SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

APRIL 29, 2006 PAGES 257-272 VOL. 169, NO. 17

ultrasound targets tumors

(not so) constant of nature

energy-efficient black holes

anthrax toxin neutralized

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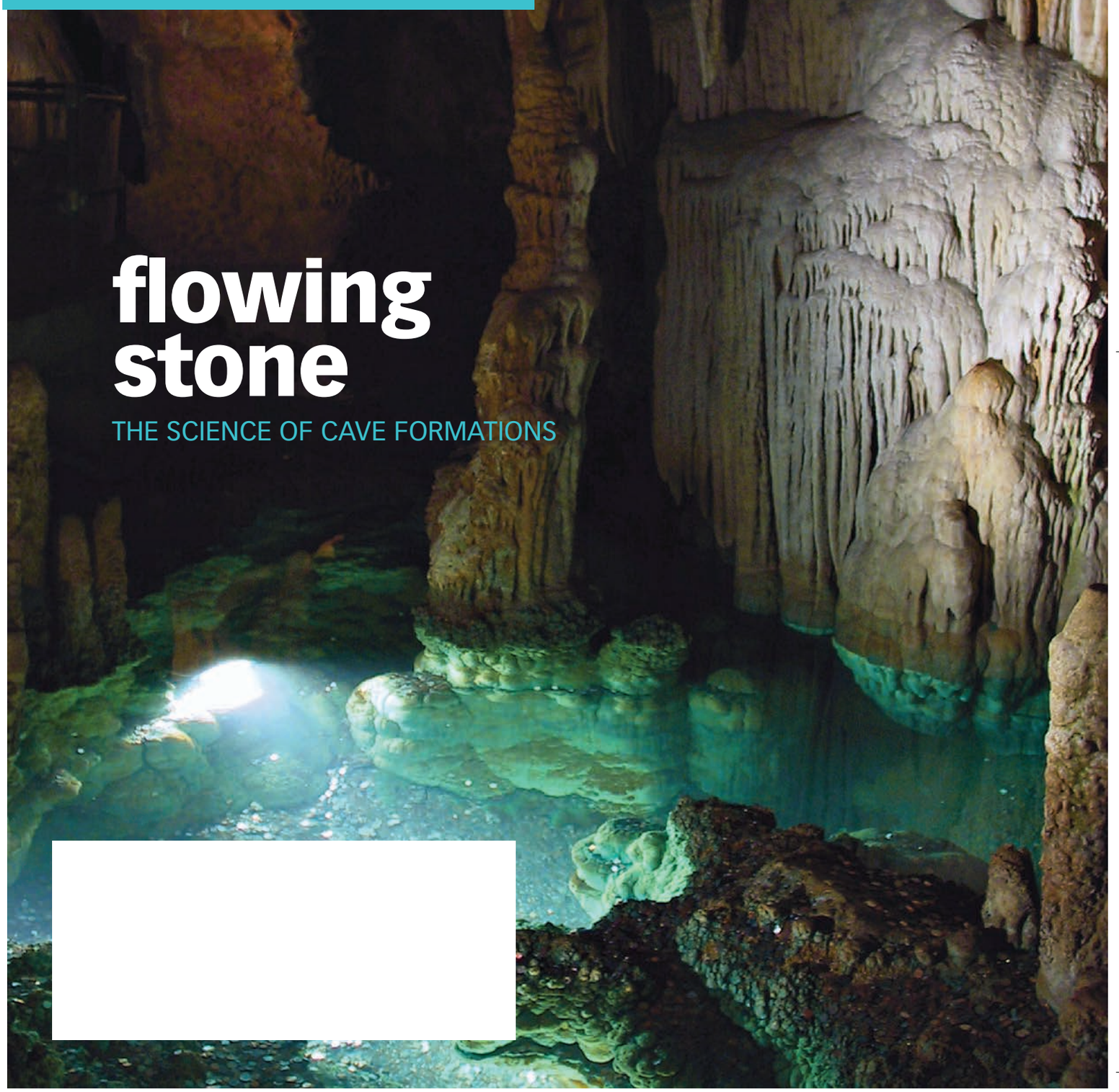
flowing stone

THE SCIENCE OF CAVE FORMATIONS



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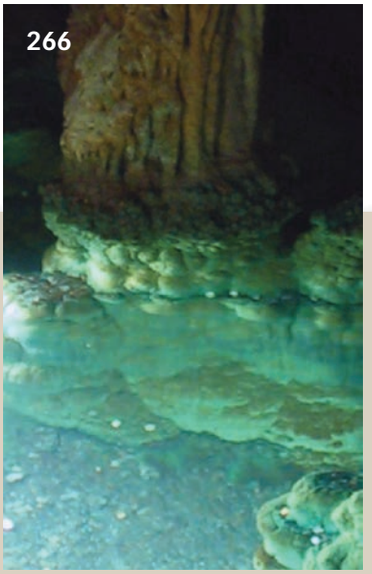

Features

This Week

Of Note

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Cover Although scientists have long understood the chemical processes that sculpt many cave formations, they've only recently come up with a mathematical model that explains some of the features' shapes. Researchers also find that bacteria contribute to some types of mineral deposits in caves. (iStockphoto) Page 266

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Universe in Flux

Constant of nature might have changed

Scientists have long assumed that a few characteristics of the cosmos are as unvarying as the laws of physics themselves. These so-called constants of nature include the speed of light in a vacuum and the masses of some elementary particles.

Now, a team of physicists and astronomers in the Netherlands, Russia, and France has found signs that one of the constants has undergone a subtle shift since the infancy of the universe.

The new findings indicate that the ratio between the mass of the proton and that of the electron—a number known as mu—might have decreased by about two-thousandths of a percent in the past 12 billion years, say Elmar Reinhold, now of the European Space Agency in Noordwijk, the Netherlands, and his colleagues. The evidence for the change in the constant, which has a current value of 1,836.153, emerged from light-absorption patterns of hydrogen molecules, the scientists report in the April 21 *Physical Review Letters*.

"If correct, it is a revolutionary result," comments Victor V. Flambaum of the University of New South Wales in Sydney, Australia. "It doesn't matter that the variation is small. If mu varies, we need new theoretical physics and cosmology."

Flambaum notes that variations in constants of nature as the cosmos evolves are part of some speculative theories of the universe, such as string theory, that call for dimensions beyond the familiar three of space plus one of time.

Since 2001, Flambaum and his colleagues have presented growing evidence that another constant, known as alpha or the fine-structure constant, has also varied (*SN: 10/6/01, p. 222*). That variation, however, is less than the newly determined change in mu. Investigations by several other teams have found no evidence that alpha, which represents the strength of the electromagnetic force, has changed its value (*SN: 5/14/05, p. 318; 5/8/04, p. 301*).

To arrive at the new findings for mu, Alexandre V. Ivanchik of the Ioffe Institute in St. Petersburg, Russia, and Patrick Petitjean of the Astrophysics Institute of Paris made extraordinarily precise telescope measurements of radiation coming from two quasars. The researchers focused on wavelengths absorbed by frigid clouds of hydrogen molecules in space. Because looking deep into space is equivalent to looking back in time, the quasar-radiation measurements probe characteristics of hydrogen molecules as they existed less than 2 billion years after the Big Bang.

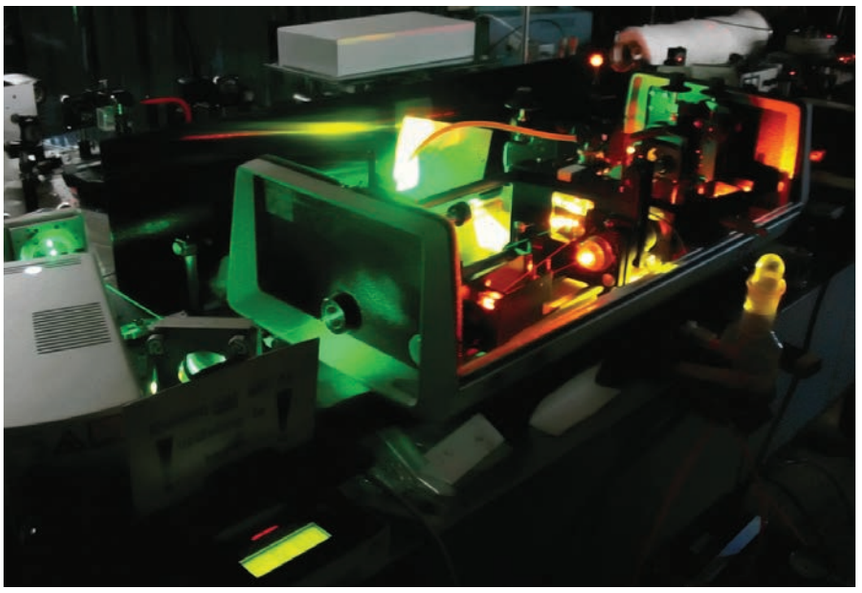
Meanwhile, Reinhold and other members of the team, led by Wim Ubachs of the Free University of Amsterdam, determined with unprecedented accuracy the wavelengths of light that hydrogen molecules absorb from laser beams in the laboratory today, 13.7 billion years after the Big Bang.

The scientists found the wavelengths to be slightly different in the two sets of data. Because the wavelengths that hydrogen molecules absorb depend on the value of mu, the results suggest that mu has changed.

Nonetheless, the absorption evidence gathered so far from two quasars isn't strong enough to prove that mu varies, say members of the team and other scientists.

Investigators studying alpha have looked at 143 quasar systems, yet the notion that alpha has varied remains controversial, notes Michael T. Murphy of the University of Cambridge in England, one of the scientists who, with Flambaum, reported the alpha variation.

