

# SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

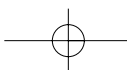
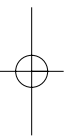
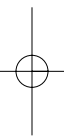
JULY 12, 2003 PAGES 17-32 VOL. 164, NO. 2

oldest, farthest planet  
stunted country cottonwoods  
clues to lou gehrig's disease  
the power of phages

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## trouble in dairyland

THE UDDER TRUTH



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**Cover** Investigative squads employing ultrasound and biochemical tests are becoming a staple of the livestock-judging circuit. The aim is to detect injections and other illegal tampering that improve the appearance of a cow's udder and other body characteristics that affect an animal's ranking. Page 24

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# SCIENCE NEWS

## This Week

### Record Breaker

#### A planet from the early universe

**Astronomers have found the oldest and most distant planet known in the universe.**

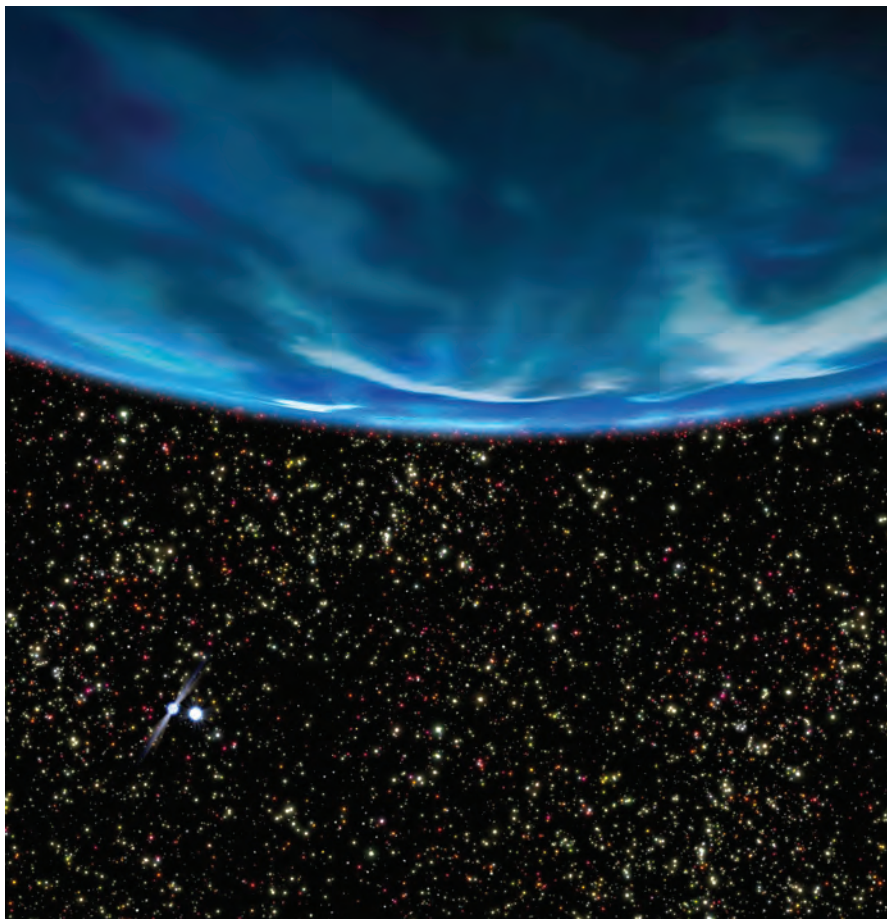
Residing 7,200 light-years away, the planet weighs 2.5 times as much as Jupiter and formed when the universe was an infant, Steinn Sigurdsson of Pennsylvania State University in State College and his colleagues report in the July 11 *Science*.

The planet's very existence suggests that such orbs formed relatively soon after the Big Bang. Moreover, the object's location—near the crowded core of a star cluster, where planetary systems might easily be ripped apart—indicates that planets might be more abundant than thought.

The planet lies near the center of the globular cluster M4, a dense grouping of stars about 12.5 billion years old. Old stars such as these are metal poor because they formed before subsequent generations of stars had produced heavy elements in abundance. Astronomers have found most extrasolar planets orbiting younger, relatively metal-rich stars. That led astronomers to rate ancient globular clusters as unlikely venues for planets. Indeed, in a 1999 study looking for planets that closely orbit stars in the globular cluster 47 Tucanae, the Hubble Space Telescope failed to find a single one.

But after examining a pair of burned-out stars in M4 with Hubble and a radio telescope, researchers now say that planets may be common in globular clusters after all. They might just be orbiting their parent stars at greater distances than astronomers had looked for in previous studies.

"The conventional wisdom is that high metallicity is required for extrasolar planets to be detected, and we now have a spectacular counterexample," notes theorist Alan P. Boss of the Carnegie Institution of Washington (D.C.). "Clearly, this discovery opens up a lot of turf for searching for more planetary-mass objects, more turf in both



**OLD ORB** Artist's view of the planet (top) orbiting a pulsar and its white dwarf companion (two brightest dots at lower left) in the globular cluster M4.

time and space."

The observations leading to the discovery date to 1988, when astronomers examining M4 discovered a pulsar, a rapidly spinning neutron star that broadcasts radio waves like a beam from a lighthouse. Tiny deviations in the arrival time of the radio waves at Earth indicated that a compact star called a white dwarf is orbiting the pulsar. Further irregularities in the radio signals indicated that yet another body is orbiting the pulsar.

Analyzing Hubble observations of the white dwarf and comparing them with the radio data, Sigurdsson's team determined the mass of the dwarf and the tilt of its orbit about the pulsar. That in turn revealed that the third body is a Jupiterlike planet that orbits the neutron star-white dwarf duo at about the same distance that Uranus orbits the sun.

Sigurdsson's team suggests that the planet initially resided at the outskirts of M4 and probably formed much closer than it is now to its parent star. Somehow, the planet survived the frenzy of star birth in what was then a young cluster, and the star and its planet sank toward the center of M4. A billion or so years ago, the pulsar ejected the companion it had then and captured both the star and its planet. The star then evolved into a white dwarf.

"This extrasolar planet sets several records at once: the oldest, the most distant, the lowest metallicity, and the first one to orbit two stars," says Boss. "Nature continues to astound us." —R. COWEN

### Secrets of Dung

#### Ancient poop yields nuclear DNA

**Researchers have extracted remnants of DNA from an unlikely source: the desiccated dung of an extinct ground sloth that lived in Nevada at the height of the last ice age. The feat is the first recovery of genetic material from cell nuclei of fossils that haven't been sheathed in permafrost. It suggests that scientists may be overlooking caches of fossil DNA preserved in warm arid environments.**

Earlier work on fossils had isolated DNA carried in mitochondria, the powerhouses of living cells. However, the DNA in a cell's nucleus is typically longer and therefore holds much more genetic information about the species and individual from which the cell derived, says Gregory McDonald, a

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## This Week

paleontologist with the National Park Service in Denver.

Now, McDonald and his colleagues have isolated snippets of nuclear DNA from a coprolite—or piece of fossilized dung—of a Shasta ground sloth, a 2.3-meter-long, 350-kilogram herbivore. The coprolite, found in a cave in southern Nevada, may be as much as 15,000 years old, says McDonald. The team's analyses suggest that as many as 4,000 fragments of nuclear DNA measuring at least 100 base pairs in length may be present in each gram of the animal's desiccated feces. The researchers report their findings in the July 1 *Current Biology*.

Scientists using only skeletal characteristics and comparisons of mitochondrial DNA have had trouble discerning the relationships among extinct and living sloths, says McDonald. Some of those studies have suggested that the tree-dwelling lifestyle of all living varieties of two-toed and three-toed sloths evolved only once. Other findings suggest that arboreal living arose separately in two-toed and three-toed sloths.

The newly analyzed differences in nuclear DNA suggest that the Shasta ground sloth is more closely related to living three-toed sloths than to the two-toed varieties, which lends credence to multiple origins of tree dwelling.

The key to the preservation of the Nevada sloth's nuclear DNA was aridity, says McDonald. Lack of humidity desiccated the dung and stymied bacterial degradation of the genetic material in the stable environment provided by the surrounding cave.

