SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

NOVEMBER 15, 2003 PAGES 305-320 VOL. 164, NO. 20

what shapes leaves?
a voracious milky way
ancient shrinking horses
you sound like an egg

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built by bugs

GEOCHEMISTRY À LA BACTERIA

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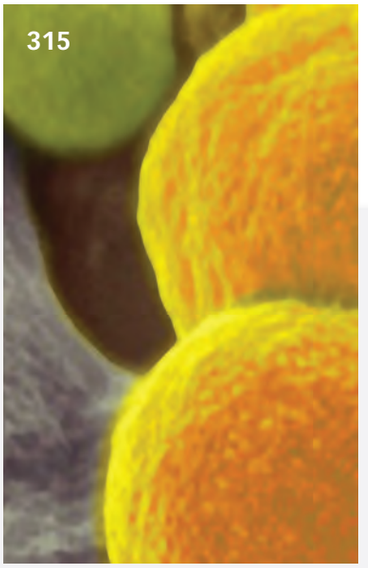

Features

This Week

Of Note

Departments

Cover These tiny spheres of zinc sulfide assembled by sulfur-reducing bacteria are smaller and more pure chemically than are mineral crystals that grow inorganically (not shown). Scientists are finding that microbes play a role in many geological processes once thought to be simple inorganic chemistry. (Jill Banfield) Page 315

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Chow Down!

Milky Way gobbles its closest known neighbor

Astronomers have discovered that the Milky Way is shredding a tiny galaxy into elongated streams of stars and claiming them for itself. At 42,000 light-years from our galaxy's center, the distorted body stands as the Milky Way's closest galactic neighbor. This marks the second time that the Milky Way has been found guilty of cosmic cannibalism.

Although the 10-billion-year-old Milky Way formed its basic structure long ago by capturing and merging myriad smaller galaxies, the new finding provides fresh evidence that our galaxy is still snacking on small-fry satellite galaxies. In an upcoming *Monthly Notices of the Royal Astronomical Society*, Rodrigo A. Ibata of the Strasbourg Observatory in France and his colleagues describe the newly discovered dwarf galaxy, dubbed Canis Major for the constellation in which it resides.

Both theoretical models and observations have indicated that the outskirts of large galaxies, such as the Milky Way, grow by gravitationally capturing gas and stars from their smaller galactic neighbors. But in consuming the newly found dwarf galaxy, the Milky Way is adding material to its starlit disk rather than to the outlying regions, Ibata notes.

His team's computer simulations reveal that the Milky Way's disk has been feeding on the dwarf galaxy—tearing out streamers of stars and wrapping them around the Milky Way—for about a billion years and will do so for another billion.

The Canis Major dwarf is a lightweight galaxy, today weighing only as much as a billion suns, or about one-fiftieth as much as the disk of the Milky Way. So far, it may have contributed as much as 1 percent of the disk's mass.

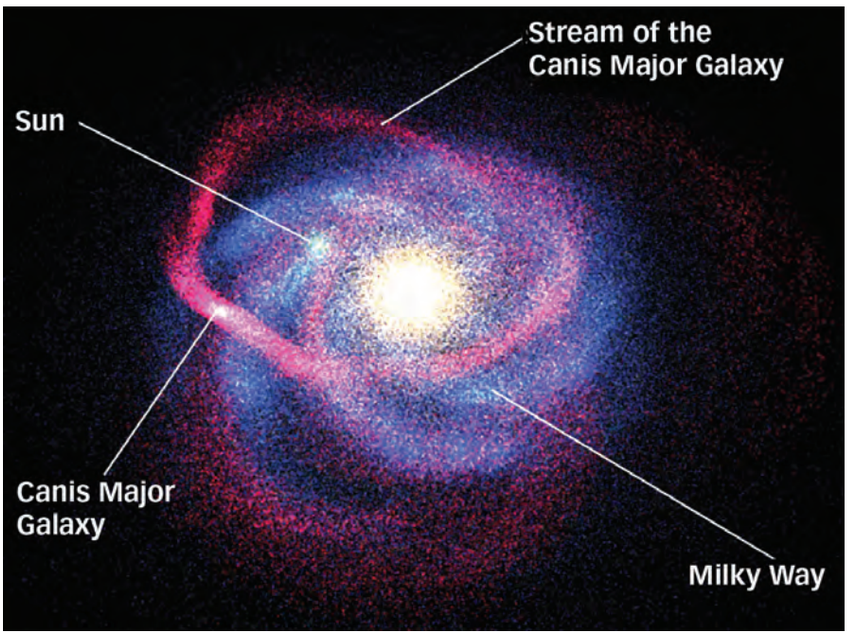
The dwarf appears to be the origin of a vast ring of stars that circles our galaxy, Ibata says. It was during a search for the source of the ring that Ibata's team came across a galaxylike clumping of stars. Finding such a stellar concentration posed a formidable challenge because astronomers had to peer through our galaxy's veil of dust.

Infrared radiation penetrates the Milky Way's dust, so Ibata's team relied on a recently completed near-infrared atlas of some 300 million stars.

By tracing out the infrared signals of bright stars along the Milky Way's vast outer ring, the researchers discovered the dwarf galaxy, which is below the plane of the Milky Way.

Astronomer Heidi Jo Newberg of the Rensselaer Polytechnic Institute in Troy, N.Y., says that she would need to see more data to be convinced that the clump of stars found by Ibata's team indeed constitutes a galaxy. But "if they have really found a dwarf galaxy in Canis Major, it is very exciting and almost certainly the progenitor of the ring-like structure," adds Newberg.

A year ago, Newberg notes, astronomers were convinced that the Milky Way was devouring just one galaxy, which Ibata's team found in 1994 (*SN: 4/9/94, p. 228*). The new discovery "opens the door to the possibility that there may be more out there for us to find," she says. —R. COWEN



IBATA ET AL.

CAPTURED STARS In this simulation, material is streaming from the newly discovered Canis Major dwarf galaxy into the Milky Way, a process that will continue for a billion years.

Northern Extinction

Alaskan horses shrank, then disappeared

Toward the end of the last ice age, a group of horse species that lived in Alaska shrank in body size over several millennia before going extinct. That finding implicates changing environmental conditions as the stimulus for equine die-offs in the region, one researcher suggests. Some scientists previously proposed that the arrival of human hunters was to blame for the demise of many species of large North American mammals (*SN: 12/4/99, p. 360*).

Caballoid horses, a group of stocky species related to some Eurasian horses, were once common in what is now Alaska. But they, along with 70 percent of North America's large mammal species, disappeared by the end of the last ice age, says R. Dale Guthrie of the University of Alaska in Fairbanks.

At the height of that ice age, about 24,000 years ago, the shinbones of caballoid horses averaged 21 centimeters in length. By the time the horses went extinct about 14,500 years ago, the average caballoid shinbone measured only 19 cm.

Ecological factors can best explain the decline in horse size and the species' ultimate extinction, Guthrie suggests in the Nov. 13 *Nature*. A sudden shift in pollen species about 15,500 years ago chronicles the evolution of the landscape from an arid, windswept grassland—an ecosystem to which the horses were particularly well adapted—to a less nourishing mosaic of lakes, bogs, forests, and tundra.

Archaeological evidence so far dates the arrival of people in the area at about 5 centuries after the disappearance of the horses. Even if some people roved through the area before horses went extinct, it's unlikely that

just a few hunters could wipe out the horses, says Guthrie. Furthermore, he notes, any theory that blames people for the demise of these horses must also explain why mammoths, another supposed target of such hunters, outlasted horses in the area by about 1,300 years.

Despite the current lack of evidence, human predation may have been at play in the horses' Alaskan extinction, says Stephen M. Rowland of the University of Nevada at Las Vegas. Ancient bands of nomads whose traces archaeologists have yet to find could have driven horses from the area, but that hypothesis would be hard to test, Rowland notes.

Elsewhere in North America, people may indeed have contributed to the extinction of horses at the end of the last ice age. For instance, researchers have found the residue of horse blood on spearheads at an 11,000-year-old archaeological site in western Canada.

