SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MARCH 25, 2006 PAGES 177-192 VOL. 169, NO. 12

naturally strong

oldest methane makers

comet composition

antidepressant add-on

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his left tooth

WHAT'S THE POINT OF NARWHAL TUSK?

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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MARCH 25, 2006 VOL. 169, NO. 12

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Cover The left tooth of a male narwhal develops into a tusk several meters long. It's the only tooth known to spiral. Scientists are taking a new look at this dental marvel and collecting data from radio tags attached to these Arctic whales. (J. Meehan) Page 186

SCIENCE NEWS is printed in the United States on process chlorinefree paper containing 90% recycled fiber with 30% postconsumer waste.

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.

Science News (www.sciencenews.org) is published by Science Service, a nonprofit corporation founded in 1921. The mission of Science Service is to advance the understanding and appreciation of science through publications and educational programs. Visit Science Service at www.sciserv.org.

Tiny Bubbles

Oldest evidence yet for methane makers

Analyses of the gases dissolved in water trapped in ancient minerals suggest that methane-generating microbes have been around almost 3.5 billion years, more than 700 million years longer than previous geologic evidence had indicated. Because methane prevents the loss of heat from Earth, the gas generated by those microbes could explain how the planet kept warm during the Archaean era even though the sun then produced less than three-fourths the radiation that it does today.

Methane is a minor constituent of Earth's atmosphere, today making up only about 1.8 parts per million of air. There are three major sources of atmospheric methane: some types of microbes that live in oxygen-poor environments, the heat-induced degradation of organic matter trapped in sediments, and the chemical reactions of simple inorganic compounds such as carbon dioxide and hydrogen.

Although methane produced via one method is chemically indistinguishable from that produced by the others, the ratio of carbon isotopes found in a sample of methane provides a clue to its source, says Yuichiro Ueno, a geochemist at the Tokyo Institute of Technology in Yokohama, Japan. Methane from biological sources contains less carbon-13 than does methane from nonbiological sources.

Ueno and his colleagues analyzed samples of transparent quartz taken from the Dresser formation in Western Australia. Radioactive dating of those samples, as well as of the volcanic layer deposited directly atop them, suggests that the Dresser quartz formed between 3.49 billion and 3.46 billion years ago, says Ueno. When the quartz crystallized, it trapped tiny droplets of water.

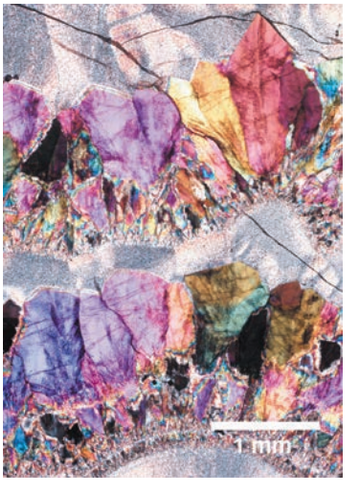
Spectral analyses revealed minuscule amounts of methane dissolved in those droplets. The researchers then ground up small samples of fluid-bearing quartz and analyzed the methane that was released.

Because the escaping methane contained much less carbon-13 than is normally found in atmospheric methane, the carbon in the gas probably had a biologic origin, say the researchers. The dearth of propane and other long-chain hydrocarbon gases coming from the droplets indicates that the methane didn't derive from the thermal degradation of organic matter. Therefore, the researchers propose in the March 23 *Nature* that the methane trapped in the quartz must have been produced by microbes.

Ueno and his colleagues "have probably uncovered the oldest-known samples of biologically produced gas," says Don E. Canfield, a biogeochemist at the University of Southern Denmark in Odense.

"It's wonderful news if they've measured a preserved sample [of methane]," says James F. Kasting, a geochemist at Pennsylvania State University in University Park. Most theories about Earth's early atmosphere presume concentrations of methane more than 500 times as great as those in today's atmosphere, he notes.

Previous studies had identified microorganisms that used sulfate to fuel their metabolism 3.5 billion years ago, but those microbes produced no methane. The new research adds a methane producer to the mix of microbes known to be active then, says Canfield. —S. PERKINS



UENO ET AL.