Scientists "need absolutely cast-iron proof" beyond the current study because the implications are so profound, agrees Lennox L. Cowie of the University of Hawaii, Manoa in Honolulu. —P. WEISS



LASER CENTER, VRIJE UNIV.

BEAMING Measurements of hydrogen molecules conducted with this laser system suggest that a constant of nature has changed its value since the universe was young.

Brain Delay

Air pollutants linked to slow childhood mental development

Pollutants spewing from vehicles and power plants may be harmful to fetal brains, new evidence suggests. The study is the first to directly link delayed cognitive development in children to their mothers' exposure during pregnancy to common air pollutants called polycyclic aromatic hydrocarbons, or PAHs.

Earlier studies established a similar relationship between slowed neurological development and prenatal exposure to lead, says Frederica P. Perera, the Columbia University environmental health scientist who led the new study.

Last year, other researchers reported that secondhand cigarette smoke may also dull kids' wits (*SN: 1/15/05, p. 37*). Such smoke also contains PAHs.

"These pollutants come largely from combustion of fossil fuels, including gasoline, diesel, and coal," Perera says. PAHs come in hundreds of chemical varieties, at least some of which are carcinogenic.

For their study, Perera and her colleagues first outfitted several hundred pregnant women with air-quality monitors that fit into small backpacks. The volunteers lived in upper Manhattan and the Bronx, N.Y. For 2 days, the monitors measured eight kinds of PAHs in the air surrounding each woman.

The researchers tested blood from mothers and infants after delivery and then annually tested each child's cognitive abilities.

They also recorded each child's birthweight and other measurements and assessed each mother's exposure to lead and secondhand smoke, her marital status, and other factors that can affect a child's development.

In a previous phase of the study, Perera's team had concluded that women who breathed high concentrations of PAHs during pregnancy were more likely than other women to have children with low birthweights or reduced fetal growth.

For their new report in an upcoming *Environmental Health Perspectives*, the team analyzed data on 183 children who had reached the age of 3.

By that age, the 42 children whose mothers had been exposed to the most PAHs "scored significantly less well on a test of cognitive development" than did the rest of the children in the group, Perera says. The youngsters of highly exposed mothers "were more than twice as likely to be developmentally delayed, according to this test," she adds.

The well-designed study took many, though not all, possible developmental factors into account before attributing any effect to PAHs, says developmental psychologist Philip Sanford Zeskind of Carolinas Medical Center in Charlotte, N.C. While pregnant women can take simple steps to avoid some harmful exposures, including cigarette smoke, "people don't have many choices" when it comes to avoiding ambient air pollutants such as PAHs, he says.

"This study offers clear evidence of a detrimental effect of prenatal exposure [to PAHs] on child cognitive development," comments Kimberly Yolton of Cincinnati Children's Hospital Medical Center. She adds that it "should encourage us to think creatively about ways in which we can reduce this exposure for pregnant women and young children."

Perera proposes that "better pollution controls on what comes out of tailpipes or smokestacks." PAH concentrations could be cut by public-policy measures that, for example, reduce power plant emissions overall or replace old, diesel-burning buses with vehicles that are either more fuel efficient or that don't burn fossil fuels, she says. —B. HARDER

QUOTE

"This study offers clear evidence of a detrimental effect of prenatal exposure [to air pollutants] on child cognitive development."
KIMBERLY YOLTON, Cincinnati Children's Hospital Medical Center

Seismic Speed Traps

Iron-rich regions may slow deep-Earth vibes

Large quantities of iron-rich minerals may be responsible for the sluggishness of seismic waves traveling through certain regions deep within Earth, a new analysis suggests.

About 2,900 kilometers below Earth's surface, molten iron from the planet's core meets a thick, overlying mantle of silicate minerals. Vibrations spreading from large earthquakes slow significantly as they pass through some patches of rock just above that core-mantle boundary, says Ho-kwang Mao, a geophysicist at the Carnegie Institution of Washington (D.C.). Those regions, dubbed ultralow-velocity zones, range between 5 and 40 km thick and can measure more than 100 km across.

Earthquakes cause a variety of vibrations, including seismic-pressure waves that travel through the ground as sound does through air and other waves that transfer shearing stresses through rock. In ultralow-velocity zones, seismic pressure waves slow 5 to 10 percent, says Mao. Shear waves can be hindered by as much as 30 percent.

Because liquids can't transmit shear waves, scientists previously speculated that partial melting of minerals in the zones was responsible for the seismic-wave slowdown, he notes. Now, Mao and his colleagues offer another explanation: high iron content.

The researchers performed lab tests on samples of an iron-rich silicate having a particular crystal structure, called a postperovskite phase, that scientists presume occurs near the core-mantle boundary. The silicate contained more than twice as much iron as other silicate-crystal structures can hold.

When the researchers squeezed the mineral to the pressure expected near the core-mantle boundary—almost 1.3 million times that exerted by the atmosphere at sea level—they noted that vibrations traveling through the sample slowed considerably. "Pressure waves traveled 7 percent slower than expected, and shear waves progressed about 30 percent slower," says Mao. The researchers report their findings in the April 28 *Science*.

The idea that iron-rich minerals cause seismic slowdown is intriguing, says Michael Thorne, a seismologist at the University of Alaska in Fairbanks. High iron concentrations could also explain the high density of minerals inferred from past observations of ultralow-velocity zones, he notes.

Large concentrations of iron-bearing minerals provide an interesting potential explanation of the seismic slowdown in the ultra-low-velocity zones, says John Hernlund of the Paris Geophysical Institute. This "iron-sponge" scenario is more feasible than that of partially melted minerals because it doesn't require the ultralow-velocity zones to be mixtures of melted and solid minerals, he adds. Such areas, especially in layers 40 km thick, probably wouldn't have been as stable over geologic time as ultralow-density zones seem to have been. —S. PERKINS

Nixing Malaria

DNA segment provides parasite resistance

A section of the mosquito genome appears to give the insects a natural resistance to malaria, scientists report. Further analysis of that DNA might suggest new ways to prevent this deadly disease.

Most of the world's 300 million to 500 million annual new cases of malaria arise in sub-Saharan Africa. In that part of the world, the disease is mainly transmitted by a species of mosquito known as *Anopheles gambiae*. A mosquito picks up the malaria parasite, typically a protozoan called *Plasmodium falciparum*, by biting people already infected with the disease.

BLOOD SUCKERS **Mosquitoes feast on blood from malaria-infected villagers in Mali.** VERNICK

Until recently, researchers had assumed that all *A. gambiae* could become infected with malaria. However, studies have shown that only a small percentage of those mosquitoes carry the parasite. Those findings led researchers to suspect that most mosquitoes have a genetic predisposition to fend off *P. falciparum*, says microbiologist Kenneth Vernick of the University of Minnesota in Minneapolis–St. Paul.

To figure out which genes might be responsible for a mosquito's resistance to

malaria, Vernick and his colleagues collected hundreds of female mosquitoes from the village of Bancoumana in Mali. After the captured insects laid eggs, the researchers raised the offspring to adulthood, then fed the bugs blood drawn from villagers who had malaria.

After giving the parasites several days to incubate inside their new insect hosts, Vernick's team dissected the mosquitoes and looked for telltale signs of malaria infection: tiny bags called oocysts, each of which holds thousands of developing parasites. Most mosquitoes had few or no oocysts in their guts. The others harbored varying numbers of the bags, with some of the bugs carrying hundreds of them.

Next, Vernick's team scanned the mosquitoes' DNA for markers that might correlate with a heavy oocyst presence. The researchers then narrowed their search to a segment of DNA that holds about 1,000 genes and eventually focused on two of these genes, *APL1* and *APL2*.

When the team used a genetic technique to turn off *APL2* in mosquitoes not previously exposed to the parasite, the change didn't alter the bugs' capacity to ward off malaria. However, turning off *APL1* increased the number of oocysts in the insects about 10-fold, the scientists report in the April 28 *Science*.

Vernick notes that much more testing is required before scientists can confirm that *APL1* plays a pivotal role in malaria resistance. But even if this gene doesn't determine mosquitoes' susceptibility to malaria, that function is almost certainly controlled by genes within the segment of DNA that he and his colleagues identified. "We've located this needle in a haystack," says Vernick. "Among 1,000 genes, we can test for the ones important in malaria resistance."

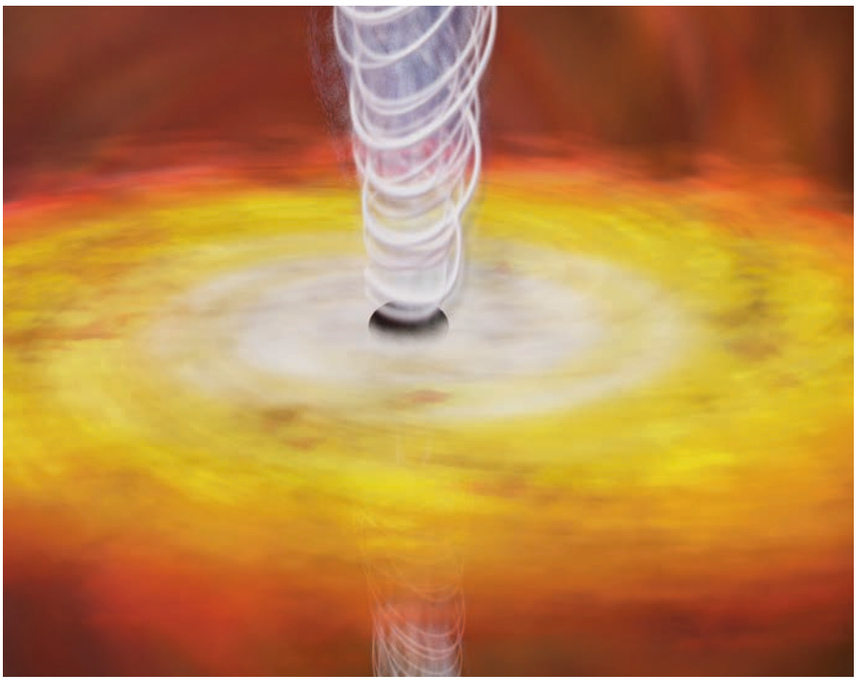
Researchers may eventually develop new malaria drugs on the basis of how malaria-resistant mosquitoes fight off the disease, notes malaria researcher Matthew Hahn of Indiana University in Bloomington. However, he adds that Vernick's findings suggest that current efforts to engineer resistant mosquitoes might not work. "Most mosquitoes seem to be resistant to malaria, but people still get infected," he says. —C. BROWNLEE

Energy-Saving Space Engines

Black holes can be green

Some seemingly quiet black holes are actually efficient engines that emit jets of high-energy particles. This finding, from the first study to directly measure the efficiency of black holes, offers a hint as to why the universe isn't more crowded with stars.

