The Sound of Fear | Why Time's a One-Way Street | Lies Antelopes Tell

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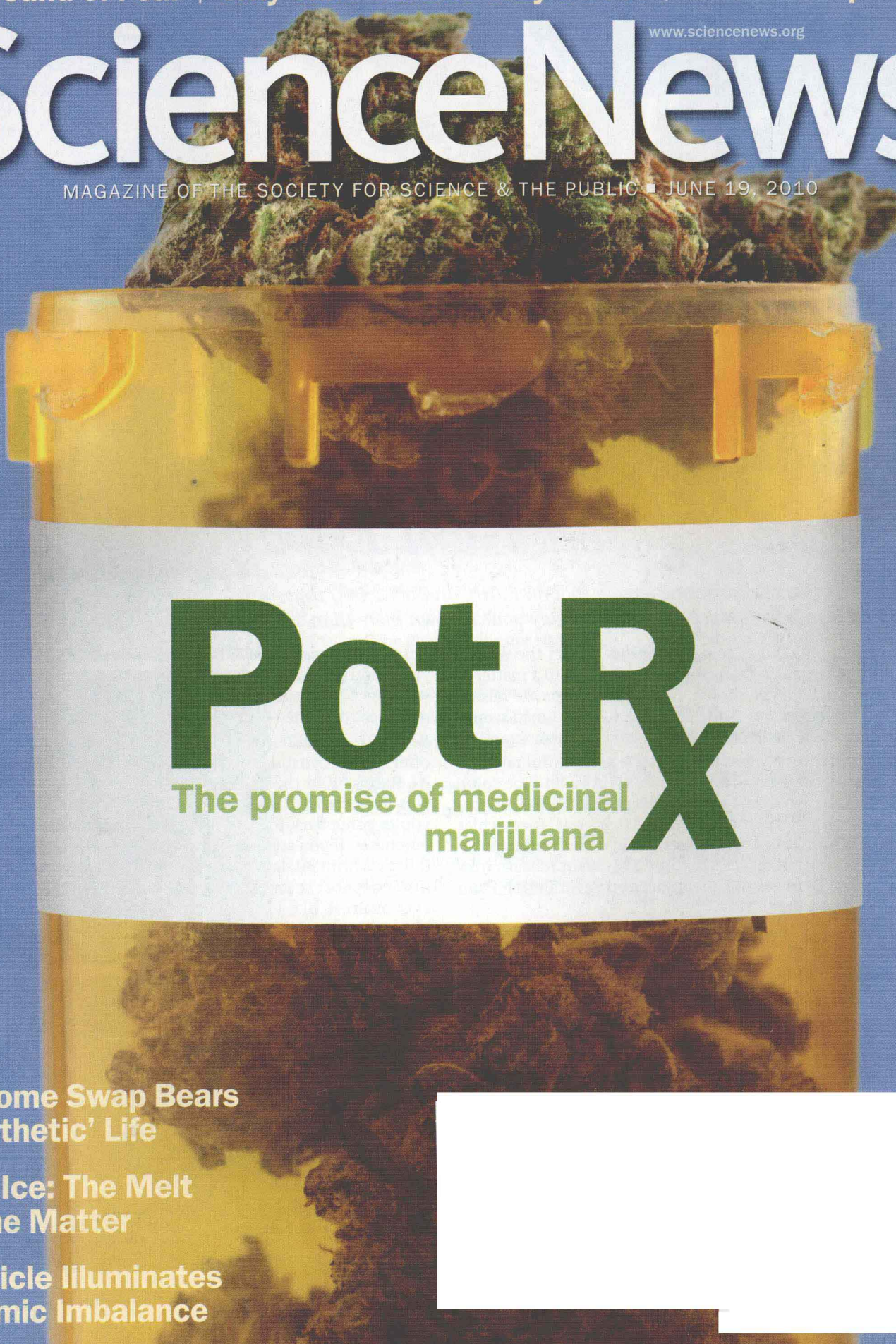
ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ JUNE 19, 2010



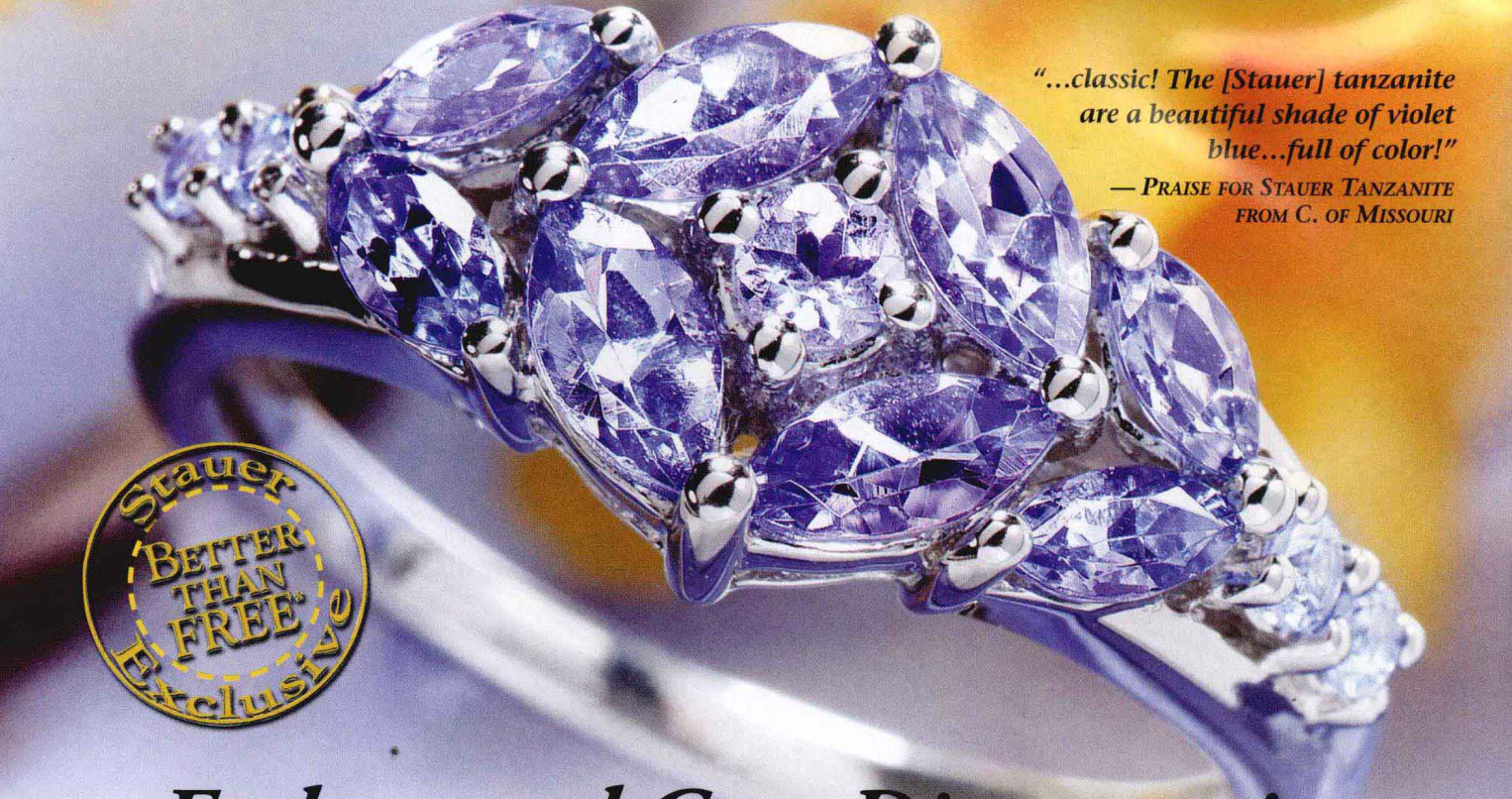
Pot Rx

The promise of medicinal marijuana

Genome Swap Bears 'Synthetic' Life

Sea Ice: The Melt of the Matter

Particle Illuminates Cosmic Imbalance



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— *Praise for Stauer Tanzanite from C. of Missouri*