GAS FROM ROCK **Microbes probably produced the methane detected in micrometer-size droplets of water trapped within these grains of quartz (colored by polarized light).**

Mood Meds' Second Wind

Depression drugs aided by extra treatment step

A second, modified course of drug treatment fosters recovery in a substantial minority of depressed adults who don't feel better after treatment with a commonly prescribed antidepressant, according to a federally funded investigation.

Among depressed patients who didn't improve on the antidepressant citalopram (Celexa), one in four became virtually symptomfree by switching from citalopram to a second antidepressant. In another test, one in three patients improved comparably within 14 weeks of adding another antidepressant to their citalopram regimen.

The researchers had earlier reported that about a third of patients get relief from citalopram alone. With the effect of the supplemental drugs, about half of the 4,041 depressed patients participating in the project shed most or all of their symptoms.

"A 50 percent remission rate is extraordinarily good given major depression's chronic nature," says psychiatrist A. John Rush of the University of Texas Southwestern Medical Center at Dallas, director of the Sequenced Treatment Alternatives to Relieve Depression (STAR*D) trial.

The researchers studied outpatients with major depression at 41 U.S. psychiatric and primary care facilities. Participants initially received citalopram for an average of 47 days. The drug increases serotonin activity in the brain. About 30 percent of people displayed symptom remission, Rush's group reports in the January *American Journal of Psychiatry*. Results for still-depressed patients who chose a second treatment appear in two reports in the March 23 *New England Journal of Medicine*.

A team led by Rush studied 727 patients who switched medications. Each volunteer was randomly assigned to receive either sertraline, another serotonin-enhancing drug; bupropion, a dopamine-and-norepinephrine booster; or venlafaxine, which raises availability of serotonin and norepinephrine to brain cells. Each medication yielded remission in 25 percent of patients.

A group led by University of Texas psychiatrist Madhukar H. Trivedi studied 565 patients who continued taking citalopram along with either bupropion or the serotonin-enhancing drug buspirone. In each group, 33 percent of the patients became symptomfree.

Another 369 patients opted for a form of psychotherapy called cognitive therapy, either alone or with medications. The results of those treatments will be published later this year. In other studies, cognitive therapy has worked as well as antidepressants as a primary treatment (*SN: 11/5/05, p. 299*).

Certain genetic traits may identify individuals likely to benefit from specific antidepressants, Trivedi says. A genetic analysis of 1,953 STAR*D patients, slated to appear in the May *American Journal of Human Genetics*, shows that many people who responded well to the initial treatment with citalopram possess a specific version of a gene critical to serotonin transmission.

The new findings are "illuminating and disconcerting," says psychiatrist David R.

Rubinow of the University of North Carolina at Chapel Hill. Half of the participants stayed depressed, he notes.

It's puzzling that medications with different chemical effects create the same improvement, he adds, noting that the study lacked a group that received placebo pills.

STAR*D results apply only to individuals willing to take antidepressants in the first place and who can tolerate their side effects, comments psychologist David Antonuccio of the University of Nevada School of Medicine in Reno. The antidepressants' many side effects led about 20 percent of the STAR*D patients to discontinue treatment. —B. BOWER

Reality Botany

Data ease doubts about plant species

Despite the doubts of some botanists, plant species aren't just some arbitrary human classification scheme, says a team of evolutionary biologists. What's more, plants don't deserve their reputation of being outrageously promiscuous, breeding across species boundaries, because some animals can do so even more freely.

Animal species can cross boundaries to mate more readily than plants do, says Loren H. Rieseberg of Indiana University in Bloomington. Among records of plant- and animal-hybridization tests, Rieseberg's team found that 31 percent of attempted plant combinations readily yielded fertile offspring, whereas 61 percent of animal-species crosses did so. "That was a surprise to me," says Rieseberg.

His team has been investigating the concept of plant species. Citing, for example, the alleged tendency of plants to hybridize, many botanists have concluded that plant species are arbitrary groupings, says Rieseberg. He and his colleagues compiled data from earlier statistical analyses of traits for species in nearly 700 plant species. In the March 23 *Nature*, the researchers argue that the data divide plants into distinct groups.

The idea of a species has changed over the years, says herbarium director Brent Mishler of the University of California, Berkeley. Before Charles Darwin, people considered each species a basic unit of creation. Darwin's emphasis on how populations gradually change gave the notion of species a more arbitrary quality: Species had whatever boundaries taxonomists chose. The idea of a species as a population of individuals that breed mostly with each other comes from 20th-century theorists.

