

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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staving off blindness
buy, buy, buy

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SCIENCE NEWS

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Improving the View

Treatment reverses macular degeneration

People with a relentless eye disease now have a better-than-average prospect of recovering some vision, thanks to a new drug that takes a lesson from an anticancer strategy, two studies show.

Age-related macular degeneration is the leading cause of blindness in the elderly. In the less common, wet form of the disease, rogue blood vessels escape normal growth control and leak fluid into the macula, the area at the center of the retina that enables a person to see fine detail.

As a result of fluid disrupting their sight, people with the condition often see straight lines as crooked. This form of macular degeneration can lead to legal blindness within months.

Cancer researchers have developed a drug to stop the similarly aberrant blood vessel growth that's often present in tumors. The new eye studies showcase a drug called ranibizumab, which is a fragment of the cancer drug. Both drugs inhibit a protein essential to blood vessel growth, says David M. Brown, a retina surgeon at Methodist Hospital in Houston who worked on both trials.

Preliminary studies of ranibizumab convinced the Food and Drug Administration in June to approve the drug to treat wet macular degeneration. The two new large trials, reported in the Oct. 5 *New England Journal of Medicine*, establish that ranibizumab reverses the disease in many patients.

"This is a huge breakthrough," says Frederick Ferris, clinical director of the National Eye Institute in Bethesda, Md. "This treatment is remarkably different from other treatments." He likened it to the added power that penicillin contributed to the fight against infections.

One wet macular degeneration trial enrolled 716 patients, and the other followed 423. Two-thirds of the participants in each study were randomly assigned to receive a monthly ranibizumab injection in

their affected eye, and one-third got an inert injection. In the smaller study, the control group also received a standard treatment—the drug verteporfin followed by laser light, which activates verteporfin. That treatment also combats abnormal vessel growth.

After 2 years, patients getting ranibizumab in the larger study could see an average of one additional line on an eye chart. More than one-fourth of them had regained three lines. After 1 year in the smaller trial, patients getting ranibizumab had recovered one to two lines of visual acuity.

In contrast, patients getting the sham injections in both trials had, on average, lost acuity and could see two fewer lines—whether or not they got the verteporfin treatment.

Ranibizumab isn't a sure cure, however. Some patients getting the drug in each trial still showed considerable vision loss. And even when the drug is successful, patients might need to continue receiving the monthly injections indefinitely.

Nevertheless, the effect in most patients is dramatic, says ophthalmologist Edwin M. Stone of the University of Iowa Hospitals and Clinics in Iowa City, who was not on the research team for the trials. He's observed that the rogue blood vessels in the eye wither and stop leaking shortly after contact with ranibizumab. The vision of one of his patients improved from significantly impaired, 20/100, to near perfect.

"We're finally getting medical treatments in which we figure out the underlying mechanisms [of a disease] and design elegant ways to counteract them, as opposed to trial and error," Brown says.

Ranibizumab is marketed under the name Lucentis by its maker Genentech of South San Francisco, Calif. —N. SEPPA

Shop Until You Can't Stop

Compulsive buying affects both men and women

Talk about buyer's remorse. A new national telephone survey indicates that nearly 6 percent of adults find themselves unable to resist frequent shopping binges that leave them saddled with debt, anxiety, and depression.

Buying gone bad, also known as compulsive buying, occurs almost as often in men as in women, says a team led by psychiatrist Lorrin M. Koran of the Stanford University School of Medicine.

The new survey offers the best estimate to date for what some mental-health workers regard as an addiction to spending

money. Earlier prevalence figures for compulsive buying, based on interviews with small groups of consumers, ranged from 2 percent to 16 percent. Because women seek psychiatric treatment for uncontrolled

spending more often than men do, scientists previously pegged it as a predominantly female condition.

"The widespread opinion that most compulsive buyers are women may be wrong," Koran says.

He and his colleagues describe their findings in the October *American Journal of Psychiatry*. Koran says that he would now like to see

a larger survey that probes the emotional and social impact of uncontrolled purchases on people's lives.

In 2004, the team conducted roughly 11-minute interviews with 2,513 individuals, ages 18 and up, contacted randomly by phone. Interviewers asked about cardinal signs of compulsive buying, such as intrusive or senseless impulses to buy, frequent purchases of unneeded or unaffordable items, and shopping for longer periods than intended. Questions also touched on financial problems and emotional letdowns after buying sprees.



BUY BUY, BABY A new survey identifies nearly 6 percent of U.S. adults as compulsive buyers, who feel depressed or anxious after shopping binges.

Compulsive buying, as defined by a high score on a tally of the cardinal signs, occurred in 6 percent of women and 5.5 percent of men, regardless of racial or ethnic background, Koran's group says. Compulsive buyers averaged 40 years of age, compared with 49 years for the other participants. A majority of compulsive buyers reported annual incomes under \$50,000, whereas only 39 percent of the others reported

QUOTE



This treatment is remarkably different from other treatments."

FREDERICK FERRIS,
National Eye
Institute

incomes in that category.

Compulsive buyers reported having the same number of credit cards as other participants did. However, compulsive buyers tended to stretch credit card limits thin, often to within \$100 of the maximum. Compulsive buyers also preferred to make minimum payments on credit card balances, regardless of their annual incomes.

Prior evidence suggested that compulsive buyers often suffer from anxiety and depression. Koran has studied antidepressant drugs as treatments for this condition.

Although compulsive buying isn't currently accepted as a psychiatric disorder, it deserves consideration as a behavioral addiction in the next official manual of psychiatric diagnoses, slated to appear in 2011, remark psychiatrist Eric Hollander and psychologist Andrea Allen, both of the Mt. Sinai School of Medicine in New York City, in a commentary published with the Koran group's survey.

Studies such as the new survey will be reviewed over the next few years to determine the diagnostic fate of compulsive buying, says psychiatrist Darrel A. Regier, director of research for the American Psychiatric Association in Arlington, Va., which publishes the manual.

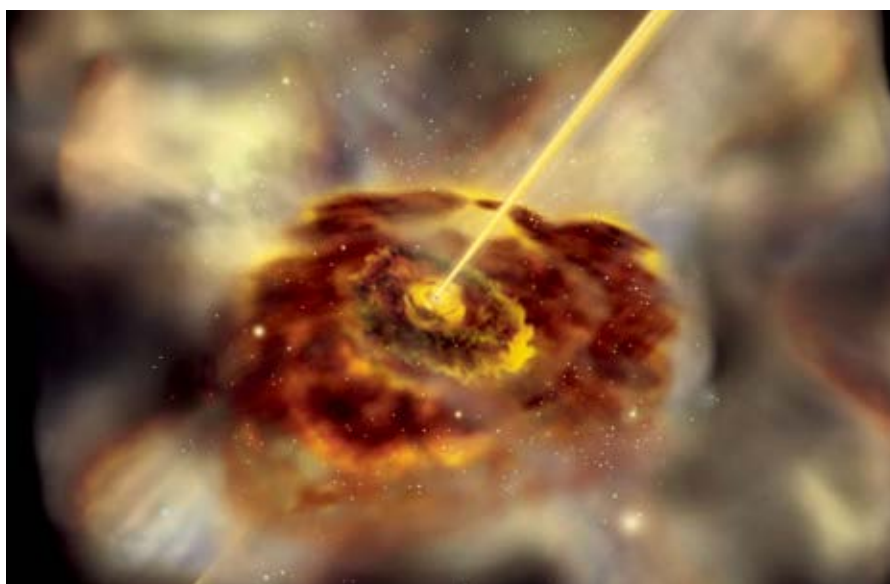
Although the Koran team's survey relies solely on self-reports, it improves on earlier prevalence estimates of compulsive buying, says anthropologist Shirley Lee of the University of Manitoba in Winnipeg. Still, if this condition gets labeled as a mental disorder, researchers may unwisely ignore social contributions to compulsive buying, such as easy credit and pervasive advertising, Lee contends.

Uncontrolled buying can't be isolated from the depression and anxiety that people experience as a result of conflicting pressures to consume and to avoid debt, Lee adds. —B. BOWER

Jet Set

Astronomers identify the makeup of quasar streams

The particle jets streaming from the neighborhood of a supermassive black hole punch their way out of their home galaxies and extend hundreds of thousands of light-years beyond. Astronomers this week reported that they have finally identified the particles in the jets as electrons and protons and



BEAMING IMAGE New observations indicate that the jets emanating from a supermassive black hole, as seen in this artist's depiction, are composed of electrons and protons.

have found that those streams of particles carry much more energy than some astronomers had theorized.

