SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

APRIL 1, 2006 PAGES 193-208 VOL. 169, NO. 13

microbial high jinks

brain quirks for high IQ

beefing up pork's benefits

less sleep, less slender?

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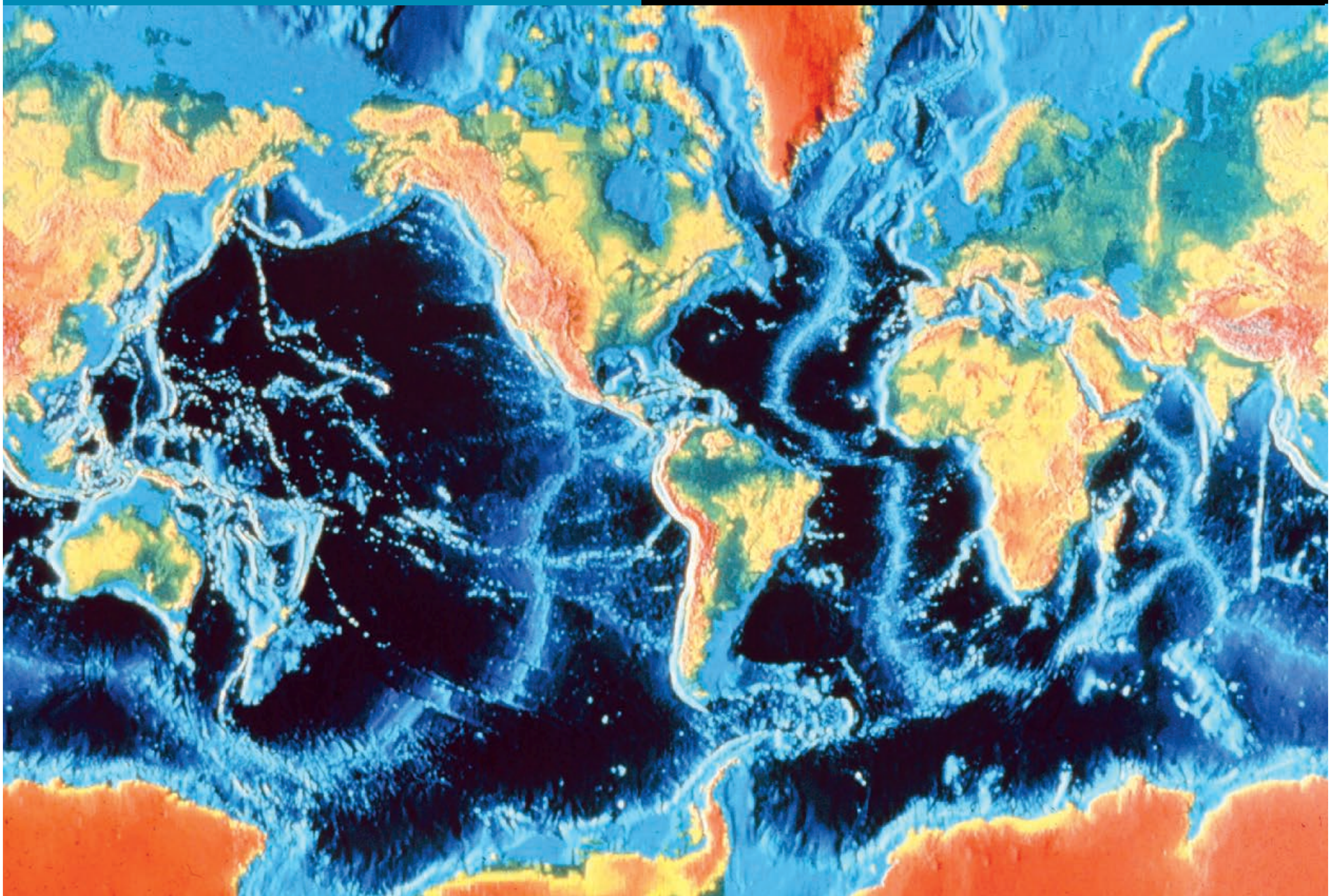

seafloor surprises

HOW CRUST FORMS AT ULTRASLOW RIDGES

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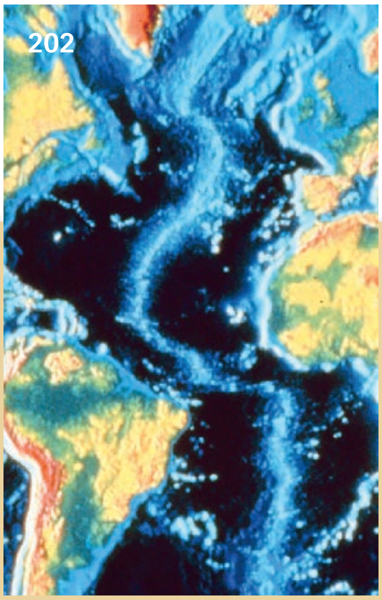

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Cover At ultraslow-spreading ridges, tectonic plates move at a snail's pace, but oceanographers are quickly getting interested. Long hidden under the most remote ocean waters, these geological formations are giving scientists fresh insight into how Earth's crust forms. (NOAA) Page 202

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Science News (ISSN 0036-8423) is published weekly on Saturday, except the last week in December, for $54.50 for 1 year or $98.00 for 2 years (foreign postage is $18.00 additional per year) by Science Service, 1719 N Street, N.W., Washington, DC 20036. Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

POSTMASTER
Send address changes to **Science News**, P.O. Box 1925, Marion, OH 43306. Change of address: Two to four weeks' notice is required—old and new addresses, including zip codes, must be provided.

EDITORIAL, BUSINESS, AND ADVERTISING OFFICES 1719 N St. N.W., Washington, D.C. 20036 202-785-2255; scinews@sciencenews.org.
LETTERS editors@sciencenews.org

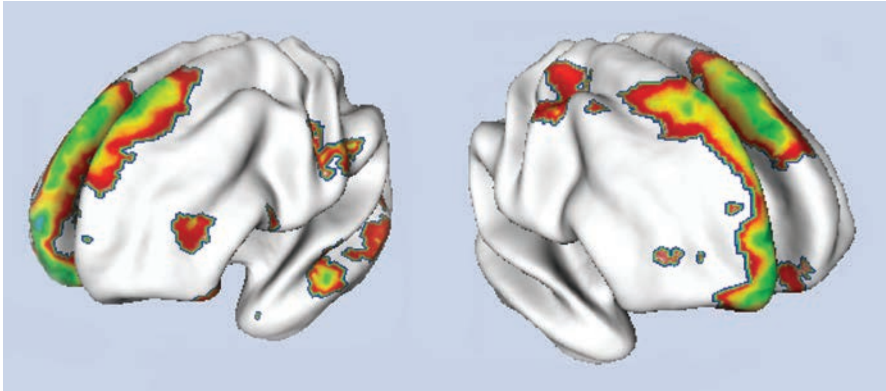
SUBSCRIPTION DEPARTMENT P.O. Box 1925, Marion, OH 43306. For new subscriptions and customer service, call 1-800-552-4412.

Science News (www.sciencenews.org) is published by Science Service, a nonprofit corporation founded in 1921. The mission of Science Service is to advance the understanding and appreciation of science through publications and educational programs. Visit Science Service at www.sciserv.org.

SCIENCE NEWS
This Week

Smarty Brains

High-IQ kids navigate notable neural shifts



THICKHEADED Colored areas of these brain maps highlight regions, mostly located toward the front of the brain, where superior-IQ children developed especially thick cortical tissue by about age 12, compared with average-IQ kids.

NIMH CHILD PSYCHIATRY BRANCH

The road to exceptional intelligence is paved with dramatic neural alterations, a new brain-imaging study finds.

Critical parts of the brain's outer layer, or cortex, thicken more rapidly during childhood and thin more drastically during adolescence in individuals with extremely high IQ scores compared with peers of average or moderately above-average intelligence, say neuroscientist Philip Shaw of the National Institute of Mental Health in Bethesda, Md., and his colleagues.

The scientists propose that distinctive brain growth in superior-IQ youth reflects prolonged development of neural circuits that contribute to reasoning, planning, and other facets of analytical thinking.

"Cortical thickness at any one age tells you next to nothing about intelligence," Shaw says. "What's important is that cortical development occurs differently in extremely clever kids, possibly as a result of particularly efficient sculpting of the brain."

The report appears in the March 30 *Nature.*

The researchers used a magnetic resonance imaging scanner to track brain changes in 307 children and teenagers deemed free of psychiatric or neurological disorders. Most volunteers submitted to two or more brain scans at intervals averaging 2 years. Participants also completed a verbal-and-nonverbal IQ test upon entering the study as children or teenagers.

Earlier research had indicated that IQ scores don't change much over time, so it wasn't necessary to administer intelligence tests more than once, Shaw says.

The sample was divided into three groups: 91 youngsters with "superior" IQ scores of 121 to 149, 101 with "high" scores of 109 to 120, and 115 with "average" scores of 83 to 108. Each group yielded about 200 brain scans.

The researchers used a computer program to analyze average patterns of cortical development, from age 7 to 18, in each group.

To Shaw's surprise, the 7-year-olds with the highest IQ scores displayed slightly thinner cortices than their peers did. However, the superior-IQ children then experienced particularly rapid cortical thickening, which peaked at age 11 to 12. The same children's cortices thinned dramatically thereafter.

