SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

JULY 5, 2003 PAGES 1-16 VOL. 164, NO. 1

harnessing microbes
pentaquarks detected
dating a van gogh
deadly dengue's spread

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ecosystem shuffle

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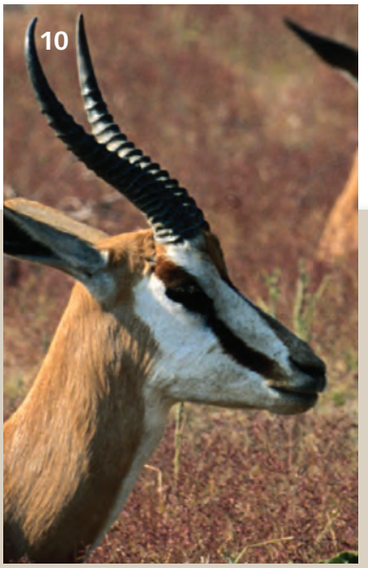

Features

This Week

THIS WEEK ONLINE
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Beyond soybeans Soy greens themselves offer anticholesterol benefits. See Janet Raloff's Food for Thought.

Of Note

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Cover New evidence indicates that communities of different mammal species repeatedly formed and disbanded in Stone Age Africa in response to environmental changes. Our ancient ancestors exhibited a special flair for adapting to one ecosystem after another, a trait that may shed light on the nature of human evolution. Page 10

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

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

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

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

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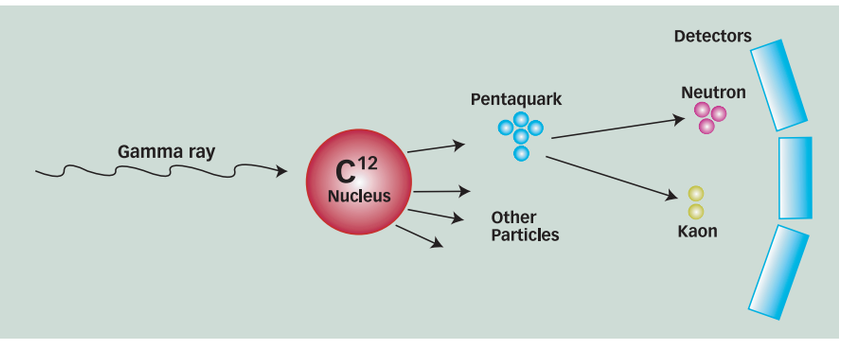


HIGH FIVE Gamma rays hitting neutrons in carbon nuclei appear to have created exotic pentaquarks, which quickly shatter into neutrons and kaons.

Wild Bunch

First five-quark particle turns up

Physicists on three international teams have recently spotted what's most likely a long-sought subatomic particle known as a pentaquark. It contains five components—four quarks and one antiquark—which are among the most fundamental bits of matter yet known. No subatomic particle detected previously contains more than three of those building blocks.

"After 30 years of failing to find any convincing evidence for something that ought to be there, this recent news is certainly met with excitement," says nuclear physicist Andrew M. Sandorfi of Brookhaven National Laboratory in Upton, N.Y.

Although unusually complex, the newfound particle fits within the prevailing theoretical framework of particle physics, known as the standard model. The newly detected bit may be just the first member of a family of pentaquark particles. The find also underscores the possibility of discovering particles with four or six quarks.

To fathom how five quark components can coexist within one particle, theorists expect to reconsider their models of the interactions among quarks and gluons, the particles that bind quarks together. For instance, it's possible that the fivefold structure is not a spherical lump but rather a moleculelike arrangement in which a so-called kaon, which is made of a quark and an antiquark, orbits a neutron, which is made of three quarks.

"Exactly what form of the theory makes it work now becomes very interesting," says theorist Peter D. Barnes of Los Alamos (N.M.) National Laboratory.

If the pentaquark can exist in labs today, it probably also was present in the very first, fiery moments of the universe, says Takashi Nakano of Osaka University, leader of the team that found the pentaquark at Japan's SPring-8 synchrotron in Hyogo.

The experiments that appear to have bagged the elusive pentaquark weren't designed to look for it. "This is an example of serendipity," says Kenneth H. Hicks of Ohio University in Athens. He's a member of both the SPring-8 team and a group at the Thomas Jefferson National Accelerator Facility in Newport News, Va., that has confirmed the SPring-8 finding.

In 1997, Russian theorist Dmitri Diakonov and his colleagues predicted the existence of a pentaquark with a mass about 50 percent heavier than that of a hydrogen atom. The theorists then urged the SPring-8 team to reexamine data from an experiment in 2001 that might have inadvertently made the particle when it had gamma rays striking a piece of plastic.

When Nakano, Hicks, and their coworkers combed that data, they in fact found signs for about 20 pentaquarks. The team is slated to present its evidence in an upcoming *Physical Review Letters*.

Inspired by the SPring-8 findings, researchers at the Jefferson lab and the Institute of Theoretical and Experimental Physics in Moscow double-checked old data from different sorts of particle collisions and netted their own pentaquark candidates.

Besides its unprecedented quark count, a pentaquark is unusual in that it includes an exotic antiquark, the so-called strange antiquark. The composite particle also contains two up quarks and two down quarks—the same ones found in ordinary matter.

Nakano says the SPring-8 team is now analyzing data from new collisions that were generated explicitly to make pentaquarks. The aim is to nail down the identity and properties of this new entity. Meanwhile, the Jefferson lab has approved an experiment intended to boost its pentaquark production 20-fold, Hicks says. —P. WEISS

A Matter of Taste

Mutated fruit flies bypass the salt

People's fondness for salty snacks reflects a fundamental biological imperative. "All cells, in order to survive, need salt," says Lei Liu of the Howard Hughes Medical Institute at the University of Iowa in Iowa City. To keep themselves supplied with this critical nutrient, animals have developed ways for sensing sodium chloride and other salts.

By creating mutant fruit flies with an impaired capacity to taste salt, Liu and his colleagues have now identified several genes that contribute to this crucial sensory system in insects. Liu suggests that the fly research could provide insights into how people taste salt. It may even lead to an effective salt substitute to fight high blood pressure and other conditions exacerbated by today's salt-rich diets, he speculates.

When it comes to salt, the fruit fly *Drosophila melanogaster* acts much like a person. Food or water sources with too much salt repel the flies, but those with low concentrations attract them. The flies can even distinguish between sodium chloride, which is typical table salt, and potassium chloride, which tastes even saltier to people.

To investigate how flies sense salt, Liu and his colleagues drew upon past work indicating that certain cellular pores, known as epithelial sodium channels, act as salt receptors in mammals. These pores, through which sodium ions flow into cells, are found on rodents' taste buds, for example.

Yet not all biologists are convinced that this sodium channel is a widespread salt-sensing receptor. For one thing, even though the sodium-channel-blocking drug amiloride impairs salt taste in rodents and some other animals, this effect isn't consistent among all species or even among different strains of rodents. Moreover, no one has shown clearly that the human tongue has this particular sodium channel, notes Sue C. Kinnamon of Colorado State University in Fort Collins.

Scientists sometimes investigate the role of an ion channel by inactivating the genes encoding the channel's protein constituents. In mice, however, this particular sodium channel appears to do more than mediate salt taste. Mice lacking the channel die as embryos or just after birth.

Seeking to do a similar gene-knockout experiment in fruit flies, Liu and his colleagues identified insect genes that closely resemble the mammalian ones that

E. ROELL

encode the subunits of the epithelial sodium channel. Some of these fly genes are active in taste-sensing tissues of larvae and in the taste-sensing bristles of the adult insect, Liu's group reports in the July 3 *Neuron*.

The investigators inactivated several of the insect genes and tested the salt perception of the resulting mutant insects. Both as larvae and adults, the flies are equally attracted to pure water and water containing low concentrations of salt, Liu and his colleagues found. Unlike typical flies, the mutant insects can't distinguish between sodium chloride and potassium chloride.

"We see a very clear salt-taste defect," says Liu.

This is the first time that gene-knockout techniques have been used to establish a component of the salt-sensing pathway in any species, says Kinnamon. Even so, she cautions, the epithelial sodium channel may not be relevant to human salt perception.