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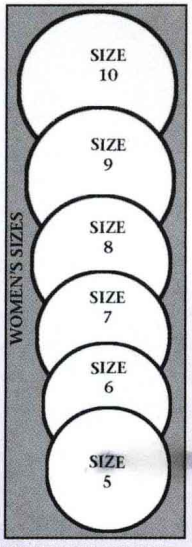

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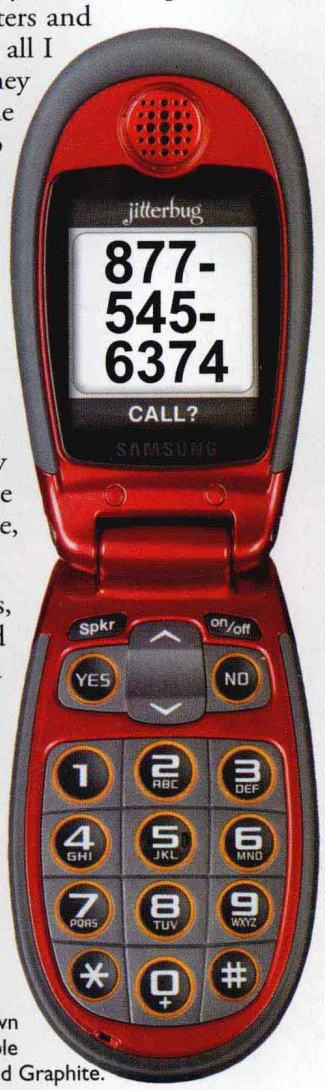

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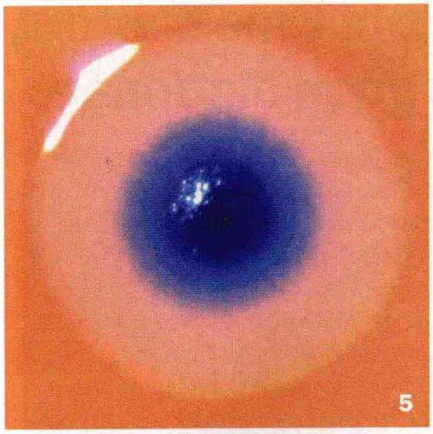
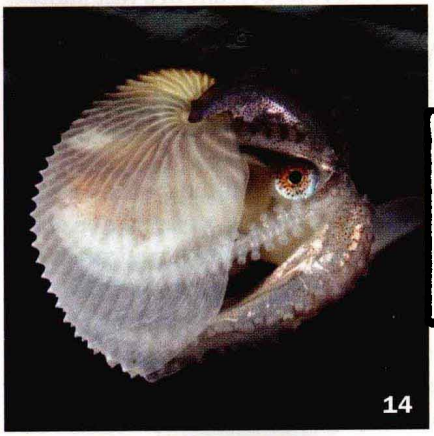




ScienceNews

In The News

5 STORY ONE
- A cell reprogrammed with a man-made genome inches researchers closer to fully synthetic life

8 ATOM & COSMOS
- Particle decay hints at why matter rules
- Black hole takes off-center stage
- WISE eyes the Heart and Soul nebulae

10 HUMANS
- Disgust and anger look the same to young kids
- Gene plus bullying ups risk of emotional fallout
- Perfect screen screams
- Ardi may or may not have been one for the trees

12 MATTER & ENERGY
- Ball lightning may be all in your head?
- Better solar-cell efficiency through quantum effects

13 BODY & BRAIN
- Major study of cell phone–brain cancer link inconclusive
- Dementia caregivers face cognitive risks themselves

14 LIFE
- Lying to get the ladies
- Why the argonaut got its shell
- New clues point to team of honeybee killers
- Chatty bacteria slow healing

Features

16 NOT JUST A HIGH
COVER STORY: Cannabis compounds show their stuff against a host of medical problems, relieving symptoms far beyond pain and nausea.
By Nathan Seppa

22 MELTING AT THE MICROSCALE
Studying polar sea ice up close could help scientists understand its disappearance.
By Alexandra Witze

Essay

26 LAW & DISORDER
For clues about why the arrow of time appears to point in just one direction, physicists look back to the Big Bang — and before.
By Tom Siegfried

Departments

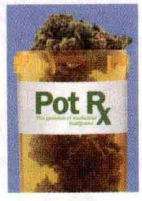
2 FROM THE EDITOR

4 NOTEBOOK

30 BOOKSHELF

31 FEEDBACK

32 COMMENT
Bioethicist Glenn McGee discusses the latest news of "synthetic" life.



COVER Once derided as fringe science, cannabis research has gone mainstream, showing promise in treating multiple sclerosis, Crohn's disease and other disorders.
belterz/iStockphoto

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FROM THE EDITOR

For source of time's arrow, consult a good dictionary

Language is infused with words and phrases that instill in human consciousness a direction for the flow of time. Not just *past* and *future*, but words like *before*, *after*, *earlier*, *next* and *then*, *soon* and *until*. It's hard to make sense about much of anything without slipping in words that allude to a temporal order.

But the mathematical language used by physicists to describe the interplay of atoms and molecules recognizes no such single time direction. Equations for the laws of motion work equally well whether time advances or reverses — in the microworld, time's arrow has two tips. In the world of everyday life, though, a one-way time street *originates* from a time-free foundation. Trying to explain how has occupied physicists *since* the late 19th century.

In an essay in this issue (Page 26), I describe one of the more *recent* efforts to explain time's direction, expounded by Caltech physicist Sean Carroll in a *new* book (which I review on Page 30). Much of what he has to say has been said *previously* by others, but there is *novelty* in his notion that the solution may be found in a time *before* the birth of the universe. If our universe is just one of many in a vast multiverse, time's arrow can point one way in some, the other way in others. Equations describing two-way time in the microworld therefore simply reflect the convenience that the same math can apply to the physics in any universe you happen to be in, regardless of which way its time flows.

Nobody really knows, of course, if multitudes of universes really exist, or whether time is an illusion, a trick played on brains by the microphysics of their neurons. It may *turn out* that the time-arrow mystery merely reflects a primitive understanding *awaiting* deeper insights, and concepts, to pierce the psychological conditioning of time-oriented language.

My favorite observation in this respect came from the late John Archibald Wheeler, a physicist who thought profoundly about explaining the foundations of physical reality. In an interview more than 20 years *ago*, Wheeler commented on the role of language in complicating his quest.