The composition of jets has been debated ever since they were detected in the 1950s. The jets were known to be electrically neutral, but astronomers weren't sure what they were made of. One theory held that they contained mainly electrons and their antimatter partners, positrons. The other theory was that the jets were made of electrons and protons. Protons are about 1,800 times as heavy as positrons.

"The question is very important," says theorist Roger Blandford of Stanford University, because "jets carry energy and momentum from the vicinity of the black hole out into intergalactic space." By redistributing matter and energy, the jets enable black holes to wield influence beyond their own galaxies.

Recent studies had hinted that jets might be primarily electrons and protons, but astronomers lacked solid evidence. Determining the composition required observations of high-energy X rays, which no telescope had clearly recorded.

Rita Sambruna of NASA's Goddard Space Flight Center in Greenbelt, Md., and her colleagues used NASA's recently launched Swift satellite, which is exquisitely sensitive to energetic X rays, to examine jets emanating from two quasars more than 10 billion light-years from Earth.

Quasars are the powerful beacons of light at the cores of galaxies. They're powered by black holes that have crushed the equivalent of millions to billions of suns into a region about the size of the solar system. Most quasars have particle jets, which seem to arise from a disk of matter that swirls around a supermassive black hole.

"Thanks to the spectra from Swift, we were able to see all the [elementary] par-

ticles in the jets," Sambruna says. Her team found that the X rays peaked at an energy of 10,000 electronvolts. Using that information, the team calculated the energy carried by particles in the jets.

Computer models developed by Fabrizio Tavecchio and Gabriele Ghisellini at the Merate Observatory in Italy indicate that jets composed of electrons and positrons would not contain as much energy as the X rays indicated. In fact, such jets would fizzle near the black hole instead of streaming into space. Therefore, the jets are probably made of electrons and protons, Sambruna reported Oct. 5 at a meeting of the American Astronomical Society in San Francisco.

"What Rita [Sambruna] is saying is that in her jets, she needs more power. ... A protonic jet will carry more power," comments Blandford. He adds that the jets probably also include pairs of positrons and electrons, as well as photons. "Undoubtedly, all are involved [in carrying energy], and there is probably a transformation from one to the other along the jet," he says.

Sambruna and her colleagues calculate that each jet moves at 99.9 percent of the speed of light and carries as much mass as that of Jupiter. —R. COWEN

Hot, Hotter, Hot

Climate seesawed during dinosaur age

Dinosaurs, too, endured climate change. Although scientists had speculated that the world some 120 million years ago was unvaryingly hot, climate fluctuated dramatically, a new report argues. Twice during a 250,000-year period in the reign of

NASA

Nobel prizes recognize things great and small

Awards focus on birth of universe and the workings of cells

The 2006 Nobel prizes in the sciences were announced early this week. U.S. scientists swept the field.

Physiology or Medicine

Eight years after revealing a mechanism that cells use to regulate protein production, a pair of U.S. scientists received the Nobel Prize in Physiology or Medicine.

Andrew Fire of the Stanford University School of Medicine and Craig Mello of the University of Massachusetts Medical School in Worcester will share the \$1.4 million award for their discovery of a phenomenon since named RNA interference, or RNAi (*SN*: 7/2/05, p. 7). According to the Nobel assembly of the Karolinska Institute in Stockholm, the RNAi mechanism was "totally unexpected and has dramatically expanded our knowledge of gene control."

For more than 40 years, researchers had known that RNA, a single-stranded nucleic acid, carries instructions from a gene to the cell's protein-making machinery. Working in the mid-1990s with a roundworm, Fire and Mello found that double-stranded RNA with a given sequence shuts down protein production of the gene with a matching sequence. That finding explained puzzling results in previous experiments by Fire and Mello and by other research teams.

Fire and Mello published their findings on this phenomenon, called gene silencing as well as RNAi, in 1998.

Other researchers subsequently worked out the basic mechanism of RNAi. Double-stranded RNA activates cellular machinery that chops up single-stranded RNA carrying messages from the particular gene.

Furthermore, researchers have found that organisms use RNAi in a variety of ways, such as to defend themselves against viruses and to regulate gene expression during development.

When publishing their first paper on RNAi, notes Fire, he and Mello "envisioned that we'd be able to do a lot of things in worms," such as shutting off particular roundworm genes one by one to determine their function. However, other research teams soon discovered that they could use the method to

muffle protein production in virtually all multicellular organisms, including fungi, plants, and animals.

Such a simple way to control proteins in experiments "has opened up a tremendous number of doors" for both basic and applied research, says physician John Rossi of City of Hope, a medical-research center in Duarte, Calif.

Rossi and other scientists also aim to turn bits of double-stranded RNA into drugs that eliminate troublesome proteins from cells. Some such drugs are in clinical trials, but none is on the market yet.

That strategy could fight AIDS, Alzheimer's disease, influenza, and other health problems, says chief scientific officer Barry Polisky of San Francisco-based Sirna Therapeutics. RNAi "has applications for all important human diseases. As amazing as that sounds, it's true," he says.

Alejandro Sánchez Alvarado of the University of Utah Health Sciences Center in Salt Lake City, who studies tissue regeneration, says that it's "terrific" that this year's Nobel prize in the life sciences was awarded for research that had no foreseeable application when Fire and Mello began their work.

Today, biologists of almost every stripe incorporate RNAi into their studies. "It's a good example of what happens when people do really good science just for the sake of doing science," Alvarado says. —C. BROWNLEE

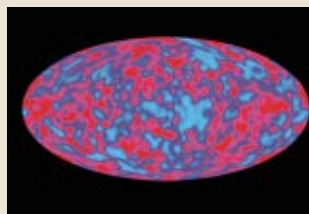
Physics

Two astrophysicists have won the 2006 Nobel Prize in Physics for their leading roles in a satellite mission that provided convincing evidence of the validity of the Big Bang theory and first detected the seeds of galaxy formation. John C. Mather of the NASA Goddard Space Flight Center in Greenbelt, Md., and George F. Smoot of the Lawrence Berkeley (Calif.) National Laboratory and the University of California, Berkeley will share the award.

In the 1970s and 1980s, Mather was "the true driving force" behind the satellite known as NASA's Cosmic Background Explorer (COBE), according to the Royal Swedish Academy of Sciences, the institute that awards the physics prize. Development of the satellite, which was expected to be put in orbit by a space shuttle, was set back by

the 1986 explosion of the shuttle Challenger, but Mather steered COBE through that obstacle and others.

"I felt like I was riding on the back of a tiger," Mather recalled at a news conference on Oct. 3.



PATCHWORK UNIVERSE

Measurements of slight variations in temperature in space (red indicates warmer than average, blue colder) provided the first glimpse of a nonuniform distribution of matter in the newborn cosmos that led to galaxies and galaxy clusters.

Launched by a rocket in 1989, COBE made the first precise measurements across the entire sky of the faint microwave glow that remains from the universe's fiery birth (*SN*: 5/2/92, p. 292). By demonstrating that that relic energy exactly fits a pattern known as a blackbody spectrum, the satellite's data bore out a crucial prediction by supporters of the Big Bang scenario.

Mather was responsible for the particular instrument—one of three on COBE—that made the blackbody measurements.

"The perfect blackbody spectrum virtually ruled out any explanation for the cosmic-microwave background other than the Big Bang," notes cosmologist Michael S. Turner of the University of Chicago.

Smoot led the development and operation of another of COBE's instruments, which discerned tiny temperature variations of the microwave background across the sky. Until then, scientists couldn't explain how the perfectly uniform ball of expanding matter of the nascent universe gave rise to today's galaxies and clusters of galaxies.

Theorists had predicted that, in the first moments of the universe, random appearances and disappearances of elementary particles—a process predicted by quantum mechanics—could have caused sub-microscopic irregulari-

ties that suddenly grew large as space rapidly expanded.

By spotting temperature differences of a few hundred-thousandths of a kelvin, Smoot's instrument revealed the first evidence of those stretched-out quantum irregularities—the seeds of further lumpiness built up by gravitational attraction.