"The salt receptor is going to be different in different species," Kinnamon says. "It might be related [to this channel] in humans, but it might not be." —J. TRAVIS

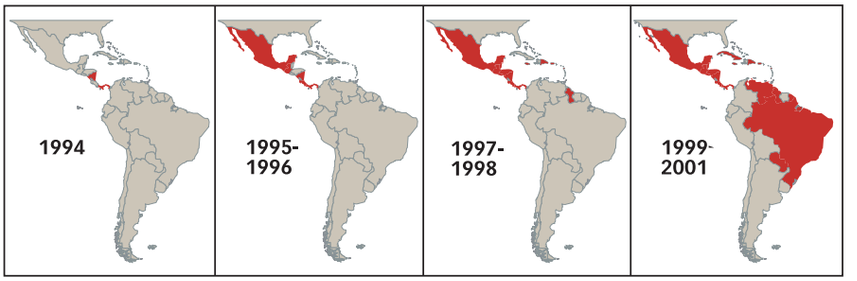
Lethal Emergence

Tracing the rise of dengue fever in the Americas

A spate of deadly outbreaks of dengue fever in Latin America in recent years stems from the 1994 arrival of a potent version of the disease that is endemic to India, genetic analyses of viruses reveal. That viral incursion followed the 1981 arrival of another lethal dengue strain in Cuba, apparently from Africa. These two variants have together changed dengue fever in the New World from at most a painful ailment into a potential killer.

The mosquito-borne dengue virus comes in four distinct types, designated dengue 1, 2, 3, and 4. Fatal cases of dengue anywhere in the world typically hit people who've been previously infected by a dengue type different from the one that causes the final illness. This pattern, an oddity among viral diseases, has slowed the development of a vaccine. In a separate study, Thai and British researchers shed light on this failure of the immune system.

Usually, each dengue type causes mild disease but sometimes brings on high fever, severe headaches, vomiting, listlessness, and joint pain. Even so, dengue fever is seldom fatal.



DENGUE DIFFUSION Since its introduction in 1994, the potent dengue 3 subtype III virus has spread steadily throughout Latin America. Mosquitoes transmit dengue fever.

However, in the form called dengue hemorrhagic fever, an infection can cause shock, internal bleeding, and death. Ecologist William B. Messer of the University of North Carolina at Chapel Hill and his colleagues report in the July *Emerging Infectious Diseases* that recent outbreaks of this hemorrhagic fever in Latin America, where lethal dengue had been rare, are attributable to the 1994 influx of the India-derived virus, dubbed dengue 3 subtype III.

By poring over the genetic makeup of virus particles obtained worldwide from patients with dengue hemorrhagic fever, the researchers found that dengue 3 subtype III exactly matches viruses gleaned from outbreaks in Mozambique in 1985 and Sri Lanka in 1989. Those viruses have genetic roots in an Indian dengue virus, which probably first arrived in Panama or Nicaragua before spreading in the Americas, Messer says.

Earlier in that decade, a variant of dengue 2 had arrived in Cuba and spread from there. "It was a double whammy," Messer says. "Now, there are two [severe forms of the virus] floating around, causing hemorrhagic dengue."

By using genetics to track dengue, scientists may learn the virus' patterns of movement and, ideally, how to predict outbreaks, Messer says. The World Health Organization estimates there are 20 million cases of dengue infection worldwide every year.

Meanwhile, other scientists who are analyzing blood samples from Thai children with severe dengue are investigating how this hemorrhagic fever incapacitates people.

Each of the four types of dengue virus induces specific immunity, so a person can get sick from dengue four times in a lifetime. However, a second infection is often worse than the first. Earlier research on severe cases showed that antibodies made during a second infection don't neutralize the virus.

Making matters worse, the immune system's other defense strategy also can fail. T cells that mobilize during a second dengue infection often don't target the new virus, instead directing their immune attack toward the viral type encountered previously, says Gavin Screaton, an immunologist at John Radcliffe Hospital in Oxford, England. That leaves an individual laden with the second virus, Screaton and his colleagues report in the July *Nature Medicine*.

Dengue infections marked by high viral loads correlate with excessive bleeding in the patient, notes Francis A. Ennis of the University of Massachusetts Medical School in Worcester. Aggressive T cell responses may be part of the problem, some studies suggest. "They make [proteins] that cause capillaries to leak," Ennis says.

A critical step toward making a dengue vaccine is to understand the human response to the virus, Screaton says. Any vaccine for dengue must address all four types of the virus at once or risk leaving individuals vulnerable. —N. SEPPA

Moonlighting

Beetles navigate by lunar polarity

By watching dung beetles roll their balls of dung at night, an international team of researchers has turned up evidence that the insect aligns its path by detecting the polarization of moonlight.

When researchers set up polarizing filters to shift the moonbeams, the African beetle *Scarabaeus zambesianus* changed direction to compensate, says Marie Dacke of the University of Lund in Sweden. "This is the first proof that any animal can use polarized moonlight for orientation," she says.

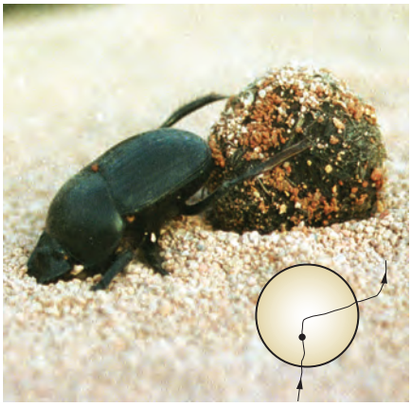
Some insects and other arthropods detect polarity patterns in sunlight and rely on those patterns for finding their way. Researchers are still debating whether some migrating birds and fish orient themselves in this way, too, says Eric J. Warrant, also of Lund and a coauthor of the report in the July 3 *Nature*.

ADAPTED FROM MESSER/EID

Dung beetles offer a great opportunity to study orientation, Warrant says, because they roll dung in straight lines. Dung, especially the half-meter-wide deposits from elephants, attracts dozens of beetles. In the species that Dacke and Warrant monitored, beetles roll small balls, 4 centimeters or so across, for their own nourishment, but males in search of mates roll 10-cm specials. A female flies in to cling to the ball for a roller-coaster ride. After the pair mates, the ball serves as baby food.

With food and family at stake, one male often tries to wrestle away another's dung ball. "The dung heap is a very competitive place," says Warrant. The best exit strategy, he notes, is a straight line out of the fray, and that's where the moonlight comes in.

The Swedish researchers, collaborating with colleagues in South Africa, found that beetles active during the day depend on sunlight polarization patterns. However, Dacke noticed that on moonlit nights, one twilight-active species worked particularly late.



DACKE; UNITED SOYBEAN BOARD

ROLL ON A South African dung beetle positioned to roll away its treasure. Inset: Diagram shows a beetle's path when scientists cover it in midcourse (at black spot) with a filter that shifts moonlight's polarization. The beetle compensates for the shift, but later when outside of the filter's influence, it returns to its original path.

It's only been 2 years since researchers first documented polarization in moonlight, so biologists are just beginning to explore its effects on animals. On moonlit nights, Dacke set out a pile of pig dung, and within minutes dung beetles came flying. The beetle researchers positioned a sheet of polarizing filter over a beetle, rotating the polarization of moonlight by 90°. Tracking 22 beetles, Dacke found that the beetles under the filter deviated from their previous course by turns of nearly 90°.

Dung-beetle specialist François Génier of the Canadian Museum of Nature in Ottawa says that because so many insects use polarized daylight, moonlight navigation "is the next logical step." He speculates that this species has taken to moonlight because at night "competition among large rollers is less fierce." —S. MILIUS

Till IL-6 Do Us Part

Elderly caregivers show harmful immune effect

Seniors whose lives revolve around caring for their incapacitated spouses often feel older than their years. It may be more than a feeling, according to a new study.

Over a 6-year period, marital Samaritans caring for a spouse with Alzheimer's disease or another brain disorder exhibited a dramatic average increase in blood concentrations of a protein involved in immune regulation, concludes a team led by Janice Kiecolt-Glaser and Ronald Glaser, both of Ohio State University in Columbus. During that same time, seniors with healthy spouses displayed a much smaller increase in blood concentrations of the substance, interleukin-6 (IL-6).

As people age, they typically produce IL-6 in larger quantities. Earlier investigations linked particularly high concentrations of IL-6 to heart disease, osteoporosis, arthritis, type 2 diabetes, certain cancers, periodontal disease, and intensified reactions to viral infections (*SN: 3/27/99, p. 199*).