"We have to learn how to use our words," he said. "It's a fantastic thing — we humans are so easily trapped in our own words. The word *time*, for instance. We run into puzzles about the concept of time and then we say, 'Oh, what a terrible thing.' We don't realize we're the source of the puzzles because we invented the word." —*Tom Siegfried, Editor in Chief*

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11. Knowledge as a Product of the Active Mind
12. Trading Reality for Experience
13. Scientific Truth in the Early 20th Century
14. Two New Theories of Scientific Knowledge
15. Einstein and Bohr Redefine Reality
16. Truth, Ideology, and Thought Collectives
17. Kuhn's Revolutionary Image of Science
18. Challenging Mainstream Science from Within
19. Objectivity Under Attack
20. Scientific Knowledge as Social Construct
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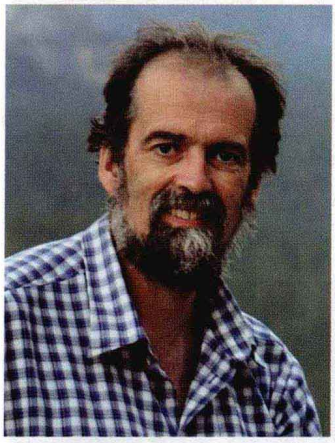

Scientific Observations

"I'm part of the generation that read Isaac Asimov and Arthur C. Clarke as science fiction authors. And they were both confident in technological fixes to human situations. That's something that's decreased over time.... Look at the developments over the last 20 years that have made huge progress in medicine, in agriculture, in improving the human condition. Whether those improvements have been implemented becomes a society issue, a political issue, but the tools are routinely being generated. And how they are managed is going to be more and more important. That's one reason why we should have a scientifically educated population, so people can make their own judgments of how technologies ought to be applied to society."

—JOHN GILBEY, AUTHOR OF THE SCIENCE FICTION STORY *CATALYST*, IN THE APRIL ISSUE OF *SYMMETRY*

Science Past | FROM THE ISSUE OF JUNE 18, 1960

USSR USES SABIN VACCINE — The Sabin live polio virus vaccine, developed in the United States but not yet licensed here, is "completely harmless" and extremely effective, Russian scientists have found. They have already immunized millions of children in the USSR with the live vaccine.... The scientists said they had been particularly careful to study the possibility that the attenuated Sabin strains might turn into dangerous virus forms. They found the live vaccine to be "completely harmless." There is no "threat of the vaccine strains' reversion to a more virulent state." They advised that the live vaccine be made compulsory, as in the case of smallpox and diphtheria in many areas.

Science Future

June 25–29
The American Diabetes Association hosts its annual meeting in Orlando. See professional.diabetes.org

July 11
A total solar eclipse can be seen in parts of the South Pacific. See viewing times for cities at eclipse.gsfc.nasa.gov

July 24–27
Clinicians and researchers meet in Vancouver, Canada to discuss heart disease research. See www.cardiologyonline.com

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LIFE
Early octopus ancestors were two-tentacled pygmies, new fossils reveal (illustration shown). See "Octopus origins."

HUMANS
A man can detect the emotions in the scent of his woman and vice versa. See "Making scents of a partner's feelings."

BODY & BRAIN
Blood vessels in mice pull a defenestration-esque move to ditch clots. See "Tiny blood vessels expel clots by force."

MOLECULES
Great martinis are not born but made by the interaction of ethanol and water molecules, chemists suggest. See "Vodka's bonds may influence taste."

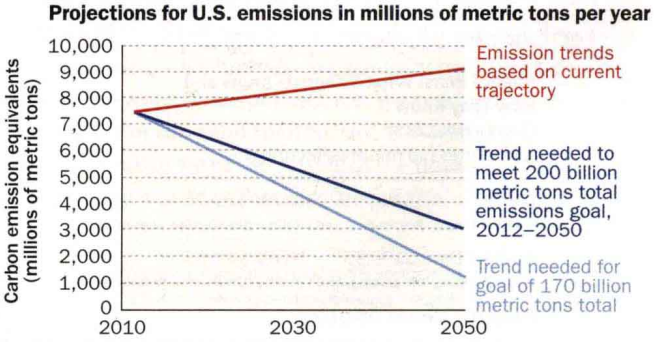
Introducing...

Conservation is its own reward, literally. A new species of antpitta, a forest bird, has been discovered and named for American Bird Conservancy president George Fenwick and his family, researchers report in the May 18 *Conservación Colombiana*. The tail of *Grallaria fenwickorum* (shown) spans about 6 centimeters, and the entire bird weighs about 50 grams, a little less than a tennis ball. Though the bird was identified within a protected area in the Andes, it may still need the aid of its human counterpart: Dubbed "Fenwick's antpitta," its conservation status is proposed as "critically endangered."

Science Stats | OFF TARGET

Energy experts have identified two goals for total U.S. carbon emissions from 2012–2050. Meeting either will take a reversal of current trends.

Projections for U.S. emissions in millions of metric tons per year



SOURCE: AMERICA'S CLIMATE CHOICES/*NATIONAL RESEARCH COUNCIL* 2010

CLOCKWISE FROM TOP LEFT: JULIE GILBEY; MARIANNE COLLINS; ©FUNDACIÓN PROAVES

“It’s such an obvious lie. Clearly there’s no lion.” —JAKOB BRO-JØRGENSEN, PAGE 14

Atom & Cosmos Clue to cosmic imbalance
Galaxy M87’s not-quite-central black hole

Humans Faces get gross around age 5
Ardi’s status as tree hugger questioned

Matter & Energy Lightning in the mind

Body & Brain Caretakers and dementia

Life Buoyancy via a maritime shell

In the News

STORY ONE

Genome from a bottle turns one bacterium into another

Wholesale DNA swap marks synthetic biology milestone

By Laura Sanders

Using a made-from-scratch genome, scientists have breathed a new kind of life into a bacterium. The feat, published online May 20 in *Science*, holds promise for designing new organisms that might do things like produce vaccines, synthesize biofuels, purify water or eat spilled oil.

Researchers from the J. Craig Venter Institute carefully stitched together the entire genome of the bacterium *Mycoplasma mycoides* and put it into a different kind of bacterium, *Mycoplasma capricolum*. This unprecedented wholesale genome swap caused the *M. capricolum* cell to switch species. The newly converted cell was nearly identical to the natural *M. mycoides*.

“This was a proof-of-concept experiment showing that we could take the sequence out of a computer, build it and boot it up to make a synthetic cell,” says study leader Daniel Gibson of the Venter Institute’s campus in Rockville, Md.

This ability to transplant complete genomes from one species to another is “a marvelous piece of work,” says bioengineer James Collins, a Howard Hughes Medical Institute investigator at Boston University who was not involved in the study. “This represents an important advance for synthetic biology.”

For decades biologists have been sculpting genomes by adding and subtracting bits of DNA, with the goal of gaining control over existing organisms — and even creating new ones.

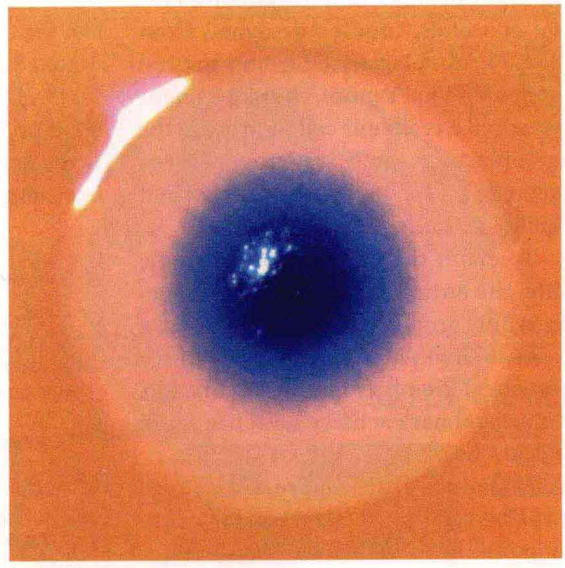
Scientists at the Venter Institute already knew the DNA sequence of the *M. mycoides* genome. But now they’ve been able to take the string of A’s, T’s, G’s and C’s stored in a computer, build the whole genetic instruction book in test tubes, put it in a cell and show that it works.