All black holes swallow matter and spit out energy. Their gravitational pull traps clouds of hot, X-ray–emitting gas, and the black holes spew radiation or jets of high-energy particles.



NASA/CXC/M. WEISS

SPACE SHOOTERS **Unlike blindingly bright young quasars that radiate light, older black holes emit their energy as superfast jets of particles (white spiral).**

The energy that black holes send out affects their environments. Scientists had presumed that young black holes producing quasars, which are beacons of light, are highly efficient. However, that efficiency hasn't been directly measured because the quasars are too bright.

Instead of focusing on quasars, a team of scientists led by astrophysicist Steven W. Allen of Stanford University used NASA's Chandra X-Ray Observatory to look at nine supermassive black holes, which are older than quasars and lie at the centers of nearby giant elliptical galaxies. "These are the boring old black holes that we thought had stopped doing anything interesting a long time ago," says team member astrophysicist Christopher S. Reynolds of the University of Maryland at College Park. The team's findings, announced this week, will be published in an upcoming *Monthly Notices of the Royal Astronomical Society*.

Though these black holes produce relatively little radiation, previous Chandra observations had noted the formation of large cavities in the surrounding gas clouds, as if the black holes were blowing bubbles tens of thousands of light-years across.

The team calculated the amount of energy needed to form those bubbles and compared it with the growth of the gas disks that encircle the black holes. From those results, the scientists estimated that each black hole converts about 2.5 percent of the mass of captured gas into jets of particles. That's about 25 times as efficient as nuclear power, Allen says.

"If you could make a car engine as efficient as a black hole engine, you could get about a billion miles out of 1 gallon of gas," he says. "That's green by anyone's book." The finding suggests that not just quasars but all black holes are efficient, whether they expel energy as radiation or jets of particles, Reynolds adds.

This research represents the "next big step" in understanding what black holes do and how galaxies and clusters evolve, says astrophysicist Kim Weaver of NASA's Goddard Space Flight Center in Greenbelt, Md., who was not on the study team.

The findings may hold clues to the puzzle of why galaxies aren't as big a cosmologists' models predict. Moving only slightly slower than the speed of light, the jets from black holes slam into the surrounding gas and heat it, preventing it from cooling enough to form stars, Weaver says.

These black holes "may be preventing galactic sprawl from taking over the neighborhood," she adds. —C. GRAMLING

Grammar's for the Birds

Human-only language rule? Tell starlings

At least some birds can learn a pattern once proposed as unique to the grammars of human languages, say researchers.

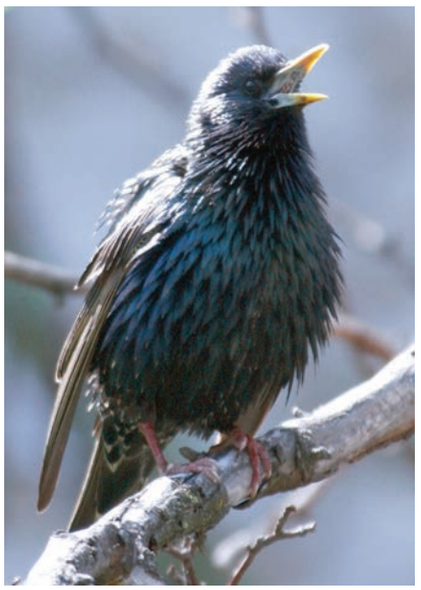
Starlings trained in a lab have learned to distinguish between sounds strung together like a laundry list and those with nested, or recursive, elements, according to Timothy Q. Gentner of the University of California, San Diego.

Human languages make ample use of recursion. A simple sentence, "Scientists argue about languages," can expand quickly as the speaker tucks in subordinate bits within the basic framework. For example: "Scientists, who have passionate opinions, argue about languages, of which there are many."

In 2004, researchers reported that cotton-top tamarins don't seem to recognize these complex patterns. Now, in the April 27 *Nature*, another team, which includes Gentner, claims that starlings can pick out that grammar trait. "It's the first foray into this complex rule learning for a nonhuman animal," says Gentner.

He traces the origin of the experiment to the 2004 tamarin paper. "We thought, if there's any species that's going to be able to do this, it's starlings," Gentner says. "They're just incredible singers."

He and his colleagues used the same basic pattern of sounds developed for testing tamarins. The laundry list pattern of sounds was represented by a pair of repeated sounds: ABAB, ABABAB, and so on. To pick a very simple case of recursion, the earlier researchers had inserted an extra AB in the center one or more times: AABB, AAABBB, and so on.



RATTLE, WARBLE, RATTLE Starlings can make a wide variety of sounds. A test now suggests that they can learn a basic principle of grammar.

To customize the test for starlings, researchers recorded some of the birds' rattling and warbling calls to use as the A's and B's. The researchers then trained 11 adult starlings to peck a key when they heard the more-complex recursive, or AABB type, string of sounds. If the birds heard the ABAB type, they were taught to refrain from pecking.

To find out whether the birds were recognizing recursion instead of using some other rule to distinguish the strings, Gentner's team tossed in other strings of the sounds.

"It was hard," says Gentner. Starlings take about 1,000 tries to learn, for example, to distinguish reliably the song of a particular bird. However, consistently sorting out the recursive strings from the nonrecursive ones required some 10,000 to 50,000 tries. Two of the 11 birds never made the grade.

W. Tecumseh Fitch of the University of St. Andrews in Scotland, one of the researchers who tested tamarins, says that he's glad that the primate work has inspired further investigation. He finds it "quite plausible" that birds do things in communication that nonhuman primates can't.

However, he cautions that the starlings spent a lot of time in "grammar school," but the tamarins had received no training. "In some ways, we're still talking about apples and oranges," he says.

However, another language specialist, Ray Jackendoff of Tufts University in Medford, Mass., says he's not persuaded that the birds learned the recursion rule. However, the experiment convinced him that they could handle grammar a bit beyond the basic stringing together of sounds. —S. MILIUS

STATS

75%

Chance of an infection caused by inhaled anthrax being fatal

Small Wonder

Taking the bite out of anthrax toxin

Using specially designed submicroscopic capsules in tests on rats, scientists have neutralized the deadly toxin released by the bacterium that causes anthrax. Although antibiotics can kill the microbe, there is currently no means of eliminating the toxin once it's unleashed in a person's body.

When *Bacillus anthracis* infects a mammal, it secretes three proteins that together prove lethal. One of the proteins, called protective antigen (PA), acts as the scout, latching on to a cell. That bond enables the other two anthrax-toxin proteins to enter the cell and kill it.

Because it's the linchpin for cell invasion, PA is an obvious target for antianthrax drugs. Some synthetic compounds had shown promise in binding to PA and blocking the toxin's lethal effect (*SN: 10/6/01, p. 212*).

Ravi S. Kane, a chemical engineer at Rensselaer Polytechnic Institute in Troy, N.Y., and his colleagues took a novel approach by using liposomes, small vesicles that have a membrane of fat molecules. Liposomes have already been approved to deliver drugs to cells in other diseases.

Kane's team studded the surface of each liposome with peptides that can attach to the sites on the PA protein that bind to a cell. The researchers spaced the peptides to match the array of binding sites on PA. That increased the likelihood that the liposome would tightly bind PA, which then wouldn't be available to attach to a cell, Kane says.

The scientists injected two different doses of the liposomes into two groups of nine rats, each of which had just been injected with anthrax toxin. In the group that got the higher dose, only one rat became gravely ill. In the group that received the lower dose, four animals became seriously ill. A third group of nine rats received only anthrax toxin. Eight of those animals became severely ill, the researchers report in an upcoming *Nature Biotechnology*.

Kane plans next to test the liposomes on animals that already have an established anthrax infection.

The findings suggest that the liposomes might serve as an anthrax-drug candidate, says John A.T. Young, a microbiologist at the Salk Institute for Biological Studies in La Jolla, Calif. "Clearly, this is a viable approach," he says.

The liposome researchers have made rapid progress in only a few years and "have identified a product that might have a great deal of value," says Phillip J. Baker, a bacteriologist at the National Institute of Allergy and Infectious Diseases in Bethesda, Md. However, he points out that Kane and other researchers have also developed anti–anthrax–toxin agents that use polymers as a scaffolding for peptides that bind PA. It remains unclear whether liposomes are markedly more efficient than the polymers are, Baker says, although liposomes may have an advantage in gaining regulatory approval.

