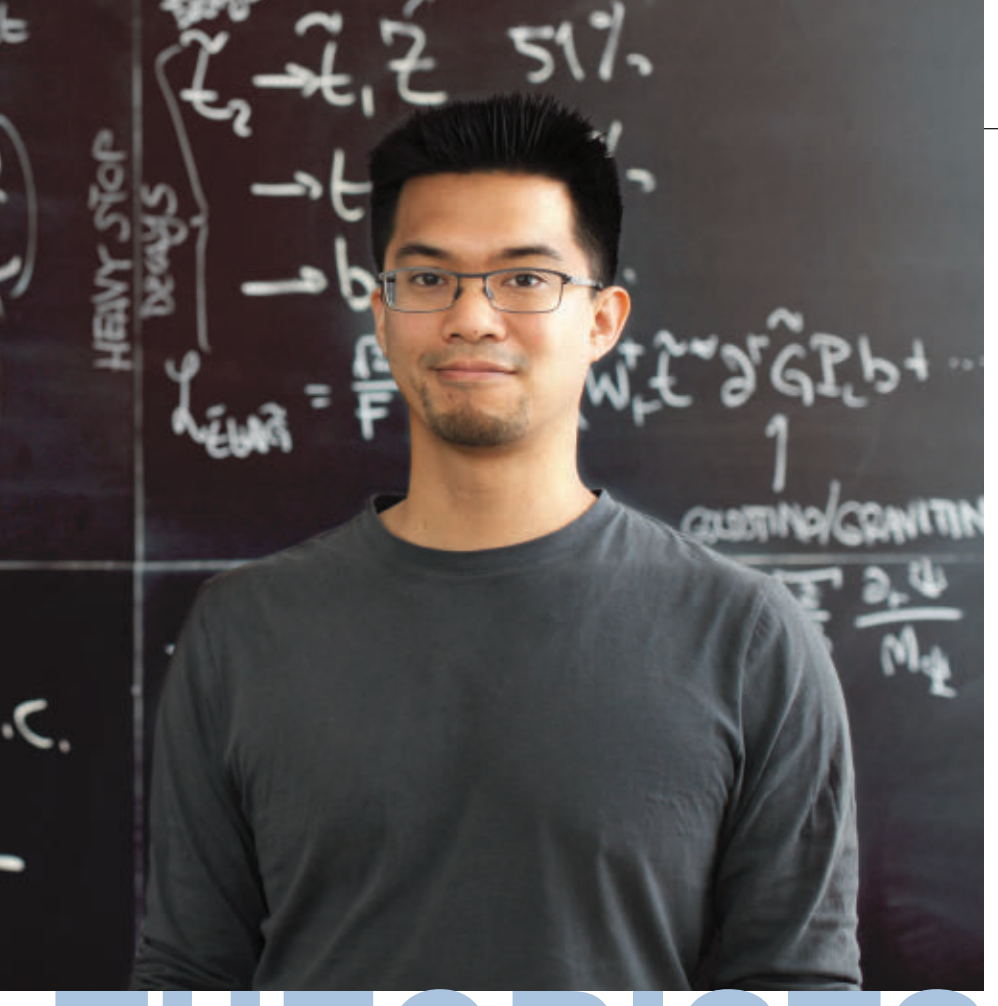
Tanedo, a fifth-year theoretical physics Ph.D. candidate at Cornell University, tuned in to a live video feed from Geneva and listened intently as physicists working with the world's largest particle accelerator discussed a momentous discovery. Data from the Large Hadron Collider revealed what looked very much like the long-sought Higgs boson. The product of a decades-long effort by thousands of physicists, the discovery solidified the leading theory of particle physics, the standard model. The Higgs particle confirmed the existence of a field that permeates the universe, imparting certain subatomic particles with mass while letting photons and other massless particles pass unimpeded.

Even from 4,000 miles away, the excitement was palpable. Two hours earlier, when the discovery was formally announced, hundreds of experimentalists who had sifted through the noise of more than a thousand trillion particle collisions to identify the Higgs entered into sustained applause, about as raucous as particle physicists get. British physicist Peter Higgs, who in 1964 proposed the particle that now bears his name, removed his glasses and wiped away tears.

While Tanedo shared the enthusiasm of his colleagues on the screen, he also had an unsettled feeling. As a theorist his job is to speculate on the inner workings of the universe. Theorists love proposing the existence of new particles and forces, but their theories must be consistent with the findings of past experiments. That makes deviations from the expected like catnip to theorists — opportunities to come up with novel explanations.

But with every new speaker in Geneva, it gradually became clear that there was nothing particularly surprising about

FROM LEFT: MURDO MACLEOD; COURTESY OF XIAOYUE GUO



In 1964, Peter Higgs (left) proposed the existence of a particle that is now named for him. Now young theorists like Flip Tanedo (right) wonder what's next.

THEORISTS

this newest addition to the particle zoo. The experimental work seemed to fit perfectly with existing theory. "It wasn't until a few hours after the talk that I started thinking, 'OK, what's next for us?'" Tanedo says.

That is the question many theoretical physicists are asking themselves right now. A year after the announcement, the latest analyses confirm a Higgs boson that is as vanilla as Tanedo initially feared.