"The COBE images are our first look at the baby picture of the universe," says David N. Spergel of Princeton University.

Since COBE's 4-year mission, scientists have used other spacecraft, such as NASA's Wilkinson Microwave Anisotropy Probe (WMAP), to refine the microwave-background measurements and thereby gauge specific properties of the universe, such as its age and composition, with unprecedented accuracy (*SN*: 2/15/2003, p. 99).

"COBE showed those variations are there, so that subsequent experiments could measure them very carefully," Smoot told *Science News*.

Spergel, a member of the WMAP team, says he was "thrilled to hear that the COBE team was recognized." —P. WEISS

Chemistry

Continuing this year's recognition of U.S. scientists, the Royal Swedish Academy of Sciences named Roger D. Kornberg of the Stanford University School of Medicine the winner of the 2006 Nobel Prize in Chemistry. Kornberg's research uncovered fundamental details of the mechanism by which cells access the protein-making directions encoded in their genes.

In 2001, Kornberg published X-ray crystallography images that depicted how a yeast cell transfers data stored in its DNA. An enzyme called RNA polymerase latches on to the DNA and builds messenger RNA, a single-stranded bearer of the information. Kornberg's molecular snapshots, which revealed the positions of the DNA and messenger RNA within the RNA polymerase, indicated how the enzyme makes a correct copy. Once the messenger RNA is complete, the cell translates it into a protein.

Next week's issue of *Science News* will elaborate on Kornberg's work. —A. CUNNINGHAM

the dinosaurs, tropical sea-surface temperatures varied by 6°C, the findings suggest. That's twice as much variability as is known to have occurred at any other time in history.

"Since animals evolved on Earth, this range of temperature shift is unprecedented," says Simon C. Brassell of Indiana University in Bloomington, an author of the report, which appears in the October *Geology*. To determine the ancient temperatures, Brassell and his colleagues used a new method that measures the composition of the cell membranes of a marine microbe that accumulated on the ocean floor.

The researchers analyzed those membranes in sediment cores from the Pacific Ocean floor 1,000 miles east of Japan. During the Cretaceous period, long before modern tectonic-plate movement, the site would have been near the equator in the middle of the Pacific. The researchers calculated that, on two occasions, the ocean-surface temperature dropped from around 35°C to less than 30°C in just a few thousand years. Each cooler period lasted between 20,000 and 35,000 years.

Because temperatures vary more slowly at sea than on land, temperature changes elsewhere on Earth were likely to have been even more dramatic, Brassell says. Furthermore, the Pacific Ocean was so large at the time that temperatures would have been stabler there than in smaller oceans. Finally, at more-extreme latitudes, changing ocean-circulation patterns or ice sheets—phenomena that don't occur in the tropics—might have further affected temperatures.

During the early Aptian epoch of the Cretaceous period, huge quantities of organic material fell to the ocean floor, depleting the oxygen in the ocean and forming a black goo that didn't rot. The large quantities of carbon locked up on the bottom of the ocean reduced atmospheric carbon and so would have tended to cool the climate. But the researchers are unsure whether this depletion triggered the drops, and, if so, why they occurred so suddenly.

The newly discovered changes in climate wouldn't have brought about the extinction of the dinosaurs, Brassell notes. That extinction occurred 55 million years later.

Brassell adds that the suddenness of

the temperature variations suggests that gradual changes to the atmosphere can have abrupt impacts on climate. "It's like driving an automatic car," he says. "As you push down on the accelerator, all of a sudden you find that you're in a different gear."

Scientists suspect that a rise in atmospheric methane, an event analogous to the current rise in carbon dioxide, might have kicked off the warm Aptian period, says Paul Wilson of the National Oceanography Center in Southampton, England. "What we see here is that the Earth's system has a kind of innate capability to get itself out of jail," Wilson says. "You don't get into a runaway greenhouse scenario."

However, he cautions that the timescale for such adjustments is long from a human perspective. Furthermore, the atmospheric changes 120 million years ago were small relative to the current increase in carbon dioxide. —J. REHMEYER

QUOTE



Since animals evolved on Earth, this range of temperature shift is unprecedented."

SIMON BRASSELL,
Indiana University,
Bloomington

Wasting Deer

Deer saliva and blood can carry prions

For the first time, researchers have shown that saliva alone can transmit a brain-destroying disease from one animal to another.

Three oral doses of saliva from a deer sick with chronic wasting disease passed the infection to other deer kept in isolation suites indoors, reports Edward Hoover of Colorado State University in Fort Collins. The finding gives substance to worries that the disease spreads through such deer social habits as touching noses and licking to groom each other.

The study also found that both an injection of blood from a sick animal and exposure to infected brain tissue transmitted the infection, Hoover and 16 colleagues report in the Oct. 6 *Science*.

Fourteen states and two Canadian provinces have reported chronic wasting disease, which strikes mule deer, white-tailed deer, Rocky Mountain elk, and occasionally moose. The disease belongs to the cluster of deadly brain ailments, such as mad cow disease, that are spread by misshapen prion proteins (*SN: 11/30/02, p. 346*). No case of human disease has been traced to game, but researchers haven't ruled out the possibility.

Biologists have known that animals can catch the disease simply by occupying an area where sick animals once lived. Contaminated land has vexed researchers, who don't want to risk introducing chronic wast-

ing disease into disease-free regions but don't want tests confounded by dirty fields.

For the new study, researchers at the University of Georgia in Athens supplied 14 white-tailed deer fawns. The state is free of chronic wasting disease. Researchers in Colorado kept the animals indoors during their 18-to-22-month lives and dosed them with material from sick mule deer.

Although saliva, blood, and brain tissue transmitted the disease, three oral doses of mixed urine and feces didn't have an effect. However, Hoover cautions that the two animals that received that material carried gene variants known to render deer less susceptible to prion infections.

Four cases of the human version of mad cow disease have been traced to blood transfusions, but Hoover notes that no study of another prion disease has shown transmission through saliva.

The saliva result is "the exciting part of this study" for wildlife managers, comments wildlife-disease specialist Margo Pybus of Alberta's Fish and Wildlife Division in Edmonton. The dose in the study, 50 milliliters of contaminated saliva, is large enough to be "unlikely" in the real world, she says, but further research may define how small a dose of saliva can transmit the disease.



OH DEER Deer can catch chronic wasting disease from contaminated saliva.

The new study "lends tremendous credibility to regulations that restrict baiting and feeding of deer," says Bryan J. Richards, who leads the chronic wasting disease work at the National Wildlife Health Center in Madison, Wis. To fight the disease, states are now banning hunters' once-common practice of setting out deer feed. In theory, deer clustering around the windfall might increase unsafe social contacts. "A lot of states have been ridiculed because there was no proof" of danger from deer baiting, says Richards. —S. MILIUS

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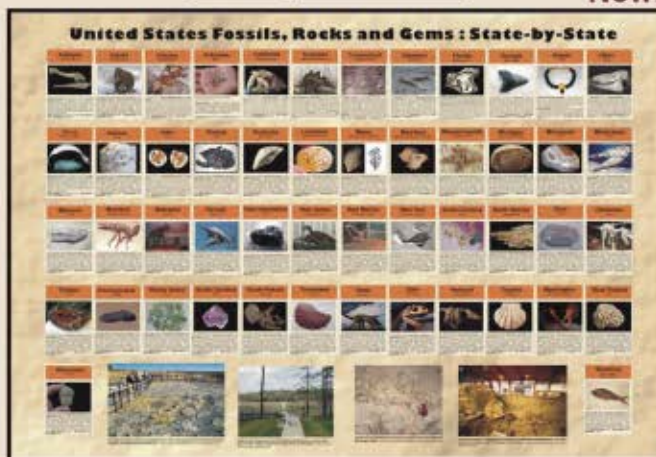
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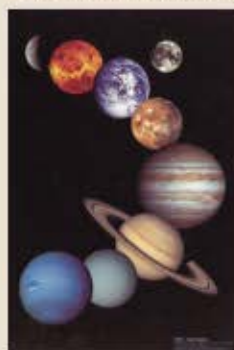
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VENTING CONCERNS

Exploring and protecting deep-sea communities

BY JANET RALOFF

Researchers cruising the South Pacific between Tonga and Fiji study huge snails that, aided by an abundance of bacteria housed in their gills, feed off plumes of metal-rich compounds at active hydrothermal vents. Scientists working off the California coast use chemical-sniffing probes, robotically driven subs, and seafloor-tethered temperature sensors to watch flows of lava pave over a once-thriving ecosystem at hydrothermal vents several kilometers below the ocean's surface. And in waters off Papua New Guinea, a mining company analyzes metal deposits around inactive, underwater volcanoes that contain, on average, 10 times as much copper as typical ores on land do.