In average-IQ kids, cortical thickness peaked at age 8 and then declined, but to a lesser extent than was observed among superior-IQ kids.

High-IQ youngsters displayed a pattern of brain development more closely resembling that of average-IQ peers than that of the superior-IQ group. The three groups ended up with about the same cortical thickness.

The most prominent cortical changes, especially in superior-IQ children, occurred in the prefrontal cortex, an area already implicated in analytical thinking. It's not known what cell processes mediate childhood thickening and thinning of cortical tissue, Shaw notes.

Although IQ measures a narrow set of analytical abilities, the new findings highlight how neural development cultivates intelligence, remarks psychologist Elena Grigorenko of Yale University. "Children are not born 'clever' or 'not clever,'" she says. "Cognitive functioning is related to the changing dynamics of a complex cascade of brain-maturation processes."

Kids in Shaw's study who came from the wealthiest families tended to have the superior IQ scores, Grigorenko notes. This raises the possibility that environmental factors, from diet to social activities, stimulate the pattern of brain development exhibited by superior-IQ kids.

Psychologist Richard Passingham of the University of Oxford in England agrees but notes that past studies have shown that genes also substantially influence brain structure and individual differences in general intelligence (*SN: 2/8/03, p. 92*). —B. BOWER

XXL from Too Few Zs?

Skimping on sleep might cause obesity, diabetes

Widespread sleep deprivation could partly explain the current epidemics of both obesity and diabetes, emerging data suggest.

Too little sleep may contribute to long-term health problems by changing the concentrations of hormones that control appetite, increasing food intake, and disrupting the biological clock, according to Eve Van Cauter of the University of Chicago.

Van Cauter and other researchers discussed possible links between sleep deprivation, expanding waistlines, and obesity-related problems this week in Washington, D.C., at a meeting titled A Scientific Workshop on Sleep Loss and Obesity: Interacting Epidemics.

Researchers have observed that people who sleep less than 7 to 8 hours a night have elevated rates of obesity and diabetes. In late 2004, Karine Spiegel of the Free University of Brussels in Belgium and Van Cauter conducted experiments in healthy men showing that forced sleep restriction for 2 days increased appetite and triggered changes in the appetite-related hormones ghrelin and leptin (*SN: 4/2/05, p. 216*). The observed ghrelin elevation and leptin suppression may have encouraged food intake, Spiegel says.

Before that pivotal study, tests had demonstrated that obesity could disrupt sleep, but few experiments had investigated whether lack of sleep could contribute to obesity.

Preliminary results close in on an independent relationship between sleep loss and diabetes. Spiegel, Van Cauter, and their colleagues collected data from 13 volunteers who habitually sleep about 5 hours per night and from 14 others who sleep about 8 hours per night. The groups had similar body weights and ages.

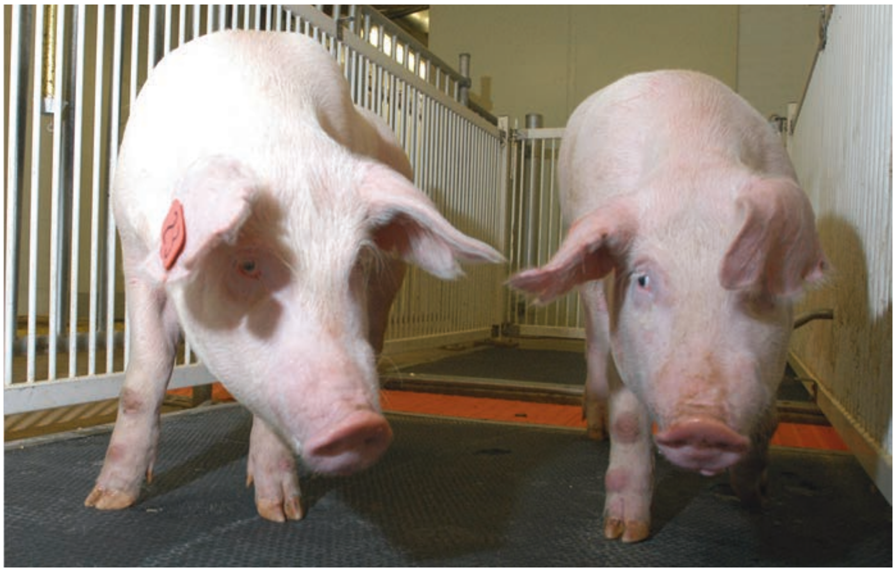
Spiegel reported at the conference that the people who sleep less produce markedly elevated quantities of the hormone insulin. Their high insulin production reflects a state, called insulin resistance, that can be a harbinger of diabetes, Spiegel says.

In another new study reported at the conference, Emmanuel Mignot of Stanford University Medical School and his colleagues tested about 2,000 employees of Wisconsin government agencies. Obesity was common in that population, and volunteers who slept either significantly less or more than the overall average tended to be heavier than people getting a moderate amount of sleep, Mignot reports. Compared with people who slept 8 hours a night, those who slept 5 hours had 16 percent lower leptin concentrations and 15 percent higher ghrelin concentrations in their blood.

Mignot and his colleagues have launched a yearlong trial that will test whether prescribing extra sleep can make some obese people lose weight. He hypothesizes that an extra 1.5 hours of sleep per night might produce weight losses of 3 to 4 percent.

But Van Cauter says that when her team previously asked patients to increase nightly sleep for extended periods of time, the changes in behavior lasted only a few days.

Short sleep might encourage overeating independent of its hormonal effects, says Mignot. "When people sleep less, they have more time for eating," he notes. —B. HARDER



LITTLE PIG, LITTLE PIG These transgenic animals have four to five times pigs' normal concentration of healthful omega-3 fatty acids in their tissues.

Pigging Out Healthfully

Engineered pork has more omega-3s

Bringing home the bacon may soon lead to a healthier meal. In a feat of genetic engineering, scientists have created pigs that sport much higher concentrations of omega-3 fatty acids in their tissues than normal pigs do.

Many studies have suggested that eating omega-3 fatty acids can prevent or reduce heart disease and other health problems. These natural oils are found only in cold-water fish, flax seeds, and a handful of other foods that are often expensive or difficult to obtain. Yet a person must consume a gram or two of omega-3 fatty acids each day to experience health benefits, says geneticist Yifan Dai of the University of Pittsburgh.

Seeking a cheap and readily available source of omega-3 fatty acids, Dai and his colleagues engineered pigs to produce large amounts of the nutrient. Their work expanded on a study published 2 years ago in which Dai's colleague Jing X. Kang of Harvard Medical School in Boston engineered omega-3–making mice (*SN: 3/6/04, p. 157*).

The secret to producing the omega-3–rich animals lies in a gene called *fat-1*, which was isolated from the roundworm *Caenorhabditis elegans*. The worm uses this gene, which isn't normally present in mammals, to convert the less healthful, more common oils known as omega-6 fatty acids into the omega-3 variety.

The researchers inserted *fat-1* into cells isolated from male fetal pigs. They then put the nuclei of these cells into pig eggs that had had their own nuclei removed. These altered eggs were transplanted into sows, which served as surrogate mothers.

Of 10 piglets born to these sows, 3 had omega-3 concentrations four to five times as high as normal. Dai's team reports these results in an upcoming *Nature Biotechnology*.

Nutrition researcher Alice Lichtenstein of the Friedman School of Nutrition at Tufts University in Boston notes that it's unclear whether the engineered pork will be as healthy as fish and other natural sources of omega-3s. "If you're going to eat bacon from these pigs, you're also going to get lots of saturated fat," she says. A heavy dose of heart-unhealthy saturated fat could overshadow the omega-3 fatty acids' benefits, and lean cuts of the engineered pork contain little of the health-promoting fatty acids.

It will take years of study—and approval from the U.S. Food and Drug Administration—before pork products derived from genetically engineered animals may become publicly available. But if the omega-3–rich pigs eventually make it to market, perhaps even people who are reluctant to consume genetically modified foods could be convinced to eat the other white meat, notes neuroscientist Greg M. Cole of the Veterans Affairs Medical Center in Sepulveda, Calif.

"Those who have issues with transgenic foods should be reminded of the current issues with omega-3 from fish, including mercury, fat-soluble toxins, high prices, and diminishing supplies," he says. "If we want the whole world to receive the health benefits of omega-3s, we shouldn't say, 'Let them eat salmon.'" —C. BROWNLEE

Cool Wire

Nanostructure boosts superconductor

Superconductive wire remains a wannabe technology for many applications. Although some ceramic wires can compete with conventional copper for use in power lines, they don't meet requirements for widespread use in industrial devices containing wire coils, such as transformers and motors.

Now, a ceramic-wire prototype has performed so well in superconductivity tests that it could win against copper across the gamut of expected uses, its inventors claim. Whether the wire could be made abundantly and cheaply remains uncertain.

UNIV. MISSOURI-COLUMBIA

Pin-length strips of the wire, a narrow, layered ribbon including a nickel-alloy base and a superconductive ceramic film, attained record currents in magnetic fields like those in coils, report researchers at Oak Ridge (Tenn.) National Laboratory.

"This is a first demonstration that, in a single superconducting wire, you can have such performance," says Amit Goyal.

Goyal and his colleagues describe the new wire in the March 31 *Science.*

"We think this is a very important result. It's a world-record result," comments Alexis P. Malozemoff of the wire-manufacturing company American Superconductor in Westborough, Mass.