In confirming the crowning theoretical achievement of 20th century physics, the LHC did exactly what it was designed to do. But Tanedo and other theorists had clung to loftier goals. Although the standard model explains extraordinarily well the particles and forces that dictate much of the world around us, it ignores gravity, and it doesn't meld with Einstein's theory of general relativity. And there's much that the standard model can't address at all: the dark matter that clumps around, within and between galaxies, for example, and the dark energy that is increasingly stretching the universe apart. In essence, even a complete standard model is incomplete, describing stuff that collectively composes a mere 5 percent of the mass-energy content of the universe. The rest is a mystery.

Scientists had hoped that clues to that mystery — or at least hints about how to start solving it — might emerge from the debris of smashed protons at the LHC. Some expected the machine to detect particles of dark matter; others thought it might find evidence of extra dimensions or of supersymmetry, a popular theory that predicts a menagerie of heavy particles. Ideally, discovering the unexpected within the subatomic shrapnel would allow theoretical physicists to expand the standard model into a stronger theory that more fully explains how the universe works.

Yet as the LHC shuts down for two years of repairs after three years of collisions, it has yet to reveal a single surprise. Adding insult to injury, other intensive physics experiments over the last year have also failed to reveal anything truly exotic. Nature's secrets, at least for the time being, are frustratingly out of reach. Physicists are now banking on revamped theories and a few peculiar clues that have popped up in a handful of experiments to advance the standard model. "It's gradually become more and more sobering," Tanedo says.

All figured out

This is not the first time that the horizons for theoretical advancement in physics have looked a bit hazy and distant. According to physics lore, in 1900 the British physicist Lord Kelvin said: "There is nothing new to be discovered in physics now. All that remains is more and more precise measurement." While there's debate over whether he actually said it, physicists often use the quote when talking about a difficult juncture in the field.

Kelvin may have felt that between Newton's laws of gravity and James Maxwell's equations for electricity and magnetism, scientists pretty much had the laws of physics figured out. Kelvin did, however, mention two small "clouds" — strange phenomena that did not quite mesh with those seemingly ironclad physical laws. One was that some objects seemed to radiate energy in an unexpected way; the other was the unknown composition of the ether, the mysterious substance that was thought to permit light to travel through the universe. Within a few decades, theories explaining those clouds — quantum mechanics and Einstein's theories of relativity — completely transformed physics and superseded previous, supposedly robust, laws.

Before the LHC collisions began in November 2009, physicists were not quite

Measure of effort Scientists proposed the Higgs' existence nearly five decades ago, but the search intensified when proton collisions began at the LHC. The numbers below refer to the LHC's operation from November 2009 to December 2012. SOURCE: FERMILAB/DOE

Higgs Of all the collisions over three years of LHC operation, only one in 5 billion produced the elusive particle.	**1.2 million**
Collisions The LHC produced roughly 90 billion particle collisions a day over the period of operation.	**5.8 quadrillion**
Physicists Collaborators from more than 40 countries worked on two of LHC's detectors, ATLAS and CMS.	**6,600**
Dollars The cost of running the LHC for three years came to about $62 per Higgs.	**74 million**
Power (MW) The electric power required to run the LHC and its experiments was enough to power about 50,000 homes.	**50**
Laps per second Traveling near the speed of light, protons in the LHC travel nearly 300,000 kilometers per second.	**11,245**

ready to compare their plight with that of Kelvin—in large part because they still hadn't seen the Higgs.

By last year's big July 4 announcement, the LHC had detected a fraction of the hundreds of thousands of Higgs bosons produced in some thousand trillion proton collisions. "The experimentalists did a great job," says Tim Tait, a theoretical physicist at the University of California, Irvine. "I didn't think the LHC would discover the Higgs this early."

But like Tanedo, Tait saw his excitement begin to fade once he digested the details of the discovery. He had hoped that the Higgs boson would be a little different from what the standard model predicts—perhaps it would be more massive, or maybe it would decay into a strange menagerie of particles. But the early results made it clear that the Higgs boson looked just the way the standard model said it would. It had a mass of 125 gigaelectronvolts, give or take a gigaelectronvolt, and decayed into other particles such as W and Z bosons at predictable rates. The Higgs did seem to decay into an unexpectedly high number of photons, but that measurement was far too preliminary to draw any definitive conclusions.

The physicists at the July 4 presentation played it safe, calling the new find a Higgs-like particle, but even they knew they had snagged a Higgs boson with all the characteristics predicted by the standard model. "We were already calling this a Higgs among ourselves," says Joseph Incandela, spokesman for the CMS detector at the LHC and a physicist at the University of California, Santa Barbara. "With the public we were more conservative."

Over the past year the evidence has become overwhelming. The CMS detection, which last July stood at the threshold of statistical significance, the five-sigma level of certainty, now sits at about 10 sigma. The mass is a more definitive 125.7 GeV, and the strange photon measurement receded after more analyses.

Furthermore, neither CMS nor the other detectors probing the LHC's proton collisions have found any hints of new fundamental particles. Combine a bland Higgs particle with the lack of other new findings at the LHC, and suddenly the state of particle physics looks an awful lot like it did during Lord Kelvin's era. "The extraordinary success of our theories actually makes me kind of uncomfortable," Tait says.