At Nevada's Gypsum Cave, northeast of Las Vegas, scientists unearthed bones from horses, camels, and other large mammals. Preliminary examinations of some of those bones have revealed scratches that "look suspiciously like cut marks," says Rowland. Also, many of the bones had been burned at temperatures that suggest they were cooked over a fire, he notes.

Rowland and Elizabeth M. Glowiak presented their findings last week at the Geological Society of America meeting in Seattle. —S. PERKINS

Humpty-Dumpty Effect

Acoustically, people resemble large eggs

Using a sound-based scanning technique to determine the shapes of moving creatures and other objects, an international team of scientists has found that the human form bounces sound waves as if each person were a huge, elongated chicken egg.

This new acoustic portrait of people as a hard ellipsoid may aid designers of concert halls and other venues where acoustics are of paramount concern, says Stéphane G. Conti of the Southwest Fisheries Science Center in La Jolla, Calif. Until now, no one had measured the absolute acoustic profile of the human body—that is, how the body scatters sound waves independently of where it happens to be.

This new acoustic description "should have application everywhere a human is embedded in an acoustic sound scape," comments acoustics specialist Vincent Gibiat of the Université Paul Sabatier in Toulouse, France.

In a hard-walled room, sound waves rebound from an object along paths determined by the object's shape. So, each object creates a distinctive interference pattern and intensity spectrum. Two years ago, Julien de Rosny and Philippe Roux of the Université Paris VII in France demonstrated that they could infer the three-dimensional shape of an object by recording sound waves as the object moved to various locations in a stark, sound-reflecting tank filled with water. They proposed using the method to automate fish counting in aquaculture tanks.

To arrive at the new acoustic representation of people, Conti, de Rosny, and Roux, now at the University of California, San Diego, and David A. Demer of the Southwest Fisheries Science Center placed a speaker and a microphone in each of two reverberant rooms—a squash court and a fallout shelter. Next, the scientists had a person walk around in one of the rooms, while they recorded the many echoes that resulted from audio pulses emitted by the speaker. The team conducted tests with 27 people from ages 3 to 55.

Analyzing those recordings, the scientists mathematically distinguished the sound waves that had bounced off just the walls of the room from those that had ricocheted off a person. In general, the team found that each person's bodily influence on the recordings matched that expected from an ellipsoid of the same height and girth as that of the person. That shape would be proportionately taller and thinner than a typical egg is.

Further measurements showed that clothing absorbs sound, but the body's acoustic absorption is negligible. Conti described the measurements last Tuesday at a meeting of the Acoustical Society of America in Austin, Texas.

The researchers, whose main interest remains sea life, undertook the human experiments in an attempt to decipher perplexing differences between sound spectra of anchovies and sardines. The challenge seemed to require certain controlled tests, and, Conti explains, "it's easier to control humans than fish." However, the new results didn't indicate why the fish spectra differ.

By building a database of acoustic models of various sea creatures, the team ultimately aims to enable fisheries specialists to automate counts of specific species in the ocean, Demer says. Moreover, he adds, if the work includes models for human divers, it may lead to automated systems that detect saboteurs entering ports. —P. WEISS

Whiffs of Perception

Sniffing activates the mind's nose

A rose by any other name smells as sweet, even when you only conjure up its fragrance in your mind. That's because people use their noses to sniff imaginary as well as real aromas, and the mere act of sniffing scentless air kick-starts odor perception, a new study finds.

Behaviors, such as sniffing, that are used to acquire sensations do themselves activate brain representations of those sensations, concludes a research team led by Moustafa Bensafi of the University of California, Berkeley.

"Sniffing is not just a way to pick up smells, it's a part of olfactory perception," says Berkeley psychologist Noam Sobel, a coauthor of the new study.

Sobel suspects that all the senses inform perception in this way. For instance, other researchers have found that people move their eyes in much the same way whether they're visualizing an object in its absence or actually seeing it. Moreover, tests have shown that it's difficult to generate a mental image if one's eyes are prevented from moving.

Bensafi's team hooked up 30 college students to a machine that measured nasal airflow as they imagined pleasant and unpleasant sights, sounds, and smells. Visual images included a sunset and a scar. Imagined sounds ranged from rainfall to a person crying. Imagined smells encompassed roses and rotten eggs.

Volunteers spontaneously sniffed only when imagining smells, the researchers report in the November *Nature Neuroscience*. Imaginary pleasant odors evoked larger sniffs than imaginary unpleasant odors did.

In a second set of trials, the scientists measured nasal airflow in 10 additional participants, who completed four tasks in random order—smelling odors, imagining odors, looking at objects, and visualizing objects that weren't present.

Sniffing occurred only as individuals smelled or imagined odors. Volunteers drew in larger volumes of air for real smells than for imagined ones. As observed for imagined smells, pleasant real smells evoked

QUOTE

"Sniffing is not just a way to pick up smells, it's a part of olfactory perception."
NOAM SOBEL, UC BERKELEY

larger sniffs than unpleasant ones did.

A final workout for the mind's nose involved 20 more volunteers. In these tests, each volunteer reported imagining smells more vividly after having been encouraged to sniff air than while wearing a nose clip that prevented sniffing.

These results underscore the influential view in neuroscience that the brain creates and saves information, such as smells, in the form of neural activity patterns, comments psychologist Stephen M. Kosslyn of Harvard University in an editorial published with the new research. Acts such as sniffing trigger odor-specific activity patterns in the brain, Kosslyn contends.

Walter J. Freeman of the University of California, Berkeley, who investigates odor perception (*SN: 10/19/02, p. 252*), interprets the data differently. Sniffing triggers action-oriented brain activity related to specific smells and the contexts in which they occur, Freeman holds. These flexible neural responses, unique to each individual, reflect the shifting significance of particular smells rather than stored information about smells, he theorizes.

Bensafi is now directing a brain-imaging study to see whether odor imagery provokes responses in the neural gateway for smell perception or only in so-called higher olfactory tissue. —B. BOWER

Plastic Memories

Polymer materials store data permanently

In their quest for alternatives to silicon, chip manufacturers are increasingly turning their attention to plastic. Low-cost, easily manufactured polymers that conduct electricity could revolutionize electronics, they say. Now, researchers at Princeton University and Hewlett-Packard Laboratories in Palo Alto, Calif., have fabricated a polymer-based memory device for permanent data storage.

In the new scheme, a single memory cell consists of a layer of polymer sandwiched between a gold electrode and an aluminum one. In the polymer's original state, positive charges carry current through the material. To encode data in a cell, the researchers apply a voltage, which injects electrons into the polymer. Positive charges from the gold electrode then flood the material to neutralize the electrons.

The movement of charge, which occurs in about a microsecond, permanently switches the polymer from a conducting to a nonconducting state—or from a 0 to a 1, in computer terminology. Says lead investigator Stephen Forrest of Princeton, "It looks like the same material, but something internally has changed quite dramatically . . . and it's very stable."

To read each cell, the researchers apply a smaller voltage. With the help of a silicon diode that electrically isolates the cell from nearby ones, they then measure the current flowing through the cell. The scientists describe their new plastic memory in the Nov. 13 *Nature*.

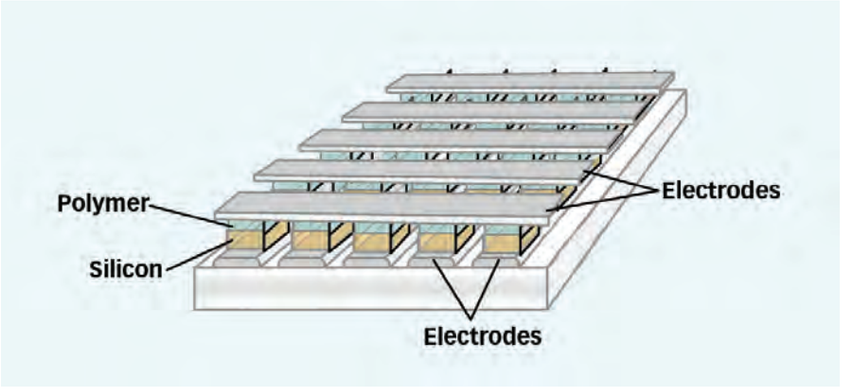
Forrest anticipates that an array of polymer memory cells on a 1-millimeter-square chip could store 1 megabit of information. Because the data are permanently inscribed, such polymer memory devices would be well-suited for storing archival materials, digital photos, and video. Although other media, such as the magnetic material in a hard drive, can store more data (*SN: 9/13/03, p. 171*), plastic devices are less expensive and require less energy to operate, says Forrest.

