SCIENCE NEWS
THE WEEKLY NEWSMAGAZINE OF SCIENCE

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new multiple sclerosis drug
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fight the bite

IMPROVING ANTIVENOM

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This Week

Of Note

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Cover The venom of this Indian cobra (*Naja naja*) can be deadly unless a bite victim quickly receives antivenom, a cocktail of antibodies harvested from horses or other large animals. New research is leading to more-effective and cheaper treatments. (iStockphoto) Page 183

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Weapon against MS

Transplant drug limits nerve damage

A drug originally devised to prevent immune rejection of organ transplants can lessen relapses in patients with multiple sclerosis, a new study finds.

The drug, called fingolimod, inhibits immune cells from destroying the fatty coatings of nerve fibers in the brain and spinal cord. Damage of such myelin sheaths leads to multiple sclerosis (MS) symptoms, which include fatigue, balance problems, and loss of muscle control.

Although preliminary, the study is the second piece of welcome news this year for MS patients. Citing new findings (*SN: 3/4/06, p. 131*) of the effectiveness and safety of the drug natalizumab (Tysabri), the Food and Drug Administration in June reinstated it for some MS patients. The agency had approved the drug in 2004, but sales were halted for safety reasons.

In the latest study, researchers in Europe and Canada gave a daily fingolimod pill to 160 MS patients. Half the recipients got a dose four times as high as the dose that the others received. Another group of 81 patients received inert pills.

All the patients saw a doctor regularly and underwent monthly magnetic resonance imaging (MRI) to detect myelin-sheath damage in the brain or spinal cord. The doctors didn't know which patients were receiving doses of the drug or the placebo.

Over 6 months, patients getting either drug dose were less than half as likely as the placebo patients to relapse, either developing new or stronger MS symptoms, says study coauthor Ludwig Kappos, a neurologist at the University Hospital Basel in Switzerland. MRI scans during that time revealed that patients getting the drug had fewer new sites of myelin damage than the participants receiving the placebo had.

After 6 months, the patients getting the placebo were switched to one of the fingolimod doses. Over 6 more months, most of those people had fewer relapses and fewer sites of new myelin damage than they had while receiving the placebo, the scientists report in the Sept. 14 *New England Journal of Medicine* (*NEJM*).

Fingolimod suppresses immunity. People taking the higher dose were more likely than those in the other groups to get upper respiratory infections, the researchers say.

Fingolimod appears to work by snagging newly minted immune cells that target myelin in the central nervous system and sequestering them in lymph nodes, pathologists Steffen Massberg and Ulrich von Andrian of Harvard Medical School in Boston say in the *NEJM* carrying the new study.

"These data are impressive," says Peter A. Calabresi, a neurologist at Johns Hopkins Medical Institutions in Baltimore. Judging from this study, fingolimod may hold off relapses better than do common MS drugs such as interferon. Only natalizumab, which is injected monthly, has performed better in tests, says Calabresi, who acknowledges that he has consulted for Novartis, the Switzerland-based manufacturer that makes fingolimod and funded the new study.

Effectiveness aside, fingolimod's real advantage might be that it's a pill, Calabresi says. "All the other drugs we have on the market are injectable therapies," he notes.

Two longer-term studies with more participants are under way, Kappos says. One is testing fingolimod against interferon beta-1a injections, and the other is another comparison with a placebo. —N. SEPPA

STATS

400,000

Number of people in the United States with multiple sclerosis

Scripted Stone

Ancient block may bear Americas' oldest writing

Road builders in southern Mexico discovered a script-covered block of stone among the rubble in a gravel quarry in 1999. A research team has now announced that the marks on the slab represent the oldest writing yet discovered in the Americas.

The quarry where the script was found abuts an archaeological site, near Veracruz, in what was the heartland of the ancient Olmec civilization. The imagery used in the writing indicates that the artifact, known as the Cascajal block, displays an early form of Olmec writing dating to nearly 3,000 years ago, says Stephen D. Houston of Brown University in Providence, R.I.

Previous examples of Olmec writing extend back no more than 2,650 years (*SN: 12/7/02, p. 355*). Samples of Mayan writing in Central America date to as early as 2,200 to 2,400 years ago (*SN: 1/21/06, p. 45*).

The rectangular Cascajal block weighs 12 kilograms. It's 36 centimeters long, 21 cm wide, and 13 cm thick. On one side, the artifact contains 62 carved signs.

"This is an unambiguous example of writing," Houston says.

He and his coworkers describe the find in the Sept. 15 *Science*. The lead author is Carmen Rodriguez Martinez of the National Institute of Anthropology and History in Veracruz, who received the block from the road builders.

The scientists regard the marks inscribed in the stone as script because they include 28 distinctive elements, such as signs depicting maize, parallel sets of eyes, and an animal skin. These signs appear in sequences that run across the block.

The signs' precise meanings and the underlying rules for this writing system remain uncertain.

The relation of the Cascajal block to later New World writing is also fuzzy. The script may represent a regional invention that died out in relative obscurity. However, Houston suspects that it spread across southern Mexico. Wooden figurines from Olmec sites of about the same age have a few similar signs carved in the backs of their heads, he says.

Although the marks on the block are "suggestive" of writing, archaeologist Philip J. Arnold of Loyola University in Chicago takes a wait-and-see approach. Martinez and his coworkers need to find comparable signs on

HOUSTON

WRITER'S BLOCK **Signs such as these (inset), inscribed on a slab from southern Mexico, may represent the earliest known writing in the Americas.**

Olmec artifacts excavated from their original locations, Arnold says.

Archaeologist Christopher A. Pool of the University of Kentucky in Lexington also regards the new find cautiously. Aspects of the inscriptions on the block are unique, making them difficult to confirm as script, he notes. For instance, signs run horizontally across the stone, whereas the region's later writing systems placed symbols in vertical columns.

Signs carved into the Cascajal block "may not be fully formed writing, but they're close to it," remarks linguist John S. Justeson of the State University of New York at Albany. He says that while the new find incorporates patterned symbols from Olmec art, it apparently lacks calendar notations and action representations, key elements of later writing systems in southern Mexico and Central America.

Houston says that his group plans to conduct new excavations near the quarry. The Cascajal block "is probably one of many such texts in the area," he surmises. —B. BOWER

Family Tree

An arboreal genome is sequenced

For the first time, researchers have deciphered the DNA code of a tree. This accomplishment makes the black cottonwood, a type of poplar, the third plant species whose genome has been sequenced.

Since 2000, scientists have spelled out the long string of DNA components for rice and *Arabidopsis*, a plant in the mustard family that's commonly used for genetic experiments (*SN: 9/3/05, p. 157; 12/16/00, p. 388*). But because both these plants are herbaceous, they are missing some genes found only in trees and other woody-stemmed plants.

Such genes might hold clues to understanding trees' unique traits, such as their capacity to push nutrients long distances within trunks and branches and to adapt to changing conditions in one place for hundreds or thousands of years.

These traits have been tricky to examine in the lab, says tree geneticist Gerald A. Tuskan of Oak Ridge (Tenn.) National Laboratory. "These organisms are large and live a long time, so they're difficult to study in a controlled environment," he says.

Tuskan and scientists from 34 institutions around the world joined forces to sequence the black cottonwood (*Populus trichocarpa*) genome. The researchers chose this species for its relatively small genome and its importance in ecological systems and agriculture.

The team used a method called shotgun-sequence assembly. In this technique, the long strands of DNA that make up each chromosome are randomly sheared into smaller pieces. These pieces are then fed into sequencing machines, which decipher the genetic code of small sections at each piece's ends. Tuskan explains that after doing this process over and over, breaking up the DNA in different places each time, the researchers elucidated the entire black cottonwood genome.

ROOTED IN SCIENCE **The black cottonwood (*Populus trichocarpa*) is the first woody plant to have its genome sequenced.**

In a preliminary analysis published in the Sept. 15 *Science*, the researchers suggest that this tree has more than 45,000 genes, about twice as many as is estimated for the human genome. They also identified 93 genes associated with components that make up the tree's cell walls.

Industrial scientists are particularly interested in two cell wall components known as cellulose and hemicellulose, says product-development manager Art Wiselogel of the Salida, Colo.–based biofuel producer BBI International. Wiselogel notes that these components can be fermented to create ethanol, a gasoline additive or alternative. Information about the black cottonwood's genes could eventually lead to the tree's becoming a major ethanol crop, he says.

David Neale, a tree geneticist at the University of California, Davis, adds that researchers might also use the black cottonwood genome to improve tree health, much as the human genome project has aimed to improve people's health.