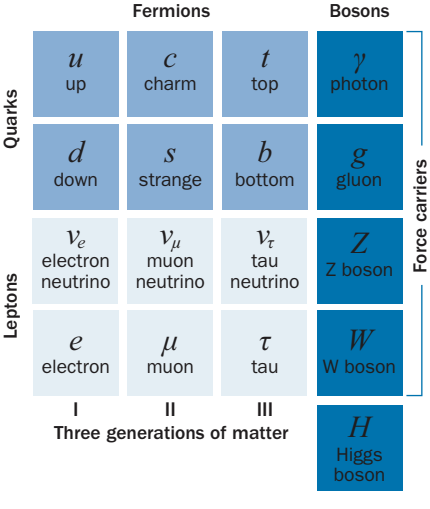
Supersymmetry a no-show

The long-accepted standard model may be extraordinarily successful, but that is not the case for other theoretical attempts to expand it and resolve its shortcomings. Tanedo has spent much of his time in graduate school working on supersymmetry, a set of theories positing that every fundamental subatomic particle has a heavier sibling called a superpartner.

Some of those massive particles would rarely interact with light or with other particles, making them great candidates for dark matter. Supersymmetry also plugs neatly into string theory, physicists' best attempt at a theory of everything combining quantum mechanics and general relativity. "Supersymmetry just seems to want to be built into physics," Tanedo says.

The most compelling supersymmetry theories were proposed in the 1990s, but Tanedo says that the LHC was considered the first machine capable of creating the predicted massive particles (the more

Final piece The Higgs boson (lower right), discovered one year ago, completed the standard model, the catalog of particles and forces in the universe.



BOTH: M. ATAROD

energetic the collisions, the more massive the particles you can produce). So, the LHC's debut seemed the perfect time for an aspiring theorist. Tanedo says physicists openly talked about the LHC finding new particles, extra dimensions and even miniature black holes. "You heard all the promises of a brand new frontier," Tanedo says. But after three years of LHC collisions, the majority of supersymmetry theories have been thrown in the garbage. Those collisions should have produced at least some superpartner particles, yet none have shown up. "Finding new physics is not as simple as turning on the LHC, as some of us had believed," Tanedo says. "We still have legitimate hopes and dreams, but people are starting to sweat."

The only supersymmetric theories that haven't been entirely ruled out contain a lot of messy work-arounds to jibe with the new LHC results. Theories that predicted four superpartners for the Higgs boson, for example, now predict five. The four-partner theories easily emerge from the mathematical foundations of supersymmetry, while five-partner theories require awkward adjustments that make most theorists uncomfortable. "The results have put a lot of the most glamorous supersymmetry models out of business," Incandela says. "They've forced the theoretical community to really think about what's going on."

Physicists associated with the LHC aren't the only ones worrying. Over the last year, multiple big-budget physics experiments like the Planck satellite (*SN: 4/20/13, p. 5*) and the Alpha Magnetic Spectrometer (*SN: 5/4/13, p. 14*) announced results that could have revealed clues about dark energy and dark matter. Each one echoed that of the LHC: Our results are exquisite, they said. The instruments worked as planned. The data provide unprecedented constraints on the standard model.

But no new physics. Such statements were typically followed by some variation of: "Nature is being very stubborn."

Hope in the dark stuff

The frustration over nature's stubbornness has Tait looking back to Kelvin for inspiration. Those clouds Kelvin described — seemingly minor, unexplained results in a handful of experiments — eventually led to the two pillars of modern physics. While the LHC has yet to deliver even a wispy cloud of surprise, Tait and other physicists are anxiously following up on a series of unexplained findings that they hope will turn into rain clouds.

Tait has his sights set on tackling the mystery of dark matter. Because dark matter appears to be an actual substance concentrated in and around galaxies, physicists think that it is made up of undiscovered particles. Theorists have proposed various new particles that could make up dark matter, including weakly interacting massive particles (WIMPs) predicted by supersymmetry and low-mass particles called axions.

At the same time, other experiments looking to directly detect dark matter particles have come up with preliminary and often confusing results. In April, physicists announced that silicon crystals in an old iron mine had detected three particles with the characteristics expected for dark matter (*SN: 5/18/13, p. 10*), but they had a lower mass than most supersymmetry theories would predict.

There is also the strange case of the DAMA experiment, which uses sodium iodide crystals in a cave in Italy to hunt for WIMPs. As early as 2003, DAMA researchers claimed to have definitively detected dark matter; now they say their evidence is overwhelming (*SN: 5/10/08, p. 12*). Other physicists are skeptical, but Tait says that DAMA's findings are at least worth investigating. "No one will stand up and say why they don't believe DAMA," he says. "Kelvin saw something he didn't understand and assumed it wasn't that big of a deal. It may be that DAMA is the thing we don't understand."

There are other promising avenues for theorists to ponder, including antimatter and lightweight particles called neutrinos. And there is still the possibility that the LHC will expose clouds of its own. Tait points out that the machine has been running for only three years, and at lower energies than it was originally designed to reach because of concerns over the magnets that steer protons around the ring. "It may be too early to be asking the question of whether we should be seeing new physics by now," Tait says. "That said, it would have been great to find a new particle."