The mummifying environment seems to promote long-term preservation of DNA despite the warm conditions, says Julio L. Betancourt, a paleoecologist with the U.S. Geological Survey in Tucson.

In separate analyses of ancient sloth dung from a sheltered ledge outside a cave in the arid foothills of the Argentine Andes, Betancourt and his colleagues may have identified a previously unknown species of extinct ground sloth. Mitochondrial gene sequences extracted from cells in the 16,000-year-old, pecan-size pellets don't match those garnered from the four other living or extinct sloth species that have been genetically sequenced to date.

The Argentine dung fragments are much smaller than those left by the extinct horse-to elephant-size ground sloths already known to have inhabited the region, Betancourt notes. The dung came either from a



**CITY HEIGHTS** Plant ecologist Jillian Gregg stands between cottonwood clones grown in urban sites in the New York metropolitan area (left) and rural sites (right).

species of ground sloth for which bodily remains haven't yet been found or from a species that also lived in another area but that scientists haven't yet genetically sequenced. Betancourt and his colleagues reported their findings in the May *Quaternary Research*. —S. PERKINS

## Double Trees

### City trees grow bigger than country cousins

**A popular tree grows twice as well in the New York metropolitan sprawl as in rural New York State, according to a new test.**

Clones of an Eastern cottonwood (*Populus deltoides*) in the Bronx and other city spots grew to double the biomass of clones planted outside small towns upstate or on Long Island, says Jillian Gregg, now of the Environmental Protection Agency's western-ecology division in Corvallis, Ore.

The growth gap comes from ozone damage, she and her New York colleagues report. Ozone chemists have known that concentrations may spike skyscraper high in city air, but during a full 24 hours, rural trees actually get a higher cumulative ozone exposure from urban pollution that blows in and lingers. A series of new experiments now shows that this hang-around ozone is the overwhelming factor in tree growth, the researchers say in the July 10 *Nature*.

"This study has profound importance in showing us most vividly that rural areas pay the price for [urban] pollution," says Stephen P. Long of the University of Illinois at Urbana-Champaign. "This work should be a wake-up call," he adds.

Earlier studies had fingered car fumes, heavy metals in soils, and other cityscape menaces to plant life. Yet some urban quirks, such as extra warmth and increased concentrations of carbon dioxide, may boost

plant growth.

To see the net effect of these opposing factors, Gregg and her colleagues planted genetically identical cottonwood saplings in farmland outside the small towns of Millbrook, Riverhead, and Upton and in four metropolitan sites. The study is "definitely the first of its kind in considering multiple factors," she says.

For 3 years, the team set out trees in July and harvested them in September. In similar light conditions, the city trees grew faster than the rural ones. Rainfall didn't differ significantly, nor did pest damage.

The boost didn't come from the soil, she concluded. City trees consistently outpaced country trees, even when both were grown in soil that she had brought from the other location. Experiments in growth chambers showed that the benefit didn't come from carbon dioxide or temperature differences.

Since she couldn't explain how the city accelerates tree growth, Gregg says, she searched for plant inhibitors in the country. Of the 18 pollutants she checked, ozone was the only one significantly higher at her rural sites, 28 parts per billion versus 16 ppb in town. That rural dose is typical in the Northeast, she says. When she compared cottonwood growth in open-topped chambers supplied with flows of ozone at a test facility, she found big differences in growth from different ozone abundances.

"We all think of urban areas, with high automobile densities, as sites of great pollution," says Eva Pell of Pennsylvania State University in State College. However, she points out, ozone is famously reactive, and the abundance of other urban pollutants, including nitric oxide, may scrub ozone out of city air.

"That doesn't mean city air is cleaner. It just means it has less ozone—and that's an important distinction," says David Grantz, an air-quality specialist at the University of California's Kearney Agricultural Center in Parlier.

CORNELL UNIV.

Cottonwood trees may not suffer much from other pollutants such as particulates. However, Grantz says, a “hot area of research” now shows that people certainly do. —S. MILIUS

## More Than a Miner Problem

### Asbestos exposure is prevalent in mining community

A new study of the residents of Libby, Mont., confirms that even people who don't work with asbestos can have lung abnormalities caused by the mineral. The “striking, very disturbing” findings indicate that asbestos released from mining or manufacturing operations may pose health threats to entire communities, says Christopher P. Weis of the Environmental Protection Agency in Denver.

Research in the late 1970s linked high rates of the lung cancer mesothelioma among miners working for W.R. Grace & Co. in Libby to their inhalation of asbestos from the town's vermiculite mine. Studies elsewhere found that workers who processed Libby's vermiculite, a mineral used in insulation and potting soil, also have high rates of mesothelioma and other lung problems. The government subsequently issued warnings and regulations to reduce occupational asbestos exposures.

In the early 1980s, the Reagan administration halted investigations of asbestos-related health problems in Libby. The data available at that time didn't indicate to environmental regulators that non-occupational exposures to asbestos could be dangerous.

Renewed investigations, spurred in part by newspaper reports about health problems among Libby residents, have “changed our perspective on that completely,” says Weis. Libby residents, he says, “have clearly been exposed to high concentrations of asbestos and [consequently] are at higher risk for both noncancer and cancer-related disease.”

Since 1999, Weis and his colleagues with the Agency for Toxic Substances and Disease Registry in Atlanta and other government agencies have X-rayed the lungs of 6,668 people who had lived in Libby for at least 6 months before 1991, by which time vermiculite mining had ceased there. The volunteers also answered questions about whether they had participated in any of 29 activities that might have exposed them to asbestos. These included working in the town's mine, living with a miner, using vermiculite insulation, and playing on a ball field near a vermiculite plant.

The researchers found that the more asbestos-linked activities a volunteer reported, the more likely that person was to have abnormalities in the pleura, or lining, of the lung. Scientists consider pleural abnormalities indicative of asbestos exposure. Ten percent of residents with one reported route of exposure showed pleural abnormalities on their X rays, while nearly 20 percent of those with six or seven routes of exposure—and 35 percent of those with 12 routes or more—showed similar abnormalities.

Even residents who couldn't recall participating in any activities that might have exposed them to asbestos had a 6.7 percent chance of having pleural abnormalities, the researchers report in an upcoming *Environmental Health Perspectives*. That incidence is the highest reported to date among people who don't work with asbestos.

The study confirms that dangerous asbestos exposure in Libby extended beyond workplaces, says William S. Beckett, who studies environmental medicine at the University of Rochester in New York. Precisely how much disease resulted or is likely to develop from community exposure to asbestos isn't yet certain because most pleural abnormalities don't actually interfere with lung function, Beckett adds.

“Community exposures can't be

ignored,” says Philip Harber of the University of California, Los Angeles. What's more, since threats from asbestos may linger in an environment long after mining or processing of asbestos-containing material ceases, Harber says the new findings imply that “asbestos concerns are not just a thing of the past.” —B. HARDER

## DNA Differences Add Risk

### Altered genes show up in Lou Gehrig's disease

Scientists' best efforts have failed to vanquish amyotrophic lateral sclerosis (ALS). There was no cure for the nerve-degenerating disease when it struck down baseball star Lou Gehrig 64 years ago, and there is none today. In fact, scientists have yet to pinpoint a cause of the disease except in individuals with certain rare genetic mutations.

In the August *Nature Genetics*, researchers report on other, more common genetic variations that crop up in ALS patients more often than they do in healthy people.



### Soft blow hardens Columbia-disaster theory

On Monday, NASA brought a dramatic conclusion to tests aimed at determining why the space shuttle Columbia disintegrated on Feb. 1, killing all seven crew members. A block of foam insulation fired from a gun at more than 800 kilometers per hour smashed this unexpectedly large hole in a shuttle wing panel. After the test, officials said that the damage was a “smoking gun” that appeared to confirm investigators' leading theory of what caused Columbia's breakup (*SN*: 5/17/03, p. 308). In recent months, the investigation has increasingly focused on an errant piece of foam insulation from the shuttle's external fuel tank. The new test provides vivid evidence that foam seen crashing into a heat-resistant panel on the spacecraft's left wing during liftoff could have punched a hole big enough to allow superheated air to enter and destroy the wing during the craft's reentry. Measuring the hole is NASA contractor Dan Bell. —P. WEISS

# SCIENCE NEWS

## This Week

Experiments show that similar genetic variations leave mice vulnerable to the sort of nerve degeneration seen in ALS patients, says Peter Carmeliet of Leuven University in Belgium.