"We can better understand natural populations of forest trees and use this technology to manage forests and health. That's where I hope this work goes," says Neale. —C. BROWNLEE

Grounded Epidemic

Reduced air travel after 9/11 slowed flu spread

In 2001, the winter-flu season developed more gradually than usual in the United States because of a reduction in air travel after the Sept. 11 terrorist attacks, a new study says. The finding indicates that in the future, restricting air travel might delay a domestic outbreak of a dangerous pandemic strain of influenza.

Although curtailing flights could slow a pandemic, it wouldn't single-handedly reduce the scale of death or illness, says study leader John S. Brownstein of Children's Hospital Boston. However, flight restrictions might buy a few extra weeks for officials to distribute flu-fighting drugs or a vaccine, he and other scientists say.

Brownstein and his colleagues analyzed the timing of flu-related deaths between 1996 and 2005. While no pandemic occurred during that period, a seasonal flu swept across the United States each winter. Those outbreaks together killed nearly 400,000 people.

The researchers also considered the volume and timing of air travel within the United States and from points abroad. Two statistical relationships emerged, they report in the October *PLoS Medicine*.

First, the volume of airline passengers entering the United States each September predicted the timing of the next annual peak in flu mortality. Greater travel volume presaged an earlier flu season. Epidemiologists assume that infected travelers introduce the flu into the country each fall, Brownstein says.

Each September of the study's first 5 years, about 4.5 million airline passengers entered the United States, and peak flu mortality occurred, on average, on Feb. 17.

By contrast in September 2001, only 3.5 million passengers entered the United States. In the 2001-2002 flu season, peak mortality occurred on March 2.

Air travel gradually rebounded in subsequent years, and peak flu mortality eventually returned to Feb. 17.

The second statistical relationship linked domestic air travel during November, with its busy Thanksgiving holiday, with the speed

USDA

with which flu spreads across the country.

Summarizing the findings, Brownstein says that after Sept. 11, 2001, "flu eventually got everywhere across the country, [but] it was delayed in getting to some places." By comparison, there was no delay in the spread of flu that winter in France, which didn't experience a reduction in air traffic.

The new study provides valuable empirical support for recent results from computer simulations, says epidemiologist Ira Longini of the Fred Hutchinson Cancer Research Center in Seattle. Earlier this year, he and other researchers concluded from simulation results that air-travel restrictions alone could delay a pandemic by a few weeks (*SN: 4/8/06, p. 213*).

But Longini agrees with Brownstein that even "drastic disruption of air travel" is unlikely to save lives unless extra doses of antiflu drugs and a vaccine become available.

Rebecca Freeman Grais, a Paris-based epidemiologist who has modeled flu outbreaks, adds that any benefit from restricting air travel would need to be weighed against substantial economic and social costs. —B. HARDER

Oversize Orb

Puffy planet poses puzzle

Astronomers have discovered what may be the largest planet yet found—an orb that's 36 percent wider than Jupiter and that circles a nearby star. Researchers say that they're baffled by the giant extrasolar body, which has the lowest density of any known planet.

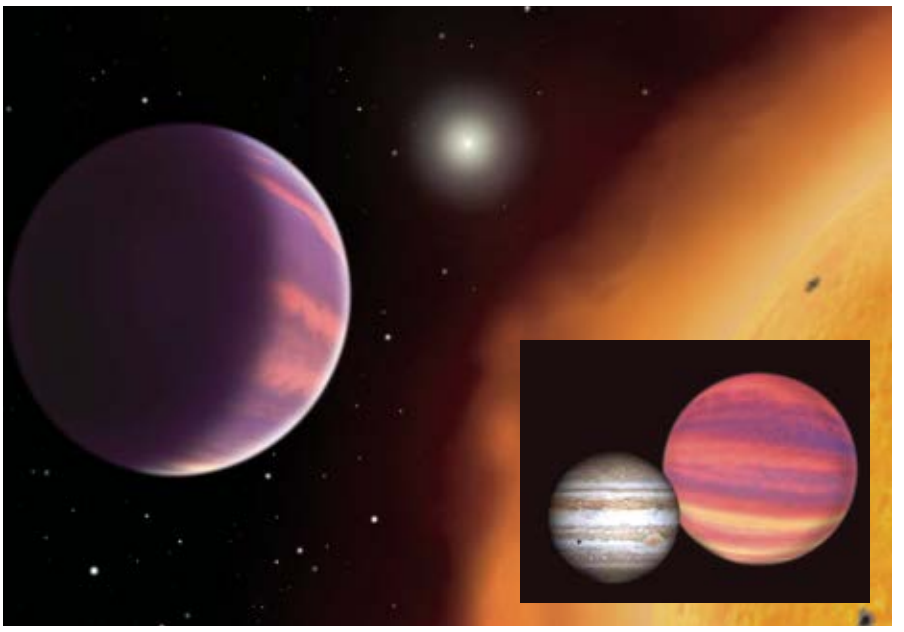
Half as massive as Jupiter and residing 450 light-years from Earth, the planet is just one-twentieth the distance from its parent star that Earth is from the sun. But the planet's presence in this hot zone isn't enough to explain the orb's low density, about one-quarter that of water, says codiscoverer Robert Noyes of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Many other extrasolar planets lie even closer to their stars, but they aren't nearly as puffy.

"We have a bit of a puzzle," says Noyes. Planet models can't explain the large radius.

The discovery team, led by Gaspar Bakos of Harvard-Smithsonian, could detect the object because it periodically passes directly between its parent star, the fainter member of a double-star system called ADS 16402, and Earth. During each transit, which lasts about 2 hours, the planet blocks 1.5 percent of the star's light from reaching Earth.

At press time, Bakos' team was scheduled to announce the finding at the Smithsonian Institution in Washington, D.C.

The new object, known as HAT-P-1b, was found by astronomers using six small robotic telescopes. Four of the telescopes are at the Whipple Observatory atop Mt. Hopkins in Arizona, while the other two are atop Hawaii's Mauna Kea. The network scans star fields as large as the Big Dipper. Follow-up observations with the large Keck 1 and Subaru telescopes on Mauna Kea confirmed the finding and provided additional data.



D. AGUILAR

BIG! **Planet HAT-P-1b closely orbits its orange-glowing parent star, while a partner star lies in the distance in this illustration. Inset compares Jupiter (left) with HAT-P-1b (right).**

Although astronomers know of some 200 extrasolar planets, most have been found indirectly, by measuring the small amount of wobble that a planet induces in the motion of its parent star. But the wobble method provides only a planet's maximum mass. In contrast, researchers can detect the exact mass and size of extrasolar planets observed in transit across their stars, as HAT-P-1b's were. HAT-P-1b is the twelfth planet discovered with the transit method.

Only one other transiting planet, HD 209458b, has a density nearly as low as that of HAT-P-1b, and some researchers had regarded HD 209458b as a fluke. Such supergiant Jupiters now have to be taken seriously as a class, says theorist Adam Burrows of the University of Arizona in Tucson.

Alan Boss of the Carnegie Institution of Washington (D.C.) says that "puffy hot Jupiters do not appear to be as rare as one might have been able to argue before this discovery."

Two other teams have also recently found planets transiting nearby stars, but those planets' sizes and densities are less unusual than those of HAT-P-1b. Weighing 1.4 times as much as Jupiter, the planet TrES-2 lies 500 light-years from Earth, David Charbonneau of Harvard-Smithsonian and his colleagues report in an upcoming *Astrophysical Journal*.

Another newly identified planet, XO-1b, is nine-tenths of Jupiter's mass and about 650 light-years away, Peter R. McCullough of the Space Telescope Science Institute in Baltimore and his colleagues report in the Sept. 10 *Astrophysical Journal*. —R. COWEN

Sexually Deceptive Chemistry

Beetle larvae fake the scent of female bees

Researchers can now explain how a male bee looking for love out in the desert can be misguided enough to embrace a writhing clump of beetle larvae instead of a female bee.

Those larvae, which grow into blister beetles, release compounds similar to the sex pheromone of the female bee, says ecologist Leslie S. Saul-Gershenz of the Center for Ecosystem Survival in San Francisco. When the deluded male touches the beetle clump, larvae rush onto his body. They use him as an air taxi to reach a female and then raid her underground nursery.

This finding of the larvae's lure puts the immature blister beetles among the few animals known to practice chemical mimicry for hunting, say Saul-Gershenz and her coauthor Jocelyn G. Millar of the University of California, Riverside.

"All around, it's a pretty remarkable system," comments chemical ecologist Kenneth F. Haynes of the University of Kentucky in Lexington.