These studies exemplify the breadth of research under way at one of Earth's last great frontiers, the geologically active ocean bottom. Sites include hydrothermal vents on the 65,000-km-long ridge that meanders through all the world's oceans and at deeply submerged volcanoes in the tropical west Pacific. Only 35 years ago, scientists didn't know that geologically active sites existed underwater. Now, they have direct evidence of some 300 such spots and suspect that another 700 or so await discovery. The researchers are also uncovering signs of past geological activity at many sites.

As recently as 1990, the cost and difficulty of getting to the few then-recognized sites limited visits by scientists. Today, however, submerged volcanoes and other deep hydrothermal vents have become stages for intensive research activity. Every visit to a vent site, even a repeat visit, brings new discoveries, says Cindy Van Dover, director of Duke University's Marine Laboratory in Beaufort, N.C.

"Some places are so popular that you get ships [above them] stacked up on top of one another," notes Van Dover. If researchers aren't careful, she says, they'll interfere with each other's work or harm the vent ecosystems.

Such concerns triggered scientists to issue, earlier this year, a code of conduct for hydrothermal-vent research. In July, underwater volcanologist Colin Devey of the University of Kiel in Germany described the code at the Euroscience Open Forum in Munich. His university

is the current home of InterRidge, the loosely affiliated group of hydrothermal-vent researchers that developed the code.

Explains Devey, "On a highway with only two vehicles, having rules of the road is fairly unimportant. But every time another vehicle comes along, it becomes increasingly important to know such things as which side of the road to drive on and who has the right of way." With scientific and mining-exploration visits to vent sites increasing, he says, "we realized we needed rules to deal with that traffic."

The new code also serves as a self-policing protocol for investigators who conduct their research largely out of sight, usually kilometers below the sea's surface.

HOT SPOTS The geologically active sites where these scientists work represent two extremes of the global tectonic system. The best characterized of these hydrothermal vents occur at various intervals along a tectonic plate's new-forming edge, known as a spreading zone. Earth's mid-ocean ridge is one near-continuous zone of spreading seafloor.

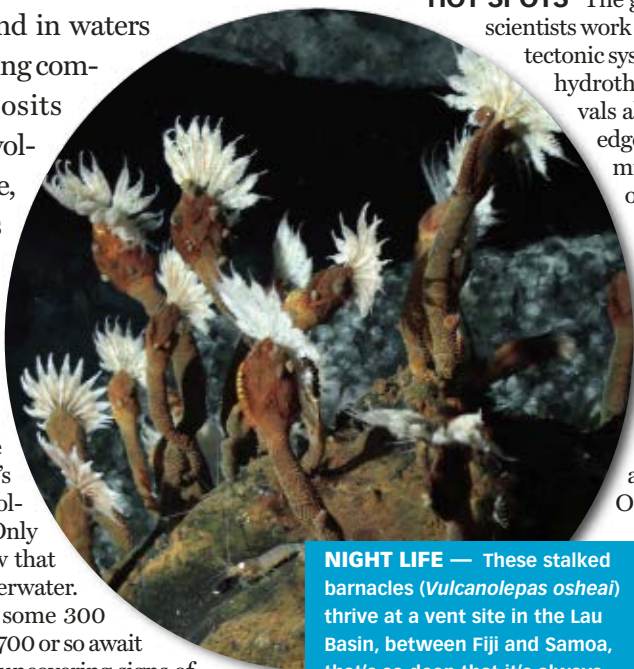
As two plates pull apart, breaches occasionally permit magma to break through the ridge's crest, where the molten rock heats zones of rock and water (*SN*: 4/1/06, p. 202). A spreading zone can be considered a "linear volcano" with vent holes occurring at various points along its meandering crest, explains Baker, an oceanographer at the National Oceanic and Atmospheric Administration's Seattle lab.

Last December, Baker and his colleagues traveled to a previously uncharted 400-km span of the mid-ocean ridge in the Pacific, just north of the Galápagos Islands. Their sophisticated equipment turned up direct evidence of three new hydrothermal vents in that spreading zone and indirect evi-

dence—hydrothermal plumes—of several more.

On the opposite end of a tectonic plate from its spreading zone may be a subduction zone, a span where two plates collide and one plate is forced beneath the other. Weak spots emerge near the edge of the disappearing plate, permitting magma to punch through and form conventional, conical volcanoes that happen to be underwater. These vulnerable areas are known as back-arc basins (*SN*: 6/10/06, p. 365).

Both types of hydrothermal vents—at seafloor ridges and at back arcs—spew hot water that's oxygen-deprived and metal-rich, and they host a wide variety of exotic marine life. Researchers marvel



NIGHT LIFE — These stalked barnacles (*Vulcanolepas osheai*) thrive at a vent site in the Lau Basin, between Fiji and Samoa, that's so deep that it's always pitch black there. The site is part of what biologist Charles Fisher describes as "the center of diversity for barnacles."

at the diversity of unusual animals populating these dark and seemingly inhospitable zones, some of the organisms surviving near water as hot as molten lead. Because animals at these sites derive their energy solely from the microbial transformation of chemicals spewed by the geological activity, their ecosystems are referred to as chemosynthetic.

In the decade after the first hydrothermal vents were discovered in 1977, notes Baker, the high costs of visiting such areas limited scientists' choices. Researchers tended to go to ridge sites where they were virtually guaranteed to find vents, so they focused on similar sites and found similar things.

Expeditions gradually began taking more gambles, and over the past decade, they've explored a greater variety of locales, including sites in the Arctic Ocean (SN: 4/1/06, p. 202). "What we've found is that there's never been an occasion where we didn't find evidence of venting within any 200-km section of [the] mid-ocean ridge," notes Christopher R. German of the Woods Hole (Mass.) Oceanographic Institution.

Vents often differ dramatically from each other in chemical and geological characteristics. However, even vents that are physically similar can host distinctly different communities of animals.

"The classic example" of a vent creature, German notes, "is those giant tube worms, perhaps 8 feet [2.4 meters] long. But you don't find those outside the Pacific." First identified on the Galápagos section of the ridge, these worms don't inhabit the northeastern Pacific. There, smaller tube worms congregate.

Go to the North Atlantic, and the tube worms are replaced by vent communities dominated by shrimp a couple inches long and mussels, German says. Move to vents in the Indian Ocean for an intermediate fauna. Atlantic-type shrimp are common there, as are barnacles, snails, and a host of animals typically found at West Pacific vents.

As part of a 10-year international census of marine life, German and others have begun mapping what they call the "biogeography of chemosynthetic ecosystems."

LIGHT-TOUCH SCIENCE Fifteen or so years ago, studying hydrothermal-vent denizens was crude: "To collect something, people used to simply drag dredges from ships through vent fields," Baker says. Over time, researchers have become gentler and more selective. Today, they first observe animals from submersibles or in pictures taken by computer-operated, torpedolike devices armed with sophisticated sensors and cameras. Biologists then perform "precision sampling" of a few critters of special interest, Van Dover says.

Using this process, scientists are finding 100 new species each year, Van Dover estimates.

The new code of conduct makes an explicit commitment to such minimally invasive sampling. The InterRidge document, endorsed by organizations representing 2,000 vent researchers, pledges to avoid engaging in research activities that "will have deleterious impacts on the sustainability" of vent populations, lead to long or significant alteration—even in just appearance—of vent sites, or take vent materials "not essential" to research.

The code also prohibits transplanting materials, such as tube worms and other animals, between vents. The researchers want to avoid introducing species that might establish themselves and alter a native vent ecosystem, German explains.

A year ago, Van Dover's experience during a biogeography study

reinforced concerns over such transplants. She and her colleagues had collected vent shellfish at back-arc vents in the Fiji Basin. At least 60 percent of the mussels (*Bathymodiolus brevior*) there had curious brown or black spots. A few days later, the researchers sampled mussels at back-arc vents in the nearby Lau Basin.