After an impaired spouse died, IL-6 concentrations in the blood of the former caregiver continued to rise at an elevated rate for as many as 3 years, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*.

"In older caregivers, it may be that their immune system activity gets reset to a higher [and unhealthy] level and stays there for several years after a spouse's death," says Glaser.

To discern the IL-6 trends, the researchers obtained at least two blood samples annually from 119 caregivers and from 106 people with healthy spouses or who were widowed, separated, divorced, or never married. Participants, a majority of whom were women, ranged in age from 55 to 89. Shortly before the study began, 28 of the caregivers' spouses had died. Another 50 of them died in the ensuing 6 years.

The researchers found that caregivers' average IL-6 concentrations in blood increased at four times the rate observed in noncaregivers. Depression, loneliness, and feelings of uncontrollable stress reported by the study participants couldn't account for the changes, the researchers note.

"Caregivers for impaired spouses experience a kind of distress that isn't easily measured," Kiecolt-Glaser says.

The investigators now plan to monitor the caregivers' health over the next 4 to 5 years. In a 1990 study directed by psychologist Richard Schulz of the University of Pittsburgh, elderly people tending spouses with a spectrum of ills died at a markedly greater rate than other seniors did.

For now, the new data raise hopes that future treatments designed to reduce excess amounts of IL-6 could prove beneficial for caregiving seniors, says Glaser.

"The discovery of age-related increases in IL-6 isn't just about the effect of caregiving," comments epidemiologist Burton H. Singer of Princeton University. "It's about the effect of experiencing chronic adversity."

If that's true, it raises the stakes for finding ways to relieve the most unrelenting forms of adversity. For instance, Singer theorizes, if a woman who cares for a husband with Alzheimer's disease also supports two children on a minimum wage, she may be at particularly high risk for developing a life-threatening illness. —B. BOWER

Suspended Drugs

Antibiotics fed to animals drift in air

Drugs added to animal feed can latch onto dust particles that become airborne and float through farm buildings, according to German scientists investigating health risks. Such antibiotics could be toxic if livestock workers inhale them and also could accelerate the evolution of drug-resistant bacteria.

Past studies have found farm-derived antibiotics in waterways (*SN: 3/23/02,*

FEEDBACK Airborne dust in pigpens might expose people to antibiotics from feed.

p. 181) and food products. The air represents a third route of unintended exposure to antibiotics, says microbiologist James Zahn of Iowa State University in Ames.

Much of the dust in farm buildings that house animals is organic matter from feed, animal skin and excrement, bacteria, and fungi, says Jörg Hartung of the Hannover School of Veterinary Medicine in Germany. Previous research had shown that inhalation of the dust can cause respiratory problems, allergies, and other health effects in farmworkers.

To see whether farm dust contains antibiotics, Hartung and his colleagues analyzed particles that had settled out of the air in a pig-confinement building on a German farm. The researchers looked for chemical evidence of six antibiotics that had been added to feed at low doses to accelerate the animals' growth.

Of samples gathered annually between 1981 and 2000, 18 of 20 contained at least one of the six compounds, says Hannover chemist Gerd Hamscher. Tylosin, the antibiotic found most often, showed up in 16 samples, the researchers report in an upcoming *Environmental Health Perspectives*.

Tylosin is not prescribed to people because it tends to induce allergies, but it's chemically related to the important medical antibiotic erythromycin. Bacteria that develop resistance to either of those drugs typically have resistance to both. Chloramphenicol, another antibiotic found in the farm dust, can damage DNA in people.

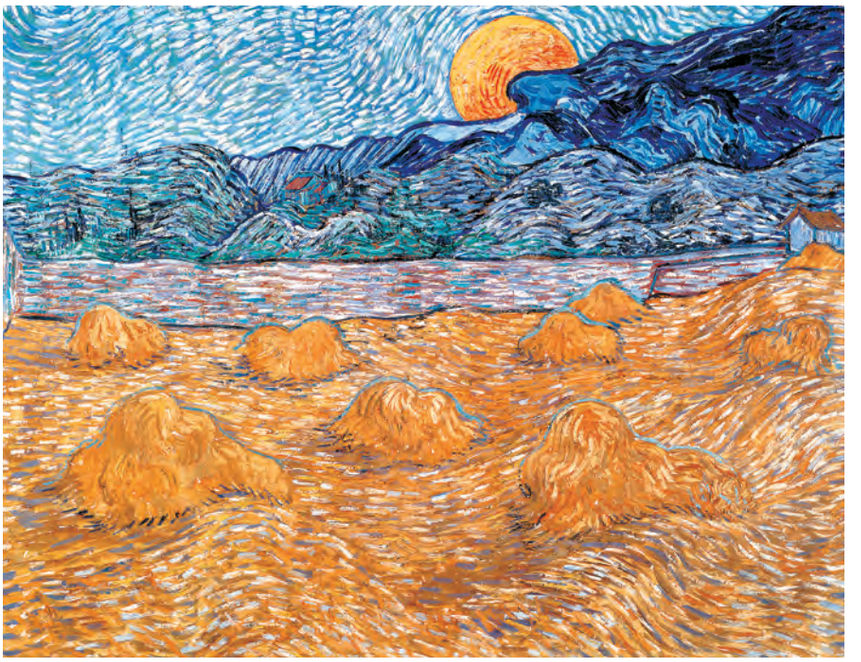
The new study "makes clear the potential for [antibiotic] exposure via inhalation," says pulmonary toxicologist Peter Thorne of the University of Iowa in Iowa City. Besides posing dangers specifically to farmworkers, airborne dust may spread antibiotic resistance, creating a more general public health concern, he says.

Exposing bacteria in the human body to small, steady doses of antibiotics is an ideal way to promote drug resistance, Thorne and the German researchers agree. However, Thorne cautions, researchers still need to determine how much exposure people are likely to get through this route.

The study is the first full report to establish that antibiotics can be spread through the air, says Zahn. At scientific meetings, he has presented data, gathered in pig confinement facilities in the U.S. heartland, indicating that tylosin—and even tylosin-resistant bacteria—can spread through the air. The drug also turns up in air expelled from these facilities by exhaust fans, he adds.

European countries are phasing out the use of antibiotics for promoting growth in animals. Recently, the McDonald's restaurant chain announced plans to reduce its use of meat produced with growth-promoting drugs (*http://www.sciencenews.org/20030628/food.asp*).

Nevertheless, dust-bound antibiotics may remain in farm buildings for some time. Some of the drugs in the German samples had persisted for 20 years, Thorne points out. —B. HARDER



ALL IN THE TIMING Researchers have determined when van Gogh painted his "Moonrise."

Timing a Moonrise

Van Gogh painting put on the calendar

Partially hidden by mountains, a glowing orange orb rises over golden stacks of wheat. Vincent van Gogh's "Moonrise" depicts a scene in Provence with the painter's unmistakable palette of brilliant, swirling colors.

Historians have long debated exactly when in 1889 van Gogh created the painting. Astronomical detectives report that they have now solved the mystery: The artist captured the rising moon as it appeared at 9:08 p.m. local mean time on July 13, 1889.

Donald W. Olson and his colleagues at Southwest Texas State University in San Marcos describe their finding in the July *Sky & Telescope*.

Van Gogh arrived at Saint-Rémy-de-Provence on May 8, 1889. For treatment of several medical problems, he moved into a local hospital housed in a monastery. Peering through his window, van Gogh wrote to his brother Theo: "I see an enclosed wheat field . . . above which I see the sun rise in all its glory." In another letter, he tells of working in the wheat field on a painting that depicted a moonrise. In late September, he mailed the picture to Theo.

But during that summer, van Gogh had become severely ill and didn't paint for 6 weeks. Historians hadn't known whether van Gogh completed "Moonrise" before or after this hiatus.

Computer calculations by the Texas researchers revealed five dates between mid-May and mid-September 1889 when a full or nearly full moon would have appeared over Saint-Rémy. To narrow the timing, the scientists journeyed to the town, looking for visual clues—the small house and overhanging cliff depicted in "Moonrise."

They found the site just southeast of the monastery. Observing the sun, moon, and stars for 6 days, the researchers determined the altitude and orientation of the cliff with respect to van Gogh's perspective. A refined calculation then zeroed in on two dates in 1889—May 16 and July 13. The colors in "Moonrise" provided the last clue. The wheat, still green in May, would have looked yellow in July.

