

THE WEEKLY NEWSMAGAZINE OF SCIENCE

tangled tale of knots
nomadic north pole
perfect storm of arctic ice melt
dead-zone chronicles

2007

THE YEAR IN REVIEW



SCIENCE NEWS

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Portrait of a Meltdown

Many factors led
to 2007's record low
in Arctic sea ice

A variety of climatological factors converged this year in a perfect storm that dramatically melted the Arctic Ocean's ice cover to a record low. The abrupt downturn could be a harbinger of ice-poor summers for decades to come.

In late summer, scientists reported that Arctic sea ice had shrunk to cover only about 4.2 million square kilometers (*SN*: 10/13/07, p. 238). That area is about 38 percent below the long-term average for late-summer ice coverage. Moreover, it's a striking 23 percent below the previous record low, set just 2 years ago. An adverse combination of factors contributed to this year's steep decline, researchers noted last week at a meeting of the American Geophysical Union in San Francisco.

First, a long-term trend in thinning and shrinkage of Arctic ice set the stage for this year's meltdown, says Jinlun Zhang, an oceanographer at the University of Wash-

ington in Seattle. End-of-summer ice coverage has been declining by about 11.4 percent per decade since 1979. Also, average ice thickness decreased by about 1.13 meters, or 22 percent, between 1981 and 2000.

Second, Zhang notes, unusually strong summer winds pushed much of the ice out of the central Arctic, leaving a large area of thin ice and open water. Third, a decrease in cloud cover in the Arctic—a trend suspected but not confirmed earlier this year (*SN*: 6/16/07, p. 382)—allowed more sunlight to reach the ocean. Because open water absorbs more of the sun's radiation than snow-covered ice, it significantly boosts warming trends both for the ocean and for the atmosphere above it (*SN*: 11/12/05, p. 312). This so-called ice/albedo feedback accelerated this year's melting, says Zhang.

In parts of the Arctic Ocean this year, sea surface temperatures were 3.5°C warmer than average and a full 1.5°C warmer than previously recorded highs, says Michael Steele, also of the University of Washington in Seattle. All that warm water chewed away at Arctic ice from below. In some parts of the Beaufort Sea, north of Alaska and western Canada, ice that started the summer 3.3 m thick ended up measuring just 50 centimeters, says Donald K. Perovich, a geophysicist at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, N.H.

About 70 cm of that shrinkage resulted from melting of the ice's upper surface—a typical amount for the summer, says Perovich. However, a whopping 2 m or so of that erosion, about five times the normal summer loss, occurred from below.

The thinning conceals the true extent of ice loss, says Perovich. "There's a lot less ice there than we think," he notes. "And the farther we go down this path, the harder it is to get back."

Indeed, the Arctic meltback may be self-perpetuating, says Steele. In some areas, the average date for winter freeze-up is now

2 months later than usual. The extra heat absorbed during summer months will suppress ice thickness by as much as 75 cm, about half the growth in thickness during an average winter.

Has the meltdown in the Arctic reached a point of no return? Many scientists, including Perovich, speculate that it has. "Years from now, we'll look back at 2007 and be amazed," he says. —S. PERKINS

Limiting Damage

Fragile X symptoms
modulated in mice

By cutting in half the activity of a gene, scientists corrected many symptoms of a genetic defect in mice analogous to fragile X syndrome, a leading cause of inherited mental retardation in people.

The research suggests a new target for drug therapy for the condition, which is currently untreatable. However, it remains uncertain whether such drugs would benefit adults who have the disease. And it would take years of clinical trials to show whether drugs could check the disease's progress in infants with the genetic defect.

"I don't think we'd be able to retrospectively correct the derailment of neural development that has occurred over decades" in adults, says lead scientist Mark Bear of the Massachusetts Institute of Technology. However, adults with the disease also suffer from abnormal signaling between nerves. A drug that targets the gene Bear's team studied, which makes a protein called metabotropic glutamate receptor 5 (mGluR5), might be able to restore some mental functioning by improving this signaling, he says.

Research on mGluR5 "does show that a pharmacological therapy could work, that this receptor is a good target," Bear says. A company that Bear cofounded, Seaside Therapeutics of Cambridge, Mass., is planning to start human-safety trials next year for a drug that reduces mGluR5 activity.

Mutations in a gene called *fragile X mental retardation 1* (*FMR1*) cause the syndrome. The gene lies on the X chromosome, so girls can carry the mutation on one of their two X chromosomes without harm. Boys, who have only one X chromosome, develop symptoms about 3 years after birth if they have the mutation.

Normally, *FMR1* throttles down protein production in the brain's nerve cells, so people without a functioning *FMR1* gene produce excess protein. According to one theory, the toxic buildup of protein leads to the symptoms of fragile X.

Because mGluR5 accelerates protein synthesis in the brain, tempering mGluR5



GOING DOWN The long-term decline in the extent of the Arctic Ocean's end-of-summer sea ice is shown superimposed on a graphic depicting this year's record-low ice coverage.

NASA

activity could offset the effects of the *FMRI* mutation and restore protein production to normal levels.

That's exactly what Bear's team found when they created a strain of mice that had the mutated fragile X gene and in which mGluR5 production was cut in half. Protein synthesis in the animals' brains was normal, as were the nerves themselves, which normally have an excess of spiny structures in mice and in people with the mutated gene. Several other symptoms of the disease were also absent, including fast body growth, seizures, and memory problems, the team reports in the Dec. 20 *Neuron*.

However, the mice with reduced mGluR5 activity still had oversized testicles, a typical trait of fragile X.

"[The study] is very well done," comments Stephen Warren of Emory University in Atlanta who has done related research on fragile X syndrome. "It's not entirely clear whether a drug would be a cure," Warren says, but he notes that a drug that targets mGluR5 might offer some benefit for patients, especially if treatment were started early in childhood. —P. BARRY

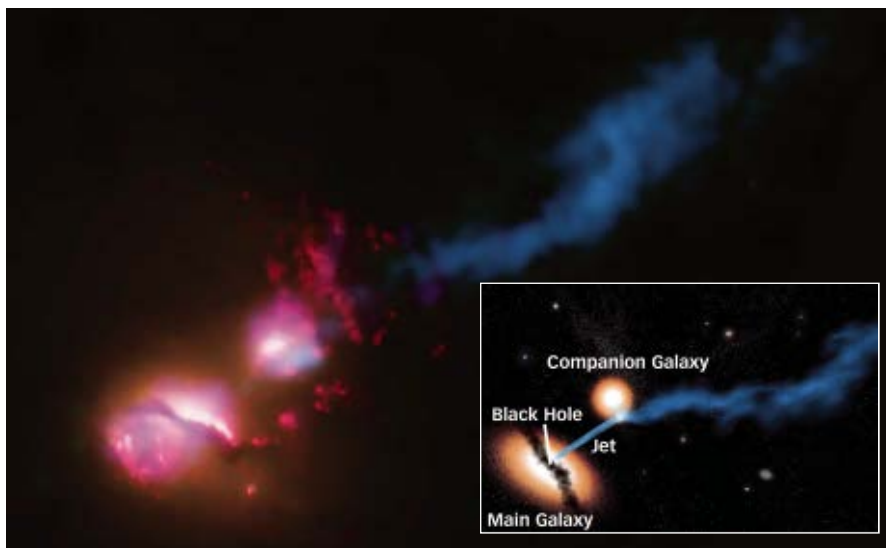
Black Hole Bully

Galaxy blasts its smaller neighbor

War has been declared between two galaxies, and the future doesn't look good for the underdog: The larger galaxy's powerful jet of high-energy radiation and matter is hitting its helpless neighbor. Ambulance-chasing astronomers hope to take advantage of this cosmic drive-by shooting to learn more about the nature of such jets, which usually spurt into empty space.

The two galaxies, together called 3C321, lie 20,000 light-years apart but will eventually merge. Like most galaxies, both harbor supermassive black holes, strong centers of gravity that suck in any nearby matter. But only the larger galaxy produces a jet, a beam of energetic particles and radiation generated as matter swirls in toward the black hole.

"Jets like this move close to the speed of light and can travel vast distances," says Dan Evans, leader of the study on 3C321. The larger galaxy once spewed X rays and gamma rays a million light-years into empty space, the scientists calculated. But then the neighboring galaxy moved into the line of fire, says



DEATH STAR A high-energy jet shoots from one galaxy to another, as revealed in this composite image of X rays (purple), optical and ultraviolet data (red and orange), and radio emissions (blue). An artist's rendering shows the path of the jet more clearly (inset).

Evans, of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

"Now, the jet violently slams into the lower half of that neighboring galaxy," he says. The result is like putting a hand in front of a hose shooting out water. The obstruction deflects the jet and slows it down.

Over time, Evans says, the jet will likely blast away the entire side of the smaller galaxy and regain its straight path. But in the meantime, the jet's radiation will destroy the atmospheres and magnetospheres of any Earth-like planets in its way.

"We are talking about tens to hundreds of stars being in the path of this jet, and some of those stars likely have planets," says co-investigator Martin Hardcastle of the University of Hertfordshire in the United Kingdom.

The jet's destruction of the smaller galaxy might not last forever. The scientists hypothesize that eventually the jet could ram together some of the galaxy's gases to create a star nursery.

To observe the deflection of the jet, scientists relied on a combination of images taken at different ranges in the electromagnetic spectrum. X-rays, optical images, ultraviolet light, and radio emissions were used to create the final picture, which will appear in an upcoming *Astrophysical Journal*.

Studying the 3C321 system can help scientists understand not only the nature of the jet itself but also the surrounding space, says Neil deGrasse Tyson of the Hayden Planetarium in New York City.

"What I find fascinating about this work is it's not just a jet and a galaxy," says Tyson. "You see the interaction of the jet with the galaxy. And every time you see the jet do something different, it tells you something about the environment the jet entered." —S. WILLIAMS

Mean Streets

Kids' verbal skills drop in bad neighborhoods

You can take a child out of a severely disadvantaged neighborhood and move to a nicer part of town, but you can't always take a bad neighborhood's harmful effects on verbal development out of the child.

That's the implication of a new, long-term study of children from various Chicago neighborhoods. Kids living in the most disadvantaged communities displayed marked declines in age-appropriate verbal ability over a 7-year span, even after moving to better areas, reports a team led by Harvard University sociologist Robert J. Sampson.

On average, children who at some point lived in neighborhoods characterized by "concentrated disadvantage" exhibited decreases of 4 IQ points on later standardized tests of vocabulary and reading skills. Comparable verbal losses occur when a child misses 1 year of school.

Concentrated disadvantage consists of a high rate of welfare recipients, high levels of poverty and unemployment, racial segregation, and large numbers of female-headed households and children per household.

Exposure to concentrated disadvantage exerted harsher verbal effects on the youngest kids, the researchers say.

"Taking steps to invest in neighborhoods directly, by creating safe public spaces and quality learning environments for children, is likely a cost-effective way to mitigate the harmful consequences of concentrated disadvantage," Sampson says.

The new findings will appear in an

upcoming *Proceedings of the National Academy of Sciences*.

Sampson's group studied 2,226 children, ages 6 to 12, living in poor, middle-class, and upper-class sections of Chicago. Kids and their parents or caretakers were tracked from 1995 through 2002. In that time, about half of the participants moved from one Chicago neighborhood to another or to other parts of the United States. Interviews with children and caretakers occurred at the study's start and twice more, every 2 to 3 years. At each interview, the children completed a vocabulary and reading test.

The researchers focused on the 772 African-American children in the study. Almost one-third of the black children lived in areas of concentrated disadvantage in 1995, compared with virtually no white or Hispanic children.

About 42 percent of the black children living in the worst neighborhoods in 1995 moved to a nondisadvantaged neighborhood later on. This group still showed a 4-point decline in verbal ability.

Concentrated disadvantage undermines verbal development in numerous ways, Sampson suggests. These include

the lack of safe public places to play with others and minimal exposure to academic English.

Economist Greg J. Duncan of Northwestern University in Evanston, Ill.,

agrees that neighborhood disadvantage worsens the reading skills of black children in Chicago. Yet in 2006, his team reported that—contrary to Sampson's results—6- to 10-year-old black children in families given vouchers to move to better neighborhoods scored higher on reading tests within 4 to 7 years. These results emerged in Chicago and Baltimore but not in three

other cities.

Sampson's analysis neglects the possibility that if smarter caretakers move to better neighborhoods, then children who move with them will be brighter—for partly genetic reasons—than those left behind, notes Linda Gottfredson, an education professor at the University of Delaware in Newark. Further research needs to track verbal ability in siblings from the same families, where some are full biological siblings and others half or less, she suggests. —B. BOWER

STATS

4

Average number of verbal IQ points lost by children living in disadvantaged neighborhoods

Not Yet

CDC panel questions antidepressant gene test

About half of all depressed people who take standard antidepressant drugs fail to improve. Some suffer unpleasant side effects and abandon the medicines, while others simply don't feel better. Commercial tests claim to predict, by a genetic analysis, how well individual patients will fare on different antidepressants, but a panel convened by the Centers for Disease Control and Prevention (CDC) in Atlanta now says that the tests don't work as advertised.

The panel "discourages" use of such tests until further studies clarify their value, according to a statement the group published in the December *Genetics in Medicine*.

"That isn't to say that eventually there won't be a role for these tests. We just don't know what that role is yet," says panel member Joan Scott of the Genetics and Public Policy Center in Washington, D.C.

The tests scan a person's DNA for variations in genes for two key liver enzymes. These enzymes break down selective serotonin reuptake inhibitors (SSRIs), a standard class of antidepressants that includes fluoxetine (Prozac) and nearly a dozen other

Unseen Risk

Lifestyle, physical problems may underlie psoriasis link to early mortality

Severe psoriasis knocks as many years off a person's life expectancy as high blood pressure does, a new study suggests.

Psoriasis is a skin disease that causes an overproduction of skin cells. Most people use topical treatments on the thick patches of skin that develop. But the disease can be itchy and painful, and those with moderate disease often resort to ultraviolet-light therapy. Severe disease can require systemic drugs.

Researchers used a British medical database to track the fates of roughly 138,000 psoriasis patients between 1987 and 2002. Nearly 4,000 had severe disease. To define a large control group, the scientists located the records of up to five other people without psoriasis who were the same age as each patient and who visited the same clinic.

Men and women with severe psoriasis died on average 3.5 years and 4.4 years earlier, respectively, than their counterparts among the controls, the researchers report in the December *Archives of Dermatology*. That's similar to hypertension's toll, says study coauthor Joel M. Gelfand, a dermatologist at the University of Pennsylvania in Philadelphia.

The researchers adjusted for different rates of heart problems, liver disease, smoking, dementia, cancer, kidney disease, AIDS, diabetes, obesity, arthritis, blood disorders, and ulcers in psoriasis patients and controls. Even so, the researchers found that severe-psoriasis patients were 42 percent more likely to die during the study than the controls. Patients with mild psoriasis showed no increased mortality risk.

The actual cause of the higher death rate is unclear, Gelfand says. Cumulative stresses and depression probably contributed to physical problems in these patients, says dermatologist Gerald G. Krueger of the University of Utah in Salt Lake City. He has noted that psoriasis patients often have unhealthy habits. Their rate of smoking is double the national average, for example. While researchers adjusted for that and other factors in this study, "many patients have a lifestyle that causes them to take on added risks," he says.

At the cellular level, psoriasis causes chronic inflammation, which has been linked to various ailments. Other underlying risks might include sticky platelets in the blood that induce unnecessary clotting or a depletion of blood vessel stem cells that could hamper vascular repair, Gelfand hypothesizes.

The researchers classified patients as having severe psoriasis if the records indicated that they were getting systemic drugs. That definition might be a weakness in the analysis, says dermatologist Robert S. Stern of Harvard Medical School in Boston. Such a group could include people harboring undiagnosed ailments, in addition to psoriasis, who would be prone to seek systemic treatment, he says. Also, severe-psoriasis patients were on average slightly older than the controls. That matters in a mortality study, adjusted or not, he says.

On the other hand, Stern adds, "this is a hard disease to live with." The red, scaly skin patches cause social embarrassment and damage quality of life. "The fundamental finding here is pretty believable," he says. —N. SEPPA

drugs. Variations in the two enzymes affect how quickly different people clear SSRIs from their blood, which in turn influences the drugs' effectiveness.

