SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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minerals fortify snail's armor

clue to liver regeneration

wetland losses freeze farms

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touchdown

ROVING ON THE RED PLANET

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Chopsticks pain Regular, long-term use of chopsticks appears to foster age-related arthritis. See Janet Raloff's Food for Thought.

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Cover Artist's conception of the European Space Agency's Mars Express spacecraft as it orbits the Red Planet. Over the next 6 weeks, three rovers, including one delivered by the Mars Express, are scheduled to touch down on Mars and begin looking for signs that liquid water once flowed on the planet's now dry surface. (ESA) Page 298

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SCIENCE NEWS
This Week

Cast-Iron Foot

Undersea snail has mineral armor

An as-yet-unnamed species of snail living around hydrothermal vents deep beneath the Indian Ocean bears an unusual suit of armor forged from the dissolved minerals spewing into its seafloor habitat.

The sides of the snail's foot are covered with scales that range up to 8 millimeters in length and overlap like roof tiles, says Anders Warén, a marine biologist at the Swedish Museum of Natural History in Stockholm. The core of those structures is made of a protein called conchiolin, a common component of many mollusk shells. What makes these flaps unique is their 100-micrometer-thick coating of iron sulfide, a biological armor that's made of mineral particles just 1 μm in diameter.

Bacteria living on the surfaces of the scales may contribute to the formation of the mineral particles there. However, because the tiny iron sulfide spheres also show up throughout the conchiolin core of each scale, the snail itself probably controls the overall growth and placement of the particles, says Warén.

As snails are wont to do, these sulfide-armored creatures live sedentary lives. This species doesn't even bother to eat. Instead, the animals gain energy from symbiotic bacteria that live within the cells of a gland in their esophagus, says Warén. Most mollusks have such tissue, but in this armored species, the gland is about 100 times the size of that found in related species. The bacteria harbored in the gland oxidize dissolved sulfides that are absorbed through the snail's gills, says Shana K. Goffredi, a marine biologist at the Monterey Bay Aquarium Research Institute in Moss Landing, Calif. She, Warén, and their colleagues describe the armored snail in the Nov. 7 *Science*.

The species is one of several creatures that make up the unique ecosystems surrounding hydrothermal vents in the western reaches of the Indian Ocean (*SN: 9/15/01, p. 165*). Although the researchers aren't sure about the function of the snail's sulfide armor, it may provide protection from predatory snails. Those killers inject their prey with poison, but their barbs aren't long enough or tough enough to penetrate the mineral sheaths on the newfound snail species, says Warén.

David R. Lindberg of the University of California, Berkeley rates the snail as "really interesting," but he doesn't buy the idea that the mineral coating serves only as armor. There have to be other advantages to the sulfide-coated scales, he says, because other species of snails—ones that are just as common and presumably just as meaty and delicious as their armored kin—thrive around the vents despite the presence of predatory snails. —S. PERKINS

S. BENGTSON AND M. SEGONZNC

SULFIDE SHINGLES **The iron-sulfide-encrusted scales on the foot of this snail may protect it from predators in its hydrothermal-vent environment (background of composite photo).**

Hot and Heavy Star Birth

Young cosmos delivers massive stars

Aided by a gravitational zoom lens, astron- omers have discovered the hottest, brightest, and most crowded star-forming region observed so far. Ablaze with a million newborn stars, the Lynx arc, named after the constellation in which it resides, lies 12 billion light-years from Earth. Telescope images of the Lynx arc thus reveal what conditions were like when the now 14-billion-year-old universe was only 2 billion years old. At that time, only a few generations of stars had lit up the cosmos.

With a surface temperature of some 80,000°C, the Lynx stars blaze twice as hot as the brightest star in our galaxy's Orion star-forming region does. That heat and the stars' white-blue color suggest that all these newborns are about 10 to 20 times more massive than the sun. In comparison, the Orion region has only four such massive stars.

The stellar masses in the Lynx arc are intriguing to astronomers because computer simulations have indicated that the first stars to have formed in the universe were even more massive, several hundred times as heavy as the sun (*SN: 6/8/02, p. 362*).

The Lynx arc stars might represent transitional objects, less massive than the first-generation stars but weightier than the average star born today, says Robert A.E. Fosbury of the European Space Agency in Garching, Germany. He and his colleagues describe their findings in the Oct. 20 *Astrophysical Journal*.

The Lynx arc "is the closest we have come so far" to seeing primordial star-forming regions, says Fosbury.

Although the Lynx arc is bright, its

great distance from Earth would ordinarily have rendered it too faint to be detected. But a massive cluster of galaxies happens to lie along the line of sight between Earth and the Lynx arc. The gravity of the cluster acts as a lens, bending and magnifying the light from the Lynx arc by a factor of 10.

Ionizing radiation from the Lynx stars blasts surrounding gas. Fosbury and his colleagues analyzed spectra of the energized gas to discover the color, temperature, and therefore weighty nature of the stars.

The chance alignment of the Lynx arc, the galaxy cluster, and Earth "is offering us insight into what the next-generation telescopes are going to provide routinely, namely, glimpses of some of the first star-forming places in the universe," says Stephen E. Strom of the National Optical Astronomy Observatories in Tucson. —R. COWEN

STAR-BIRTH BOOM **Left: Red-glowing gas (arrow) indicates the distant Lynx arc, the hottest and brightest star-forming region known. This composite view consists of an image taken in red light by the Hubble Space Telescope and six ground-based images recorded at visible-light and near-infrared wavelengths. Right: Artist's depiction of the massive young stars burning brightly in the Lynx arc, as it would appear if the star-birth region were in our own galaxy rather than 12 billion light-years away.**

Getting Back to Normal

Protein enables the liver to regenerate quickly

The liver is resilient. Surgeons removing a tumor, for example, can cut out as much as two-thirds of the liver, and the organ will rapidly grow back to its original size. A sugar-laden protein called stem cell factor (SCF) drives this remarkable regeneration, according to a new study.

The protein has long been known to trigger the proliferation and maturation of bone marrow cells that produce white and red blood cells. Yet there have been an increasing number of hints that SCF influences a wider range of tissues. Several research teams have recently documented the presence of SCF or the activity of its gene in the liver, for example.

Lisa Colletti of the University of Michigan Medical School in Ann Arbor and her colleagues now report that there is a surprisingly large supply of SCF in the livers of mice. The investigators also demonstrated that the removal of 70 percent of a mouse's liver, a surgical procedure known as a partial hepatectomy, produces a dramatic drop in the concentration of SCF in the remaining organ along with a rise in SCF in the mouse's blood. The team hypothesized that after the liver operation, SCF, which typically sits inactive on the surface of liver cells, is released in a soluble form that stimulates the growth of the remaining cells.

The researchers then showed that the absence of SCF activity impairs liver regeneration. After a partial hepatectomy, the livers of mice given antibodies that block the protein and of mice genetically engineered to lack SCF grew back more slowly than mouse livers typically do. Injecting the mutant mice with SCF, however, enabled the liver to regenerate at the normal pace, Colletti's team reports in the November *Journal of Clinical Investigation*.

"Stem cell factor is a key player" in liver regeneration, says Neil D. Theise of Beth Israel Medical Center in New York. He suggests that physicians may soon test whether SCF can speed the recovery of people who have undergone partial hepatectomies.

The protein may also protect people from acute liver failure, notes Theise, pointing to another recent study. Independently of Colletti's group, a research team at the University of Michigan Medical School, along with colleagues at the University of Edinburgh, examined whether SCF could defend mice from liver damage caused by an overdose of acetaminophen, which is best known as the active ingredient in Tylenol.

In the February *Laboratory Investigations*, the scientists reported that mice administered SCF at the same time as acetaminophen suffered less liver damage than did rodents given acetaminophen alone.

University of Michigan's Nicholas W. Lukacs, a coauthor of the acetaminophen report, cautions that simply injecting SCF into a person with liver problems may activate immune cells that can cause a severe allergic reaction. Targeting delivery of SCF to only the liver could avoid that problem, he suggests. Or, he adds, scientists might use SCF to prod the growth of liver cells in test tubes and then transplant those cells into a patient.