The final choice for stockpiling anthrax antitoxins may hinge on the drugs' prices and ease of storage as well as their effectiveness, Baker says. —N. SEPPA

D. BALECKAITIS

SO MANY GREAT TOPICS, ONE GREAT SCIENCE WEEKLY

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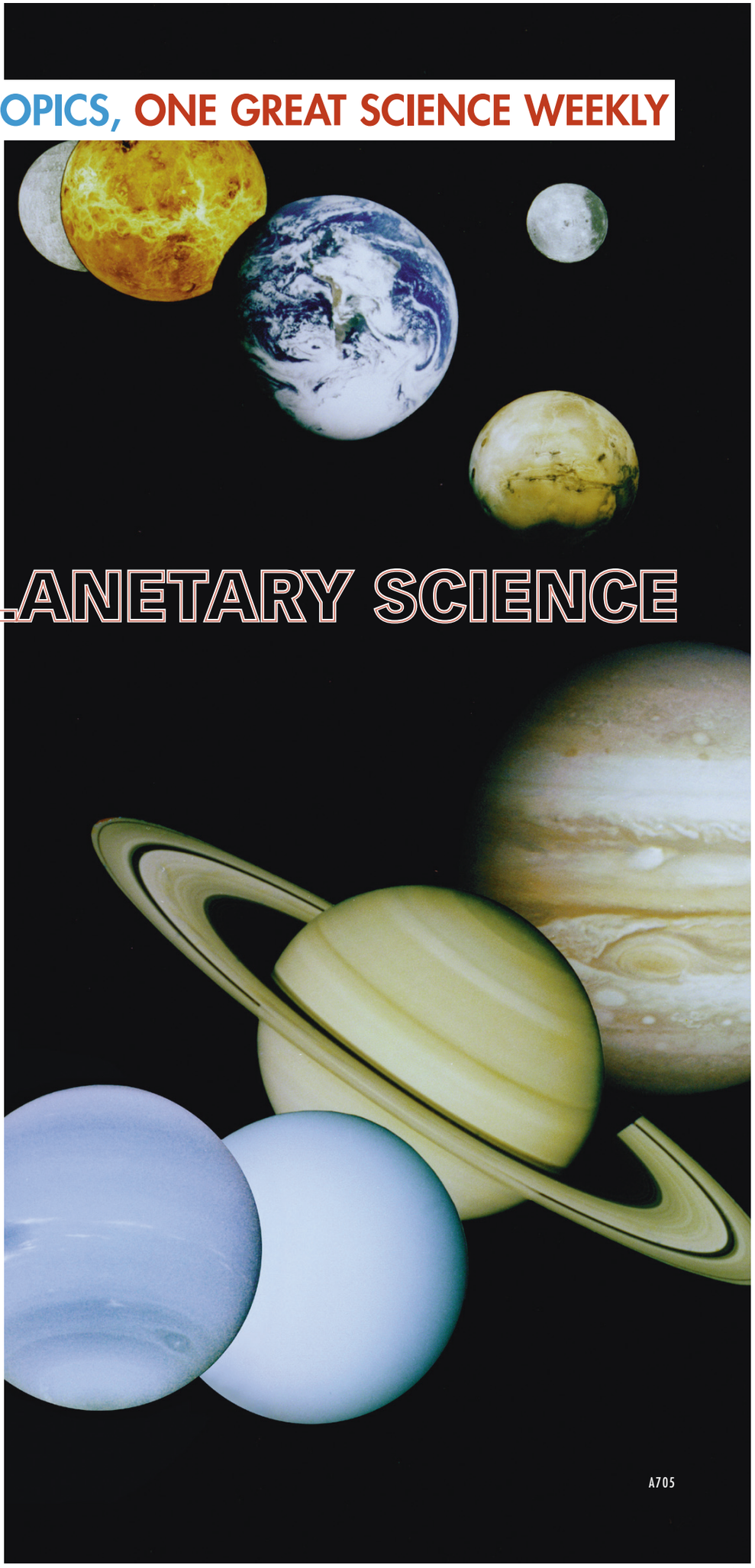


ULTRASOUND'S NEW FOCUS

Can it eradicate tumors?

BY BEN HARDER

The Dominican Republic is known among tourists for its white sands, magnificent waterfalls, and unusual wildlife. But none of those was the attraction that drew Charles A. Reinwald. He came for a rendezvous with an ultrasound device. Reinwald had aggressive prostate cancer, and he didn't care for the treatment options available in the United States. So, one day in late June 2004, Reinwald traveled from his home in Tequesta, Fla., to a hospital in the Dominican city of Santiago. There, a Miami-based urologist directed ultrasonic waves at the patient's cancerous prostate gland.

The Dominican Republic and various other countries, including Canada, England, and Mexico, permit doctors to treat prostate cancer with a technique called high-intensity focused ultrasound, or HIFU. It often avoids the irreversible side effects, including impotence, that can arise during surgery, radiation, and the other treatments available in the United States.

In the Santiago hospital, urologist George Suarez and his assistants inserted a transducer emitting ultrasonic waves into Reinwald's rectum. The curved transducer put the waves on converging paths in the same way that a magnifying glass focuses sunlight. Where the streams of energy intersected at the prostate, the temperature soared to more than 80°C, cooking small batches of tumor cells in seconds.

For about 2 hours, the transducer steadily shifted its aim across rows of space. Its progress resembled that of a dot matrix printer applying ink to paper. Tissue just millimeters away from the HIFU target zone remained unharmed.

Reinwald's cancer isn't cured, but he hasn't required medical intervention since the operation. At age 80, he works full-time as president of the Cancer Cure Coalition, a nonprofit organization that he founded in 2000 after his wife's diagnosis of cancer.

He expresses no regrets about his HIFU treatment. "Why do [surgery] when I have available to me a less toxic treatment?" he asks.

HIFU, however, is not generally available in the United States. It has been approved for only one use: treating uterine fibroids. Suarez and other urologists who treat U.S. men who have prostate cancer do so abroad and charge about $20,000 per case. Patients also need to pay their own way to Santiago, Toronto, or another foreign city to undergo the procedure.

A handful of companies market HIFU devices. Although they vary in design and therapeutic purpose, all the machines rely on the same underlying principle. They focus ultrasound energy at a point several centimeters away from the transducer and destroy tissue there.

The companies, including US HIFU of Charlotte, N.C., which Suarez partially owns, have funded research to test whether the new approach is safer and more effective for a variety of cancers than standard therapies are. Breast, bone, brain, and liver tumors are among those cancers being treated experimentally with HIFU. Investigators also continue to study the efficacy of the technique in women with fibroids. In each case, physicians must place the transducer within a few centimeters of the target.

While HIFU appears to sidestep some typical side effects of surgery and radiation, it's not yet clear whether the novel approach is as successful at curing cancers as those standard treatments are. So far, no study has directly compared the ultrasound procedure to an established cancer treatment.

A British government body, the National Institute for Clinical Excellence, maintains that the evidence "appears adequate to support the use of this procedure for prostate cancer." But it also states in a document that offers guidance to the National Health Service, "The effects of HIFU for prostate cancer on quality of life and long-term survival remain uncertain."

FIXING FIBROIDS Uterine fibroids are nonmalignant tumors that can impair fertility and sometimes cause pain, heavy menstrual bleeding, and urinary frequency. The condition has traditionally been treated by surgical removal of the uterus, or hysterectomy. This approach definitively rids a woman of fibroids and relieves the pressure that the fibroids had placed on nearby tissues.

> "There's a sense of urgency. [Prostate cancer] is the most common cancer in men."
>
> — GEORGE SUAREZ, M.D.
> MIAMI, FLA.

In contrast, HIFU "does not totally get rid of the fibroids," says radiologist Fiona Fennessy of Brigham and Women's Hospital in Boston. "This isn't a malignant tumor. All we're trying to do is improve symptoms."

To minimize risks such as skin burns and damage to healthy internal tissues, radiologists destroy only the center of the fibroid and don't attempt to heat the surrounding area, called the margin, Fennessy says.

However, because the blood vessels that support a fibroid are concentrated near its core, destroying the center usually eliminates part of the margin, says gynecologist Phyllis Gee, director of the North Texas Uterine Fibroid Institute in Plano.

To evaluate HIFU's success, Brigham and Women's researchers led by gynecologist Elizabeth A. Stewart treated more than 100 women who had fibroids. The team used a machine made by InSightec Ltd. of Haifa, Israel, that incorporates an ultrasound transducer into a magnetic-resonance (MR) scanner.

During treatment, a sedated woman lies facedown on the bed of the scanner. Beneath her abdomen, the ultrasound transducer aims and fires away for up to 3 hours while the MR scanner lets doctors monitor tissue temperature and fibroid position.

Most patients experience a "mild level of pain" during and immediately after procedure, Stewart says.

Stewart's team reported in the January *Fertility and Sterility* that 71 percent of the patients treated have a significant reduction in fibroid symptoms for at least 6 months, and 51 percent experience that improvement for at least a year. HIFU doesn't produce sufficient relief for all women, however. Seventeen percent of the volunteers sought another treatment, such as hysterectomy, within a year, Stewart says.