People classed as rapid or ultrarapid metabolizers, for instance, might clear the drugs before they can work in the brain. Slow metabolizers, in contrast, might maintain too much of the drug, leading to unpleasant side effects such as jitteriness or loss of libido.

Finding a happy medium is the goal of the genetic tests, which physicians can order from laboratories and consumers can mail order from Roche Molecular Diagnostics in Pleasanton, Calif., for \$300 to \$400. The Food and Drug Administration approved the Roche test in 2004, concluding that it accurately measured genetic variations in the two enzymes. However, the FDA never asked Roche to prove that its test led to better patient outcomes.

So the CDC panel reviewed 16 studies and found that enzyme variations do not neatly correspond to blood concentrations of SSRIs. The panel also found no evidence that the tests led to improved patient outcomes.

"There was no consistency in the data," says Scott. Some individuals classified as ultrarapid metabolizers—who in theory should maintain low blood concentrations of the drugs—had higher drug levels than some so-called slow metabolizers.

That's because the two enzymes are "just one piece of a bigger picture" of how the body breaks down SSRIs, says Scott. Diet, other drugs the patient may be taking, and genetic variations the tests don't account for can also affect SSRI metabolism, she says.

Robert Bernstein, executive director of the Bazelon Center for Mental Health Law in Washington, D.C., says that "everybody would benefit from better tailoring of treatment for depression. The idea that gene testing might [lead to] better treatment is promising."

However, he agrees with the CDC panel that much more work needs to be done to reach that goal. —B. VASTAG

Furry Math

Macaques can do sums like people in a hurry

Monkey see, monkey add. And in the same test of high-speed arithmetic, it turns out, people see and people add using what looks



MONKEY MATH The rhesus macaque can manage basic addition in computer tests, performing much as people do on the same tasks when told to answer fast without counting.



like the monkey method for doing rough sums without counting.

"What we're doing is accessing a primitive system for nonverbal arithmetic," says Elizabeth Brannon of Duke University in Durham, N.C. She and Duke colleague Jessica Cantlon tested both rhesus macaques and college students for their ability to do split-second addition. Similarities in the two groups' performance support the idea of an evolutionarily ancient capacity for dealing with numerical quantities, the researchers say in the December *PLoS Biology*.

"The paper marks an important milestone in the development of our understanding of the roots of mathematical cognition," comments Charles R. Gallistel of Rutgers University in Piscataway, N.J.

Experiments with rats, pigeons, and other creatures have already shown that non-human animals have some ability to do approximate computations, says Gallistel. Experiments have even shown pigeons doing a form of subtraction.

Brannon says she wanted to devise a test that both adult humans and monkeys could take. Earlier tests that worked for monkeys didn't make sense for people. In one such protocol, for example, monkeys watched as researchers at Harvard University put a group of lemons, and then a second group, behind a screen. When the researchers lifted the screen, they might reveal the correct "sum" of the two groups of lemons—or they might have sneaked in some extras. Monkeys stared longer when a revealed pile had

the wrong number of lemons, suggesting that the animals have some computational ability. But measuring gaze length isn't an ideal way to assess math skills in human adults.

So Brannon and Cantlon set up computer tests. One set of dots flashed on the screen for a half-second. After a delay, another set appeared. Finally a screen showed two boxed sets of dots, one representing the correct sum of the previous sets and the other showing an incorrect sum. Test subjects had to tap the correct box. The computer changed the size of dots in the possible answers, so that relying on area alone wouldn't yield a correct score.

Two female macaques got lessons on how to do sums, with correct answers earning sips of Kool-Aid. The lessons used only even numbers as totals, but the tests included odd sums, up to totals of 17. Fourteen college students also went through the screens, receiving \$10 instead of Kool-Aid.

Brannon says she told the college students to tap an answer quickly without counting. The students answered each problem in about a second, which is indeed too fast to count both dot sets.

The students reached 94 percent accuracy; macaques averaged 76 percent. Both primates and students lost accuracy when the two sets of possible answers differed by only a few dots.

"These data are very good for telling us where our sophisticated human minds came from," says Cantlon. —S. MILIUS

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NORTH BY NORTHWEST

The planet's wandering magnetic poles help reveal history of Earth and humans

BY SID PERKINS

Hikers in the wilderness often place their faith in a trusty compass. But any navigator worth his salt knows that compasses can't truly be trusted: Only along certain longitudes in the Northern Hemisphere does a compass needle point due north.

In other locales, a compass needle slews either to the left or the right of true north by a certain angle, a process commonly known as declination. That's because a compass isn't attracted to the north geographic pole, the point at which Earth's rotational axis pierces the Arctic ice. Instead, the needle is attracted to the north magnetic pole, the spot where the planet's invisible magnetic field lines burst from the surface and point directly upward.

Astronomers have long known that a compass doesn't always point true north, a bearing in the night sky that lies within 0.5° of Polaris, the North Star. Their measurements of declination, along with those made by seafaring explorers, enabled 16th-century sailors to better navigate along their trade routes, especially those linking the New World to the Old. What many scientists didn't appreciate until the 1600s, after they had compiled a few decades' worth of precise measurements at astronomical observatories, was that declination varied through time. Suddenly, they realized: The magnetic pole moves!

What difference does this make in today's world, where pilots, navigators, and even backcountry campers increasingly depend on satellite-based technology such as Global Positioning System equipment to find their way? In practice, not much: Earth's magnetic poles are located in remote regions and in recent times they've moved, at most, only a few dozen kilometers a year.

However, a slowly wandering magnetic pole is a boon for archaeologists and other researchers who study the past. Often magnetic substances in rock, paint, and other materials become aligned with



MOVED BY MAGNETISM — Explorers first found the north magnetic pole at Canada's Cape Adelaide in 1831. Blue dots (direct surface observations) and red dots (models using satellite data) denote the pole's movement since then. Green dots indicate the pole's future location if its current rate and direction of motion continue.

Earth's magnetic field under certain conditions, enabling researchers to, say, determine when a mural was painted, when a town was built, or when a fireplace was used for the last time.

WANDERING POLES Draw a line between the north and south geographic poles, and it runs smack through the center of the planet. Earth's rotation around this axis once each 24 hours produces the familiar cycle of day and night. Unlike the geographic poles, however, our planet's north and south magnetic poles aren't located directly opposite one another, says Nils Olsen, a geophysicist at University of Copenhagen.

Earth's geographic poles are fairly stable, wobbling back and forth across the landscape only a few meters every year or so (*SN*: 8/12/00, p. 111). The north and south magnetic poles are far more mobile, and they move independently of one another, says Olsen. Now located in the Arctic Ocean just north of Canada, the north magnetic pole is moving northwest toward Siberia by about 50 km each year. The south magnetic pole, just off the Antarctic coast south of Australia, is also—for now—heading northwest, but only at around 5 km/yr, Olsen and Mioara Manda, a geophysicist at the National Research Center for Geosciences in Potsdam, Germany, report in the July 17 *Eos*.

Such wanderings stem from irregularities in the process that generates the magnetic field, says Olsen. Although Earth's inner core is solid and primarily composed of iron, its outer core is a molten mix of iron and lighter metals that is constantly on the move. The flow of that material, which carries charged particles and conducts electricity, produces the magnetic field, says Olsen. Long-lived eddies and swirling currents in the fluid, which moves at an average speed of about 20 km/yr and is no more viscous than water, make the magnetic field deep within Earth much more complex than it is at the planet's surface. "It's a highly chaotic system," says Olsen.

In particular, he notes, that turbulence can create "reversed-flux patches," regions on the surface of the outer core where magnetic field lines point opposite to those pre-

OLSEN AND MANDEA

dominant at the Earth's surface. Variations in the size and strength of these patches significantly affect the location and the motion of the magnetic poles. For instance, the growth and movement of a reversed-flux patch beneath northern Canada is causing the north magnetic pole to surge toward Siberia.

At its current rate, the north magnetic pole will pass within 400 km of the north geographic pole in 2018, Olsen and Manda report. Because of the chaotic nature of the field-generating processes in the outer core, predicting the pole's location more than a decade into the future is tricky, says Olsen. Nevertheless, the pole has been moving toward the northwest, although with varying speed, for more than a century.

In the past few decades, the strengthening of reversed-flux patches—especially ones beneath Canada and the South Atlantic Ocean—has weakened Earth's magnetic field, says Olsen. If the field's overall strength keeps dropping at today's rate, it will reach zero in a few hundred years. However, he notes, it's not clear whether recent fluctuations in field strength are routine variations or the prelude to a full-blown reversal of Earth's magnetic field—something that happens, on average, every quarter-million years or so.

Although the strength of the Earth's magnetic field is now dropping, it is 50 percent stronger than the estimated average for the past 60 million years, says Lisa Tauxe, a paleomagnetist at the Scripps Institution of Oceanography in La Jolla, Calif. At its most recent peak, about 2,000 years ago, the magnetic field was about twice as strong as it is now. "Data is spotty, but we have a crude idea of what's going on [with the magnetic field]," she notes. The data also suggest that "the field can change rapidly over a shorter time than [scientists] had thought."

AROUND THE WORLD Only in the past couple of centuries have scientists visited the Earth's magnetic poles. The first explorers to find the north magnetic pole did so at Cape Adelaide, on the west coast of Canada's Boothia Peninsula, in 1831. An expedition 73 years later discovered that the pole had moved about 50 km to the northeast. In the following century, the pole moved more than 1,300 km toward the northwest, along the same path it is taking today.

Despite this limited history of direct observations, researchers can use various clues to estimate the size, strength, and polarity of Earth's magnetic field at many times in the past. For instance, some minerals that crystallize as lava cools can record the direction of the planet's magnetic field at the time the eruption occurred, says Steven T. Johnston, a geologist at the University of Victoria in British Columbia. In many cases, such information enables scientists to establish the latitude where pieces of Earth's crust originated and thereby infer their long-term tectonic motion, he notes.

As long as magnetized minerals aren't heated above a characteristic temperature known as a Curie temperature, the alignment of the magnetic materials contained therein remains intact. If the rocks are heated beyond the Curie temperature, which typically lies between 500°C and 600°C, the stored magnetic information gets scrambled, says Cathy Batt, a paleoarchaeologist at

the University of Bradford in England. Then, when the rocks cool, their magnetic materials realign themselves with the planet's magnetic field (*SN*: 3/13/04, p. 174). Because fires usually are hotter than a mineral's Curie temperature, magnetic materials lining a hearth record the strength and direction of magnetic field lines at the last time a fire had been lit there—a finding of great interest to an archaeologist, for example.

By combining data gathered by geologists and archaeologists, researchers have tracked the motions of the magnetic poles for the

past 7,000 years or so, says Manda. During that time, the magnetic poles have wandered through all longitudes, roughly circling the geographic poles, she notes. While the north magnetic pole has remained well within the Arctic Circle, the south magnetic pole has recently roamed farther away from the south geographic pole and is now around 64°S.

Using information collected in Britain, mostly from England and Wales, Batt and her colleagues have compiled a record of how magnetic declination has varied in that region during the past 4,000 years. To provide a more useful comparison among

sites, the researchers adjusted each measurement to replicate what the magnetic field would have been like at Meriden, England, a town about 150 km northwest of London. The model should be valid for any site within 500 km of that town, which is roughly the center of the England-Wales region, Batt and her colleagues note in the Feb. 16 *Physics of the Earth and Planetary Interiors*.

The team's data also include information about magnetic dip, the angle between the Earth's magnetic field lines and a horizontal plane. Only a few of the 858 sets of measurements, most notably the 238 data points taken at observatories since the 1600s, include data about paleointensity, or how strong the planet's magnetic field was at the time data were gathered. The combination of two or more of these parameters enables researchers to better estimate the age of an artifact when other clues don't provide a clear answer, says Batt.

Most centuries during the past 4 millennia are represented by at least 10 data points. However, few archaeological sites have been dated to the centuries between A.D. 600 and 800, which historians often refer to as the Dark Ages. Data for the centuries before 1000 B.C. are similarly sparse.

During the past 4 millennia, magnetic declinations in Britain have varied through an angle of 70° and their magnetic dips have ranged about 25°, the researchers report.

To test their model, Batt and her colleagues analyzed an archaeological site that was exposed during construction in downtown Exeter, England. The city has been continuously populated since the Roman period, so sites there often include a jumble of artifacts from different periods. One sample the team analyzed probably came from a fireplace in a home or other structure. Another sample was, most likely, just a spot of burned soil.

The combination of declination and dip found in the fireplace sample suggest the material could have been last heated during any of three intervals during the past 4 millennia, says Batt. However, because two of those intervals long predate known occupation in the area, the researchers dismiss those possibilities. Therefore, the fireplace probably last hosted a fire in the 11th century, during



DIGGING THE SCENE — Paleomagnetic data from a series of hearths unearthed in central Winchester, England, yield information about the city's early history.

Europe's early-medieval period. The burnt spot of soil is a century or so older than that, the magnetic data suggest.

Using paleomagnetic data offers archaeologists "a good tool to figure out who occupied a particular area at a particular time, and what they were doing," says Batt.

PROBING THE PAST One debate among English historians regards what stimulated urban development in the fledgling nation. King Alfred, who with his brother unified the nobility in the mid-800s, commissioned earthwork defenses in many areas of southern England after Viking attacks in the 860s. One big question: Were the cities encircled by those earthworks well developed before construction of the defenses, or did those fortifications provide the protection needed for small villages to grow into thriving cities?

Information unearthed during a construction project in downtown Winchester, about 90 km southwest of London, could help settle the debate, says Ben Ford of Oxford (England) Archaeology and director of excavation at the site. During a 5-month investigation at the 2,000-square-meter construction site, he and his colleagues uncovered the remnants of many ancient structures, including some blacksmith shops. The researchers drilled samples from each of 17 hearths, estimated their ages using paleomagnetic dating techniques, and then carbon-dated organic

material such as ash, burned seeds, and small sticks—presumably the remnants of the hearths' last fires—to verify the results.

Most of the ancient structures were found in an area measuring 60 m long and 12 m wide, a hint that the densely packed buildings sat along an established road, says Ford. The full range of estimated ages of the Winchester hearths runs from the 9th century to the 14th. Preliminary results for two of the samples suggest that those structures were last used in the 840s and the 850s—decades that clearly predate the earthworks commissioned by King Alfred, Ford notes.

"These [findings] provide detail in the historical record for an area that isn't well known," says Mark Hounslow, a geographer at Lancaster (England) University, who has worked at the Winchester site.

Finding so many hearths of different ages at one site will be a boon for paleomagnetists, says Ford. Results of the team's paleomagnetic analyses can be added to comprehensive data-

bases like Batt's, he notes. And, the new findings may allow scientists to fine-tune the patterns of magnetic pole movement inferred from those data.

By using paleomagnetic data, researchers no longer have to infer the ages of strata from the presence of easily dated objects such as coins or distinct forms of pottery, says Ford. "Now," he notes, "we can write history from archaeological data." ■



HALF-BAKED DATA — The strength and direction of the magnetic field trapped in minerals forged by fire in ancient hearths (reddish materials at arrows) can help archaeologists estimate the date when those fires last burned.



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DEAD SERIOUS

Experts worry about lack of progress in efforts to reduce lifeless zone in the Gulf of Mexico

BY SARAH C. WILLIAMS

The water that tumbles out of the Mississippi River into the salty Gulf of Mexico has traveled thousands of miles. From its source in Minnesota, the river winds through 10 states on its journey to the ocean, collecting runoff from the Rocky Mountains, the Appalachian Mountains, and everywhere in between. The river flows through the fields of the Corn Belt, gathering fertilizer, and through cities, where sewage leaches into its currents.

By the time the Mississippi empties into the Gulf, along the shores of Louisiana, it carries more than just water. Nutrients from both agricultural and urban runoff convert the river's outflow into a rich broth. Every summer in the Gulf, this enriched water encourages algae to grow in massive quantities, using up the oxygen that fish and other marine species need to survive. The result of this process: an area the size of Massachusetts that supports almost no life beyond algae and bacteria.