Exactly six 19-year lunar cycles have elapsed since 1889, and history is about to repeat itself. On July 13, 2003, the researchers note, "observers during evening twilight [in Saint-Rémy] will see a nearly full moon rise in the southeast, much as it did on July 13, 1889, when van Gogh stood among the wheat stacks in the monastery field and captured the scene in his remarkable 'Moonrise'." —R. COWEN

COURTESY KRÖLLER-MÜLLER MUSEUM, THE NETHERLANDS

MICROBIAL MATERIALS

Scientists co-opt viruses, bacteria, and fungi to build new structures

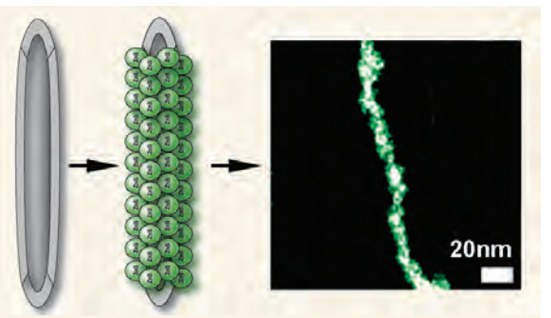
BY JESSICA GORMAN

Bone. Nerve. Muscle. Horn. Hide. Silk. With ingenious assemblages of atoms and molecules, biology produces fantastic substances that have long inspired scientists to develop the synthetic materials of the modern landscape. Lately, materials scientists have turned to biology's smallest individuals—viruses, bacteria, and fungi. Not only can these microbes be coaxed to produce high-tech components, but they can also themselves serve as valuable ingredients in new classes of materials.

Scientists are beginning to employ microbes, for example, to organize crystals into complicated geometries or provide living templates for growing crystals. Since the structure of materials is intimately linked to their behavior, a new means of controlling crystal organization creates a buzz among materials scientists.

Microbes have several advantages as laboratory reagents. Some microorganisms, such as viruses, measure tens of nanometers in length. Researchers can't make uniform synthetic particles at this scale, but microbes are readily available, uniform in size, and easy to work with. Because they typically live under comfortable conditions of temperature, pressure, and acidity, microbes are candidates for development of manufacturing techniques that are more environmentally friendly than today's often hot, high-pressure, and caustic processes.

Microorganisms "represent tremendous untapped potential" for materials science, says chemist Chad Mirkin of Northwestern University in Evanston, Ill.



WIRY VIRUSES — Genetically engineered viruses (depicted at left) bind zinc sulfide semiconductor particles (middle). The modified viruses look like wires (right).

C. MAO AND C. FLYNN

HIRING MICROBES Many microbes produce inorganic substances of interest to materials scientists. Single-celled, ocean organisms known as diatoms make silica, the silicon-and-oxygen mix of typical glass (*SN: 1/26/02, p. 51*). Other microbes formulate nanoscale magnetic particles out of iron oxides.

Some microbes consume metals and then excrete them in precise configurations. One species of *Pseudomonas* bacteria lives in ore deposits rich in silver—a metal that's generally toxic to microorganisms—and produces tiny, silver-laden crystals with specific shapes (*SN: 12/4/99, p. 367*). Two years ago, a team from the National Chemical Laboratory in Pune, India, reported that a fungus called *Verticillium* can be induced to fabricate silver nanoparticles within its cells when it's placed in a silver nitrate solution.

Bacteria and other microbes can be genetically engineered to interact with the material world in unusual ways. Three years ago, for example, biologist Stanley Brown of the University of Copenhagen and his colleagues used bacteria to create crystals of gold. They examined millions of *Escherichia coli* bacteria that were genetically engineered to sport different proteins on their surfaces. The scientists sifted through this bacterial library to isolate the microbes that bind to gold particles.

The researchers then found that three of the gold-binding proteins that they'd detected on *E. coli*, when used in isolation from the bacteria, sped up the formation of gold crystals in a solution containing dissolved gold. This accelerated growth influenced the resulting crystals' shapes.

More recently, in the Dec. 17, 2002 *Advanced Materials*, Brown and his coworkers reported that they had isolated and characterized proteins from other genetically engineered *E. coli* that can distinguish between very similar crystal faces of zeolites—porous inorganic crystals that are used to separate molecules and catalyze chemical reactions. The faces of a zeolite crystal, which is made of aluminum and silicon, have the same atomic makeup but subtly different structures. Ultimately, chemists might specify which surface of a crystal provides the substrate for growing another material.

Brown and his colleagues now are using libraries of genetically engineered *E. coli* to find proteins that bind other inorganic materials, such as mica. A geneticist, Brown is interested in how a microbe's genes produce proteins that interact with different inorganic surfaces. He notes that materials scientists and chemists may find this information useful for engineering new structures. In time, these bacterial proteins might become another material-making tool in the inorganic chemist's toolbox, says Brown.

VIRUS LINEUP Viruses offer materials scientists still more possibilities. No one has been able to uniformly synthesize rod-shaped polymers the size of viruses, says physicist Seth Fraden of Brandeis University in Waltham, Mass. Yet scientists are especially interested in particles of that size because they organize themselves into structures resembling liquid crystals and so could open new routes for controlling synthesis of materials.

When the virus particles arrange themselves this way, they can move more freely in a solution (*SN: 8/15/98, p. 108*). If viruses instead cluster randomly, Fraden says, they'll bump into each other and jam up like logs on a river.

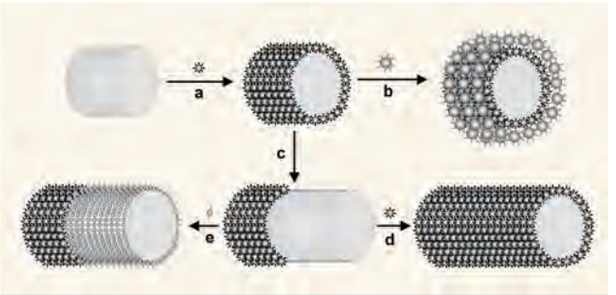
To investigate how virus-size particles organize themselves, Fraden and his colleagues are now genetically engineering viruses to have precise lengths, mixing them with polymer spheres, and then examining the structures that spontaneously form.

Materials scientists are already exploiting such self-assembly strategies for controlling—down to the nanometer scale—the structures of new materials that they design.

For example, Angela Belcher of the Massachusetts Institute of Technology now employs viruses coated with various inorganic materials. The adorned viruses assemble into intricate structures that are potentially useful for building a new generation of optical, magnetic, and electronic devices.

During her doctoral work at the University of California, Santa Barbara, Belcher studied how natural materials, such as abalone shells, grow. Later, Belcher says, she decided to "move on to other materials that nature hasn't worked with yet."

In the May 3, 2002 *Science*, Belcher describes how she genetically altered the proteins at the tips of bacteria-infecting viruses, known as bacteriophages, so that they bound to zinc sulfide semiconductor crystals called quantum dots. These viruses weren't just a curiosity. When Belcher placed them in a solution at sufficiently high concentrations, they organized themselves into a liquid-crystal-like structure in which the quantum dots were aligned. Such control of quantum dot–containing material is otherwise difficult to attain, she says.



LIVING TEMPLATE — As a filament of fungus grows, gold nanoparticles adorned with single-stranded DNA attach to its surface (a). Other particles decorated with complementary strands of DNA will bind to the gold, creating additional layers of particles of different sizes or materials (b). If the fungus continues growing (c), new naked surfaces can be adorned (d, e).

In more recent work, reported in the May 2 *Advanced Materials*, Belcher's group demonstrates a method to attach viruses to a wide variety of organic and inorganic substances, including gold nanoparticles and fluorescent dye molecules. The viruses with their attachments then assemble into fluid, yet well-organized, two- or three-dimensional structures.

Belcher and her coworkers from MIT and the University of Texas at Austin recently developed a strategy for making viruses into miniature wires that they describe in the June 10 *Proceedings of the National Academy of Sciences*. The team genetically altered viruses so that the protein coat along the length of each microbe was covered with peptides that bound either zinc sulfide or cadmium sulfide.

Researchers in her lab are engineering viruses to have specific chemical groups at each end of the virus as well as pick up a coating of semiconductor along its length. The team expects that those chemical groups will serve as specialized connectors that the researchers can use to link the semiconductor-coated viruses into specific combinations and structures on a surface. In effect, this would create semiconductor wires that can automatically latch together. In time, Belcher says, her team would like to arrange such wires to create simple electronic devices that are far smaller than those in conventional electronic chips.