And there's room for improvement, he notes. In the new plastic device, each cell measures 17 square microns. However, Forrest predicts that his team could get that dimension down to just a couple hundred nanometers. What's more, he says, "you can stack the devices on top of each other." To demonstrate that, he has created a 1-centimeter-cube model device that, in theory, could store 10 gigabits of data, or about double the amount on a CD-ROM.

In the future, a small, cube-shaped device such as this one could sit in a digital camera and permanently store thousands of photos, Forrest says.

"It's a brilliant approach," says Vladimir Bulovic, an electrical engineer at the Massachusetts Institute of Technology. However, MIT chemist Tim Swager cautions that because the underlying mechanism remains unclear, he's unconvinced that the voltage-induced switching is permanent.

The new work falls in line with the worldwide effort to develop polymer memory devices for applications including rewritable chips, such as the short-term memory on a computer. "That's a much harder task," says Bulovic. —A. GOHO



FORREST

CROSSROADS A polymer film sandwiched between electrodes makes up this memory device. At each junction, an applied voltage switches the polymer from a conducting to a nonconducting state. A silicon diode helps distinguish between the states.

Not Just Neurotoxic

Pesticide chlorpyrifos affects heart and liver cells

A pesticide known to be toxic to the brain at high doses may have subtle effects throughout the body, researchers suggest. They have found abnormalities in heart and liver tissues of animals exposed during early development to chlorpyrifos.

At high doses, this chemical, which belongs to a group of pesticides called organophosphates, can cause headache, nausea, and other symptoms. Lower doses during fetal growth and early life have been shown to alter brain development and adult behavior in laboratory animals.

To reduce exposures in children and cut the chemical's prevalence in urban waterways, where it is commonly detectable, the Environmental Protection Agency in 2000 restricted certain uses of chlorpyrifos. It's nevertheless widely used legally in the United States to protect fruit and vegetable crops and to fight insects in buildings and lawns.

To test for effects of the chemical outside the nervous system, researchers at Duke University in Durham, N.C., injected rats daily with 1, 2, or 5 milligrams of chlorpyrifos per kilogram of body weight for 4 consecutive days. Some animals received the injections while they were pregnant, and their offspring were then studied for possible effects. Other animals were exposed during the first or second week of life. The researchers looked for effects shortly after exposure and when the animals were juveniles and adults.

The doses of chlorpyrifos were too low to cause immediate symptoms, but rats exposed in utero or during the first week after birth later showed subtle biochemi-

cal abnormalities. Chlorpyrifos exposure in older animals seldom had an effect, suggesting that a "window of vulnerability" closes soon after birth, say Theodore A. Slotkin and his colleagues at Duke.

The abnormalities affect adenylyl cyclase signaling, a process by which cells communicate, and in some experiments, effects were evident only in male rats. Because adenylyl cyclase signaling modifies insulin production, glucose metabolism, and heart rate, the findings imply that early exposure to chlorpyrifos and other organophosphates could increase risks for cardiovascular and metabolic disorders that typically arise later in life, Slotkin argues.

The report will appear in an upcoming issue of *Environmental Health Perspectives*.

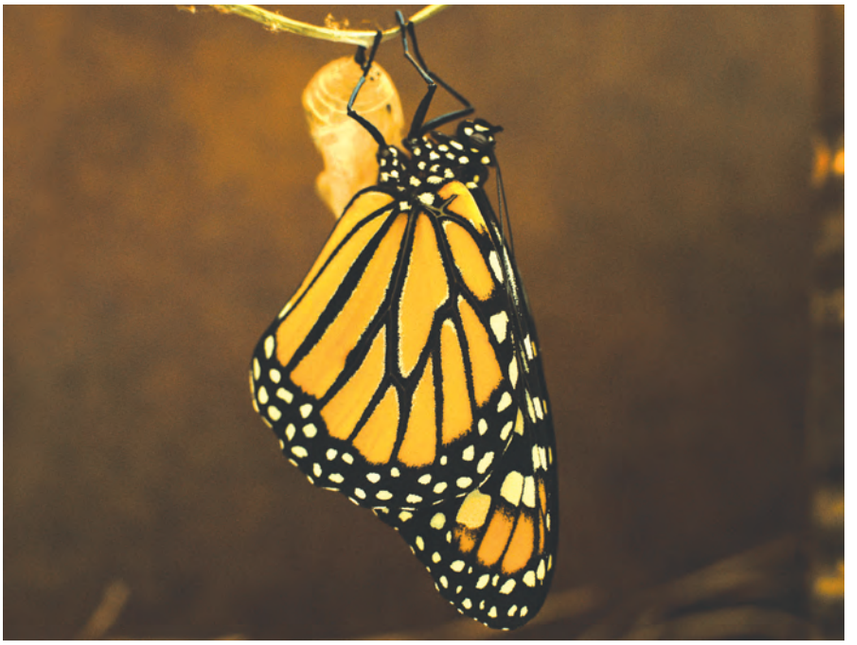
In another paper to appear in that journal, Slotkin and his colleagues report that chlorpyrifos exposure also influences the programming of immature brain cells that controls their response to serotonin. That neurotransmitter acts through a different mechanism than the one previously shown to be responsible for chlorpyrifos' neurotoxic effects.

The doses used in the new experiments are much higher and shorter-term than those that people typically experience, says organophosphate toxicologist Subramanya Karanth of Oklahoma State University in Stillwell. A more relevant dose for revealing long-term effects of exposure during development would be in the range of 0.1 mg/kg per day for a month. Furthermore, he says, feeding chlorpyrifos to rats rather than injecting the chemical would better reflect the dietary exposure that most people experience. "Further research should be done to determine whether changes occur at levels of exposure encountered in the environment," says Janice E. Chambers of Mississippi State University in Mississippi State. —B. HARDER

Will Climate Change Depose Monarchs?

Model predicts too-wet winter refuges

A computer analysis suggests that climate change could ruin the current Mexican overwintering sites for monarch butterflies and perhaps wipe out the insect's populations in eastern North America.



HANG IN THERE Monarch butterflies' winter homes in Mexico may become unsuitable as the climate changes and the risk of snow and ice increases.

While monarchs that summer in the western United States and Canada gather each autumn by the tens of thousands at spots along the California coast, east of the Rocky Mountains, monarchs head toward Mexico. Some 200 million of these butterflies flee cold weather to bask on about a dozen tree-covered mountain slopes in Mexico, explains Karen Oberhauser of the University of Minnesota at Minneapolis St. Paul.

A technique called ecological-niche modeling suggests that these sites will grow dangerously moist, increasing the chances of monarch-killing ice and snow, she and A. Townsend Peterson of the University of Kansas in Lawrence predict. The change could take place by 2050, the researchers say in an upcoming *Proceedings of the National Academy of Sciences*.

The butterflies might change their winter destination, but will refuges with the required characteristics become available? "I think it's really concerning," says Oberhauser.

The new analysis is valuable because people might otherwise dismiss the impact of climate change on monarch butterflies and other long-distance travelers, says Chris Thomas of the University of Leeds in England, who also models climate effects on animals. "Because migrant species are so mobile, one might assume that they will be capable of responding to climate change immediately and easily, simply shifting their distributions into new areas," he says.

Monarchs need a winter site that doesn't freeze or get too warm. Migrating butterflies have immature reproductive systems. "They're like 11-year-old kids," Oberhauser says. High temperatures might prematurely kick the monarchs' development into gear while they're still overwintering. Without the milkweed abundant farther north, they would miss their opportunity to reproduce.