Further studies of the roles of SCF within the liver may also reveal why the celebrated cancer drug imatinib, better known as Gleevec, sometimes causes damage to that organ. SCF seems to work by binding to a protein called c-kit. Gleevec inhibits the function of that protein and therefore may interfere with SCF's protection of the liver, Lukacs notes. —J. TRAVIS

Frosty Florida

Spread of agriculture may promote freezes

Sunny southern Florida seems like a perfect place to grow fruits and vegetables, even in the winter. But the 20th-century transformation of what had been wetlands into croplands might have had unintended consequences. The shift has made the area more susceptible to crop-damaging freezes, researchers suspect.

In the early 1900s, much of Florida's citrus industry moved south to areas of the state that seemed the least prone to ruinous freezes. To make room for orchards and farms, people drained wetlands and diverted rivers, actions that affected the local climate, say Roger A. Pielke Sr. and Curtis H. Marshall of Colorado State University in Fort Collins and Louis T. Steyaert of the U.S. Geological Survey in Greenbelt, Md.

The scientists mathematically reconstructed south Florida's pre-1900 plant cover and mapped the area's current vegetation. By plugging these data into a weather-modeling program that Pielke and another colleague developed, he and Marshall could predict the temperatures before and after the draining of the wetlands.

FOSBURY ET AL., ESA/NASA/NOAO; FOSBURY ET AL., ESA/ NASA

They found an overall cooling trend of a few degrees Celsius where wetlands were replaced by farmlands. The greatest change appeared in the area south of Lake Okeechobee, where farmers now grow citrus fruits, sugarcane, and winter vegetables. Also, the temperatures were likely to stay below freezing for a few hours longer per episode than they did when wetlands were prevalent. The researchers report their findings in the Nov. 6 *Nature*.

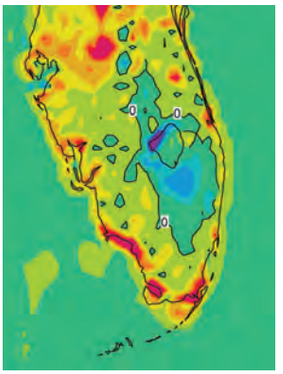
"With the current landscape, there's a different input of heat and moisture into the atmosphere," says Pielke. The wetlands used to provide a buffer that absorbed the heat during the day and released it at night, he says. "The area is more susceptible now to freezes than it would have been in the late 1800s."

Others have studied the effects of major weather systems such as El Niño on Florida crop freezes, but the simulations provide a first look at the consequences of local land-use changes, says Pielke.

"It seems obvious that changing the surface properties really can change the local climate," says Eugenia Kalnay of the University of Maryland at College Park. "What's difficult is to quantify it." The new model enables researchers to do just that, she says.

Climatologist Jim O'Brien of Florida State University in Tallahassee contends that even if the encroachment of farmlands made local freezes slightly more likely, it's the big weather patterns bringing cold Canadian air to Florida that have the most severe impacts on crops.

Even if that is so, Pielke and Marshall say they hope forecasters realize that weather conditions may cause more-frequent and long-lasting cold spells than they did a century ago. Knowing this, they say, farmers could be better prepared to protect their crops from freezes. — K. RAMSAYER



FROZEN ORANGES The lowest temperatures in parts of south Florida are now a few degrees colder than they would have been before 1900. On the map, purple, blues, and dark green represent those chillier areas, which coincide with farmland that was dominated by wetlands a century ago.

MARSHALL ET AL./ NATURE

Forgetting to Remember

Emotion robs memory while reviving it

Emotionally charged events often seem particularly memorable. But this vivid recall may come at a cost. A new study in England suggests that the same biological process that aids recall of emotional experiences also blocks memories of what happened just before those arousing occurrences took place.

These memory effects appear to depend on a common neurobiological mechanism, says neuroscientist Bryan A. Strange of University College London. Women suffer larger emotionally instigated memory losses than men do, Strange and his coworkers also have found.

Emotion-induced memory gains and losses reflect the activity of stress hormones from the adrenal glands on the amygdala, an inner-brain structure, the scientists assert in an upcoming *Proceedings of the National Academy of Sciences*.

Prior research suggested that these adrenergic hormones, stimulated by emotionally arousing events or language, induce the amygdala to create long-term memories of those inputs. Those studies tested memory after a delay of several weeks or more.

In contrast, Strange's team examined recall in the immediate aftermath of an emotional language–based event. Lists of neutral nouns presented to 58 male and female volunteers contained a single, randomly placed noun with a disturbing connotation, such as *murder* or *scream*. Nouns appeared on a computer screen at a rate of one every 3 seconds and were visible for 1 second. After viewing a list, volunteers tried to remember as many words as possible before moving on to the next list.

Overall, men and women recalled the emotional words much more often than they did the neutral words. Moreover, the poorest memory occurred for neutral words that were presented immediately before the disturbing words. Women forgot those words twice as often as men did.

Emotions are critical to this memory effect, Strange says. Among the same adults, no comparable pattern of memory enhancement and impairment appeared for all-neutral-noun lists that contained a single word in a different font or one word with a meaning unrelated to that of any of the other words.

Moreover, participants who were administered a propranolol pill before viewing lists didn't exhibit the superior memory for disturbing words seen without the drug. Propranolol blocks transmission of beta-adrenergic hormone and thus blunts emotional reactions. Intriguingly, the people who took this drug recalled words that had appeared just before emotional words better than they did other neutral words.

In the same study, a man with extensive amygdala damage due to a rare genetic disease showed no emotion-related memory effects after viewing noun lists.

The new findings "have moved us closer to understanding both the beneficial, and harmful, effects of emotion on memory," comments neuroscientist Larry Cahill of the University of California, Irvine. Although common biological processes may underlie emotion-induced memory enhancement and amnesia, there may be differences between short-term and long-term memory, Cahill adds.

For instance, the brain may activate adrenergic hormones primarily in response to brief, mildly arousing experiences such as reading disturbing words, thereby fortifying short-term memories of those experiences, he theorizes. However, Cahill notes, adrenergic activation by sensory and motor neurons outside the brain may enhance long-term memories of highly emotional events. The surprising evidence for propranolol's potential as memory-boosting agent also deserves further investigation, Cahill adds. —B. BOWER

Calcium Makes Germs Cluster

Ion dilution leads cholera bacteria to disperse

A chain of sugars on the surface of cholera-causing bacteria enables the pathogens to clump together in seawater and yet scatter in fresh water, new data suggest. Microbiologists propose that the dispersal facilitates seasonal outbreaks of cholera in coastal areas.

Vibrio cholerae bacteria naturally inhabit both fresh and salt water. Researchers have linked cholera outbreaks to high waters along the coast of Bangladesh, where sea level rises during the annual monsoon. Influxes of pathogen-bearing seawater, driven by monsoon winds, may alter conditions in coastal estuaries and trigger epidemics.

As many bacteria do, *V. cholerae* cluster on surfaces, such as the bodies of small aquatic animals. Certain genes, called *vps* genes, enable *V. cholerae* to stick together in bacterial communities, or biofilms, in both fresh and salt water.

But Katharine Kierek and Paula I. Watnick of the New England Medical Center in Boston recently discovered that *V. cholerae* can form biofilms in salt water even without the action of those genes. The team reports that finding in the September *Applied and Environmental Microbiology*.

To look for other factors that control the bacterial congregations, Kierek and Watnick tested a natural strain of *V. cholerae* and mutant strains unable to make one or both of two cell-surface structures. Both structures include a chain of sugars called the O-antigen polysaccharide, which triggers people's immune response to cholera.

The researchers attempted to grow biofilms of each strain in a solution containing calcium ions and other salts found in seawater. The natural strain and mutant strains with intact polysaccharide structures formed biofilms on submerged surfaces, but strains lacking the normal sugars didn't.

Then, to simulate a cholera biofilm entering fresh or estuary water, the investigators drained off the artificial seawater and submersed the biofilms in a calciumfree solution or added a compound that binds calcium ions. The biofilms disintegrated rapidly.

Removing other ions didn't have the same effect, Kierek and Watnick report in an upcoming *Proceedings of the National Academy of Sciences*.

"When you take calcium away, the biofilms fall apart, and the bacteria are essentially free-swimming," Watnick says. Presumably, she says, this happens when *V. cholerae* biofilms move into fresh water. Thus dispersed, the bacteria might readily find their way into a person's mouth, colonize the gut, and cause disease.