The blister beetle species *Meloe franciscanus* and the host bees meet in the dunes

of southwestern U.S. deserts. Biologists have long known that the orange-brown larvae climb plant stems.

In 2000, Saul-Gershenz and a colleague described male bees, *Habropoda pallida*, visiting clumps of beetle larvae and picking up larvae (*SN: 5/6/00, p. 295*). The researchers proposed that the tiny, flightless larvae hitch a ride on the male bee and then transfer to a female that he encounters. Carrying the beetle larvae, the female burrows several meters deep into the sand and then lays a single egg and stores some pollen. The egg and pollen can sustain tagalong beetle larvae.

A new paper, published online and in an upcoming *Proceedings of the National Academy of Sciences*, describes how the larvae fool a bee. Researchers designed a larvae-cluster model from crumpled aluminum foil dabbed with water-based paint. To human eyes, the model looked good.

When Saul-Gershenz set out models in the desert, though, unscented ones didn't attract male bees. However, male bees paid visits to models scented with extracts from blister beetle larvae as often as they did to real beetle clumps.

Millar, a chemical ecologist, found that female-bee allure depends on blends of hydrocarbons, but the beetle larvae produce only a few of those components. The mimicry is "good enough," says Saul-Gershenz.

Diluting the larval extract before applying it to a model reduced its seductive power. Therefore, it takes many larvae to release an effective dose, says Saul-Gershenz.

She points out that the match isn't as close as it is in the two other well-studied examples of what scientists call aggressive chemical mimicry. Orchids emit accurate knockoffs of female-bee pheromones, thereby fooling futilely romantic male bees into transferring orchid pollen.

Adult female bolas spiders of North America also mimic insect sex pheromones, says Haynes. He and his colleagues have shown that adult female spiders of one bolas species produce the appropriate ratio of two components of a moth's sexual attractant. Male moths that respond make up most of those spiders' diet. —S. MILIUS

Solid Surprise

High-pressure oxygen takes unpredicted form

For more than a quarter century, scientists have been trying to determine the structure of a particular form of solid oxygen. X-ray analysis of the substance under high pressure now indicates that oxygen's two-atom molecules aggregate into groups of four in a crystalline structure that's never been seen before and isn't accounted for in current theory.

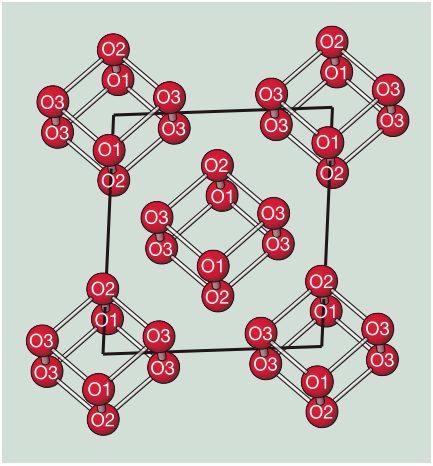
Oxygen is the third-most-common element in the universe, trailing only hydrogen and helium. At the pressures and temperatures ordinarily found at Earth's surface, molecules of oxygen form a gas. At various combinations of lower temperatures and higher pressures, oxygen becomes a liquid. At very low temperatures or exceedingly high pressures, the substance takes on solid form.

Solid oxygen has six known varieties, each designated by a Greek letter, says Lars F. Lundegaard, a physicist at the University of Edinburgh. Scientists first observed the dark-red epsilon phase, or ε-oxygen, during high-pressure experiments in 1979.

Despite nearly 3 decades of analyses, scientists hadn't come up with a convincing model of ε-oxygen's crystalline structure. Some teams had suggested that the form's crystals are groups of eight-atom chains, Lundegaard notes. Others had speculated that the atoms link to form a single ring of eight atoms, as does sulfur, oxygen's chemical relative. "As it turns out, no one was right," Lundegaard says.

When some researchers compressed pure oxygen, their equipment applied shearing stresses that distorted the material. Lundegaard and his colleagues avoided that problem by mixing helium and oxygen. As the researchers added pressure, the gas mixture liquefied and then separated into the two components. Adding even more pressure caused the oxygen and helium to solidify, resulting in 100-micrometer-long ε-oxygen crystals that were surrounded by solid helium and therefore protected from shear stresses.

Passing X rays through the ε-oxygen crystals revealed that the two-atom molecules were arranged in rhombus-shaped groups of four. The distance between molecules within a group is 0.218 nanometer, and the distance between groups is at least 0.256 nm, the researchers report in the Sept. 14 *Nature*.



TWO BY FOURS **Under high pressure, oxygen molecules (labeled O1-O2 and O3-O3) aggregate into groups of four, each of which is surrounded by four neighbors. Such a grouping of molecules had never been observed.**

This "pressure-induced association of molecules was unanticipated," says team member Paul Loubeyre, a physicist at France's Atomic Energy Commission in Bruyères-le-Châtel. Although there seems to be some type of bonding among the molecules in each group, it's not yet clear what that is, he notes.

Scientists usually apply quantum mechanics equations to come up with approximations of crystal structure. That didn't work, however, in the case of ε-oxygen, indicating that the approximations don't account for all possible molecular interactions.

"The standard methods failed for this problem," says Burkhard Militzer, a physicist at the Carnegie Institution of Washington (D.C.). The new findings "open up a fresh dimension of chemistry that we are only just getting to know," he comments in *Nature*.

"This structure shows [that] we have a limited understanding of even simple materials," says Lundegaard. —S. PERKINS

SAUL-GERSHENZ/PNAS; LUNDEGAARD ET AL./NATURE

SMELLS RIGHT **Blister beetle larvae cluster (left) on a plant stem and release a seductive odor. Drawn by the pheromone, a male bee suddenly finds himself covered with beetle larvae.**

PICK YOUR ANTIPOISON

Researchers work to make antivenom safer, cheaper, and more effective

BY CHRISTEN BROWNLEE

On a warm, sunny afternoon last June, emergency room physician Sean Bush got a call on his pager that made his blood run cold. The number was his wife's, followed by three digits: 9-1-1. Whatever the page concerned, Bush knew that it was a serious emergency—he and his wife don't take those numbers lightly.

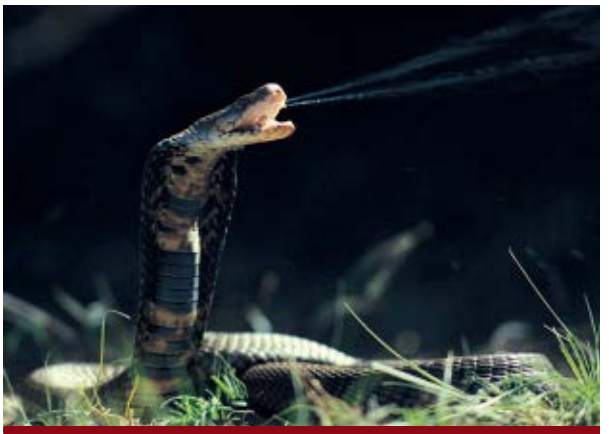
A quick call from the hospital where he was on duty to his home 22 miles away brought terrifying news. Through panicked tears, Bush's wife related that a small rattlesnake had just bitten the couple's 2-year-old son, Jude, as he played with another child in the couple's backyard. When the curious boy had reached down to pick up the snake, the reptile sank its fangs between Jude's right thumb and forefinger.

"It's not every parent's nightmare, but it's certainly mine," says Bush, who specializes in treating venomous snakebites at Loma Linda University Medical Center in California.

Bush had seen some frightening snakebite scenarios: victims twitching, hemorrhaging throughout their bodies, or unconscious from venom's effects. He knew that a 2-year-old boy could die from a rattlesnake bite that might only wound an adult.

A rescue team to air lifted Jude to meet him and a team of other doctors at the emergency room, where a complex cocktail of antibodies, known collectively as antivenom (also antivenin or antivenene), awaited the boy. The intravenous treatment neutralized the toxin in time to save Jude's life—a testament to antivenom's powers.

Although treatment with antivenom in the United States is usually successful, for most people around the world who are bitten by snakes, the story doesn't have a happy ending. Because the treatment is costly, it isn't available to many people in developing countries. Even among people who do receive antivenom, problems such as life-threatening allergic reactions, can arise. New research using several strategies is improving on methods of producing antivenom and may soon make treatment of venomous bites and stings less expensive, less risky, and more effective.



SPITTING MAD — Venom expelled by this Mozambique spitting cobra contains hundreds of deadly toxins.