He and his colleagues compared genetic profiles of 750 ALS patients with those of 1,219 healthy people of similar age in Belgium, Sweden, and Great Britain. The people with ALS were nearly twice as likely to have one of two variant forms of a gene for the protein called vascular endothelial growth factor (VEGF).

Scientists suspect that many genetic and environmental factors contribute to ALS. However, until recently, there had been little reason to connect VEGF with the disease. The main job of VEGF is to trigger blood vessel growth. But recent studies have revealed that VEGF also has a role in protecting neurons that are stressed because they have too little oxygen. Indeed, the VEGF gene switches on in response to oxygen deprivation.

The three variants that Carmeliet's team has linked to ALS show up in the gene's promoter region, the piece of DNA that activates the rest of the gene.

ALS destroys neurons—in particular, those that control muscle movement. Some evidence suggests that this motor-neuron damage in ALS stems from a lack of oxygen.

Two years ago, Carmeliet's team reported that mice lacking the oxygen-sensing part of the VEGF gene showed motor-neuron damage. Other researchers have shown that normal VEGF can hold off degeneration of neurons starved of oxygen while growing in a lab culture.

Motor neurons are susceptible to running short of oxygen because they are “very large neurons which have to work hard to transmit signals over very long distances,” Carmeliet says.

To test whether VEGF protects oxygen-deprived neurons, the European team compared two sets of mice. All were susceptible to ALS-type disease, but some had been bred to have a VEGF gene with a promoter defect. After the scientists shut off blood—and therefore oxygen—flowing to part of the spinal cord, those mice harboring the defect showed significantly more paralysis than the others did.

The mouse experiment suggests that the link between VEGF and ALS seen in the European population study has a biological basis, says David A. Greenberg of the Buck Institute for Age Research in Novato, Calif. A shortage of VEGF “is not neces-

sarily causing ALS, but it is somehow increasing the risk for it,” he says.

“This is a beautiful study [that will] spur basic neuroscientists to study VEGF much more than they have in the past,” says Solomon H. Snyder of Johns Hopkins Medical Institutions in Baltimore. “Researchers are going to jump all over this.” —N. SEPPA

## Digging for Fire

### Burning peat underlies Mali's hot ground

In regions of northern Mali, the parched ground is punctuated with smoking, glowing holes that reach 750°C at their rims. Locals have long attributed the appearance of these holes and the superheated ground around them to evil spirits or, in a more scientific vein, to volcanic activity. But Norwegian geologists have found that a less truculent force is at work. A seam of peat-like material is smoldering about 2 feet below the surface.

The geologists, from the University of Oslo and the Volcanic Basin Petroleum Research group in Oslo, carried out their study at the invitation of Mali officials, who worried that a recent intensification of the phenomenon could presage a volcanic eruption.

“For the first 3 days of our expedition, we were mapping what we thought was hydrothermal-vent activity from volcanism,” says Dag Kristian Dysthe of the University of Oslo.

But the slow, uniform migration of the underground heat in what appeared to be a “heat front,” was not typical of volcanic activity, Dysthe says. In a 10-month period,

the front scorched a 2-square-kilometer area of rich vegetation as it advanced toward a village at a rate of several centimeters per hour.

To uncover the heat source, the geologists conducted a simple experiment: “We dug a hole,” Dysthe says.

With members of the Tuareg tribe gathered around, the scientists dug a 3-foot-deep trench, revealing the fire below. They took samples of the burning material and found that it was like peat, but with an 8 percent organic content—one-sixth that of normal peat deposits. They report the findings in the July *Geology*.

“I was surprised the deposits caught fire at such a low carbon content,” comments Susan Page of the University of Leicester in England. Because of the low carbon content, she says, the carbon dioxide and other gaseous emissions from the Malian fires are much lower than those from peat- and coal-seam fires in places such as Indonesia and Pennsylvania (*SN: 5/10/03, p. 298*).

The volcanic description of the region comes from French naturalist Theodore Monod who, in the 1960s, erroneously identified rocks there as coming from magma—even though the region is a craton, a geological zone where scientists wouldn't expect to find volcanic activity. Dysthe says that the survival of Monod's theory is “a good story in the sociology of science.” Scientists following up on the work of Monod, a respected authority on the deserts of West Africa, didn't question his theory.

The debunking of the volcanic theory was heartening news for the local people. No one has ever stopped volcanic activity, but it might be possible to contain subterranean peat fires, which can burn for years and render vast tracts of land unusable, Dysthe notes. —S. MCDONAGH



**SPIRIT, LAVA, OR FIRE?** A Tuareg tribesman stands by a smoking hole previously suspected to be caused by volcanism but now known to be caused by subsurface peat fires.

VOLCANIC BASIN PETROLEUM RESEARCH

# UDDER BEAUTY

Ensuring that dairy queens are selected for their natural splendor

BY JANET RALOFF

**T**he scourge of udder tampering has not escaped the attention of humorist Dave Barry. In one of his columns, he laments unscrupulous dairy farmers who inject foreign udder-enhancing substances into their animals' mammary glands in a desperate bid for a competitive edge at livestock shows. Barry likens these competitions to human beauty pageants, except that the cows get no credit at all for being smart or having nice personalities.

Alas, udder fraud is no laughing matter to people who make their living raising and marketing Holsteins and other dairy breeds. Because grand champions and their progeny command a high price, "there's a lot of money at stake," notes David Kendall, executive secretary of the Brown Swiss Association in Beloit, Wis.

Forty percent of a cow's score in the showing traces to the shape, size, and feel of her udder. The judging values no other part of the body as highly. The reasoning is simple: In dairying, Kendall explains, "that's where we make or lose our money." This focus invites fraud, and many of the perpetrators are good at evading detection.

About 5 years ago, concerned that the rumored pervasiveness of this problem was beginning to scare away honest competitors, dairy associations began recruiting veterinary experts to develop fraud-busting tactics.

Veterinary radiologist Robert T. O'Brien of the University of Wisconsin-Madison is one of those who entered the fray. "We had published an article describing the appearance of diseases in the udder as viewed by ultrasound," he notes. When a colleague in the veterinary school read the article in 1998, he popped into O'Brien's office and asked him for a consult on the possibility of screening show animals for evidence of injected gas in their udders. "We didn't know what we were getting into," O'Brien says. "Now, we've become the infamous udder-ultrasound dudes."

He and his colleagues found that ultrasound examination could reveal fraud at shows. After putting the technique to work in Wisconsin, they've now begun training a cadre of veterinarians around the world to test for fraud.

Under O'Brien's team's aegis, the Brown Swiss Association will this year institute mandatory udder screening for all champions in its five national competitions—beginning with the All American Dairy Show, Sept. 26, in Harrisburg, Pa. Holstein Association USA of Brattleboro, Vt., the world's largest dairy-breed group, is

considering a similar screening requirement for all national champions in the 11 shows it sponsors.

As with drug testing of Olympic athletes, O'Brien says, screening of udders will probably become a permanent fixture of dairy competitions. Since a major Wisconsin fair began ultrasound tests of its winners 4 years ago, he says, the incidence of cheating has fallen dramatically—although new tricks emerge all the time.

"We never get ahead," O'Brien says, "but we do try to keep up."

**BIG BUCKS** In dairy shows, the champion usually gets a purple ribbon and its owner takes home a \$50 to \$100 check. Such "pocket change" will cover only a fraction of what it costs to get an animal to the show and pay for a family's several-day stay, notes Peter Cole of Holstein Association USA. The real financial benefit comes from marketing a champion or its offspring, he says.