This 7,900-square-mile seasonal dead zone has been around since the 1970s, when scientists first began taking notice of the fish-depleted area. Now the Gulf of Mexico dead zone is the largest such zone in the United States and one of the largest in the world. In the summer of 2007, the dead zone covered the third-largest area since scientists started measuring it in the 1980s. But the problem was largely ignored until the '90s when 17 environmental groups threatened to sue the U.S. Environmental Protection Agency for not taking action on the problem. In response, the National Science and Technology Council published an assessment of the dead zone in 2000. The report outlined the problem and the steps lawmakers should take to reduce the size of the area. But the draft of a new action plan, released by the council in November, suggests that little progress has actually been made in the past 7 years.

Now the years of inaction are exacting a toll, scientists say. New research hints that a nutrient that had been largely ignored in the dead zone may, in fact, be driving the problem past the point of no return. What's more, much of the runoff that causes the dead zone comes from cornfields. And an increasing demand for corn, used to make ethanol, could mean more runoff, and a worsening of the habitat destruction in the Gulf.

Don Boesch, now president of the University of Maryland Center for Environmental Science in Cambridge, was among the first scientists to take notice of the dead zone. After hearing anecdotal accounts of poor fishing in once-thriving sections of the Gulf, he decided to map these areas in the late 1970s.

"Contrary to what was thought at the time—that this dead zone area would be very patchy, would come and go—we found it was massive in size and pretty persistent over most of the summer," he says.

This means that every summer, numerous species' habitats disappear. It's been hard to quantify the effect on commercial fishing, though, says David Whitall of the National Oceanic and Atmospheric Administration in Silver Spring, Md.

Whitall recently studied the impact of the dead zone on brown shrimp, the primary catch in the Gulf. In the April 2007 *Marine Pollution Bulletin*, he and his colleagues showed that shrimpers catch fewer brown shrimp during years when the dead zone is largest.

"It's not so much a problem of shrimp dying as of shrimp moving" out of once-productive areas, he says.

But any decline in shrimp numbers can't be pinned entirely on the dead zone, Whitall says, because there are so many factors influencing marine populations. Overfishing and climate changes affect the shrimp populations as well.

In addition, relying on records from shrimpers to estimate whether shrimp are on the decline is inherently biased—any shrimper will quickly learn to avoid dead-zone areas, where he

doesn't catch anything. And some scientists suggest that the "herding effect" of the dead zone may in fact help shrimpers.

"There are some areas, like the edges of the dead zone, where you might actually have a larger catch because of that herding effect," notes Boesch.

Though it's hard to find quantitative evidence that shows the destruction caused by the dead zone, most experts agree that such an area isn't good for the long-term health of the oceans. So scientists are focusing their efforts on figuring out how

"We found [the dead zone] was massive in size and pretty persistent over most of the summer."

— DON BOESCH,
UNIVERSITY OF MARYLAND

to bring the dead zone back to life.

That focus, over the past decade, was largely on monitoring and minimizing the nitrogen that runs into the Mississippi from fertilizer. Spread on fields, synthetic nitrogen fertilizers spur crop growth. But when they wash off the fields into water, fertilizers help algae bloom.

The 2000 report identified fertilizer, and specifically nitrogen, as the primary cause of the Gulf dead zone. But there's another nutrient that algae require: phosphorus. Only within the past few years, scientists say, has it become clear that phosphorus should be included in efforts to reduce nutrient runoff into the Mississippi.

Don Scavia of the University of Michigan in Ann Arbor recently created a model to study the interplay between phosphorus and nitrogen in the dead zone. His simulation, published Dec. 1 in *Environmental Science & Technology*, showed that a dead zone can switch from being limited in size by how much nitrogen flows into it to being limited by its phosphorus content. He hypothesizes that such a switch is happening right now in the Gulf.

"Over the past 30 to 40 years," he says, "we've added so much nitrogen to the system that there's plenty of it around, and phosphorus is becoming limiting."

This doesn't mean that all efforts to monitor and control the dead zone should switch to phosphorus, he says, but that policy makers need to take both nitrogen and phosphorus into account. In many cases, the steps to control the nutrients are the same. About 75 percent of nitrogen and around 60 percent of phosphorus in the runoff comes from fertilizer, with the rest leaking into the rivers from urban sources.

Scavia says that controlling phosphorus alone probably would not alleviate the dead zone, and might even make it worse. Reducing phosphorus, he says, would clear up algal blooms close to the shore. This would allow nitrogen-laden water to flow farther out into the Gulf, where phosphorus exists naturally. Here, the vastness of the Gulf and the mixture of nitrogen and phosphorus would allow for an even larger dead zone than the coastal area permits.

"This has actually happened in the Neuse River in North Carolina and in the Pearl River in Hong Kong, where they controlled phosphorus and it made the problem move downstream and become worse," says Scavia.

While controlling only phosphorus would worsen the problem, controlling only nitrogen would be equally detrimental to the dead zone. Phosphorus, it turns out, is harder to get rid of than nitrogen once it's in the ocean.

When algae and other phytoplankton die, their phosphorus- and nitrogen-rich corpses sink to the bottom of the ocean. Much of the nitrogen is removed from the water by microbes that convert nitrogen compounds, like nitrate and nitrite, into nitrogen gas which makes its way up through the water and into the atmosphere. Phosphorus, however, accumulates in the sediments and water column, feeding future algae growth.

This means that high levels of phosphorus can lead to problems that remain long after phosphorus and nitrogen runoff is controlled. This struggle is playing out in the Baltic Sea right now, in an out-of-control dead zone.

"You've gotten into a vicious cycle," Boesch says. "The system there is so overloaded with phosphorus that there are tens of years of phosphorus available."

In addition to now being fingered for limiting the dead zone in the Gulf of Mexico, phosphorus has long been described as the limiting factor in freshwater systems, such as the Mississippi River itself. In rivers, cyanobacteria that get energy through photosynthesis, like plants, thrive. These bacteria process nitrogen from the atmosphere into the kind of nitrogen that feeds algal growth. Limiting phosphorus in these situations will improve not only the dead zone but the health of the Mississippi and the rivers that empty into it.

Most researchers agree that reducing both nitrogen and phosphorus is what needs to happen to shrink the dead zone.

"A lot of the management steps you would take to go after nitrogen would help with phosphorus too," points out Robert Howarth of Cornell University. "It's not like it's twice as much work to go after both."

These management steps include limiting fertilizer use on fields and requiring buffer zones and wetlands between agricul-

tural fields and rivers, to catch nutrients. These steps have been suggested before, in the 2000 dead-zone assessment, but policy makers have not yet provided the money needed to put them into practice.

In a recent book, Scavia and colleagues reported on recently surveyed Iowa farmers who were asked whether they'd be willing to implement such changes.

"They would be happy, in fact they would prefer, to have a more diverse landscape with wetlands and conservation buffers," he says. "They would do that if the government would pay them to do that rather than pay them to grow corn. As long as money is coming through."

But right now, the most money comes from growing corn. Scientists worry that a recent increase in corn production to support the ethanol industry will soon be reflected in the size of the dead zone.

Corn, says Scavia, is grown in soil with tile drains. More nitrogen seeps into the river from cornfields than from fields growing other crops.

"Corn is really the leaky crop that causes most of the nitrogen problems in the Gulf," Scavia says. And this year, farmers grew 14 million more acres of corn than ever before. A report on the impact of biofuel production on U.S. water quality issued by the National Research Council raises concerns that this increase will lead to more nitrogen flowing down the Mississippi as well as to numerous other water-quality problems.

In an upcoming paper, Howarth and colleagues estimate that the conversion of soybean fields to cornfields to support the biofuel industry will mean an extra 117 million kilograms of nitrogen entering rivers across the country. Many of these rivers flow into the Mississippi. This 37 percent increase in nitrogen runoff, scientists hypothesize, will lead to an increase in the size of the Gulf's dead zone.

Howarth says action to reduce nitrogen and phosphorus pollution must be taken now, before the dead zone gets out of control.

"It may be," he says, "that once we have the political will to reduce the nutrients in the Gulf of Mexico, it will be harder to backtrack than it would have been to stop the nutrient flow in the first place."

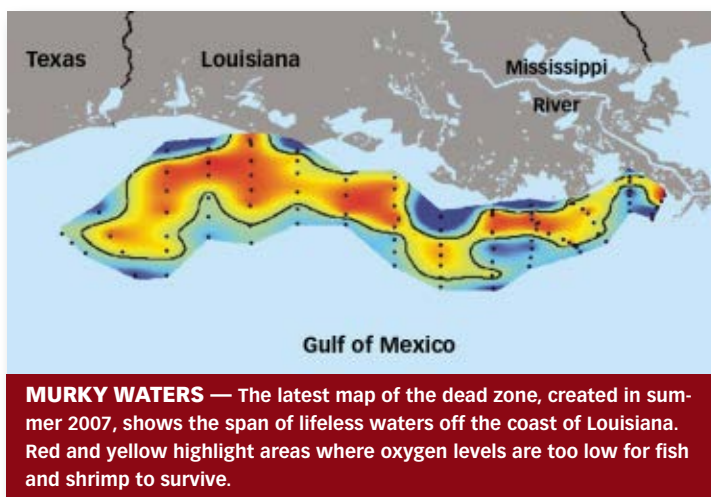
With this urgency in mind, environmental lobbyists are pushing—so far, in vain—to get conservation measures into the next farm bill, the U.S. legislation that governs agricultural policy and is rewritten every few years. The next version of the bill, environmental groups hope, could set new guidelines for fertilizer use and allocate money to farmers who set aside land for wetlands and river buffer zones.

Boesch, who has followed the dead-zone research for decades, echoes the message of urgency, and says the new draft action plan is disappointingly timid.

"They're kind of backsliding on it rather than being more aggressive about it," he says. "I think we're not yet serious about making the commitments to deal with the problem." ■

"Corn is really the leaky crop that causes most of the nitrogen problems."

— DON SCAVIA,
UNIVERSITY OF MICHIGAN



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TIED UP IN KNOTS

Anything that can tangle up, will, including DNA

BY DAVIDE CASTELVECCHI

Knotted threads secure buttons to shirts. Knots in ropes attach boats to piers. You can find knots in shoestrings, ties, ribbons, and bows. But even without Boy Scouts or sailors, knots would be everywhere.

Call it Murphy's Law of knots: If something can get tangled up, it will. "Anything that's long and flexible seems to somehow end up knotted," says Andrew Belmonte, an applied mathematician at Pennsylvania State University in University Park. Belmonte has plenty of alarming anecdotal evidence. "It certainly happens in my house, with the cords of the venetian blind." But the knot scourge is a global one, as anyone who owns a desktop computer can confirm after peeking at the mess of connection cables and power cords behind the desk.

Now, scientists think they may have found out how and why things find their way into knotty arrangements. By tumbling a string of rope inside a box, biophysicists Dorian Raymer and Douglas Smith have discovered that knots—even complex knots—form surprisingly fast and often. The string first coils up, and then its free ends swivel around the other coils, tracing a random path among them. That essentially makes the coils into a braid, producing knots, the scientists say.

The results' relevance may go well beyond explaining the epidemic of tangled venetian blind cords. That's because spontaneous knots seem to be prevalent in nature, especially in biological molecules. For example, knottiness may be crucial to the workings of certain proteins (*Math-Trek*; sciencenews.org/articles/20061014/mathtrek.asp). And knots can randomly form in DNA, hampering duplication or gene expression—so much so that living cells deploy special knot-chopping enzymes.

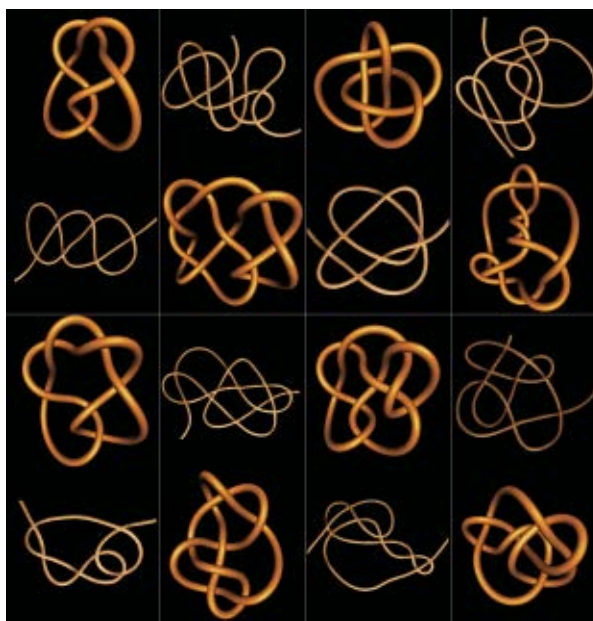
Raymer's interest in knots began as an answer waiting for a question. Two years ago, he was an undergraduate student working in Smith's lab at the University of California, San Diego (UCSD). Raymer fancied taking a class about the abstract theory of knots, offered by UCSD's math department. Smith told him that he should take it only if he could find a practical use for it—some kind of knot experiment.

Raymer never took the class, but he and Smith did come up with a simple idea for an experiment. They put a string in a cubic

container the size of a box of tissue. By tumbling the box 10 times "like a laundry dryer," as Raymer puts it, the researchers hoped to observe knots forming spontaneously on occasion. They didn't have to wait for long: Knots formed right away. "The first couple of times, it was pretty amazing," Raymer says.

The researchers repeated the procedure more than 3,000 times, and knots formed about every other time. Longer strings, or more-flexible strings, tended to knot more often.

The researchers took pictures, planning to gather precise statistics of the types of knots that were forming. Raymer soon realized that, to make sense of the mess, he'd need to teach himself the mathematics of knots after all.



CATALOG OF COILS — Ropes knotted up spontaneously when tumbled in a box. Each knot (off-white) example is paired with the corresponding idealized knot (gold).

READY-MADE TOOLS The theory of knots began in earnest in the 1860s, under the stimulus of the British physicist William Thomson, later known as Lord Kelvin. Kelvin suggested that atoms of different elements were really different kinds of knotted vortices in the ether. So to lay the foundations of chemistry, he believed, it was imperative to classify knots. Ultimately, physicists discovered that the ether didn't exist. But mathematicians took an interest in knots for knots' sake, as part of the young branch of mathematics called topology.

Topology studies shapes. Specifically, it studies shapes' properties that are not affected by stretching, moving, twisting, or pulling—anything that doesn't break up the object or fuse some of its parts. The proverbial example is that, to a topologist, a coffee mug is the same as a doughnut. In your imagination,

you can squash the mug into a doughnut shape, and it will retain the property of having a hole, namely its handle.

A sphere is different. You can stretch a sphere into a stick and bend the stick so its ends touch. But turning that open ring into a doughnut will involve fusing the ends, and that's forbidden.

In topology, a knot is any curved line that closes up on itself, possibly after a circuitous path in three dimensions. A circle is regarded as the "trivial" knot. Two loops are considered to be the same knot if you can turn one into the other by topological manipulation, which in this case means anything that does not break the curve or force it to run through itself.

Topologically, a knotted string is not a real knot, as long as its ends are free. That's because either of the ends can always thread back through any entanglement and undo the knot. An open string, no matter how garbled, is the same as a straight segment. (Mathe-

RAYMER/UCSD

maticians usually think of strings as being stretchable and infinitesimally thin, so in topology there is no issue of a knot being tight.)

Strictly speaking, then, the string in Raymer and Smith's box was never knotted. But it was still a mess. When the researchers joined the string's ends, they made it into a closed loop, often something that even a mathematician would call a knot.

Raymer soon realized that telling different knots apart, or recognizing when two knots are the same is a tricky business. Topologists usually work with two-dimensional drawings of knots called knot projections. From different points of view, the same curve will look different and so will its projections. Topologists' best tools for distinguishing knots are algebraic expressions called knot polynomials. These are sums of multiples of a variable, such as x , raised to different powers. The variable has no meaning per se, and all the information is in the numbers by which it's multiplied. But the x 's make it easier to calculate a knot polynomial starting from a knot projection.

James Alexander, a Princeton University mathematician, invented the first knot polynomial in the 1920s. Two topologically equivalent knots always will give the same Alexander polynomial, no matter how different their projections look. So if two knots have different polynomials, they're certainly nonequivalent. The converse, however, is not true: Some distinct knots have the same Alexander polynomial. That means that the Alexander polynomial is not a fail-safe way of distinguishing knots.