There are also alternative uses for viruses with specific chemical groups assigned to each end. Belcher suggests that one end of a virus might be designed to carry a magnetic material, and the other a chemical group that binds to a toxic pollutant. Theoretically, researchers could then use such designer particles and a magnet to sponge up pollutants from a solution.

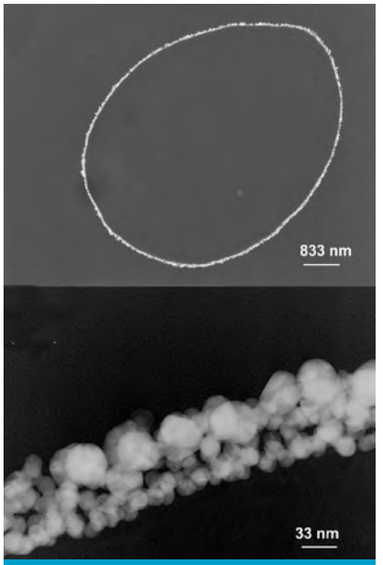
PROTEIN WIZARDRY Mark Young of Montana State University and his colleagues are focusing on another aspect of viruses. The scientists can modify viruses' protein shells both chemically and genetically. They custom-design these cages to bind particular materials and adjust the way the cages open and close to let particles in and out.

In effect, the cages provide nanoscale hands for assembling new materials, tiny piece by tiny piece. By placing magnetic crystals such as maghemite or magnetite inside the cages, Young and his collaborators aim to create magnetic data storage devices.

The researchers have also isolated and modified cages of protein from bacteria and archaea that resemble iron-storing ferritin cages in mammalian cells. The scientists aim to intersperse virus cages with the ferritin-like cages to create two-dimensional arrays that could be incorporated into magnetic data-storage devices.

While microbes' benign living conditions might prove a boon to environmentally friendly manufacturing, they may limit the organisms' use in the harsh environments of many current production processes. Young and his coworkers have taken aim at these restrictions in two ways. They collect so-called thermophile microorganisms from the hot springs at Yellowstone National Park and also chemically modify the protein coats of conventional viruses to withstand variations in temperature and acidity.

So far, Young and his collaborators have identified or crafted protein cages that handle a pH range from 0 (extraordinarily acidic) to 11 (somewhat basic). Some of these protein cages can survive temperatures above 100°C, Young says. These advances promise to extend the potential marriage of microbes and materials synthesis into new, even more technologically challenging territories.



GOLD RING — A cross-section shows a single fungal hypha that has been decorated with gold nanoparticles (top). Higher magnification reveals the individual gold particles.

ZHI LI ET AL./ ANGE. CHEMIE. INT. ED.

Because the structures of the protein shells of many viruses are well understood even at atomic scales they can be particularly useful as nanoscale building tools, says M.G. Finn of the Scripps Research Institute in La Jolla, Calif. Last year, Finn and his colleagues reported genetically engineering cowpea mosaic viruses to make them bear sulfur-containing amino acids, to which the researchers subsequently bound gold particles and fluorescent dyes (*SN: 2/2/02, p. 68*). The scientists aim to use these constructions as building blocks for electronic circuits and new materials.

Since last year, Finn's group has expanded its repertoire to a few more viruses that the scientists collect from cells they grow in their lab. None of these viruses infect humans, Finn points out.

In yet another approach to high-tech materials, the researchers are attaching single-stranded DNA to the plant viruses, which they can then link to other materials via complementary

DNA strands. In this way, the viruses aggregate into two- and three-dimensional structures that also may prove useful for constructing electronic devices.

GLITZY FUNGI According to Mirkin, fungi can provide "truly living templates" for designing materials with specific nanoscale and microscale features. In his lab, researchers have gold-plated a meshlike tangle of thin fungal fibers known as hyphae, which are very uniform in diameter and have a characteristic width for each fungus species.

In the May 23 *Angewandte Chemie International Edition*, Mirkin's team at Northwestern University describes how it cultured spores of the fungus *Aspergillus niger* in the presence of 13-nm-wide gold particles that aggregated on the fibrous hyphae. Once there, the gold particles, each of which was linked to multiple short strands of DNA, could bind an additional nanoscale component bearing complementary DNA strands. This provides a means for readily mixing and matching a variety of nanoscale building blocks into ever more sophisticated structures, Mirkin says.

The team has already demonstrated the template procedure for additional fungi, which have different hyphae dimensions. This technique could be used to coat microbes with a variety of materials, such as magnetic and semiconductor particles, Mirkin says. He suggests that hyphae also might be custom-coated with catalytic materials to provide a large surface area for catalysis in chemical reactions. Meanwhile, other fungus-based nanostructures might serve as designer optical, electronic, and magnetic materials.

By doing nanoscale construction work for scientists, these fungi, viruses, and bacteria may make material design easier. The marriage between microbes and materials science ought to thrive. After all, a material's architecture at microbial scales largely determines what the substance can do. ■

THE ULTIMATE COLONISTS

Human ancestors settled into one ecosystem after another

BY BRUCE BOWER

The Stone Age was rough on community life, at least among animals trying to make a living in Africa. A range of species would move into a local habitat—gazelles, zebras, pigs, people, you name it—and take a few generations to establish the web of interactions that characterizes an ecosystem. After a millennium or so, dramatic climate shifts would then radically remodel the habitat, motivating the residents to leave. Eventually, a new collection of species would inhabit the area.

As these communities formed, dispersed, and reformed, one line of creatures always found a place in the mix—members of the *Homo* lineage, the ancestors of people today. Therein lies a couple of surprising lessons for researchers trying to untangle Stone Age evolution, says anthropologist Richard Potts of the Smithsonian Institution in Washington, D.C.

First, climate fluctuations reshaped regional habitats in unique ways rather than exerted uniform environmental effects worldwide or even across continents, as scientists have often assumed. As a result, animals had the option to leave hostile habitats and find greener pastures. Earlier theories have treated dramatic climate change primarily as a trigger for extinctions and the evolution of new species.

Second, although long envisioned as a time when our ancestors lived stable, simple lives, the heart of the Stone Age may actually have featured much social ferment and innovation, as people adjusted to shifting habitats throughout Africa. No brand of mammal, it seems, adapted to new ecosystems with the deftness of the genus *Homo*.

"We can see for the first time that strong environmental variability [during the Stone Age] was mirrored in the ecological domain and was powerful enough to disrupt any continuity in community evolution," Potts says. "Only [human ancestors] were adaptable enough to colonize the diverse animal communities that were repeatedly built up and broken down."

These climate fluctuations (*SN: 7/12/97, p. 26*), dramatic makeovers of local environments, and community transitions appear to have gone on throughout the Stone Age, says Potts. He presented his findings in Tempe, Ariz. at the recent annual meeting of the Paleoanthropology Society.

HANDY TOOLS — Handheld stone axes such as these indicate that human ancestors lived in Kenya's Olorgesailie region nearly continuously for 500,000 years, despite substantial environmental changes.

J. CLARK

COME TOGETHER Potts' curiosity about prehistoric ecosystems had been piqued by a wave of scientific interest in how modern species come to coexist in specific areas. Much of this discussion focuses on three factors that influence the composition of species in an animal community: the existence of dominant competitors for food and other resources, the capacity of certain animals to move quickly and claim fertile new areas, and the overall fit of a species with the climate, available food, and other environmental variables.

Potts wondered whether the Stone Age fossil record reflected those three factors. He began by examining the site he knows best, Olorgesailie in southern Kenya.

Olorgesailie has yielded not only nonhuman animal bones but also stone tools and toolmaking debris in sediment layers that range from 500,000 to 1.2 million years old. Three fossil samples, each containing bones from a variety of mammals, proved crucial for Potts' analysis of this site. The first sample dates to 990,000 years ago and accumulated approximately 1,000 years. The second dates to 900,000 years ago and also covers a 1,000-year span. The third dates to 650,000 years ago and encompasses perhaps several thousand years.

Each sample held a different community of species, Potts notes. Wild horses are the most abundant animals in the oldest group of fossils. That title passes to large, baboon-like creatures—each about the size of a female gorilla—in the next set of fossils. Extinct forms of pigs and hippopotamuses predominate in the youngest sample.