13 TeV

LHC (2015)
Expected energy (in teraelectronvolts) of LHC particle collisions beginning in 2015

8 TeV

LHC (2012)
Energy of LHC particle collisions during 2012 operations

1.96 TeV

Tevatron
Energy of particle collisions in the now-defunct 6.3-kilometer Tevatron collider

SOURCES: CERN AND FERMILAB

The wait for new physics will likely continue at least a few years longer. Once the LHC turns back on in 2015, physicists may gain access to a realm of new, high-mass particles that for now are just out of reach. "I'm guardedly optimistic that in the next run, something will pop up and things will start to come together," Incandela says. In the meantime, he says he expects theorists to toss out some of their pre-LHC assumptions and formulate new ideas.

As a part of the new generation of theorists, Tanedo may well serve an integral role in devising the framework that will refresh the standard model. Having just earned his Ph.D., he will have to conduct his postdoctoral research without the luxury of new data from the LHC. Nonetheless, he says that the existing clouds, and the possibility of more to come, have him upbeat about the future. "I know some graduates who have taken this with a lot of pessimism," Tanedo says. "Me, not yet." ■

Explore more

- *Science News* coverage of Higgs announcement: www.sciencenews.org/higgsboson
- U.S. coalition at LHC: www.uslhc.us

In the Eye of the Tiger

Global spread of Asian tiger mosquito could fuel outbreaks of tropical disease in temperate regions

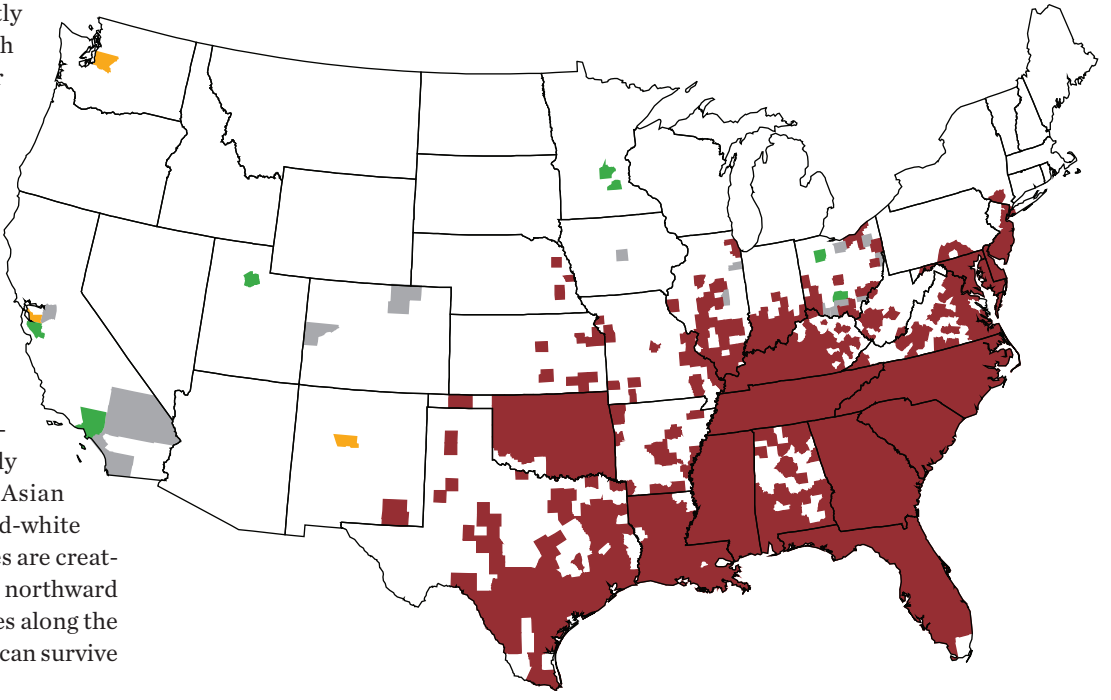
By Carrie Arnold

There is no shortage of mosquitoes in North America, and adding one more variety might seem like just a minor uptick in summertime's itchy-scratchy. But the Asian tiger mosquito, *Aedes albopictus,* comes with some particularly irritating characteristics. It's an aggressive hit-

and-run biter that frequently lives in close contact with humans. It's a daytime feeder that dines on humans, dogs, livestock, birds and a host of wild animals. "The feeding behavior of *Aedes albopictus* is very catholic," says Duane Gubler, a vector-borne disease expert at Duke–National University of Singapore. "It feeds on everything."

People in the southeastern United States are already well acquainted with the Asian tiger, named for its black-and-white stripes. But these mosquitoes are creating quite a buzz as they drift northward into more temperate climates along the East Coast, where their eggs can survive even cold winters.

The buzz would be just so much handwringing if it didn't include an alarming public health component: The Asian tiger turns out to be a competent vector for a raft of diseases, some lethal. It can carry dengue fever, yellow fever, chikungunya virus, West Nile fever and two forms of encephalitis named for St. Louis, Mo., and La Crosse, Wis. Among these diseases, only yellow fever is preventable by vaccine. Ominously, dengue has already gotten a toehold in southern parts of the United States.