Oberhauser and Peterson found climate data for Mexican areas that do and don't support overwintering monarchs. The scientists fed some of the data into an ecological model that formulated the best rules for where the monarchs winter. When tested on the rest of the real-world data, the rules worked well.

"This is the first time anyone has used niche modeling to look at the seasonal dynamics of a migratory species," says Oberhauser.

The most important factors for the butterfly refuges turned out to be mean minimum January temperature and mean January precipitation.

Next, the researchers consulted detailed climate predictions from the Hadley Center in Exeter, England. Under both a conservative and a more dramatic scenario, the rules predict that the temperatures at the sites will fall within the butterflies' tolerance. However, in both conditions, precipitation will more than triple by 2050, moving far beyond the amount that overwintering monarchs are known to survive.

Because monarchs have four or five generations per year, people can't just move the monarchs to new winter locations and expect them to return. It's their great-great-grandchildren that will migrate south next year.

The species does have some flexibility, Oberhauser points out, since it's already expanded its range from North America to other continents. —S. MILIUS

MICRO SCULPTORS

Tiny RNAs mold the development of leaves

BY KATE RAMSAYER

Although you may not feel like admitting it as you rake them into trash bags, leaves are works of art. Their brilliant colors and elegant shapes have attracted and inspired artists. Each leaf assumes its appearance and operations through a finely balanced process of cell division and specialization. Yet leaves of some plants don't conform to popular notions of leaf beauty. They may, for example, scrunch up where other leaves of the same species lie flat. Oddly shaped leaves and the plants that yield them have intrigued botanists and cell biologists for more than a century because they provide clues into how normal plants take shape.

For botanists studying development of plant structures, "this is probably the most exciting time," says Nancy Dengler of the University of Toronto. "There have been hundreds of leaf-shape mutants identified during the 20th century, but it is really only in the last decade that the molecular identity of a number of [shape-changing] genes has been established."

FRILLS — When a normal snapdragon leaf (left) lacks the *cincinnata* gene, cells along the outside of the leaf divide uncontrollably and form wavy edges (right).

In their search for what makes leaf growth and other aspects of plant development go right or wrong, scientists have found both traditional genes and some surprising ones. In the oddball category, plants contain stretches of DNA that are influential even though they don't encode any protein. Instead, they result in snippets of RNA that researchers call microRNAs. These snippets control biochemical reactions by squelching the creation of specific proteins (*SN: 1/12/02, p. 24*), just as some proteins do. Research over the past few years indicates that microRNAs play an essential role in the delicate control over when and where genes turn on and off in the developing organism, be it a mammal, fly, or plant.

"MicroRNAs control some really interesting biological functions and address long-standing questions in developmental biology," says James C. Carrington of Oregon State University in Corvallis. "What microRNAs do is provide a totally novel layer of genetic regulation."

"So many people have jumped into this field. The pace of discovery is so rapid, that literally every few days a breakthrough paper is published," Carrington says. Many of these advances are coming from research on plants, where identification of the molecular targets of microRNAs is relatively straightforward.

THIS SIDE UP In the first years after their initial identification in worms in 1993, microRNAs appeared to be a molecular rarity. When scientists began systematically searching through bits of RNA in various organisms, however, an explosion of microRNA discoveries occurred in worms, flies, fish, mammals, and plants.

"The numbers [of discoveries] went from two to a couple of hundred," says Carrington. By 2002, for example, researchers had found about 20 different microRNAs in the commonly studied mustard plant called *Arabidopsis*.

By then, scientists had proposed that plant microRNAs control protein production by glomming onto messenger RNAs, an essential intermediate in the creation of a protein. The RNA snippets, each containing 21 nucleotides, attach wherever the longer RNA contains a chemical sequence complementary to that of the microRNA. This prevents the messenger RNA from forming a protein. In many cases, when microRNA binds, the larger RNA fragments.

In 2002, a group led by David P. Bartel at the Whitehead Institute in Cambridge, Mass., scanned the newly decoded *Arabidopsis* genome to identify genes that the species' microRNAs should be able to stick to. The team identified 49 possible gene targets for 14 microRNAs. "Virtually all of them were important in *Arabidopsis* development," says Bartel.

One family of target genes that immediately caught researchers' attention plays an important role in early leaf development. Before a leaf pokes out from the shoot, the cells destined to form that leaf must determine whether they'll end up on the top or bottom. If they're top-leaf cells, they have to build in the proper proteins for catching photons. Bottom-surface cells need equipment for exchanging carbon dioxide and oxygen with the surrounding air.

Two genes that play a role in the up-down directive are *phabulosa* and *phavoluta*. In 2001, a group led by M. Kathy Barton, now at the Carnegie Institution of Washington in Stanford, Calif., identified topsy-turvy plants that harbor mutations in the DNA sequence of a region found in both the *phabulosa* and *phavoluta* genes. Whereas the genes are normally active in cells on a leaf's top surface, these mutations somehow caused the encoded proteins to appear in cells that line the bottom of the leaf, transforming them into toplike cells.

In fact, Bartel's team identified messenger RNA from *phabulosa* and *phavoluta* as potential targets of microRNAs. The researchers have proposed that mutations in *phabulosa* and *phavoluta* can render those genes invisible to a microRNA that would normally destroy their messenger RNA in leaf-bottom cells. This would blur the distinction between the two sides of a leaf.

Another lab later showed that in a slurry of plant extracts, microRNAs do cause *phavoluta* messenger RNA to be chopped up. At a June 2003 *Arabidopsis* meeting in Madison, Wis., Bartel and Barton's groups presented evidence that microRNAs regulate these genes in whole plants, as well.

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FLAT OR CRINKLY? The influence of microRNAs extends beyond early leaf development. Once leaves start growing, the cells must divide and expand in a specific pattern to create a characteristic shape.

Organisms "go through a lot of trouble to make things flat," says Enrico Coen of the John Innes Centre in Norwich, England. "Flatness is a specific outcome of genetic control ensuring that things come out a certain way."

The curvature of leaves depends on the speed and duration of cell division. If cells in the middle replicate too much, the leaf bulges. If extra cells crowd the leaf edges, they fashion a crinkly perimeter.

Coen and his colleagues investigated one crinkly-leaved snapdragon line first described in Germany in the 1930s. In the Feb. 28 *Science*, they report that disruptions in a gene called *cincinnata* can convert normal snapdragons to plants with similarly wavy, rounded leaves.

In a growing leaf that will end up flat, cells keep dividing until they get a signal to stop. Cells at the leaf tip stop dividing first, then the stop signal progresses to the base of the leaf. The signal goes slower in the center of the leaf and faster along the edges. Normally, the *cincinnata* gene is turned on where cells stop dividing, especially toward the perimeter of the leaf.

In the crinkly snapdragons and plants engineered to lack *cincinnata*, however, the progression of the stop signal is disturbed. The cells divide for a longer time than they should, especially along the leaf edges, resulting in the wavy leaves.

"This made us realize that normally the plant is doing something really carefully," says Coen. He suggests that *cincinnata* expression influences how cells respond to arrest signals.

What controls the critical spacing of *cincinnata* expression that determines whether a plant will have crinkly or flat leaves? MicroRNAs make convincing candidates.

Until recently, Detlef Weigel of the Max Planck Institute for Developmental Biology in Tübingen, Germany, had been puzzled by a mutant *Arabidopsis* plant line he described a few years ago. The plants—dubbed jaw because the leaves appear serrated like dinosaur teeth—resulted from the overexpression of a messenger RNA that didn't make a protein. That didn't make sense to Weigel until other scientists started describing the apparent functions of microRNAs.

"When I read these papers, it occurred to me that [jaw] might be a microRNA mutant," says Weigel. He also realized that the *jaw* and *cincinnata* genes could be linked. Perhaps *jaw* mutants produce too much of a microRNA that chops up *cincinnata*, producing the same leaf defect seen when *cincinnata* isn't expressed in the first place.

"What [Coen] found was a key controller of cell division during development," says Carrington, who collaborated with Weigel. "What we found was a key controller of the controller."