Surprisingly, gazelles and other hoofed creatures, known collectively as bovids, accounted for only 13 percent to 28 percent of the mammals at each time. Bovids typically make up 60 percent to 80 percent of the mammal fossils found at East African fossil sites.

That anomaly concerned Potts. It raised the possibility that the repeated formation and breakup of animal communities at Olorgesailie was an isolated phenomenon.

His concern evaporated as he examined previously excavated animal remains from other African Stone Age sites ranging in age from 500,000 to 1.1 million years: Tanzania's Olduvai Gorge, a pair of Ethiopian sites in the fossil-rich Awash Valley, and sites in south-central and southern Africa.

The effort revealed that ancient animal communities contained distinctive blends of species from one part of Africa to another. Communities broke apart and reassembled in unique ways at Olduvai and in the south-central–Africa sample, just as at Olorgesailie. The Ethiopian and southern-Africa sites exhibited so much species change over time that Potts couldn't pin down clear community identities for them.

Strikingly, none of the factors that biologists currently have highlighted as determining the species composition of modern ecosystems appears to have loomed large at the African sites, Potts argues. No single, superior competitor species strutted its stuff at Olorgesailie or elsewhere throughout the Stone Age. Grassy expanses at

all the Stone Age sites favored grazing animals, but a wide variety of these creatures came and went, with none achieving a lasting fit to the environment.

The animals that succeeded must have moved in quickly to inhabit a region abandoned by others, Potts says. However, in his view, mobility alone can't explain how such a wide variety of "lead grazers" paraded through the same sites.

Enter a fourth factor that Potts dubs environmental dynamics. This influence plays out as a kind of thrust-and-parry duel between animals and their shifting surroundings. The action proceeds as follows: A distinctive combination of species colonizes a region, coexists for a while, and departs in the face of massive environmental change. A new species mix better suited to the remodeled surroundings then fills the vacuum. During the Stone Age, this back-and-forth battle ensured that no single large-mammal community evolved as a continuous entity.

That's an intriguing possibility, remarks Ian Tattersall of the American Museum of Natural History in New York. Potts' ideas aren't yet confirmed and get scant attention among anthropologists. Nevertheless, they raise the possibility that our ancestors nimbly adjusted to a constantly changing world, according to Tattersall.

"The repeated assembly and disassembly of species communities apparently took place widely over Africa during the middle Stone Age," Potts says.

TOOLING UP There's one bit of consistency in this ancient picture of volatile animal interactions. Stone tools have turned up in each collection of animal remains studied so far.

"[Early] toolmakers were already equipped by the middle Stone Age to accommodate to substantial diversity in their ecological settings," Potts asserts.

Paleontologists typically don't grant so much flexibility to our ancestors of that time—whether classified as *Homo sapiens* or as any of several other *Homo* species. Researchers have often portrayed the middle Stone Age, which runs from around 1.5 million to 400,000 years ago, as a time during which our ancestors stuck to a fairly narrow repertoire of behaviors. This argument hinges on the extended distribution of a single type of tool, the Acheulian hand axe. Scads of these double-edged, teardrop-shape implements have been excavated at African sites from throughout the middle Stone Age.

In a world of revolving-door ecosystems, Acheulian hand axes may well have been supremely adaptable instruments. These tools, which also appeared in China by around 800,000 years ago (*SN: 3/4/00, p. 148*), probably functioned as Stone Age versions of Swiss Army Knives, Potts theorizes. The sharp, easily graspable devices could be used in all sorts of environments to cut meat off carcasses, to dig up plants and tubers, and to whittle points on digging sticks, just for starters.

Many researchers who study ancient hand axes now regard them as having been used for a variety of purposes, notes archaeologist Ofer Bar-Yosef of Harvard University. Nonetheless, ancient human groups in some regions died out as water sources dried up, he argues, whereas those at sites with consistent water supplies, such as Olorgesailie, managed to survive.

Potts plans to examine animal remains at Stone Age sites in China for signs of repeated formation and dispersal of distinctive animal communities. Evidence of considerable movement by human ancestors along a north-south corridor in eastern China already exists, he says.

DIG IT — Workers at Olorgesailie in Kenya excavate a 990,000-year-old elephant-butchery site. Their efforts also yielded the remains of zebras, baboons, pigs, hippos, and some large mammals that had died out by 400,000 years ago.

POTTS

CHANGE OR DIE In Potts' view, constant species shuffling in Stone Age ecosystems deals a bad hand to another influential idea, the turnover-pulse hypothesis. Devised by Elisabeth S. Vrba of Yale University, this theory holds that old species die out and new ones arise in response to massive changes in their physical surroundings.

In particular, according to Vrba, a global cooling trend around 2.5 million years ago led to the evolution of new types of rodents and antelopes and the extinction of ancient forms of pigs, monkeys, and giraffes.

Yet fossil evidence that appears to show the emergence of some species and the loss of others at a given location may actually reflect the dispersal and regrouping of animal communities, Potts contends.

New investigations support this possibility, he notes. Several studies presented at the recent annual meeting of the American Association of Physical Anthropologists in Tempe indicated that regional rises and falls in the populations of certain species occurred with surprising frequency in the Stone Age.

For instance, the relative abundance of species from three major bovid groups changed over time in unique ways at two sites in Ethiopia and two in Kenya, say René Bobe of the Smithsonian Institution and his coworkers. The dramatic thinning out of specific bovid species and the rise of others occurred at these sites as many as four times between 4 million and 1 million years ago, the scientists say. Changes in bovid populations are a sensitive marker of environmental change, Bobe notes.

Sites in the same part of Africa also witnessed local population shifts among monkey species, reports Stephen R. Frost of

the American Museum of Natural History. One such shift transpired at Ethiopian and Kenyan sites around 3.4 million years ago, Frost says.

Subsequent shifts took place from 2.9 million to 2.5 million years ago in Ethiopia and 2 million years ago in Kenya. The 2.5-million-year-old cooling trend central to Vrba's turnover-pulse theory appears to have had little effect on the fate of monkey species in eastern Africa, Frost adds.

Such data point to the need for a closer analysis of how a variety of mammals fared at different points in the Stone Age, according to Potts. His provocative theory coincides with a growing interest among evolutionary biologists in how all sorts of organisms adapt to fluctuating environments.

Several mechanisms have been proposed for coping with environmental change. Lauren A. Meyers and James J. Bull, both of the University of Texas at Austin, described them in the December 2002 *Trends in Ecology and Evolution*.

One possibility is that environmental shifts induce major genetic changes in organisms. In an example of this phenomenon, published in the May 30 *Science*, Ivana Bjedov of Paris (France) University and her colleagues report that most strains of wild bacteria exhibit elevated DNA-mutation rates during periods of starvation. The genetic alterations that result aid survival when nutrients are scarce, the scientists say.

HARD WARES — A catwalk at Olorgesailie was built over a spot where thousands of stone hand-axes have eroded from soil, lakeside, and stream deposits that date to between 800,000 and 900,000 years old.

POTTS

Another prospect is for a population to maintain different lineages, each with its own environmental specialty. Consider a species of desert flower in which a white-flowered variety fares well in wet years but a blue-flowered version does well in dry years.

Alternatively, organisms can produce offspring so diverse that at least some can weather drastic environmental changes.

Moreover, the evolution of extended individual development, as in *H. sapiens*, may have stoked an aptitude for learning and innovation that permits human adaptation to one habitat after another (*SN: 9/21/02, p. 186*).

Still, much about Stone Age evolution remains unexplained, Potts acknowledges. "For years, I and many others simply connected the dots from one ancient animal community to the next through time, treating them as part of a continuous evolutionary process," Potts says. "We can't do that anymore." ■

OF NOTE

ENVIRONMENT

Second cancer type linked to shift work

Two years ago, a pair of research teams each reported finding an elevated risk of breast cancer among women who sometimes worked nightshifts. One of the teams now finds that those women also face an increased risk of colorectal cancer.

Eva S. Schernhammer of Brigham and Women's Hospital in Boston and her colleagues pored over data on 600 colorectal cancers diagnosed among 78,500 nurses participating in a long-running health study. As before, the researchers compared cancer incidence in women who reported working the graveyard shift with that of women who never worked nights.

In the June 4 *Journal of the National Cancer Institute*, the epidemiologists report finding a 35 percent higher risk of colorectal cancer among workers who pulled night duty several times a month for at least 15 years.