FIELD OF SPECIES Biologists present evidence that plant species represent natural entities rather than simply a classification arbitrarily defined by people.

Rieseberg and his colleagues reviewed 218 studies that have classified organisms by quantifying traits such as stem height or leaf shape and then calculating how similar various populations are.

In more than 80 percent of plant and animal genera with at least five species studied this way, the species made tidy clusters instead of forming a continuum, Rieseberg and his colleagues report. The clusters argue for species as distinct entities.

To see whether members of the numerically derived clusters breed mostly within a cluster, Rieseberg and his colleagues searched for studies of hybridization. They examined results of more than 1,000 experimental crosses of plants and more than 600 of animals. Ferns had the least successful mating across species boundaries. Birds had the most.

John Kress, curator of botany at the Smithsonian Institution in Washington, D.C., says that Rieseberg and his colleagues' study makes progress, but he doubts that it "will put an end to the controversy over species as arbitrary constructs versus objective entities."

Mishler calls the group's approach "clever" but argues that plant classification has already moved beyond such issues. The most modern approach to classifying plants, he says, depends on sorting out the family histories of lineages before defining species. —S. MILIUS

Defect Detector

Plugging holes in a breast cancer–gene screen

A European genetic test catches mutations that are missed by the sole test commercially available in the United States to screen the so-called breast cancer genes, a new study shows.

The genes, called *BRCA1* and *BRCA2*, normally encode proteins that suppress rampant cell growth. But when these genes are mutated, they can yield defective proteins that leave a person vulnerable to cancer. A woman harboring a mutation in *BRCA1*, for example, faces a lifetime risk of 50 to 80 percent of developing breast cancer. A mutation in either *BRCA* gene also confers an increased risk of ovarian cancer.

Women with a known *BRCA* mutation can be closely monitored and frequently screened for breast cancer, or they may even choose to have their breasts or ovaries surgically removed to prevent disease.

PHOTODISC

In the United States, Myriad Genetics of Salt Lake City holds exclusive rights for testing for mutations in the *BRCA* genes. However, this exclusivity isn't recognized in Canada or Europe. In recent years, European researchers have devised other *BRCA* tests and have reported *BRCA* mutations that the Myriad test doesn't detect.

In the new study, geneticist Mary-Claire King of the University of Washington in Seattle and her colleagues identified 291 women with breast cancer, 6 women with ovarian cancer, and 3 men with breast cancer. Even though each had at least four relatives diagnosed with breast or ovarian cancer, the 300 participants tested negative for *BRCA* mutations by Myriad's commercial test.

Using a Dutch test kit, King's team analyzed each person's *BRCA* genes. The scientists identified a *BRCA* mutation in 12 percent of the participants. The work appears in the March 22 *Journal of the American Medical Association*.

The two *BRCA* genes can harbor any of 1,000 or so different mutations, which alter the protein ultimately produced by the cell. Many of the mutations result from a change in DNA at a single position.

Myriad maintains that its screening test catches 99 percent of known mutations, but it can miss a defect that appears in only one of a person's two copies of the gene. The alternative technique, called multiplex ligation-dependent probe amplification, catches such mutations, King says.

The commercial test wasn't designed to ferret out every mutation hidden in a gene, says Gregory C. Critchfield, a pathologist and the president of Myriad. While the more exhaustive screen found what he considers "rare mutations," Critchfield says that King's team has produced "an important paper ... that answers the [mutation] question for a subset of patients."

The Myriad test "is not sufficient," King concludes. "There are women who ... are negative in normal genetic testing but who nonetheless carry cancer-causing mutations. They cannot be detected by methods used in this country. We need to have nonexclusive licensing for patents on genes." —N. SEPPA

Still Standing

Tsunamis won't wash away Maldives atolls

Tiny coral-reef islands such as those in the Maldives archipelago may appear fragile, but they aren't easily swept away, a new study shows. The waves of the Dec. 26, 2004 tsunami were devastating to the islands' inhabitants, but researchers now find that the waves' geological impact on the islands themselves was minor and had little effect on their long-term stability.