U.S. invasion Since its arrival in Texas in 1985, the Asian tiger mosquito has spread north and east. Westward spread has been slow, partly because the drier climate of the Great Plains region inhibits breeding. But the females need only tiny amounts of water in which to lay eggs, so can make use of any containers that collect rainwater, such as flower pots and bird baths.

Kicking the competition

The Asian tiger mosquito has joined a rogues' gallery of invasive species — including zebra mussels, red imported fire ants and Africanized bees — now established in North America. In Florida and other subtropical parts of the Deep South, it has shown clear signs of displacing a predecessor-in-crime, the *Aedes aegypti* mosquito, which is best known for spreading yellow fever before that scourge was quelled by a vaccine. While it's unclear whether the Asian tiger has muscled out resident mosquitoes farther north, one glance at a map shows its territory expanding.

Like many invader species, the Asian tiger arrived by hitchhiking. It departed its native habitat in Southeast Asia as larvae tucked in tiny pools of rainwater in stacks of used tires. In the last couple of decades, the international trade in used tires has carried those larvae around the world.

But the notion that the Asian tiger might be a public health concern in temperate zones didn't arise until it fueled a 2007 outbreak that started in a small Italian town, Castiglione di Cervia, about a two-hour drive south of Venice on the Adriatic Sea. There a man who had been bitten by mosquitoes on a trip to India fell ill with chikungunya virus. Shortly after the man became ill, so did others in the area, reporting high fever, rashes and debilitating joint pain. It had been a mild winter, and the Asian tiger mosquitoes were out in force. Investigators believe the sick man was bitten by the mosquitoes, which then bit other people, transmitting the disease he'd picked up in India.

Travelers have been returning home from tropical sojourns with exotic mosquito-borne diseases since the days of stagecoaches and sailing ships. But in those days, temperate-zone mosquitoes were unable to transmit those ailments from returning travelers to their friends, family and neighbors. Once an infected person returned home, the chain of contagion was cut.

Today, air travel allows more and more people to crisscross the globe in a matter of hours. But even more important, another globe-hopper has made it possible for infected people to spread some of their unwanted pathogenic souvenirs:

An aggressive biter, the Asian tiger mosquito can carry a variety of pathogens that cause debilitating diseases in humans and some domestic animals.

OPPOSITE PAGE: JAMES GATHANY/CDC. THIS PAGE: CHESTER G. MOORE/COLORADO STATE UNIV. FORT COLLINS

the Asian tiger mosquito. In fact, a growing number of scientists have concluded that *Aedes albopictus* may be an underestimated threat to public health in the temperate zones of the United States and Europe.

Asian tiger takeover

An evolutionarily diabolical trick has allowed the Asian tiger to displace resident *A. aegypti* mosquitoes in many places where *A. aegypti* had dominated for hundreds of years. The scheme relies on the fact that although the two closely related species can't produce offspring, they can mate. When a male Asian tiger mates with a female *A. aegypti*, chemicals in his semen render her sterile. Preventing *A. aegypti* from reproducing is a huge advantage to the Asian tiger and allows it to rapidly overpower resident populations. "This is one of the key components of how the Asian tiger mosquito is managing to be so competitive," says Irka Bargielowski, an entomologist at the University of Florida in Vero Beach.

Her recent research, published February 19 in the *Proceedings of the National Academy of Sciences,* shows that *A. aegypti* may be learning to avoid mating with the Asian tiger, which would make it less likely that *A. aegypti* will be displaced.

But there are other dangers. Just as other species of mosquitoes are adapting to the presence of the Asian tiger, so too are the pathogens it transmits. Take the chikungunya virus. Public health officials studying the appearance of chikungunya on the Indian Ocean island of Réunion in 2005–2006 noted that there were very few *A. aegypti* mosquitoes there. Since the island's Asian tigers were not known to transmit chikungunya, officials were stumped. However, when researchers sequenced the Réunion Island strain of the virus, they found that it had mutated. The Asian tiger could now pass the virus on very efficiently.