It's a "proof of principle" but not an advance that could be incorporated directly into American Superconductor's manufacturing approach, Malozemoff adds.

On the other hand, Goyal says, companies in Japan and Germany are pursuing a wire-making process compatible with the Oak Ridge advance.

Since the early 1990s, many researchers have made wires from ceramic materials, known as high-temperature superconductors, that carry electricity without resistance (*SN: 11/30/02, p. 350*). Although the materials superconduct only at less than about 135 kelvins, that's balmy compared with the temperatures near absolute zero required by some other superconductors.

American Superconductor and other companies already produce such a wire, but it contains silver, making it pricey. Furthermore, it's superconductive in high magnetic fields only when it's cooled to about 30 K. A magnetic field tends to disrupt superconductivity when eddies of electric current created by the magnetic field move along with the main current.

In wires such as the Oak Ridge prototype, structural irregularities in the ceramic coating can preserve superconductivity by holding the eddies in place.

Using a laser in a vacuum, the Oak Ridge team vaporized a mixture of powders of the superconductive compound yttrium barium copper oxide (YBCO) and of barium zirconate, which doesn't superconduct. As the vapor condensed on the ribbon, it formed a film of YBCO containing nanometer-scale disks of barium zirconate.

The Oak Ridge team reports that the barium zirconate disks stack up in orderly columns that span the film. The wires' exceptional performance stems from how well such columns pin down the eddies, the group concludes.

Stephen R. Foltyn of the Los Alamos (N.M.) National Laboratory says that the Oak Ridge samples' performance is similar to that of the wires that he and his colleagues previously made of YBCO with randomly scattered barium zirconate particles.

David C. Larbalestier of the University of Wisconsin–Madison says that the Oak Ridge wire is an advance because its superconducting layer is thicker than that of earlier prototypes. Although he doubts that the vaporization method is compatible with manufacturing, he says, "the new result ... shows the technology has real legs." —P. WEISS

Awake and Learning

Memory storage begins before bedtime

Learning isn't a task that just happens overnight. While research has suggested that a good night's sleep aids in memory storage, some memory is processed while a person is still awake, a new study finds.

Previous research in both people and animals has found that the parts of the brain engaged in learning a task reactivate during sleep, perhaps transferring a memory from short-term to long-term storage (*SN: 10/11/03, p. 228*).

But sleep may account for only a few steps in the transfer process, says Philippe Peigneux, a neuroscientist at the University of Liège in Belgium. Rather than passively holding on to memories until bedtime, the wakeful brain may get a head start on memory consolidation.

To learn what happens to these memories during waking hours, Peigneux and his colleagues imaged the brains of 15 volunteers to determine how quickly they learned lessons from several tasks.

In the study, each participant spent 30 minutes learning either a spatial or a procedural task. In the spatial task, the subjects studied and then navigated routes through a virtual town to locate an object. In the procedural task, participants learned to press a button corresponding to each of four positions of a dot that appeared in a repeating sequence on a screen.

The researchers scanned the participants' brains with functional magnetic resonance imaging (fMRI) immediately before and after each learning episode. During the scan, a subject performed a separate, distracting task that didn't require any learning.

After a 30-minute break, the team scanned the subjects' brains a third time. After the participants performed each task one more time, a final, fourth scan revealed which parts of the brain were active while the subjects performed the task.

Activity in specific learning areas of the brain, as determined by the fourth scan, was higher after the initial task than before it. For the spatial task, activity increased immediately in the hippocampus and other regions corresponding to navigation. After the procedural task, increased activity didn't appear right away in some of the relevant brain regions. But activity did show up in all those areas by the third fMRI scan. For both tasks, brain activity indicative of memory processing persisted through the third scan, 1 hour after the task had been completed.

These findings, published in the April *PLoS Biology*, suggest that the brain can begin to process some memories almost immediately, even while subjects are performing unrelated cognitive tasks, the researchers report.

While previous neuroimaging studies had looked at what happens in the brain during a learning task, this is the first imaging study to track what happens "off-line" after a learning session, says neurologist Ilana Hairston of the University of California, Berkeley. That strategy eliminates any potential effects of concurrent learning in studies of memory consolidation.

"It's a unique experiment and remarkable work," Hairston says. "On the one hand, it supports the idea of off-line [memory] consolidation. On the other hand, it also suggests that sleep may not be necessary for the process." —C. GRAMLING

Coral Clues

Rise and fall of reefs record quakes' effects

Shallow coral reefs around islands west of Sumatra chronicled the uplift and subsidence that resulted from massive quakes that struck that region recently, a new study shows. From data recorded in this biological database, scientists may learn why two undersea ruptures stopped where they did.

D. NATAWIDJAJA/INDONESIAN INSTITUTE OF SCIENCES

THE RISEN DEAD The top of the coral in the foreground indicates the level of low tide at this site in Indonesia before March 28, 2005. That day, a magnitude 8.7 earthquake permanently lifted the spot almost 2 meters out of the water, killing the reef.

On Dec. 26, 2004, a magnitude 9.3 temblor beneath the Indian Ocean spawned killer tsunamis (*SN: 1/8/05, p. 19*) and a flood of scientific interest (*SN: 8/27/05, p. 136*). Researchers rushed to the affected region to install sophisticated instruments, many of them in time to record the effects of a magnitude 8.7 quake in March 2005 (*SN: 4/2/05, p. 211*). But some of the best sensors—the reefs surrounding the region's islands—had been in place all along, says Richard W. Briggs, a geologist at the California Institute of Technology in Pasadena.

Many corals, especially those in the genus *Porites*, naturally record sea level. They grow to the water's surface but can't tolerate dry conditions for more than a few minutes. Once a mass of corals including those species reaches the sea's surface, it stops growing taller but continues to grow laterally, says Briggs. Thus, a flat top on a *Porites* colony marks the previous level of a site's lowest tide. Briggs and his colleagues surveyed reefs around islands west of Sumatra to estimate quake-induced rises and falls. They report their results in the March 31 *Science*.

The two quakes approached the 100-kilometer-long island of Simeulue from different directions. The island's northwestern tip rose 1.45 meters during the December 2004 temblor, says Briggs. However, the southeastern tip of the island, farther from the quake's epicenter, didn't rise or fall noticeably.

In contrast, after the March 2005 quake, the island's northwestern tip held a steady elevation, while the southeastern tip was lifted about 1.65 m.

Reefs along the midsection of Simeulue rose only 50 centimeters or so in response to the 2004 and 2005 temblors, says Briggs.

That pattern suggests that in central Simeulue, stress on the fault had been relieved by previous small quakes, including one in 2002, or during periods when the fault had slipped without causing a temblor. That stress relief might have prevented the quakes of 2004 and 2005 from progressing through this region.

Alternatively, the geometry of the fault beneath the island may have arrested the progress of the quakes' ruptures, says Briggs.

Understanding why the Indonesian ruptures of 2004 and 2005 stopped where they did will be important for evaluating seismic risk throughout Southeast Asia, says Roger Bilham, a seismologist at the University of Colorado at Boulder. —S. PERKINS

Propelling Evidence

Cassini finds clues to source of Saturn's rings

Four propeller-shaped gaps in one of Saturn's main rings are the latest evidence that a shattered moon produced the planet's dazzling hoops. The discovery supports the theory that a comet or asteroid struck a large, icy Saturn moon about 100 million years ago and that the distributed debris formed rings. They cover a region broader than the distance between the Earth and its moon.

The 5-kilometer-long gaps turned up in images taken by the Cassini spacecraft on July 1, 2004, as it slipped through the rings before settling into orbit around Saturn. By performing a thorough analysis of faint features in the images, planetary scientists led by Joseph A. Burns and Matthew Tiscareno of Cornell University found the gaps in the bright, mostly homogeneous middle section of Saturn's A ring.

They suggest that the gaps were cleared out by moon fragments about 100 meters across, which still exist but are too small for even Cassini to see.

The moonlets represent an intermediate-size population of ring objects whose presence had been predicted by computer models but never discerned. Previous A-ring observations by spacecraft only found evidence of water-ice particles up to 20 meters across and two much larger, icy moonlets: 30-km-wide Pan and 7-km-wide Daphnis (*SN: 11/19/05, p. 328*).

Pan and Daphnis are massive enough to each clear a circular gap extending all the way around the ring. In contrast, a smaller moonlet would clear out two short arcs, one on either side of its location.

The Cassini images of the short gaps thus provide the first evidence for intermediate-size moonlets. Such ice chunks would be common if Saturn's rings arose from the breakup of a moon into a variety of large and small pieces, says Burns. He and his colleagues describe the findings in the March 30 *Nature*.