The novel findings imply that both calcium and *V. cholerae*'s O antigen are vital to biofilm formation in seawater, says microbiologist Dianne K. Newman of the California Institute of Technology in Pasadena. Since the water in estuaries is relatively low in calcium, she says, the research also "provides a very simple environmental mechanism that could explain the mobilization of the pathogen." —B. HARDER

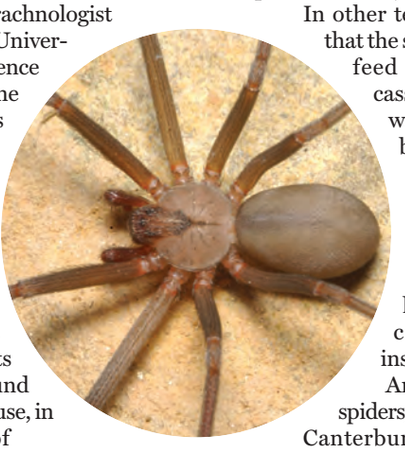
Not-So-Great Hunter

Said the spider to the fly: Eek! I'm outta here

Despite the general image of spiders as avid hunters, brown recluses in recent laboratory tests typically preferred dead prey to live ones. Other species of spiders have been known to scavenge now and then, but the brown recluse may be the first one revealed as primarily a scavenger, says the researcher who performed the experiment.

People generally try to avoid brown recluse spiders because their bites fester into painful sores. Roughly the size of a quarter, these spiders thrive in the south-central United States. When arachnologist Jamel Sandidge of the University of Kansas in Lawrence puts traps in a house, he may collect as many as 1,400 brown recluses in 2 months.

Sandidge began his recent work after hearing that some exterminators urge people to starve the brown recluse spiders by killing all the insects in their homes. He found the advice suspect because, in his visits to dozens of Kansas houses, he'd seen the spiders feeding on insects that had been dead for weeks.



SHY TYPE? The brown recluse spider may be more of a scavenger than a hunter.

In his laboratory, Sandidge tested 147 adult brown recluses, putting each into an enclosure with a live insect and a carcass of the same species and size. After 5 minutes, Sandidge checked to see which insect the spider had been feeding on. The spiders went for the dead prey more than 80 percent of the time, whether they were dining on crickets, which are larger than brown recluse spiders; yellow mealworm larvae, which are similar to the spider in size; or wax moth larvae, which are smaller, Sandidge reports in the Nov. 6 *Nature*. He's seen the spiders run away from the live crickets.

In other tests, Sandidge found that the spiders were willing to feed on month-old carcasses of cockroaches, as well as crickets that had been dead for 2 weeks. He also reports that 10 spiders showed no ill effects during the 10 months after eating a cockroach that had been killed with a common pyrethrin insecticide.

Another investigator of spiders, Simon Pollard of the Canterbury Museum in Christchurch, New Zealand, is studying spiders that ingest blood by catching well-fed mosquitoes. He comments, "While it is not that unusual for spiders to eat inanimate things, like pollen, nectar, or prey remains, it is unusual for a spider to seem to prefer dead prey over live prey."

However, he can imagine advantages to a spider that eats carcasses. "A disgusting thought," he explains, "but spiders externally digest their prey and suck up the dissolved nutrients. If the prey is starting to break down into a liquid form, it may require less digestive fluid." —S. MILIUS

Chemical Reaction

Two flame retardants to phase out in 2004

On Monday, the sole U.S. manufacturer of two flame retardants pledged to cease making both products next year. The firm had initiated discussions with the Environmental Protection Agency about a potential phase-out just last month (*SN: 11/1/03, p. 275*). This week's announcement accelerates by 4 years the compounds' recently mandated elimination in California. The European Union had already announced a ban on the two flame retardants, which are widely used in furniture and plastic products. That ban is slated to go into effect next year.

The chemicals—mixes of polybrominated diphenyl ethers (PBDEs)—have become ubiquitous pollutants in both the environment and people. Recent animal tests have shown that these chemicals are harmful at doses similar to those that would result in the milk, blood, and fat concentrations that had been measured in some people in North America (*SN: 10/25/03, p. 266*).

EPA "commends Great Lakes Chemical Corporation for taking this action voluntarily," says Stephen L. Johnson, the agency's acting deputy administrator. The move will accelerate a shift from these PBDEs to safer alternatives, he says.

The products to be phased out are known as the penta mix and octa mix because they contain predominantly PBDEs with five and eight bromine atoms per molecule, respectively. Manufacturers add the penta mix primarily to foam in furniture and the octa mix to the plastic parts in personal computers and small appliances.

Great Lakes, based in Indianapolis, has already developed an alternative known as Firemaster 550 for use in foams. EPA's preliminary evaluation of the product concludes that the new flame retardant doesn't persist in the environment or accumulate in animals and isn't acutely toxic to aquatic organisms. The agency hasn't yet determined whether Firemaster 550 might be toxic to other animals and people. —J. RALOFF

SAMFORD UNIV. DEPT. OF BIOLOGY

THE SHAPE OF SPACE

Have cosmologists glimpsed signs that the universe is bounded?

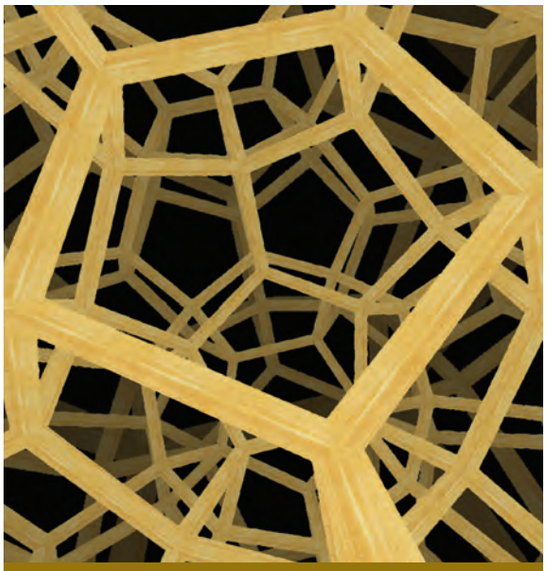
BY ERICA KLARREICH

Gaze deep into the night sky, and space appears to extend infinitely far in all directions. Given such a view, it's mind-boggling to think that space might be bounded. Yet, just as the flat-seeming Earth is in fact a sphere, infinite-seeming space may curve in on itself to close up into a compact shape. Recently, the debate over the shape of space took some new twists. In the Oct. 9 *Nature*, a team of mathematicians and astrophysicists proposed an exciting idea. The universe may have a particular finite shape, modeled on a 12-sided geometric object known as a dodecahedron, they propose. The same week, a second group of scientists announced findings that may refute that proposal.

Both groups have based their analyses on first-year data from NASA's Wilkinson Microwave Anisotropy Probe (WMAP), which in February produced a snapshot of temperature waves shortly after the Big Bang (*SN: 2/15/03, p. 99*). These waves produced a puzzle: One of the longest wavelengths, known as the quadrupole, is less powerful than expected. This is like saying, in an analogy with sound waves, that the universe doesn't play low notes.

To many cosmologists, the reduced quadrupole is a hint that the universe may be finite. In an infinite universe, all wavelengths should be equally abundant, whereas in a finite universe, waves can never be longer than the universe itself.

By analogy, "you don't get really long waves in a bathtub because the waves can't be bigger than the bathtub is long," says Jeffrey Weeks, a freelance geometer based in Canton, N.Y., who is one of the authors of the *Nature* paper.



HALL OF MIRRORS — In the dodecahedral model of the universe, each pentagonal face is theoretically glued to the opposite face. In such a universe, if you look straight through one of the faces, you see what looks like a new dodecahedron but is really the original dodecahedron seen from a new vantage point.

COMPLEX SOCCER BALL Weeks and his coauthors report that a shape called the Poincaré dodecahedral space is a good fit for both the quadrupole data and estimates of the universe's curvature.

The Poincaré dodecahedral space is formed by gluing together opposite faces of a slightly curved dodecahedron—a soccer-ball-like shape with 12 pentagonal sides. Such a gluing is impossible to carry out physically within ordinary three-dimensional space. However, by keeping track of which faces are theoretically glued, scientists can measure the physical attributes of such a space.