Schernhammer's team suspects this link may trace to a reduced secretion of the hormone melatonin by the brains of people working nights. Melatonin is produced mainly when a person is in darkness. Several recent studies showed that colon cancer patients tend to secrete less melatonin than healthy people do. Animal studies have also indicated that melatonin can inhibit the development of cancer (*SN: 10/2/99, p. 221*). —J.R.

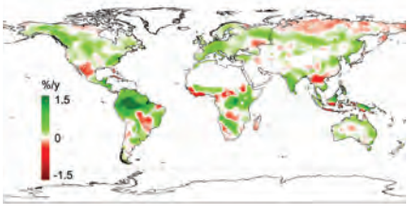
EARTH SCIENCE

Satellites show Earth is greener

Daily observations from space for nearly 2 decades indicate that our planet is getting greener.

Satellites gathered data from 1982 to 1999, measuring the amount of chlorophyll on Earth. Analyses show that Earth's net primary production—a measure of how much foliage plants generate and, by inference, the amount of carbon dioxide they absorb—jumped about 6 percent over the period. On a global basis, land plants pulled 12.5 billion metric tons more carbon dioxide from the air in 1999 than they did 18 years earlier, says Ramakrishna R. Nemani of the University of Montana in Missoula.

Although the concentration of carbon dioxide in Earth's atmosphere rose about 9 percent during that period, not all of the extra greenery stemmed from that gas' fertilizing effect. For example, large swaths of India received extra rainfall in the 1990s from that decade's strong monsoons, says Nemani. Also, decreased cloud cover over Amazonian rain forests enabled the trees there to slurp up 5 billion more metric tons of carbon dioxide in 1999 than they did in 1982.



WINNERS AND LOSERS In 1999, rain forests in central Africa and the Amazon produced more vegetation (green shades) in the early 1980s. Siberia and southern China, on the other hand, produced less greenery (red shades) in 1999.

Net primary production in some regions did decline from 1982 to 1999. Cooling in Siberia led to a shorter growing season there, and a drop in precipitation in northern Mexico and the southwestern United States stunted growth of vegetation.

Nemani and his colleagues report their analyses in the June 6 *Science*. —S.P.

ZOOLOGY

Sumo wrestling keeps big ants in line

In a Malaysian ant species, scientists are reporting that the large workers fight among themselves in "spectacular shaking contests."

The workers of *Acanthomyrmex ferox* include a class of extra-large hulks, called majors. These female ants do the tough jobs, such as cracking seeds and defending the colony. Like the queen, these workers have six egg-producing organs, whereas smaller workers in the colony have two egg organs. While the queen is alive, the workers' eggs are nonviable and serve as a food source.

The possibility for conflicts involving majors intrigued Bruno Gobin of Catholic University of Leuven in Belgium and Fuminori Ito of Kagawa University in Miki, Japan. In more than 500 hours of videotaping *A. ferox* colonies, the researchers caught 79 of what they delicately call "interactions." In some of these situations, majors engaged in antennal boxing, with one major hammering its antennae against another's body. More dramatic were episodes of a major mounting its forelegs on the head of another and then rocking furiously, rattling its target.

Shaking bouts have a flavor of sumo wrestling, the researchers say in an upcoming *Naturwissenschaften*. The majors established a stringent pecking order on the basis of these bouts.

To see how majors behave during a crisis, Gobin and Ito removed the queen from four colonies. Majors clashed more frequently, but the pecking order stayed the same. Also, the big workers began laying viable but unfertilized eggs, which turn into males. High-ranking majors produced more eggs than lowly ones. No major mated and became a queen, but the top major patrolled the doomed colony and ate the others' eggs. —S.M.

HEALTH PHYSICS

Monitoring radiation with Britney Spears?

Here's a potential use for unwanted or damaged compact disks: Set them aside as home radon detectors.

Radon is a radioactive gas that can accumulate in homes as it seeps from the soil or from building material, such as stone. Some studies have suggested that the alpha particles ejected when radon decays may rank second only to tobacco smoke as a source of lung cancer (*SN: 8/15/87, p. 105*).

Now for the CD connection. Dobromir S. Pressyanov of the St. Liment Ohridski University of Sofia, Bulgaria, and his colleagues investigated the capability of alpha particles to mark plastic as they collide with it. In the May *Health Physics*, the physicists describe exposing compact disks made from polycarbonate plastic to known quantities of radon. After a day, the researchers removed each disk's surface to a depth at which only alpha particles would have left a mark. Then they chemically treated the newly exposed plastic to enlarge each mark enough to make it visible with a regular microscope.

The density of the marks accurately indicated the amount of radon exposure, whether or not the disks had been inside plastic jewel cases, the researchers report. The data indicate that if the age of a disk and average temperature of a home were known, measurements of alpha particle

OF NOTE

etching in a compact disk could indicate radiation exposure from radon with an accuracy of about 10 percent, Pressyanov and his team claim. The disks could actually record a person's cumulative exposure over at least a decade. —J.R.

PHYSICS

Magnetic current flows solo

Besides possessing an electric charge, every electron totes around a tiny magnetic field that points either up or down. The particle's magnetism arises from a quantum mechanical property called spin. Now, an international team of physicists has induced spins to flow without an accompanying flow of charge.

That feat could prove important to the burgeoning field of spintronics, which aims to control spin currents much as the field of electronics controls charge currents, says Henry M. van Driel of the University of Toronto (*SN: 2/22/03, p. 118*).

To achieve pure spin flow, van Driel and his colleagues simultaneously trained pulses from two lasers—one at twice the frequency of the other—onto a semiconductor. This input prompted some up-spin electrons to flow within the semiconductor in the opposite direction, yet at the same rate, as some down-spin electrons.

Because the electrons had like charges but opposite paths, the charge currents canceled out. However, the spin currents enhanced each other because they were of opposite polarity and direction, van Driel says. So, in the final analysis, only spin took a spin.

The scientists describe their experiments in the April 4 and May 30 *Physical Review Letters*. —P.W.

SCIENCE & SOCIETY

Tobacco treaty penned

Every day, people around the world light up some 15 billion cigarettes. This addiction to tobacco has reached epidemic proportions, according to the World Health Organization in Geneva. In hopes of curbing the escalating health and economic toll associated with tobacco use, negotiators from around the world drafted a tobacco treaty in May at the 56th World Health Assembly. On June 16, the first day the document was open for signatures of support, 28 nations and the European Community signed on. The United States didn't.

Once ratified by the governments of 40 nations, the Framework Convention on Tobacco Control will become international law. It argues that "Every person should be informed of the health consequences, addictive nature and mortal threat posed by tobacco consumption and exposures." The document calls for country-by-country political action to protect people from exposure to tobacco smoke—especially children and those with compromised health.

The convention would prohibit sales of tobacco products to people under age 18, of toys or snacks that resemble tobacco products, and of individual cigarettes or small packs that are more affordable to minors than full packs.

Furthermore, the treaty would require each ratifying nation to "undertake a comprehensive ban of all tobacco advertising, promotion, and sponsorship"—not only within its own borders, but by local companies selling in other countries. Ratifying members would also have to track the production and distribution of tobacco products with a view to eliminating illicit trade in them. —J.R.

MEETINGS

American Diabetes Association
New Orleans, June 13 – 17

PHYSIOLOGY

Strict regimen pays off years later

Diabetes patients who adhered to a tight program of blood sugar control over nearly 7 years starting in the 1980s are still showing heart benefits, even though most have slipped back into a less diligent routine of blood-sugar monitoring.

Twenty years ago, researchers enrolled 1,441 people with juvenile-onset, or type 1, diabetes in a study to gauge the value of rigorous blood-sugar control. Half the participants practiced standard control with one or two insulin injections and finger-prick blood tests each day, while the others controlled their blood sugar more closely with three insulin shots and four blood tests daily. Results reported 10 years ago showed that the latter, more intensive program led to fewer diabetes complications.

A reassessment of these participants 8 years after the end of the program indicates that although both groups now have similar blood-sugar concentrations, those formerly on the intensive program have significantly less damage to blood vessels, including calcification of coronary arteries, report John M. Lachin and Patricia A. Cleary of the George Washington University in Rockville, Md. —N.S.