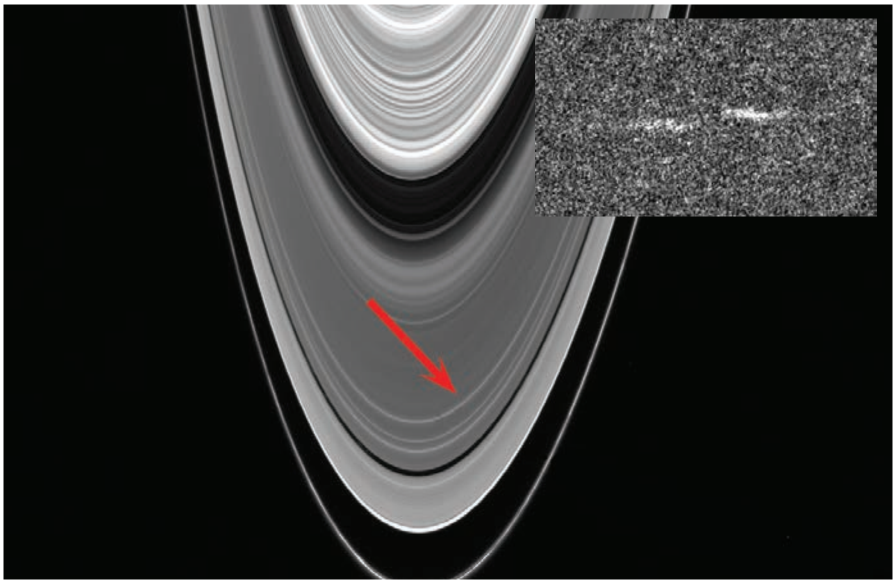
The new data don't support an alternative to the breakup model. In the alternative scenario, most of the material in Saturn's rings comes from small, primordial leftovers from the planet-forming disk of gas, dust, and ice that surrounded the young sun, notes Burns.

However, the evidence for the intermediate-size moonlets "connects the small particles to Pan and Daphnis," indicating that they're all fragments of a large moon that once orbited the planet, Burns adds.

Theorist Frank Spahn of the University of Potsdam in Germany agrees. He says that if the rings' particles were indeed relics from the birth of the solar system, Saturn's gravity and collisions among the particles would have prevented them from growing much larger than 10 m across.

Cassini photographed the four propeller-shaped gaps within a 2,500-square-kilometer patch of the A ring. The Cornell team's extrapolation suggests that the A ring alone houses some 10 million of the 100-m-diameter moonlets.

The gaps and moonlets could offer researchers insights about planet formation in the solar system and around other stars, Spahn says. In the process of accumulating matter, fledgling planets may create propeller-shaped gaps in the primordial disk from which they arise. The features now found in Saturn's A ring may be small-scale versions of such structures, Spahn suggests. —R. COWEN



SATURN'S WINGS A propeller-shaped gap (white streaks in inset) in Saturn's A ring (arrow) supports the theory that the planet's rings were created when a comet or an asteroid shattered a large Saturnian moon. A moonlet about 100 meters wide would have created the gap.

CASSINI IMAGING TEAM, JPL/NASA

THUGS AND BUGS

Cellular pathogens act like human criminals

BY CHRISTEN BROWNLEE

From across the street, a man clad in a black suit surveys an office building. Several of his henchmen have just cut the building's phone lines and scrambled its Internet and cell phone signals so that the workers inside have no way to summon help. Striding confidently, the man ducks into the building's service elevator. After punching in a secret code—learned from covert surveillance—he easily slips inside the thick metal doors and zooms upward.

The elevator drops him off on the top floor, where he spies a young woman sitting in a nearby office. "Can I help you?" she asks.

He says, "The name is Coli. Edward Coli. I'm a friend of your boss."

But before the assistant has time to dial her boss' extension, the intruder injects her and then her boss and the floor's other occupants with a chemical weapon. With these captives set to do his bidding, Coli's conquest is complete.

Think this takeover artist is just a piece of fiction? Change Edward's name to *Escherichia*, and you've got a different predator that shares elements of the modus operandi. A slew of findings shows that bacteria, viruses, and other pathogens cause infections with strategies similar to those that Edward and actual human criminals use.

With some laboratory detective work, scientists are discovering how various pathogens interact with their targets. New studies indicate that HIV scrambles cells' communications so that they can't summon help and that other viruses barge into a victim's cells by short-circuiting their protective barriers. Separate research suggests that a worm called the root-knot nematode sneaks past plants' defenses by disguising itself as a friend and that some bacteria inject one of a group of proteins that co-opt a cell's actions.

"A lot of things that we know about in cell biology come from studies of interactions with pathogens," says Jeffrey Bergelson of the Children's Hospital of Philadelphia. The more that researchers learn about these true crimes, the better they'll be able to prevent or stop them.

COMMUNICATION SCUTTLER At least one virus devastates the immune system by silencing the immune components that sound an alarm when they detect a foreign invader. Normally, an encounter with a pathogenic virus or bacterium prompts these components, helper T cells, to ooze proteins that alert other immune cells to work together to vanquish the intruders. But helper T cells don't issue their typical cry when they're attacked by HIV, the virus that causes AIDS.

Some researchers had theorized that HIV silences the cell's alarm when, to replicate itself, the virus tampers with a T cell's DNA. But Yechiel Shai and Irun Cohen of the Weizmann Institute of Science in Israel and their colleagues had a different idea. They suspected that the virus might specifically suppress the T cells' help signals, just as a human crook might cut a building's phone lines.

In a study published in the August 2005 *Journal of Clinical Investigation*, the researchers focused on a snippet of a protein that makes up HIV's viral envelope. This protein piece, called the fusion peptide, plays a pivotal role in merging HIV's envelope with a T cell's membrane, the first step in AIDS infection.

Shai's team affixed glowing molecules to purified fusion peptide and then watched through a microscope to see where the peptide attached when it was mixed with rat T cells. It stuck to two specific cell-surface molecules: one called cluster of differentiation 4 (CD4) and the other, T cell receptor (TCR).

Since both molecules trigger the cascade of gene activity that summons other immune cells to the scene, Shai and his colleagues wondered whether fusion peptide was disabling CD4 and TCR. Sure enough, when the researchers injected the peptide into rats that had been inoculated with protein pieces from tuberculosis bacteria, which normally spur a strong immune system response, the animals' T cells didn't secrete the chemicals that call up other immune cells.

> "A lot of things that we know about in cell biology come from studies of interactions with pathogens."
>
> — JEFFREY BERGELSON, CHILDREN'S HOSPITAL OF PHILADELPHIA

"When [fusion peptide] disrupts a T cell's communication, there is no alarm and HIV gets inside the cell," says Shai.

That's bad news for a person fighting HIV, but fusion peptide may be useful as a target for anti-HIV drugs. It might also be redirected to dampen the immune system in autoimmune diseases such as rheumatoid arthritis, Shai suggests. In fact, when the researchers injected fusion peptide into rats with a form of arthritis, the severity of symptoms dropped by more than 50 percent.

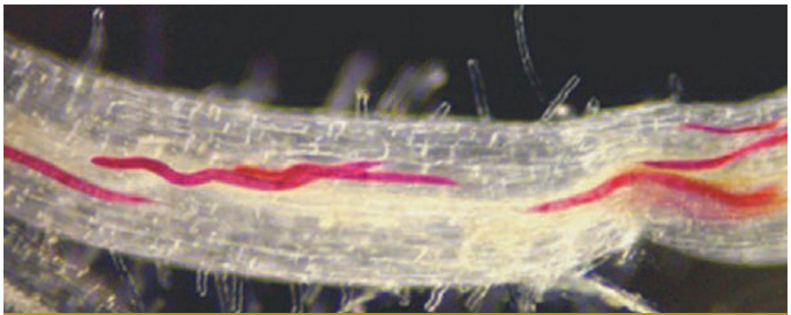
BREAK-IN ARTIST Some viruses seem to have figured out how to take advantage of a signal that sneaks them past strong protective barriers. Researchers have long known that people pick up group B coxsackieviruses (CVBs) through contaminated food or water. These microbes then travel to the intestines and pass into the epithelial cells that line the bowel wall. Once inside the intestines' tough barrier system, the viruses can cause meningitis or an inflammation of the heart called myocarditis. In infants, they occasionally produce a fatal, systemwide infection.

How these viruses sneak through the intestines' barrier was a mystery. Asymmetrical, oblong epithelial cells line the intestines. At the inside surface of the intestines, where they come into contact with digesting food and drink, the epithelial cells press snugly against each other to form a seal known as the tight junction.

To get inside the lining cells on their way to the rest of the body, CVBs need to attach to a cell-surface receptor that's buried within the tight junction. However, CVBs are too large to squeeze through the gap.

To get a look at how CVBs slip into cells, Bergelson and his colleagues used a method similar to one with which Shai's group studied HIV. The researchers attached glowing antibodies to some CVBs and then added them to human intestinal epithelial cells growing in a lab dish. Every few minutes, the team took a snapshot of the viruses, constructing a series of images while the infection took place.

The scientists report in the Jan. 13 *Cell* that CVBs, rather than heading straight to the tight junction, first attach to a protein on the surface of epithelial cells that's easily accessible outside the barrier. The images showed that when a virus sticks to this decay-accelerating factor (DAF), those combination particles clump together and then travel toward the tight junction. Several minutes afterward, the snug link between the cells loosens enough for the virus to slip through.



FAUX FRIEND — By disguising themselves as beneficial bacteria, root-knot nematodes (red) sneak into plant roots to steal nutrients.

BIRD

"Clumping DAF seems to trigger a signal that moves the virus to the tight junction," says Bergelson.

"Through evolution, variants of these viruses probably bound to lots of different things," he notes. "The one that bound to DAF hit pay dirt because DAF seems to take it to the tight junction," he says.

Scientists don't know what role DAF plays in normal body processes. Learning more about DAF could offer new ways to stop CVBs and related viruses from using it to sneak into cells, Bergelson adds.