If the universe had this shape, a traveler who crossed through one of the pentagonal faces would instantly reappear at a face on the opposite side of the dodecahedron. Video game characters make such treks in two dimensions when they vanish from one side of the screen and reappear at the other. In the dodecahedral universe, a trip across the solid would span many billions of light-years.

Weeks and his collaborators were drawn to study the dodecahedron because recent observations of the universe's cosmic microwave background radiation have suggested that the universe either is flat or has slightly positive curvature, such as a sphere does. This estimate makes many of the possible shapes for the universe unlikely. The few more-likely candidates include the dodecahedron and a shape called the three-torus, made by gluing opposite sides of a box.

Preliminary examinations of various kinds of three-torus—made from boxes of different shapes and sizes—have yielded no shape that fits the quadrupole data well. The dodecahedron model, however, appears to match data on both the quadrupole and the next-longest wavelength, called the octopole.

NOT SO FAST The Poincaré dodecahedron's apparent match with the quadrupole data and the curvature measurement is "intriguing," says David Spergel, an astrophysicist at Princeton University and a member of the WMAP team. However, at a cosmology conference in Cleveland on the day after the *Nature* paper appeared, Spergel reported findings that he says undermine the dodecahedron model.

Spergel and his collaborators examined whether the dodecahedron satisfies a criterion called the circle test. This criterion rests on the observation that, because we can see equally far in all directions, the boundary of our visible universe is an enormous sphere.

Think of our visible universe as a bubble at the center of the dodecahedral model. If the bubble were much smaller than the dodecahedron, we would see nothing of the pentagonal faces. If the bubble were to grow, it would eventually touch each pentagonal face at a single point at the center. If the bubble were to grow a tiny bit further, it would cross each face, intersecting it in a circle.

According to the model in the *Nature* paper, the dodecahedral universe is just the right size for the bubble to intersect the pentagonal faces in circles. Because each of the 12 pentagonal faces is glued to the opposite face, each circle should match an identical circle on the opposite pentagon. Therefore, the sky should contain

WEEKS

six pairs of matching circles on which all the physical data, including the temperature waves in the WMAP data, are identical.

Spergel and his collaborators have been combing the WMAP data looking for such circle pairs. According to Spergel, the circles are not there.

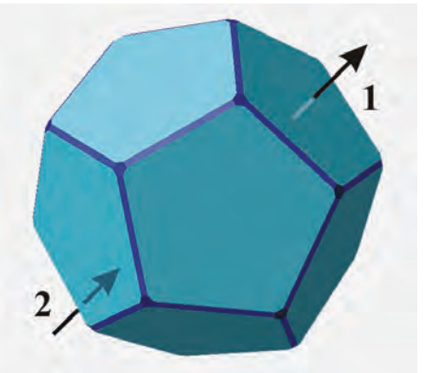
Weeks agrees that the absence of matching circles would kill the dodecahedron model. However, he says, it's possible that Spergel's team missed the circles. Although in principle we should see identical light coming from the matching circles in the sky, in reality, effects such as noise obscure the circle pairs. If the noise is strong enough, Weeks says, the circles might elude detection by the algorithm Spergel's team used.

The WMAP team has tested its algorithm on a simulated sky map that factored in noise and other distortions, says Neil Cornish of Montana State University in Bozeman, one of Spergel's collaborators. According to those simulations, if circles are in the sky, there is less than a 1 percent chance that the algorithm would miss them.

However, the team carried out its test simulations in a three-torus model rather than a dodecahedral model. It's not clear whether the 1-percent-error estimate would carry over to the dodecahedron, Weeks says.

The circle search team plans to run its simulations on the dodecahedral shape. "We're going to be able to make extremely strong statements about their model," Cornish says. "It's such a dramatic claim that it's worth going that extra mile to test it."

However, he does not expect the simulations to validate the dodecahedron model. "I really think there isn't any room left," he says.



SPACE TREK — In dodecahedral space, if you journey across one pentagonal face (1), you instantly reappear through the opposite face (2), on the other side of the universe.

WEEKS

TESTING, TESTING Until Spergel, Cornish, and their collaborators have performed simulations on the dodecahedron and cosmologists have had a chance to scrutinize the work, it's premature to agree or disagree with the team's findings, Weeks says. "The recent history of cosmic topology is littered with examples of people claiming to rule out various possibilities, only to find later that their analysis had flaws," he notes. At this point, he says, both the dodecahedron model and the evidence against it should be considered with caution.

If the dodecahedron is ruled out, "it will be a disappointment," Weeks says. "It fits the data really well, and there aren't a lot of backup candidates to go." Among the plausible shapes that remain to be tested is a three-torus made out of a slanted box.

In an ambitious project, Spergel, Cornish, and their colleagues are scanning the sky for any evidence of circle pairs that would indicate these or other possible shapes. That wider search should be completed soon, Cornish says.

"What's nice is that we don't need to launch another satellite to test [the models]," says Max Tegmark, a cosmologist at the University of Pennsylvania in Philadelphia. "The answer is there in the data and just needs to be ferreted out."

If the dodecahedron model turns out to be incorrect, the question of why the universe doesn't play low notes will remain.

"We don't know whether it's a fluke, a compact universe, or some other cosmological effect," says Charles Bennett of NASA's Goddard Space Flight Center in Greenbelt, Md., who is the director of the WMAP project. "That's the exciting part." ■

MARTIAN INVASION

Probing lively puzzles on the Red Planet

BY RON COWEN

Just 2 months ago, Mars loomed high in the sky, its ruddy countenance so close that anyone with a backyard telescope could make out the planet's white south-polar cap and a central smudge known as Syrtis Major. Not in 60,000 years had Mars and Earth been so close, and they won't be again for another 2 centuries. But even as the two planets now drift slowly apart, three envoys from Earth are racing to the Red Planet.

If all goes according to plan, the European Space Agency's Mars Express will begin orbiting Mars next month, using radar to search for hidden reservoirs of water. The craft will also jettison a suitcase-size stationary lander, Beagle-2, that will look for signs of life by examining soil at and just below the surface of a region called Isidis Planitia.

Then, in January, two NASA craft bearing identical rovers, named Spirit and Opportunity, will touch down in regions of the planet that may once have had water coursing through them and so could have hosted primitive life.

"Successful landings of all three spacecraft will more than double our experience with the . . . environments of Mars," says James B. Garvin, NASA's Mars-program scientist in Washington, D.C. "I am anticipating major breakthroughs in our understanding."

RED ROVING — After bouncing to a stop, the lander's petals will unfold and the Mars Exploration Rover will drive onto the surface.

NASA

Planetary scientists studying Mars could use a breakthrough. Recent evidence has shaken what has been one of the most tantalizing core beliefs about the Red Planet—that ancient Mars was much wetter and warmer than the planet is today and even harbored a planetwide ocean.

On the one hand, the planet's now bone-dry surface is scarred by sinuous channels, apparent lake beds, deep canyons, and thousands of gullies. These all bear the marks of having been carved by liquid water. On the other hand, there's a troubling scarcity of minerals such as limestone and other carbonates, which commonly form in the presence of liquid water.

There is a "direct conflict" between the geological and mineralogical evidence for water on Mars, says Bruce M. Jakosky of the University of Colorado in Boulder.

Determining whether parts of Mars ever carried a substantial amount of liquid water and, if so, for how long would help answer the ultimate question about the Red Planet: Is it now or has it ever been a living world?

MISSING MINERALS The water conundrum intensified late last summer, when Philip R. Christensen of the Arizona State University in Tempe and his colleagues reported the results of a 6-year study with an infrared spectrometer aboard the orbiting Mars Global Surveyor observatory. The instrument scrutinized large swaths of the Martian surface and atmosphere for carbonates, minerals that are associated with water. On Earth, carbonates such as limestone form when carbon dioxide from the atmosphere dissolves in water, making carbonic acid. The acid eats away at rocks, and their remains precipitate out as carbonate deposits. A notable example is the White Cliffs of Dover.

Researchers had been looking for carbonates on Mars for more than a decade, and in the Aug. 22 *Science*, Christensen's team announced that it had finally found some. But there was little reason to rejoice. Carbonates were detected in only small amounts—up to 5 percent—in the planet's surface dust.

"We believe that the relatively small amounts that we see probably did not come from oceans, but from trace amounts of water vapor in the atmosphere interacting directly with dust," Christensen says.