Once home, Van Dover examined the flesh of the Fiji Basin mussels more closely and discovered that their spots were caused by a fungal infection. In some specimens, she says, "there was more fungus than mussel."

Because her team didn't wash out the collection boxes between sites, Van Dover worries that her team may have transferred fungus spores from infected mussels of the Fiji Basin to healthy shellfish in the Lau Basin.



INFECTED — This Fiji mussel's flesh, which in a healthy animal (*Bathymodiolus brevior*) is beige, has been blackened by an advanced fungal infection. Researchers are concerned because they may have spread this disease to mussels at another vent site.

"I won't go back out again without carrying bottles of bleach to do washdowns," Van Dover says.

Species can spread via other means. Van Dover notes that the submersibles used to survey vent sites contain ballast water that's jet-tisoned as the vehicles surface. Animals or microbes can be sucked in with the ballast water at one site and released elsewhere.

Antje Boetius of the Max Planck Institute for Marine Microbiology in Bremen, Germany, finds less reason for concern about transplanting fungi or other microbes. Because all oceans are connected, she notes, "an educated guess would be that we cannot introduce microbes ... to

new sites because they're already there." Nevertheless, she adds, "our code of conduct will be so strict that, in theory, it would prevent even this—transporting microbes from one place to another."

COMMERCIAL APPEAL The InterRidge code was drafted and adopted by scientists conducting basic research. However, vent sites also receive attention from investigators engaged in applied research for commercial firms, principally companies interested in mining the copper, gold, silver, zinc, and lead that bubble up at vents and then lie exposed on the ocean floor.

"I don't expect the mining community is terribly aware of the code of conduct for scientists," says Toronto-based consulting geologist Steven D. Scott. However, he notes that 5 years ago, the International Marine Minerals Society, based in Honolulu, adopted its own code for environmental management of marine mining.

That code calls for mining companies to "apply best practical procedures" for environmental and resource protection, "consider environmental implications" through all stages of mining starting with exploration, return unused extracted materials to the seabed "in a manner that will facilitate future sustainable use of the area," and conduct environmental studies as a basis for evaluating risks and responsible postproduction-cleanup strategies.

In other words, Scott argues, the mining community is also trying to exhibit responsible environmental stewardship of vent resources. At the Euroscience Open Forum, he conceded that ocean mining has the potential to adversely affect vent ecosystems. However, he says, "it should present far less of a problem than mining on land."

With vent water carrying metals directly from Earth's mantle, 2 tons of ore from ocean sites should yield as much copper as 80 million tons of material mined on land, according to his company's recent study in waters off Papua New Guinea, reports David J. Heydon, chief executive officer of Nautilus Minerals in Vancouver, British Columbia. Nautilus Minerals is one of two companies formed so far to mine ocean-bottom minerals.

Mining companies are focusing on extinct-vent sites to avoid the

challenges of superheated water and molten rock. Ecosystems at these thermally extinct vents may be less novel than those dominated by the short-lived, quick-growing animals at active vents (*SN*: 7/14/01, p. 21).

On the other hand, Van Dover points out, there's evidence suggesting that tube worms have lived for 100 years at some cold sites. Ecologically, she says, killing them during mining might be equivalent to cutting down an old-growth forest. Indeed, she argues, animals at these sites "may turn out to be more sensitive than those at [still-hot] vents. We don't yet know."

CRADLES OF LIFE? Vent sites are unstable. Every 10 to 100 years, a new flow of lava kills off life and repaves the surrounding ocean bottom. Yet only days later, animals begin recolonizing a vent. That finding, which is less than 2 decades old, has established the "simple but profound truth," Baker says, that "volcanoes and the presence of water are sufficient [to support] life."

Direct ancestors of vent bacteria "may extend back 4 billion years," he notes. Studying current generations of these microbes may therefore offer clues to life's origins (*SN*: 1/9/99, p. 24) and the possibility that geologic activity has similarly fostered life elsewhere "in and beyond our own solar system," Baker says.

Although large fauna such as tube worms (*SN*: 4/15/06, p. 228) and hairy blond crabs (*SN*: 4/1/06, p. 205) garner most of the pub-

lic attention given to deep-sea vents, Boetius points out that the biggest share of undiscovered species there are microbial. As part of the International Census of Marine Microbes, under way through 2010, she hopes to resolve whether bacteria at vent sites are novel

or just the same marine species—perhaps in different proportions—that occur elsewhere in the ocean.

However, some scientists challenge the ethics of conducting these and other studies, charging that they all pose risks to life at vent sites.

For instance, in a Jan. 13, 2005, letter to *Nature*, former vent scientist Magnus Johnson of the University of Hull in Scarborough, England, cited a 1977 report that vent shrimp were probably blinded by floodlights on exploratory submarines (*SN*: 4/3/99, p. 219). "The Worldwide Fund for Nature has recognized that one of the greatest threats to hydrothermal vents comes from 'uncoordinated and unregulated' research," Johnson pointed out.

Charles Fisher of Pennsylvania State University in University Park, who has just returned from a South Pacific research cruise, concedes that scientists and their equipment are probably the greatest threats to deep sites—but only because few other people get down there. However, he argues that scientists aren't inflicting much injury on vent ecosystems. Moreover, he and others note that the new code of conduct is intended to limit even that small potential for researchers' doing harm. ■



FINE CHEMICAL DINING — Nestled in a bed of mussels are big, hairy, light-colored snails (*Alviniconcha hessleri*) and their darker cousins (*Ifremeri nautiliei*). All these western Pacific-vent animals host bacteria that nurture the shellfish by filtering compounds from hydrothermal plumes and passing the chemicals on to the mollusks.

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CELL-SURFACE STORIES

Miniature electrodes probe diminutive domains

BY AIMEE CUNNINGHAM

The rat in the plastic box has a drug habit. Every 5 minutes or so, he presses a lever that sends a shot of cocaine through a catheter into his veins. Even more unusual is his “rat hat,” the data-transmitting headgear that monitors the animal’s brain activity without immobilizing the head. The hat positions several insulated wires within the rat’s brain.

For more than 50 years, scientists have been inserting electrodes into tissue samples and animals’ bodies to eavesdrop on electrical activity. But the latest-generation electrodes go further. They detect the ebbs and flows of chemicals at the surfaces of cells.

Researchers first developed electrodes that could measure chemical compounds in the early 1980s, but it took a couple of decades for scientists to figure out the best ways to fabricate and use them, says R. Mark Wightman, an analytical chemist at the University of North Carolina in Chapel Hill.

“Once that was done, people started in on applications,” says Wightman, who is using microelectrodes in rats to study how cocaine influences the brain circuitry that rewards behaviors.

An electrical property of these microelectrodes “enables chemical events occurring on the sub-microsecond time scale to be monitored,” Wightman noted in the March 17 *Science*.

Moreover, the tools’ small size makes a large difference in their capabilities. The microelectrodes, also called ultra-microelectrodes, are typically 50 to 100 micrometers (μm) long. The wire’s uninsulated tip, which does the sensing, is 10 μm or less in diameter.

With tips in the same size range as cells, microelectrodes are reaching into biological realms that can’t be accessed by their bigger cousins. “If you want to look at chemistry next to a single cell or some other very small space, you would want a microelectrode,” says Wightman.

AT THE PUMP Drugs intended to kill microbes and tumors are often foiled by busy cellular pumps. One research team is using microelectrodes to investigate how cells expel those drugs.

A microelectrode senses what’s going on at the cell’s surface by exchanging electrons with chemicals in solution surrounding the cell. By carefully moving a microelectrode across the surfaces of one or many cells, researchers can map a compound’s concentration.

Allen J. Bard of the University of Texas at Austin applies this technique to cells as they rid themselves of toxic substances. He and his colleagues have used the information from concentration maps in a mathematical model that calculates how quickly a cell pumps out material across its entire surface.

The researchers scanned lab-cultured liver cells as they encountered menadione, an analog of a drug used against cancer. Menadione changes to a toxic form inside the cell. But the cell can tag menadione with another chemical group and pump out the resulting compound, called thiodione, through channels in the cell membrane.