One of the major challenges in the new study was figuring out how to knit short pieces of DNA together in a particular order to create a large genome. Through earlier experiments, the team had found that proteins in yeast cells could quickly assemble large pieces of DNA. “We were amazed that yeast has this capacity, so we tried to push the limits,” Gibson says.

After going through three rounds of assembly in surrogate yeast cells with progressively bigger chunks of synthesized DNA, the researchers produced a genome of record-setting size, clocking in at 1,077,947 DNA letters. This synthetic genome was then introduced into *M. capricolum* cells, which began to forget their own characteristics and instead adopt properties, including the protein profile, of the genome-donor species, *M. mycoides*.

“It’s still pretty stunning to me that simply by changing the software in the cell, the cell immediately starts this process of converting into another species,” says biologist J. Craig Venter. “It’s all about how life works, how dynamic it is.”

In most ways, the man-made genome was similar to the natural one, with a few important tweaks: The scientists added DNA sequences that the genome needs to survive the yeast-based assembly step and the transfer into its new cell. The team also added sequences encoding a substance that causes a cell to turn blue in the presence of certain drugs, making



A DNA sequence in a newly engineered synthetic genome made recipient cells turn blue under certain lab conditions (colony shown above). This allowed researchers to distinguish the cells with the man-made genome from those that didn’t take it up.

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colonies with the synthetic genome identifiable with the naked eye. And finally, four unique genetic "watermarks" that would unambiguously distinguish an *M. mycoides* cell with synthetic DNA from a naturally occurring cell were included.

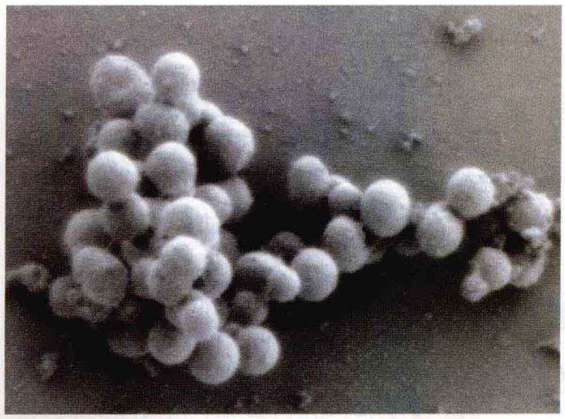
So far, Venter and his team haven't engineered any useful properties into the synthetic genome. "This is not so much about parts as it is a chassis to put the parts into," says George Church, a geneticist and technologist at Harvard Medical School in Boston.

Researchers have been tinkering with genes for many years, but the ability to replace an entire genome is different, Venter says. Other studies typically change a small number of genes isolated from bacteria. "Now we start with information in the computer. We start with digital code and create new genetic code from four bottles of chemicals [the A's, T's, G's and C's that make up DNA]. I think that's the biggest philosophical difference."

To some, though, this man-made genome is not technically artificial. "It's a great feat, but I wouldn't call it an artificial organism," Collins says. Synthetic, he contends, implies designed from scratch, not plagiarized from a natural genome. What's more, the experiment required a recipient cell to provide the cytoplasm to hold the transplanted genome. "It's small, but it's an important quibble," Collins says.

To claim the creation of synthetic life, the entire organism must be successfully produced from raw materials, asserts Glenn McGee of the Center for Practical Bioethics in Kansas City, Mo. "The landmark achievement has yet to occur," he says.

Semantics aside, the real challenge will be turning this technology into something useful. Gibson says designing genomes and transplanting them into microorganisms could create special bugs that produce vaccines, other pharmaceutical compounds and biofuels, for instance. Scientists at the Venter Institute are already working with Exxon Mobil to create bugs that slurp up carbon dioxide and convert it into clean fuel. Other applications include designer organisms that could convert wastewater into drinking water and clean up hazardous chemical spills.



After taking up a synthetic genome based on that of *Mycoplasma mycoides*, cells (shown) adopted the characteristics of their genome-donor species.

Such efforts will require an incredibly detailed knowledge of the biology of the organisms, something scientists currently lack, Collins points out. "At best, we have a rudimentary understanding of these functions," he says.

Making targeted changes to existing genomes may prove just as successful as making organisms from scratch. "If the stated goal is to make useful microorganisms for commercial purposes, there are alternatives already in use," Church says. "It's not absolutely clear that suddenly a lot of people are going to adopt this method.... Nevertheless, it's a big milestone." ■

Back Story | CRACKING THE CODE

In order to identify organisms with the made-from-scratch genome, researchers at the Venter Institute put four unique DNA sequences into the blueprint to serve as "watermarks." For fun, the team figured out a way to encode all the letters of the alphabet (along with necessary punctuation) using the A's, T's, C's and G's that make up DNA. This feat allowed the team to include secret words and phrases, which you can try to decipher yourself by visiting **www.sciencenews.org/ventercode**

Included in the watermarks:

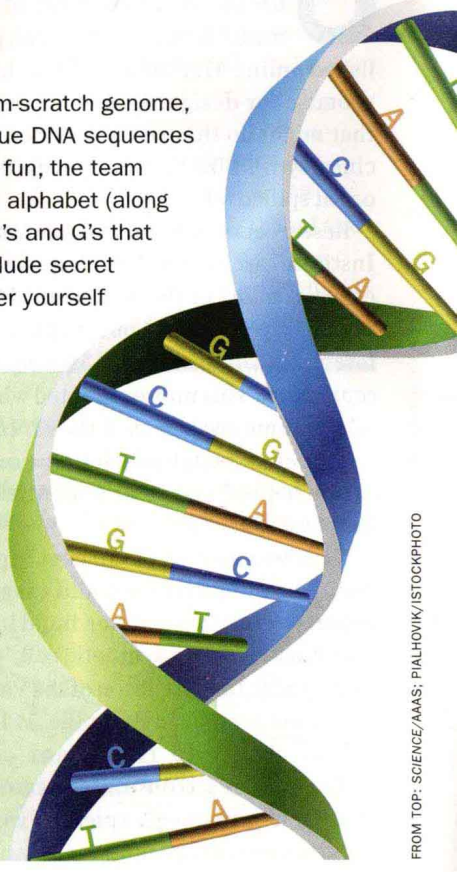
1. The **key** to the alphanumeric code.

2. The **names** of members of the research team, including J. Craig Venter.

3. A **quote** from James Joyce's *A Portrait of the Artist as a Young Man*: "To live, to err, to fall, to triumph, to recreate life out of life."

4. A **website address** where those who have solved the code can go to gloat.

Hint: In the same way that three genetic letters in DNA code for an amino acid, three genetic letters code for each alphabet letter. That's not necessarily true for punctuation, though.