This study, as well as other new evidence (see page 301), "really points to a cold, frozen, icy Mars that has probably always been that way, as opposed to a warm, humid, oceanic Mars some time in the past," Christensen adds. The extensive carbonate layers that would have formed early in Martian history if the climate had been warm and oceans plentiful "are simply not there," he says.

There may be geologic processes that could have hidden or transformed carbonates at the Martian surface to make them undetectable from orbit, acknowledges Chris Chyba of the SETI Institute in Mountain View, Calif. However, he says, "unless and until there's strong evidence of such a mechanism, I think we should take the data at face value."

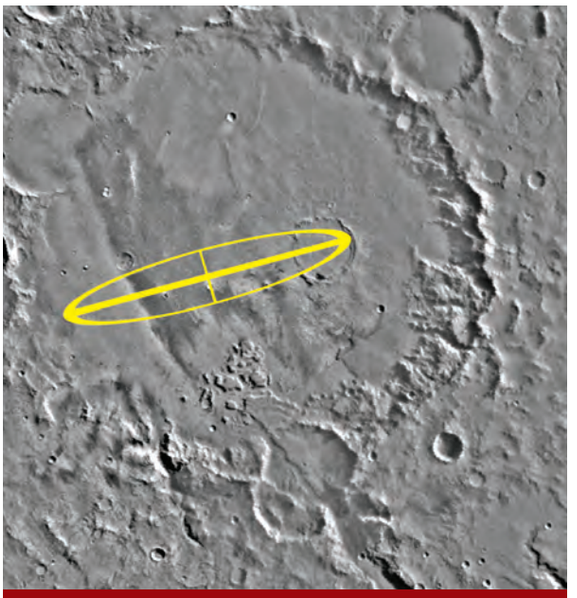
ROVING FOR WATER The evidence that Chyba seeks can come only from spacecraft that land. On the surface, their instruments can search for carbonates and other water-derived minerals, along

with water-carved features, on scales far finer than those at which an orbiting observatory can investigate. NASA's rovers will explore two strikingly disparate places. Both regions appear to have had an encounter with liquid water but have different tales to tell about their aquatic past, says Steve Squyres of Cornell University. His team built the twin rovers' array of instruments.

"We think these will be the most exciting landed missions of exploration since the Apollo program," declares NASA's Garvin. Each vehicle is about five times as large as its diminutive cousin, Sojourner, which on July 4, 1997, became the first rover on the Red Planet.

Compared with Sojourner's single scientific instrument, an X-ray spectrometer, each of the new rovers has nine cameras, three spectrometers, and a robotic arm. The spectrometers will analyze the chemical composition of the rocks, while a microscope imager at the end of the arm will act like a hand lens, revealing the texture and shape of minerals. Like the Beagle-2, each rover also has a scraper that can remove about half a millimeter of material—about the thickness of a nickel—from the surface of rocks covered with dust or other debris. The solar-powered, all-terrain vehicles can travel about 40 meters a day, compared with Sojourner's 1 meter. Researchers expect them to explore rocks for at least 3 months, about the same as Sojourner's life span.

On Jan. 3, Spirit, the first of the two $400-million rovers, will descend along with its mother ship into Gusev crater, a 160-kilometer-wide crater that appears to have a dried-up riverbed running into it. "We'll look for lake sediment or sea sediment—the rocks that may have been deposited by running water and that may have been entombed there," says Garvin. Spirit's close-up examination will seek sedimentary layers of rock that might be present and determine whether the rock was chemically altered by water that vanished long ago.



HOLE-Y SITE — Mars' Gusev crater, a 160-kilometer-wide hole in the ground, is the landing site of the NASA craft that will touch down Jan. 3, 2004. Yellow ellipse marks the targeted area for the lander.

NASA

WATER AND HEMATITE Three weeks after the spacecraft carrying Spirit lands, the second NASA craft and its rover, dubbed Opportunity, will touch down at the edge of a smooth plain called Meridiani Planum.

Here, the hunt for evidence of past water will primarily rely on chemistry. The region is one of two places on Mars covered with a vast deposit of hematite, a gray, crystalline iron oxide that on Earth usually forms in the presence of water. (A ubiquitous, finer-grained version of the same oxide gives Mars its rusty-red hue.) Observations of Meridiani Planum from orbit suggest that the gray hematite was deposited by a watery source, perhaps an ancient and vast hot spring.

The rover's capacity to examine the texture and distribution of the hematite, even its microscopic grain structure, will be critical in determining how the material and related minerals got there, notes James F. Bell of Cornell.

Christensen has proposed several scenarios to explain the hematite; all but one require substantial amounts of water.

In one scenario, the hematite is but one layer of a band of iron-rich mineral deposits, like the iron-oxide bands seen in Lake Superior and other large standing bodies of water on Earth. The bands form when dissolved iron particles combine with oxygen and precipitate out as layers of hematite.

Each layer, says Christensen, demarcates a significant climate change, such as a dramatic difference in the temperature of the water or the concentration of oxygen in it. "If you get [to the planet], and you pick up a rock and it has some banded layers of hematite in it, that's a smoking gun for a lake deposit."

A second explanation for the hematite centers on massive amounts of rain or snow that may have dissolved minerals in the topmost layer of the region. Hematite might then have recrystallized in a deeper layer. Millions of years of wind erosion may have brought that once-buried layer to the surface. If that's the case, then the rover should detect iron-poor rocks, the vestiges of the topmost layer in which minerals were dissolved away, as well as iron-rich ones.

Or maybe water had nothing to do with hematite. The material could have arisen when iron-rich volcanic eruptions interacted with oxygen in the atmosphere. If so, Opportunity will find the hematite to be a fine-grained ash dispersed uniformly through the rocks the rover analyzes, Christensen says.

If Opportunity finds that hematite is merely a surface coating, like the rust on a junkyard car, it could mean that the rocks were exposed to water for only a short amount of time or simply interacted with trace amounts of water vapor in the atmosphere.

Magnified images that reveal the specific shapes of mineral will provide additional clues to the origin of the iron oxides at either landing site, notes Bell. For instance, large, rounded grains of hematite suggest transport by a flow of water, while fine, flatter grains point toward the rust-formation mechanism.

Christensen says his favorite explanation for the hematite at Meridiani Planum is that a warm or hot spring percolated through the rocks there. The water, he suggests, could have come from a frozen lake covering layers of iron-bearing sediment. If some underground heat source, such as an erupting volcano, melted the ice, the water would have percolated through the sediment. If this scenario holds true, Opportunity "would see a hematite cement" filling in the rock pores, Christensen says.

Even if the hematite's origin remains ambiguous, trace amounts of other minerals could serve as additional markers of past water. Consider goethite, the water-bearing iron mineral named for the German poet Johann Wolfgang von Goethe, who dabbled in mineralogy. Goethite formation requires water, and the mineral, when heated, can slowly convert to hematite. Small amounts of goethite would clinch a watery origin for the hematite at Meridiani Planum.

There is at least one way that liquid water could have been present on Mars without leaving behind carbonate fingerprints. Proposed by Christensen and other planetary scientists, this hypothesis could have important implications for future missions to Mars, especially in determining where to look for life.

If the Martian surface were somewhat warmer in the past—just above −20°C instead of today's average of −60°C—frozen water could liquefy as thin films at the boundary between layers of ice and dust, Jakosky notes. At that temperature, the chemical reactions that would lead to the formation of carbonates proceed so slowly that little carbonate would be made before the water refroze.

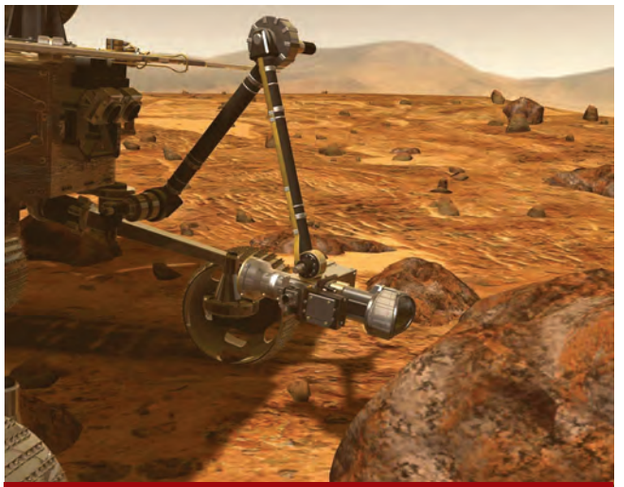
Supporting this idea, Christensen notes that many of the features on Mars that appear to have been sculpted by flowing water, including channels, don't require liquid water to last very long or

to cover vast stretches of the planet. For example, the sudden melting of a reservoir of ice, creating a flash flood lasting for just a few weeks on a section of the Martian surface, would suffice to create a channel.