SWEET TALKER Some pests get into their victims by mimicking beneficial microbes. Root-knot nematodes are destructive little worms, measuring about 1.6 millimeters in length, that cause an enormous amount of damage to agricultural plants. They exact their toll—to the tune of $100 billion per year worldwide—by burrowing into plant roots, then forcing plants to supply them with nutrients. Eventually, the roots become grossly misshapen, impeding a plant's uptake of water and nutrients from soil.

Since plants have strong defense systems to ward off other nefarious invaders, researchers have puzzled over why plants seem to invite root-knot nematodes inside. "Plants are defenseless against this pathogen—it's their Achilles' heel," says David Bird, a plant pathologist at North Carolina State University in Raleigh, N.C.

In a study published in the Feb. 22, 2005 *Proceedings of the National Academy of Sciences,* Bird and his colleagues reported evidence backing up a new theory: Root-knot nematodes sweet-talk their way inside plants by pretending to be friendly bacteria called rhizobia.

For about 60 million years, peas, beans, and other legumes have been engaged in a close business relationship with rhizobia. Plants supply the bacteria with energy, and in exchange, rhizobia convert atmospheric nitrogen into a form that plants use to make proteins.

"To set up this partnership, two conversations need to go on," says Bird. Plants secrete various signals called flavonoids that advertise their energy-supplying services, and in turn, rhizobia put out a chemical called NOD factor that identifies them as friends.

After plants check this natural security badge, tiny hairs on the plant roots become wavy and branched, then curl around the bacteria and welcome them inside.

Bird and his colleagues noticed that when they put root-knot nematodes near the roots of lotus plants, the root hairs branched and curled as if the roots had been introduced to rhizobia instead. Further investigation showed that plants encountering the nematodes activate the same genes that turn on in the presence of rhizobia. This result suggests that nematodes and the bacteria put off a similar—if not identical—signal.

"Our hypothesis is that through evolution, nematodes have learned about the detection system plants use for rhizobia and are exploiting it by secreting their own signal," says Bird.

When his team introduced nematodes to plants that had been genetically altered to not recognize rhizobia's NOD factor, the plants' root hairs didn't respond to the worms. Although these nematodes were only 10 percent as effective as normal ones in infecting plants, they didn't fail completely at breaking into plant roots. "Nematodes seem to have lots of arrows in their quiver," says Bird.

To reduce agricultural losses caused by this devious pathogen, researchers may need to figure out what other means the worms are using to disguise themselves and to find a way to stop plants from being fooled by the nematodes' signals.

WEAPON WIELDERS

A common set of weapons seems to underlie the wide range of bacterial species that cause what's broadly known as food poisoning. *Salmonella*, *Shigella*, and *Escherichia coli* aren't closely related, and each exacts its illness in a slightly different way. However, recent research suggests that these bacteria use different members of a family of 24 related proteins to force cells in their hapless victims to act as the bacteria demand.

Pharmacologist Jack E. Dixon of the University of California, San Diego and his colleagues found this group of proteins when they were investigating a single protein, called Map, that's pivotal in *E. coli* infections. Previous studies had shown that when this bacterium injects Map into cells, they respond by flexing their cytoskeletons, the internal fibers that set a cell's shape and move around its contents. The researchers suspected that the motions induced by Map pull apart the tight junction between intestinal cells, causing diarrhea that spreads *E. coli* to new hosts.

Since Map seems so integral to *E. coli* infection, Dixon and his colleagues wondered whether other bacteria might inject related proteins into cells to carry out similar functions. To investigate this question, the researchers ran a computer search through databases of known bacterial proteins. "We basically asked ourselves, 'What else looks like Map?'" Dixon says.

Eventually, the team came up with 24 candidate proteins, which bacteria tend to use in combination. All consist of a similar-length string of amino acids framed by tryptophan on one end and glutamate on the other. When the researchers injected these proteins into human cells growing in the lab, all of them seemed to act, as Map does, on the cells' cytoskeletons.

However, each protein influenced the function of a different cytoskeletal part. "It's like these proteins each contain a different zip code, and they're getting shipped to different places in the cell," says Dixon. For example, some proteins affected the fibers that shuttle nutrients and immune components around a cell, and others focused on the fibers that set the shape of the cell membrane. Dixon's team is investigating how each of these actions increases a pathogen's chance of survival.

Learning more about the mechanisms that these proteins use to seize control of a cell's normal functions could lead to new ways of stopping the criminal behavior of many types of bacterial infections.

Notes Dixon: "If we can understand how these proteins function, it will give us a leg up on understanding how to combat them." ■

UNCHARTED TERRITORY

Ultraslow ridges hold new clues to crust's formation

BY CAROLYN GRAMLING

At the top of the world in the late summer of 2001, the U.S. Coast Guard's icebreaker *Healy* carved a slow path through the ice-covered Arctic Ocean. On board, marine geologist Henry Dick sent dredge after dredge through the ice to the seafloor, searching for telltale rocks that would help shed light on how Earth's crust forms. "People said, 'You'll never get a single rock off the seafloor,'" Dick says. "They said, 'You can't dredge in the ice.'" But in fact, Dick's team collected more than 200 rocks—many of which turned out to be pieces of Earth's mantle.

Under the ice and 2 kilometers of water was a 1,800-km-long underwater mountain range known as the Gakkel Ridge. The *Healy*'s expedition, conducted in tandem with the German icebreaker *Polarstern*, was the first exploration to that Arctic ridge to attempt to collect geological samples.

The surprising discovery of mantle rocks indicated that Gakkel Ridge is one of only two places known on the planet where the tectonic plates that make up Earth's hard outer crust slide apart and expose large slabs of the mantle on the seafloor. That mantle is normally buried under 6 km of crustal rock.

The other site, the 8,800-km-long Southwest Indian Ridge (SWIR), is on the far side of the world. Like the Gakkel Ridge, the SWIR is utterly remote. It's located beneath treacherous high seas.

Oceanographers are only now beginning to explore these areas in detail. They have already made surprising geological finds, including the exposed mantle. They've also uncovered evidence at both ridges of hydrothermal vents, fissures in the seafloor through which circulating, magma-heated seawater escapes. Researchers say that these two ridges may represent a new class of tectonic boundary, called an ultraslow-spreading ridge. The finding offers scientists the chance to explore new ideas about how Earth's crust forms and to study the rich ecosystems spawned by the vents.

CUTTING THROUGH ICE — The U.S. Coast Guard's icebreaker *Healy* carves a path through the icebergs above the Arctic's underwater Gakkel Ridge. On its first research mission, *Healy* found signs of a new type of ridge.

DICK

LAYER CAKE For 3 decades, oceanographers have been studying the undersea creation of crust, Earth's outermost layer. Still, "we don't understand the crust at all well," Dick says. "We know more about the moon than the ocean floor."

The theory of plate tectonics is a blueprint for Earth's surface as it is continuously recycled. The crust is broken into plates that rest on a warm, soft layer in the mantle, the material that reaches all the way to Earth's core. Driven by heat from that underlying mantle, the plates shift, collide, and move apart. Where the plates pull away from each other, the crust is thinner and magma from the interior of the planet rises in response to lessened pressure from overlying rock. Much of the rising magma collects and solidifies in a reservoir below the surface, but when enough pressure builds up, it erupts as lava through thousands of volcanoes on the seafloor, where it ultimately cools and forms new crust.

This endless cycle of thinning crust, rising magma, and erupting lava occurs along the mid-ocean ridge system, a 55,000-km-long volcanic mountain chain that includes both Gakkel Ridge and SWIR. The system, divided by fault lines called transform faults that lie perpendicular to the ridge, circles the planet like a seam on a baseball.

Midocean ridges are classified into two groups: fast- and slow-spreading. Each group has characteristic geological features. At fast-spreading ridges, such as the East Pacific Rise, the plates move apart at a rate of 100 to 200 millimeters per year and are rapidly supplied with hot magma. These ridges are narrow with a tentlike shape, formed by sheets of lava flowing from a hot, buoyant central peak.

Slow-spreading ridges, such as the Mid-Atlantic Ridge, move at less than 55 mm per year and have a slower magma supply. Their topography is broader and rougher, with wide, deep rift valleys forming along the axis of the ridge.

Traditionally, scientists have envisioned most of the under ocean crust as a layer cake of three rock types. The layers correspond to different chemical stages of the magma as it emerges where the plates split and cool. Together, the layers provide a 6-to-7-km-thick covering over Earth's mantle.

That well-established model began to be questioned 8 years ago, when researchers exploring some sections of the slow-spreading Mid-Atlantic Ridge found small, widely dispersed areas of exposed mantle rock on the seafloor. The absence of the layer cake was surprising, says marine geologist Jian Lin, a colleague of Dick's at the Woods Hole Oceanographic Institution (WHOI) in Massachusetts.