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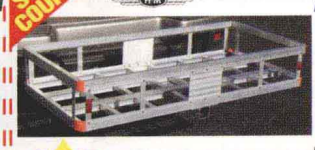

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Muons offer clue to why universe isn't just space

Matter-antimatter imbalance hints at need for new physics

By Ron Cowen

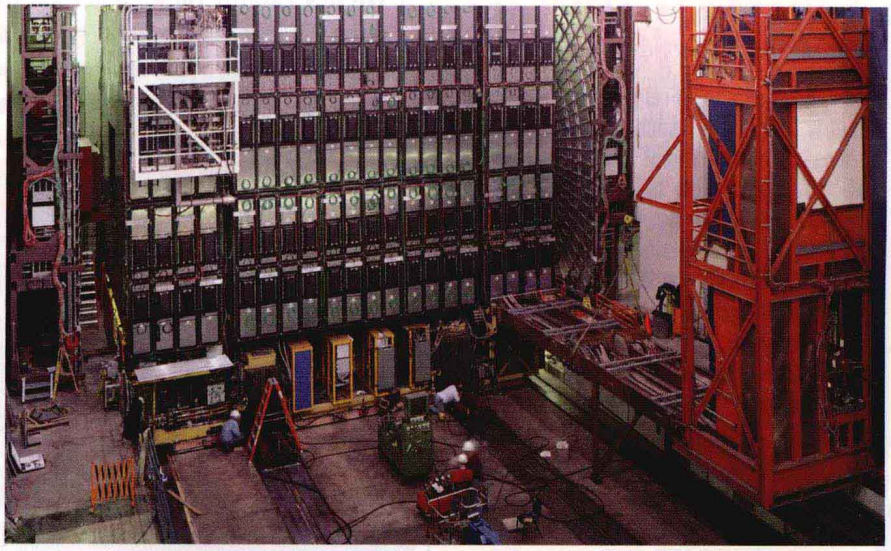
Less than a trillionth of a second after the Big Bang, another tumultuous event unfolded. In a cosmos born with equal parts matter and antimatter — which should have annihilated each other — matter somehow began to dominate.

Physicists now have uncovered a new clue about what caused this fortunate imbalance, which led to the existence of galaxies, planets and people.

The new result is based on seven years of studying trillions of short-lived particles called B mesons produced at the Fermi National Accelerator Laboratory's Tevatron particle collider in Batavia, Ill. Scientists on the Tevatron's DZero experiment have found hints that when B mesons disintegrate, they produce about 1 percent more pairs of muons, a heavy version of the electron, than pairs of the muon's antiparticle, the antimuon. That imbalance, a signature of a phenomenon known as CP violation, may bode well for eventually understanding how matter outstripped antimatter in the universe.

The finding, reported at a Fermilab seminar May 14 and posted online at arXiv.org May 18, also improves the odds that the Large Hadron Collider, the European accelerator that recently superseded the Tevatron as the world's most powerful atom smasher, will discover new elementary particles or other novel physics.

Although small, the 1 percent surplus is 50 times larger than the asymmetry between matter and antimatter predicted for B meson decays by the standard model of particle physics, notes DZero spokesperson Stefan Söldner-Rembold of the University of Manchester in England.



The DZero detector (shown) at Fermilab's Tevatron accelerator has recorded an excess of matter over antimatter in the decay of particles called B mesons. That excess could help physicists figure out why matter exists in the universe today.

"It was a goose bump situation," says Söldner-Rembold of the moment in early May when he and his 500 DZero collaborators realized what they had discovered. "We were very excited because it means there's some new physics beyond the standard model that has to be within our reach for the asymmetry to be so large."

Although there's less than a 0.1 percent chance that the DZero results are a fluke, by the standards of particle physics the results should be regarded as hints that still must be confirmed, cautions theorist Yuval Grossman of Cornell University. Söldner-Rembold notes that the DZero findings are similar to an asymmetry in matter-antimatter production discovered in 2008 by another Tevatron experiment, called CDF, but the new results have much less uncertainty.

> **"Some new physics beyond the standard model ... has to be within our reach."**
> STEFAN SÖLDNER-REMBOLD

Theories that might account for the DZero result include supersymmetry, which assumes that each elementary particle in the standard model has an as-yet-undiscovered heavier superpartner, notes theorist Marcela Carena of Fermilab, who is not a member of the discovery team. Other possible theories, she notes, include a model in which gravity and other forces operate in extra, hidden dimensions, and the notion of a fourth family of quarks beyond the three known generations (up and down, strange and charm, and top and bottom).

In models with a fourth quark family, the interaction of new, heavy quarks with the known families could lead to a larger matter-antimatter imbalance than in the standard model. With supersymmetry, interactions of heavy superpartners with other particles might slightly favor the production of matter over antimatter. In theories with extra dimensions, new force-carrying particles could cause the added imbalance, Carena says.

"Still, it is difficult to find a theory that can generate this asymmetry without contradicting other experimental results," Carena says. Nonetheless, some new asymmetry source "is needed to explain the matter-antimatter imbalance in the universe, and hence our existence."

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8.7 suns | Mass of the Cygnus X-1 stellar black hole

4.1 million suns | Mass of the Milky Way's central supermassive black hole

Black hole found a little off-center

Displacement could provide clue to history of galaxy M87

By Ron Cowen

Supermassive black holes are shiftier beasts than astronomers suspected. A new study finds that the giant black hole at the core of galaxy M87 somehow got displaced from the galaxy's center.

Off-kilter black holes "could represent a significant change in our understanding of supermassive black holes, galaxies and the ways in which they may interact with each other," said Daniel Batcheldor of the Florida Institute of Technology in Melbourne.

Sorting through old Hubble Space Telescope observations of M87's core, Batcheldor and colleagues found that its giant black hole, weighing the equivalent of about 6 billion suns, doesn't lie smack-dab at the galaxy's center. Rather it is displaced by about 22 light-years, possibly as the result of a merger with another as-yet-unknown supermassive black hole in the galaxy. Or the black hole might have been pushed aside by one of the twin central jets of gas and dust that emanate from the core of M87, Batcheldor reported May 25.

The finding, to be described in an upcoming *Astrophysical Journal Letters*, has also been posted online at arXiv.org.

The result is plausible, says Karl Gebhardt of the University of Texas at Austin. But finding M87's true center is difficult because the light associated with the black hole isn't entirely symmetrical and could be confused with the blobs of material ejected by the galaxy's jets.

Theorist Avi Loeb of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., notes that there are several ways the jets could have confounded efforts to determine the galaxy's center. Jets plowing into surrounding gas can generate excess light or even create new stars by shocking the gas.

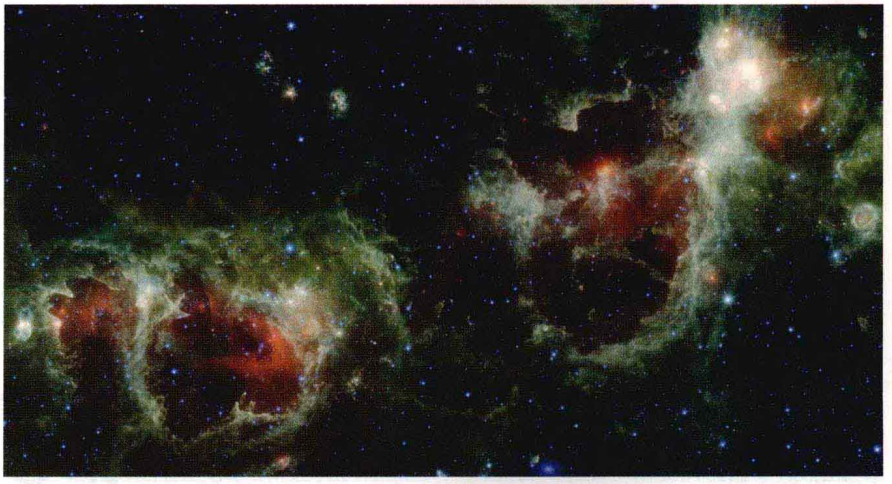
Astronomers hadn't realized earlier that the giant black hole was off-center because there was little reason to search for such an offset, Batcheldor said.