NEW SYNTHESIS, NEW MISSIONS Brief interludes when water was liquid also seem to have occurred recently. A camera aboard the Mars Global Surveyor spacecraft spied thousands of gullies at high latitudes where water would typically be frozen but under some circumstances could liquefy for brief periods. Free of craters and other blemishes typically acquired by older surfaces, the gullies look remarkably young, suggesting that water flowed there as recently as a few million years ago.

Such episodic flows would permit dormant organisms "to revive and repair themselves every few million years," Jakosky and his colleagues argue in the summer 2003 *Astrobiology*. Studies of life in extreme environments on Earth suggest that, "even at very low temperatures that would allow metabolism but not necessarily growth, organisms could effectively reset any damaged systems, including DNA, and thus allow very long-term survival," the team says. "Mars today appears to be right at the edge of being habitable by microorganisms."

According to this hypothesis, some of the best places to look for life—or its remains—have vast reserves of ice. These promising regions include the north and south poles of the planet, according to data gathered by the Mars Odyssey spacecraft. Because the tilt of Mars's polar axis dips as much as 60° every million years or so, some of this ice could have been liquid in the not-so-distant past. At such places, a lander or rover might discover primitive life or its vestiges in the topmost layers of ice, says Jakosky. Last summer, NASA announced plans to launch a lander to the north-polar regions of Mars in 2007.



ROCK SCRAPER — The abrasion tool, located on the arm of each of NASA's twin robotic landers, can remove a nickel's thickness of material from a rock so that spectrometers and other instruments can explore the sample's interior.

NASA

"At the same time that evidence is accumulating that early Mars may globally not have been very warm, evidence is also accumulating that contemporary Mars still intermittently has water flowing on its surface in specific locations," says Chyba. "There are over 100 locations where water seems to have flowed recently," he notes. "It will be fascinating to see what the rover missions tell us."

Back at NASA, Garvin says he is looking forward to what could be the most nerve-wracking 6 minutes of his life. That's when the first rover and its mother ship will careen through the Martian atmosphere at 20,000 kilometers per hour with only a cocoon of airbags to cushion their fall. Says Garvin: "We'll all be on the edge of our seats." ■

OF NOTE

ENVIRONMENT

Seals' meals, plastic pieces and all

Bite-size pieces of plastic chipped from wave-battered consumer products work their way up marine food chains, suggest researchers examining fur seals in Australia.

The oceans are awash in plastic flotsam, and scientists have long studied this debris and its effects on wildlife. Small plastic pellets are a hazard for hungry seabirds, which mistake them for fish eggs or other food. These pellets—the raw material for plastic products—accumulate oily contaminants such as PCBs on their surfaces (*SN: 2/3/01, p. 79*). Larger refuse, such as fishnets and soft drink containers, has been considered hazardous but generally not because animals confuse it with food.

Between 1990 and 1997, Harry Burton of the Australian Antarctic Division in Kingston, Tasmania, and Cecilia Eriksson of Hobart, Tasmania, collected scat from two species of Antarctic fur seals living along beaches on Macquarie Island, Australia. In 145 droppings that the researchers examined, they found a total of 164 plastic particles. Almost all particles were irregularly shaped—not spherical or cylindrical, as industrial pellets are—and showed evidence of abrasion, suggesting to the researchers that the plastic bits derived from larger pieces.

Seals probably didn't consume the particles directly. More likely, Burton and Eriksson say in the September *Ambio*, the seals ate fish that had ingested bits of consumer products broken to pieces by rocks and waves. —B.H.

ASTRONOMY

Bone-dry Mars?

Finding only trace amounts of carbonate minerals on Mars isn't the only strike against the hypothesis that most of the Red Planet was once wet and warm (*see p. 298*). The presence of large amounts of olivine, a mineral that undergoes rapid transformation into other minerals when exposed to liquid water, also argues against ancient oceans or lakes on Mars.

Using the same spectrometer on the Mars Global Surveyor spacecraft that found the carbonates, Todd M. Hoefen of the U.S. Geological Survey in Denver, Philip R. Christensen of Arizona State University in Tempe, and their colleagues found substantial amounts of olivine in a Martian region called Nili Fossae. The mineral is abundant in a 30,000-square-kilometer area within Nili Fossae, a complex of depressions and fractures adjacent to an impact basin, the researchers report in the Oct. 24 *Science*. The absence of water is more than skin deep. A spectrometer aboard the Mars Odyssey spacecraft detected olivine in a layer about 7 km below the rim of the canyon Valles Marineris, Christensen reported earlier this year. The olivine layer suggests the mineral at Valles Marineris "did not encounter subsurface water at any time in its long life, nor has it [encountered] surface water since it was exposed in the wall of the canyon," he notes. —R.C.

MATERIALS SCIENCE

Underwater balancing act

Tweaking the structure of crystals nestled in the inner ears of zebrafish can throw the fish off balance, biologists have found. During development, proteins guide the assembly of calcium carbonate molecules into tiny crystals called otoliths. These structures, which lie on top of gravity-sensing organs in the inner ear, influence both balance and hearing.

Researchers from the Max Planck Institute for Developmental Biology in Tübingen, Germany, and the European Synchrotron Radiation Facility in Grenoble, France, identified a gene that codes for one of the crystal-organizing proteins.

When the researchers hindered the activity of the gene, the fish developed elaborate star-shaped otoliths, instead of the spherical structures found in normal fish. Silencing the gene, dubbed *Starmaker*, resulted in a different crystal altogether. In normal otoliths, calcium carbonate forms crystals known as aragonite—the same form of calcium carbonate that forms pearls. In the *Starmaker*-silenced fish, however, the minerals form large, chunky calcite crystals.

J. BERGER

SHAPE SHIFTER Round aragonite crystals (top) in the inner ears of zebrafish control balance. Genetically modified zebrafish produce star-shaped aragonite crystals (right) and, in extreme cases, calcite (bottom).

In tanks with moving water, fish with the modified otoliths became disoriented and swam in circles. The research team, led by Teresa Nicolson, who is now at the Oregon Health and Science University in Portland, reports its findings in the Oct. 10 *Science*.

In people, a similar protein has been associated with hearing loss and teeth formation. The zebrafish work may lead to a better understanding of deafness and dental defects, the researchers say. —A.G.

SCIENCE & SOCIETY

POPs treaty enacted

On Oct. 23, a new international treaty—the Protocol on Persistent Organic Pollutants (POPs)—went into effect, although the United States hasn't signed on. Brokered under the aegis of the United Nations, the POPs treaty calls for reduction or elimination of toxic chemicals that are long-lived and have the propensity to travel long distances.

When first drafted in 2000, this treaty looked to curb what many scientists referred to as the dirty dozen: dioxins, furans, polychlorinated biphenyls (PCBs), and the pesticides aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, and toxaphene (*SN: 12/16/00, p. 389*). Since then, signatory nations have added four more POPs to the list: the pesticides lindane (also known as gamma-hexachlorocyclcohexane) and chlordecone (also known as kepone); hexabromobiphenyl, a polybrominated flame retardant; and polycyclic–aromatic hydrocarbons (PAHs), which are combustion byproducts.

Most of the POPs are slated for immediate elimination by nations that have ratified the treaty. In the United States, most of the POPs are already banned or severely controlled. A few compounds, such as DDT and PCBs, will remain in limited use in some countries for the time being. Because no one deliberately produces dioxins or PAHs, the treaty commits nations to restricting release of these chemicals as much as possible.

To date, Canada, Iceland, and 15 European nations, including France and Germany, have ratified the new treaty. —J.R.

TOXICOLOGY

Pollutants shape baby-gator gonads

Over the past decade, comparisons of alligators from two Florida lakes—the relatively pristine Woodruff and the pesticide-laden Apopka—have turned up numerous reproductive impairments in the Apopka animals. Low hatching rates, abnormal sex-hormone concentrations, perturbed egg production, and shorter-than-usual penises, are among the effects observed over the years (*SN: 7/15/95, p. 44*).