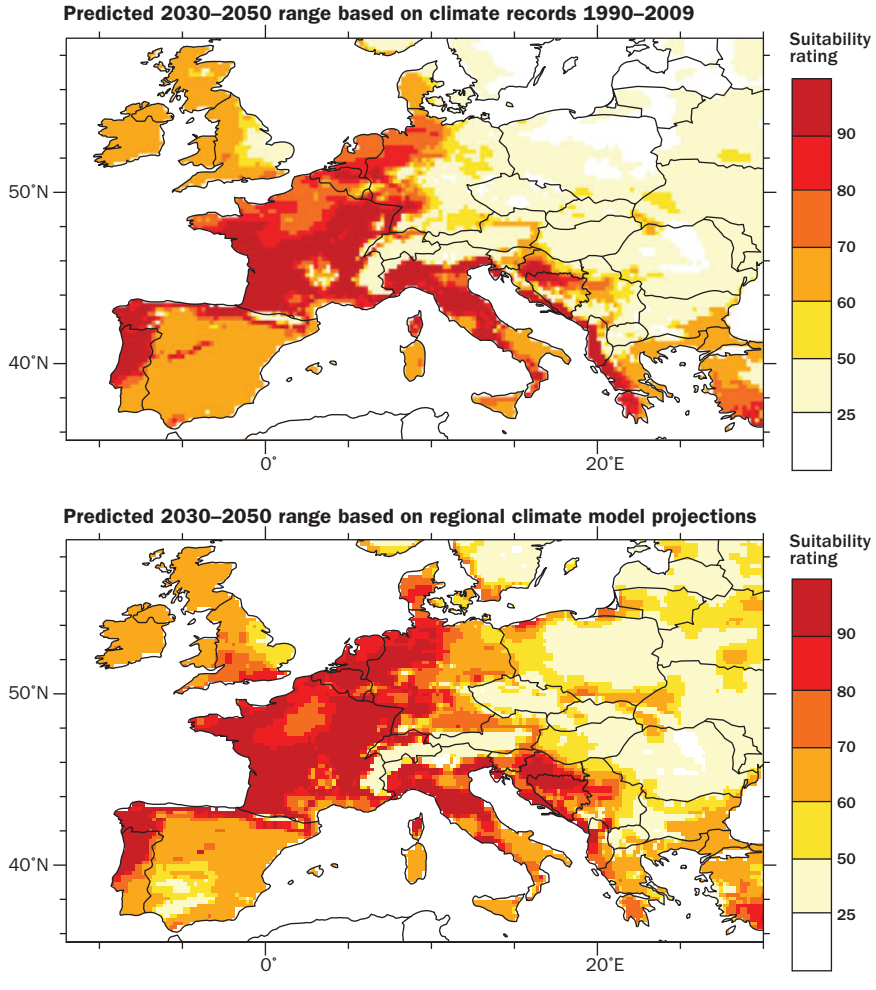
That mutated strain has continued to spread. Epidemics of chikungunya have occurred in India, Malaysia, Singapore and Sri Lanka. Since many of these areas are home to both *A. aegypti* and the Asian tiger mosquito, it's difficult to say exactly which species is responsible for the bulk of transmission. Still, one of the Indian Ocean chikungunya strains is the same as the one identified in Italy in 2007, and its adaptation to the Asian tiger makes it the most threatening to Europe and North America.

Quantifying the risk

Laura Harrington, an entomologist at Cornell University, wanted to estimate the threat of a chikungunya outbreak in the United States. To transmit chikungunya, the mosquito must first bite an infected person and then pass along the infection by biting another person. If the mosquito bites a cat or dog, the virus is stopped dead in its tracks. Harrington and colleagues planned for a worst-case scenario and assumed that the mosquitoes would feed almost exclusively on humans.

To quantify the threat, Harrington and her colleagues calculated the likelihood of a chikungunya outbreak if the virus were brought to the United States by a single traveler. The analysis focused on three East Coast cities: New York, Atlanta and Miami. Published last November in *PLOS Neglected Tropical Diseases,* the study incorporated

As climate changes The Asian tiger mosquito, a competent vector for several tropical diseases, has gained a foothold in temperate regions in Europe and around the world. As Western Europe's climate changes in years to come, certain areas will become more suitable and some less. The two maps below illustrate two scenarios for the decades from 2030 to 2050. The top map is a computer simulation based on actual climate data from 1990 to 2009. The bottom map, based on an ensemble of regional projections, paints an even more dramatic picture, with suitable Asian tiger habitats shifting even farther north into France, Germany and Austria.



C. CAMINADE *ET AL/ J. R. SOC. INTERFACE* 2012

information about local temperature and other factors to determine the number of mosquitoes, including Asian tigers, that would be present at the time the virus was imported.

In Miami's tropical climate, an infected traveler could spark a chikungunya outbreak year-round. For New York and Atlanta, however, Harrington and colleagues discovered a distinct seasonal pattern. In New York, the risk of an outbreak approached 38 percent if an infected person arrived in August. In Atlanta, the high-risk period was longer — June through September. Although these risks are likely overestimated since the Asian tiger doesn't usually feed on humans as frequently as assumed in the calculations, the numbers still indicate a significant probability of chikungunya spreading in North America, thanks in part to the Asian tiger.

"No one has really been talking about this, even among public health officials and scientists. And now I can say, 'Hey, if this can happen in Italy, this could happen here in the U.S.,'" Harrington says.

> **"If this can happen in Italy, this could happen here in the U.S."**
> LAURA HARRINGTON

Although the potential range of the Asian tiger extends into far more temperate areas than *A. aegypti*'s, plenty of places on Earth are still far too cold for the mosquito. As the Earth's temperature slowly warms, however, areas even farther north will become hospitable for the Asian tiger mosquito. A group of researchers led by Cyril Caminade at the University of Liverpool modeled the potential future spread of the Asian tiger throughout Europe in a study published in October in the *Journal of the Royal Society Interface.*

Besides temperature, Caminade and colleagues found that rainfall was a significant predictor of the future habitat of the Asian tiger. As expected, they found that warming climate will probably push the range of the mosquito northward. Interestingly, southern Europe, where the mosquito is currently thriving, may become less hospitable with climate change since the area will become drier as well.

"Since the paper came out, people have been telling me how they have found the mosquito in exactly the areas that the model predicted," Caminade says. "They are not scientists, so we cannot be sure, but the mosquito was detected in places where France and Germany share a border."