The Maldives includes about 1,200 coral-reef islands, or atolls, in the Indian Ocean. The reefs sit atop the craters of a string of undersea volcanoes south-southwest of India. The low-lying islands are vulnerable to sea level rise. Monsoon winds, which reverse direction from winter to summer, also impose a seasonal effect on the shorelines, redistributing beach sands to alternating coasts.

NASA EARTH OBSERVATORY

TOUGH ISLES **The December 2004 Sumatran tsunami battered, but didn't break, the 1,200 atolls of the Maldives.**

Many scientists had assumed that the islands would be highly vulnerable to tsunamis, says coastal geomorphologist Paul Kench of the University of Auckland in New Zealand. In the absence of previous data on the impact of tsunamis on the structure of reef islands, Kench and his colleagues set out to assess how the 2004 disaster affected the long-term stability of the Maldives.

The tsunami, generated by an earthquake 2,500 kilometers away off the coast of Sumatra, reached the eastern islands of the Maldives within 4 hours. A series of surges inundated the country, leaving 80 people dead and many islands uninhabitable.

Kench's group compared current shorelines and sand depths with pre-tsunami data. "We were able to detect geological changes on the islands, but these were not catastrophic," Kench says.

The tsunami appeared to mimic the effect of a full season's monsoon winds, eroding 5 to 9 percent of the easternmost islands' area and 1 to 5 percent of the western islands. It also redistributed sand to the sheltered sides, rather than washing it away, the researchers report in the March *Geology*.

The way tsunami waves build in height probably prevented severe geological damage, Kench says. As the waves approach most shores, the sea's depth decreases, and wave height increases. The waves that hit Thailand, for example, were 10 to 15 meters high.

However, the sudden transition from deep ocean to steep reef islands gave the waves no time to build, Kench says. Along the Maldives, the tsunami waves were no more than 3 m tall.

The study presents a "unique opportunity" to directly observe both pre- and post-tsunami effects on these islands, says sedimentologist Gene Lankey of the University of Miami's Rosenstiel School of Marine and Atmospheric Science. The new tsunami data can provide comparisons for future research.

"They'll be able to see what is preserved 6 months from now," he notes, "when the winds change again." —C. GRAMLING

Tipsy Superfluids

Glimpsing off-kilter quantum clouds

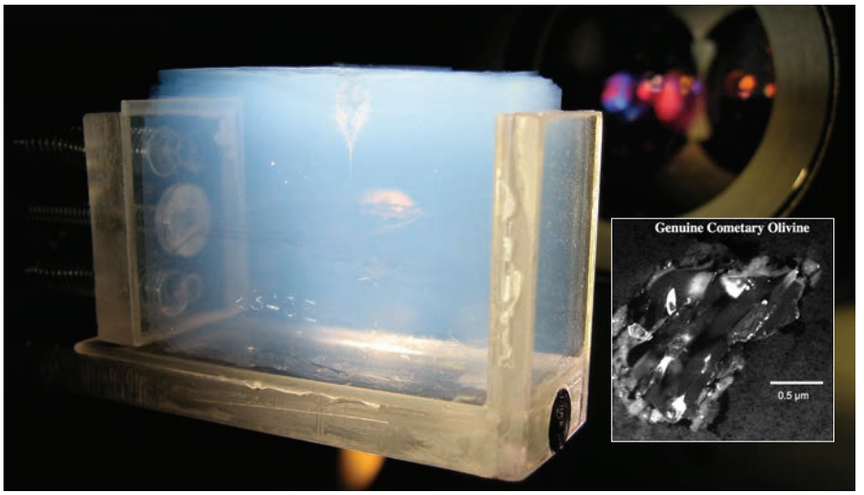
Physicists last year created an exotic state of matter previously unattainable in the laboratory but whose characteristics theorists have debated for more than 40 years. The latest probes of the new state suggest that the material—a cloud of ultracold atoms that's imbalanced with regard to a quantum property known as spin—behaves differently than most theorists had anticipated.

The new findings promise physicists a deeper understanding of superfluidity, a condition in which a fluid flows without resistance. The results may also provide insight into superconductivity, a form of superfluidity in which paired electrons flow without resistance.

The studies apply, in particular, to superfluids made up of particles known as fermions. The fermion-particle family includes electrons, protons, neutrons, quarks, and many atoms. All fermions have spin, a magnetic trait analogous to the spinning of a top. When two similar fermions meet and have opposite spins—designated as spin-up and spin-down—they'll often form a pair.