These impacts in Lake Apopka's animals had been chronicled only in adolescent and adult gators. Biologists at the University of Florida in Gainesville wanted to see whether the changes occur even in baby gators. So, Teresa Bryan and her coworkers collected 150 alligator eggs from nests on Lake Woodruff and incubated many of them in water laced with nine hormone-mimicking pesticides typical of Lake Apopka. Those include DDT, dieldrin, toxaphene, heptachlor, and alpha-chlordane.

To the researchers' surprise, the pollutants left year-old male gators—the developmental equivalent of human toddlers—with bigger-than-normal phalluses, not smaller ones.

Bryan studied males and females, which both develop phallus-shaped sex organs. Untreated baby males and those getting a half-strength recipe of the pollutants had phalluses about 3.2 millimeters long—0.4 mm shorter than those in males incubated in the full-strength mix of pesticides. Exposure to the pollutants didn't affect lengths of the baby female's organ called the clitero-phallus, although part of the organ was wider in animals getting the full-strength mix.

Bryan now suspects that the babies process the pollutants differently than older animals do. In the youngest gators, she says, "the contaminants are acting as [excess] androgens." —J.R.

EPIDEMIOLOGY

Sewage linked to fish-gender quirks

During dry spells, the water in some streams can come mostly from municipal sewage-treatment plants. A new study finds reproductive impairments among fish residing in such waters.

Alan Vajda and his colleagues at the University of Colorado in Boulder sampled white suckers and flathead chubs upstream and downstream of waste-treatment plants on three Colorado rivers. He harvested the fish during last year's drought, when each stream's flow was dominated by sewage effluent.

Fish upstream of a Boulder treatment plant were fairly evenly divided between males and females. However, 93 percent of the 60 fish caught downstream in the same river were females. Ovaries in many of these fish were smaller than those in their upstream cousins, contained testicular tissue, bore an unusual shape, and held less-developed eggs.

Of 21 fish captured downstream of a Denver water-treatment plant, 81 percent were females and all of the males there had testes containing ovarian tissue.

The sex ratio downstream of the one Colorado Springs sewage-treatment plant was close to normal, but Vajda notes, "We still found intersex fish," which have gonads containing male and female tissue.

What's shocking, Vajda told *Science News*, is that the source of pollutants at the Colorado sites isn't industry, but flushed toilets.

Vajda and his colleagues are now looking to tie the gender bending of fish to particular pollutants and to find out whether the extra downstream females are the products of a selective die-off of males or a pollutant-triggered sex reversal. —J.R.

ENVIRONMENT

UV-pollutant combo hits tadpoles hard

Many of the studies documenting a global decline in amphibians have linked the shrinking populations with exposure to excessive ultraviolet (UV) sunlight or to pollutants, especially ones with a hormonal effect. Biologists now find that slightly elevated UV exposure reduces the chance that tadpoles will become frogs. That chance declines even more with coincident exposure to an estrogen-mimicking pollutant.

Maxine Croteau's team at the University of Ottawa exposed leopard frogs to UV radiation for 8 months. Exposures started at hatching and lasted 12 hours a day at doses emulating what would occur 50 centimeters below the water surface at midday in May in northern North America. In the wild, only frogs in ditches or in small, evaporating ponds—and therefore without access to shielding plants—encounter such a constant UV exposure.

Ordinarily, between 6 and 11 percent of leopard frog tadpoles survive and metamorphose into adults, notes coauthor Vance L. Trudeau. In contrast, just 2 to 4 percent of the UV-exposed tadpoles reached adulthood, and they took at least a month longer to do so than did frogs raised in the lab but not exposed to excessive UV. The pollutant 4-t-octylphenol, an estrogenic breakdown product of popular surfactants in detergents, soaps, and other products, didn't affect metamorphosis—except in frogs getting daylong UV. In those groups, metamorphosis rates plummeted to a mere 1 or 2 percent, even when the 4-t-octylphenol concentration was 0.2 parts per billion, an amount found in the environment. —J.R.

ENDOCRINOLOGY

Soy compounds thwart estrogen

Although soybeans have gained renown as a source of the isoflavones genistein and daidzein, which can mimic the activity of the hormone estrogen, those same compounds occasionally have the opposite effect and block estrogen's activity. Now, a team of New Orleans researchers reports that a different family of soy isoflavones blocks estrogen even more consistently.

These unusual isoflavones, known as glyceollins, might lead researchers to improved drugs that starve breast cancers of the estrogen that many depend upon, notes research leader Stephen M. Boué of the Agriculture Department's Southern Regional Research Center.

When soybeans are infected or otherwise stressed, the plants make three glyceollins with natural pesticidal properties. In their experiments, Boué and his team infected tissue from soybean seeds with a fungus. Within 3 days, the concentration of glyceollins in the bean tissue spiked to as much as 1,000 parts per million.

When added to human breast cancer cells in a lab dish, the glyceollins inhibited the estrogen-sensitive cells' growth. The glyceollins also dramatically reduced the ability of estrogen to turn on the cellular receptors that it usually activates.

Estrogen receptors come in two types: alpha and beta. Though glyceollins inhibited estrogen's binding to both, the compounds proved far more effective at suppressing activity of the alpha receptors—the ones that play a central role in the growth of most breast cancers. In contrast, Boué notes, daidzein and genistein have their biggest effect on the beta receptors. —J.R.

Books

A selection of new and notable books of scientific interest

COMMON TO THIS COUNTRY: Botanical Discoveries of Lewis and Clark

SUSAN H. MUNGER

Today, many people take *Echinacea* to ward off a cold—a remedy that seems to be ancient in its heritage. However, before Meriwether Lewis and William Clark's famed 1804-to-1806 expedition, the substance's source, the coneflower, was unknown. It was one of some 226 new plants documented on the trip across what is now the western United States. This book profiles 25 botanical specimens collected by the duo, including Osage orange, snowberry, camas, bearberry, and ponderosa pine. Each vignette relates the discovery—often in Lewis' own words—and further details the history of the plant since that time. There is also cursory information about the growth and flowering of the plant, as well as a beautiful color illustration. ***Artisan, 2003, 128 p., color illus., hardcover, $22.95.***

HOW TO DUNK A DOUGHNUT: The Science of Everyday Life

LEN FISHER

A common refrain among schoolchildren is, "Why do we have to know this?" That's the question Fisher attempts to answer in these pages. He shows how science applies to everyday activities, ranging from boiling an egg to having sex. In the process, he gives readers insight into what scientists do, why they do it, and how they go about it. Some great discoveries, it seems, have come about by doing ordinary things. He points out that Count Rumford in the 18th century discovered the principle of heat convection after burning his mouth on an apple pie. Each chapter is built around a familiar activity and introduces a scientific concept that is central to it, such as how molecular structure explains foam in beer and bathtubs and how the laws of energy and force dictate the use of hand tools. In this book, Fisher makes a lot of concepts clear to unscientific minds. Originally published in Great Britain in 2002. ***Arcade Pub Inc, 2003, 255 p., b&w photos/illus., hardcover, $24.95.***

PROTECTING AMERICA'S HEALTH: The FDA, Business, and One Hundred Years of Regulation

PHILIP J. HILTS

In the late 1800s, foodstuffs sold at market were regularly contaminated, adulterated, or rotting. Ingredients in medicines were often diluted, faked, or mixed with dangerous substances. In response, Congress established the Food and Drug Administration as the first citizen-protection agency of the federal government. Championed by Theodore Roosevelt, the FDA established the principle that the government should both promote commerce and intervene when abuses occur. Other regulatory agencies, including the Environmental Protection Agency and the Securities and Exchange Commission, followed. In the early days, the FDA was a small operation employing a handful of chemists and inspectors. Today, 9,000 employees are responsible for overseeing the products of 95,000 businesses, which amount to $1 trillion worth of goods a year—about a quarter the United States' economy. Hilts relates scores of egregious acts by major corporations, as discovered and thwarted by the FDA. He also depicts the day-to-day activities of the agency. During the Reagan administration, deregulation effected major changes within the FDA. For instance, the agency no longer regulates herbal remedies and food supplements. Hilts charts the history of the FDA and explains the agency's influence not only in the United States, but also around the world. ***Knopf, 2003, 394 p., b&w plates, hardcover, $26.95.***