Most searches for off-center black holes have focused on objects traveling thousands of kilometers per hour. A fast-moving black hole is relatively easy to spot because its velocity has either carried it farther from its galaxy's core or has modified its light spectrum so it stands out from other sources, or both.

Supermassive black holes ejected from a galactic center with velocities of only a few hundred kilometers per second — like the one in M87 — are harder to detect but may be more common.

The most likely explanation for the offset is that the collision of two supermassive black holes at some time in the past 10 billion years kicked the newly merged black hole out of the galaxy's center, Batcheldor and his team suggested.

Once kicked, a supermassive black hole can spend millions to billions of years oscillating about the galactic center before coming to rest. The displacement of the hole can therefore reveal the merger history of the galaxy, says team member David Merritt of the Rochester Institute of Technology in New York.



JPL-CALTECH/NASA, UCLA

WISE craft probes Heart and Soul

A new orbiting observatory has captured the Heart and Soul of its mission. Less than six months after launch, NASA's Wide-field Infrared Survey Explorer, or WISE, has examined two giant bubbles of gas and stars, the Heart nebula (right) and the Soul nebula (left), both about 6,000 light-years from Earth. The craft's infrared sensitivity enabled it to peer more deeply into the cold, dusty regions of each nebula, both sites of intense star formation, than a visible-light telescope could. This image of the nebulae, released May 24, showcases the probe's ability to uncover star formation in regions heavily buried in dust, said Ned Wright of the University of California, Los Angeles, lead researcher for the mission. WISE is devoted to finding cold or dusty objects that emit most of their light at infrared wavelengths. These bodies include not only nebulae like Heart and Soul, but also galaxies millions of light-years from Earth and asteroids in the solar system. So far, the mission has observed more than 60,000 asteroids, about 11,000 of which have never been seen before, said WISE researcher Tommy Grav of Johns Hopkins University in Baltimore. Most lie in the main asteroid belt between the orbits of Mars and Jupiter, but about 50 of them are previously unknown objects with paths taking them close to Earth's orbit. —*Ron Cowen*

Humans

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

Young kids can't face up to disgust

Until age 5, ability to interpret facial expressions is limited

By Bruce Bower

BOSTON — Young children have a gift for doing things that adults find disgusting. But kids themselves take a surprisingly long time, until about age 5, to grasp the meaning of adults' facial expressions of disgust, according to evidence presented May 28 at the annual meeting of the Association for Psychological Science.

Disgust expressions are not well discerned by kids under age 5.

This conclusion flies in the face of a popular idea that evolution has produced an innate facial expression for this emotion that even infants should comprehend, said Boston College psychologist James Russell. Theoretically, an ingrained recognition of adults' disgusted expressions would keep youngsters from eating poisonous and potentially fatal items or putting them in their mouths.

"From that traditional view, it's surprising that kids don't understand facial expressions of disgust until age 5," says Russell. "But we find that, until then, they see a 'disgust' face as being angry."

Russell regards the new results as consistent with his controversial rejection of an influential theory that six emotions built in from birth — happiness, sadness, anger, fear, surprise and disgust — appear in distinctive facial expressions displayed by people everywhere. Instead, Russell proposes that two scales of feeling, high arousal to low arousal and positive reaction to negative reaction, provide the building blocks for emotions that get elaborated in each culture.

His team has previously found that most children misidentify feelings expressed in adults' facial expressions. Even at age 14, a substantial minority still err on this task.

In two new experiments, Russell and colleagues observed that youngsters often know the meanings of words for emotions before comprehending the meanings of the facial expressions that go with them.

The researchers studied nearly 600 kids, ages 2 to 7, from middle- to upper-income families in the Boston area. Children viewed images on a computer screen of adults displaying the six basic emotional expressions, then assigned faces to boxes on the screen designated for specific emotions, such as an "angry" box.

At age 2, children's accuracy was limited to putting happy faces in a "happy" box. Toddlers treated all negative emotional expressions as being angry.

Shortly after age 3, an appreciation of sad faces emerged. About a year later, kids correctly identified only angry faces as angry. Accurate designations of other facial expressions soon followed, with comprehension of disgust appearing last.

Children may not discern facial expressions of disgust until age 5 but use words synonymous with disgust, such as "gross" and "yucky," much earlier, says psychologist Lera Boroditsky of Stanford University. Kids may use such words in certain situations years before recognizing the facial expression, Russell proposes.

Gene exacerbates harm of bullying

Dual dose of short genetic variant linked to emotional woes

By Bruce Bower

There's nothing fair about getting bullied. To add insult to injury, a new study finds that bullied kids who have inherited one form of a stress-related gene develop the most emotional problems.

Symptoms of anxiety, depression and social withdrawal appeared most often in regularly bullied kids with two copies of a short version of the *5-HTT* gene, says a team led by psychologist Karen Sugden of Duke University in Durham, N.C.

One-third of bullied children who had two short copies of the gene displayed emotional problems severe enough to merit mental health treatment. That figure fell to 29 percent for regularly bullied kids with one short copy of the gene and 15 percent for those with two long copies.

By tracking pairs of twins, Sugden and colleagues ruled out the possibility that preexisting emotional problems led genetically vulnerable children to be victimized by bullies. In cases where each twin had two short copies of the *5-HTT* gene but only one got repeatedly bullied, emotional difficulties were observed only in the bullied twin, the researchers report in a paper scheduled to appear in the *Journal of the American Academy of Child & Adolescent Psychiatry*.

Other evidence suggests that the short form of the gene, involved in transporting the chemical serotonin in the brain, intensifies emotional reactions to various kinds of stress, possibly by triggering the release of high levels of stress hormones, remarks Stanford University psychologist Ian Gotlib, who was not part of the study team.

His team has found that teenage girls who were socially excluded or lied about by peers showed more signs of depression if they had two copies of the short *5-HTT* gene. Other studies have failed to link the *5-HTT* gene to stress-related emotional problems (*SN: 7/18/09, p. 10*). But most such studies collected data by phone or questionnaire, not in thorough interviews, says psychologist Terrie Moffitt of Duke, a coauthor of the new study.

VIKAVALTER/ISTOCKPHOTO

"Potentially, there are universal rules of arousal and ways to communicate fear." —DANIEL BLUMSTEIN

Chaos makes a scream seem real

Researchers dissect movies to learn what fear sounds like

By Rachel Ehrenberg

As horror-flick titles go, *Night of the Living Chaos* and *Rosemary's Nonlinearity* aren't the catchiest. But filmmakers know that chaos — the mathematical kind — is scary. Now scientists know it too.

Filmmakers use chaotic, unpredictable sounds to evoke particular emotions, a team assessing screams and outbursts from more than 100 movies reports online May 25 in *Biology Letters*.

"Screams are basically chaos," says cognitive biologist W. Tecumseh Fitch of the University of Vienna, who was not involved in the study. "The classic example would be a screaming baby on an airplane, the kind you can't ignore and makes your life hell."

Cries are harder to ignore when irregular and chaotic, research suggests. Scientists believe that such noises, uttered or roared when an animal is really worked up, can play the crucial communication role of frantically demanding attention.

By exploring the use of harsh sounds in film, scientists hope to get a better understanding of how fear is expressed, says study coauthor Daniel Blumstein of the University of California, Los Angeles.

"Potentially, there are universal rules of arousal and ways to communicate fear," says Blumstein, who typically studies screams in marmots, not starlets.