Weigel and Carrington's group made their discovery in a series of experiments with an *Arabidopsis* engineered to overexpress *jaw*. The team reports in the Sept. 18 *Nature* that extra copies of *jaw* caused plants to have unusually low concentrations of a group of proteins related to *cincinnata*. These important developmental proteins share a structure called TCP—an acronym for the names of the three proteins in which it was discovered.

In one experiment, the researchers replaced a TCP-containing gene with a slightly altered version. The variation makes messenger RNA that's resistant to microRNA binding but still produces a functional protein. The resulting plant line had multiple developmental problems and stopped growing at the seedling stage. Because there was no shortage of the cell-division-controlling protein, the researchers attributed these defects to the lack of microRNA binding to messenger RNA. This indicated that regulation by microRNA is required for normal plant growth.

The researchers hypothesized that in *jaw* mutants, a microRNA is repressing the normal TCP genes more than it usually does. The team then tested what would happen if it put enough TCP genes into the mutant plant so that even the abundant *jaw* microRNA couldn't overcome them. When the scientists inserted excess copies of another TCP gene into *jaw*-mutant plants, the leaves were flatter and less crinkly than those in typical *jaw* mutants.

"It's a pretty nice demonstration" of microRNA action, says plant geneticist Robert Martienssen of Cold Spring Harbor (N.Y.) Laboratory, who envisions more and more researchers using a similar set of experiments to demonstrate the actions of other microRNAs.

Two recent papers support this trend. In the Oct. 14 *Current Biology*, John Bowman's group at the University of California, Davis shows that microRNAs control *revoluta*, a cousin of the *phabulosa* and *phavoluta* genes. When the *revoluta* messenger RNA sequence was changed so that microRNAs couldn't bind to it, the cells in the plant's stem developed abnormally.

FOILED FLOWERS — When scientists add extra copies of a microRNA to a normal *Arabidopsis* plant (left), its petals are replaced by additional reproductive organs (right). This design is similar to what happens when the *apetala* gene is malfunctioning (center), suggesting that the microRNA normally acts on *apetala*.

It appears that flowers can depend on microRNAs, as well. In an upcoming *Science* paper, Xuemei Chen of Rutgers University in Piscataway, N.J., shows that a microRNA controls proper formation of plant reproductive organs and flower petals.

"We're just scratching the surface in terms of the roles that [microRNAs] have in development," says Bartel.

MINI MYSTERIES In addition to verifying targets of microRNAs, scientists are studying the basics of their action. While some microRNAs, such as those from *jaw*, appear to cause messenger RNA to be chopped up, others leave the RNA intact but use as yet undetermined methods to prevent protein formation. And while microRNAs appear to be potent gene regulators, little is known about how other plant molecules control the expression of the individual microRNAs.

These snippets of RNA might possess beneficial properties that, in some situations, would make them preferable to proteins for developmental tasks. For example, microRNAs could play a role when cells switch from an undifferentiated state, in which they could conceivably turn into a variety of cell types, to the state in which cells have a definite function. In plants, this happens when stem cells in the shoot take the plunge and start becoming leaf cells.

"In order to do that, [a cell] needs to turn on new genes, and turn off some of the old ones," says Bartel.

When a cell shuts genes down, however, the messenger RNA produced earlier might still lurk in the cell, making unnecessary proteins. MicroRNAs might provide way to clear out these messages out quickly and efficiently, says Bartel.

Whatever their benefits or limitations, microRNAs represent a new class of molecules for scientists to explore in their attempt to understand the complexity that underlies the development of something as simple and elegant as a leaf. ■

CHEN/SCIENCE

ATTACK OF THE ROCK-EATING MICROBES!

Some bacteria break down minerals, while others make them

BY SID PERKINS

Geologists are studying bacteria nowadays. It's not that the rock hounds have gone soft. Instead, they've found that geological processes once attributed solely to simple inorganic chemistry have microbial fingerprints all over them. In rocky venues ranging from abandoned mines in California to water wells in Bangladesh to hydrothermal vents on the seafloor, bacteria are at work. If the microbes aren't driving the underlying chemical reactions in those places, they're at least taking advantage of the energy that's being released by these reactions.

Researchers are finding that bacteria living on the seafloor may be key players in the chemical reactions that slowly transform the rocks there, and in the process, help balance ocean chemistry. Others are discovering that microbes can create tiny mineral particles by extracting exceedingly small concentrations of dissolved metals from the fluids that course through soils and sediments. In at least one instance, bacteria probably created a significant deposit of high-value mineral ore (*see box, p. 316*).

ACID STREAM — Bacteria accelerate the formation of acidic mine drainage, an environmental problem that taints more than 19,000 kilometers of streams and rivers nationwide.

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION

HEAVY METAL Geochemists are finding that mineral-eating bacteria can be partly to blame for major environmental problems. For instance, when mines go bust, they often leave behind a mix of water and minerals that bacteria can convert into acidic runoff that's deadly to plants and animals.

Nationwide, acidic mine drainage affects more than 19,000 kilometers of rivers and streams. Some scientists rate toxic mine drainage as the greatest water-quality problem facing the western United States. In Colorado alone, the effluent from more than 7,000 abandoned mines contaminates more than 2,500 km of streams, says Diane McKnight, a geologist at the University of Colorado in Boulder.

Consider the Richmond Mine in California's Iron Mountain, about 15 kilometers northwest of Redding. Active from the late 1800s until the 1960s, the mine yielded a bounty of iron, silver, gold, zinc, and copper ores. All of the blasting and tunneling that went on at the site riddled the mountain with fractures, exposing enormous areas of rock and mineral deposits to oxygen and water.

When that combination includes sulfide minerals, the sulfuric acid that's produced leaches toxic metals out of the rock, says Jill Banfield, a geochemist at the University of California, Berkeley. But it's the presence of particular microbes that really aggravate the situation.

For instance, the oxidation of iron exposed by mining typically takes place more slowly in acidic conditions than in solutions with neutral pH. However, acid-tolerant microorganisms can accelerate the oxidation reaction and harness the energy it provides. This process also speeds up the mineral breakdown and releases up to 10 times as many metal ions into the water as sterile acid runoff would.

Waters draining through Iron Mountain and collecting in the mining tunnels have a pH between 0 and 1, about the same as that of battery acid. According to the Environmental Protection Agency, Iron Mountain at one time yielded the most acidic mine drainage in the world. Chemical analyses by Banfield and her colleagues show that dissolved in each liter of today's drainage can be up to 80 grams, or a heaping teaspoon, of dissolved iron and as much as 6 g of zinc. Other trace elements include copper and arsenic.

Before cleanup efforts began there in the late 1980s, acidic runoff from Iron Mountain annually dumped into local streams about a ton of dissolved copper and zinc—about one-quarter of the total national discharge of those metals from industrial and other point sources each year.

Most efforts to clean up bacterially exacerbated acidic mine drainage focus on treating the effluent after it's created. However, processes that reduce the concentration of dissolved oxygen and thus limit bacterial growth in mine fluids might prevent much of the acid production in the first place, says McKnight.

UNWELL WELLS In some parts of the world, mineral-munching bacteria may be releasing heavy metals directly into people's drinking water. Arsenic exposure from well water tainted in this way is particularly widespread in Bangladesh, where millions of people rely on well water that courses through arsenic-contain-

Microbial Machinations

Metabolic processes often produce minerals as byproducts

Microbes leave footprints. When they assemble minerals, they create particles with distinctive sizes and shapes. Such patterns can help scientists, including geochemist Katrina J. Edwards of Woods Hole (Mass.) Oceanographic Institution, identify where bacteria are having geochemical and mineralogical effects.

In Edwards' lab, cultures of iron-oxidizing bacteria produced iron oxide particles that appeared to grow at the surface of the cells or within a capsulelike layer around them. Particles measured between 2 nanometers and 2 micrometers across, and most aggregates of particles were less than 5 µm in diameter.