GETTY IMAGES

SYNTHETIC SOLUTION In most places around the world, antivenom is still made in much the same way as it was in the late 1800s. Experienced handlers milk venom from poisonous snakes, spiders, and scorpions. Workers then inject small amounts of that venom into large animals, such as a horses, cows, or sheep.

The tiny quantities of venom don't harm the animals but spur them to produce floods of antibodies, the immune molecules that attach to venom's toxins and tag them for destruction by other parts of the immune system. After a few weeks, a worker collects an injected animal's blood and removes the blood cells to isolate the serum, which is swimming with antibodies against the venom. Those antibodies are purified from the serum and administered to patients.

A dose of antivenom is specific for the poisons produced by a single species of snake or other poisonous animal. To make an antivenom that fights venoms of several species, vaccine-farm workers inject a large animal with several venoms at once. Poison-control centers typically keep such polyvalent antivenoms on hand rather than stocking vials of antivenoms geared toward each of the poisonous species in the area. In the United States, the most common treatment uses portions of antibodies to neutralize the venom of several snakes native to this country.

In developing countries, tens of thousands of people die from snakebites each year. One reason is that the current method of antivenom production isn't practical in many of the places where treatment is needed most, notes Simon Wagstaff, a researcher at the Liverpool School of Tropical Medicine in England.

For example, the treatment can cost thousands of dollars per dose. To make each batch of antivenom, a manufacturer must pay for housing and handling of both the poisonous creatures and the host animals that produce the antibodies.

Moreover, antivenom can have its own dangerous effects. About a quarter of patients treated develop extreme allergic reactions to antibodies and other substances present in the host animal's serum. This allergic reaction, called anaphylaxis, is a danger for a snakebite victim being treated even in the most sophisticated hospital, and it's all the more threatening in a village clinic in rural Africa.

Researchers have speculated that antivenom might spur fewer allergic reactions if it contained only antibodies targeted to the most damaging toxins in venom. However, Wagstaff notes that researchers would have to isolate and purify individual poisons before injecting them into antibody-producing animals. "That's a difficult order, since venom has so many components," he explains.

Wagstaff and his colleagues published a study in the June *PLoS Medicine* that provides a clue to alleviating both the cost and safety problems of snake antivenom. Rather than injecting large animals with milked venom to make serum, Wagstaff says, antivenom producers might inject the animals with snake DNA.

The researchers worked with DNA isolated from the venom glands of saw-scaled vipers, the species responsible for most of Africa's snakebite deaths. Wagstaff and his colleagues determined the

sequence of about a dozen genes that code for metalloproteases. In a snakebite victim, these enzymes break down tissues, including the proteins that line blood vessels, and cause profuse bleeding.

The researchers took snippets of seven metalloprotease genes and strung them together to create a synthetic gene that's easy to generate in large quantities in the lab. They then inserted this manufactured gene into mice, whose cells produced pieces of snake-venom proteins. The rodents, playing the part of the typical horse, cow, or sheep in today's antivenom operation, produced antibodies to counter these proteins.

In lab-dish tests, the researchers found that those mouse antibodies recognized and latched on to venom much as conventional antivenoms do. The mouse antibodies attached to venom not only from saw-scaled vipers but also from several other African viper species, such as horned vipers and puff adders, that share many metalloprotease genes, says Wagstaff.

He and his colleagues also found that antibodies from the DNA-treated mice could neutralize bleeding in other mice that had been injected just under the skin with saw-scaled viper venom.

Wagstaff notes that injecting antibody-production animals with snake DNA instead of venom could eliminate the expensive and dangerous task of maintaining and milking venomous snakes. The synthetic gene can be produced in a laboratory.

By selecting DNA for specific venom toxins, manufacturers could also reduce the variety of antibodies that the large animals produce. That would lessen the chance of allergic reactions, Wagstaff adds.

"We're very encouraged by this proof-of-principle study," he says. He and his team are currently supplementing their synthetic gene with pieces of venom-producing DNA from a variety of snakes.

LOOKING TO NATURE Though snakebites can be fatal for people, certain species of mammals, including mongooses, opossums, and ground squirrels, can resist some venoms' effects. Scientists are studying this resistance for clues to developing new types of antivenom, says chemist Jim Biardi of the University of California, Davis.

Decades ago, scientists nailed down the basic mechanism for how these mammals avoid damage by venom. Proteins that circulate in a resistant animal's blood neutralize venom's toxins. These protective proteins belong to a class of molecules called protease inhibitors. People have many types of protease inhibitors in their blood, but not the ones that break down certain venoms.

Injecting people with protease inhibitors collected from venom-resistant animals would be expected to cause allergic reactions at least on par with those associated with traditional antivenom, so most scientists don't consider that a viable strategy. Instead, some researchers have proposed modeling synthetic-antivenom drugs on the venom-fighting enzymes, says Biardi.

However, he adds, several questions first need to be answered. For example, can resistant animals neutralize a variety of venoms or just those to which they're likely to be exposed? Drugs based on protease inhibitors from animals resistant to multiple venoms would be more useful than those that can neutralize the venom from just a single species.

Biardi and his colleagues are currently examining California ground squirrels, a species that's resistant to rattlesnake bites. These small mammals adopt menacing postures, throw dirt, and even bite snakes that encroach on their burrows (*SN: 10/9/99, p. 237*). In a study published in the November 2005 *Journal of Chemical Ecology*, Biardi's team described its geographic survey of venom neutralizing among hundreds of ground squirrels in California.

They surveyed squirrel populations in four locations in the state, ranging from as far north as Winters, near Sacramento, to as far south as Santa Barbara. Squirrels in three of the locations lived near Northern Pacific rattlesnakes, while those in the southernmost location lived near a second species, the Southern Pacific rattlesnake.

When Biardi and his colleagues tested the squirrels' blood serum against venoms from both those snake species and several others, they found that all the squirrels could counteract venom from both the northern and southern California rattlers. However, the animals' serum had little effect on the venom of related rattlesnake species, such as the western diamondback, whose range is distinct from that of California ground squirrels.

Although California ground squirrels seem to resist only the venom from local rattlesnakes, further research might turn up animals that can counteract several types of venom. "Finding a prey species that's resistant to a bunch of venom variants could be great for developing new therapeutics," says Biardi.

> "Finding a prey species that's resistant to a bunch of venom variants could be great for developing new therapeutics."
>
> — JIM BIARDI, UNIVERSITY OF CALIFORNIA, DAVIS

RIGHT HERE, RIGHT NOW Although snake DNA or antibodies from mammals naturally resistant to bites could someday yield new snakebite treatments, some scientists make their first priority improving antivenoms now in use.

Six years ago, U. S. doctors started using the first new antivenom approved by the Food and Drug Administration in more than 50 years. The drug, CroFab, neutralizes venom from a group of snake species that includes pit vipers, rattlesnakes, and coral snakes.

Old-school antivenom formulations contain Y-shaped antibody molecules known as immunoglobulin Gs (IgGs). The two short arms of an IgG molecule neutralize venom, while the long tail prompts most allergic reactions. CroFab's manufacturer, Protherics of Brentwood, Tenn., makes its antivenom using IgG fragments representing only the arms.

Switching to the new antivenom has reduced the proportion of people who have problematic reactions to treatment for poisonous bites. Up to 75 percent of people getting whole-IgG antivenoms have at least minor allergic reactions, whereas less than 5 percent of bite victims receiving IgG fragments do, says Jude McNally of the University of Arizona in Tucson.

However, cleaving the antibodies introduces a treatment challenge. Unlike the larger IgG antibodies, which can neutralize toxins for weeks, the smaller pieces that make up CroFab are often taken up by the kidneys before they've done their jobs. After a large initial dose of antivenom, patients may need to receive maintenance doses for several days, McNally explains.

He and his colleagues intend to apply a strategy that researchers in Europe and some Latin American countries have used to create a new generation of antivenoms not yet in use in the United States. Sophisticated biochemical techniques retain an IgG's hinge portion while eliminating its tail. This keeps the Y's arms connected, thereby postponing their removal.

McNally and his colleagues, led by University of Arizona researcher Leslie Boyer, are conducting a trial of a hinged-fragment antivenom against scorpion stings in people. The drug is produced by a company called Bioclon Institute in Mexico City and has been used for 5 years in Mexico. Boyer, McNally, and their colleagues intend for the drug to be available for the 200 or so cases of serious scorpion stings that occur each year in the United States, mostly in Arizona.

Although the trial isn't complete, Boyer says that she's "very excited" about the preliminary findings. The drug appears to be safe, effective, and long lasting, she says.