“What we find is that the cell is very efficient at getting rid of the menadione,” says Bard. His group determined that each cell exports 6 million molecules of thiodione per second. That’s almost as fast as the rate at which menadione gets in, he says.

Bard’s group is beginning to study whether cancer cells discharge chemotherapy drugs with a similar speed.

In the long term, Bard’s goal is to shut down the export processes that cancer cells and infectious microbes use to resist drugs intended to kill them. If cells are “using that kind of pump mechanism, and if you could shut that off with another drug, you could get rid of that resistance,” Bard says.

EYEING CELLULAR EXITS Detailed monitoring of cell surfaces can also provide insight into the release of chemical messengers, such as hormones, that carry signals to other cells. Scientists have developed a tool to examine the molecular anatomy of the opening where the cell discharges signal molecules.

During the secretion process, a sac, or vesicle, containing a cargo of molecules inside a cell moves to the cell’s membrane and fuses with it. The cargo then leaves the cell through a channel called a fusion pore that opens between the membranes the vesicle and the cell.

Manfred Lindau, a biophysicist at Cornell University, and his colleagues are working to identify the proteins that form the fusion pore. Toward that goal, they’ve developed a microelectrode array to locate a single active channel. Each microelectrode reports hormone concentration in its vicinity.

The researchers patterned four platinum electrodes onto a glass coverslip, “like a printed circuit board,” Lindau says. In the space at the middle of the four electrodes, they placed a cell that in the adrenal gland releases the stress hormones adrenaline and noradrenaline. The cells, called chromaffin cells, have large vesicles, 200 nanometers (nm) across.

“When you use several electrodes, you can sort of triangulate the position where that release occurs,” says Lindau. His team applied a computer analysis to locate the site secreting adrenaline or noradrenaline.

To confirm that the strategy works, the researchers filled chromaffin-cell vesicles with a fluorescent dye that would flash green when the vesicle spilled its contents. They found that the location indicated by the microelectrode array was within 500 nm of the location shown by the fluorescence. Lindau’s group described the arrays in the Sept. 27, 2005 *Proceedings of the National Academy of Sciences*.

To learn more about which proteins make up the fusion pore, Lindau and his colleagues plan to attach fluorescent tags to certain proteins. As before, Lindau’s group will place a chromaffin cell

“If you want to look at chemistry next to a single cell ... you would want a microelectrode.”

— R. MARK WIGHTMAN,
UNIVERSITY OF NORTH
CAROLINA AT CHAPEL HILL

in the microelectrode array and locate the secretion event. Then, the researchers will focus on the fluorescence coming from an area as a secretion event occurs there.

Lindau's team intends to tag three proteins, two found in the cell membrane and one found in the vesicle membrane. The tags' fluorescence will change only if the proteins change their shape. If this happens at the site of a secretion event in progress, it's an indication that the proteins are forming a fusion pore.

"We'll look at fluorescent signals and see how they change related to this fusion-pore opening," says Lindau, "to give us an idea if there are conformational changes happening."

DOPAMINE HIGHS Installing microelectrodes just outside neurons can illuminate the ways in which specific signal molecules influence behavior. With a microelectrode, "you're watching in on a conversation of neurons with one another" as they pass information through the brain, Wightman says.

Wightman's group uses carbon-fiber microelectrodes to detect one chemical message, dopamine. Brain neurons release this neurotransmitter to reward eating, drinking, and some other behaviors critical to survival. Certain addictive drugs also stimulate the release of dopamine.

Past studies have used microelectrodes to detect neurotransmitters in anesthetized animals. But Wightman, psychologist Regina M. Carelli, and their colleagues at the University of North Carolina wanted to learn how dopamine concentrations change in the brains of cocaine-addicted rats as they move around.

So, the university's machine shop designed the high-tech rat hats that hold three microelectrodes in place in an animal's brain. To avoid impeding the animals' normal activities, the researchers ran wires from the hats through a swiveling disk in the ceiling of the plastic box and then to a computer and other equipment. Similarly, the tubing that provides the cocaine permits the rat to wander within the cage.

Two of the microelectrodes placed in the rat brains bookend the groups of nerve cells that constitute the reward pathway. The researchers used one microelectrode to detect dopamine and to measure its concentration fluctuations in the nucleus accumbens, located toward the front of the brain. To stimulate release of dopamine, the researchers used an electrode placed in the ventral tegmental area, which is in the central brain. The third microelectrode was a reference electrode in the cortex on the other side of the brain.

To learn how dopamine concentrations change as the rats inject cocaine, the team fitted six cocaine-addicted rats with the hats. In 2003, they found that about 10 seconds before the rats gave themselves doses of cocaine, dopamine concentrations in the rats' brains rose for less than a second.

"You can think of it as being an anticipatory response that cocaine is coming," says Wightman.

In another experiment, the researchers investigated whether they could spur the rats to seek cocaine. They induced an increase in dopamine concentration with the stimulating electrode. Immediately after that, the rats demonstrated the behavioral routines, such as approaching and backing off from the lever, that typically occur before they inject cocaine.

In further work, the researchers detected a dopamine increase about 2 seconds after an animal pressed the cocaine lever. Like the anticipatory burst, this postresponse dopamine increase lasted less than a second.

The researchers sometimes added light and sound cues as a rat received cocaine. The postresponse spike then occurred even when the researchers triggered the flashes and rings without a rat having pressed the lever. In the May 19, 2005 *Neuron*, Wightman and his colleagues further demonstrated that when rats repeatedly press the lever for cocaine delivery but the researchers block the drug, the dopamine burst that occurs with the cue gradually declines. This suggests that these dopamine spikes teach the rats to associate the cues and the drug, the researchers say.

These transient dopamine changes "would have been absolutely impossible to detect with other techniques," notes Wightman. "These things all happen right at the lever press, in less than a second—there's no other way to figure it out."

He adds that future investigations with this technology should also provide insight into the role of dopamine in behaviors such as learning and memory.



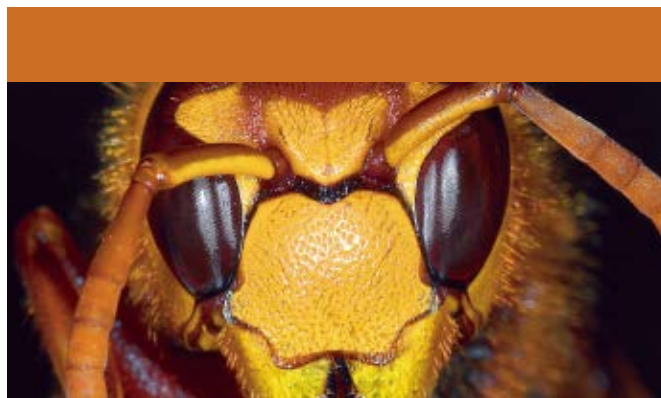
RAT IN THE HAT — A cocaine-addicted rat is seen through a wall of its plastic box. The rat presses a lever to inject itself with the drug while microelectrodes held in the brain by the rat hat measure changes in dopamine concentrations.

SMALLER STILL Researchers now plan to move their chemical and electrical measurements from the surface to the inside of cells. To succeed, scientists will have to shrink the sensors further.

Michael V. Mirkin at the City University of New York in Flushing has accepted that challenge. At recent scientific meetings, he has described initial work with a nanometer-size electrode. Its diameter is about one-thousandth that of the smallest microelectrodes now in use.

Scientists have been concerned that putting an electrode inside a cell could cause damage, notes Mirkin, but in his experiments so far, the cell is "essentially not disrupted." The next step will be to see how well a nanoelectrode provides information from its location inside the cell.

Mirkin says that information collected from experiments using this technique might, for example, have relevance to cancer and other diseases. If it's possible to use nanoelectrodes in this way, it would be "wonderful," says Mirkin. But, he cautions, this application "still has to be proven that it works well." ■



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PLANETARY SCIENCE

A discordant name for a dwarf planet

The largest known object at the fringes of the solar system, the icy body whose discovery heated up the debate about planethood, has an apt new name.

The International Astronomical Union (IAU) announced on Sept. 14 that the body, which had provisionally been called UB 313 and nicknamed Xena, would now be officially called Eris, after the Greek goddess of discord and strife. Furthermore, Eris' moon has been designated Dysnomia, the goddess of lawlessness.