Some people enjoy owning a cow that's recognized for its superior appearance, and they'll pay up to \$600,000 for it, Kendall says. These animals are "living, breathing pieces of art, like dogs or any other exhibited species," he argues. However, he adds, as with dogs, "selling offspring is where you make the most money." How much you can get for offspring of "dairy queens," depends on the superiority suggested by the parent having won contests, Kendall says.

Consider the market for cow embryos. Farmers administer fertility drugs to prize cows and then artificially inseminate them. A week later, experts flush out fertilized embryos and freeze them until they're sold for implantation in surrogate mothers.

"Cows that are extremely good flushers produce 35 to 40 embryos at one time," Kendall says. Each embryo from a ribbon-winning cow can yield a farmer \$5,000 or more. However, if an embryo comes from an animal that won a championship through fraud, Kendall says, "you may be buying a bogus genetic package because the quality of the [parent] is not as good as was represented."

That's one reason Ohio passed its Livestock Show Reform Act in 1995. It was the first law to make livestock tampering a felony, Kendall says. The state spends \$150,000 to \$200,000 a year on testing and investigations.

Indeed, boasts Fred L. Dailey, Ohio's director of agriculture in Reynoldsburg, his investigations under this law have sent several people to prison. Additional scofflaws have had to buy full-page advertisements in national livestock magazines showing their pictures along with an acknowledgment that they cheated. Many have also been sentenced to community service and banned from competing for several years.



**DAIRY VALUE** — At competitions, judging focuses on the udder, the business end of the cow.

**GAS 'ER UP?** The practice of sprucing up animals is part and parcel of showmanship. No one begrudges a farmer or 4-H youth wanting to make a cow look its best. Groomers will wash an animal and trim its hairs so that judges get a good look at the cow's ribs, withers, and hips. Some groomers rub talcum powder into stains on a white animal or shoe polish onto her hooves to make them shiny black.

Such preening is allowed. Administering drugs, such as steroids, or giving injections is not. That's why analysis of urine has become routine at big fairs.

But only some forms of tampering are evident in urine samples. Injections of gas into the udder, for example, aren't.

Until 2000, cheats frequently injected into the udders of perfectly healthy show cows an antibiotic drug for mastitis, a condition in which milk ducts become inflamed. The antibiotic's delivery system relies on a propellant—*isobutane*, the fuel in cigarette lighters—that can subtly alter an udder's contours.

One spritz and a quadrant of the udder that might have been a tad small, somewhat misshapen, or asymmetrical, can be cosmetically corrected. Urine tests don't reveal that drug.

O'Brien's studies have now shown that even radiological clues to such primping with compressed gas are gone within 72 hours. But in an ultrasound scan conducted immediately following the ribbon ceremony, the doctoring showed up as distinctive black streaks penetrating from just below the skin down to bubble-shaped patterns deep within the tissue (<http://www.sciencenews.org/20030712/bob8.asp#vetsees>). O'Brien found that in the first years of experimental udder scans—before judges began booting crooks from the showing—the incidence of injected gas was between 30 and 40 percent among the top-judged cows.

No sooner did he publish analyses showing how to diagnose this tampering than did the incidence of such knavery drop to a mere 5 percent—at least in shows that had advertised the Wisconsin team would be screening winners. In fact, O'Brien observes, “we hadn't seen a single case since 2000—until this April, when we stumbled on a lone instance.” Some people performing the scans “didn't even recognize [the telltale pattern],” he says, “because it had been so long since we'd seen it.”

Which reinforces, he says, the need for vigilance.

The current rarity of gas injections doesn't mean cheating has ended. Scoundrels have embraced a newer trick: injection of so-called mild silver protein. This liquid concoction—a purported remedy for infections that is widely available over the Internet—triggers a localized inflammation that induces swelling. By targeting the size of injections, their number, and their placement, a cow's owner can subtly reshape an udder.

O'Brien and his radiology colleagues have had their eye on this development. In tests, they injected the silver formulation at 17 sites in a half-dozen lactating cows, imaged each animal's udder with ultrasound, and then asked an outside expert to pinpoint signs of the treatment on sonograms. In the Aug. 1, 2002 *Journal of the American Veterinary Medical Association*, O'Brien's group reported that every injection site had been found, with no false positives. The irritant caused an unusual “corrugated appearance,” the researchers note, that showed up on the ultrasound images as alternating white and black bands (*see URL above*).

In a subsequent test, O'Brien established that this diagnostic pattern generally persists for nearly 5 days but can last up to 16.

Injecting saline is an older trick for pumping up udders. “We wouldn't be able to pick it up on ultrasound,” O'Brien says. So, he

emphasizes, livestock shows need to employ several types of tests. For instance, saline injections show up as reductions in glucose concentrations in milk.

To screen for such manipulations in major Ohio championships, “after each dairy show, we'll milk out each quarter [of a champion's udder] and test that milk,” notes Dailey.

**STEER CLEAR OF THESE** Fraud in livestock competitions isn't limited to well-endowed cows. The stakes are especially high in steer contests, where an auction of the winning animal often immediately follows the judging. The high bidder writes a check for up to \$75,000 to the farmer or a 4-H teenager who raised the animal, and then the buyer dispatches the prized purchase to a butcher. Traditionally, premium bids have been a vehicle for providing farm kids with college funds.

Nine years ago at the Ohio State Fair, 7 of the top 10 class-champion steers—animals from which the grand champion and its runner-up were chosen—showed evidence of tampering. The first clue? “A state meat inspector noticed some oil dripping out of a [slaughtered] steer—and it was not animal oil,” Dailey recalls.

Carcass examinations showed that most of those champions had been injected with vegetable oil to improve the appearance of their musculature or received clenbuterol, an asthma medicine that in livestock improves the conversion of feed into muscle instead of fat.

In other instances, judges have found evidence of surgery in beef cattle to pare down muscle in the “brisket” region, or upper chest, to give them what Dailey describes as “a cleaner front end.” When asked about telltale scarring, he says, the owners will claim that the cow got caught in a barbed wire fence.

Hog farmers apparently resort to yet other deceitful tactics. “Right now,” Dailey says, “I'm handling a case where testicular tissue was found in a barrow”—a supposedly castrated hog. “That may not sound too serious,”

he says, “but it's a big advantage for it to have male hormone.” It helps the animal bulk up on muscle.

When the first case turned up a few years back, judges suspected it was a rare, natural instance where one testis failed to descend from the abdomen. “But the next year,” Dailey says, “we had 3 of these in the top 10 animals.” It's now clear, he says, that “sometimes people perform operations on the animals to push [the testes] back into the body cavity.”

Other illegal tricks include: ice enemas to make a sheep's muscles contract, temporarily producing firmer loins; beating a sheep or steer in select areas to create swelling that improves the body's contours; or bleeding a steer and storing its blood for later reinjection into muscles as a way to make them look beefier. Some exhibitors have even been caught snaking a hose down their steer's mouth right before showing, to give the animal the appearance of more weight gain.

Unlike dairy winners, other livestock champions usually go directly to slaughter. In Ohio, “As soon as a judge slaps an animal on the butt and says he's the champion, our people are out with collection cups to take urine,” Dailey says. “We maintain a chain of custody on those samples and the animal itself—to the packing plant.” There, meat inspectors have an opportunity to probe the entire animal—and stretch the hide to look for signs of an injection. Some veterinary researchers are developing biochemical assays to detect more subtle signs of tampering.

Dailey and O'Brien both see a never-ending challenge in sleuthing out the dirty tricks. ■



**LOOKING FOR TROUBLE** — Robert T. O'Brien demonstrates the ultrasound scanning that is being phased in this year at many dairy competitions.



# ALL THE WORLD'S A PHAGE

Viruses that eat bacteria abound—and surprise

BY JOHN TRAVIS

**S**maller than bacteria, some of them look like microscopic spacecraft. You can find them almost anywhere: under a rosebush or miles out to sea. These strange entities are bacteriophages, viruses that prey upon bacteria, and there's a staggering number of them. A pinch of soil or drop of seawater, for example, contains many millions of bacteriophages.

"They're nature's most successful experiment," says Marisa Pedulla of the University of Pittsburgh. "They outnumber all the bacteria, all the humans, whales, trees, et cetera, put together."