Bush says that such improvements to antivenoms could make treating venomous bites and stings cheaper and more effective by the time his son grows up. But in the meantime, Bush says, he and his wife are trying to reduce the chance that their son will be bitten by another rattlesnake.

"I think we're all a little more the wiser from the experience," he says. "I don't take my eyes off him in the backyard, even for a moment." ■

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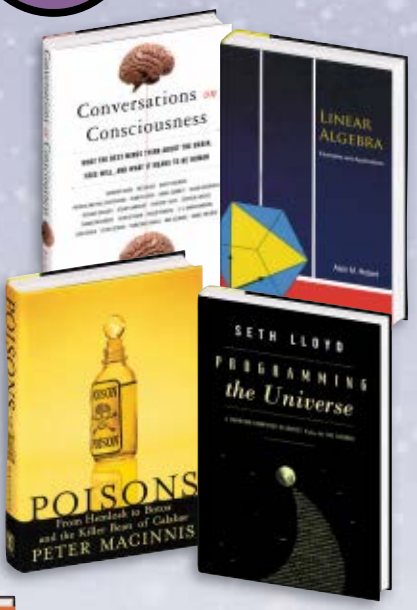

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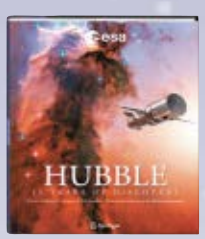

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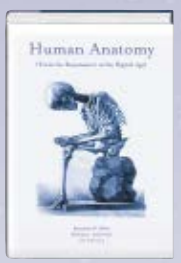

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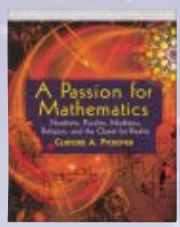

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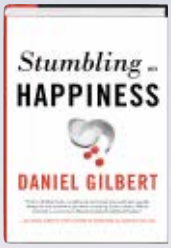

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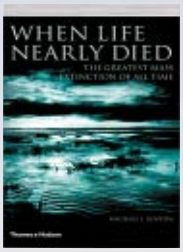

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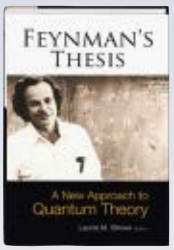

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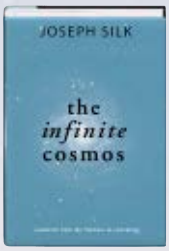

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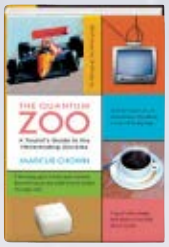

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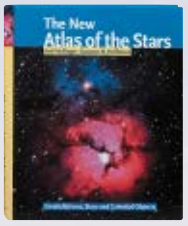

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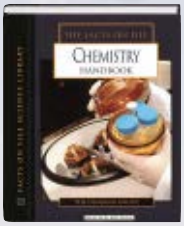

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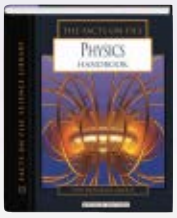

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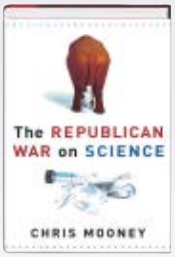

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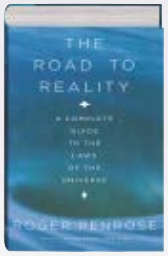

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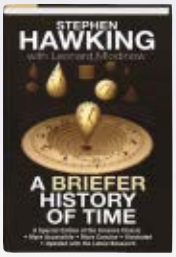

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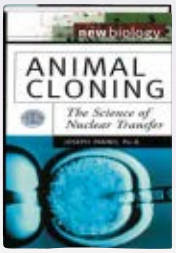

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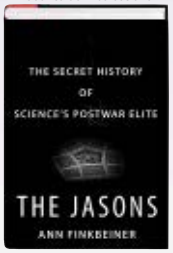

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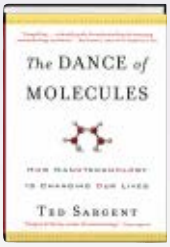

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BATTLE OF THE HERMAPHRODITES

Sexes clash even when sharing the same body

BY SUSAN MILIUS

Anybody who's ever mused that the world would be better if men got pregnant needs to talk to Nico Michiels. And so does anybody who's asked—or sung—"Why can't a woman be more like a man?" Michiels has seen that world, or at least a version of it, and he's even got pictures to show. It's not pretty, he says.

Many snails, slugs, and worms are so-called internally fertilizing, simultaneous hermaphrodites. In any encounter, such creatures can deliver sperm, receive it for fertilizing eggs internally, or do both.

Michiels, an evolutionary ecologist at the University of Tübingen in Germany, offers the striking example of hermaphroditic polyclad flatworms called *Pseudobiceros bedfordi*.

When two of these small, speckled sea worms meet to mate, there's no taking turns. Each worm, 2 to 6 centimeters long, wields its pair of side-by-side penises like a weapon. One worm tries to fertilize the other by ejaculating anywhere on its partner's body, splashing it with sperm in a cocktail that dissolves flesh. After the brew eats a hole through the skin, the sperm work their way through various tissues until they reach the eggs.

DUELING FLATWORMS — Two hermaphroditic flatworms, *Pseudobiceros bedfordi,* each with pale, side-by-side penises, show their undersides as they square off to mate.

MICHIELS

In many *P. bedfordi* encounters, only one member of the pair gets its sperm to the other's eggs. The recipient of the sperm eventually deposits clutches of hundreds of eggs on some suitable surface and glides away.

The holes and wrinkly streaks on many worms' bodies are ejaculate burns, says Michiels.

It's not that the duelists could choose a less violent way to couple. In these worms, the reproductive tract has an opening, but it doesn't lead to the eggs.

And in many other simultaneous hermaphrodites, if one partner deposited sperm into the other's reproductive tract, elaborate plumbing would divert a sizable portion of the sperm to digestive organs, presumably as a snack for the recipient.

Of course, animals with separate sexes can be rough and tumble too, says Michiels. However, he and a colleague propose that gender wars are more likely to flare into bodily harm among simultaneous-hermaphrodite species with internal fertilization than among their separate-sex counterparts.

In the violence that's evolved in many of these simultaneous hermaphrodites, says Michiels, "the result is an almost ridiculous escalation."

The mating quirks of simultaneous hermaphrodites are attracting growing interest. Researchers are exploring the sexual conflicts that escalate into bodily harm. A few species, however, have gone in the other direction, developing systems for cooperative bouts of mutual insemination or for taking turns.

From Michiels' perspective, though, hermaphrodites "tell us it's very useful to have the sexes separate."

FORMERLY BENIGN Roughly 15 percent of animal species live a hermaphroditic lifestyle of some form, Michiels estimates. Many of them are sequential hermaphrodites, such as clown fish that spend their young adulthood as one gender and then switch to the other.

Among the animals that are simultaneously male and female, Michiels distinguishes between hermaphrodites where partners make contact to achieve internal fertilization and those in which at least one of the partners releases a cloud of gametes, so the partners don't themselves make physical contact.

According to Michiels, the fertilizers without partner contact are less likely to careen into a violent conflict than are hermaphrodites with full-contact internal fertilization.

For years, biologists didn't think much about sexual conflict, even in species with separate sexes, says Nils Anthes, also of Tübingen. Mating seemed "benign," as Anthes puts it. Both males and females have urges for offspring, so at first glance, producing youngsters should be a happy, family project.

That rosy view began fading in 1948, when fruit fly researcher Angus John Bateman of England argued that males invest much less energy in producing offspring than females do. That investment gap suggested that the best reproductive strategy for one sex isn't equally good for the other. Bateman argued that the average male would do well to mate as widely as possible, while a female should be particular about whose sperm she accepts. What could make better tinder for conflict between the sexes?

In 1979, theorist Eric Charnov, now at the University of New Mexico in Albuquerque, proposed that these ideas could apply to simultaneous hermaphrodites. For example, conflicts could arise as individuals of those species sort out when to play each sexual role.

For years, theorists assumed that tactics in the hermaphrodite

gender war would be fairly consistent within an individual or even a species, says Anthes. However, in the July *Animal Behaviour*, Michiels, Anthes, and Annika Putz, offer what they call a new framework for thinking about hermaphrodites. It urges theorists to compare his and hers benefits under changeable, thus realistic, conditions. Strategies could vary, for example, with the characteristics of available partners. In another paper, Michiels and Anthes report that sea slugs donate more sperm to a partner that's been isolated than to one that's recently mated and so already carries plenty of sperm.