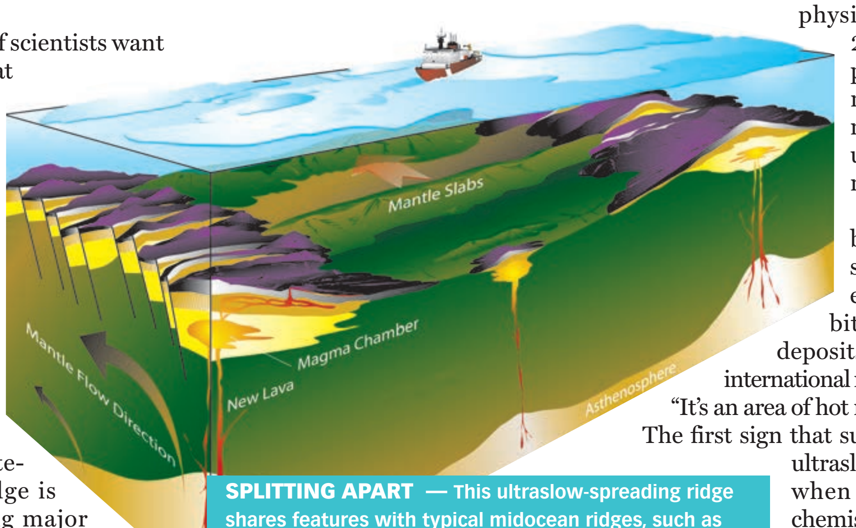
The finding suggested a dearth of magma flow in those sections. It challenged the view that the ocean crust is ubiquitous. It also raised the possibility that different chemistries and mechanics of mantle and seafloor rocks might affect plate spreading.

At the Mid-Atlantic Ridge sites, geologists discovered a rock called serpentinite instead of the basalt found on the seafloor elsewhere. Seawater interacting with exposed mantle creates serpentinite, which is softer and mechanically weaker than basalt. Serpentinite is "very different in chemical composition, in mechanism, in biological character" from crustal rocks, Lin says.

Another long-standing question is how the perpendicular transform faults develop. All the small, exposed areas of mantle rock were found at the ends of ridge segments, near the transform faults. That result suggests that the faults may be important for magma channeling. But, Lin says, "we don't know the mechanism yet of how they are formed at all."

Perhaps, some researchers speculated, a ridge with an even lower magma supply than that at the exposed-mantle sites on the Mid-Atlantic Ridge might be the place to look for these answers.

SOMETHING NEW If scientists want to know what happens at a ridge when the rate of spreading drops close to zero, Gakkel Ridge is the best bet, says marine geochemist and *Healy* cochief scientist Charles Langmuir of Harvard University. Nearly 20,000 km, or one-third, of the total midocean-ridge system is likely to fall into the new, ultraslow category, and Gakkel Ridge is "the slowest-spreading major portion," he says. There are hypotheses about the mantle "that can be tested there and nowhere else," Langmuir proposes.



SPLITTING APART — This ultraslow-spreading ridge shares features with typical midocean ridges, such as upflows of molten magma that collect below the surface (front left and right corners in image). At the ultraslow ridges, however, solid slabs of cooled mantle rock may rise directly to the seafloor (center of image).

P. OBERLANDER AND DICK

The Gakkel cruise, along with a series of voyages to the SWIR between 1997 and 2005, led researchers to the unexpected discovery that these ultraslow ridges were completely devoid of transform faults. Transform faults form only perpendicular to a ridge. Scientists had thought that the faults take up the stress between adjacent blocks of new seafloor and also fit together straight-edged ridge sections with curving plate boundaries. Researchers also thought that the faults might determine where the magma erupts along a ridge. Faults would create channels below the surface that focus magma into widely spaced volcanoes. But on the Gakkel, separate, scattered volcanoes were present even in the absence of faults, Langmuir says.

Instead of transform faults, an entirely new plate-boundary structure is linking the volcanoes on ultraslow-spreading ridges, Dick says. Between the volcanoes, the crust fractures and solid mantle rock rises up to the seafloor. These fractures and the mantle rock filling them extend from the ridge at various angles.

Another interesting feature of the ultraslow ridges is that they're much colder than even the slow-spreading ridges are. They ought to be brittler, Lin says, resulting in more earthquakes as the ridges strain to pull apart. But actually, there are fewer earthquakes recorded in the ultraslow-spreading areas. Perhaps earthquakes require transform faults, or the mechanically weak serpentinite might fill the cracks and lubricate the plates, says Lin.

He ponders the role of transform faults. "Are they not needed?" he wonders. "It's very exciting. When you are so close to the fundamental types of plate tectonics, your heart starts beating very fast."

HOT SITES Beyond the unusual seafloor surface, expeditions to both Gakkel and SWIR brought an additional surprising discovery: cloudy, warm patches in the water column that contain unusually high concentrations of minerals. These plumes are considered evidence of hydrothermal vents.

Until 2 decades ago, researchers had held that vents arise only on fast-spreading ridges, such as the East Pacific Rise, because slower-spreading ridges don't have enough heat. However, in 1985, a large hydrothermal vent field was discovered on the Mid-Atlantic Ridge. In early 2005, new vent fields turned up in slow-spreading parts of the ridge system in the Arctic and South Atlantic oceans.

These finds are "flying in the face of the consensus," says Peter Rona, a marine geologist at Rutgers University in New Brunswick, N.J.

Rona, along with his WHOI colleague Rob Reves-Sohn, organized one of three sessions dedicated to slow-spreading ridges and hydrothermal vents for the American Geophysical Union's December 2005 meeting. Just in the past 2 years, Rona says, research on hydrothermal vents at slow- and ultraslow-spreading ridges has taken off.

Although vents haven't been observed in an ultraslow-spreading area, scientists have dredged up bits of hydrothermal deposits from the seafloor. An international race is on to find the vents. "It's an area of hot research," Rona says.

The first sign that such vents might exist at ultraslow ridges came in 1996, when WHOI marine geochemist Chris German, then at the Southampton Oceanography Centre in England, found hydrothermal plumes at the SWIR. Though the data were scanty, they "proved the point that hydrothermal activity is there," German says.

Lin, with Dick and fellow WHOI scientist Hans Schouten, traveled to the SWIR in December 2000 and found more plumes along the ridge. The cruise "set new expectations," Dick says.

Then came the 2001 Gakkel cruise. Marine geochemist Hedy Edmonds of the University of Texas at Austin was invited on the off chance that evidence of hydrothermal vents would turn up. "The idea was that I would be really bored," she says.

She attached a sensor that recorded temperature, pressure, and optical backscatter—which detects suspended sediment—to each dredge line cast from the *Healy*. Of the dredge casts, 82 percent showed evidence of hydrothermal plumes (*SN: 1/18/03, p. 37*). The hydrothermal vent activity was "astounding," Edmonds says. "It got to be a joke halfway through the cruise."

In 2005, Lin returned to the SWIR as one of two U.S. scientists on the Chinese ship *DaYangYiHao*. He again detected hydrothermal plumes, including one that he calls particularly huge. "It's exciting because it's a very strong signal," Lin says.

Lacking the equipment to scour the seafloor, the researchers were unable to locate the vent. "But we are going back," he says.

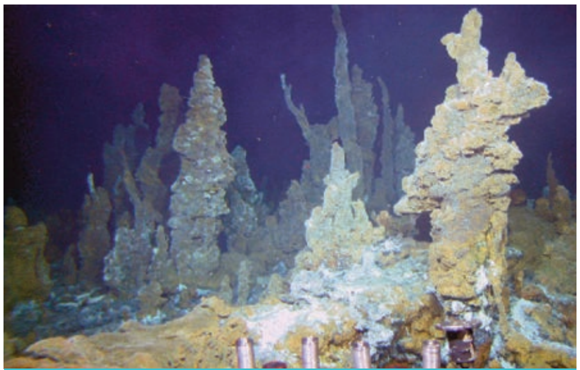
Edmonds also plans to return to her site. "To me, the most exciting question is to go back and actually find [the vents]—and find out what's living there," she says.

REMOTE SENSING The challenge of locating those vents is driving the development of the next generation of remote equipment. "It's going into the unmapped jungle and finding out new things," Reves-Sohn says. "The real problem is [learning] how prevalent venting is on the seafloor. We make all these extrapolations based on some pretty heavy assumptions."

At the moment, there are two ways to directly investigate the seafloor. Manned submersibles such as WHOI's Alvin can take scientists down, but they are limited to 8-to-10–hour shifts. Furthermore, weather conditions on the surface frequently don't permit submersible use.

The other approach is to drop sensors that are connected to the ship by long tethers. "A lot of the technology we've been using up to now was deployed with wires from the surface ship," German says. That doesn't lend itself to prolonged, precise searches on the seafloor, he adds.

German and others are developing a new breed of robot, known as autonomous underwater vehicles, that isn't limited by wires and time (*SN: 2/1/03, p. 75*). One such vehicle, called the Autonomous Benthic Explorer (ABE), can be dropped into a plume, where it zooms around in the water column and maps a 5-km-square grid of the chemical signal. After constructing a second, more detailed grid of the region of highest mineral concentration, it can locate the source of the plume and dive down to the seafloor to take photographs. It's been used to locate and explore deep-sea vents on both the Mid-Atlantic Ridge and the East Pacific Rise but hasn't yet visited any ultraslow ridges.



SIGNS OF LIFE — At hydrothermal vents such as this one along the slow-spreading Mid-Atlantic Ridge, hot, mineral-rich fluids build rock columns and sustain diverse life.

NOAA

Another obstacle to ocean exploration is money. There are few suitably equipped ships, and the cost of a scientific cruise can be prohibitive, particularly for scientists whose target sites require expensive icebreakers such as the *Healy*.

With the manned submersible Alvin, the unmanned ABE, and ongoing development of autonomous robots that can scan the seafloor in detail, the United States has the best tools, Reves-Sohn says. But "one of the stark realities is that it's going to be other countries that will discover a lot of vents. It would be nice if our country would get interested again in exploring the seafloor."