Scientists have long wondered whether superfluidity in a fermionic fluid could persist in the face of a spin imbalance, when there are more fermions with one spin than with the other. Many theorists had expected that if this condition came about, the superfluid would contain alternating bands of superfluid and normal fluid.

Spin imbalance in nature is difficult or impossible to study. For instance, the mismatch occurs in complex, poorly understood, extremely unusual compounds known as heavy-fermion superconductors, which are both magnetic and superconductive. A similar discrepancy is expected in such celestial objects as neutron stars.



COMET COMPLEXITY A block of frothy material called aerogel contains dust particles from Comet Wild 2. Inset: A grain of olivine, a mineral that forms at high temperatures, expelled by the icy comet. Encased in melted aerogel, the grain is about 2 micrometers across.

G. PARTRIDGE/RICE UNIV.; BROWNLEE ET AL., JSC/NASA

However, since the late 1990s, laboratory researchers have confined fermionic atoms, such as lithium-6, in traps and then chilled the particles to nearly absolute zero, so that the particles coalesced into what are known as superfluid fermionic condensates (*SN: 9/11/99, p. 166*). Physicists can then use these condensates as models of experimentally inaccessible substances such as the innards of neutron stars (*SN: 9/18/04, p. 186*).

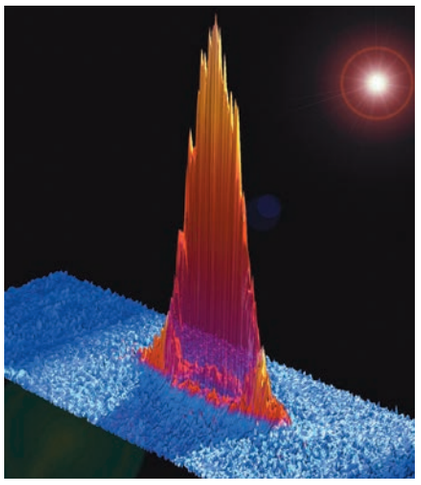
At the American Physical Society meeting in Baltimore last week, several physicists discussed the latest twist on such studies—making fermionic condensates from unequal numbers of spin-up and spin-down lithium-6 atoms.

Independent teams led by Wolfgang Ketterle of the Massachusetts Institute of Technology (MIT) and by Randall G. Hulet of Rice University in Houston recently explored polarization in condensates by using radio waves to flip the spins of varying portions of the condensates' atoms. Both teams have reported evidence that some superfluidity persists even if the condensate is skewed so that as many as 70 percent of its atoms are of one spin type.

Yet none of the experiments observed signs of the banded superfluid–normal fluid that theorists have anticipated since the 1960s, notes theorist Tin-Lun (Jason) Ho of Ohio State University in Columbus—a finding he calls "great progress."

The Rice team reports additional findings that the MIT group disputes. For example, the Houston scientists say that they've observed evidence of a superfluid with unpaired atoms interspersed among paired atoms. That finding is "astounding," Ho says. "This state is not supposed to exist according to conventional theory."

Although the disputed Rice results "are really intriguing and exciting," says Harvard University theorist Eugene Demler, "we don't understand them so well yet." —P. WEISS



MISMATCH MAKER In this density plot of a spin-imbalanced lithium cloud, the transparent center of the plot depicts a region of paired atoms that lies within a shell of excess, unpaired atoms.

Comet Sampler

Fire meets ice

The first study of comet dust brought to Earth by a spacecraft has revealed several minerals that could have formed only at the fiery temperatures close to the sun or another star. The findings come as a surprise because comets, frozen relics of the early solar system, were born beyond the orbit of Neptune and spend most of their time there.

Don Brownlee of the University of Washington in Seattle and his colleagues base their findings on the first particles they've examined from the Stardust craft, which sped within 236 kilometers of the nucleus of Comet Wild 2 in 2004 and collected material expelled by the frozen body. In January, a canister of the samples parachuted to a Utah desert (*SN: 1/21/06, p. 37*).

The scientists have sliced a few of the micrometer-size grains into hundreds of samples. The grains include the green silicate crystal olivine as well as minerals rich in titanium and aluminum. Olivine forms at temperatures from 900 to 1,100 kelvins, while the other minerals require a temperature of about 1,400 K.