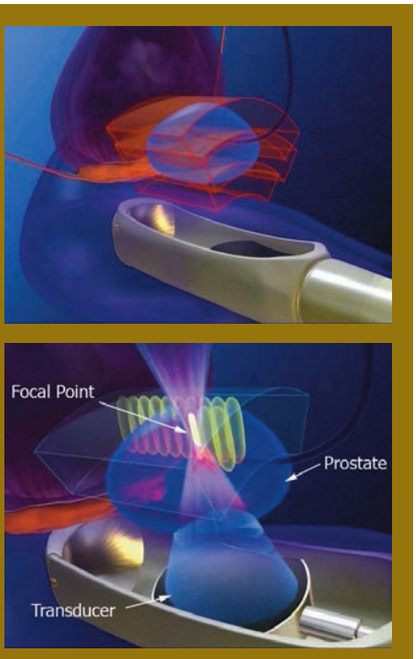
Women treated with HIFU missed an average of 1.4 days of work after the operation, Stewart says. That compares with 18.9 missed days among women treated by hysterectomy for similar fibroids, Stewart reported in Jerusalem last June to the Israel Society of Obstetrics and Gynecology.

To measure the benefit 3 years after treatment, Gee is leading a new study that will track 70 women with fibroids who received HIFU. InSightec funded both studies.

After reviewing preliminary clinical data, the U.S. Food and Drug Administration in late 2004 approved the InSightec equipment for clinical use in treating fibroids.

SOUNDING OUT MALIGNANCIES

Unlike fibroids, malignant tumors need to be rooted out entirely if they're to be beaten. In surgery, doctors remove a specific amount of surrounding healthy tissue to avoid leaving behind any cancer cells. Similarly, in HIFU, doctors may need to kill a veneer of healthy tissue around each tumor, concluded Moshe Papa and Douglas Zippel of Sheba Medical Center in Tel Hashomer, Israel, in the January 2005 *Breast Cancer*.



AIM AND FIRE — Inserted into the rectum, an ultrasound device images the prostate (top) and then focuses tumor-killing waves at points inside the gland (bottom).

Those researchers used HIFU to treat 10 women who had breast cancer and were planning to have partial mastectomies. After the procedure, the investigators removed a portion of each treated breast to see whether HIFU had eliminated the tumors. Two volunteers showed no sign of remaining cancer, but eight patients retained at least some cancerous cells at the tumor site.

Feng Wu and his colleagues in Chongqing, China, have taken a more aggressive approach. Between 1998 and 2001, they administered HIFU—in combination with either surgery or chemotherapy—to 45 women with breast cancer. They intentionally destroyed a 1.5-to-2-centimeter-thick layer of normal tissue around each tumor.

Five years later, 89 percent of the women had had no recurrence of disease, Wu reported last December at the Radiological Society of North America meeting in Chicago. Wu holds stock in the company that makes the device that his team tested. The study didn't include a comparison group of similar patients receiving a conventional treatment.

In other studies, it's not uncommon to find that after surgery and radiation therapy, more than 90 percent of volunteers who have breast cancer go at least 5 years without recurrence.

InSightec-sponsored researchers have begun a trial of HIFU in treating breast tumors and surrounding breast tissue in 200 women in Germany and Japan.

The cosmetic side effects of HIFU are minimal. Since HIFU doesn't break the skin, it rarely disfigures the breast, Wu says.

David Gianfelice of Toronto General Hospital, one of the first North American researchers to use HIFU in breast cancer treatment, notes that third-degree skin burns have resulted in some cases. But recent refinements to the InSightec hardware have minimized that problem, he says.

By delivering "a nice, tight package of heat" to the tumor, MR-guided HIFU might eventually supplant surgery as the treatment in some cases of breast cancer, Gianfelice says.

That same goal applies in prostate cancer, which researchers abroad have been treating with HIFU since the mid-1990s. For example, more than 400 men with early-to-mid-stage prostate cancer have received HIFU as an initial therapy using the device manufactured by EDAP of Vaulx-en-Velin, France.

Andreas Blana and his colleagues at the University of Regensburg in Germany reported results from 146 of these patients, who were tracked for an average of nearly 2 years. Blana's team reported in the February 2004 *Urology* that 87 percent of the patients remained free of their cancer. In studies of traditional prostate cancer therapies, up to 95 percent of men with early-stage cancer remain cancerfree at least 5 years after treatment.

At Hachioji Hospital in Tokyo, Toyoaki Uchida and his colleagues have treated more than 200 men since 1999.

Overall, 81 percent of the men remained free of disease 1 year after the procedure, and 77 percent had no disease after 5 years, Uchida reported at a meeting of the International Society for Therapeutic Ultrasound in Boston last October.

But more evidence is needed to prove that HIFU rids men of cancer as effectively as established therapies do, says urologist Peter Scardino of Memorial Sloan-Kettering Cancer Center in New York City.

Other researchers are now testing HIFU in patients with terminal liver or brain cancer or patients in whom tumors from other organs have spread to bone. These trials are intended to relieve pain.

JUST WARMING UP In addition to scoring direct hits against cancer, HIFU may provide assists when used in combination with established drugs. Researchers at the National Institutes of Health's Clinical Center in Bethesda, Md., showed at last year's radiology meeting that HIFU can boost the amount of a chemotherapy drug that reaches a tumor. Sergio Dromi and his colleagues injected skin tumor–carrying mice with microscopic envelopes of fat, called liposomes, that contained the anticancer drug doxorubicin. Liposomes carry drugs and other substances into cells.

In some mice, the researchers then used a HIFU machine to deliver intermittent pulses of ultrasound energy to each tumor, elevating its temperature to 42°C and breaking down the liposomes. Examination of the tumors revealed that three times as much doxorubicin reached the target in the HIFU-treated mice as in the other mice.

Other researchers are pursuing HIFU as a method for cauterizing hemorrhaging internal wounds (*SN: 1/6/01, p. 12*) and breaking up blood clots and kidney stones (*SN: 11/26/05, p. 346*).

Suarez, the urologist who treated Reinwald in Santiago, anticipates that HIFU may treat pancreatic and kidney cancer, fix heart arrhythmias, and even improve liposuction.

Use of HIFU for cancer could dramatically reduce health care costs, argues Suarez. It requires little or no hospitalization and less recovery time than alternative treatments do. Because HIFU is associated with a low rate of permanent complications, it also decreases the cost of treating those side effects.

"I'm treating about 20 patients a month [with HIFU]," Suarez says. "We are concentrating on prostate cancer right now. There's a sense of urgency—it is the most common cancer in men." ■

BURIED TREASURES

Constructing—and deconstructing—cave formations

BY SID PERKINS

In the summer of 2003, geologist Leslie A. Melim and two of her undergrads were exploring a 6-meter-by-12-m chamber deep within New Mexico's Carlsbad Caverns. As the team members were on their hands and knees conducting a detailed survey of the cave floor, one of the students blurted out, "Hey, what's this?"

"This," says Melim, was an oddly configured carpet of white minerals lining a shallow basin that had long ago, when the region's climate was wetter, held water. The sharp, wispy peaks of the carpet were less than 1 centimeter tall and 1.5 cm across at their bases, resembling crests atop a lemon meringue pie.

"It was unlike any cave formation I'd seen or heard of, and I was pretty sure no one else had seen it before either," says Melim. Considering the location of the find and its appearance, the team from Western Illinois University in Macomb dubbed the mineral coating "pool meringue." The group has since found similar formations in two other dried pools in Carlsbad's lower reaches.

As at Carlsbad Caverns, many treasure vaults lie deep beneath Earth's surface in cathedral-like chambers, accessible only through narrow passages, often with fanciful names such as Contortionist's Delight or Fat Man's Squeeze. In these pitch-black and usually humid confines, mineral formations range from iciclelike deposits that can weigh tons to delicate crystals that shatter at the slightest touch. Although scientists have long understood the chemical processes that sculpt many cave formations, they've only recently come up with a mathematical model that explains some of their shapes.

An even fuller explanation of the intricate decor will also have a biological component, according to researchers who are characterizing the unusual bacteria that live in caves. In Mexico's Cueva de Villa Luz, as in many others, moist surfaces bear gleaming coats of mineral-depositing bacteria, filmy ribbons of their microbial kin undulate in cave-floor pools and streams, and damp globs of microorganisms hang from the walls. Some types of mineral deposits that form in caves appear to be produced by communities of bacteria or by the environmental conditions that they create. On the opposite side of the coin, some of the same organisms are threatening prehistoric cave art.

ROCKY HANG-UP — Scientists have only recently developed a mathematical model that explains a stalactite's carrotlike profile.

ISTOCKPHOTO

DANGLING DEPOSITS Cave formations come in numerous shapes and sizes, and many of their names—popcorn, cave bacon, and soda straw, for example—seem to have sprung from the minds of imaginative—and hungry—cavers. The two formations best known to noncavers, however, bear the names *stalactite* and *stalagmite*. Pity the grade school test taker who forgets that the c in *stalactite* stands for "ceiling" and the g in *stalagmite* stands for "ground."

Stalactites, stalagmites, and other cave deposits form when water picks up minerals as it percolates through sediments and then seeps into a cave. If the water has traveled through limestone on its journey, it typically is saturated with calcium carbonate and carbon dioxide, says Raymond E. Goldstein, a physicist at the University of Arizona in Tucson. This seepage can also contain trace amounts of a wide variety of elements.

In the first fraction of a second after water seeps from a cavern ceiling, some of the gas dissolved in the seepage enters the humid air because the cave's air isn't saturated with carbon dioxide. This process, a gentle fizzing like that in soda pop, causes the water droplet to become more acidic, Goldstein says. As a result, some of the calcium carbonate in the droplet crystallizes on the cave ceiling, and—voilà!—a stalactite is born.

As seepage continues, new droplets hang from this bump and leave their crystalline residue. When droplets fall to the cavern floor, the dissolved minerals that they carry often accumulate there as stalagmites. When a stalactite and its underlying stalagmite have nearly grown together, the deposits' shapes are almost perfect mirror images. Further growth melds the formations into a column with a narrow waist, which continues to thicken as the minerals precipitate from the water flowing over the surface.