His team analyzed 30-second cuts from such movies as *Aliens*, *Goldfinger*, *Annie Hall*, *Slumdog Millionaire*, *Titanic*, *Carrie* and *The Shining*. Not unexpectedly, horror films had a lot of harsh and atonal screams. Dramas had fewer screams but a lot of abrupt changes in acoustical frequency. Adventure films had a surprising number of harsh male screams.

Screeches that devolve into mathematical chaos evoke a visceral response.

One bloodcurdling scream has become a film favorite. More than 200 movies have used the Wilhelm scream, named for a character who unleashed it in the 1953 western *The Charge at Feather River*.

Experts debate hominid habitat

Discoverers dispute claim that Ardi roamed savannas

By Bruce Bower

An ancient hominid hung out on grassy savannas, not in forests as first claimed, a new study argues. Whether the species trucked across savannas has major implications for understanding how and why human ancestors began walking upright.

The discoverers of the species *Ardipithecus ramidus* disagree with the new study and say that other evidence keeps these hominids in the woods.

When a 4.4-million-year-old partial *Ardipithecus* skeleton was unveiled in October 2009, its owner, dubbed Ardi, was presented as a forest dweller that split time between walking upright and crawling along tree branches (*SN: 1/16/10, p. 22*). In this scenario, a two-legged gait had evolved to support long-distance foraging by males seeking to impress potential mates. But the new analysis, published in the May 28 *Science*, supports a long-standing idea that shrinking African forests spawned the evolution of hominids capable of walking across vast savannas.

In Ardi's neck of the woods, at what is now Aramis, Ethiopia, "there is abundant evidence for open savanna habitats," says geologist Thure Cerling of the University of Utah in Salt Lake City. Ardi could have inhabited a grass- and shrub-covered region in a thin wooded strip that bordered a river flowing through a savanna, Cerling's team suggests.

Cerling and colleagues analyzed data from soil and plant fossils collected by Ardi's discoverers. Forms of carbon in fossil-bearing sediments indicate that tropical grasses covered much of Ardi's home area. Microscopic fossils of such grasses found near Ardi's remains also point to a savanna, the researchers say.

Levels of carbon isotopes in teeth from giraffes and other animals found among *Ardipithecus* fossils resemble those of browsing animals that range today from woods bordering rivers to savannas, the scientists say, noting that aridity and rainfall estimates for Ardi's ancient homeland are compatible with such a habitat.

In a response in the same issue of *Science*, Ardi's discoverers, including anthropologist Tim White of the University of California, Berkeley, say that no reliable way exists to estimate the extent of savanna in Ardi's corner of East Africa. Fossil and geological evidence indicate that *Ardipithecus* favored wooded areas over savanna patches, in White's opinion.

Groundwater and springs probably deposited fossil wood, seeds and invertebrates near Ardi's remains, White notes. No evidence of an ancient river or lake has been found at fossil sites in that area.

If Ardi's kind frequented savannas, as Cerling's team proposes, a biological mystery emerges, White says. "What were these large-bodied hominids doing out on an open grassland, besides providing meals to resident predators?"

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Matter & Energy

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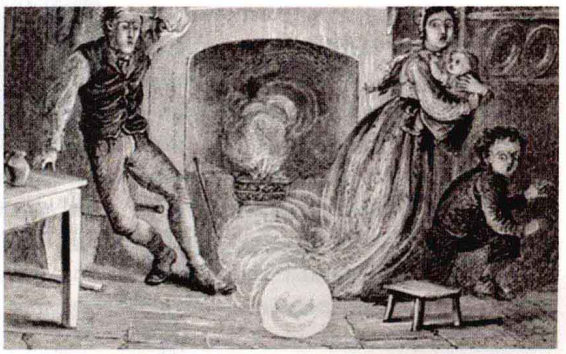
'Ball lightning' may be hallucinatory

Magnetic fields in real bolts might trigger brain's visual area

By Alexandra Witze



Evanescent glowing orbs called "ball lightning" have been reported for centuries, but never fully explained.

Talk about a flash of insight. Lightning strokes could stimulate people's brains and cause them to hallucinate bright blobs of light the same way a magnetic medical procedure does, two physicists propose in an upcoming *Physics Letters A*. That process could help explain some reports of "ball lightning," mysterious floating orbs that have been reported for centuries but are poorly understood.

"We don't claim to have a solution for the mystery of ball lightning," says study coauthor Alexander Kendl, a plasma physicist at the University of Innsbruck in Austria. "But this is a possible hypothesis."

Lightning forms when electrical charges become separated in a storm cloud and build up electrical potential between them, which is then discharged in the sudden bolt. Lightning strokes typically come in clusters. In some cases, Kendl says, they can come very rapidly, perhaps 20 to 60 strokes, each about 100 milliseconds long, raining down over the course of several seconds.

These rare repetitive strokes, Kendl's team found, generate magnetic fields similar in strength, and in how they rise and decay over time, to those used in a brain-stimulation technique called transcranial magnetic stimulation, or TMS.

TMS applies magnetic fields to the brain to treat conditions such as depression. When the stimulation is applied to the visual cortex, some patients report seeing blobs of light. Such experiences of seeing light when light is not actually entering the eye are known as phosphenes. (The pattern of light you see when you rub your closed eyes is a type of phosphene.)

Others have proposed that ball lightning is hallucinatory, but this study is the first to relate it to a known phenomenon.

Working with graduate student Josef Peer, Kendl calculated that repetitive lightning strokes would trigger phosphenes "astonishingly well." A person would need to be within about 200 meters of the lightning to experience the effect.

Thomas Kammer, a TMS expert at the University of Ulm in Germany, isn't convinced. Patients report many kinds of TMS-induced phosphenes, but they don't generally mesh with descriptions of ball lightning. "I cannot imagine that long-lasting visual phenomena as described with ball lightning might be based on induced phosphenes," Kammer says.

Scientists have struggled for centuries to explain ball lightning, often described as a yellowish ball that hovers around eye height for a few seconds before vanishing. Other reports describe ball lightning of various colors moving rapidly, fizzling or even exploding. The diversity of descriptions, Kendl says, suggests ball lightning may be a catchall term describing many different types of experience.

Cheating the thermodynamic laws

Quantum effect could boost maximum efficiency of solar cells

By Laura Sanders

Atoms in a solar cell coaxed into a curious simultaneous quantum state may convert sunlight into electrical energy more efficiently than previously believed possible, a new study proposes.

The laws of thermodynamics set the upper limit of solar cell efficiency at around 80 percent, says study author Marlan Scully of Texas A&M University in College Station and Princeton University. But this estimate doesn't take some quantum effects into account. Scully's model shows that the ultimate energy efficiency can be pushed even higher.

Photovoltaic cells convert photons of light into electrical energy. In a typical cell, photons hit atoms and knock electrons free, resulting in a roaming electron and an electron-hungry area called a "hole." Ideally, electrons are funneled into a path, creating an electrical current. But sometimes, they fall into a hole and emit a photon, an energy-squandering process called radiative recombination.

In the new work, published May 21 in *Physical Review Letters*, Scully proposes that photon squandering can be curbed through a process called quantum coherence, in which atoms are in two energetic states simultaneously. Applying microwave radiation to the photovoltaic cell can induce this coherence, which diminishes the chances of free electrons finding holes.

The scheme doesn't really cheat the laws of thermodynamics, because creating the coherence requires energy. "The thing he didn't take into account is, what is the energy cost in establishing this coherence?" says Ting Shan Luk of Sandia National Laboratories in Albuquerque.

Scully says he has ideas about how to create coherence without using energy.