In the early 1980s, Vaughan Jones of the University of California, Berkeley rekindled mathematicians' interest in knots when he defined a new kind of knot polynomial, a discovery that earned him the Fields Medal, the most coveted prize in mathematics. The Jones polynomials distinguish knots with greater, if not complete, accuracy than the Alexander polynomials. That made the Jones polynomials Raymer's choice to catalog his knots.

TIE LAND Raymer wrote a computer program to calculate Jones polynomials from the pictures he had taken each time he opened the box. The program found that the humble box had produced at least 120 distinct types of knots. Some were pretty complex.

The most basic measure of knot complexity is the minimal crossing number, the number of overpasses needed to draw the simplest possible projection of the knot. For the trivial knot, that number is zero. The simplest true knot, the trefoil requires that just three crossings be drawn. A few of the knots from the tumbling box required as many as 11, Raymer and Smith report in the Oct. 16 *Proceedings of the National Academy of Sciences*.

Raymer says he and Smith were surprised, because previous knot experiments—physicists have tried a few in recent years—had seen only some of the simplest knots. For example, in 2001 Belmonte and his collaborators showed that a hanging chain (not from Belmonte's venetian blinds) tended to knot up when shaken. In 2006, a team led by physicist Jens Eggers of the University of Bristol in England got a ball chain to form knots by setting it on a vibrating dish.

De Witt Sumners, an applied mathematician at Florida State University in Tallahassee, says he was not surprised that knots would form in a box. In computer simulations, mathematicians have found that random motion creates paths that almost always

tie themselves up. Together with Stu Whittington of the University of Toronto, Sumners demonstrated mathematically in 1988 that if you wait long enough, these random walks will get knotted virtually 100 percent of the time.

Sumners suspects that with longer tumbling, Raymer and Smith would have gotten knots almost always, instead of just every other time. "They should have spun longer," to see the full effects, Sumners says.

In their paper, on the other hand, Raymer and Smith propose a theoretical explanation for the mess in their box that differs from the most general type of random walk. Because their string tended to coil up whether or not it formed knots, they created a mathematical model of a bundle of coils as a series of parallel, horizontal strands. In a computer simulation, Raymer and Smith allowed one of the strands—representing one of the free ends of the string—to cross over or under one of the others in the bundle. After several such steps, the strands had braided, which often meant that the string as a whole was now knotted.

This simplified model didn't reproduce the exact results of their experiment, but it did predict that specific knots had about the right odds of forming within the allowed time.

JAM-PACKED Belmonte calls the braid model "very obvious, but maybe not universal," meaning that different physical phenomena probably tie knots in different ways. In bacterial DNA, for example, one way that knots can form is by genetic recombination. That's when, to facilitate the reshuffling of genes, enzymes cut DNA at two places and reattach the ends in a different order. Bacterial genomes are circular, so recombination can produce veritable knotted loops.

In the late 1990s, biochemists discovered enzymes that seem able to detect when DNA has a knot. The enzymes then undo the knot by brute-force cut and paste.

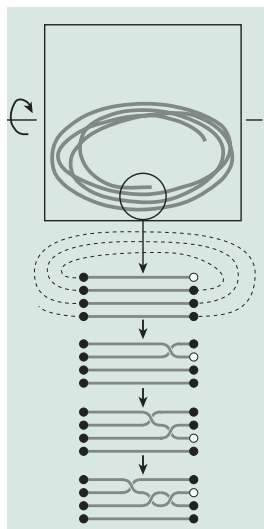
Keeping DNA tidy may be crucial to some of the cell's most important functions. That's because copying DNA and reading out the information it contains are performed by other enzymes, called polymerases, which walk along DNA. "When [a polymerase] comes to a knotted area, it will be stuck," Belmonte says.

Scientists have discovered similar knot-busting enzymes in cells that have open-string chromosomes, such as in humans. The presence of such enzymes suggests that knotting may be an issue for human chromosomes as well. And scientists have also found knots in mitochondria, cellular organelles that contain loop DNA.

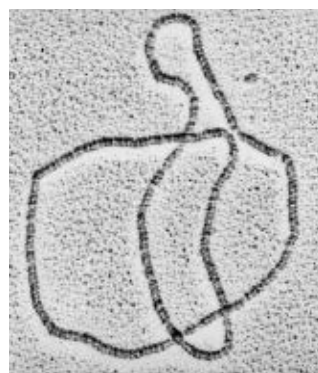
Another place where DNA knots can form is inside viruses, says Andrzej Stasiak, a structural biologist at the University of Lausanne in Switzerland. Viruses build containers called capsids in which the viruses tightly pack their DNA for traveling from one host cell to the next. In some viruses, the capsid keeps DNA at a pressure of more than 60 atmospheres.

Stasiak says that the packing process probably produces coiling similar to that seen by Raymer and Smith. Their coil-and-braid model could help explain why the DNA of some viruses often ends up being knotted.

But even if Raymer and Smith's results don't prove to be directly relevant to the molecules of life, they are "a very good beginning" for a general study of physical knots, according to Belmonte. "Now we can at least ask these questions: Are there universal laws of knots?" ■

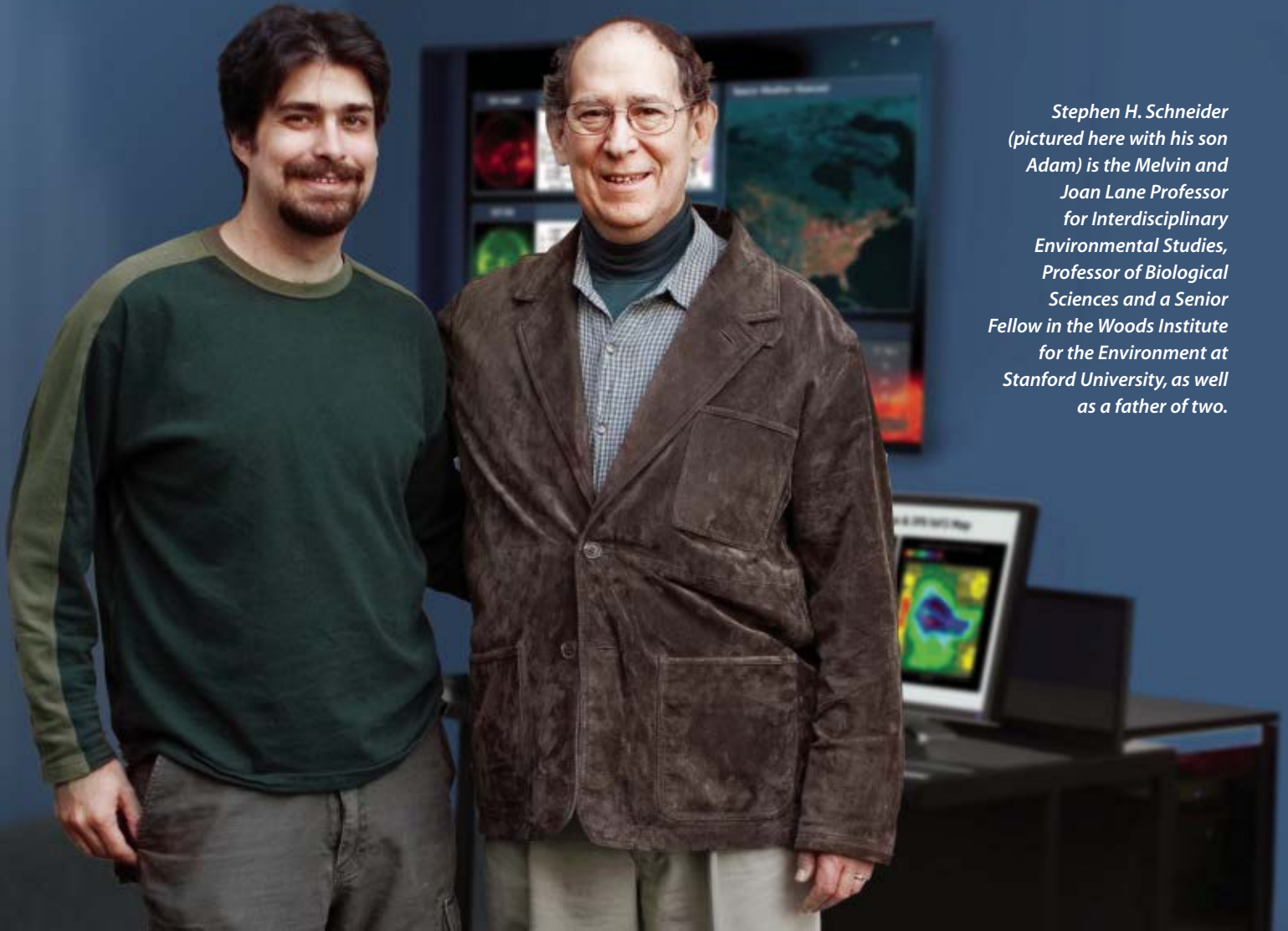


KNOTS HAPPEN — Computer models showed how a coiled string in a tumbling box (top) will tangle up when one of its ends is free to swivel around the other coils.



LOOP THE LOOP — This electron microscope image shows bacterial DNA tied in a trefoil, the only knot with just three crossings.

"It is time for action. Today is the day to start protecting our children's tomorrow."



*Stephen H. Schneider
(pictured here with his son
Adam) is the Melvin and
Joan Lane Professor
for Interdisciplinary
Environmental Studies,
Professor of Biological
Sciences and a Senior
Fellow in the Woods Institute
for the Environment at
Stanford University, as well
as a father of two.*

I have spent my professional life on global climate research and can tell you there is still time to curb the most dangerous effects of global warming. But to do so, government, businesses and individuals must work to cut carbon emissions by 80% by the year 2050. It sounds like a big number, but in fact this is achievable with a 2% annual reduction in emissions, starting this year.

There are many things you can do to reduce your carbon emissions on the state and local levels, but also from your home, car and office. The most important thing is to remember why you need to take action. Our children and the world they will inherit are counting on us.

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PHYSICS

Airy theory, but true

For decades, physicists have known that quantum theory allows for wavelike objects to follow curved trajectories known as Airy functions, after the 19th-century British astronomer George Biddell Airy. Scientists have now managed to bend a beam of light into just such a shape.

Demetri Christodoulides, Aristide Dogariu, and their colleagues at the University of Central Florida in Orlando passed an ordinary, but thick, laser beam through a liquid-crystal screen. The incoming light waves were oscillating in sync, but the orientations of the liquid crystals knocked them out of sync in a predetermined way. So the waves emerging on the other side formed interference patterns—with their peaks and troughs either canceling or reinforcing one another. One main shape veered to one side, tracing a parabola similar to the ballistic trajectory of a cannonball. Similar, but thinner shapes, also part of the Airy function, extended parallel to the main parabola, the team reports in the Nov. 23 *Physical Review Letters*.

Christodoulides says the curved patterns could help in the manipulation of light and also, because of light's pressure, of matter. "Maybe we can find ways of sending energy around obstacles ... or push particles along curved trajectories," he says. —D.C.

NEUROSCIENCE

Macho pheromones rile fellows

Two male mice often fight when put in a cage, but if one is neutered they get along fine. Decades ago, scientists found out that dabbling urine from an intact male mouse on the back of a neutered mouse gave the latter the chemical signature of an unaltered male. The neutered mouse soon found himself brawling with the guys.

Combining this behavioral test with modern biochemical analyses, molecular biologist Lisa Stowers and her colleagues at the Scripps Research Institute in La Jolla, Calif., now reveal some of the chemistry behind the aggression.

In male mouse urine, proteins in a cluster called the major urinary protein (MUP) complex function as pheromones that literally strike a nerve in other males, the scientists report in the Dec. 6 *Nature*. An individual mouse has only a few of the 20 or so proteins that can show up in an MUP cluster. In the study, those few were enough to act as a fight pheromone when researchers dabbed them on neutered males.

Because neutered mice don't make significant amounts of testosterone, they lack MUP proteins, Stowers notes.



TURNING POINT A computer simulation shows that a laser beam tweaked by going through a liquid-crystal panel will take a curved trajectory. Experimental data confirmed the predictions.

Pheromones are chemical cues given off by animals that trigger others' behavior by binding to sensory receptors in the vomeronasal organ in mice.

To substantiate the behavioral findings, Stowers and colleagues placed the urine proteins in contact with live neurons obtained from male mouse vomeronasal organs in a lab dish. Using imaging techniques, the researchers detected when 1 of the roughly 250 receptors on the neurons was activated.

The tests verified that the MUC proteins were pheromones and revealed that two neuron receptors, called Gnax and V2Rs, act as docking ports for them. —N.S.

SCIENCE & SOCIETY

Fishing curbs can lead to profit

Economists say that their computer models could bring peace, at last, between the fisheries industry and conservationists.

The models show that cutting back on fishing until a marine population rebounds, a dream of conservationists, also maximizes profits over time, says Quentin Grafton of Australian National University in Canberra. He and his colleagues found that after populations recover, profits rise. When fish are abundant, catching the quota takes less time and requires less fuel. The increased profits eventually compensate for industry losses during the prior period of restraint, Grafton and his colleagues say in the Dec. 7 *Science*.

The team's computer models show this scenario working out in all of the four fisheries studied. In three populations—big eye and yellowfin tuna in the Pacific and prawn north of Australia—stocks could rebound in less than a decade. More remarkable, says Grafton, is that the economic scenario also plays out in orange roughy, which would need decades to rebuild their population.

An expectation of future profits should allow for schemes to ease the pain during the initial period of restraint, says Grafton. For example, a program might compensate crews during the stock-building phase but collect a share of later profits.

Economists had previously talked about the possibility that marine abundance would boost profits, but Grafton and his colleagues say they are the first to show the dramatic influence of what is called the stock effect.

Even before publication, their analyses convinced Australia to adopt a delayed-gratification policy for prawn fisheries, starting in 2008. —S.M.

FOOD & NUTRITION

Vitamin D: Blacks need much more

The sunshine vitamin offers a broad range of benefits—from boosting bone and muscle strength to offering protection against cancer and diabetes. Unfortunately, the diet is a poor source of vitamin D, and dark skin filters out much of the sun's vitamin-producing ultraviolet light. To achieve healthy concentrations of vitamin D, therefore, many African-American women may need hefty daily supplements, a new study finds.

Researchers at the Winthrop University Hospital in Mineola, N.Y., recruited 208 postmenopausal black women for a 3-year trial during which half received large daily doses of vitamin D.

Increasingly, nutrition scientists advocate at least 75 nanomoles of vitamin D per liter of blood as a minimum target value for health, notes John F. Aloia, an endocrinologist and coauthor of the study.

Even after 2 years of supplementation with 800 international units of vitamin D daily—twice the recommended daily intake—treated women attained only 88 percent of the target value for this vitamin in their blood, Aloia's group reports in the December *American Journal of Clinical Nutrition*. The supplemented women reached the target value only after their intake was bumped up to 2,000 IU per day in the third year of the trial. —J.R.

American Society of Hematology
Atlanta, Ga.
Dec. 8–11, 2007

IMMUNOLOGY

Novel fused protein quells inflammation

A new compound made from the fusion of two proteins revs up cells to knock down the inflammation underlying a wide range of health problems.

The synthetic creation is dubbed GIFT-15, short for its two components, interleukin-15 and a compound called GMCSF. In lab dish tests, GIFT-15 induced mouse spleen cells to produce interleukin-10, a potent anti-inflammatory protein, reports Moutih Rafei, an immunologist at the Montréal Centre for Experimental Therapeutics in Cancer.

Rafei and his colleagues also tested GIFT-15 in mice with transplanted human tissue. While mice without GIFT-15 rejected the transplants outright, animals treated with the fusion protein tolerated it.

In another experiment, GIFT-15 stopped inflammation in spinal cords of mice with a disease similar to multiple sclerosis (MS). Before treatment with GIFT-15, the animals showed loss of muscle control arising from inflammatory nerve damage. Afterward, they recovered within 6 weeks.