The growth of a stalactite is incredibly slow—typically, it takes a century to add a centimeter of length. At first, stalactites grow irregularly, but once they've reached a length of 5 cm or so they take on a characteristic shape. From the side, the formation doesn't look like a perfect cone but bulges like a plump carrot, says Goldstein.

Although scientists had long recognized this distinct profile, no one had explained how stalactites end up with their bulging shape, he notes. Now, Goldstein and his colleagues have come up with a mathematical model that reproduces a stalactite's silhouette.

Earlier experiments had shown that the rate of mineral precipitation on each small patch of stalactite correlates with the thickness of the layer of water that's dribbling down the forma-

tion. At the top of a stalactite, where the layer of flowing water may be only a few micrometers (μm) thick, calcium carbonate is deposited slowly, says Goldstein. Near the bottom of the formation, where the flowing water is spread over a smaller area, the film of water is thicker and crystals form more quickly.

Because the top of the stalactite has a larger diameter and more surface area than the bottom does, more rock is deposited there overall. However, the more-rapid mineral deposition at the bottom portions widens the formation to create the characteristic carrot profile. Goldstein and his colleagues reported their findings in the August 2005 *Physics of Fluids*.

When the seepage rate into a cave is extremely slow, mineral-laden droplets can hang on the ceiling for a long time before they fall. In such a case, the calcium carbonate crystallizes in a ring shape. The crystals that precipitate from subsequent droplets extend the ring into a delicate tube, generating a so-called soda straw that can grow several centimeters long, says Goldstein.

Only about 1 percent of the calcium carbonate that's dissolved in the water flowing down a stalactite remains on that formation, Goldstein and his colleagues estimate. The rest is carried to the cave floor within the dripping water. Over time, the deposits from drips can produce stalagmites.

Although his team's model doesn't address those structures' formation, Goldstein speculates on how a stalagmite's shape develops. As stalactites do, stalagmites grow irregularly at first. The crystals accumulate in a broad, random pattern, probably because the mineral-rich droplets splash when they hit the cave floor, says Goldstein. As the mineral layers thicken and the formation grows upward, the distance through which the droplets fall becomes shorter, so the droplets splash less when they strike and the stalagmite takes on a more predictable carrot shape that's often the mirror image of the stalactite above it, he proposes.

GOLDEN RING — Cave formations called soda straws develop as crystals grow from a ring-shaped deposit on the ceiling of a cave. A drop of water hangs at this soda straw's tip.

ANDERSON/DARKLIGHTIMAGERY.NET

BUILT BY BUGS? Hundreds of types of rock appear in cave formations. The most abundant ones are forms of calcium carbonate deposited when mineral-rich waters seep into an open space underground. Increasingly, however, researchers are finding that many exotic cave formations are in one way or another associated with bacteria.

For instance, some of the walls in New Mexico's Lechuguilla Cave are coated with gnarly bumps of various sizes, a type of formation that cavers have nicknamed popcorn. The smallest bumps are 2 to 3 millimeters across and look more like bacterial colonies growing in a petri dish than like popcorn, says Hazel A. Barton, a microbiologist at Northern Kentucky University in Highland Heights. The largest knobs of the hard, white rock are thumb-size replicas of the popped kernels of the snack that shares their name.

Microscopic analyses of the bumps and knobs show layers of bacteria that have been fossilized in calcium carbonate. Barton and her colleagues have scraped samples of unidentified live bacteria from cave walls and took them back to the lab. When fed a calcium-containing substance, the microbes made crystals of calcium carbonate, the same material that encases their fossilized brethren.

Microbes are present on most moist cave surfaces. However, because not all such bacteria can be cultured in the lab, it's often difficult to confirm which organisms, if any, are responsible for forming cave minerals, says Brian Jones, a geologist at the University of Alberta in Edmonton who has studied cave microbes.

In some instances, bacteria appear to play a more indirect role, merely creating the environmental conditions under which dissolved minerals are more likely to crystallize. For example, quartz pebbles and rocks in many cave-floor streams are coated with a layer of manganese oxide–containing minerals that can range from fractions of a millimeter to a few millimeters thick, says William B. White, a geochemist at the Pennsylvania State University in University Park. The predominant mineral in the coatings is birnessite, a manganese oxide compound that includes traces of sodium, calcium, and potassium.

Microscopic analyses of the birnessite coatings reveal many fossilized bacteria, so White speculates that those organisms derived energy from the manganese dissolved in the water that flowed over them. During the energy exchange, the manganese ions were converted to an insoluble form that then precipitated to form the birnessite.

At this stage of research, White says, it's unclear whether the microbes had a role in the coatings' formation or whether they simply inhabited the veneer after it formed.

The pool-meringue formation in Carlsbad Caverns may represent a stronger link between microbes and cave minerals. Scattered throughout the meringue are smooth tubes 2 to 3 μm long and less than 1 μm in diameter. That's the right size and shape to be microbial filaments, says Melim.

Lab results also hint that the filaments have a microbial origin. Compared with the rock that encased them, the microscale tubes are more resistant to mild acid and contain slightly more carbon.

STARVATION DIET Ecologically, caves are some of the world's most isolated environments. That seclusion offers stability: In large caves, temperatures rarely fluctuate, and the humidity in caves receiving a steady flow of mineral-rich groundwater stays close to 100 percent. "It's like a sauna, only a lot cooler," says Jones.

The isolation and stability also make several cave features valuable recorders of geologic and even climatic history. The ratio of oxygen isotopes in a sample of carbonate can provide clues about the temperature at which the cave mineral crystallized. While soil temperatures at or near Earth's surface rise and fall with the seasons, these fluctuations are tempered in deep caverns. Therefore, a deep cave's temperature matches the average annual temperature at ground level directly above it.

Although useful to scientists, a cave's isolation from Earth's surface causes problems for organisms living there, says Barton. It's pitch-black deep inside a cave, so no food chain can be based on photosynthesis. Many microbes obtain energy by breaking down rocks and taking advantage of the chemical energy from those reactions (*SN: 11/15/03, p. 315*).

Most of the nutrients available to support life are those carried in by groundwater. Each liter of water seeping into a cave typically carries between 15 and 50 micrograms of organic carbon, about one-thousandth the concentration that's considered a starvation diet for microbes living at Earth's surface. Forced to make a living from such slim pickings, the cave-dwelling organisms have developed unusual techniques for extracting energy from their surroundings.

"These bacteria are incredibly starved, but they're incredibly diverse," says Barton.

With that variety in the face of adversity, microbes have evolved complex communities that work together to efficiently process the minuscule quantities of nutrients that flow their way, she notes.

These communities take many forms, including slick films on rock walls, mats in the cave's streams and pools, and moist globs that geologists have dubbed snottites.

Microbes quickly take advantage of any nutrients brought into the cave by human or animal explorers as well as by seeping water, says Penelope J. Boston, a microbiologist at the New Mexico Institute of Mining and Technology in Socorro. Ropes installed by spelunkers in Lechuguilla Cave are being slowly consumed by fungi, she notes. Tubing used to siphon drinking water from cave pools, if left dangling into the water, soon gains a coating of microbes that derive nutrition from organic compounds that leach from the plastic. Even the hair and skin cells shed by the occasional caver provide a source of nutrition for cave bacteria, says Boston.

ART IN DANGER — The prehistoric art in many European caves, such as this bull depicted in France's Lascaux Cave, is threatened by microbes that consume the ancient pigments.

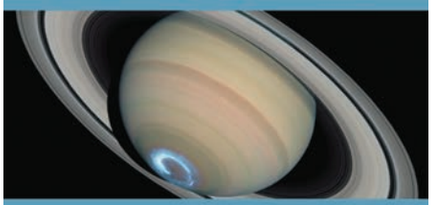
The microbial penchant for consuming any substance with nutritive value poses a threat to some of humanity's priceless works of art, the cave paintings that are scattered across much of Europe. Some of those works date back to the midst of the last ice age. To make their paints, the prehistoric artists mixed minerals such as iron oxide and organic substances such as charcoal into binders such as vegetable oils and fats—appetizing ingredients all, for a starving microbe.

Recent surveys have found a wide variety of bacteria living on or near cave paintings at several sites, says Cesareo Saiz-Jimenez, a microbiologist at the Institute of Natural Resources and Agrobiology in Seville, Spain. Some of the more-renowned masterpieces under attack include cave art in France's Lascaux Cave and Spain's Altamira, La Garma, and Tito Bustillo caves. Scientists haven't worked out lab methods to grow many of the microbes attacking the paintings, so those organisms haven't been studied in detail. However, analyses of their DNA provide hints about their family relationships and lifestyles.

For example, cave paintings in Altamira Cave support microbes from the group Crenarchaeota, which can be found in many soils but also inhabit extreme environments such as near-boiling springs, Saiz-Jimenez and his colleagues reported in the January *Naturwissenschaften*. The same paintings also host microbes from the genus *Acidobacteria*, which often thrive in acidic soils. Such microorganisms threaten not only the cave art's pigments but also the underlying rock.

Attempts to kill or control the art-loving microbes with disinfectants might not work, say some cave-art conservators. They're concerned about damage by such cleansers to the rock. Furthermore, killing some of the microbes might simply shift the balance of power to an even more destructive set of organisms and thus accelerate damage rather than prevent it.

The best hope for the cave art, says Saiz-Jimenez, lies in continued research, which may yield insights into how to inhibit the growth of microbial communities and how to minimize the damage they're causing. ■



OF NOTE

ARCHAEOLOGY

Ancient text gives Judas heroic glow

A 1,700-year-old manuscript that has been conserved, authenticated, and translated by an international team of scholars describes Judas Iscariot, portrayed in the New Testament as a traitor, instead as a hero who handed Jesus over to authorities for crucifixion because Jesus asked him to do so.