Other scientists have caught bacteria in the act of making minerals, too. In 2000, Jill Banfield, a geochemist at the University of California, Berkeley, and her colleagues reported formation of zinc sulfide particles by bacteria living in a flooded tunnel of an abandoned lead mine near Tennyson, Wis. In the low-oxygen conditions there, thick mats of sulfate-reducing bacteria grew on the carbonate rocks. As the microbes extracted energy from sulfates dissolved in the mine waters, they produced sulfide ions that chemically bonded to dissolved zinc. Individual particles of zinc sulfide were about 3 nm across and aggregated into spherical clumps about 3 µm in diameter.

The concentration of zinc in the bacterial mats was about 1 million times that of dissolved zinc in the surrounding water, says Banfield. Also, the mineral particles contained no lead and only trace amounts of impurities such as iron or arsenic.

Such purity is a sure sign that microbes assembled the mineral particles, says Thomas M. Bawden of the company Global Mineral Resources in San Francisco. Deposits of zinc sulfide ore that weren't created by bacteria often contain as much as 10 percent iron, as well as significant quantities of arsenic and lead.

In the October *Geology*, Bawden and his colleagues publish their analyses of samples from a massive zinc sulfide deposit located in a gold mine in Nevada. Several characteristics of the minerals taken from the deepest portion of that deposit suggest that the sulfide formations there were assembled by microbes.

First, the particles are spherical and measure less than 1 µm in diameter. Also, they're pure zinc sulfide. Finally, the particles contain a much smaller fraction of sulfur-34 isotopes than normal—a characteristic that Bawden says is a "smoking gun" for biological activity. That's because bacteria usually react more readily with compounds that contain lighter isotopes of sulfur. In all, the Nevada deposit contains about 400,000 metric tons of seemingly bacteria-produced sulfides.

The sediments containing the ore are capped by a layer of volcanic ash that was laid down about 15.5 million years ago, so the Nevada sulfide deposits probably were produced between 16 million and 20 million years ago, says Bawden. If the volcanic ash hadn't entombed the sulfide deposits, all evidence of the bacteria-produced minerals might have disappeared. At the time of the ancient eruption that produced the ash, Nevada's climate was arid and the water table was dropping, conditions that would have exposed the upper layers of the deposit to sulfide-destroying oxygen.

There's no reason to think that similar mineral deposits aren't being created by microbes in many places on Earth today, says Bawden. —S.P.

ing rock (*SN: 11/23/02, p. 325*). Chronic exposure to even small amounts of arsenic in drinking water increases a person's risk of cancer and other diseases, and the element disrupts some of the body's hormonal systems (*SN: 3/17/01, p. 164*).

The most prevalent arsenic-bearing compounds in minerals are arsenates. These compounds strongly bind to several common minerals, so they don't typically dissolve into waters flowing through underground reservoirs, says Ronald S. Oremland of the U.S. Geological Survey in Menlo Park, Calif. Problems arise when chemical reactions change the arsenates into arsenites, which don't bind tightly to other minerals and can therefore enter the underground water supply.

Evidence is now mounting that organic matter and the microbes it feeds may be playing a role in the formation of arsenites in aquifers. Scientists have isolated and identified 16 different microbes that can feed on arsenic, says Oremland. They're found in many different environments including hot springs, gold mines, highly alkaline lakes, and the gastrointestinal tracts of people and other animals. Some extract the energy from oxidation reactions, in which the arsenic atoms end up losing electrons, and others tap into reduction reactions, in which the arsenic atoms gain electrons. "These microbes make a living off what's normally considered to be a potent toxin," he notes.

The organisms, which come from at least nine different groups of microbes, can engage arsenic in a variety of chemical reactions. Oremland and John F. Stolz, a microbiologist at Duquesne University in Pittsburgh, discussed what they call "the ecology of arsenic" in the May 9 *Science*.

The arsenic-metabolizing organisms don't dine exclusively on compounds bearing that one element, says Oremland. Several can also gain energy from reactions involving sulfate compounds. One species, *Sulfurospirillum barnesii*, can metabolize no fewer than nine types of atoms or ions other than arsenates, including sulfur, nitrates, nitrites, and selenates.

Part of the solution to this arsenic problem may be to nurture soil microbes that would lock down arsenic compounds instead of releasing them. In Bangladesh, geologists experimented with this approach by injecting into a tainted aquifer large amounts of nitrates that would theoretically nourish some desirable bacteria. The test produced a rapid and dramatic decrease in the concentration of arsenic in the water from nearby wells. The result suggests the presence of a thriving community of anaerobic microbes that used the nitrates as fuel and converted the poisonous arsenites in the water to less-soluble arsenates.

Also supporting that scenario, says Oremland, other scientists have cultured arsenic-metabolizing microbes from sediments drilled from tainted aquifers in Bangladesh.

SOGGY CRUST Just as arsenic in aquifers and sulfide minerals in mines can nurture pollution-enhancing bacteria, lava-derived minerals in the seafloor may be nourishing mineral-metabolizing microbes. Some scientists suspect that the deep-sea phenomenon may be vast enough to transform the chemical composition of the ocean floor. Because more than 70 percent of Earth's surface is ocean bottom, these mineral beds could actually amount to one of the planet's largest ecosystems.

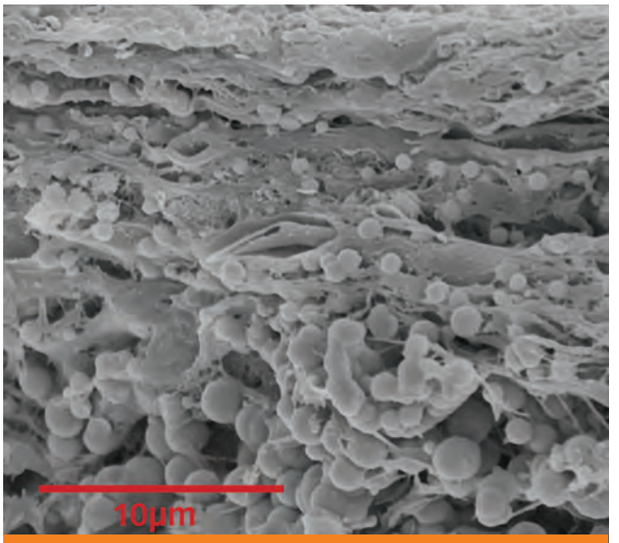
Chemical analyses of basalt drilled from the ocean floor show that in new rock being extruded from midocean ridges, only about 15 percent of the iron atoms are ions that have a triple dose of positive charge. Core samples of older seafloor rocks indicate that after 10 million to 20 million years of exposure to seawater, that form of ion—the same type generated by bacteria in acidic mine runoff—makes up around 45 percent of the iron atoms. Over the same period, approximately 70 percent of the sulfides originally present in the basalt have dissolved.

While some scientists have held that microbes play a significant role in these lethargic mineral transformations, no one could iden-

tify the metabolic mechanisms that any such organisms might use, says Katrina J. Edwards, a geochemist at Woods Hole (Mass.) Oceanographic Institution. A series of experiments by Edwards and her colleagues suggests that iron-oxidizing bacteria may indeed play a part in the so-called weathering of ocean-floor minerals.

First, the researchers used deep-diving robots to obtain samples of sulfide minerals from a seafloor hydrothermal vent off the coast of Washington State. To create surfaces that would reveal seafloor-bacterial effects, the scientists polished and sterilized the minerals before returning them in July 2000 to the ocean floor near the vent site. Other sterilized samples, including pure sulfur and other sulfur-bearing minerals collected around the world, were placed in the same test location. The frigid waters surrounding the samples, about 2,400 meters below the ocean's surface, held few dissolved metals and no detectable hydrogen sulfide.

When the researchers retrieved the samples less than 2 months later, each of the iron-bearing sulfide samples had a pitted, microbe-infested surface that was coated with iron oxide particles. The thickest accumulation, up to 1 millimeter in spots, appeared on the sulfide fragment originally taken from the seafloor vent, says Edwards. She and her colleagues reported these findings in the Aug. 1 *Geochimica et Cosmochimica Acta*.



FILM STARS — Bacteria in the low-oxygen fluids of an abandoned mine created these zinc sulfide spheres. Like most other mineral particles assembled by microbes, these have a consistent size, shape, and chemical composition.