IT MUST BE LOVE — The sharp calcium spike stuck through the head of the common garden snail on the left was launched during courtship by its mating partner.

CHASE & KOENE

MATE THIS Some of the mating habits of simultaneous hermaphrodites can be difficult for humans to understand. For that reason, the University of California, Santa Cruz doesn't emphasize that its athletic teams' mascot, a hermaphroditic banana slug, has been reported to practice apophally, or penis biting. Theorists have proposed several dramatic hypotheses about the conflicted sex lives of the big, land-living, bright-yellow slugs. One focused on the possible value of a detached organ as a barrier to the recipient mating with others.

Heike Reise of the State Museum of Natural History in Görlitz, Germany, suggests something simpler: The worms just get stuck. The reproductive-tract muscles may sometimes grip its partner's penis too tenaciously. This would explain reports of slugs appearing to strain apart before one bites off its partner's penis.

These and other hermaphroditic matings that look like maulings have inspired many scientific publications in recent years. Michiels and Leslie Newman described in 1998 what has become a classic example, called penis fencing, in the *Pseudoceros bifurcus* marine worm from Australia's Great Barrier Reef. When potential mates meet, they rear up and face off, feinting and dodging.

The researchers argued that each worm was trying to fertilize the other's eggs while minimizing the sperm it receives. A worm delivers its sperm by using its penis to punch a hole in the partner's skin, anywhere on the body. As in the ejaculate-splashing polyclad worms, the sperm's navigational prowess gets it to the eggs.

Since 1998, the scientists have found relatives of *P. bifurcus* that mate even more aggressively, says Michiels.

"Everybody wants to be male, and nobody wants to be female," is Michiels' basic explanation. The species keep evolving tactics, some of them violent, to maximize fatherhood. Michiels and Joris Koene of the Free University in Amsterdam present a mathematical model in the August *Integrative and Comparative Biology* predicting that hermaphrodite species face an extra-high risk of evolving violence between mates.

If the species had separate sexes, females would act as a safety brake, says Michiels. When the male function starts taking a big toll on female reproduction, females take countermeasures. But that doesn't happen when each individual is both male and female. To Michiels, the prospects for creatures living this way look so perilous that he speculates that they're headed for "an evolutionary dead end."

DOPING SCANDALS Some hermaphrodites have a literal take on Cupid's arrows. The common brown garden snail (*Cantareus aspersus*) and members of at least four families of land snails shoot what's popularly called a love dart.

Over some 7 days, a garden snail forms a 9-millimeter-long, sharpened shaft in a gland near the opening of its reproductive tract. As two snails wriggle around, positioning themselves to pump sperm into the reproductive tract of each other, each launches its dart toward each other's body.

"It's a strange thing to do to your prospective mate," notes neurobiologist Ronald Chase of McGill University in Montreal.

Chase got curious about the snails' darts in the 1980s. The prevailing explanation at the time, he says, had been floating around since the early 18th century: The dart would make the partner more willing to mate.

That explanation was "easy to refute," says Chase. First, virgin snails don't shoot a dart when they first mate, and other snails flub the shot about half the time. They either botch the launch so that the dart bounces off the partner without embedding or they miss the partner entirely. In various studies, he and a colleague compared aspects of mating, for example, the length of time that the snails courted before copulating, when snails mated with and without dart piercing. "It made absolutely no difference," he says.

Having undermined the previous explanation of the dart, Chase began seeking others. He found that snails triumphing at the dart thrust gained an advantage. They sired twice as many offspring as did snails whose darts missed their targets.

Among garden snails, a sticky substance coats the darts, and Chase and a series of collaborators have experimented to see whether the darts deliver some mate-managing chemical. When researchers dissected out snail reproductive ducts that receive sperm and smeared them with dart mucus, the ducts began contracting in ways that Chase speculates would send sperm toward the storage organs on the route to fertilization rather than toward a gland that digests sperm.

These findings suggested that darts deliver snail drugs, but Chase still wondered whether the stabbing itself had an effect. Chase's McGill colleague Katrina Blanchard has just ruled out that possibility. She removed the dart-making gland and its contents from about 200 garden snails. When these snails mated, she did the stabbing herself, using a syringe to inject either a saline solution or an extract of dart goo. The stabbing and saline injection didn't boost paternity, but a shot of dart goo did, Chase and Blanchard report in the June 22 *Proceedings of the Royal Society B*.

Garden snails do well if they make one jab, but other species hold on to their love darts and wield them as daggers. A Japanese hermaphroditic snail stabs its partner some 3,000 times during a single mating encounter, report Koene and Satoshi Chiba of Tohoku University in Sendai, Japan. In work released online for the October *American Naturalist*, the researchers say that the pattern of darts and daggers throughout the snail family tree shows that among hermaphroditic species, repeated stabbing probably evolved before single-use darts did.

Koene has used dart-stabber family trees to look for evidence of arms-race escalation in sexual traits. He and Hinrich Schulenburg of Tübingen found that among Helicoidea snails, two traits tend to occur in the same species. Fancified darts with flanges deliver extra goo, and elongated sperm-receiving organs diminish the goo's power by requiring it to act on a greater area of tissue. That pairing looks like the aftermath of escalating conflict, the researchers argued in the March 30, 2005 *BMC Evolutionary Biology*.

Although the examples are striking, Chase says that he's not

convinced that the males' and females' interests clash. Chase and his McGill colleague Kristin Vaga reported in the April *Behavioral Ecology and Sociobiology* that they haven't found clear behavioral signs of conflict, such as avoidance, in the mating of garden snails.

Until now, snail love darts have dominated research on mate-controlling chemicals. But other structures are now being considered. A study of common earthworms (*Lumbricus terrestris*), which are simultaneous hermaphrodites, has found that some 30 of each individual's 40 special hairs pierce its partner's skin, according to Koene, Michiels, and Tina Pförtner of Westfaelische Wilhelms University in Münster, Germany. These hair stabs change the partner's uptake of sperm, possibly by injecting chemicals, the team reported in the December 2005 *Behavioral Ecology and Sociobiology*.

FAIR TRADE — Two hermaphroditic *Chelidonura hirundinina* sea slugs prepare for one of several simultaneous sperm exchanges. (Red arrows indicate female openings; yellow arrow shows male organs.)

ANTHES AND MICHIELS

Anthes is working with the sea slug *Siphopteron quadrispinosum*. Its penis has an attached stylet that plunges into a partner's body during mating. The slug taking the hit slows down, so Anthes speculates that the syringelike prong injects a sedative.

Although many simultaneous hermaphrodites play the guy's role more aggressively than the girl's, Michiels notes that in a few cases the sperm receiver seems to take charge. He's found early–20th-century accounts of a rare freshwater European flatworm without a functional penis. Instead, according to the reports, the individual acting as a female thrusts a faux penis into its partner and draws out a supply of sperm.

EQUAL PARTNERS? Sex isn't all conflict, though. Some hermaphrodites take turns being male and female or simultaneously deliver and receive sperm. Scientists had proposed that one partner might become more or less cooperative depending on what the other one just did. Anthes and Michiels have come up with a new method for testing this idea. They studied a "very beautiful" sea slug that's a simultaneous hermaphrodite, says Anthes.

Yellow and blue lines shimmer along the black body of *Chelidonura hirundinina*, but what the researchers find even more beautiful is a little fold of skin lined with hairs that guide blobs of sperm from a worm's testes along a brief trip in the outside world to its penis. The researchers cauterized the groove in a few worms so that sperm wouldn't reach the penis.

Mating slugs normally exchange some sperm, back off, and then return for another round. They reciprocally transfer sperm five to eight times during a mating. When researchers cauterized the sperm-guiding groove of one slug, so that it no longer provided sperm, the partner broke off the exchanges after only two to four rounds, the researchers reported in the Oct. 11, 2005 *Current Biology*.

When the researchers have tried the experiment in another species, *Chelidonura sandrana*, cauterization produced no change in mating. That might have been a disappointment, but Michiels says that the difference between the two species might hold clues to the value of reciprocity.

Such unexpected twists, Michiels says, attracted him to the study of hermaphrodites. "I really had the feeling that we know about males and females," he says. For hermaphrodites, though, "it's a completely different world." ■

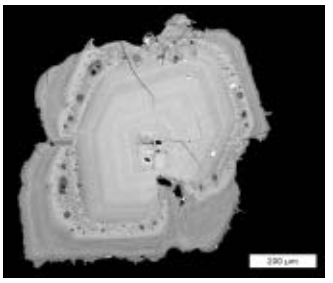
OF NOTE

EARTH SCIENCE

Magma heats up as it crystallizes

Molten rock moving up through a volcano's plumbing prior to an eruption can heat up substantially, an unexpected finding that could affect scientists' models of the eruption process.