The results suggest that Wild 2 and perhaps other comets are amalgams of some of the hottest and coldest materials in the solar system, Brownlee said last week at the annual Lunar and Planetary Science Conference in Houston.

Two leading theories may account for the high-temperature materials in the comet, he notes. According to one scenario, the particles formed in the inner solar system when the sun, now 4.6 billion years old, was less than 10 million years of age.

At that time, the sun would have been swaddled by a disk of gas, dust, and ice, the birthplace for planets. Olivine and other minerals could have formed within the innermost part of the disk and then been pushed out by the sun's wind to the solar system's chilly outskirts. There, the grains could have been incorporated into fledgling comets.

The other theory suggests that the minerals were forged around the hot, inner region of another star that happened to reside near the young sun. Wind from that star could have expelled the material into the solar system's icy periphery.

To determine which theory is correct, researchers now plan to measure the relative abundance of isotopes, such as oxygen-16, -17, and -18, within each of the high-temperature grains. If the grains are native to the solar system, their isotopic composition ought to be identical to that of the sun.

Wild 2 isn't the only comet known to contain high-temperature minerals. Remote observations of material excavated when a spacecraft fired a projectile into Comet Tempel 1 last July 4 (*SN: 9/10/05, p. 168*) revealed that this frozen body also contains olivine, notes Casey Lisse of the Johns Hopkins Applied Physics Laboratory in Laurel, Md.

But scientists could observe this impact only from afar. By bringing back samples of Comet Wild 2, Stardust "is now giving us the ground truth" about comets and confirming the remote studies of Tempel 1, Lisse says. —R. COWEN

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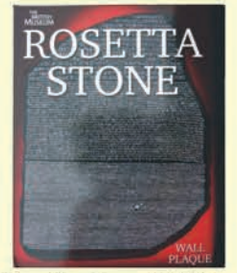

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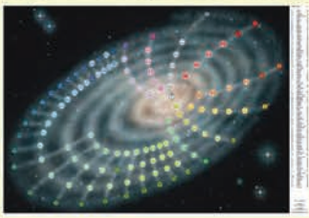

Chemical Galaxy poster is a new creation in the world of periodic table charts. Developed by Philip Stewart, Oxford University, this table was created in a spiral design. It uses a starry pathway to link the elements and to express the astronomical reach of chemistry. Copyright 2006, Size: 26"H X 38"W Laminated, info sheet provided. Order#JPT-2221, Cost $28.95

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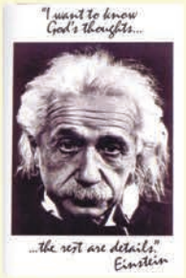

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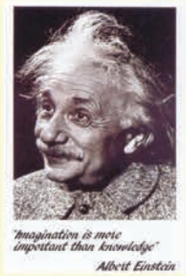

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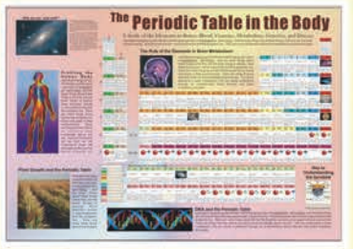

The Periodic Table in the Body
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MAKING THE MOST OF IT

How nature turns weakness into strength

BY AIMEE CUNNINGHAM

Marc A. Meyers came up with the idea for his most recent research project on a walk with his father some 40 years ago. They were in the forest near their home in a small town in Brazil, and Meyers stopped to rest. That's when he noticed a toucan skull lying on the ground. The bird's previously bright-yellow beak had faded, he recalls, but was otherwise intact. He picked it up. "The beak was so light, yet it was reasonably strong and stiff," he says.

Another researcher likes to browse through shell shops for some of her study subjects. On one visit a few years ago, Joanna Aizenberg of Bell Laboratories in Murray Hill, N.J., came upon a type of deep-sea sponge that she had never seen before. "It was clearly, incredibly beautiful design-wise," she says. After having studied its strength in detail, she adds, "I would now say it's the most perfect design I have ever seen."