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Body & Brain

2.2 minutes Average length of a cell phone call in U.S., 1990

3.0 minutes Average length of a cell phone call in U.S., 2005

2.3 minutes Average length of a cell phone call in U.S., 2008

Cell phone–cancer study an enigma

Researchers remain uncertain about safety of mobile devices

By Janet Raloff

A new international study of cellular phone use and brain tumors poses an enigma for epidemiologists. Though researchers found elevated risk for users who talked on average more than 30 minutes a day and had used the devices for more than a decade, moderate cell phone users actually had decreased risk compared with landline callers.

"This study did not confirm or dismiss the possible association between cell phones and brain tumors. That's the bottom line," says Siegal Sadetzki of Tel Aviv University's Sackler School of Medicine.

Sadetzki and colleagues recruited 21,770 participants from 13 countries (not including the United States) as part of the Interphone study. Researchers analyzed risk for two types of brain tumors, meningiomas and gliomas, and found that only gliomas could be linked to cell phone use, and only to heavy use. Even this association was not ironclad, the researchers report online May 17 in the *International Journal of Epidemiology*.

Rodolfo Saracci of the National Research Council in Pisa, Italy, and Jonathan Samet of the University of Southern California in Los Angeles suggest that the conclusions were finessed so as not to alarm cell phone users.

"None of today's established carcinogens, including tobacco, could have been firmly identified as increasing risk in the first 10 years or so since first exposure," the two write in an editorial that accompanies the new paper. Tumors among the Interphone study's participants were diagnosed between 2000 and 2004 — even though widescale cell phone use got under way only in the mid-1990s. Fewer than 5 percent of meningiomas and 9 percent of gliomas seen in study participants occurred among people who had used cell phones for more than 10 years.

"The question as to whether mobile phone use increases risk for brain cancers remains open," Saracci and Samet say.

> "This study did not confirm or dismiss the possible association."
> SIEGAL SADETZKI

The study's authors acknowledge that the jury is still out on cell phone safety. Until follow-up data on heavy users come in, Sadetzki recommends that cell owners adopt "the precautionary principle," assuming that some risk might exist and limiting exposures. Tactics might include avoiding long calls, sending text messages instead of leaving voice messages and using a Bluetooth or other hands-free device to keep a mobile phone farther away from the head.

Dementia care may boost risk

Those who tend sick spouses more vulnerable themselves

By Nathan Seppa

Caring for a spouse who has dementia puts elderly people at increased risk of developing dementia themselves, a study finds. The stress of attending to a mentally incapacitated spouse may somehow contribute to the added risk, scientists report in the May *Journal of the American Geriatrics Society*.

Previous studies have shown that chronic stress increases levels of the hormone cortisol in the body, which can suppress immunity, says study coauthor Peter Rabins, a psychiatrist at Johns Hopkins School of Medicine in Baltimore who teamed with researchers at Utah State University in Logan and others to do the study. "It's long been thought that this might have adverse outcomes psychologically and physiologically," Rabins says.

In the new study, researchers assessed the mental status of 1,221 Utah couples who had agreed to be part of a health study that started in 1995. The men averaged age 76 and the women 73 at that point, and 95 percent had been married for more than 20 years. Researchers tracked these couples' mental status for up to 12 years. No participants had dementia at the start.

During the follow-up years, 229 people found themselves caring for a spouse with dementia. Caregivers were six times more likely to develop dementia themselves compared with people whose spouses did not develop dementia. The researchers accounted for differences in age, education, socioeconomic status and the presence of variants in the *APOE* gene that increase risk of Alzheimer's disease.

While this is the first study to look at actual dementia risk in this type of spousal caregiver, other research has documented an array of physical and mental problems associated with caregiving. These include depression, sleep problems, less exercise and an unhealthy diet, says Peter Vitaliano, a psychologist at the University of Washington School of Medicine in Seattle, writing in the same issue of the *Journal of the American Geriatrics Society*. All of these factors may influence dementia risk, he notes.

Some of the increased risk may be due to shared environment. The couples had been married on average for 49 years upon enrollment in the study. But what those shared environmental risk factors might be remains unknown.

Life

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Deceptive cads of the savanna

Male topi antelopes will lie to keep ladies from leaving

By Rachel Ehrenberg

As any dating woman knows, men can be dogs — but a new study suggests that antelopes might be a better fit.

Male topi antelopes resort to deception to keep a potential mate around, snorting as if there's a lion nearby when it seems she might wander off. It's the first report of outright mate deception in an animal other than *Homo sapiens*, scientists report in the July *American Naturalist*.

Some birds will feign a broken wing to lure a predator away from their nest, and there are reports of male monkeys and squirrels deceiving other males in the heat of competition. But the male antelope behavior "is the clearest example of tactical deception between mates in animals other than humans," comments Cornell University's H. Kern Reeve, an expert in the evolution of cooperation and conflict in animal societies.

Study leader Jakob Bro-Jørgensen discovered the devious behavior while studying topi antelopes at the Masai Mara National Reserve in Kenya. Female antelopes are sexually receptive for one day only, and they spend that day visiting several males, munching grass and mating.

Male topi antelopes will falsely warn of a predator to keep a female (right) nearby.

Bro-Jørgensen noticed that when a female started to wander away from a male's territory, the male would look in the direction she was headed, prick his ears and snort loudly — the same snort the antelopes use when they notice a lion, leopard or other predator approaching.

"It was quite funny — it made me laugh," says Bro-Jørgensen, an evolutionary biologist at the University of Liverpool in England. "It's such an obvious lie. Clearly there's no lion."

Suitors in nature often exaggerate their virtues. But this work documents a rare case in which evolution favors outright lying in the mating game, Reeve says. The cost of the lie is minimal to the male; he merely snorts. But the cost to the female of ignoring the lie could be great: If there truly is a predator nearby, she's dead.

Bro-Jørgensen and colleague Wiline Pangle of Ohio State University in Columbus first observed males when they were making honest snorts. Even when alone, male antelopes snorted when a human approached, suggesting that rather than being a warning to fellow antelopes, a true snort is directed at the predator itself.

This makes sense, says Bro-Jørgensen. If they have enough of a head start, topi antelopes can outrun lions and even cheetahs. By snorting at a cat who thinks it's hidden in the grass, an antelope says, "I see you predator. Give it up."

The researchers also recorded true and false snorts and played them back to female antelopes, to see if the ladies could tell the difference. Judging by their reactions, the females couldn't tell true from false snorts. The clincher that the males were lying to get lucky came from observations of the animals in action. A male antelope secured two to three more chances at mating with a restless female if he pulled the false-snort trick.

Argonaut casing offers lift

After centuries of speculation, biologists have documented a way that female argonauts, which belong to a group of four species closely related to octopuses, use their delicate white shell-like cases. It turns out the animals trap air bubbles in the cases to float at a comfortable depth, Julian Finn and Mark Norman of Museum Victoria in Melbourne, Australia, report online May 19 in *Proceedings of the Royal Society B*. When Finn maneuvered *Argonauta argo* females so air escaped from their cases, the animals flailed as if to maintain their orientation and quickly jetted to the water surface. There they rocked their cases and took on air, then positioned body parts to seal in some of the air and jetted downward, leaving behind a trail of bubbles. When the argonauts stopped several meters below the surface, water pressure compressed the remaining air inside the cases enough to counteract the animals' weights, leaving the argonauts floating neutrally buoyant at a chosen depth. —*Susan Milius*

FROM TOP: J. BRO-JØRGENSEN *ET AL./AMERICAN NATURALIST*; J. FINN, MUSEUM VICTORIA