The researchers plan to remove some of a patient's cells, treat them with GIFT-15 in a lab dish, and multiply the cells. Ideally, these cells could then be returned to the patient as anti-inflammatory therapy for MS, organ transplants, inflammatory bowel disease, and other conditions, Rafei says. Being a person's own cells, they would avoid immune rejection, he says. —N.S.

BIOMEDICINE

In search of safer marrow transplants

A bone marrow transplant preceded by destruction of one's own bone marrow with radiation or chemotherapy is a bleak prospect for a leukemia patient. Although the procedure can be lifesaving, it carries toxicity risks and weakens the patient. That's why people with autoimmune diseases rarely get a marrow transplant—even though it's potentially curative.

Scientists have now devised a synthetic antibody called ACK2 that targets a protein displayed on the surface of marrow cells and destroys them without radiation or chemo. These marrow cells, also called hematopoietic stem cells, can develop into various immune cells. In autoimmune diseases, some of them run amok and orchestrate tissue damage.

When researchers gave ACK2 to mice, it wiped out roughly 98 percent of the animals' marrow cells with few side effects. After the ACK2 had cleared from the animals' blood, the researchers gave them healthy donor marrow cells, which developed into a nondefective immune system.

Immunologist Agnieszka Czechowicz of Stanford University School of Medicine and her colleagues found that treating mice with ACK2 left prominent niches in bone marrow where replacement cells could grow. She doesn't envision ACK2 as a treatment for leukemia patients since it doesn't specifically target cancer cells. But it might benefit people with noncancerous immune disorders such as type 1 diabetes, multiple sclerosis, or sickle cell disease, Czechowicz says. —N.S.

BIOMEDICINE

Immune cells to fight leukemia

A cancer "vaccine" that uses small proteins found in abundance on the surface of leukemia cells shows strong signs of keeping the blood cancer at bay if given when the disease is in remission.

Cancer vaccines attempt to rally a person's immune cells to fight a malignancy. Researchers gave the vaccine to 13 leukemia patients in remission and 53 others who had active disease. All the patients had received other drugs previously. Although some were in remission, none was a good candidate for continued standard treatment because all had advanced leukemia, says study coauthor Muzaffar H. Qazilbash, a hematology oncologist at the M.D. Anderson Cancer Center in Houston.

The cancer vaccine had shown early promise in stimulating production of immune T cells that attack leukemia cells, which display excess amounts of two enzymes—proteinase-3 and neutrophil elastase (*SN: 1/4/03, p. 13*). Patients received three to six injections of the vaccine at 3-week intervals.

The 13 patients in remission at the outset fared best, averaging nearly 9 months of continued remission. One patient has avoided any relapse for 6 years after getting the vaccine, another for 5 years, Qazilbash says. Patients who were still fighting active disease at the time they got the cancer vaccine benefited much less, averaging only about 3 months of remission.

The vaccine works only in leukemia patients who carry a specific kind of immune protein called HLA-A2. About 40 percent of people have it, Qazilbash says. —N.S.

GENETICS

New clue to Down syndrome, leukemia link

People with Down syndrome are at least 10 times as likely as people without it to develop leukemia. Scientists now report that a mutation in the *JAK2* gene on chromosome 9 shows up in one-fifth of people who have Down syndrome and acute lymphoid leukemia (ALL), suggesting that the mutation accounts for some of this increased risk. It's the second mutation implicated in the Down-leukemia puzzle.

People with Down syndrome have an extra, or third, chromosome 21. This so-called trisomy causes the condition, and scientists have wondered whether it also predisposes to leukemia. But since most people with Down syndrome don't develop the blood cancer, researchers assumed there were other genes involved. Five years ago, researchers reported that one-fifth of people with Down syndrome who have acute myeloid leukemia have a mutation in a gene called *GATA1* on the X chromosome.

In the new study, physician Shai Izraeli of Tel Aviv University in Ramat Gan, Israel, and his colleagues analyzed blood samples from more than 8,000 childhood-ALL patients. The team found that 16 of 81 samples from patients with Down syndrome had the *JAK2* mutation. The defect was exceptionally rare in ALL patients without Down syndrome.

"We think trisomy in chromosome 21 gives a survival advantage to cells carrying the *JAK2* or *GATA1* mutations," Izraeli says. To a cancer researcher, "survival advantage" is a bad thing—a trait that enables a malignant cell to live on and on.

JAK2 normally encodes a protein associated with cell proliferation. A *JAK2* mutation also shows up in people with polycythemia vera, which is marked by abnormal red blood cell growth. Although the *JAK2* mutation linked to ALL differs slightly from the defect in polycythemia vera patients, research into *JAK2* inhibitors already under way for that disease could speed drug development for ALL patients with Down syndrome, Izraeli says. —N.S.

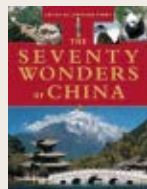
Books

A selection of new and notable books of scientific interest

THE SEVENTY WONDERS OF CHINA

JONATHAN FENBY, ED.

As China emerges as a world economic power, this volume—edited by Jonathan Fenby, former editor of the *South China Morning Post*—brings new appreciation to the country's cultural and geographic marvels. The nation's natural wonders include the world's tallest mountain, Mount Qomolangma—better known in the English-speaking world as Mount Everest—and the Yellow River, a waterway so laden with sediment that some



say it's more accurately described as a mud flow than as a river. China's manmade wonders range from Beijing's Forbidden City to the palaces and monasteries of Tibet, from the millennia-old Great Wall to the 4,000-strong forest of skyscrapers in modern-day Shanghai. The nation's innumerable inventions—gunpowder, porcelain, paper, and the compass, to name a few—influence the lives of nearly everyone on the planet. This volume comprehensively describes Chinese advances in science, religion, and philosophy alongside cultural developments such as calligraphy, martial arts, and feng shui. **Thames & Hudson, 2007, 304 p., b&w and color illus., hardcover, \$40.00.**

KALEIDOSCOPE SKY

TIM HERD

The sky provides an ever-shifting spectacle painted with all colors of the rainbow. In this richly illustrated book, meteorologist Tim Herd reveals the beauty and the science behind a wide variety of atmospheric phenomena, ranging from the daily pageantry of sunrises and sunsets to the rarely seen bursts of ball lightning. Many high-lights in the Earth's skies are produced by light scattering, refracting, or diffracting through the atmosphere and the particles it contains. Halos, arcs, and coronas about the moon and sun are generated by light scattering off a plethora of small particles—not just high-altitude ice crystals and water droplets but also volcanic ash and grains of pollen. Ghostly, shimmering auroras result when charged particles of the solar wind slam into Earth's atmosphere. Reading this book, armchair enthusiasts are taken on a clear and accessible tour of meteorological marvels. **Abrams Books, 2007, 240 p., b&w and color illus., hardcover, \$19.95.**



COPERNICUS' SECRET: How the Scientific Revolution Began

JACK REPCHECK

Most people know that Nicolaus Copernicus was the first to establish that the Earth revolves around the sun. But Copernicus, a scientist in 16th-century Poland, kept his manuscript tucked away for decades, fearing that portions of his theory might be wrong. Jack Repcheck explores the turn of events that led the man to make public his history-changing treatise. It might have gone to the grave with him but for the intervention of Georg Joachim Rheticus, a young professor who tracked down the reclusive Copernicus at a time when the astronomer, a cleric, was in trouble. Copernicus kept a mistress and might have been sympathetic to the Protestant Reformation, even though such heresy could be fatal. Rheticus and Copernicus worked for 2 years to finish the manuscript, *On the Revolutions of the Heavenly Spheres*. It was published in 1543, the year of Copernicus' death. **Simon & Schuster, 2007, 256 p., b&w illus., hardcover, \$25.00.**



WHAT'S EATING YOU?

Parasites—the Inside Story

NICOLA DAVIES

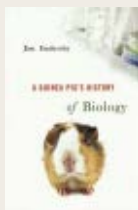
Looking even stranger than the most bizarre extra-terrestrials, the parasites presented in this book are sure to entertain as well as educate kids and adults alike. But the faint of heart be warned: Even cartooned googly eyes and outfits don't make ticks, lice, or nematodes any less itchy. Author Nicola Davies and illustrator Neal Layton, who previously collaborated on the books *Poop and Extreme Animals*, manage to present biological facts in a hilarious manner. Among the book's creative features is a board game that takes players through the life cycle of the tapeworm. Davies, a zoologist as well as a writer, doesn't shy from Latin names like *Succulina*, a crustacean that manipulates crab behavior by infecting crab brains and that Layton metaphorically illustrates as a puppeteer pulling on strings attached to an infected crab. The tale ends with pages devoted to the power of hygiene, sanitation, and the human immune system. The book is especially appropriate reading for anyone who needs to be reminded why it's important to wash their hands. **Candlewick Press, 2007, 59 p., color illus., hardcover, \$12.99.**



A GUINEA PIG'S HISTORY OF BIOLOGY

JIM ENDERSBY

Inheritance is an essential component of the theory of evolution by natural selection, but Darwin left to future generations the task of discovering exactly how it worked. While Darwin's ideas required a plethora of plants and animals, the experimental biologists who followed sought to minimize variation. As a result, Jim Endersby's book about biology since the 1800s can focus on just 12 organisms, including the guinea pig. Without these well-breeding lab rats, which ushered in the science of genetics, Darwin's species' origins would remain incompletely explained. The guinea pig was the first animal used to understand human diseases in the Victorian age; later, it would be replaced by experimental models using animals with short life cycles, such as fruit flies and mice, or with clear eggs, such as zebra fish. Endersby, a lecturer in history at the University of Sussex, uses these creatures to introduce the larger characters, plots, and themes in the development of molecular biology. **Harvard Univ. Press, 2007, 499 p., hardcover, \$27.95.**



LETTERS

Amylase with your veggies

Your article ("Advantage: Starch," *SN*: 9/15/07, p. 173) notes how groups of people may have different numbers of copies of the amylase gene. Is it correct then that individuals have varying numbers of the gene as well? If so, would this explain why some people don't like meat and become vegetarians and others just need to eat meat?

ROBERT KRASE, SPRINGVILLE, CALIF.

The researchers found that among 50 Arizona college students, the number of copies of the amylase gene ranged from 2 to 15. As for whether this explains vegetarian leanings, researcher Nate Dominy says that because amylase quickly converts plant starch to sugar in the mouth, excess amylase may make eating vegetables "a more rewarding experience." —B. VASTAG

Proof's absence

Sid Perkins' article on long-missing species ("Back from the Dead?" *SN*: 11/17/07, p. 312) validates a long-held principle of logic, namely, that one cannot prove a negative. It reminds me of an oft-cited legal warning: "Absence of proof does not constitute proof of absence."

MARK MAILLOUX, FENTON, MICH.

Antiscience attitudes

In all the recent discussions regarding science education in the U.S. ("Showdown at Sex Gap," *SN*: 11/24/07, p. 328), one factor that has not been mentioned is the antiscience attitude of many leaders and people in the media. It is fashionable to be ignorant of math, but not to be illiterate. This must have some effect on motivation to learn about science.

DENNIS BROWN, PORTLAND, ORE.

Correction "Shadow World: How many dimensions space has could all be a matter of perspective" (*SN*: 11/17/07, p. 315) incorrectly stated that Niklas Beisert is at Princeton University. He is at the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) in Potsdam, Germany. His collaborators were his Max Planck colleague Matthias Staudacher and Burkhard Eden of Utrecht University in the Netherlands. The article also stated that Larry McLerran is an experimentalist, but he is a theorist.

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All letters subject to editing.

SCIENCE NEWS

Of the year

THE WEEKLY NEWSMAGAZINE OF SCIENCE

Tuning In to Science

In its own way, science is a lot like '60s rock 'n' roll on AM radio. If you're old enough, you remember the slogan: "And the hits just keep on comin'."

With science, the news just keeps on comin'. Somehow, year after year, science never runs out of hit discoveries. From land-based laboratories to the depths of the oceans to remote realms of the cosmos, intrepid investigators find enough novelties in nature each year to fill the pages of thousands of journals and populate the programs of countless conferences.

Condensing the highlights from those discoveries into a few magazine pages isn't as challenging as making the discoveries to begin with, but it is almost as fun. So *Science News* staff writers enjoyed poring over the potpourri of science stories from 2007 to select those most worthy of enshrinement in the magazine's annual year-end issue.

There's no point in ranking these stories for impact or importance—that judgment comes only after the ensuing years (or decades) sort the permanent and profound additions to knowledge from false alarms and flashes in pans. But many items are worth mentioning as reminders of how deeply science touches society. Politicians concerned with the problem of violence should note the news about charging juveniles as adults (*SN*: 4/21/07, p. 243*) and school violence-prevention programs (*SN*: 9/1/07, p. 133*). Observations of Venus provide insights into its atmosphere that are relevant to understanding the Earth's (*SN*: 12/1/07, p. 339). Studies of the preservative thimerosal help inform debates over vaccine dangers (*SN*: 9/29/07, p. 197). Women pondering hormone replacement therapy should be aware of the relevance of age in assessing its implications for heart risks (*SN*: 4/28/07, p. 270).

Of course, no one of these new studies is the final, or only, word. The very nature of science guarantees future revisions of past findings and occasional overthrows of conventional belief. Making sound social policy requires keeping up with science as it marches along. And that's why pausing to reflect on each year's advances is so worthwhile (besides being so much fun).

— Tom Siegfried, Editor in Chief

HOW TO OBTAIN FULL ARTICLES This review lists important science stories of 2007 reported in *SCIENCE NEWS*. The reference after each item gives the volume and page number on which the main article on the subject appeared (vol. 171 is January–June; vol. 172 is July–December). Full text of any article can be obtained for \$2.50 from ProQuest (pqasb.pqarchiver.com/sciencenews). Back issues are available for \$3 each (prepaid). Send orders to **SCIENCE NEWS**, 1719 N Street, N.W., Washington, D.C. 20036.

Anthropology & Archaeology

Eastern roots A mix of anatomical traits on a 40,000-year-old partial human skeleton unearthed in China supported the controversial possibility of interbreeding among Stone Age *Homo* species (171: 211).

Early walkers New fossil finds showed that 1.77-million-year-old human ancestors trekked from Africa to Asia using legs, feet, and spines shaped much like ours, although they had small brains and apelike arms (172: 179*).



Researchers excavated a 4,600-year-old village in southern England that was inhabited by the same people who built nearby Stonehenge as a memorial to their dead (171: 67).



A coastal South African cave yielded evidence of surprisingly complex behaviors, including shellfish harvesting and pigment use, about 164,000 years ago (172: 243).

Pacific trips DNA extracted from a chicken bone found in Chile suggested that Polynesian seafarers brought poultry to South America by about 620 years ago (171: 356*). Other evidence indicated that, roughly

* An asterisk or a URL address indicates that the text of the item is available free on **SCIENCE NEWS ONLINE**. Links for these items are available at (www.sciencenews.org/articles/20071222/bob22.asp).

A. STANFORD/AERIAL-CAM FOR NATIONAL GEOGRAPHIC; MOSSEL BAY ARCHAEOLOGY PROJECT

1,000 years ago, Polynesians sailed canoes to Hawaii and back (172: 198).

Chimp hunters Researchers for the first time observed wild chimpanzees, mainly females and youngsters, making and using tools for hunting small animals (171: 131*). An excavation in western Africa revealed that a chimp stone age started at least 4,300 years ago (171: 99*).



A new analysis of fossil teeth from the fossilized remains of a nearly 8-year-old child suggested that people evolved an extended childhood at least 160,000 years ago (171: 163).

Tree walking Field work in Indonesia demonstrated that orangutans at times walk upright much as people do, suggesting that an upright stance evolved in a common ancestor of all living apes (172: 72*).

Tool time Primate and brain-scan studies converged on the notion that human tool use grew out of an evolutionarily ancient neural capacity for manipulating objects (171: 88).

Astronomy

Alien orbs Astronomers found what they are calling Earth's closest known analog outside the solar system, an object with an average temperature that may allow water to be liquid (171: 259*). A newly discovered planet outside the solar system—an exoplanet—appeared to be Neptune-sized and composed mainly of water solidified under high pressure (171: 308*). Researchers for the first time recorded the spectra of radiation emitted by two exoplanets (171: 115*). They also discovered the largest—and lowest-density—exoplanet yet found (172: 174).