Although scientists generally agree that global warming will expand the range of the Asian tiger mosquito, some, like Gubler, have doubts about its public health significance. Although the Asian tiger can transmit dengue in a laboratory setting, it happens less frequently in real life. When compared to *A. aegypti,* the Asian tiger is much less of a threat in Gubler's opinion because it is much less likely to spread viruses when it bites.

"We need to focus on the people and animals that are moving these viruses around the world. The main drivers of the re-emergence of these diseases aren't *Aedes albopictus,* they're humans," Gubler says.

Still, the Asian tiger has been responsible for several significant outbreaks of chikungunya — and a dengue outbreak in Hawaii in 2001. It also brings the potential for outbreaks to areas that have never before been at risk. Scientists agree that part of the solution to this problem is to increase mosquito-control efforts by reducing places for females to lay eggs and by the use of properly applied pesticides. Then, as Gubler explains, it won't matter what species of mosquito is currently causing problems or how many humans are traveling. ■

Explore more

■ D. Ruiz-Moreno *et al.* "Modeling Dynamic Introduction of Chikungunya Virus in the U.S." *PLOS Neglected Tropical Diseases*. November 2012.

Carrie Arnold is a science writer living in Virginia.

Invasion of a vector

As the Asian tiger mosquito establishes itself in temperate climates, it brings with it the ability to spread tropical diseases to those with no immunity.

1894
Asian tiger mosquito, *Aedes albopictus* (originally *Culex albopictus*), first described scientifically

1979
Asian tiger emerges in Europe (Albania)

1985
First continental U.S. breeding population established

1990–91
Asian tiger populations found in Italy

1999
Asian tiger emerges in France

2004
Asian tiger invades Croatia

2005–2006
Chikungunya outbreak on Réunion Island in Indian Ocean

2007
Chikungunya outbreak in and around Castiglione, Italy

Global trade in used tires has spread Asian tiger mosquitoes from their native Southeast Asia.

E. OTWELL; PHOTO: KROMKRATHOG/SHUTTERSTOCK

Math on Trial

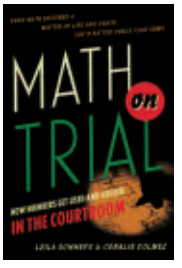
Leila Schneps and Coralie Colmez

"Torture numbers and they will confess to anything," author Gregg Easterbrook once wrote in a magazine piece on climate change. But his quip could have been the subtitle for this new book on the abuse of numbers in the courts.

Its authors, mother-daughter mathematicians, belong to a research group devoted to improving the use of statistics in criminal trials. Each chapter focuses on cases exemplifying a particular class of statistical error. Poignant tales detail exonerations resulting from faulty math used in the original trials (errors usually corrected only after intervention by statisticians, some of whom stepped in independently).

In one example, the authors tell the stories of grieving mothers charged with child abuse after each lost several children to crib death. Gross miscalculations of the probability that this might occur repeatedly within a family resulted in murder convictions for several women.

Then there was the 1894 conviction of French army captain Alfred Dreyfus for high treason. The officer had been charged with sending secrets to the enemy in a coded message. The real traitor eventually emerged, but only after a faulty statistical analysis of handwriting and codes had sent Dreyfus to a long imprisonment on an isolated island off French Guiana.



Not all those exonerated by faulty stats are sympathetic characters; in one of the book's examples a person convicted by miscalculated numbers may have been guilty anyway. Regardless, the authors argue, "the misuse of mathematics can be deadly." Most important, problems tend to arise from inadvertent errors, they find, "not from any inherent inapplicability of mathematics to justice." *—Janet Raloff*

Basic Books, 2013, 272 p., $26.99

A Tale of Seven Elements

Eric Scerri

The periodic table, which arranges elements based on chemical behavior and physical properties, is a triumph of science. Yet the first table, developed in the late 1860s, was riddled with gaps created by undiscovered elements.

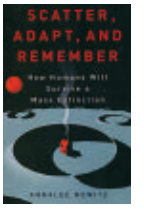
By the time researchers recognized in 1913 that elements should be arranged by atomic number (the number of protons in their nuclei) rather than by atomic weight, only seven gaps remained in the list of naturally occurring elements. Chapter by chapter and element by element, Scerri, a historian of science, chronicles scientists' efforts to fill those holes. A bonus chapter covers elements above uranium, created in laboratories.

Five of the seven natural elements were missing largely because they are incredibly radioactive and thus short-lived. Two — francium (element 87) and astatine (85) — are so rare that Earth's entire crust is thought to contain no more than 30 grams, or about the weight of a paper clip, of each element at any one time.

More than a description of seven rare elements, the book also recounts the pivotal experiments and false starts that preceded each discovery. Scerri's *Tale* gives an absorbing account of scientific process in the early 20th century, when nationalism drove chemists and physicists to seek the glory that would result from discovering a new element.