Under a budget crunch, U.S. oceanographers are looking to international and interdisciplinary collaboration to get back to sea, such as Lin's 2005 cruise to the SWIR, a collaboration between Chinese, German, and U.S. scientists. The 2007–2008 International Polar Year has plenty of prospects for cash-strapped geologists to piggyback on already-funded cruises, Lin says.

"The Arctic Ocean is an ideal case," he notes. "It's a wonderful opportunity for geologists and biologists to tag along and sample hydrothermal vents or map ocean ridges while [other researchers] do climate change and ice coring."

Overall, the new ridge—and hydrothermal-vent—discoveries have had something of a galvanizing impact on the global oceanography community. One bellwether is the excitement at the geology meeting last fall, where there was "a tremendous response" to the ridge sessions, Rona says.

There is still debate over whether designating a new, distinct class of ultraslow ridges simply provides intriguing new avenues for researchers to study how the crust forms or whether it introduces a textbook-rewriting paradigm shift.

Whatever the outcome, Dick asserts, "this is a significant change to plate tectonics theory." ■

NO FOOLING

ZOOLOGY

Hairy crab lounges deep in the Pacific

A newly discovered deep-sea creature has the body of a crab—except with long, fluffy, blonde hair covering its legs.

It lives some 2,200 meters deep in the southeast Pacific near hydrothermal vents, says Joe Jones of the Monterey Bay Aquarium Research Institute in California. The hair is so heavily infested with as-yet-unidentified bacteria that Jones and his colleagues speculate that the microbes are metabolizing compounds from the vents and providing energy for the crab.

DEEP BLONDE A creature from the southeast Pacific is not just a new species. It's in a new genus and family.

That feeding strategy could explain why the crabs sometimes sit with their legs extending into the warm water leaking near vents. Living off dirty-blonde body hair isn't these crabs' only option. Researchers saw them feast on mussels that the submersible cracked open when landing.

The crabs don't have eyes so it's also possible that the hairs work as sensors.

Jones and his colleagues first spotted the 15-centimeter-long species last year when taking the research submersible Alvin down to new lava fields south of Easter Island. They collected one sample crab. In the winter issue of *Zoosystema*, the researchers formally name it *Kiwa hirsuta*. The crab merits not only a new species and genus but also a new family among the crustaceans called squat lobsters. Because it reminds them of the fabled, hairy abominable snowman, researchers informally refer to the creature as the Yeti crab. —S.M.

BIOMEDICINE

On a dare, teen advances medical science

A 16-year-old daredevil inadvertently demonstrated the incubation period of a common roundworm-caused disease after she swallowed an earthworm at a friend's behest. The earthworm harbored larvae of the parasite, her doctors later concluded.

It took about 4 weeks for the young woman to develop a cough, wheeze, nausea, fever, and facial swelling.

Roundworms of the genus *Toxocara* are common in dogs and cats and annually infect about 10,000 people in the United States, mostly children who play in yards fouled with pet feces. Because infected kids are usually in frequent contact with the contaminated dirt, the parasite's incubation period in people has been difficult to assess.

According to a report in the February *Pediatrics*, dogs had frequently played in the friend's yard from which the ingested earthworm was taken, and the patient had no other potential exposure to roundworm larvae. LeAnne Fox of Children's Hospital in Boston and her colleagues, who diagnosed the cause of illness, successfully treated it by administering a 10-day course of an antiworm drug.

Most *Toxocara* infections in people cause no symptoms and go away without treatment, but in the lungs, the parasite can cause problems that mimic pneumonia or asthma. The worms can also affect the eye and liver. —B.H.

TECHNOLOGY

Device rids homes of sounds of rap

If you live in a house with wood siding—or in a log cabin—you might need protection from a little-recognized but destructive avian threat. "Woodpeckers cause millions of dollars in damage each year to homes and buildings across the United States," says Jim Tassano, a pest-control specialist in Sonora, Calif. That damage typically results from the birds hammering to find food, to make a nest, or to attract a mate.

BE GONE! Better than a fake snake.

Killing the birds isn't legal because all woodpeckers in the United States are protected by law. Also, inflatable owls, fake snakes, and similar devices rarely work against persistent woodpeckers.

Now, technology comes to the rescue. Tassano invented the Birds-Away Attack Spider, a battery-operated, sound-activated device that some homeowners may choose to install beneath their eaves near places frequented by woodpeckers. When the dinner-plate-size gadget detects a loud noise, such as a woodpecker rapping, it quickly drops down its 18-inch string and makes a racket that scares away the avian ne'er-do-well. Then, the device climbs back up the string to await the next rapper. Tassano recommends that homeowners install several of the "attack spiders" that he sells.

"At first glance, [the attack spider] might seem unusual, and even comical, but customer loyalty proves that it works," Tassano notes. His company, Sophron Marketing, also sells a device called The Screw Up for installing attack spiders and other things, such as holiday lights, in high places.

Written testimonials available at Tassano's Web site suggest that the Attack Spider is indeed effective, if not selective. Customers report, with varying degrees of glee, that the device has terrorized pets, deer, children, and unsuspecting package-delivery men as well as rappers. —S.P.

ZOOLOGY

Wary male spiders woo lifelessly

Certain male spiders confront the threat of a cannibalistic female with a novel tactic: They play dead while having sex.

Nursery spiders (*Pisaura mirabilis*) belong to a family known for violent females that, on occasion, attack and eat males attempting courtship, notes Trine Bilde of Århus University in Denmark.

Biologists already knew that males of this species have one method for lowering the risks of romance: They show up with a gift of food. For example, the courting male might bring his intended a fly carefully wrapped in spider silk. The suitor holds the gift in front of him in his mouthparts.

But Bilde and her colleagues have noticed an additional trick. They report in the March 22 *Biology Letters* that in 51 observed courtships, almost half the males suddenly "dropped dead."

Not brain-dead, that is. Even when keeled over, a male kept his gift between him and his sweetheart.

Such fainting spells sometimes struck males during their first approaches to females and sometimes, if the female grew restless, during actual mating. Typically, the female then shifted her attention from the motionless male to the snack. When she settled down to eat, the male came back to life and to mating. —S.M.

A. FIFIS/IFREMER; SOPHRON MARKETING

MEETINGS

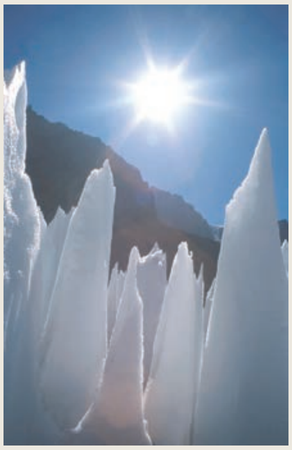
American Physical Society
Baltimore, Md.
March 13-17

GEOPHYSICS

Shafts of snow sculpted by sun

On the surfaces of many glaciers high in the Andes Mountains, towering spikes of snow called *penitentes* crowd the terrain like legions of white ghosts. Now, experiments on miniature, laboratory versions of such spikes suggest that those remarkable pillars start to form when strong sunlight, bitter cold, and snow-surface irregularities conspire to cause snow to evaporate first from low spots.

Understanding how *penitentes* arise and then vanish may clarify the expected impact of global warming on the snow pack in the Andes and elsewhere, says Meredith D. Betterton of the University of Colorado, Boulder. Previous simulations by other scientists had suggested that fields of *penitentes* might slow glacier disappearance because the towers cast shadows that diminish the amount of sunlight absorbed by the glacier surface.



SUN KISSED In the high Andes, these pinnacles of snow, called *penitentes*, may form because trapped sunlight erodes zones between pillars.

J. CORRIPIO/SWISS FEDERAL INST. TECHNOLOGY

To create lab-grown *penitentes*, Betterton, Vance Bergeron of the École Normale Supérieure in Lyon, France, and Charles Berger of École Normale Supérieure in Paris made artificial snow in a bathtub-size freezer by mixing water vapor and air that had been chilled by liquid nitrogen. The team then illuminated a block of snow with a flood lamp, representing the sun. Within a few hours, spikes up to 5 centimeters tall formed.

The experiments confirm prior notions that budding *penitentes* enlarge by reflecting and concentrating light into the valleys between them, Betterton says. The illumination initially makes the snow in those valleys sublime, or evaporate directly from its solid form, the experiments indicate. However, changes in the patterns of spike growth revealed that once the *penitentes* reach larger sizes and capture more light, melting contributes to further stages of *penitente* formation.

When the researchers tested the effect of particulate pollution on *penitentes* by using snow dirtied by a thin layer of carbon powder, they were surprised to find that the dirt accelerated spike formation. Ironically, if *penitentes* actually do preserve glaciers, pollution may enhance glacier survival by speeding *penitentes* development, Betterton notes. —P.W.

SUPERCONDUCTIVITY

Tiny wires trigger electric reversal

Physicists have observed an unexpected reversal of conductive behavior in ultracold, ultrathin zinc wires.

Typically, a metal wire more readily superconducts, or transports electricity without resistance, when it spans superconductive electrodes. However, that wire loses its superconductivity if strung between electrodes of normal metals.

Yet in recent experiments, ultrathin zinc wires did just the opposite: They conducted normally when between superconductive electrodes but became superconductive when between normal electrodes.

The reversal is "very stunning, very surprising," says theoretical physicist Dung-Hai Lee of the University of California, Berkeley.