The 26-page Gospel of Judas, a translation from Greek into the Coptic language of ancient Egypt, represents the thinking of early gnostic Christians, researchers announced April 6 at the National Geographic Society in Washington, D.C. A bishop in Roman Gaul made the first known reference to the Gospel of Judas in an A.D. 180 treatise attacking its idiosyncratic take on Christianity.

PAGING JUDAS The missing half-page of the Gospel of Judas.

The document, part of a deteriorating, leather-bound, papyrus manuscript found in an Egyptian cave more than 30 years ago, reached researchers in 2001 via an antiquities dealer. Investigators pieced together nearly 1,000 fragments of the text and performed radiocarbon dating of leather and papyrus samples. The writing's content and linguistic style revealed its gnostic origins.

Gnostics believed that salvation derived from secret knowledge, delivered by Christ to his disciples, about how people can escape their bodily prisons and return to a spiritual realm. The newfound manuscript says that Judas will be despised by the other disciples but will also be exalted over them for helping Jesus shed his bodily self and liberate his spiritual self.

The Gospel of Judas and other recently discovered gospels demonstrate "how diverse and fascinating the early Christian movement really was," remarks religion professor Elaine Pagels of Princeton University.

Still, the historical accuracy of the Gospel of Judas can't be confirmed, and the text is unlikely to replace New Testament accounts among Christians today, says the Reverend Donald Senior of the Catholic Theological Union in Chicago. —B.B.

BEHAVIOR

Stimulant use eases in U.S. children

The sharp increase in youngsters taking prescribed stimulants that was noted a decade ago largely leveled off between 1997 and 2002, according to an analysis of data from an annual national survey. Physicians commonly prescribe stimulants such as Ritalin and Adderral for attention-deficit hyperactivity disorder (ADHD).

For children age 18 or younger, stimulant use increased from 0.6 percent in 1986 to 2.4 percent in 1996. Over the next 5 years, that rate stayed at about 2.7 percent, say psychiatrist Benedetto Vitiello of the National Institute of Mental Health in Bethesda, Md., and his coworkers.

In 2002, 4.8 percent of 6-to-12-year-olds took stimulants, compared with 3.2 percent of 13-to-18-year-olds and 0.3 percent of children under 6 years of age, the researchers report in the April *American Journal of Psychiatry*. An estimated 2.2 million children received stimulant medication in 2002, compared with 2.0 million in 1997.

Annual surveys consisted of interviews with members of 7,200 to 11,700 households, as well as data from their pharmacies. Interviewers didn't determine whether stimulant users had ADHD, which occurs in 4 to 5 percent of the general population. —B.B.

GENETICS

Mutation blocks fat absorption

A newly discovered gene in zebrafish seems to prevent the animals from absorbing fat molecules from their diets. The finding could lead to new strategies to fight obesity, high cholesterol, and other lipid-related disorders in people.

Five years ago, Baltimore-based Steven A. Farber of the Carnegie Institution of Washington (D.C.) and his colleagues discovered mutant zebrafish larvae that don't absorb lipids from dietary fat. Since all cells need fat to function properly, this disorder killed the larvae soon after they hatched. The researchers suspected that a single gene was altered in the mutant fish.

In a new study, published in the April 4 *Cell Metabolism*, Farber's team zeros in on a gene that the researchers call *fat-free* (*ffr*). It's on the fish's chromosome 10. When the team inserted normal *ffr* into fish embryos carrying the mutant gene, the resulting larvae could process lipids as well as healthy zebrafish could.

To determine the gene's function, the researchers examined mutant fish larvae under the microscope. Compared with healthy larvae, the mutants' intestinal cells had grossly enlarged Golgi bodies, cell structures that process lipids and proteins. Rather than leaving these structures after processing, lipids in the mutant animals' cells became trapped inside.

Farber notes that the new findings give researchers a better understanding of how cells process lipids. Scientists may eventually exploit this knowledge to selectively control lipid processing throughout the body, he adds. —C.B.

MATERIALS SCIENCE

Microbe holds fast

A common aquatic microbe makes a sticky substance that produces "the strongest biological adhesion ever discovered," says biophysicist Jay X. Tang of Brown University in Providence, R.I. The adhesive might lead scientists to new water-resistant glues.

SUPER STICKER A *Caulobacter crescentus* cell (bottom)—with adhesive at the tip of its stalk—divides to produce a daughter cell (at top) with a flagellum.

The bacterium *Caulobacter crescentus* begins its life as a mobile, tail-sporting cell. As it matures, it loses its tail, or flagellum, and replaces it with a stalk that it uses to attach to rocks or other surfaces. The tip of the stalk secretes an adhesive made of sugars and proteins.

Tang and his colleagues measured the strength of the adhesive, which scientists call holdfast. They grew the microbe on a

OF NOTE

thin, flexible micropipette, then pulled away its body. The team calculated holdfast's strength by measuring how far the micropipette bent before the microbe detached from it, says Tang.

The adhesive's strength measured 68 newtons per square millimeter (N/mm^2), the researchers report in the April 11 *Proceedings of the National Academy of Sciences*. A single, hairlike protrusion on the toe of the much-studied gecko has an adhesive strength of about 10 N/mm^2.

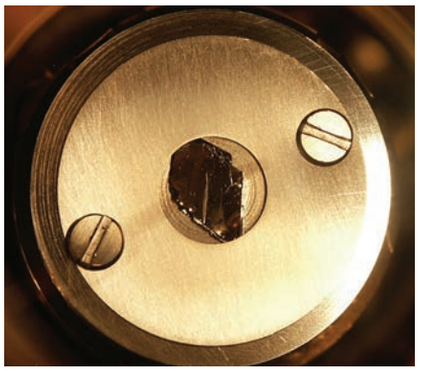
A wet, 10-square-centimeter surface slathered with holdfast could potentially hold about 70 tons, Tang says. —A.C.

PHYSICS

Abuzz about uranium

A type of atomic vibration never before seen in ordinary solid materials has been observed in uranium.

Using X rays and neutrons to monitor crystals of the heavy metal while they're being heated in a furnace, Michael E. Manley of Los Alamos (N.M.) National Laboratory and his colleagues have detected vibrations long-predicted to randomly occur in solids within isolated groups of two or three atoms.



HEAVY VIBES X rays pinpointed never-before-observed atomic vibrations in this ultrapure uranium crystal.

The solitary crystal vibrations, dubbed lattice solitons, appeared at temperatures of 177°C and higher. They probably occur in many solids but are harder to detect in them than in uranium, Manley says. He and his colleagues report their findings in the March 31 *Physical Review Letters*.

Other common atomic vibrations associated with heating spread easily throughout a material. But because the newfound vibrations have an unusually large amplitude and a frequency uncommon for uranium, they don't spread to surrounding atoms.

The solitary vibrations mimic structural defects that affect crystal malleability, Manley says. So, the new findings may account for a long-known, but unexplained drop in uranium pliability at 177°C. —P.W.

EARTH SCIENCE

Greenland glacial quakes becoming more common

The number of earthquakes that occur beneath surging glaciers in Greenland has doubled in the past 4 years, another possible effect of the melting ice sheet there.

Just 2 years ago, scientists reported a newly recognized phenomenon: earthquakes occurring beneath glaciers, probably from sudden slips of those ice masses (*SN: 1/3/04, p. 14*). The magnitudes of those quakes, which aren't associated with known faults, measure between 4.6 and 5.1, says Göran Ekström, a geophysicist at Harvard University.

Seismic data gathered from 1993 to late 2005 identify 136 quakes along the southeastern and southwestern coasts of Greenland, all of them originating beneath glaciers that flow at the fast pace of at least 2 kilometers each year, says Ian Joughin, a glaciologist at the University of Washington in Seattle.

About three-quarters of the temblors originated beneath the island's largest glaciers: Kangerdlugssuac, Jakobshavn Isbrae, and Helheim. Recent field studies have shown that all three glaciers have thinned and accelerated during the past 2 years (*SN: 12/17/05, p. 387*).

Greenland's glacial quakes are five times as common in the summer as they are in winter, which hints that melting promotes the events. Before 2003, the island never suffered more than 15 such earthquakes per year. Since then, the temblors have steadily become more frequent. Between January and October 2005, more than 30 glacial quakes occurred in Greenland, Ekström reports in the March 24 *Science*. —S.P.

PALEONTOLOGY

Dinosaur neck size reaches new extreme

Scientists have unearthed remains of a massive, plant-eating dinosaur whose neck may have measured twice the length of its body.

Herbivorous dinosaurs called sauropods are noted for their massive bodies and long necks. However, the partial remains of *Erketu ellisoni*, excavated from 100-to-120-million-year-old sediments in Mongolia, set a new record for neck-to-body proportions among the sauropods, says Daniel T. Ksepka, a vertebrate paleontologist at the American Museum of Natural History in New York.

Remains of the specimen include only six neck bones, the longest of which measure 49 centimeters. That dimension—plus the expectation that *E. ellisoni* had 15 neck bones, as its closest relatives did—suggests that the creature's neck may have been as much as 7.8 meters long, says Ksepka.

Dimensions of other bones, including the partial remains of one of *E. ellisoni*'s hind limbs, suggest that the sauropod's body was only about half the length of its neck. Although other sauropod species had necks that were longer than *E. ellisoni*'s, none of their necks was so lengthy in comparison with its body.

Ksepka and museum colleague Mark A. Norell describe *E. ellisoni* in the March 16 *American Museum Novitates*. —S.P.