Bacteriophages, also known simply as phages, came to light around 90 years ago, when two European scientists independently discovered that there are viruses that kill bacteria. Like an Apollo spacecraft landing on the moon, these viruses settle onto the surface of a bacterium. Next, they inject their genes. They reproduce inside the microbe, and eventually their multitudinous descendants explode out of the host.

One of the discoverers of these odd viruses was Felix d'Herelle of the Pasteur Institute in Paris. He coined the word *bacteriophage*, which translates to "eater of bacteria," and began to promote the viruses as treatments for infectious diseases, such as cholera and bubonic plague, caused by bacteria.

Because of inconsistent results, phage therapy never took root in the United States, especially after powerful antibiotics such as penicillin emerged. Yet many physicians in the former Soviet Union continue to use bacteriophages. And with the rise of antibiotic-resistant bacteria, some investigators and biotech firms in the United States are trying to resurrect d'Herelle's dream (*SN*: 6/1/96, p. 350).

Bacteriophage researchers, however, say that these viruses are of interest beyond medicine. At this year's American Society for Microbiology meeting in Washington, D.C., in May, bacteriophages dominated the agenda of several symposia, only one of which was focused on medical therapy. Several talks concen-

trated on the total number of bacteriophages in nature and their impact on bacteria and the environment in general. Another series of lectures revolved around phages that can make bacteria more virulent (see box, page 27). And a number of talks made the point that bacteriophages have an amazing amount of genetic diversity and possess an untold number of novel genes.

Bacteriophages represent a "vast, untapped wealth of genetic information," says Pedulla. They're "the pinnacle of creation," adds Pedulla's colleague Graham Hatfull, a Howard Hughes Medical Institute investigator at the University of Pittsburgh. "Phages represent the major form of life in the biosphere."

**THEY'RE EVERYWHERE** Bacteriophages are drawing renewed interest in part because scientists are only now coming to appreciate how many of these viruses exist. It was just over a decade ago that scientists realized the amazing number of phages

in oceans, Curtis Suttle of the University of British Columbia in Vancouver recalled at the recent microbiology meeting. The realization occurred after several investigators training powerful transmission electron microscopes on drops of seawater and that viral particles, most of them bacteriophages, flooded the images.

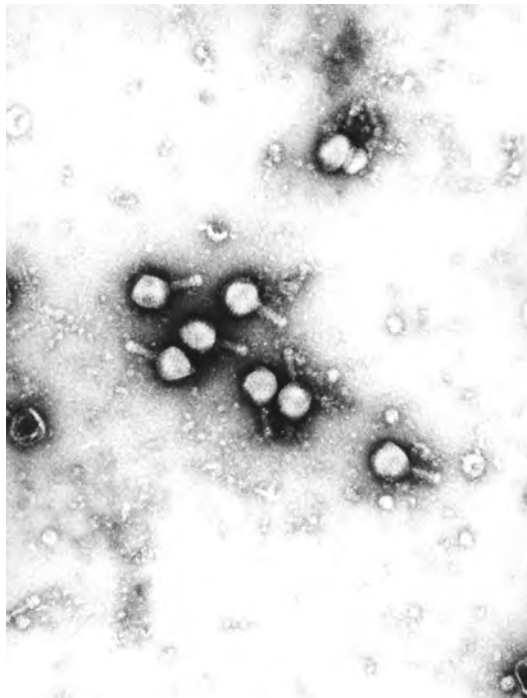
"Believe it or not, nobody had looked before," says Suttle. "On average, there are 50 million viruses per milliliter in seawater. The question is, What the heck they're doing there?"

Microbiologists then documented similar, and even higher, concentrations of phages in soil samples. This led to estimates of  $10^{31}$  bacteriophages worldwide, a staggeringly large number that many scientists initially dismissed. "We can't wrap our brains around it," says Pedulla. "If phages were the size of a beetle, they would cover the Earth and be many miles deep."

An independent line of reasoning, however, lends support to such a phage tally. Other microbiologists have recently estimated the planet harbors  $10^{30}$  bacteria. If there are 10 phages for every bacterium, a reasonable assumption according to Hatfull, then  $10^{31}$  is

a fair estimate for the number of bacteriophages in the world.

These plentiful viruses could have a profound impact on their environment, especially in water. According to estimates put forth by Suttle, phages destroy up to 40 percent of the bacteria in Earth's oceans each day. In doing so, bacteriophages may influence the oceans', and perhaps the entire world's food sup-



**PHAGE POWER** — Bacteriophages, such as these, infect bacteria all over the planet. The abundance and diversity of these bacteria-killing viruses has stunned scientists.

JACOBS

ply by limiting the volume of bacteria available for other organisms to eat. Bacteria destroyed by phages fill the water with organic matter that's either consumed by other bacteria or settles to the ocean floor.

"If we've got 40 percent of bacterial cells dying each day, that's certainly going to be important to carbon cycling," says Suttle. Viruses are "major players" in the global exchange of carbon between organisms and the environment, he says.

"Phages, being so numerous and such excellent predators of bacteria, are going to be very involved in bacterial turnover. That's a large amount of carbon being recycled," agrees Pedulla.

**WHAT'S INSIDE** Almost as staggering as the number of bacteriophages is their genetic diversity, according to scientists at the microbiology meeting. "Phages are probably the most diverse things on the planet," says Forest Rohwer of San Diego State University.

**"Phages represent the major form of life in the biosphere."**

—GRAHAM HATFULL

DNA-analysis techniques, having a single copy of a phage doesn't permit a complete reading of its genome, but the investigators can determine the sequence of a few fragments of its DNA. With this approach, Rohwer and his colleagues com-

Scientists usually study a phage's DNA after it has reproduced within a bacterial host. This provides many copies of a phage's genome, enabling researchers to read the virus' full genetic sequence. The strategy, however, may limit the types of phages examined, since up to 99 percent of bacteria have yet to be grown in a laboratory environment.

Rohwer's group has instead directly isolated individual bacteriophages free-floating in the ocean waters around San Diego and La Jolla, Calif. Given current

## Phages Behaving Badly

Viruses can control how dangerous some bacteria are

**F**or almost a century, some physicians have championed the medical uses of bacteriophages, but others have been sobered by these viruses' darker side. Acting as gene-delivery vans, phages can shuttle genetic sequences among different bacterial species and strains—and that can be bad news for people.

Not all phages destroy the bacteria they invade—at least not immediately. Some infect bacteria and then lie dormant. The phages sometimes insert their own genes, and any they've acquired by reproducing inside other bacteria, into the chromosomes of their new host. These phage-delivered genes make some bacteria dangerous, scientists have found.

In the 1950s, for example, investigators realized that the bacterium *Corynebacterium diphtheriae* causes the upper respiratory illness known as diphtheria only if a certain bacteriophage infects the microbe. The phage, in fact, contains the gene for the toxin that triggers diphtheria. A similar story emerged in the 1990s for cholera. This deadly disease is attributed to infections by *Vibrio cholera*, but it's actually bacteriophages genes inside the bacterium that carry the instructions for cholera toxin (*SN: 6/29/96, p. 404*).

More recently, James M. Musser of the National Institute of Allergy and Infectious Diseases in Hamilton, Mont., and his colleagues have fingered phages as co-conspirators with bacteria known as group A *Streptococcus* (GAS) in illnesses ranging from simple sore throats to heart-damaging rheumatic fever and deadly toxic shock syndrome. When the researchers probed the full genetic sequences, or

genomes, of several GAS strains, they were surprised to find that a significant part of each one's genome consists of phage genes. Indeed, bacteriophages are the major source of genetic differences among GAS strains and seem to account in large part for strain differences in virulence, Musser reported in May at the American Society for Microbiology meeting in Washington, D.C.