Blooming comets Flaunting a majestic tail over southern skies, Comet McNaught became the brightest comet in more than 40 years (171: 52). In late October, Comet

17P/Holmes suddenly burst into brightness and became a naked-eye object for several weeks (172: 309).

Five in one With the discovery of a fifth planet circling the nearby star 55 Cancri, astronomers found the most populous—and heaviest—planetary system beyond the sun's (172: 334).

Death and life An exoplanet survived after its aging parent star ballooned into a red giant that almost engulfed it (172: 163), while infrared observations depicted dusty vestiges of a planetary system dancing around a dead star (171: 100). Material shed by a dying star might give birth to planets, researchers reported (171: 62).

Planetary prelude An infrared portrait of an embryonic, sunlike star revealed an early, crucial step in the process of planet formation (172: 358).

Joe average A collection of low-mass galaxies, dating from when the universe was just 2 billion years old, appeared to be the typical building blocks of large galaxies like the Milky Way (172: 373).

In transit Observations of minieclipses that occur when a distant planet passes in front of its parent star revealed new insights into the size, composition, and temperature of exoplanets (172: 24*).

Distant dustup Some of the best evidence yet emerged for an asteroid belt beyond the solar system (171: 5*).

Smash up Images recorded one of the biggest cosmic collisions known: four galaxies ramming into each other (172: 173).

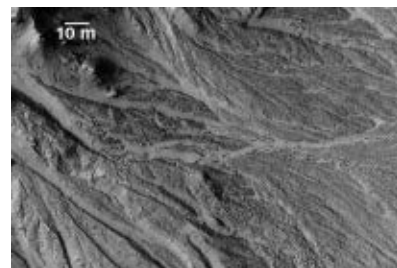
Pondering plumes The action of Saturn's gravity generates the plumes of water vapor shooting out from cracks on the moon Enceladus (171: 350). The Cassini spacecraft will change course to take a closer look at the plumes next March (172: 110).

Dark riddle Debris from an ancient collision of galaxy clusters seemed to show cosmic dark matter behaving in a puzzling way (172: 117*).

SISTER PLANET

A spacecraft found evidence that Venus once had more water than it does today as well as proof of Venusian lightning and of a formerly unknown hot spot near the south pole (172: 339).

Heavenly chemistry Discovery of a rare, negatively charged organic molecule shed light on conditions in interstellar gas clouds, where amino acids, sugars, and other prebiologic compounds form (172: 54).

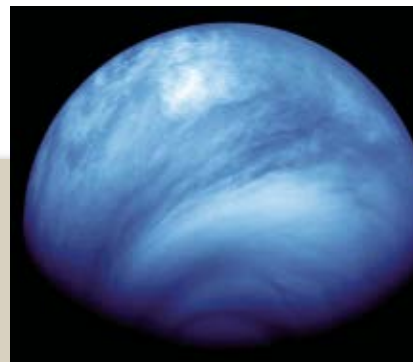


New images of the planet diminished the likelihood that liquid water has flowed on some parts of Mars, but bolstered the case in other places (172: 181*). Evidence that Mars once had a vast ocean gained support from a proposal that the planet was tipped halfway over on its side several billion years ago (171: 373).

In the black A flotilla of X-ray-observing spacecraft homed in on the whirlpool of activity surrounding a supermassive black hole (171: 8). A chance eclipse enabled astronomers for the first time to measure the width of a disk of swirling, hot matter around a supermassive black hole (171: 253).

Stellar spectaculars Astronomers reported the two brightest stellar explosions ever observed (171: 293), which could be the first examples of a rare type of supernova involving a freakishly massive star or a single star undergoing multiple outbursts (172: 269).

Passing galaxies The newly measured speeds of two familiar companion galaxies to the Milky Way suggest that they are not gravitationally bound to the Milky Way, but are relative newcomers passing by for the first time (171: 19; 172: 253).



SCIENCE NEWS

Of the year

Sun watchers Twin spacecraft began taking three-dimensional images of the sun and for the first time tracked solar storms from their birth in the lower depths of the sun's atmosphere all the way to Earth's orbit (171: 93, 133).

Tilted rings The rings of Uranus, now tilted edge-on to Earth, exhibited never-before-seen structures (172: 157).

Watery Mars Liquid may have percolated through underground rock on the Red Planet, providing a possible habitat for primitive life, suggest images of ancient cracks on Mars (171: 158). An ultrasharp image of part of one Mars crater showed waterborne sediments and volcanic ash (172: 245).

Red ice The global darkening of Mars' surface in recent decades has significantly raised the Red Planet's temperature, a possible cause for the substantial, recent shrinkage of the planet's southern ice cap (171: 214). If the frozen water stored near the south pole of Mars suddenly melted, it would make a planetwide ocean 11 meters deep (171: 206). An immense volume of ice-rich material may underlie a formation that extends about one-quarter of the way around Mars' equator (172: 277).

Ringing portrait NASA's Cassini spacecraft took the most sweeping views ever recorded of Saturn's icy rings (171: 148).

Martian caverns Images taken by a Mars-orbiting spacecraft depicted what appear to be caves on the Red Planet (171: 237).

Kaput The sharpest, most sensitive camera on the aging Hubble Space Telescope stopped working (171: 68).

Dino killer unveiled The asteroid that wiped out the dinosaurs 65 million years ago may have been a wayward fragment from a violent collision in the asteroid belt (172: 148*).

Dwarfing growth Researchers found the smallest galaxy known (171: 62). Another

wispy dwarf galaxy, called Leo A, appeared to challenge models of galaxy evolution (171: 195). A small galaxy at the periphery of the giant Andromeda galaxy looked to be a galactic building block of the modern-day universe (171: 357).

Puny Pluto Ex-planet Pluto suffered another demotion, as observations showed that it's much less massive than Eris, another distant denizen of the outer solar system's Kuiper belt (171: 413). Astronomers found the first "extended family" of related objects in the Kuiper belt (171: 164).

Heavy weight The discovery of a stellar-mass black hole almost 16 times as massive as the sun, as well as the possible discovery of an even heavier one, challenged theories of how such black holes form (172: 261).

Match made in heaven Researchers discovered a group of nearby galaxies nearly identical to some of the remotest known, offering a close-up glimpse of the remote era when galaxies first formed (172: 212).

Sunny fate The solar system already lies in the suburbs of the Milky Way, but analyses indicated the sun and its planets will be yanked even farther out in about 5 billion years (171: 365).

Death spin Researchers identified what appears to be the fastest-spinning stellar corpse ever documented (171: 173).

Plenty of nothing Researchers found the largest hole in the universe, a billion light-year-wide region devoid of matter (172: 190).

Violent origins A massive star pummeled our infant solar system, first blasting it with a massive wind, then exploding nearby, driving shock waves into the fledgling system that irrevocably altered its chemistry (171: 323*).



LIQUID CENTER

Mercury's core is at least partially molten, a radar study of the planet's spin revealed (171: 277*).

Sunstruck Spacecraft images revealed that a magnetic hurricane from the sun severed a comet's ion tail (172: 228).

Sunny view In Peru, researchers found the oldest known solar observatory in the Americas—a group of 13 towers first used around 300 B.C. to mark the positions of sunrises and sunsets from summer to winter solstice (171: 280).

Satellite dreams The launch of Sputnik 1 half a century ago ushered in a scientific and technological revolution, but dreams of the human conquest of space have stalled (172: 212*).

Behavior

Killer genes Depressed patients who had inherited certain gene variants displayed an increased tendency to contemplate suicide while taking antidepressant medication, a finding with potential treatment implications (172: 211*).

IQ insight By tracking the development of two groups of children, scientists found that breast-feeding substantially raises IQ scores only for those who inherit a specific gene variant involved in processing mothers' milk (172: 291*).

Compulsive clues Mice bred to lack a gene involved in brain-cell communication developed excessive grooming and other problems that may represent an animal model of obsessive-compulsive disorder (172: 116).

Autistic DNA An international study directed the search for autism-influencing genes to a previously overlooked DNA segment that contains several promising candidate genes (171: 117).

Om style Researchers demonstrated that intensive meditation training amplifies control over one's attention and the ability to notice rapidly presented items (171: 291*).

Stem awareness Observations of children born missing much of their brains, combined with animal studies, indicated that the brain stem organizes a basic form of consciousness (172: 170).

Bipolar bulge Scientists reported that rates of bipolar disorder among children and teenagers have dramatically increased since 1994, raising concerns about overdiagnosis of this severe mood disorder (172: 150).

Violent leads A research review concluded that transferring young offenders into the adult-justice system does more harm than good (171: 243*). Another review concluded that various violence-prevention programs in the schools reduce disruptive behavior (172: 133*).



High schizophrenia risk among Pacific islanders focused attention on environmental and cultural contributions to this psychiatric ailment (172: 8).

Word shifts Two investigations quantified ways in which frequently used words change slowly over thousands of years while rarely used words rapidly take on new forms, a key mechanism in language evolution (172: 227*).

Forget it Investigators identified brain areas that contribute to the ability to forget disturbing memories on purpose (172: 21).

You again Transference, a psychological process in which a person unconsciously overlays past relationships onto current ones, received renewed scientific attention (171: 363*).

Biomedicine

Mother's milk Reversing earlier advice, health authorities now say that babies born to HIV-positive mothers in poor countries have a better chance of avoiding infection if they breast-feed exclusively (172: 187).

Social disease A new test for human papillomavirus (HPV) detected cervical cancer more reliably than traditional Pap smears (172: 243*). Cancer of the throat and tonsils can arise from an HPV infection (171: 291*). The widely used spermicide nonoxynol-9 may boost HPV's infectiousness (172: 6).

Theory debunked Thimerosal, a mercury-containing vaccine preservative, showed no signs of causing memory or attention problems in children (172: 197*).

HIV then and now Analyses of 25-year-old blood samples indicated that HIV reached the United States in about 1969, 12 years before AIDS was first formally described (172: 275*). Three genetic variations picked out by powerful whole-genome scans helped explain why some people develop AIDS quickly while others keep it at bay (172: 35*). HIV can cause dementia by killing mature brain cells and blocking the creation of new ones, data showed (172: 157). A hepatitis B drug spurred resistance to HIV drugs in people infected with both diseases (172: 29), but an antiviral drug commonly taken for genital herpes seemed to suppress HIV in people harboring both pathogens (171: 116).

Cancer biology Survivors of a childhood cancer face a six-fold increased risk of developing a new cancer later in life, one study found (171: 157). Four proteins work together to assist cancer growth and metastasis, tests in mice suggested, and drugs against them inhibited both processes (171: 229). Susceptibility to radiation-induced tumors runs in families (171: 307).

Bacterial woes A resistant staphylococcus strain sabotages immune cells' ability to survive, data showed (172: 307). *Acinetobacter baumannii*, a common bacterium, showed signs of becoming more drug resistant (172: 228*), as did a microbe that causes middle ear infections (172: 301). Honey from New Zealand gums up bacteria, which indicated a potential means of combating difficult-to-treat infections (171: 366).

Shot in the arm An experimental vaccine for hepatitis E proved nearly 96 percent protective in a test in Nepalese soldiers (171: 131). A vaccine for meningitis and pneu-

monia prevented many childhood ear infections and the complications that they cause (171: 222).

Multiple sclerosis A DNA vaccine against MS passed a safety trial and showed signs of suppressing immune-directed nerve damage in humans (172: 99*). A drug for MS prevented subtle vision loss in many patients (171: 245). Childhood exposure to direct sunshine appeared to protect people against developing MS later (172: 51). A study in mice suggested that small amounts of carbon monoxide might alleviate MS symptoms (171: 53).

Kitty, kitty A nursing home cat in Rhode Island predicts with uncanny accuracy when residents will die, researchers reported (172: 53*). People allergic to dust mites, mold, grass, and other common irritants—but not to cats—still had breathing difficulties when they lived around felines (172: 4).

Surgical advances Drastic weight loss achieved through gastric bypass and other stomach surgeries improved long-term survival in very obese people (172: 115). A new artificial knee ligament that sparks regeneration of natural tissue could eventually make recovering from knee-repair surgery less painful and debilitating (171: 116*).

Cardio risks Many heart disease deaths among firefighters occurred during blazes (171: 180). A common imperfection in the structure of the heart appeared to exacerbate obstructive sleep apnea (171: 218). People who take the diabetes drug rosiglitazone (Avandia) may face an increased risk of heart attack, one study found (171: 397; 172: 164*). Illicit use of methamphetamine could lead to heart problems because the drug alters immune proteins, data show (171: 405).

Eye advance Scientists developed a technique to grow corneal tissue that includes nerve cells, an advance that may enable researchers to test consumer products in lab dishes rather than in live animals (171: 142).

Good to the bone The drug teriparatide inhibited bone loss in people who took medicinal glucocorticoid steroids (172: 309). Older women with osteoporosis who received yearly infusions of a drug that prevents bone loss had far fewer fractures than did peers not getting the drug (171: 275).

Influenza update For the first time, researchers reported drug resistance in type B influenza virus and concluded the drug-resistant strain might jump from person to



JUST SAY NO

Vaccines currently in development could give people a novel way to kick their addictions and lose weight (171: 90*).

person (171: 213). Flu shots prevented some deaths and limited hospitalizations for pneumonia in elderly people (172: 213).

Open wide Doctors propped open narrowed arteries in the brain with a tiny mesh cylinder called a stent, similar to the device used in the heart (171: 99). A biodegradable magnesium stent opened clogged blood vessels and then dissolved, circumventing problems linked to permanent metal stents (171: 356). After a meteoric rise, stents coated with drugs to prevent renarrowing of arteries have begun to fall from favor among cardiologists (171: 394).

Breathing easier Heating lung tissue to kill overgrown smooth muscle in airways thwarted asthma (171: 195). Children whose stomachs carry the bacterium *Helicobacter pylori* faced a decreased risk for asthma (172: 270), but infants who got several courses of antibiotics before their first birthdays proved to be at greater risk later (172: 14).

Odd vectors Fruit bats in Bangladesh regularly trigger small outbreaks of Nipah virus, which causes brain inflammation and death (171: 366).

Toxic intake Smoking before pregnancy may harm the reproductive capacity of female offspring, one study found (172: 326). Attempts to cleanse illicit drugs from the body by taking large doses of niacin caused life-threatening reactions (171: 212). Nanoparticles in diesel fumes thwarted proteins that dissolve blood clots, perhaps increasing the risk of heart attacks (172: 205).

Stopping stroke An experimental procedure that delivers a clot-busting drug directly to the brain triggered a remarkable turnaround in some stroke patients (171: 126). The antibiotic minocycline seemed to limit brain damage in stroke patients (172: 238).

Liver care A slate of treatments, including three established diabetes drugs, appears therapeutic for nonalcoholic fatty liver disease (171: 136).

Tropical scourges The parasitic worm that causes river blindness showed signs of developing resistance to the only drug that controls it (171: 388). Mosquito nets treated with insecticides decreased death rates among children in Kenya (172: 195). Chil-

dren in Uganda who contract malaria recovered faster with a drug based on artemisinin, derived from Chinese wormwood, than with the standard therapy (171: 381).

Prions Diseases caused by prions, deformed proteins that cause brain-destroying illnesses such as mad cow disease, can be reversed if caught early enough, experiments in mice indicated (171: 68*). Prions proved more infectious when bound to soil particles (172: 36).



DON'T FORGET

A component of the spice turmeric, which colors yellow curries, appeared to help prevent, and possibly treat, Alzheimer's disease (172: 167; 172: 37). Another study showed that a gene that's active in the brain offered one clue to why emotional stress seems to increase the likelihood of getting Alzheimer's disease (172: 13). In mice, measuring certain blood proteins offered an early warning of Alzheimer's disease (171: 301).

Bad to the bone Popular acid-reducing drugs called proton-pump inhibitors appeared to increase the risk of hip fractures in people over 50 (171: 3).

Steady, there Nail-gun injuries among do-it-yourself carpenters have tripled since 1991 (171: 334).

Parkinson's disease Lifelong smoking roughly halves the chance of getting Parkinson's disease, a study showed (172: 20). Transplants of human brain stem cells triggered signs of improvement in monkeys with a Parkinson's-like disorder (172: 45).