NANOTECHNOLOGY

Long-lasting liposomes

A coat of nanoparticles can prevent a popular lab-made capsule from fusing with its neighbors in solution and losing its structure, researchers report.

Liposomes are hollow, spherical capsules made from phospholipids, the same components found in cell membranes. They can be used to carry drugs or other biological cargo. But individual liposomes are fragile and tend to fuse into blobs after a couple of days, spilling their contents prematurely in the process, says Steve Granick of the University of Illinois at Urbana-Champaign. "We want to keep them discrete," he says.

Granick and graduate student Liangfang Zhang studded the liposomes with polystyrene particles 20 nanometers (nm) in diameter. The nanoparticles covered about 25 percent of the 200-nm-diameter liposomes.

The enhanced liposomes remained stable in solution for 50 days, the researchers report in the April *Nano Letters*.

The method may enable researchers to make liposomes in high concentrations, in contrast to the dilute solutions used today to "prevent them from banging into each other," says Granick. About 75 percent of an enhanced liposome's surface is still free for attachments of biological molecules that can direct the liposome to a specific target, notes Granick. —A.C.

C. OPEIL/LOS ALAMOS NATIONAL LAB

Books

A selection of new and notable books of scientific interest

THE SECRET LIFE OF NUMBERS: 50 Easy Pieces on How Mathematicians Work and Think

GEORGE G. SZPIRO

Most people give little thought to how mathematicians work and how that work pertains to everyday life, Szpiro writes. He attributes the attitude to the misguided notion that any math but the most basic is too difficult for the average person. The author attempts to remove some of the mystery surrounding mathematics and its pursuit as a vocation. In 50 brief, entertaining, and often-whimsical stories, the author, a mathematician turned journalist, details such mathematical calculations as those behind making a calendar and laying ceramic tiles efficiently. He reveals some of the personal stories that are part of the history of mathematics. Vignettes reveal the role of math in political elections and why icicles have ripples. Szpiro's collection of puzzles and trivia can give readers a new appreciation for math. ***Nat. Acad. Press, 2006, 216 p., hardcover, $24.95.***

NIGHT SKY TRACKER: Backyard Astronomer's Logbook

LESLIE ALAN HORVITZ

In this unique, glow-in-the-dark handbook, amateur astronomers learn the techniques necessary for observing the heavens. As Horvitz points out, astronomy is an egalitarian pursuit, available to anyone with access to the night sky. In fact, many important discoveries, such as the length of a day on Uranus, have been made by amateurs. Horvitz provides a brief history of astronomy and the telescope and describes equipment and methods needed for the successful identification of celestial objects. The book includes star maps, definitions of astronomy terms, and instructions for "star hopping," or using the known location of a star or constellation to locate other objects in the sky. The author supplies background information on various types of stars, galaxies, nebulae, comets, and meteors. Finally, the book features a logbook for documenting observed objects. ***Barron, 2006, 224 p., paperback, $16.99.***

THE VIEW FROM THE CENTER OF THE UNIVERSE: Discovering Our Extraordinary Place in the Cosmos

JOEL R. PRIMACK AND NANCY ELLEN ABRAMS

In the span of 400 years, Earth has gone from the center of the universe—according to people's understanding—to a perhaps-insignificant planet in an immense expanse of stars and emptiness. Early scientists such as Galileo and Copernicus permanently altered what was a universally accepted theory of humanity's place in the universe. Though our understanding of the universe and its origins is now deeper than ever, our connection with it has become tenuous and to many people, unimportant, cosmologist Primack and writer Abrams argue. This assumption is mistaken, they also assert. Humans do hold a special place in the universe. The authors review the history of cosmology and myth, starting with the beliefs of ancient civilizations such as the Egyptians and Greeks. In part two of the book, Primack and Abrams use a question-and-answer format to convey information on the composition of the universe, its size and shape, the nature of time, and the search for extraterrestrial life. In the book's third and final portion, the authors explain that by understanding Earth, people can give more meaning to their place in the cosmos. ***Penguin, 2006, 400 p., hardcover, $26.95.***

THE SCIENCE OF SHERLOCK HOLMES: From Baskerville Hall to the Valley of Fear, the Real Forensics behind the Great Detective's Greatest Cases

E.J. WAGNER

Legendary author Sir Arthur Conan Doyle created one of literature's most famous characters, the detective Sherlock Holmes. Holmes was a man of science who prized fact, evidence, and meticulous forensics over assumption and superstition. In this book, Wagner merges her fascination with true-crime history with her love for the Holmes stories. Wagner tells readers, for instance, that as examination of corpses and autopsies became standard forensic procedure in the 19th century, Doyle's stories "A Study in Scarlet" and "The Resident Patient" reflected that trend. A man of science, Holmes debunked many of the prevailing misconceptions about death, including the belief that fingernails and hair continue to grow. Wagner outlines the history of forensic techniques, including fingerprinting, identifying poisons, studying footprints, and analyzing blood stains, and she details the roles that they played in Doyle's famous fictional cases as well as in the celebrated real-life cases of Jack the Ripper and Lizzie Borden. ***Wiley, John & Sons, 2006, 256 p., hardcover, $24.95.***

WILDFLOWERS IN THE FIELD AND FOREST: A Field Guide to the Northeastern United States

STEVEN CLEMANTS AND CAROL GRACIE

Everyone's seen them, but few people can identify them by name. They 're the wildflowers along a forest path, by the side of the road, and in almost every home owner's yard. Botanists estimate that there are nearly 2,000 wildflower varieties growing in the northeastern United States alone. This book covers 1,450 of them. It is divided by flower color and then subdivided by other clues to a flower's identity, such as leaf characteristics and the number and arrangement of various flower parts. A color photo, usually accompanied by insets showing leaf shape, shows every flower type and is accompanied by the species' common name, its scientific name, and a list of distinguishing characteristics. Also included is information on each plant's range in the Northeast, season of bloom, and habitat. This is a sturdy paperback designed to be thrown in a backpack or car glove compartment. ***Oxford University Press, 2006, 480 p., color illustrations and photographs, paperback, $35.00.***

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LETTERS

Creating a controversy

The real irony of ironies is that evolution has not evolved ("Evolution in Action: The trials and tribulations of intelligent design," *SN: 2/25/06, p. 120*). When even mainstream evolutionary scientists propose any change to "the fact of evolution," they are immediately silenced. That's not science. As it has been practiced by many, including Darwin, evolution is really a religion. As a result, no one should be surprised to find a reaction to this religion in the form of creationism, intelligent design, or whatever.

DAVE MCCALL, DETROIT, MICH.

Thanks for keeping us up-to-date on the designs a large group of Americans have on our educational system. As their name evolves, we should be ready with our disclaimer sticker: "This textbook contains material on Creation Science. Creation Science is an oxymoron based on a myth regarding the origin of living things. This material should be approached only by rational human beings with a well-developed sense of humor."

LARRY GIOANNINI, LAS CRUCES, N.M.

Paleontologist Stephen Jay Gould's description of the evolutionary theory of punctuated equilibrium points out that geologically abrupt appearance and subsequent extended stasis of species is a fair description of evolutionary reality. Also, while retaining a Darwinian base, punctuated-equilibrium theory says that many evolutionary changes have been directed by forces other than natural selection.

MARY A. CAYWOOD, HONOLULU, HAWAII

Gut feeling

Perhaps in addition to using a friendly strain of *Clostridium difficile* to crowd out the disease-causing variety in the gut ("Flora Horror: Hospitals struggle with a serious new gut microbe," *SN: 2/18/06, p. 104*), other species of benign bacteria could be reintroduced at the same time. This might be done inexpensively using "probiotic" bacterial cultures already being sold by some health food companies.

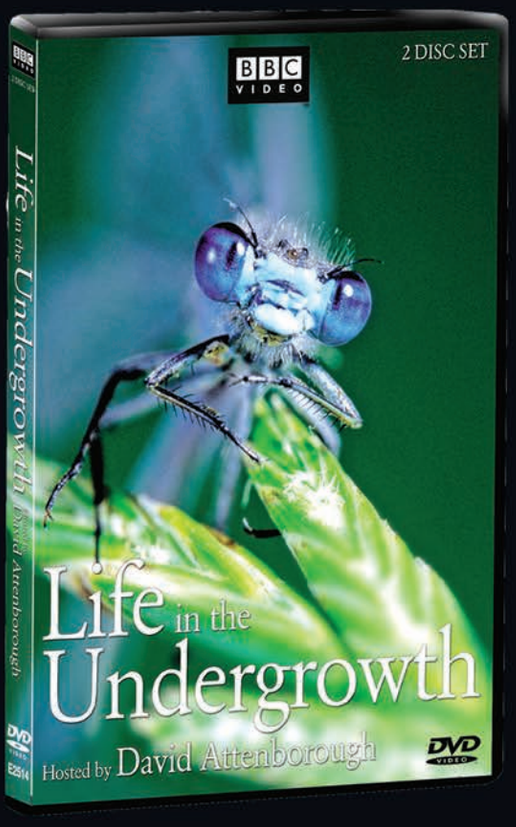
MICHAEL DUNPHY, NAPERVILLE, ILL.

Researchers have tested benign bacteria against C. difficile, *with some reported success (*SN: 2/2/02, p. 72*). But a review last year concluded that there isn't sufficient evidence for the routine use of probiotics to prevent or treat* C. difficile *infections.* —B. HARDER

For Every One of Us There Are 200 Million of Them

Discover a World Teeming with Secrets and Surprises

Join David Attenborough on his groundbreaking exploration. Thanks to technical innovations in lighting, optics and computerized motion control, the turbulent, super-organized world of invertebrates is finally revealed from the perspective of its extraordinary inhabitants.



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