Magma crystallizes as it slowly loses heat to the environment, a process in which minerals with the highest melting points are the first to solidify. However, magma can also crystallize when volatile substances such as water and carbon dioxide bubble out suddenly, causing pressure within the lava to drop, says Kathy Cashman, a volcanologist at the University of Oregon in Eugene. When pressure drops slowly, the first minerals to solidify give up large amounts of heat that warms the remaining molten rock, Cashman and her colleagues report in the Sept. 7 *Nature*.



J. BLUNDY AND CASHMAN

GROWTH RINGS Chemical analyses of layered crystals in congealed lava indicate that some magma gets hotter as it ascends through a volcano.

For their study, the researchers chemically analyzed crystals that had formed within lava that erupted from Mount St. Helens between 1980 and 1982 and from Shiveluch, a Russian volcano, in 2001 and 2002.

Molten rock that had risen to Earth's surface in those volcanoes over the course of weeks or months heated up by as much as 100°C during its journey, the team's analysis suggests. That degree of warming can alter several physical properties of molten rock, especially its viscosity. Understanding such changes may enable scientists to better predict the timing and violence of future volcanic eruptions, says Cashman. —S.P.

CHEMISTRY

Better protection

A new molecular catalyst shortens a widely used reaction into a one-step process, with a bonus: It makes the reaction's products into one of two possible mirror-image forms.

When chemists synthesize compounds, they often add a protective group of atoms to a specific site on a molecule to prevent that site from reacting in subsequent steps. For example, a silicon-based group is added to an alcohol site in many syntheses of organic molecules, says Marc L. Snapper of Boston College.

However, protecting an alcohol site in this manner previously required up to seven chemical steps, he notes. To expedite the process, Snapper, Amir H. Hoveyda, and their Boston College coworkers searched for a small molecule that could catalyze that addition in a single step.

Furthermore, chemists often want to synthesize one of two possible mirror-image forms, or chiral molecules. The function of some molecules depends on its mirror-image form.

Snapper and his colleagues used their catalyst, which is chiral, on a compound with two alcohol groups in symmetrical positions on the molecule. The catalyst added the protecting group to only one position, making the compound also chiral. The researchers report in the Sept. 7 *Nature* that the reaction makes 98 percent of one mirror-image form and only 2 percent of the other.

The researchers are now working to improve the speed of the reaction and apply the catalyst to compounds with different numbers of alcohol groups. —A.C.

BIOMEDICINE

Forewarning of preeclampsia

Scientists have found an early warning sign of preeclampsia, a pregnancy complication marked by high blood pressure. Pregnant women with too much of a protein called soluble endoglin in their blood have a heightened risk of preeclampsia, the researchers say.

Endoglin normally sits on the surface of blood vessels, where it plays a role in vessel dilation and facilitates blood flow. But endoglin can escape these moorings and dissolve in the blood.

Epidemiologist Richard J. Levine of the National Institute of Child Health and Human Development in Bethesda, Md., and his colleagues tested stored second-trimester blood samples from 552 pregnant women. Of these, 72 had developed preeclampsia late in their pregnancies. Those women had blood concentrations of soluble endoglin that were nearly double those found in women who had uncomplicated pregnancies. The warning sign appeared 2 to 3 months before preeclampsia struck, the researchers report in the Sept. 7 *New England Journal of Medicine*.

The work adds soluble endoglin to a growing list of proteins that, in aberrant supply, signal an increased risk of preeclampsia (*SN: 2/14/04, p. 100*). For example, pregnant women who are destined to develop preeclampsia often have too little placental growth factor in their blood and too much of a protein that regulates blood vessel growth (*SN: 5/10/03, p. 293; 3/8/03, p. 147*).

In fact, Levine and his colleagues found that using measurements of soluble endoglin and the ratio of these two other compounds to each other provided even better predictions of preeclampsia than either test did on its own.

The next step is to combine these measurements into a reliable test for preeclampsia that yields few false-positive readings, says Levine. —N.S.

SCIENCE & SOCIETY

Women: Where are your patents?

While compiling a database of life scientists participating in biotech start-up companies since the 1970s, Toby E. Stuart of Harvard Business School in Boston gave a start when he ran across the name *Nancy*. It stood out, the sociologist says, because it was the only obviously female name among the first 70 entries. They discovery prompted him and two of his colleagues at other business schools to investigate additional gender gaps among life scientists in academia. The researchers found a doozie: men and women with potentially money making patents.

The trio randomly chose 4,200 scientists from the life science fields most likely to foster commercial spin-offs and then examined 30 years of patent records.

In the Aug. 4 *Science*, Stuart and his team report finding that 5.65 percent of the women in this group were patent holders versus 13 percent of men. Because "women faculty members patent at about 40 percent of the rate of men," many women lost out on significant extra income from royalties and entrepreneurial opportunities, says Stuart.

Attempting to explain the male-female differential, the researchers tracked down some 23,400 journal articles that the 900 women in their study had published. Then, they matched each paper, by year, with one from a man in the study's sample. Overall, women's papers were cited by other scientists slightly more often than were the men's, thereby offering "no evidence that women do less important work," Stuart says.

Some of the older women in the study said in interviews that they had felt "excluded from industry relationships" that might have led them to pursue commercial aspects of their work, Stuart reports. —J.R.

CHEMISTRY

Compounds pass the smell test

A vile-smelling but versatile class of compounds may find a role in more chemistry laboratories with the introduction of easily made, inoffensive versions.

Isonitriles, chemicals characterized by a triple bond between a carbon and a nitrogen atom, are useful in many reactions. But many chemists have shunned them because of their pungency, says Michael C. Pirrung of the University of California, Riverside. "It makes your nose burn," he says. Moreover, the primary way to make the chemicals is difficult and uses highly toxic gas.

Pirrung frequently uses isonitriles in his research, and he wanted to simplify the production method. So, he and Subir Ghorai developed a one-pot reaction using materials found in most chemistry laboratories.

The researchers started with a compound called an oxazole. They added a strong base, followed by an organic acid. The resulting isonitriles contained chemical groups called esters, which typically produce fruity and flowery smells. While the motivation behind the work "was to gain easier access to isonitriles," Pirrung says, it turned out that the reaction also produced better-smelling compounds.

Each of the nine isonitriles that he and Ghorai made had a different ester and a different—and pleasant—aroma, ranging from mild cherry to taffy to soy. The researchers describe the isonitriles in the Sept. 13 *Journal of the American Chemical Society*.

When Pirrung and Ghorai tested the compounds in reactions, they found that the new versions worked as well as or better than the stinky isonitriles.

Now that isonitriles can be easily made and are better smelling, "I hope there will be people inspired to do things with them," says Pirrung. —A.C.

SCIENCE & SOCIETY

Undergrad science and engineering are broadly useful

Although they aren't researchers, the majority of people who earned bachelor's degrees in science and engineering at least 10 years ago find their knowledge of those fields useful in their current workplaces.

The findings, which come from an analysis of three national databases of college graduates, were reported in August by Mark C. Regets of the National Science Foundation in Arlington, Va.

Overall, 13 percent of the college grads with a bachelor's degree in science or engineering had gotten an advanced degree in the same broad field that they started in—say, biology or computer science. Only 4 percent received a doctorate degree. By contrast, almost one-third of the graduates had gone on for advanced degrees in nonscientific fields, such as law or business.

About half of the college graduates went no further academically. Still, 44 percent of this group conduct research and development as their primary activity.

People with degrees in engineering, math, and computer science were most likely to describe their work as "closely" related to their training. However, 63 percent of science and engineering bachelor's degree holders who didn't go into those areas found their jobs—such as teaching elementary school or selling products—"related" to their degree field. —J.R.

TECHNOLOGY

Cyber attack depletes cell phone batteries

Bad guys armed with computers might remotely and secretly drain the batteries of cell phones, a new study shows. By commandeering communications channels that cell phones use to capture images and video from the Internet, attackers might repeatedly awaken an idle phone from a low-power slumber into a state of readiness that saps its electric power.

In multiple tests on a Nokia 6620 phone, computer scientists Hao Chen, Denys Ma, and Radmilo Racic of the University of California, Davis used a fake server to repeatedly send information to the phone, depleting the device's battery in an average of 7 hours. The phone would ordinarily run for 156 hours on one charge. Tests on two other types of phones also resulted in dramatic drops in battery-charge duration.