BANFIELD AND S.A. WELCH

In follow-up laboratory experiments, Edwards and other scientists examined those weathered vent minerals and cultured microbes that had colonized the sterilized samples' surfaces. Analyses of the organisms' DNA distinguished nine species of bacteria, all of which starved in the lab if they weren't provided with iron-bearing minerals or solutions containing dissolved iron. Even sugar solutions, on which bacteria normally thrive, didn't supply the proper nutrients, says Edwards. The microbes grew best in water temperatures ranging from 3°C to 10°C and on the surface of sulfide rocks that the researchers had retrieved from the hydrothermal vent.

The evidence that microbes are transforming vast volumes of ocean crust remains circumstantial, says Edwards. However, she and other scientists now have an idea of where to look for direct evidence.

If iron-oxidizing microbes do thrive within the 500 m of seafloor basalt through which ocean water slowly circulates, Edwards notes, "it's a huge environment." That volume of rock far exceeds that of the more biologically productive sunlit zone of the ocean, which extends down from the sea's surface only about 100m. ■

OF NOTE

ENVIRONMENT

Bioengineered crops have mixed eco effects

An unusually large research project in Great Britain has revealed that growing beets and canola that had been genetically modified to resist herbicides lowers the abundance of other plant species and certain insect groups that typically grow along with these crops. On the other hand, cornfields harboring genetically modified (GM) corn that resists herbicides have more weeds and insects than regular cornfields did, according to a series of reports in the Nov. 29 *Philosophical Transactions of the Royal Society of London B*.

The mixed results are from a set of experiments covering about 60 farm fields. The 3-year trials, funded by the British government, grew out of concerns that previous studies of the ecological effects of GM crops hadn't been big enough, says test coordinator Les Firbank of the Center for Hydrology and Ecology in Merlewood, England. Half of each test field was planted with the conventional crop and half with a GM version.

Areas growing GM beets and spring-planted canola ended up with weed-seed densities about 20 percent lower than those of areas with conventional crops. The GM portions of the beet fields also had fewer butterflies, but more springtails, which are small arthropods that feed on dead plants.

The GM cornfields, in contrast, hosted more insects and a more abundant population of weeds than conventional cornfields did. These differences are due to the somewhat weaker herbicide used in the GM cornfields, compared with the herbicide used on the conventional cornfields, the researchers suggest.

"There are many who are either strong supporters or firm opponents of GM crops, and each camp may be tempted to see support for their views in the findings," notes Semir Zeki, editor of *Philosophical Transactions*, in a commentary accompanying the reports. —S.M.

ANTHROPOLOGY

Europe's Iceman was a valley guy

Hikers in the Alps took a big step back in time in 1991, when they came upon a man's frozen, mummified body. Scientists have now tracked the geographic origins of the 5,200-year-old Iceman to an area encompassing a few valleys about 37 miles southeast of where his body turned up.

The findings show that people inhabited central Europe's Alpine valleys at the time of the Iceman's demise, say Wolfgang Müller of Australian National University in Canberra and his colleagues. During that period, much of Europe witnessed the

OF NOTE

spread of farming villages and the growth of a copper industry.

Müller's team compared the chemical composition of the Iceman's teeth, bones, and intestines that of soils and water throughout the region. Chemical signatures of particular locales are deposited in people's bodies by food and drink. Analyses mainly focused on specific forms of strontium, lead, oxygen, and carbon.

The Iceman spent his entire life based in the area south of the Italy-Austria border, where his body was discovered, the researchers conclude in the Oct. 31 *Science*. He may have lived in a group that raised livestock and migrated seasonally from low-altitude settlements to summer grazing areas in the mountains, they propose. —B.B.

BIOLOGY

Chronicling a war of beetle vs. leaf

A rare meshing of family trees may reveal an ancient arms race between plants that deploy poisons and the beetles that deploy metabolic or behavioral countermeasures so they can eat the leaves anyway.

It's been tricky to find evidence that such ploys coevolved in any species of plants and their pests, says Judith X. Becerra of the University of Arizona in Tucson. That's because it's necessary to determine that both sides in a presumed arms race rolled out a weapon and countermeasure at the same time in evolutionary history.

BOMB SQUAD A beetle larva takes about an hour to nibble and defuse a long leaf tube that holds pressurized toxins.

In an upcoming *Proceedings of the National Academy of Sciences*, Becerra says she's found such evidence. She analyzed DNA to figure out evolutionary lineages for *Bursera* plants and the *Blepharida* beetles whose larvae feast on the plants' leaves. Some Burseras defend themselves with chemical cocktails or toxins that squirt out of leaves under attack.

In the family trees of beetles and plants that Becerra constructed, there are species from both the New and Old Worlds. That means that certain lineages diverged at least 95 million years ago, when Africa and South America split. With that timing, and the age of a *Bursera* fossil, Becerra used models of evolutionary change to date critical branchings within the *Bursera* and *Blepharida* lineages.

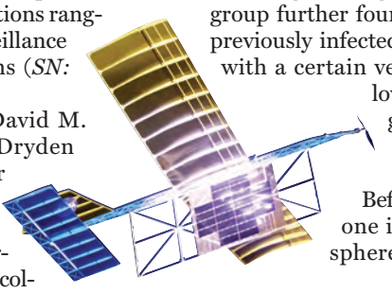
Dates for the advent of beetles and plants with certain antagonistic traits matched. For example, Becerra found, squirting *Bursera* lineages arose simultaneously with beetles whose larvae nip the high-pressure leaf channels and defuse them. —S.M.

TECHNOLOGY

Laser beam powers flying machine

A NASA-led engineering team announced on Oct. 9 that it has flown a lightweight, remote-controlled aircraft that receives power in flight from a ground-based laser. Theoretically, such a plane would never have to land for refueling. Such drones may someday serve as cheap alternatives to satellites for applications ranging from military surveillance to telecommunications (*SN: 8/23/03, p. 125*).

The team, led by David M. Bushman of NASA Dryden Flight Research Center in Edwards, Calif., built the drone from balsa wood, carbon-fiber-strengthened tubes, and colorful Mylar skin. Beneath the 1.5-meter wingspan, hangs a solar panel that's wired to the vehicle's electric motor.



LIGHT FLIGHT A laser beam powers this drone—seen from below—by striking the cross-shaped, solar-cell array.

Using an infrared laser such as those that cut steel in auto manufacturing, the researchers beamed enough energy into the plane's photovoltaic cells to drive a propeller and keep the vehicle airborne.

Last year, scientists in Japan used a laser's power to launch a paper plane (*SN: 7/20/02, p. 46*). Nevertheless, the recent NASA demonstration is the "first unfueled, sustainable flight" driven by laser, Bushman says.

Future aircraft could carry batteries and rely on the laser only for periodic recharging during long missions, Bushman says. This laser-driving technology should work at distances up to 30 kilometers, he adds. —P.W.

MICROBIOLOGY

The good side of a viral infection?

A gene linked to asthma and allergies also has a role in hepatitis A viral infections, according to a new study. This unexpected discovery has investigators speculating that a past infection with the hepatitis A virus may protect some people from asthma and allergies.

There's been a dramatic rise in the number of people with these conditions over the past few decades, and some scientists blame it on modern society's cleanliness. In a theory labeled the hygiene hypothesis, they argue that our immune systems are no longer exposed to enough microbes early in life. This sets the stage for the body's defenses to overreact to normally harmless stimuli, causing allergies and asthma (*SN: 8/14/99, p. 108*).

Dale T. Umetsu of Stanford University and his colleagues now propose that mild hepatitis A infections may ward off such immune dysfunction. In the Oct. 9 *Nature*, they report that a gene called *TIM-1* governs the development of allergies and asthma in mice. Other research had shown that the hepatitis A virus enters cells by attaching to this gene's protein. Umetsu's group further found that among people previously infected with the virus, those with a certain version of *TIM-1* had a lower incidence of allergies and asthma than did people without this variant.

Before 1970, almost everyone in the Western Hemisphere typically became infected with hepatitis A. Today, less than one-third of people in those countries contract the virus. Umetsu and his colleagues plan to investigate whether hepatitis A vaccinations, which aren't routinely given in the United States, have antiasthma and antiallergy effects. —J.T.