I got rhythm Sildenafil (Viagra) helped laboratory rodents recover from circadian disruptions similar to jet lag (171: 324).

Bad inheritance A heightened risk of brain aneurysm seemed to be passed down in some families, and the life-threatening rupture of an aneurysm

appeared to strike earlier in a succeeding generation (171: 126).

Botany & Zoology

Big changes The Intergovernmental Panel on Climate Change reported biological evidence for global warming has grown substantially since the 2001 assessment (171: 378*). In a rare study of how ocean acidification could affect animal behavior, a shoreline snail was shown to lose its defenses against crabs (172: 245).

Bad news bears Climate and population models predicted Arctic ice will soon melt so drastically during summers that two-thirds of polar bears will disappear by mid-century. Other species will feel the disruption too (172: 346*; 172: 37).

Wet frontier The Census of Marine Life, a 10-year project to explore vast regions of the oceans, found weird new species and unexpected diversity in deep waters and the polar oceans (171: 107; 171: 308).

Green trees Two major analyses of genes from chloroplasts agreed on the basic shape of the family tree for flowering plants (172: 366). Obscure plants long thought to be relatives of grasses represent one of the most ancient surviving lineages of flowering plants (171: 205).

Virus toll Population declines in five common birds, including robins and bluebirds, were linked to West Nile virus (171: 413).

Bee collapse Many U.S. worker honeybees mysteriously vanished (172: 56*). The little-known Israeli acute paralysis virus was linked to the collapse as a cause or a marker (172: 147*).

Cousins Gliding mammals called colugos, which aren't quite primates, showed up in a genetic analysis as primates' nearest kin (172: 275).



DNA evidence put the living Laotian rock rat into a rodent family that scientists assumed had vanished 11 million years ago (171, 260*).

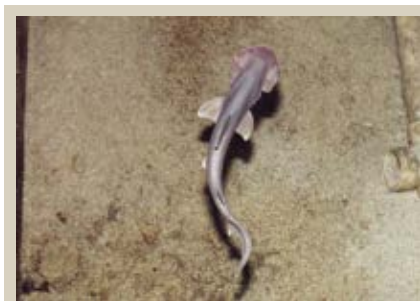
ISTOCKPHOTO; FSU RESEARCH IN REVIEW MAGAZINE

Urban life Loud background noise eroded mate fidelity in zebra finches (172:116).

Smells funny Just an hour's swim in slightly contaminated water gave fish such bad body odor that former schoolmates shunned them (172: 262).

Tough bluebirds As western bluebirds recolonize Montana, aggressive males move in first to push out rival species—an unusual example of behavior influencing animal distribution (172: 222).

Hey, bro A little beach plant recognized its siblings as long as their roots grew in nearby soil (171: 372).



NO DAD

DNA testing confirmed that a shark reproduced without mating, bringing to five the tally of major vertebrate lineages with the capacity for virgin birth (171: 323).

Musical shield The clicking sounds of moths dodging bats revealed what could be the first evidence of acoustic mimicry as a defense against predators (171: 397).

Sex again Some beetle mites may be the first animal lineage to have abandoned sexual reproduction and then redeveloped it (171: 302).

Fish switch Salmon implanted with trout reproductive tissue—a new aquaculture technique—bred and produced a generation of normal rainbow trout (172: 164).

Cell & Molecular Biology

Stem cells from skin Two groups of scientists converted people's skin cells directly into stem cells without creating or destroying embryos (172: 323*), an accomplishment built on similar feats performed with mouse cells (172: 29).

Beyond genes Detailed explorations of the human genome showed that individual genes can have complex structures, and that much of what had been called junk DNA is anything but (172: 154*).

Capricious evolution Reconstruction of an ancient protein showed how random, seemingly unimportant mutations set the stage for later genetic changes that gave the protein its modern function (172: 101).

Genome swap Transplanting the entire genome of one species of bacteria into another paved the way for making microbes with synthetic DNA (171: 403*).

Longevity lessons People on reduced-calorie diets experienced many of the same cellular changes as did long-lived animals on such diets (171: 147*). Nerves in the brain proved crucial to the life-extending effect of calorie-restricted diets, experiments with roundworms showed (171: 414). Mice lived longer when they were fooled into sensing lower insulin levels than they actually had (172: 62). In insects, the scent of food alone actually diminished the longevity advantage of low-calorie diets (171: 94).

Nerve renewal The brain constantly sprouts new neurons, a recently discovered phenomenon that neuroscientists and drug makers began working to understand and exploit (171: 376).

Mapping genomes For the first time, one man's genome, including both sets of chromosomes, was decoded (172: 147). Thirty-five labs unveiled a draft of the genome of the rhesus macaque, the most widely used laboratory primate (171: 237*).

Bacterial inheritance Bacteria exchange genes all the time, but data indicated that they can donate their DNA to some animals as well (172: 131*).

Early evolution The surprisingly complex genome of the starlet sea anemone, a creature with ancient evolutionary roots, showed that animals became genetically robust much earlier than scientists had thought (172: 30).

Amniotic stem cells Scientists discovered that about 1 percent of the cells that float in the fluid that bathes fetuses are stem cells with traits of both embryonic and adult stem cells (171: 30).

On the cheap Methods under development could make DNA sequencing quicker and less expensive, a study found, paving the way for the day when treatments can be tailored to each person's genetic profile (171: 235).

Cell factories Scientists found a master gene that allows tissue-regenerating stem cells to retain their regenerative capacity (171: 292). Certain adult stem cells from female mice regenerated better than those from males, indicating that not all adult stem cells are created equal (171: 228).

Bossy bones A protein made by bone cells had a surprising influence on energy metabolism, and could have a role in treating diabetes (172: 83*).

Chickengineering Genetically engineered hens can not only produce useful drugs in their eggs but also reliably pass on this characteristic to new generations of offspring (171: 35*).



RENEWED NEWT

The ability of newts to regenerate severed limbs depends on a protein released by the insulating sheath around nerves, researchers showed (172: 276).

Mistaken identity Embryonic stem cells claimed by discredited Korean researcher Woo Suk Hwang to have come from cloned human embryos actually came from embryos that grew from unfertilized eggs (172: 69).

Crossing the line With the help of a molecule from the rabies virus, scientists selectively ferried a drug across the blood-brain barrier to treat a neurological disease in mice (171: 387*).

Live wire Nerve axons are not simply passive carriers of electrical signals in the brain, as scientists had thought, but proved influential in how neurons fire (172: 148).

Bio-computer Artificial genes inserted into cells produced RNA—molecules that carry genetic information within the cell—that performed logical computations (171: 413).

Radiation diet The pigment melanin may enable certain fungi to convert dangerous radiation into usable energy (171: 325*).

Stowaways The trillions of microbes that live in the human gut and on the skin may be essential to health (171: 314*).

Microbe memory Amoebas appeared to possess a rudimentary form of memory that keeps them from walking around in circles (171: 205).

Space bugs Bacteria that flew on a space shuttle became more virulent than their Earthbound counterparts (172: 197).

Primitive immunity In social amoebas, sluglike clusters of usually independent organisms, certain cells take on a protective role, a finding that hinted at the origin of immune systems in higher animals (172: 125).

CSI Africa Scientists tracked the origin of an illegal ivory shipment to Zambia by using an improved DNA-analysis technique to study the confiscated tusks (171: 158).

Chemistry

Beyond petroleum A faster, simpler manufacturing technique showed promise for making a synthetic biofuel into an even stronger competitor to ethanol (171: 389*). Also, a new chemical process held out the potential that many products now manufactured from petroleum could one day be made from sugar molecules (171: 120*).

1,001 tiny uses? Nanoparticles of magnetite have catalytic properties that may be useful in wastewater treatment and biomedical assays (172: 174). Small clusters of drug molecules attached to nanoparticles of

gold appeared capable of delivering a safer and more effective chemotherapy punch to tumors (172: 180). Gluing together nanoscale clay particles with a simple adhesive created a strong but flexible material (172: 254).

Passing through A new polymer membrane efficiently separated carbon dioxide from methane and could greatly ease the processing of natural gas (172: 269).

Black and white Layers of microscopic filaments sprayed onto a surface prevented it from reflecting light, a potentially useful trait for technologies from solar cells to fiber-optic communications (171: 132). At the other extreme, scales covering the *Cyphochilus* beetle offered researchers a model for microstructures that could make a variety of surfaces whiter and brighter (171: 78).

Shocking films Ultrathin sheets made of cellulose and carbon nanotubes served as flexible, versatile batteries (172: 100).

Magnet makeover A new family of hybrid magnets debuted as a first step toward organic versions of the familiar metal objects (171: 77).

Crystal matchmaker Nonperiodic structures called quasicrystals acted as interfaces between crystal structures that ordinarily would not stick to each other (172: 46).

No sweat A new, breathable fabric, envisioned for use in comfortable protective gear, proved impervious to chemical-warfare agents (171: 13).

Heal thyself A self-repairing composite material repeatedly healed damage at the same spot (171: 398).

Got mussel? A new, adhesive that borrowed tricks from the gecko and the mussel stuck and detached repeatedly—even when wet (172: 78).

Sop story A new, porous gel efficiently removes mercury from contaminated water and might find use in catalyzing chemical reactions, such as those that generate hydrogen for fuel (172: 52).

CRINKLE WRINKLE

Analyzing the shape and pattern of wrinkles in a thin film revealed the film's thickness and elasticity, researchers found (172: 69).



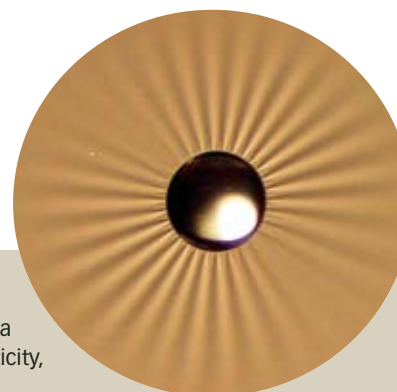
Solvents in nanoscale droplets provided a safer way to clean centuries-old frescoes (171: 310).

Sensing soot A chemical in urine revealed a person's exposure to diesel exhaust (172: 69).

Earth Science

Pin the blame With a 90 percent certainty, the Intergovernmental Panel on Climate Change linked last century's rise in global average temperature to rising concentrations of heat-trapping greenhouse gases (171: 83).

Hot times On the heels of the continental United States' warmest year on record in 2006 (171: 46), sea ice in the Arctic Ocean in September 2007 fell to a modern-day low (172: 238). Satellite observations indicated that Arctic regions reflected less sunlight into space in the summer of 2006 than in other recent years, a change that might exacerbate warming of Earth's climate (171: 382).





HIGH AND DRY

Air pollution reduces the amount of precipitation that falls in high-altitude regions, data from a Chinese mountaintop indicated (171: 149).

Young and restless The oldest rocks in the world, found in Greenland, showed that Earth's shifting crust began its tectonic movements at least 3.8 billion years ago (171: 179*).

Oxygen rocks A dramatic rise in the concentration of oxygen in Earth's atmosphere resulted from a change in volcanic activity about 2.5 billion years ago (172: 132).

Getting warmer A long-term decrease in Lake Superior's winter ice cover has caused the lake's surface waters to warm faster than air temperatures at nearby sites onshore, scientists said (171: 286).

Reach deep In a remote part of the southeastern Pacific where marine life is sparse, ultraviolet light penetrates to unprecedented depths, research showed (172: 77).

Killer clay A certain type of French clay smothers a diverse array of bacteria, offering a treatment for antibiotic-resistant strains and a nasty pathogen that causes skin ulcers (172: 276*).

Lake-bottom bounty Surprisingly, sediments in a few lakes in northeastern Canada were not scoured away during recent ice ages, a discovery that might aid climate researchers (172: 211).

Climate sensors Scientists developed a way to use corn plants to monitor and map modern human-generated emissions of carbon dioxide (171: 93). Meanwhile, other teams worked to discern past climates by analyzing harvest dates of grapes in Switzerland (172: 318) and gases trapped in lumps of glass formed when lightning struck sandy ground (171: 101*).

Flotsam science Researchers harnessed the power of floating items as diverse as tennis shoes, tub toys, and hockey gloves to chart the path and speed of currents in the North Pacific Ocean (171: 267*).

Stunting growth Rising concentrations of ground-level ozone due to pollution will stifle the growth of vegetation in many regions, accelerating the buildup of planet-warming carbon dioxide in the atmosphere, researchers concluded (172: 52*).

A smashing end? Field studies across North America indicated that an extraterrestrial object exploded above Canada about 12,900 years ago, sparking devastating wildfires and triggering a millennium-long cold spell at the end of the last ice age (171: 339*).

No fooling Lofting tiny particles high into the atmosphere to counteract global warming could provoke extended droughts and other weather disruptions, scientists theorized (172: 125).

Mixed results Using groundwater to irrigate crops adds planet-warming carbon

dioxide to the atmosphere (172: 301), research indicated, but the cooling effect created by such irrigation can significantly alter local climate and mask effects of global warming (171: 174).

Withering weather When southern Europe receives scant rainfall in the winter, the whole continent tends to bake the following summer, a new analysis found (171: 269).

Environment & Ecology

Plastic concerns Early exposure to bisphenol A, a chemical building block of clear plastics, can trigger a variety of later health problems, two new studies showed (172: 84*). Later, large review panels concluded that existing animal data suggest this dietary pollutant might cause myriad adverse human-health effects at doses comparable to those people now encounter (172: 202).

Heavy impact Demands of the world's population as a whole consume nearly a quarter of Earth's total biological productivity, an analysis found (172: 235*).

Aquatic non-scents Many common pollutants were found to jeopardize the survival of fish and other aquatic species by blunting their sense of smell (171: 59*).

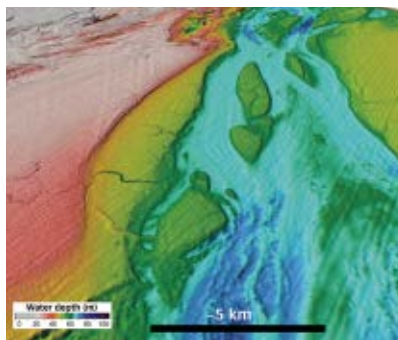
Counterintuitive toxicity Standard high-dose testing of poisons frequently fails to predict potentially important impacts—either risks or benefits—of very low-dose exposures (171: 40*).

Tadpole stalker A mysterious protozoan disease was discovered to be triggering mass die-offs of frog tadpoles throughout much of the United States (172: 325*).

Great-gram's fault Pollutant exposures in rodents triggered behavioral changes that persisted generation after generation (171: 198).

Policing fisheries Congress reauthorized and strengthened a 30-year-old federal law governing fishing and ocean management (171: 30).

Herbal herbicides Scientists have begun tapping plants and the self-defense chemicals they make for new weed killers, many of which may find use in organic farming (171: 167).



Hundreds of thousands of years ago, the spillover from an immense glacial lake carved a chasm that in a matter of weeks severed continental Europe from what is now Britain (172: 35).



The age-old mystery of sand dunes that produce loud, thrumming noises was explained by a new theory that involves a resonant layer of dry sand (172: 149).

SCIENCE NEWS

Of the year

Nonstick releases Nonstick coatings on fry pans and microwave-popcorn bags can, when heated, release traces of potentially toxic perfluorinated chemicals (171: 61).

Mercury magnets Certain areas of North America proved particularly susceptible to environmental accumulation of mercury (171: 45).

Sooty triggers Nanoparticles in diesel exhaust activated genes that worsen cholesterol's damaging effects (172: 93). Small blood vessels in rodents lost the ability to precisely regulate blood flow after exposure to an oily constituent of diesel soot, but effects varied greatly by age and gender (171: 381).

Ethanol conundrums Strong expansion of the U.S. corn-to-ethanol industry could soon divert more than half of U.S. corn yields from food into transportation fuel (171: 78). An alternative cellulose-based ethanol could help lower greenhouse-gas emissions, some research showed, but the technologies required are far from straightforward (172: 120).

Suffocating impacts Seasonal oxygen shortages in coastal waters, increasing in severity because of pollution, were shown to impair fish reproduction (172: 158).