Because Pluto is slightly smaller than Eris, the discovery of the body in 2005 intensified the controversy about whether Pluto should continue to be called a planet. The IAU voted on Aug. 24 to demote Pluto to "dwarf planet," a classification that the group devised to separate these objects from planets. Three other objects—Eris, Pluto's moon Charon, and Ceres, the largest asteroid—are also categorized as dwarf planets (*SN*: 9/2/06, p. 149).

Monikers invoking strife and lawlessness are perfect for the newly named dwarf planet and its moon, says Mike Brown of the California Institute of Technology in Pasadena. He and his colleagues, who suggested the names, discovered both objects.

Indeed, the strife is far from over. In late August, a group of more than 300 planetary scientists signed a petition protesting Pluto's demotion. —R.C.

EARTH SCIENCE

Reading the tale of an ancient river

Ocean-floor sediment near England holds material deposited there during the last ice age by what was then Europe's largest river system. A new analysis suggests that the waterway began carrying substantial

amounts of precipitation and meltwater from European ice sheets at least 20,000 years ago, a few millennia earlier than scientists had previously suspected.

At the height of the last ice age, thick layers of ice covered much of northern Europe. What today is the English Channel was then a broad river valley, says Guillemette Ménot, a paleo-oceanographer at Université Aix-Marseille III in Aix-en-Provence, France. Much of the water draining from European rivers would have flowed into that valley's waterway, which scientists have dubbed the Channel River.

Ménot and her colleagues analyzed sediment drilled from the seafloor about 250 kilometers southwest of the English Channel, a spot that would have been just offshore from the Channel River delta.



DISTANT DWARF The sun is a faint spot, as seen from behind the newly named dwarf planet Eris, in this artist's depiction.

They found that slightly more than 20,000 years ago, the sediment began to include organic substances typically found in the cell walls of soil bacteria, a sign that the material came from land via the Channel River.

That initial surge of land-derived organic material in the sediment peaked about 19,500 years ago, the researchers report in the Sept. 15 *Science*. After a short hiatus, the river again brought large amounts of organic material to the region between 18,500 and 17,000 years ago. These two periods of increased river runoff probably represent the initial stages of melting of the European ice sheets, says Ménot. The sediment record at the seafloor site doesn't show the later stages of ice sheet melting, probably because the Channel River delta moved northeast as sea level rose. —S.P.

BIOMEDICINE

Bad Alzheimer's proteins sow disorder in the brain

Like a bad seed that overtakes an entire garden, a single abnormal protein may spoil other proteins nearby and begin the progression of Alzheimer's disease, a new study suggests.

Recent research has suggested that a protein called amyloid-beta is a likely culprit in causing the disease. Healthy brain cells produce this protein in small amounts and regularly clear away any excess. But in brains plagued by Alzheimer's disease, the protein becomes misshapen and clumps, hindering its removal.

Though this clumping process has been well studied, scientists know little about what corrupts the protein and makes clumps spread across the brain. To investigate, Lary C. Walker of Emory University in Atlanta and his colleagues injected the brains of young mice with diluted samples of brain tissue from Alzheimer's patients. The mice were of a type that's genetically predisposed to develop a form of the disease.

Rather than develop amyloid-beta clumps after age 10 months, as brains of these mice typically do, the organs of the infected mice were ridden with clumps within 4 months.

A closer look suggested that the brain extracts from Alzheimer's patients acted as amyloid-beta seeds, encouraging the growth of clumps around them. Normal amyloid-beta that came in close contact with these seeds appeared to have become similarly misshapen, multiplying and spreading the problem proteins. Mice injected with diluted brain tissue from a healthy elderly person or from healthy old mice didn't develop the clumps more quickly than usual.

The researchers suggest in the Sept. 22 *Science* that misshapen amyloid-beta might arise spontaneously in people, spreading its corruption through contact with healthy protein. This process resembles the destructive interactions of other proteins called prions. If researchers can find a way to catch the bad amyloid-beta proteins early, says Walker, they might stop Alzheimer's disease in its tracks. —C.B.

ASTRONOMY

Oversize supernova

Although they can't fully explain why a star blows up, astronomers thought that they had accurately determined the maximum mass that a star could have before exploding as a common type of supernova. Now, they've found a star that breaks the rule.

According to prevailing theory, a type 1a supernova is triggered by a compact star called a white dwarf piling up matter stolen from a bloated companion star. When the white dwarf becomes as heavy as 1.4 times the mass of the sun, the high density and heat generated by the matter spark a thermonuclear explosion.

Researchers have found a type 1a supernova so luminous that it must have been produced by a much heavier star than the standard theory allows. Andy Howell of the University of Toronto and his colleagues report in the Sept. 21 *Nature* that the supernova, called SNLS-03D3bb, is 2.2 times as bright as expected and that the star that exploded had to be 50 percent heavier than the 1.4-solar-mass limit.

The most likely explanation for the overweight star, comments David Branch of the University of Oklahoma in Norman, is that the matter accumulated by the white dwarf revved up the star's rotation, creating a centrifugal force that provided extra support against the crushing force of gravity. Then the dwarf could pack on additional mass before exploding.

Because most type 1a supernovas have about the same peak brightness and can be seen from afar, astronomers have used the explosions to measure cosmic distances. The new finding doesn't undermine that practice, but astronomers need to be aware of extra-bright supernovas, the team says. —R.C.

EPIDEMIOLOGY

Cigarettes and lead linked to attention disorder

Nearly half a million cases of attention-deficit hyperactivity disorder among U.S. children are related to exposures to lead or their mothers' smoking while pregnant, a nationwide study suggests. The two environmental hazards might account for more than a quarter of drug-treated ADHD cases.

The finding bolsters earlier research that linked smoke exposure to ADHD and provides the best evidence yet that lead, a brain-damaging metal, might also contribute to the common behavioral disorder.

Published online on Sept. 19 for an upcoming *Environmental Health Perspectives*, the study analyzed data on 4,704 children who were 4 to 15 years old when they participated in a recent nationwide survey of health and nutrition.

Surveyors recorded that 4.2 percent of the children had been both diagnosed with ADHD and prescribed stimulants to treat the condition. The researchers collected other data as well, including the concentration of lead in a blood sample from each child, whether the child's mother had smoked during pregnancy, and whether anyone subsequently smoked in the child's home.

Children whose mothers smoked before giving birth—but not those exposed later—were 2.5 times as likely as other children to have ADHD, the new analysis shows. And kids with the highest blood-lead concentrations were 4.1 times as likely to have the disorder as were children with the lowest concentrations,

report researchers led by Bruce Lanphear of Cincinnati Children's Hospital Medical Center.

Given the percentage of surveyed children who are taking drugs for ADHD, at least 1.8 million children nationwide have the disorder, the researchers estimate. About 480,000 of those cases could be attributed to smoke exposure, lead exposure, or a combination of the two, the scientists say. —B.H.

ANIMAL SCIENCE

Silky feet

Zebra tarantulas can secrete silk from their feet, researchers have found. The discovery raises questions about the original function of silk.

Spiders step securely on surfaces because of the hold of thousands of hairs on their feet. Stanislav N. Gorb of the Max Planck Institute for Metals Research in Stuttgart, Germany, and his colleagues had intended to study whether spiders' feet produce fluid to aid in the attachment.

They had zebra tarantulas (*Aphonopelma seemanni*) crawl up inclined glass slides. During short breaks, the researchers would tilt the slide to a steep incline, knowing that the spiders wouldn't move from their position, says biologist Adam P. Summers of the University of California, Riverside.

Once, when the glass was almost vertical, one of the researchers noticed that a spider slipped a few millimeters before reattaching itself. "Suddenly, you could see these little fibers coming out from the tip of every foot," says Summers. "It was completely unexpected." The researchers imaged the spiders' feet with a scanning electron microscope and found silk-producing spigots nestled among the hairs. The team reports the finding in the Sept. 28 *Nature*.

The foot's silk-secreting capability may have emerged after the spiders' abdominal spinnerets were already producing the material for webs, the researchers say. But if the feet turn out to be an earlier source of silk, it would imply that "the primitive function of silk was adhesion instead of prey capture or web building," Summers says. —A.C.

OCEANOGRAPHY

Krill kick up a storm of ocean mixing

A single Pacific krill doesn't grow as big as its cocktail-shrimp cousins. Yet a swarm of krill making its daily commute in a Canadian inlet boosted water turbu-

lence by factors ranging from 2,000 to 20,000.