Last year, for example, his team determined that the GAS strain M18, which causes acute rheumatic fever, contains phage genes that encode toxins, but that another strain, which causes strep throat, doesn't have those genes (*SN: 3/30/02, p. 198*). The investigators also reported in the July 23, 2002 *Proceedings of the National Academy of Sciences* that M3, an unusually deadly strain of GAS that produces toxic shock syndrome, has yet a different set of phage genes. And in the Feb. 18, 2003, issue of that journal, Musser and his colleagues revealed that when certain immune cells begin to engulf GAS bacteria, the microbes activate several phage-derived genes. The function of these genes remains unknown, but they appear to be part of the bacterium's coordinated response to avoid destruction.

Scientists have also recently discovered that bacteriophages may do more than just hand over toxin genes to a bacterium—sometimes, they control the release of those toxins. Take the case of *Escherichia coli*, a normally harmless gut bacterium. Strains of *E. coli* that produce a molecule known as Shiga toxin can cause a deadly form of food poisoning. The Shiga-toxin gene turns out to be a part of a phage genome that has integrated itself

into the DNA of some *E. coli* strains. The toxin gene becomes active only when phage begin to reproduce inside an *E. coli*, says Matthew K. Waldor of Tufts University School of Medicine in Boston.

Moreover, intact bacteria carrying the gene don't secrete Shiga toxin into people. It's the rupture of the bacterial cells by phages that releases the toxin, Waldor and his colleagues report in the May 2002 *Molecular Microbiology*. If there's a mutation in the gene that the bacteriophages use to disrupt bacterial membranes, the toxin merely builds up inside the *E. coli*.

"Phages not only disseminate virulence genes but also regulate the production of the virulence factors," says Waldor.

This discovery has brought a disconcerting fact about certain antibiotics to light. Fluoroquinolones, the class of antibiotics that includes the anthrax-fighting drug Cipro, actually trigger the activity of phage genes—and thus can increase production of Shiga toxin, notes Waldor.

In the June *Infection and Immunity*, John F. Prescott of the University of Guelph in Ontario and his colleagues say that fluoroquinolones also induce the activity of a phage genome that typically lies dormant within *Streptococcus canus*, a bacterium that normally harmlessly infects dogs and some other animals. The recent use of these antibiotics in dogs may therefore explain why veterinarians have recently reported some severe cases of toxic shock syndrome and flesh-eating infections in dogs infected with *S. canus*.

Prescott wonders, "Is our use of certain antibiotics helping to spread phages, which may also encourage the spread of virulence genes?" —J.T.

piled nearly 2,000 of these partial sequences from seawater phage genomes and ran them through a computer database of all known genetic sequences of plants, animals, fungi, bacteria, viruses, and other microbes. Only 28 percent of the phage sequences bore similarities to previously documented genes. "Most phages' sequences are unknown," concludes Rohwer.

With the help of high school students in Pennsylvania and New York, Hatfull and Pedulla have reached a similar conclusion. Working with William R. Jacobs, a Howard Hughes Medical Institute investigator at Albert Einstein College of Medicine in New York, and Jacobs' sister, Debbie Jacobs-Sera, who is a high school biology teacher in Pennsylvania, Hatfull and Pedulla asked the teenagers to take soil samples.

The students collected soil from barnyards, gardens, and even the monkey pit at the Bronx Zoo. The scientists then taught the students how to isolate a bacteriophage from the soil by growing the viruses in *Mycobacterium smegmatis*, a harmless bacterial relative of the microbe that causes tuberculosis.

"We guarantee them that the bacteriophage they find will never have been discovered before. We know that because the diversity is so high, and we've never isolated the same bacteriophage twice," says Hatfull.

In the April 18 *Cell*, Hatfull and his professional and teenage collaborators describe the genomes of 10 soil-dwelling bacteriophages that they had isolated. Of the more than 1,600 genes that the team identified, about half are novel, that is, they don't match any previously described genes in any other organism. "For a very large number of genes, we just don't have a clue what

**"Phages are probably the most diverse things on the planet."**

—FOREST ROHWER

they do. They don't look like anything else we've seen before," says Hatfull.

The University of Pittsburgh team has also recently deciphered the DNA sequence of a bacteriophage with a relatively massive genome. Known as bacteriophage G, this virus has nearly 700 genes, many more than some bacteria. And the proteins encoded by almost 500 of those genes don't match any known proteins, the scientists discovered.

Equally bewildering, however, are some of the newfound bacteriophage genes that do have matches. One phage contains a gene for a molecule that resembles a human protein called Ro. People with the autoimmune disease known as lupus often have antibodies to Ro, Hatfull points out.

The phage finding raises the possibility that the virus has a role in lupus. There's been conflicting evidence about whether bacterial infections can trigger the disorder, notes Hatfull. Perhaps, he says, it takes the combination of a bacterium and a certain phage.

Another genetic puzzle comes from a phage called Rosebush, which a high school student isolated from the soil around such a plant. It has two genes resembling those used by many animal immune systems to defend against mycobacterial infections such as tuberculosis and leprosy. Other phages contain genes for proteins that the mycobacteria produce to manipulate immune responses in their hosts. All these phage genes may influence how the microbes cause illness, the scientists suggest.

"We see these [genes], and we don't know what they do or why they're there. Speculation becomes rife," says Hatfull. "All we can say is that there are genes that we didn't really expect" in bacteriophages.

If that sounds as if Hatfull is saying that he and his colleagues remain largely ignorant when it comes to phages, so be it. "I can't think of a better word to describe our state of knowledge of the bacteriophage population," he admits. "We are thoroughly ignorant." ■

# BEAT THE HOUSE

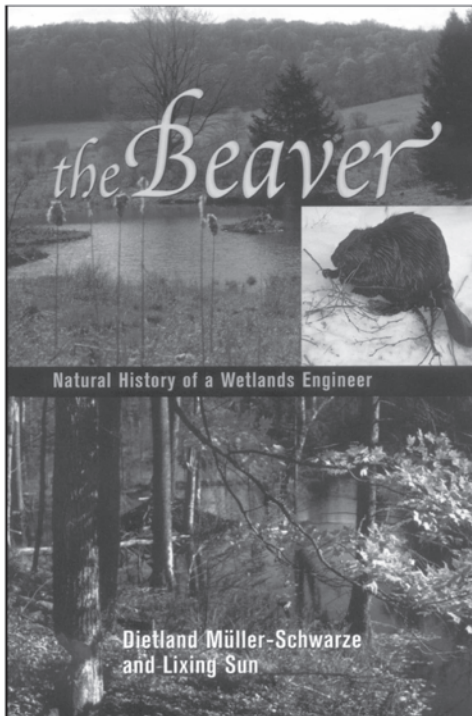
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# OF NOTE

## ZOOLOGY

### Flight burns less fuel than stopovers

The first measurements of energy use in migrating songbirds have confirmed a paradox predicted by some computer models of bird migration: Birds burn more energy during stopovers along the way than during their total flying time.

Martin Wikelski of Princeton University and his colleagues monitored 38 Swainson's and hermit thrushes during the nights of their spring migration through the northern United States. The researchers injected the radio-tagged birds with chemical-isotope tracers that enabled the scientists to measure the birds' metabolism. The team members spent their nights driving a car, trying to keep up with a tagged bird. "We got stopped by a cop just about every night, not because we were speeding, but because they wanted to know what somebody was doing in a little town in Wisconsin at 4 a.m. with a giant antenna on the roof of a car," says Wikelski.

A dozen birds took night flights covering up to 600 kilometers. The rest stayed put. The scientists determined that the birds that flew burned 71 kilojoules of energy on an average night's flight of 4.6 hours. The birds that didn't fly burned energy at 88 kJ per day.

Since the birds spent about 24 days and nights on stopovers during a typical 42-day journey from Panama to Canada, actual flying consumed only 29 percent of the total energy budget for the migration, Wikelski and his coworkers report in the June 12 *Nature*. —S.M.

## BEHAVIOR

### U.S. survey probes depression care

More than half of all people with major depression now seek treatment for the disorder, up from about one-third a decade

ago. Even so, only 1 in 5 depressed people receives adequate antidepressant medication and psychotherapy, according to a national survey in the June 18 *Journal of the American Medical Association*.

The findings underscore the need for more-aggressive depression treatment and more referrals by primary-care physicians, who care for most people with major depression, concludes a team led by sociologist Ronald C. Kessler of Harvard Medical School in Boston.