Asbestos, really Federal mineralogists corroborated earlier evidence that foothill com-

HAMMERED SAWS

Shark relatives that almost went extinct several decades ago gained global protection under an international treaty (172: 90*).

munities around Sacramento, Calif., lay atop soils laced with asbestos (171: 29).

Rocky fallout New research explained why a carcinogenic form of chromium has been turning up in ground and surface waters far from industrial sources (171: 254).

Belittling pollution Pregnant women exposed even to moderate amounts of several common air pollutants tend to have babies with low birthweights (171: 261).

E-hazards The dismantling and recycling of electronic devices was linked with high concentrations of flame retardants in the blood of Chinese residents—even those living 50 kilometers away (172: 20*).

Polluted cats An epidemic of hyperthyroidism in house cats was linked with environmental exposures to certain flame retardants (172: 125).

Toxic similarities At concentrations found in the environment, three dissimilar toxic agents each seized control of a signaling pathway that regulates developing brain cells (171: 134).

Dirty printers Some laser printers emitted substantial amounts of potentially hazardous nanoscale indoor-air pollution (172: 158).

Nanorisks Making carbon nanotubes also produced lots of airborne carcinogens (172: 142).

Food & Nutrition

Supersized livers A diet of sweet and high-fat foods rapidly and dangerously fattened the livers of rodents (*science news.org/articles/20070609/food.asp*). Another rodent study narrowed this link to overconsumption of the rapidly digesting carbohydrates typical of breads, fries, and sweets (*sciencenews.org/articles/20070929/food.asp*). But tricking the body into storing excess calories in fat cells—not the liver—disconnected the link between overeating and fatty liver



disease (*sciencenews.org/articles/20071006/food.asp*).

Redefining nutritious Among children prone to diabetes, those who consumed the most omega-3 fatty acids showed the lowest incidence of disease (172: 237). Moderate consumption of beer, wine, or gin lowered blood glucose, suggesting alcohol may help stave off type 2 diabetes (171: 405).

D benefits and risk To prevent rickets, a Canadian medical society recommended pregnant women and nursing moms dramatically boost their intake of vitamin D (*sciencenews.org/articles/20071117/food.asp*). Two new studies offered evidence of an additional benefit: a diminished risk of asthma when babies get ample vitamin D (*sciencenews.org/articles/20070519/food.asp*). However, plenty of this vitamin will increase a child's uptake of any lead in the environment (*sciencenews.org/articles/20070512/food.asp*).

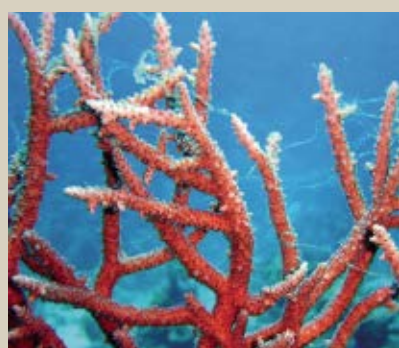
Cocoa flow A chocolate drink that retains natural ingredients, ones normally removed to improve cocoa's flavor, boosted blood flow to the brain (171: 142).

Weighty matters Among mice, being either over- or undernourished before birth altered gene activity that fosters obesity in adulthood (171: 115).

Meaty hormone Overcooked meat forms chemicals that mimic a female sex hormone, which offered a "biologically plausible" explanation for why breast cancer risk has been linked to red-meat intake (*sciencenews.org/articles/20071020/food.asp*).

Java fiber Coffee was identified as a significant source of dietary fiber (171: 125).

Wrong formula Low-birthweight babies fed catch-up formulas rich in calories had significantly higher blood pressure by age 8 than did kids given regular formula (*sciencenews.org/articles/20070217/food.asp*).



SLIME DWELLERS

Microbes that corals recruit into their surface blankets of slime influence the reef builders' health and adaptability in the face of adversity, studies showed (171: 346*).

Finding focus An amino acid in tea combines with the brew's caffeine to enliven brain cells that aid concentration (172: 206).

Pee for produce A study with cabbage demonstrated that human urine can outperform conventional fertilizer (172: 222).

Buzzing kids Common food colorings and a common preservative increased a child's risk of exhibiting hyperactivity and inattentiveness (172: 349).

Smart pills A dietary supplement combo boosted older adults' performance on simple mental tests (171: 301).

Green rescue A constituent of green tea appeared capable of rescuing brain cells damaged in Parkinson's disease (172: 206).

Fighting malaria An herbal-tea remedy for malaria contains a component that showed potential as the basis for a novel drug against the disease (171: 77).

A diet for noise Consuming certain dietary supplements before encountering a dan-

gerous din can limit or eliminate noise-induced hearing loss, animal data showed (sciencenews.org/food/articles/20070421/food.asp).

Challenged improvement A controversial trial of interesterified fat—a chemically modified fat—suggested it was more harmful than a partially hydrogenated vegetable oil rich in *trans* fat (171: 84).

Infectious pâté Fatty goose liver contains amyloid that triggered amyloid brain disease when fed in large quantity to mice (sciencenews.org/articles/20070630/food.asp).

Nutrient puzzle The more calcium and vitamin D that elderly individuals consumed, the greater the number and size of lesions that showed up in their brains (171: 381).

Never mind The herbal supplement black cohosh proved no more effective than a placebo in reducing hot flashes in menopausal women, contradicting earlier claims (171: 29).

Oolong slim Rats absorbed less dietary fat and gained less weight when their diets contained lots of oolong tea (171: 318).

Thoughtful brews Caffeinated coffee and tea appeared to keep aging wits sharp—but only in women (sciencenews.org/articles/20070818/food.asp).

Bad time to drink Regular alcohol consumption during pregnancy tripled the chance that any son would be born with undescended testes, a risk factor for male infertility (sciencenews.org/articles/20070106/food.asp).

Mathematics & Computers

Second lab Epidemiologists and social scientists tapped into virtual online worlds such as Second Life to collect data with real-world uses (172: 264).

Good epidemics An analysis of global exports showed that a country's competitive edge can spread industry to industry, like rumors or diseases, offering an explanation for why some developing economies seem condemned to depend on a handful of products (172: 138*).

His last theorem Mathematicians reconstructed part of Srinivasan Ramanujan's

lost work, which offered pattern-connecting formulas—called mock theta functions—that crop up in different branches of science (171: 149*).

No prison, no dilemma In games that would normally favor cheaters, making participation voluntary can instead promote cooperation, researchers showed (sciencenews.org/articles/20070714/mathtrek.asp).



STINK BUGS

When crushed or stressed, invasive Asian ladybugs—which love grapes—release obnoxious-smelling chemicals that can easily spoil a batch of wine, chemists showed (sciencenews.org/articles/20070428/food.asp).

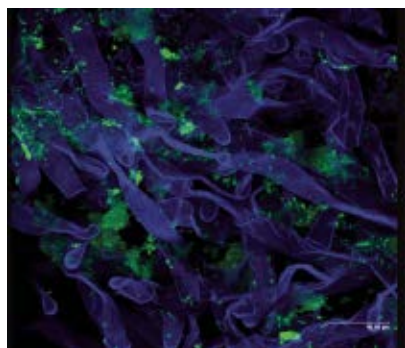
Separate is never equal Segregation leads automatically to economic inequality, even in the absence of significant discrimination, a mathematical model showed (sciencenews.org/articles/20070915/mathtrek.asp).

Growth formulas Golden angles and other mathematical patterns revealed how plants develop structures with intriguingly elegant geometries (172: 42).

Checkers solved Thanks to an immense calculation that worked out every possible game position, computers learned how to play a flawless game of checkers and force a draw every time (172: 36*).

Internet tentacles A study of the flow of digital information around the world revealed that the Internet's structure resembles that of a medusa jellyfish (171: 387).

Cloudy crystal balls Models may never predict climate accurately, no matter how fast computers get, because subtle uncertainties in the models—rather than in the data themselves—may prove inherently unavoidable, researchers concluded (sciencenews.org/articles/20070804/mathtrek.asp).



Food-poisoning germs can enter crops and can't be washed off, scientists found (172: 250*).



New farm rules aimed at keeping microbes from tainting leafy greens in the field began to impose substantial environmental costs (172: 362).

Fractal or fake? Algorithms that look for fractal patterns to establish the authenticity of paintings provoked controversy among scientists (171: 122*).



ANCIENT GEOMETRICAL WONDERS

Traveling in the Middle East, physicists found 15th-century Islamic tiles laid in patterns that can cover an infinite plane without repeating themselves (sciencenews.org/articles/20070224/mathtrek.asp).

Paleobiology

Ancient extract Analyses of a *Tyrannosaurus rex* leg bone revealed substantial remnants of proteins, a find that strengthens the purported link between modern birds and dinosaurs (171: 228).

Gone under A new analysis of Australian fossils bolstered the notion that humanity's arrival on the island continent led to the extinction of many large creatures there about 50,000 years ago (171: 38*).



Paleontologists unearthed remains of a 3.5-meter-tall, birdlike dinosaur that lived 70 million years ago in what is now China (171: 371*).

Digging the scene Dinosaur remains fossilized within an ancient burrow were the first indisputable evidence that some dinosaurs maintained an underground lifestyle (172: 259*).

Caught in the act Paleontologists unearthed fossils providing direct evidence of something scientists had long suspected: Tiny bones in the middle ears of modern-day mammals evolved from bones located at the rear of their reptilian ancestors' jaws (171: 190).

Slow rise Early dinosaurs didn't quickly eclipse the creatures they evolved from, but lived alongside them for perhaps 20 million years (172: 78).

Pre-Wright flight A meter-long dinosaur swooped from tree to tree using the same arrangement of wings as the Wright brothers' biplane, a new study indicated (171: 53*).

The oldest *matrushka*? A fossil preserved the remains of one creature inside another that lay nestled inside yet another, which offered the first direct evidence of a three-level food chain of aquatic vertebrates (172: 286).

Unexpected archive Hair from ancient mammoths contained enough genetic material to permit reconstruction of parts of the animal's genome (172: 195*).

Quick bite Saber-toothed cats living in North America around 10,000 years ago had a much weaker bite than modern big cats, analyses suggested (172: 213*).

Physics

Einstein unruffled Thirty-five years of laser-tracking a mirror on the moon confirmed that the laws of gravity are the same in all frames of reference, a cornerstone of Einstein's general relativity (172: 324). But technical glitches forced an even longer-running project—a probe NASA began developing in the early 1960s—to delay confirmation of its preliminary data on another general-relativity prediction: that Earth's spin drags the fabric of space around it (171: 270).

Antimatter matter Physicists showed that positronium "atoms," consisting of an electron and a positron (the electron's antimatter counterpart), could bind together briefly to form positronium molecules. The technique used could lead to gamma-ray lasers (172: 163*).

Imaging biomolecules Physicists demonstrated techniques that may enable a new generation of lasers to decode the structure of single biomolecules in motion, rather than in static crystalline form (171: 253; 172: 86).

Critical steps The onset of panic in a dense crowd resembles the onset of turbulence in a fluid, videotapes from a Muslim pilgrimage site showed, helping physicists advise Saudi authorities on how to prevent stampedes (171: 213*).

Getting no axion Experiments contradicted earlier evidence suggesting the existence of the axion, a possible constituent of cosmic dark matter (172: 245*).



Tests in wind tunnels demonstrated that flying bats generate lift and thrust with their wings much differently than birds do (171: 293).

Broadband vision Physicists showed that specialized, cone-shaped cells efficiently transport light to the back of the retina by acting like optical fibers (171: 317).

Still baffling An experiment failed to confirm the existence of a strange elementary particle called the sterile neutrino, but the new data still potentially contradict current physics theories (171: 254).

Knots everywhere Data showed that a tumbled rope will form surprisingly complicated knots, surprisingly often (172: 398).

Who ordered that? In experiments that created the heaviest isotope of magnesium yet, an unexpected isotope of aluminum also showed up; both types of matter may exist in the crusts of neutron stars (172: 260*).

Within reach An old particle accelerator at the Fermi National Accelerator Laboratory in Illinois might discover a crucial elementary particle before Europe's forthcoming Large Hadron Collider does, scientists reported (171: 270).

Not much latitude A physicist proposed testing a controversial gravitational theory with an experiment that can be done only at a precise time of the year and at exactly 79°50' N, 56° W (171: 206).

Solar processor The wavelike behavior of energy in chlorophyll showed that plants channel solar energy in a way that resembles how a quantum computer would process information (171: 229).

Science & Society

Better yardsticks A federal survey concluded that a lack of measurement tools is jeopardizing the United States' innovative edge (171: 251).

Extreme encyclopedia A consortium of museums and laboratories unveiled plans for a free, Web-based Encyclopedia of Life, which plans to eventually offer an entry for every living species (171: 294).

Hot jobs Workers in the United States toil longer than their counterparts in most other places, leading to dramatically higher U.S. energy and climate-warming costs per employee (171: 13).

NIH stagflation Stationary funding for the National Institutes of Health, in the face of rising costs, has forced many scientists to downsize their labs and abandon some of their most promising work (171: 206).

Inhumane deaths Prisoners given lethal injections may be conscious and experience pain and burning sensations while they asphyxiate (171: 302).

Summing up benefits Taking more math in high school improved students' college grades in physics, chemistry, and biology (172: 78).

Citizen astronomers Scientists recruited online help from the public to classify the shapes of 1 million galaxies in never-before-viewed photographs (172: 62).

Smokin' media White adolescents who frequently watch television and R-rated movies were more likely to try smoking than were peers less exposed to these media (171: 149).

Technology

Graphene is forever For the first time, physicists carved transistors out of carbon layers one atom thick and tougher than

CITY SPREADS

Accumulating evidence suggested that urban sprawl discourages physical activity and may thereby contribute to obesity and related health problems (171: 43*).



diamond, creating strong contenders for replacing silicon in future computer chips (172: 200*).

Wireless recharger Scientists transferred power wirelessly across a room using oscillating magnetic fields, opening the possibility of recharging laptops and other gadgets without plugging them in (172: 40*).

Hybrid advancements New metal alloys and nanoparticles increased the efficiency of the platinum catalyst in fuel cells (171: 21). A new type of fuel cell did away with platinum altogether—replacing it with far cheaper metals—and runs on a liquid hydrogen-based fuel that would be easier to distribute and store than pure hydrogen (172: 253).

Power on the fly Engineers packed the most energy yet into a high-speed, lightweight flywheel, which could make electric trains run 15 percent more efficiently or replace batteries in hybrid vehicles (171: 312).

Biowarfare Scientists engineered viruses to penetrate and dissolve bacterial colonies known as biofilms (171: 404).

Spot on A technique for printing dots just 250 nanometers wide—nearly 100 times smaller than dots made by ink-jet printers—offered to ease the production of flexible electronics such as plastic displays and solar cells (172: 166).

Transferred touch Engineers improved amputees' control of prosthetic limbs by rerouting nerves from limbs to muscles in the chest (171: 85*).

Bio DJ Ordinary CD players were adapted to perform chemical assays and potentially to offer medical diagnoses (172: 253).

Crystal clear A scientist grew orderly arrays of nanowires on a crystal, a technique that could lead to high-density memory chips and transparent LEDs (172: 334).

Traffic light Engineers carved chains of microscopic silicon ridges to delay and temporarily store light signals, a step toward computers that process data using photons instead of electrons (171: 3).

Right dosage Physicists built a pipette that dispenses a billionth of a trillionth of a liter at a time—droplets a thousand times as small as previously achieved (171: 244*).

Tractor beam Chemists created nanoparticles that selectively bind to targeted bacteria and drag them toward a magnet—a step toward decontamination of water supplies or bacterial sorting and identification (172: 366).

Beyond retouching New technologies allowed photographers to relight and even refocus scenes after shooting (171: 216*).

On second thought ... A company started selling easy-to-remove tattoo inks—pigment-filled nanoparticles that can be selectively destroyed by the right wavelength of light (172: 232).

Atomic landscapes An electron microscope not only imaged single atoms but also mapped the locations of different chemical elements in a sample (172: 110).



A DAY IN THE LIFE OF A CELL

A laser technique similar to a CAT scan produced 3-D images and movies of living cells (172: 100).

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