The simulated attacks took place through two commercial–cell phone networks without triggering any alarms, the team reports.

Chen's team proposes several ways to thwart such attacks. In particular, changes to cell phone networks could enable their equipment to recognize the pattern of Internet message traffic during a battery attack, Chen says.

Racic presented the new study Aug. 30 in Baltimore at a computer-security conference. —P.W.

METEOROLOGY

Link between El Niños and droughts in India

Scientists report that droughts in India are associated with a particular type of El Niño, the climate phenomenon marked by increased sea-surface temperatures in the tropical Pacific.

The rainy season in India occurs in June, July, and August. Between 1871 and 2002, central India experienced 10 severe summertime droughts, says Martin Hoerling, a meteorologist with the National Oceanic and Atmospheric Administration in Boulder, Colo. Every one of those dry spells occurred during an El Niño, he notes. However, not all El Niños during that 132-year period caused droughts—in 13 cases, summer rainfall during an El Niño was at or slightly above normal.

The explanation, says Hoerling, is that not all El Niños are the same. While some primarily warm up the eastern Pacific near South America, the hot spots for other El Niños appear mainly in the central Pacific. Indian droughts seem to result from only the latter type, Hoerling and his colleagues report online and in an upcoming *Science*.

Warmer-than-normal ocean temperatures in the central Pacific send large amounts of moist, warm air up to high altitudes there. This shift in the atmosphere causes air masses to move downward over central India, climate models suggest. Such downwelling tends to suppress rainfall.

Few studies have scrutinized central-Pacific El Niños, says Hoerling. A better understanding of that type may enable scientists to develop an early-warning system for Indian droughts, he notes. —S.P.

Books

A selection of new and notable books of scientific interest

THE SUN

STEELE HILL AND MICHAEL CARLOWICZ

The sun is familiar and, astronomically speaking, rather unremarkable as stars go. Nevertheless, the authors offer dozens of dramatic, high-resolution pictures in this small-format book. Hill, an expert in solar imaging, and science writer Carlowicz provide images from satellites such as Skylab and the Solar and Heliospheric Observatory. These provide unusual views of the sun, highlighting phenomena such as solar flares, sunspots, and coronal mass ejections. Images depicting how sunlight interacts with forests, fields, and clouds reveal the sun's beauty, while others present rare views of full and partial eclipses and auroras. ***Abrams, 2006, 240 p., color images, hardcover, $19.95.***

SQUIRRELS: The Animal Answer Guide

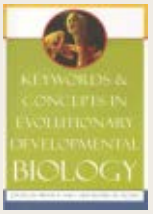
RICHARD W. THORINGTON JR. AND KATIE FERRELL

Squirrels are probably the rodents most familiar and best tolerated—or even beloved—by people in many countries. They're among the most-recognized mammals, with more than 278 species living on all continents except Antarctica and Australia. Thorington, curator of mammals at the Smithsonian's National Museum of Natural History, and his research assistant Ferrell reveal the hidden lives of these often-watched animals. They explain the aerobatics of flying squirrels, the variations in squirrel-coat colors, the techniques with which squirrels avoid predators, and squirrels' success in surviving in a multitude of environments. The authors even explain why so many squirrels are hit by cars. Thorington and Ferrell detail the enduring relationship between squirrels and people, as revealed by the squirrels in literature and mythology. The book includes more than 100 photographs and an appendix outlining the many species of squirrels. ***Johns Hopkins, 2006, 183 p., b&w photos, color plates, paperback, $24.95.***

KEYWORDS AND CONCEPTS IN EVOLUTIONARY DEVELOPMENTAL BIOLOGY

BRIAN K. HALL AND WENDY M. OLSON, EDS.

Nicknamed "evo-devo," evolutionary developmental biology is based on the premise that evolution operates through inherited changes in the ways in which organisms develop in the womb and soon after birth. This book is a collection of essays written by scientists in the field, who describe the processes of development and the ways that evolution acts on them. The authors cover the main topics within evo-devo, including evolution, genetics, environment, selection, and the relationship between genotype and phenotype. Within those topics is an explanation of, atavism, or the reappearance of a characteristic typical of a remote ancestor. The phenomenon shows that potential morphologies can be conserved for millions of years. Other topics include how fossils illuminate ancient ontogeny, how genetic information is inherited, and how phylogenetic trees convey the evolutionary processes of species. This book is intended mainly for students and scientists seeking an introduction to the concepts in this increasingly popular field. ***Harvard, 2006, 476 p., b&w illus., paperback, $29.95***.



LINEAR ALGEBRA DEMYSTIFIED

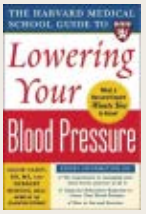
DAVID MCMAHON

This guide is for math students seeking a head start and professionals looking for a refresher course in linear algebra. Using an informal style and plain language, mathematician and physicist McMahon explains how to solve the linear algebra problems that are likely to arise in coursework. The book provides guidance not only on systems of linear equations and matrix algebra but also on the often-harder-to-grasp topics of vector spaces, linear transformations, determinants, and eigenvector problems. Each chapter offers problems to help students determine their strengths and weaknesses. The book ends with a 100-question final exam and supplies solutions designed to reinforce the ideas presented earlier in the book. ***McGraw Hill, 2006, 255 p., b&w illus., paperback, $19.95.***

THE HARVARD MEDICAL SCHOOL GUIDE TO LOWERING YOUR BLOOD PRESSURE

AGGIE CASEY, HERBERT BENSON, AND BRIAN O'NEILL

One of the most prevalent and dangerous medical conditions is hypertension. High blood pressure has long been known as the "silent killer" because it can show no symptoms while befalling even people who seem quite healthy. With O'Neill's help, Casey, a registered nurse and an associate in medicine at Harvard Medical School, and Benson, president of the Mind/Body Medical Institute at Harvard, present this guide for managing hypertension. They cover the basics of blood pressure, defining what qualifies as hypertension and explaining what the numbers in a typical blood pressure reading mean. They detail why hypertension develops and describe both the risk factors that can't be changed, such as gender and age, and the ones that can, such as smoking, obesity, and excessive salt intake. They review how managing chronic stress and eating a proper diet can lower blood pressure. They include tips for incorporating exercise into the daily routine and advise when medication may be necessary. Appendixes outline relaxation techniques and heart-healthy recipes. ***McGraw Hill, 2006, 187 p., b&w illus., paperback, $14.95***.



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LETTERS

Hot topic

It seems more likely that a decline of total precipitation and humidity would be the direct cause of both temperature and fire incidence ("The Long Burn: Warming drove recent upswing in wildfires," *SN: 7/8/06, p. 19*). It is fashionable to blame every weather problem on greenhouse gases and global warming, but in this case doing so may lead to false conclusions.

PAUL BADE, MANKATO, MINN.

Neither the study nor our story attributed the regional warming since 1970 to global warming. The study did find that spring and summer temperatures correlated with decreases in precipitation. —B. HARDER

Short shrift to sea sheer

As a malacologist, I enjoyed "Shells may represent oldest known beads" (*SN: 7/8/06, p. 30*). Although the holes look like what could be made with a stone tool, the *Science* paper acknowledged that a small percentage of naturally occurring holes look similar. Either the people deliberately selected shells with suitable holes or else they perforated them deliberately. Both options show effort at obtaining decorative objects.

DAVID CAMPBELL, TUSCALOOSA, ALA.

A penetrating look

When discussing how polarized light can help clarify our understanding of supernova mechanisms, "Astronomy Gets Polarized" (*SN: 7/8/06, p. 24*) initially quotes Doug Leonard's explanation that "one does not see deeper into an object using polarimetry." Later, the story says that "polarization studies viewed deeper and deeper layers of the explosion." Which is it?

HAL HEATON, DAMASCUS, MD.

Polarization studies don't provide a more penetrating view in the way that a radio wave or infrared detector can peer through dust. Rather, as dust around a supernova thins, the amount of polarized light can tell you the shape of the exploded star. —R. COWEN

Stupid-human tricks

On "Live Prey for Dummies: Meerkats coach pups on hunting" (*SN: 7/15/06, p. 36*), real cats do this too. I have observed many adult cats teaching kittens (not necessarily theirs) to hunt. People who receive "presents" from their cats are not being gifted. The cats are trying to teach them how to hunt, but the cats probably think we are pretty dumb.

EMILY JOHNSTON, WESTMINSTER, MD.

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