ASTRONOMY

Sound of the fury

The current barrage of solar storms pummeling Earth hasn't harmed power grids on our planet or damaged satellites, but it's generated a lot of buzz. On Oct. 28, the Cassini spacecraft recorded the radio emissions of one of these flares. The burst is one of the most powerful in decades, and its signal, as recorded by Cassini, resembles the clicking of a telegraph machine followed by the rush of a jet engine, according to Donald A. Gurnett of the University of Iowa in Iowa City.

Traveling at the speed of light, the flare's radio waves took just 69 minutes to journey from the sun to the Saturn-bound spacecraft, which now lies about 8.7 times as far from Earth as our planet does from the sun. The radio signals, which are produced by electrons moving out from the solar flare, can be heard online at *http://www-pw.physics.uiowa.edu/space-audio/*. —R.C.

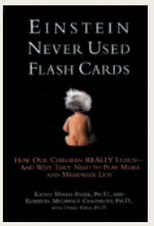
L. VENABLE/PNAS; T. TSCHIDA

Books

A selection of new and notable books of scientific interest

EINSTEIN NEVER USED FLASH CARDS: How Our Children Really Learn and Why They Need to Play More and Memorize Less

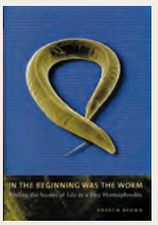
KATHY HIRSH-PASEK AND ROBERTA MICHNICK GOLINKOFF, WITH DIANE EYER



Numerous products target parents trying to jumpstart their infants' intellectual development. Hirsh-Pasek and Golinkoff are two developmental psychologists who argue that the sounds of Mozart and the effort of flash card drills are futile in developing creativity and critical thinking, the benchmarks of intelligence. They also deride the notion that faster, earlier learning is better. They encourage parents to allow children to learn problem solving and creativity through play rather than through scheduled activities, organized classes, and other structured events. The authors cite a wealth of research indicating that children who learn through play also develop social and emotional skills that serve them throughout life. The book provides data that contradict the belief that memorization fosters long-term retention or higher IQs. The authors bridge the gap between scientific research and parenting skills to explain how children learn and what parents can do to encourage them. The book describes how everyday games and other activities can foster learning. For instance, there's math in sharing french fries or cutting a cake. Shapes are everywhere, and therefore so is geometry. The authors assert that this type of awareness will help parents cultivate smart, well-rounded and less anxious children. ***Rodale, 2003, 302 p., hardcover, $22.95.***

IN THE BEGINNING WAS THE WORM: Finding the Secrets of Life in a Tiny Hermaphrodite

ANDREW BROWN



The nematode worm has only 959 cells, yet it is one of the most intensely studied and scientifically documented animals on Earth. In *Caenorhabditis elegans*, scientists discovered the phenomenon of programmed cell death, which explains how biological development occurs in animals. The worm was the first multicellular organism to have its genetic code mapped, and this finding secured a Nobel prize for the trio of John Sulston, Bob Horvitz, and Sydney Brenner. Brown blends the story of this extended dissection of the worm with the stories of these three men devoted to understanding the creature. He illustrates how the story of the worm stretches across the history of molecular biology and the understanding of biological development in animals, from worms to people. ***Columbia U Pr, 2003, 244 p., hardcover, $27.95.***

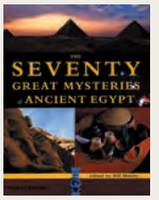
MAGNIFICENT MARS

KEN CROSWELL

This volume includes the stunning images to be expected in an oversize, coffee-table book. In this case, they display the Red Planet's striking topography. More surprising is the depth of the captions that weave a comprehensive story of Mars. Four sections explore Martian geology from the planet's iron core to its rocky mantle and its red surface and into its thin, cold atmosphere. Brilliant color photographs gathered by the Hubble Space Telescope, Viking, and Pathfinder probes show volcanoes taller than Mt. Everest and gorgeous wind-sculpted dunes. Many maps detail various elevations and topographical elements from every corner of the planet. ***Free Pr, 2003, 208 p., color photos/plates, hardcover, $60.00.***

THE SEVENTY GREAT MYSTERIES OF ANCIENT EGYPT

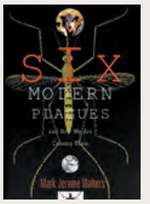
BILL MANLEY, ED.



For 200 years, modern people have studied the culture of Egyptians who lived up to 5,000 years ago. This beautifully illustrated guide considers past and continuing mysteries concerning pyramids, tombs, pharaohs, queens, as well as how people lived and what they believed. Among the mysteries addressed: Who were the first kings of Egypt? Did pharaohs really marry their sisters? Why did Egyptians mummify the dead? Contributors to this volume include prestigious Egyptologists and archaeologists. They draw from their expertise in many facets of ancient Egyptian culture and artifacts. ***Thames Hudson, 2003, 304 p., color photos/illus., hardcover, $40.00.***

SIX MODERN PLAGUES: And How We Are Causing Them

MARK JEROME WALTERS



Epidemics such as severe acute respiratory syndrome and mad cow disease make headlines around the world and stymie epidemiologists and physicians. In considering these diseases, as well as AIDS, hantavirus, Lyme disease, and a new strain of salmonella called DT104, Walters explores how ecological changes brought on by people have facilitated the spread of each of these ailments. Climate change, deforestation, and global travel and commerce have all contributed to the spread of diseases. For instance, Walters asserts that global warming increases the number and severity of droughts and floods, which in turn encourage mosquitoes and ticks to move and spread new diseases such as West Nile fever. Forest degradation has reduced populations of eagles, coyotes, and foxes, all of which are natural predators of the deer and mice that host ticks carrying Lyme disease. Walters also points a finger at our overdependence on antibiotics that are engendering resistant strains of disease bacteria. This book is a call to cure environmental ills that threaten human health. ***Island Pr, 2003, 206 p., hardcover, $22.00.***

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LETTERS

What's fair?

I suggest that we view the results described in "Unfair Trade: Monkeys demand equitable exchanges" (*SN: 9/20/03, p. 181*) as indicating that humans frequently act like monkeys, not vice versa. Further, what is being measured as fairness may better be seen as the basis for envy and greed. It is not surprising that monkeys have the ability to display these tendencies, but they are not the epitome of what makes us human.
PHIL VON VOIGTLANDER, NORTHPORT, MICH.

I don't see how the experiment demonstrates a sense of fairness in monkeys. The monkey rejecting the cucumbers could have been thinking, in effect, not "I should get a grape because she did," but "I should get a grape because they're available and I prefer them." If monkeys shown grapes and cucumbers but given only grapes reacted less vigorously when they didn't see another monkey getting grapes, that would be more convincing.
HENRY JONES, BATON ROUGE, LA.

Researcher Sarah Brosnan says that monkeys tested without partners displayed greed for grapes but grew more likely to exchange their tokens for cucumbers by the end of their sessions. In contrast, in the test with an over-rewarded partner, the monkeys grew less likely to make that exchange. Brosnan interprets this as signaling that a monkey becomes more upset about an inferior reward when its partner receives the better one. —S. MILIUS

Short-term limitation

"Faulty Memory: Long-term immunity isn't always beneficial" (*SN: 9/27/03, p. 196*) makes a common error. Whereas chicken pox is caused by one virus, a "cold" is a set of symptoms that can be caused by more than 200 distinct viruses. A better example for short-term immunity might have been pertussis or tetanus.
JENNIFER L. BANKERS-FULBRIGHT, MAYO CLINIC, ROCHESTER, MINN.

Corrections *The last sentence of "Healed scars tag* T. rex *as a predator" (*SN: 11/1/03, p. 286*) shouldn't have said that* Tyrannosaurus rex *was the only meat eater in the ecosystem described.* T. rex *was the only meat eater that could have left the bite marks noted on the fossilized* Triceratops.

*"The Nature of Things" (*SN: 10/25/03, p. 264*), which implied that a noble gas typically has six electrons in its outer shell, should have said it has six electrons in its "outer subshell."*