While a few of these scientists later claimed Nobel prizes or appeared on postage stamps, one gained what may be the ultimate chemical accolade: Austrian physicist Lise Meitner had element 109, meitnerium, named in her honor. *—Sid Perkins*

Oxford Univ., 2013, 304 p., $19.95



Scatter, Adapt, and Remember

Annalee Newitz

A journalist looks into how the human race might survive if a major disaster wipes most life off the planet. *Doubleday, 2013, 320 p., $26.95*

The Milky Way

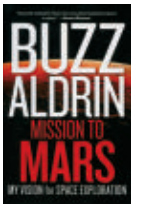
William H. Waller

An astronomer takes readers on a tour of the galaxy, from Earth all the way to the black hole "monster" that sits at the Milky Way's center. *Princeton Univ., 2013, 316 p., $29.95*

The Kingdom of Fungi

Jens H. Petersen

Stunning color photographs are the highlights in this exploration of the diverse and surprisingly beautiful fungal world. *Princeton Univ., 2013, 265 p., $29.95*



Mission to Mars

Buzz Aldrin with Leonard David

The celebrated astronaut makes a case for space exploration and explains how humans can reach Mars by 2035. *National Geographic, 2013, 258 p., $26*

Ticked

James A. Fussell and Jeffrey P. Matovic

Matovic and Fussell, a writer, describe how Matovic became the first person to have a "brain pacemaker" implanted for controlling Tourette syndrome. *Chicago Review Press, 2013, 272 p., $26.95*

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Invertebrate enigmas

I found the recent article "Evolutionary enigmas" (*SN: 5/18/13, p. 20*) fascinating because I know of another example of an invertebrate animal possessing a "strictly vertebrate" quality. As a high school human anatomy and physiology teacher, I sometimes have my students test the effects of the constituents in cigarette smoke on live *Daphnia* heart rates. These arthropods are known to have myogenic hearts, whereas most arthropods have neurogenic hearts. Myogenic hearts contain muscle cells with an innate ability to contract without neural input, just as vertebrate heart muscle does. This makes me wonder what other invertebrate phyla might contain oddball members with vertebrate characteristics, thus helping "fill in the dots" and establishing sound evidence for a parallel line of evolution that never quite fully blossomed.

John Gallo, Plano, Texas

Pole flipping

The illustration of the magnetic poles in "Spinning the core" (*SN: 5/18/13, p. 26*) correctly shows that the field lines run from geographic south in Antarctica to geographic north in the Arctic. However, the convention is that magnetic field lines run from north magnetic poles to south magnetic poles, so the magnetic pole in Canada is actually a south pole, not a magnetic north pole as illustrated.

Francis X. Hart, Sewanee, Tenn.

Technically, yes. By geophysical convention, though, the magnetic pole located in the Arctic region is known as the north magnetic pole. —Alexandra Witze

Correction

The cricket shown in "Dying crickets less choosy" (*SN: 5/4/13, p. 8*) is male, not female. Thank you to astute reader David Shen of Reno, Nev., who noticed its lack of an ovipositor.

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

Obituary

For more People stories, visit **www.sciencenews.org/people**

Engineer Tim Samaras (left) was tracking an Oklahoma tornado when he died in May with his son and a colleague.

Tim Samaras, 1957–2013

As a child, Tim Samaras frustrated his parents by sneaking kitchen appliances into his bedroom to dismantle them. One day his mother had to coax him to come watch a movie musical with her. It was *The Wizard of Oz*, and the 9-year-old sat transfixed throughout the tornado scene. As he recalled last year, his only thought was: "I've got to take that apart!" For much of the last two decades, the tornado chaser tried to do just that (*SN: 7/28/12, p. 32*).

On May 31, Samaras, 55, died along with his 24-year-old son Paul and meteorologist Carl Young, 45. The storm chasers were caught in the widest twister in recorded U.S. history, just south of El Reno, Okla. The three are the first storm chasers known to be killed by a tornado, according to a statement by the National Oceanic and Atmospheric Administration in Norman, Okla.

An engineer, Samaras systematically probed how a tornado's winds rev up. In 1999, he decided to build instruments and place them in the path of a tornado. He was told not to bother; that others had tried — and had proven that the instruments would never survive.

"Fortunately, I didn't listen," Samaras said. His probe would push into the ground as a tornado passed over, allowing him to map the wind fields inside in 3-D. He collected data demonstrating a record-breaking 100-millibar pressure drop inside an F-4 tornado and showed that the greatest acceleration of winds occurs in the bottom two feet of the funnel.

Anyone who explores new environments faces challenges, says John Francis, vice president for Research, Conservation and Exploration at the National Geographic Society in Washington, D.C. Biologists brave disease-carrying insects and perilous terrain to find new species. Volcanologists climb craters to study gurgling lava. Tornado chasers have a reputation as danger junkies, but not Samaras. "I never saw him as thriving on adrenalin," Francis says. "I never saw him as anything but a serious researcher, driven to better understand these phenomena." He and others describe Samaras as thoughtful, cautious and analytical.

In 2003, Francis signed off on the first of his organization's 18 research grants to Samaras, to build a probe that would survive a tornado. Funding it "was a tough one for me," Francis recalls, "because it was so experimental — so high risk from the sense of, would this even work? But in the end we felt he had the background and experience to pull it off." For all Samaras' accomplishments, Francis says, "we will miss Tim most because he was demure and just a wonderful person, accomplishing things that no one else on the planet had." — *Janet Raloff*

Storm chasers' tribute
On June 2, hundreds of U.S. storm chasers used an app called RadarScope to spell out the initials of Tim Samaras, Paul Samaras and Carl Young as a tribute to the men, who died in a May 31 twister. The chasers normally use the app to track the weather and each other.

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