BIOMEDICINE

Epilepsy drug eases diabetes woes

The epilepsy drug topiramate can alleviate intense finger and toe pain in people with diabetes and also seems to help them lose weight, two studies show.

Diabetes is the most common cause of neuropathy, a condition in which poor blood flow in the extremities and the accumulation of reactive oxygen species such as hydrogen peroxide can damage nerves. A person with neuropathy can feel numbness or sharp pain in the fingers and toes.

Topiramate benefits epilepsy patients by limiting damage to their nerve cells. This protective effect inspired researchers to give the drug to 11 people with type 2, or adult-onset, diabetes.

The volunteers, average age 60, had significantly less pain by the end of the 8-week trial and showed reduced blood pressure, blood sugar, and cholesterol, says Aaron I. Vinik of the Eastern Virginia Medical School in Norfolk.

Earlier studies suggested that topiramate mitigates a self-destruct signal in sensory nerve cells of diabetic patients. That seems to induce nerve rebuilding, says Vinik. "In the past, it would have been heretical to say nerves can regrow," he says, but measures of nerve-fiber density in these patients suggest it's happening.

In another study, Arne Astrup of the Royal Veterinary and Agricultural University in Copenhagen and his colleagues found that topiramate helps diabetes patients keep off extra weight.

The researchers enrolled 288 people who had lost 8 percent of their weight on a strict low-calorie diet coupled with regular exercise. The scientists gave topiramate to 191 of these patients and an inert pill to the rest. After 44 weeks, three-fourths of the people in the topiramate group, compared with only one-third of volunteers getting the placebo, had maintained their weight or lost more pounds. —N.S.

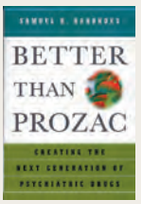
Books

A selection of new and notable books of scientific interest

BETTER THAN PROZAC: Creating the Next Generation of Psychiatric Drugs

SAMUEL BARONDES

Thirty years ago, psychiatrists generally prescribed medications to people with the most serious mental conditions. Today, Barondes reports, more than 100 million people around the world take psychiatric drugs. Here, he tracks the development of these medications and examines how psychopharmaceuticals are soon likely to improve. This is thanks to scientists' deepening understanding of the molecular mechanisms of the brain and advances in genetics that allow them to mimic and then study human mental illnesses in rats. Case studies combined with solid descriptions of research reveal an interesting path of development for psychiatric drugs, which has faced many stumbling blocks along the way. ***OUP, 2003, 219 p., hardcover, $26.00.***



THE BIG SPLAT: Or How Our Moon Came To Be

DANA MACKENZIE

For 400 years or so, scientists have toiled over the exact origins of Earth's moon. Even once humans set foot there, the mystery was still not solved. Some astrophysicists argued that the moon was ripped from a rapidly spinning Earth or that it came from elsewhere in the solar system and got caught up in Earth's gravity. Others proposed that the moon and Earth were created from the same cosmic gas and dust. Mackenzie reviews these plausible but not provable ideas and others that preceded what most scientists today say: A Mars-sized object (a doomed planet now called Theia) collided with Earth, and the remains of this giant explosion—the Big Splat—coalesced to form the moon. Mackenzie provides historical accounts of scientists, such as Galileo, Isaac Newton, and George Darwin (son of Charles), who paved the way for William Hartmann to formulate and Alastair Cameron to elaborate on the Big Splat theory. Mackenzie gives readers an accessible introduction to the geology and history of our lunar neighbor. Along the way, he answers questions such as: How old is the moon? What caused its craters? Why is it made entirely of rock? ***Wiley, 2003, 232 p., b&w photos, hardcover, $24.95.***

THE ENIGMAS OF EASTER ISLAND

JOHN FLENLEY AND PAUL BAHN

Located in the middle of the South Pacific, 2,250 miles from Chile and 2,171 miles from the Galapagos Islands (its closest neighbors), Easter Island is one of the most isolated inhabited places on Earth and a hotbed of anthropological research. This revised edition updates text that defines how people initially came to this remote outpost, how the giant stone statues for which the island is known were erected, and how the island was discovered and changed forever by Europeans. Flenley and Bahn also introduce the birdman cult found in the island's art and explore the recently deciphered Rongorongo script found on wooden boards there. These aspects of Easter Island life come to light through the authors' accounts of archaeological study that begins with Captain Cook's voyage in 1774 and includes the in-depth work of William Mulloy, who was the foremost expert on the island. ***OUP, 2003, 256 p., color plates/b&w photos/illus., hardcover, $30.00.***

NATURAL GARDENING IN SMALL SPACES

NOËL KINGSBURY

Kingsbury details scores of gardens that are friendly both to the environment and to wildlife and can be planted in rooftop containers, borders, or a small portion of a larger yard. The author imparts a working knowledge of how plants grow in nature and how a gardener employs that knowledge in creating spaces that invite wildlife and convey a natural and inspired look. Once these fundamentals are in place, Kingsbury details specific designs based on natural habitats including woodland, grassland, and wetland. He offers practical suggestions on the plants and soils to use in a natural garden, as well as cultivation tips. More than 100 photographs illustrate these examples. An extensive plant directory at the book's end lists varieties and includes pertinent details about height and spread, bloom, growing season, soil, and zone. ***Timber Pr, 2003, 176 p., color photos, hardcover, $29.95.***

THE ONE TRUE PLATONIC HEAVEN: A Scientific Fiction on the Limits of Knowledge

JOHN L. CASTI

In the spirit of his book *The Cambridge Quartet*, in which Casti gave voice to such scientists as Alan Turing and Edwin Schrödinger in a mock discussion about artificial intelligence, the author here assembles a new cast of notable scientists and thinkers. They ponder whether some questions about the world are logically beyond the power of science to resolve. In this scientific fiction, as he calls it, Casti imagines Kurt Gödel, J. Robert Oppenheimer, John von Neumann, Lewis L. Strauss, and Albert Einstein. They meet at the Institute for Advanced Study in Princeton, N.J., in spring of 1946. T.S. Eliot, Wolfgang Pauli, David Bohm, and a few others drop by to render an opinion here and there. Casti takes some license in putting words into these mouths, but he provides insight into these people's thoughts and opinions on topics ranging from quantum logic to the structure of economic systems. The exercise provides a candid look at the logical barriers that great scientists have overcome in their pursuits. ***Joseph Henry, 2003, 160 p., b&w photos, hardcover, $22.95.***

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LETTERS

One man's opinion

I was diagnosed 12 years ago with Klinefelter's syndrome, which has as a symptom low testosterone ("Unproven Elixir," *SN: 5/10/03, p. 296*). After starting bimonthly injections of testosterone, I experienced some mild body changes but nothing excessive. I'm nearly 65 but feel like I'm 55. Testosterone may kill me some day by causing prostate cancer, but I'll gladly take the risk for what the hormone has done for my increased health and enjoyment of life.

H. DENIS NEUMANN, REDWOOD CITY, CALIF.

Down to it

"Going Down? Probe could ride to Earth's core in a mass of molten iron" (*SN: 5/17/03, p. 307*) neglects the most difficult problem associated with sending a probe to the vicinity of Earth's core: sending the information back. Even a few feet of earth will stop conventional radio waves. Extra-low-frequency transmissions would do the job, but a transmission could take years.

AUGUSTO SOUX, SAN DIEGO, CALIF.

David J. Stevenson of the California Institute of Technology in Pasadena envisions a probe that sends data via encoded vibrations at low frequencies. Sensitive detectors at Earth's surface can pick up small seismic waves that would be produced by a 10-watt vibrating source, he notes. Over the course of a mission, the probe would send out about 100 million vibrations—enough to encode sufficient information about the deep-Earth environment. —S. PERKINS

The liquid iron channels already exist—in the form of active volcanoes.

ALLAN MORRISON, MANITOBA, CANADA

There is a far more interesting way to get to the core than setting off hydrogen bombs and filling the crack immediately afterwards. A better method would be to drop a 100,000-ton hardened-iron mass shaped like a spear from a great height, like an orbit. This would go through the crust pronto. To get the spear in orbit, you simply go to the moon with a few robots and mine the needed iron. With a little acceleration, the iron is in orbit, and presto, you're ready for action. Cheers.

THOR OLSON, REDMOND, WASH.

Correction *In "Cancer vaccine gets first test in patients"* (SN: 6/21/03, p. 398)*, the vaccine name was misspelled. It should have been TRICOM.*