In 2001 and 2002, the researchers interviewed a national sample of 9,090 adults, ages 18 and older. Major depression was diagnosed on the basis of the presence of symptoms such as extreme sadness, insomnia, and loss of interest in all activities.

About 16 percent of the sample, representing around 34 million people in the United States, had at some time suffered from major depression. In the year before being interviewed, 6.6 percent, representing 13.5 million people, suffered bouts of major depression. That roughly matches an earlier estimate of the prevalence of depression (*SN*: 2/16/02, p. 102).

Major depression often interfered with daily functioning at home and at work, especially for the half of the depressed sample who exhibited severe symptoms.

Past research indicated that primary-care physicians often regard supportive counseling as better than medication in treating mild-to-moderate depression (*SN*: 3/11/95, p. 148). Physicians on the front lines need better studies of the effectiveness of specific antidepressants and psychotherapies, especially for severe depression, remarks physician Thomas L. Schwenk of the University of Michigan Medical Center in Ann Arbor. —B.B.

## BIOCHEMISTRY

### Let there be light

Many scientists suspect that ribonucleic acid, or RNA, preceded DNA and served as life's first genetic material. Yet it's never been clear how long strands of RNA, or DNA for that matter, could form in the harsh conditions of the primordial Earth, especially under the intense ultraviolet (UV) light that flooded the planet. Instead of being a barrier to RNA creation, however, UV light might actually have been a help, a new study suggests.

When the planet formed, there was no

ozone layer, so the amount of UV light hitting the surface was about 100 times what it is today. Most origin-of-life researchers argue that such a bombardment would destroy fledgling organic molecules unless they were hidden underwater or otherwise protected.

"The existing theories consider the high UV level as a major obstacle and offer several different strategies for hiding the first life forms from it," says Michael Y. Galperin of the National Center for Biotechnology Information in Bethesda, Md., and two of his colleagues. They challenge that notion in a paper published online May 28 in *BMC Evolutionary Biology*. "Here, we invoke the alternative possibility that UV irradiation played a positive role in the origin of life," they say.

The researchers note that the nitrogen-containing bases that are a part of RNA and DNA molecules are "powerful quenchers" of UV light. That is, these bases can absorb the radiation and quickly dissipate its energy, thus protecting the more vulnerable sugar-based backbone of RNA and DNA molecules. In computer simulations, UV light favors the creation of strands of nitrogen-containing bases over other organic molecules, Galperin and his colleagues found. —J.T.

## BOTANY

### Crop genes diffuse in seedy ways

Sugar beets in French farm fields are less likely to spread their genes to wild relatives by wafting pollen than by releasing seeds that people unintentionally transport, according to a new genetic study. The finding could complicate debates about the threat of gene transfers from genetically modified crops.

Most previous studies of gene escapes have focused on pollen straying far and wide, says Jean-Francois Arnaud of the Université de Lille 1 in France. Arnaud and his colleagues decided to look at seeds as well as pollen as vehicles of gene transfer.

The scientists studied sugar beets, a wind-pollinated crop that is cultivated widely in northern France. A weedy subspecies, called a sea beet, grows wild along the region's coast and can cross with its cultivated cousin.

Arnaud's team collected beet plants from a commercial field, the coast, and a riverbank between the two that might serve as a mixing zone. To check for pollen-introduced genes in the beets, the researchers looked for particular patterns of DNA



**NIGHT FLYER** A thrush wired for radiotracking.

# OF NOTE

markers in the cell nuclei. To find seed-introduced maternal genes, the researchers looked for a stretch of DNA that pollen doesn't carry but that does show up in the chloroplasts of seeds.

Very little evidence showed up for pollen that had escaped from cultivated beet fields, the researchers report in an upcoming issue of *Proceedings of the Royal Society of London B*. However, about a third of the riverbank plants showed signs of DNA descended from seeds of cultivated plants.

The result is "highly unexpected," Arnaud says. It indicates, he explains, that people may be dispersing the seeds far and wide via muddy tires and other low-profile means. —S.M.

## NEUROSCIENCE

### Adults' brains show temperamental side

Using brain-imaging techniques, psychologists have identified possible neural locations underlying shyness or gregariousness.

Thirteen people in their early 20s whom the psychologists had categorized as inhibited during infancy displayed much more amygdala activity when shown new faces versus familiar ones, say Carl E. Schwartz of Massachusetts General Hospital in Charlestown and his coworkers. In contrast, nine young adults who were uninhibited as infants didn't show this difference in amygdala responses to novel and recognizable faces, the scientists report in the June 20 *Science*.

The amygdala, an inner-brain structure involved in regulating emotions, responds to novel social cues differently depending on the extent to which a person is reserved or outgoing, Schwartz's group theorizes.

In the study, a magnetic resonance imaging scanner tracked neural blood flow, an indirect sign of brain-cell activity, as volunteers viewed new and familiar faces.

An inhibited temperament may be the prime reason for previous reports of heightened amygdala activity in people diagnosed with social phobia, a condition marked by constant fear and avoidance of unfamiliar people. In the new study, two people in the

inhibited group had social phobia, but that condition didn't further boost their amygdala responses. —B.B.

## ENVIRONMENT

### Antimosquito coils release toxic fumes

In places with nocturnal mosquitoes, many people burn spiral-shaped strips of insecticide-treated plant matter near their beds.



**MORTAL COIL** Mosquito coils release chemicals that keep bugs away but can also harm people.

These mosquito coils smolder through the night to keep bugs at bay, but they can also cause asthma and wheezing in children. Now, researchers have measured several pollutants in smoke emitted from mosquito coils.

Formaldehyde is one example. A single burning coil can release as much of the carcinogen as can 51 cigarettes, the researchers report in an upcoming *Environmental Health Perspectives*. Each coil can also emit PM<sub>2.5</sub>, or airborne particles less than 2.5 micrometers wide, in amounts equivalent to those released by 137 cigarettes. Particles that small can carry toxic compounds deep into the lungs.

Junfeng Zhang of the University of Medicine and Dentistry of New Jersey and Rutgers University in Piscataway, N.J., and his colleagues obtained their data by testing six popular brands of mosquito coils from China and Malaysia. Since the amounts of various pollutants emitted by these brands differ widely, systematic testing of coils could help consumers make informed choices, the researchers suggest. —B.H.

## TECHNOLOGY

### Giving solar cells the rough treatment

Researchers in Germany have modified standard solar cell designs so that they can be made from cheaper materials. That could be important, because price has long been a major obstacle to wider use of photovoltaics.

Typically in commercial solar cells, photons from the sun jolt electrons loose from chemical bonds in a layer of silicon several hundred micrometers thick. Dislodged electrons escape the silicon layer into an adjacent substance that lets them flow freely.

To ensure that liberated electrons don't get trapped by defects within the silicon's crystalline structure, manufacturers deposit the material with as few defects as possible. That precision in manufacturing adds to

the cell's cost.

Instead, says Rolf Könenkamp of Portland (Ore.) State University, it's possible to "use extremely inexpensive and essentially bad material to make a solar cell."

Such a material must be thin so its defects don't impede the light-generated electrons. However, a thin light-absorbing layer can be too transparent.

At the Hahn-Meitner Institute in Berlin, Könenkamp and his colleagues created an electron-accepting layer of titanium dioxide with a rough surface. Onto the bumpy surface, the team deposited an imperfect, 150-nanometer-thick layer of the light-absorbing semiconductor cadmium telluride.

In the June *Semiconductor Science and Technology*, the researchers report that the electron-accepting titanium dioxide's bumpiness bounces photons around within the light-absorbing layer, upping the chance for electrons to be freed. Meanwhile, the cadmium telluride layer's thinness permits those electrons to escape into the titanium dioxide.

Other teams had demonstrated this roughened-surface approach using more exotic solar-cell technologies, says Könenkamp. However, this new work shows that the approach also holds promise for improving upon well-established methods for making cells. —P.W.

## ZOOLOGY

### Killer sex, literally

Videotapes of yellow garden spiders show that if a female doesn't murder her mate, he'll expire during sex anyway.