That's the result of the first measurement of a creature's contribution to the mixing of ocean waters, explains Eric Kunze of the University of Victoria in British Columbia. He says that he hopes the finding will inspire other scientists to measure biological turbulence in addition to mixing from storms and tides.

Turbulence drives many ocean events with global implications. For example, mixing affects gas exchange between the atmosphere and the water.

In recent years, scientists have estimated how much ocean creatures might stir things up. After listening to a talk on such calculations, Kunze says, he and several colleagues realized they had equipment to measure that mixing.

They made several sets of measurements in 2005 at Saanich Inlet on the coast of Vancouver Island. They had located a swarm of Pacific krill spending daylight hours some 100 meters down in the inlet. As the sun went down and light-dependent predators stopped hunting, the krill

rushed to the inlet's surface to feed on plankton.

During the 10 or 15 minutes of the krill commute, the team's monitors picked up as much turbulence as that produced by a rushing tide. At dawn, the krill swam down, again stirring the water.

These short frantic bursts raised the inlet's daily average for water mixing 100-fold, Kunze and his colleagues report in the Sept. 22 *Science*. —S.M.

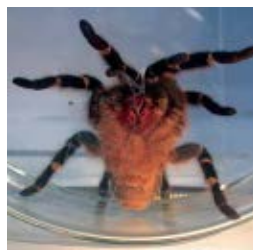
SCIENCE AND SOCIETY

U.S. population to surpass 300 million

At approximately the midpoint of this month, the population of the United States will hit 300 million, according to the U.S. Census Bureau. Seconds later, it will eclipse that mark.

The bureau calculates that a new birth adds to the population every 7 seconds, and that a death brings it down every 13 seconds. Each minute, on average, two more migrants arrive in the country than depart it. The net gain is six people per minute.

The U.S. population surpassed 100 million in 1915 and 200 million in 1968, according to historical estimates, which are available at www.census.gov/ipc/www/. In the past century, the only year-to-year decline in population occurred between July 1917 and July 1918, when the country was at war. —B.H.



SILKEN STEPS In a pinch, this zebra tarantula can secrete silk from its feet.

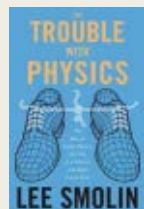
Books

A selection of new and notable books of scientific interest

THE TROUBLE WITH PHYSICS: The Rise of String Theory, the Fall of a Science, and What Comes Next

LEE SMOLIN

In their quest to understand nature at its deepest level, many scientists have been led astray, according to Smolin. The seductive quest to unify quantum theory and general relativity has led to a flurry of



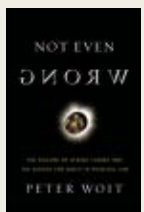
work for the past 25 years on an idea known as string theory. Proponents claim that it unifies all particles and all forces of nature. The problem with this, Smolin explains, is that string theory is not really a theory in the scientific sense of the word; it is unsupported by experiment, unfalsifiable, and unconfirmable.

In this detailed explanation of a controversial subject, Smolin, a physicist and founder of the Perimeter Institute, explains how string theory rose to such eminence despite its major flaws. In doing so, he reviews the greatest challenge facing theoretical physics today: the search for a unified-field theory. He outlines the history of string theory, reviewing how it evolved from an idea supported by only a handful of physicists to a theory that revolutionized the physics world. Smolin offers a list of alternative theories beyond string theory and suggestions for avoiding the "groupthink" that he says has hijacked theoretical physics. *Houghton Mifflin, 2006, 392 p., hardcover, \$26.00.*

NOT EVEN WRONG: The Failure of String Theory and the Search for Unity in Physical Law

PETER WOIT

String theory has become the most popular area of pursuit among theoretical physicists seeking a unified theory of elementary particles. Despite this, string theory lacks the most fundamental aspects of



a scientific theory: It cannot be tested, and there is as of yet no experimental evidence of the existence of its superstrings. Woit, a lecturer in mathematics at Columbia University, explains how theorists developed string theory, which addresses some of the shortcomings of the standard model of physics, he says.

According to Woit, that early success has unfortunately culminated in a new era of failure within theoretical physics. He details why he considers string theory not to really be a theory, but simply a hunch that has been perpetuated by leaders in the physics community who refuse to acknowledge its failure. *Basic, 2006, 291 p., hardcover, \$26.95.*

THE NEW PSYCHOLOGY OF LOVE

ROBERT J. STERNBERG AND KARIN WEIS, EDS.

What is love? No one definition exists, even though love drives much of human interaction and that artists and scientists ponder it endlessly. In this fol-

low-up to a volume published in 1988, Sternberg, dean at Tufts University, and Weis, a fellow at the University of Connecticut, compile the latest



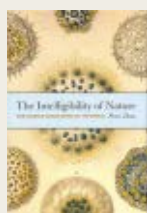
hypotheses about love from the researchers studying it. Each section of the book covers a different approach to understanding love. Biological theories, for example, include evolutionary explanations of why emotion and related romantic behaviors may have arisen and evidence of how love and rejection are experi-

enced physically. Though love is in its title, this book is filled with academic-weight essays from more than a dozen contributors, including Helen Fisher, David M. Buss, and editor Sternberg. *Yale, 2006, 338 p., hardcover, \$35.00.*

THE INTELLIGIBILITY OF NATURE: How Science Makes Sense of the World

PETER DEAR

Science has become the dominant approach to human understanding of the world. By extension, scientists are viewed as fonts of wisdom, to whom



people turn for answers of practical and theoretical importance. In this book, Dear, a professor of the history of science at Cornell University, analyzes how science achieved this ascendancy and describes its evolution from a natural philosophy to a practice routinely applied to our everyday lives. Dear reviews early

attempts at classification of the heavens, plants, and animals. From there, he recounts the chemical revolution and the emergence of the theory of evolution as he attempts to pinpoint when science as a whole made the leap from conjecture to application. He also notes that under the modern scientific method, the efficacy of a scientific theory is often given supremacy over its intelligibility. *Univ. Chicago Press, 2006, 242 p., b&w images, hardcover, \$27.50.*

DRIVING TO MARS

WILLIAM L. FOX

Two dozen scientists travel annually to an uninhabited island 900 miles from the North Pole. There,



they practice for a trip to Mars. Haughton crater is a 12-mile-wide, 1,000-foot-deep chasm that is the most Marslike feature on Earth. On three occasions, Fox traveled there with NASA scientists who were equipped with military vehicles and prototypical space suits. He documents their efforts to traverse

and study this barren landscape. He also notes the unique problems that arise when people try to navigate a disorienting, featureless desert and take notes and samples while wearing 50-to-70-pound space suits. Fox details the elaborate planning that goes into provisioning and equipping one of these mock missions. Along with firsthand descriptions of the scientists at work, Fox provides asides on the history of the space program and the inspiration for a Mars voyage, the possibility of microbial life on Mars, and the ways that the planet is portrayed in the arts. *Shoemaker & Hoard, 2006, 264 p., color plates, paperback, \$16.00.*

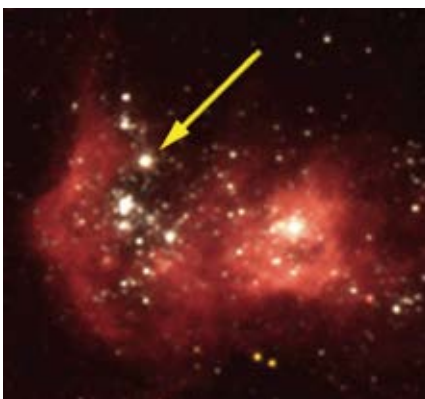
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Correction The wrong caption and credit were printed for one image in "Temperamental Monsters" (SN: 9/23/06, p. 200). Here is the correct information.



DISTANT OUTBURST — The bright, massive star V1 (arrow) in the galaxy NGC 2363, which lies about 11 million light-years from Earth, is undergoing an outburst less violent than the one that convulsed Eta Carinae in the mid-19th century. V1 may have experienced other outbursts in the recent past.

L. DRISSEN, J.-R. ROY, C. ROBERT, NASA

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QC2 headphones (left).
New QC3 headphones (right).

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for easy storage.



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