Led by Moses H.W. Chan, researchers at Pennsylvania State University in State College observed the contrary conductivity. They created nanoscale-diameter wires within pores in thin membranes of polycarbonate or aluminum oxide and then placed the membranes between pairs of metal electrodes. The electrodes' shapes made it possible to measure the electrical properties of nanowires one at a time.

Penn State team member Ming-Liang Tian reports that the wires' conductivities depended on their thicknesses and lengths, as well as on the types of metals making up both the wires and electrodes.

For instance, when connected between superconductive electrodes made of tin or indium, zinc nanowires 40 nanometers in diameter anomalously exhibited normal conductivity. But when a magnetic field suppressed the superconductivity of the electrodes, the zinc nanowires unexpectedly turned superconductive.

In contrast, tests of 40-nm wires made of tin, of 70-nm zinc wires, and 40-nm zinc wires sandwiched between lead electrodes, found that the usual conductivity rules prevailed.

To explain the extraordinary reverse behavior, Lee and his colleagues theorize that a known inability of superconductive electrodes to absorb small amounts of energy results in a buildup of quantum disturbances in some wires. Those disturbances, in turn, destroy the wires' superconductivity. Conversely, normal-metal electrodes shunt away some of that disruptive energy, allowing superconductivity to reestablish in the wires. —P.W.

MICROSCOPY

Corralling Brownian motion

If you think making a little kid sit still for a camera is hard, try it with a protein in a water droplet. Such tiny objects jitter constantly from collisions with molecules of the water around them, and that activity quickly drives a protein molecule out of a typical microscope's view.

A new microscope system can compensate for those jitters, known as Brownian motion. The system has held minuscule fluorescent objects in its view for seconds at a time. The newfound stability promises scientists a means to study important biological agents in their natural environment, report the gadget's inventors. "We can trap smaller objects than can be trapped by any other means—all the way down to individual proteins," claims Adam E. Cohen of Stanford University.

He and William E. Moerner, also of Stanford, built their jitter-correction system around a particle trap made of two glass slides. The researchers etched one slide with shallow, intersecting channels, each attached to an electrode. Fluids move through these channels in and out of a hair-width trapping region at the intersection. The scientists then mounted this transparent trap above the lens of an inverted optical microscope equipped with a laser to excite the trap's contents.

When a fluorescent particle moves within the trap, the system immediately applies electric signals to fluid in the channels. The signals propel the fluid and drive the particle toward the center of the microscope's view.

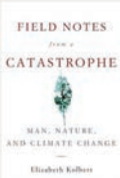
Among the items that the team has trapped are viruses and nanocrystals. To confine yet-smaller protein molecules, however, the researchers had to add glycerol to the water to make it more viscous. A new, faster-feedback version of the trap won't need the glycerol, Cohen says. —P.W.

Books

A selection of new and notable books of scientific interest

FIELD NOTES FROM A CATASTROPHE: Man, Nature, and Climate Change

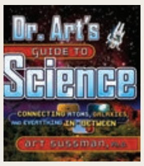
ELIZABETH KOLBERT



In the Arctic, land that was once permanently frozen is collapsing into giant sinkholes. Huge glaciers are melting and accelerating downstream toward the Atlantic Ocean. Each year is warmer than the year before. These are just a few of the signs that the Earth is undergoing a rapid and perhaps unstoppable climate change precipitated by human activities, writes Kolbert. She originally wrote a three-part series in the *New Yorker* on this topic after traveling to the northern areas most affected by the increasing temperatures. This book presents interviews with scientists at the forefront of climate research who say that human activity has become the dominant factor influencing the world's climate. Their prediction: Unless measures are taken to stem the increase in industrial, agricultural, and automotive carbon emissions, modern civilization could go the way of the Akkadian and Mayan civilizations, which collapsed during periods of dramatic climate change. ***Bloomsbury, 2006, 192 p., hardcover, $22.95.***

DR. ART'S GUIDE TO SCIENCE: Connecting Atoms, Galaxies, and Everything in Between

ART SUSSMAN



In this colorfully illustrated and irreverent book, Sussman, a science educator, introduces the young reader to the major concepts in science and how they connect everything from stars to atoms to ourselves. For instance, Sussman explains how heat energy from the sun is converted into the moving energy of the wind, how it evaporates water to power the water cycle, and how it's trapped on Earth by the greenhouse effect. He also examines the universe from the moment of the Big Bang to the beginning of life on Earth to the abundance of people and other organisms today. A page at the end of each chapter encourages the reader to stop and think about the concepts introduced, further illustrating how scientists ask questions and attempt to understand complex subjects. A helpful and clever "glindex" defines terms used in each chapter. For children age 12 and older. ***Wiley, 2006, 256 p., color illus., hardcover, $22.95.***

SKY WALKING: An Astronaut's Memoir

THOMAS D. JONES

This is the book for anyone who has ever wondered how astronauts train, what happens off camera on space trips, or how exhausting it might be to take a space walk. Jargonfree and without bravado, *Sky Walking* is a candid look at astronaut training, flying shuttle missions, and building the international space station. An Air Force Academy graduate, a B-52 pilot, a Central Intelligence Agency scientist, and a holder of a doctorate in planetary sciences, the author was selected for astronaut training in 1990. He made the first of his four shuttle flights in 1994, eventually spending 52 days orbiting Earth and more than 19 hours outside the shuttle. Jones, who coauthored *The Complete Idiot's Guide to NASA*, rounds out this book by offering suggestions for NASA's focus after the shuttle program ends. The United States should continue human flights "even beyond the moon," he asserts. ***HarperCollins, 2006, 384 p., color photos, hardcover, $26.95.***

WHEN THE RIVERS RUN DRY: Water—The Defining Crisis of the Twenty-First Century

FRED PEARCE

Earth contains 1.1 quadrillion acre-feet of water, yet its supply of fresh water is quickly dwindling to crisis levels. In individual consumption and agriculture, each person in the world uses about 500,000 gallons of water per year. A global trade in water is having an indelible effect on the world's rivers. Pearce, a veteran writer on water issues, traveled to more than 30 countries to analyze the state of the world's freshwater supply. He describes how the Rio Grande no longer flows into the Gulf of Mexico and wetlands in Nigeria have disappeared. Pearce examines how reservoirs give up water to evaporation, how dams threaten the ecological balance of their surroundings, and how political disputes over water supplies can lead to violence. With an ever-increasing global population, even desalination of ocean water won't be enough to meet the world's water needs. Pearce asserts that countries must develop better methods for decreasing water waste. ***Beacon, 2006, 320 p., b&w illus., hardcover, $26.95.***

AMERICAN GREEN: The Obsessive Quest for the Perfect Lawn

TED STEINBERG

Maintaining the ideal lawn is a constant battle against crabgrass, drought, weeds, and lawn-destroying vermin. It takes gas-powered machines, potent fertilizers, and nasty herbicides. Yet many home owners wage this war with enthusiasm. Historian Steinberg examines the evolution of America's obsession with the perfect lawn and reveals how turf grass, which isn't native to North America, became the most popular crop in the United States. He traces the lawn's history from early colonists, who transplanted turf from England, to its proliferation among post–World War II conformist suburbanites. With humor and wit, Steinberg reveals the whimsical side of lawn care, from checkerboard lawn designs to the home owner who transformed his yard into the 12th hole at Augusta National Golf Course. This obsession with turf, however, has a darker side, the author says. The pesticides and fertilizers deemed necessary for a perfect lawn threaten the health of people, animals, and the environment in general. Steinberg offers suggestions for a more balanced approach to lawn care. ***Norton, 2006, 224 p., b&w photos, hardcover, $24.95.***

LETTERS

The prion game

I must quibble about the headline of the piece about chronic wasting disease in deer ("Hunter Beware: Infectious proteins found in deer muscle," *SN: 1/28/06, p. 52*). "Hunter Beware" sounds ominous, but in order to get the mice to exhibit symptoms after getting muscle tissue from infected deer, it was necessary to use genetically engineered mice carrying deer protein. While hunters would be unlikely to take and consume a deer showing symptoms of chronic wasting disease, even if they did, there would be no danger. That is, of course, unless we are talking about genetically engineered hunters.

BOB HENKE, ARGYLE, N.Y.

Pesky pesticides

I refer to the article on pyrethroid insecticides, "A Little Less Green?" (*SN: 2/4/06, p. 74*). I suggest that all pesticides, regardless of their chemical structure, should be applied by trained operators who are equipped to degrade the run off before it enters public water and soil. This group of products is unsuitable for casual use by people at large.

S. BANERJI, MUMBAI, INDIA

Cool idea

After reading about the use of electrons in a particle accelerator to "cool" the antiprotons in a secondary ring ("Smashing Success: Accelerator gets cool upgrade," *SN: 2/4/06, p. 68*) I have a question. Is it possible to make a long straight stretch of the main ring feed high-energy electrons in at an oblique angle to a deflection magnet and thereby bend the electrons into the antiproton stream to cool it? At the next deflection magnet, the electrons would once again be bent through a relatively sharp angle and go back toward the center of the main ring. If the electrons could then be "cooled" and circled around to the first deflection magnet, they could be recycled many times to continue cooling the antiprotons.

MIKE BUSHROE, TUCSON, ARIZ.

The idea of electron cooling in an accelerator's main ring is good in principle, says physicist Sergei Nagaitsev of the Fermi National Accelerator Laboratory in Batavia, Ill. Indeed, accelerator specialists in New York State plan to build an electron-cooling system into the main ring of an accelerator there, he notes. —P. WEISS

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