THE MOONS OF JUPITER

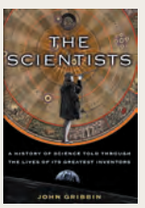
KRISTIN LEUTWYLER

Four hundred years ago, Galileo Galilei first spied Jupiter through his telescope. Fourteen years ago, NASA launched a space probe named in Galileo's honor to orbit the planet and send back images of it and its moons. This album features more than 100 brilliant color photographs collected by the Galileo probe that focus on four Jovian moons: Io, Europa, Ganymede, and Callisto. Lengthy captions provide detailed explanations of how the images were shot as well as what each picture tells us about Jupiter and its 40-some moons. The glossy photographs are detailed enough to reveal elements the size of a city bus and provide magnificent views of the volcanoes of Io and the craters of Callisto. ***Norton, 2003, 240 p., color photos, hardcover, $39.95.***

THE SCIENTISTS: A History of Science Told through the Lives of its Greatest Inventors

JOHN GRIBBIN

Beginning with Copernicus and the shift from mysticism to reason, Gribbin tracks 500 years of Western-science history through the life stories of the people who charted the course. The text is enlivened by anecdotes that define the characters and their achievements. For instance, genetics pioneer Gregor Mendel couldn't afford to attend a university and so pursued his interests at a monastery, where he toiled with now-famous pea plants. All fields of science are included, from physical laws revealed by Benjamin Thompson (also known as Count Rumford) to Michael Faraday's studies in electromagnetism, Charles Darwin's theory of evolution, and Joseph Black's discovery of carbon monoxide. Gribbin carefully illustrates how each such accomplishment, rather than being an isolated advance, has been part of a burgeoning scientific revolution that continues today. ***RH, 2003, 646 p., b&w photos/illus., hardcover, $35.00.***



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LETTERS

Early immigrants, earlier

The multiple-origin theory of ancient New World immigration reported in "Continental Survivors: Baja skulls shake up American ancestry" (*SN: 9/6/03, p. 150*) has a long and respectable scholarly history, though it's tarnished from time to time by enthusiasts for one race or another. For an early popular treatment, see *Men out of Asia* by Harold Sterling Gladwin (1947, McGraw-Hill). Gladwin even mentioned the Pericú, who were cited in the article.

GENE MCWHORTER, LONGVIEW, TEXAS

Link's no lock

Multiple sclerosis (MS) is considered to be an autoimmune disease of the central nervous system that attacks the myelin sheath around neurons. If there were a relationship between myelin and psychiatric illnesses, as suggested in "DNA Tie for Two Disorders: Genetic defects link psychiatric ailments" (*SN: 9/13/03, p. 164*), then many people with MS would suffer from schizophrenia or bipolar illnesses. The study is much too small to make such sweeping claims.

VIC ARNOLD, HOUSTON, TEXAS

Error bars get no respect

In your article on experimental hints of a new subatomic particle ("Particle decays hint at new matter," *SN: 9/20/03, p. 189*), three values are quoted for a particular charge-parity violation, all with error bar. Given the large uncertainties in two of these, the three are undistinguishable. Yet you claim that they "don't agree." Does no one look at error bars any more?

R.A. WILLIAMS, LOS ALAMOS, N.M.

Illuminating

What would sessile organisms do with information provided by the light from "their meals" ("Channeling light in the deep sea," *SN: 9/20/03, p. 190*)? Just because spicules on a sea sponge transmit photons doesn't mean that that's their function.

DAVID CONTEY, BOULDER, COLO.

Each Euplectella *sponge houses a pair of bioluminescent shrimp. The researchers speculate that the spicules transmit the shrimps' light into the sponge's surroundings. The glow attracts organisms that the shrimp eat. In turn, the sponge feeds on waste products of the shrimp.* —P. WEISS

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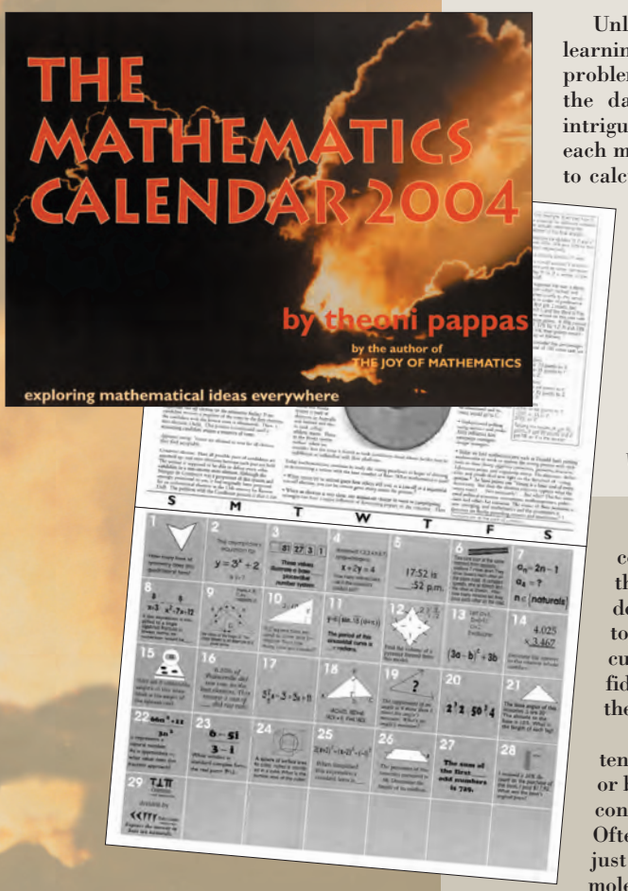
Explore Math *with Theoni Pappas*



Unlock a fascinating world of mathematical challenges and learning with *The Mathematics Calendar 2004*. It features math problems for every day of the year; in each case, the solution is the date. An informative essay, mathematical curiosity, or intriguing problem—plus a handsome graphic—accompanies each month. Problems cover the spectrum from basic arithmetic to calculus. The answer is only one small part in the process of solving a problem. The challenge is discovering how to arrive at the solution and possibly discovering more than one method of solving it.

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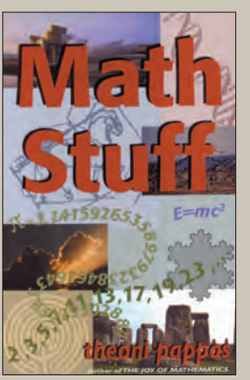
Math Stuff is not a book of numbers, formulas, or computations. It's a book of ideas. The mathematics behind these ideas is discussed in general terms, and each chapter is designed to be self-contained allowing the reader to open a topic at random. Many of the ideas presented are on the cutting edge and deal with anything from abstract concepts to fiddlehead ferns, from a number to numeral, from software to the nuts and bolts of a computer.



Stuff is the layperson's unpretentious word, which has no limits or boundaries. Math Stuff fills both conscious and unconscious space. Often we're oblivious to math stuff, just as we're oblivious to atoms and molecules. When crossing a bridge, most of us never think about the multiple equations and numbers crunching that went into the bridge's design and construction. When hiking or gardening, we don't think about the mathematics behind rock formations or plant forms. Or when flipping on the TV or using a cell phone, the mathematics of wave theory is farthest from our minds. Yet, math stuff is there describing, explaining, and influencing our lives.

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Mathematical Footprints follows the trail of mathematics. The order in which these mathematical footprints is presented is random, simply because that is often how they occur. For example, the Pythagoreans did not expect to uncover irrational numbers in the diagonal of a square. Nor did Fibonacci or future mathematicians expect the Fibonacci numbers to be so prevalent in nature. Or, who would have predicted fractals would become so important in describing everyday objects?

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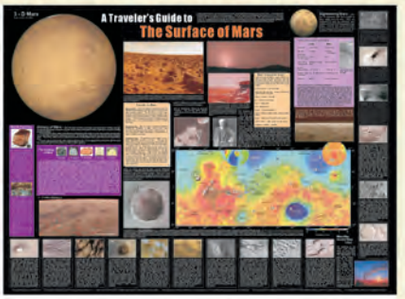

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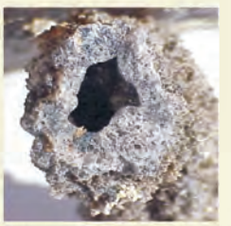

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