"As far as we know, it's the first time anyone has shown males spontaneously dying during copulation," says Daphne J. Fairbairn of the University of California, Riverside. She's not talking about the odd heart attack among romancing fellows. Among males of the yellow garden spider, "all of them do it," she says.

Tapes of 44 *Argiope aurantia* males that inserted both pedipalps—their sperm-delivery structures—into their mates without getting attacked show the males' legs curling up motionless within seconds. In a different test, males' hearts stopped within 15 minutes of sex. Another male, who made his second pedipalp insertion into a nearby mealworm, also died, Fairbairn and Matthias W. Foellmer of Concordia University in Montreal, Quebec report in an upcoming *Proceedings of the Royal Society of London B*. The mechanism of death remains unknown.

The whole business raises interesting problems. "Imagine humans if every time teenage males had sex they died," Fairbairn says. "It seems like a bad plan for the species."

There may be one consolation for the spider male. The researchers note that as his dead body dangles in place, it will keep other males from impregnating his mate. —S.M.

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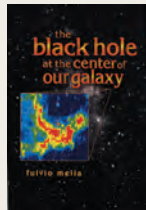
# Books

A selection of new and notable books of scientific interest

## THE BLACK HOLE AT THE CENTER OF OUR GALAXY

FULVIO MELIA

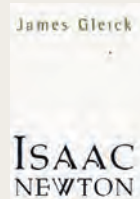
New, improved, and high-powered telescopes are finally lifting the veil from the Milky Way's core. Astronomers have discovered, behind this shroud of thick dust, a dark entity devouring everything around it. Although the existence of such a void has been suspected for a long time, the emerging evidence for a Milky Way black hole the mass of almost 3 million suns is compelling and exciting. The proximity of Sagittarius A\* (as this black hole is called) just 28 light-years away makes conceivable several tests of ideas about the cosmos that sprang from the minds of Albert Einstein and other physicists. Melia details the machinery that has confirmed the existence of Sagittarius A\* and explains the implications of the data that scientists are now harvesting from this relatively nearby black hole. *Princeton U Pr, 2003, 189 p., color photos, hardcover, \$29.95.*



## ISAAC NEWTON

JAMES GLEICK

Gleick is known for simply titled books with fascinating content and clear exposition, including *Chaos*, *Faster*, and *Genius*—a biography of Richard Feynman. Now, the author turns his attention to another of science's famous characters. Gleick's reverence for Newton and his vision is clear. He states early on that Newton "was the chief architect of the modern world," a man who "made knowledge a thing of substance: quantitative and exact." The author notes that Newton answered the ancient riddles of light and motion, effectively explained gravity, and showed how to predict the courses of heavenly bodies. On a personal level, Newton was a profoundly solitary man who trod the brink of madness much of his life. He also dabbled in alchemy and theological esoterica, says Gleick, who charts all these avenues of Newton's existence. In the process, Gleick reveals a great deal about how one man made such an extensive contribution to our understanding of the world around us. *Pantheon, 2003, 272 p., b&w photos/illus., hardcover, \$22.95.*

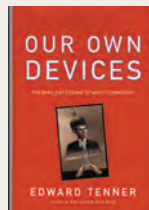


## OUR OWN DEVICES: The Past and Future of Body Technology

EDWARD TENNER

The author of *Why Things Bite Back* considers how everyday inventions such as sandals, reclining chairs, and helmets affect how we use our bodies—how we sit, stand, walk, and communicate—and how those actions in turn affect our images of each other. Most historians focus on such devices themselves, rather than on how we develop techniques for using them. Tenner picks up the slack by explaining, for instance, how touch-typing followed the development of the typewriter keyboard and how

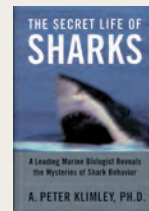
different types of footwear affect a walker's gait. The author also explores unintended consequences of inventions. Rubber nipples on baby bottles were supposed to improve infant nutrition, but they might have done the opposite. Reclining chairs were originally intended to promote healthful relaxation for the overtaxed body, but they have become the symbol of the slovenly. This tome is rife with such examples that provide a unique perspective on tools we use everyday. *Knopf, 2003, 314 p., b&w photos/illus., hardcover, \$26.00.*



## THE SECRET LIFE OF SHARKS: A Leading Marine Biologist Reveals the Mysteries of Shark Behavior

A. PETER KLIMLEY

Most beachgoers sweat not only the sun but also the sharks they imagine are lurking in the water. Movies such as *Jaws* have tainted our view of these creatures, leading us to believe that sharks are "dumb feeding machines" and man hunters, Klimley writes. He, on the other hand, thinks nothing of swimming alongside the fascinating fish. After 3 decades of shark research, most specifically with hammerheads and great whites, Klimley sees sharks as surprisingly intelligent animals that carefully choose their prey, navigate long distances with unerring precision, and have complex social relationships. In fact, Klimley's research indicates that great white sharks don't particularly care for the taste and texture of relatively bony, muscular human flesh, which is often spit out after a first bite. Instead, this species tracks fatty sea lions. Klimley theorizes that sea lions' high-calorie fat maintains the sharks' relatively high body temperature. Tagging and monitoring these creatures over long periods has provided Klimley with a great deal of data about the sharks' methods of communication and social structure. The details make for interesting reading. *S&S, 2003, 292 p., b&w plates, hardcover, \$25.00.*



## THE SPECKLED MONSTER: A Historical Tale of Battling Smallpox

JENNIFER LEE CARRELL

By the time smallpox was eradicated in 1977, it had taken hundreds of millions of lives. It killed more people than the Black Death and all the wars of the 20th century combined. Carrell takes readers back to the 1720s when Louis Pasteur's germ theory was 140 years in the future, Edward Jenner's initial work in immunology was 70 years off, and smallpox was rampant in Boston and London. She introduces two individuals who fought to stave off the disease. Lady Mary Wortley Montagu of London and Zabdiel Boylston of Boston borrowed from the folk medicine of Ottoman women and African slaves and injected small amounts of the smallpox virus under the skin of their children to inoculate them. Carrell provides a historical dramatization of these stories and describes them as laying the groundwork for infectious-disease advances by Jenner and Pasteur years later. *Dutton, 2003, 474 p., b&w plates, hardcover, \$25.95.*



# LETTERS

## The truth is out there

"Patterns from Nowhere" (*SN: 5/17/03, p. 314*) was very interesting. While hiking in terrains ranging from midwestern prairies to alpine environments, I've seen different forms of buckling due to freezing forces. Though evaporation was given a nod in the article, it too can be a significant force to form patterned ground. In March of 2002, I walked out to the middle of Death Valley at Badwater, the lowest point in the continental United States. There were polygonal regions throughout the surface as it changed from regular soil of high salt content to pure salt. The polygons typically were 3 to 5 feet across.

DEREK WALLENTINSEN, SAN PEDRO, CALIF.

The article states that the "concentration of radioactive helium-3 isotopes" in rocks suggests information about the history of the rocks. Insofar as I know, there is only one isotope of helium-3, and it isn't radioactive.

DONALD A. NEEPER, LOS ALAMOS, N.M.

*The helium-3 isotope indeed isn't radioactive, but it is cosmogenic. That is, it's produced when the rock is exposed at Earth's surface and bombarded with natural cosmic rays and so carries information about a rock's history.* —S. PERKINS

## Get right back up

The discovery that humans share 99.4 percent of their genetic sequences with chimps does not make chimps like us in any meaningful sense or lower "humanity's pedestal" in the slightest degree ("Humanity's pedestal lowered again?" *SN: 5/31/03, p. 349*). In some 5 million years on Earth the sum total of chimps' cultural achievements has been exactly 0. In only 200,000 years, modern humans have gone from the swamps to the stars, and most of that in only the last 10,000 years. Poking a stick in an anthill (the peak of chimp tool use) doesn't equal the creation of a worldwide industrial civilization and all the accumulated knowledge that that requires. Either the geneticists have missed something or that 0.6 percent is of enormous importance.

EDWIN A. LOCKE, WESTLAKE VILLAGE, CALIF.

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