These materials scientists are not the first to be inspired by nature's engineering skill. For decades, researchers have been marveling at seashell nacre, commonly called mother-of-pearl. But as engineers continue to seek stronger, lighter, more durable materials, they are increasingly looking to examples from nature. "We develop all of these wonderful synthetic materials—metals, polymers, ceramics, composites—but we are kind of running out of ideas," says Meyers, a materials scientist at the University of California, San Diego.

Nature's design secrets are particularly valuable because organisms, unlike engineers, must make do with whatever materials are at hand. "In biological systems, resources are often limited," says Aizenberg. For example, silica and chalk, two building materials in tough sponges and seashells, aren't usually known for strength.

A recent crop of studies, including the first to describe the structures and mechanics of the glass sea sponge *Euplectella aspergillum* and the Toco toucan's beak, exemplify how nature finds strength in unlikely places. But while such blueprints are illuminating, borrowing designs from nature to build structures from synthetic materials remains technically challenging.

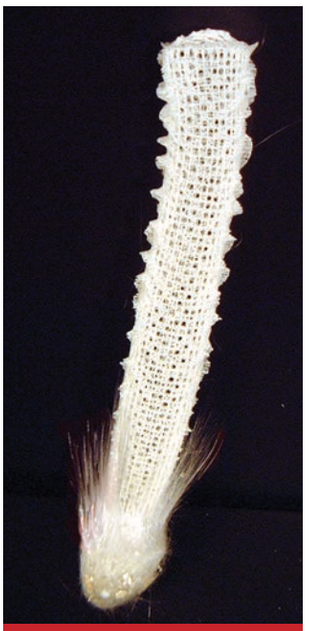
Identifying the structure "is the easy part," says Meyers. "More difficult is trying to reproduce it."

GLASS HOUSE The strength of the sea sponge *E. aspergillum* impressed Aizenberg. It lives in the western Pacific Ocean as deep as 1,000 meters. The sponge consists of a thin layer of cells that coats an intricate silica, or glass, cylindrical skeleton roughly 20 centimeters long and a few cm in diameter.

"It's almost 100 percent glass, but it's very rigid," Aizenberg says. "You have to really jump on top of this glass cylinder to introduce some cracking, and you still won't break the whole structure."

In the July 8, 2005 *Science*, Aizenberg and her colleagues in California and Germany described how the sponge's design avoids the normal brittleness of glass.

The first, visible level of design consists of vertical and horizontal beams that form the grid making up the cylinder's walls. Every second square of that grid contains two diagonal beams, and every third set of diagonal beams is thick enough to stick out of the grid's plane. This three-dimensional structure prevents the cylinder from being crushed when it's squeezed, notes Aizenberg. Think of how much sturdier a soda can would be if its sides had ridges.



DESIGNER GLASS — The crisscross beams in the walls of the silica sea sponge *Euplectella aspergillum* make up one of several strength-bestowing levels of design.

AIZENBERG

The researchers employed visible-light and scanning electron microscopy to dig further into the design. At the micrometer scale, they found that each beam consists of thinner cylinders cemented together by more glass. These parallel bundles of cylinders are stronger than each cylinder alone, says Aizenberg, because if one cylinder fails, its neighbors can take up the slack.

Furthermore, each thin cylinder consists of concentric rings, like tree rings, of glass glued together by an organic material. The rings are thicker toward the center of the cylinder: Outside rings are roughly 0.2 micrometer (μm) thick, while inner rings span about 1.5 μm.

This structural characteristic is what makes the sponge "almost unbreakable," says Aizenberg.

A regular glass rod will crack easily, but in a layered glass rod, the incoming energy from a mechanical load dissipates into the glue between the layers. A crack in one of the thin, outer layers of the cylinder doesn't travel very far before it reaches the organic glue, which diverts the crack from the next layer.

A final design detail is the glass wires that attach the sponge to the ocean floor. Anchor points are typically weak spots in structures, notes Aizenberg. Rather than thickening the point of attachment, the sponge employs flexibility, loosely incorporating additional thin cylinders into the vertical beams at the bottom of the sponge. This way, the sponge can swing freely, moving with whatever force it encounters, says Aizenberg.

The mechanical principles integral to the sponge's design—diagonal ridges, bundled beams, and layered rods—can be found in structures that engineers build every day. But Aizenberg points out that engineers tend to use these principles separately.

Combining these design elements to create even stronger materials "is something that nature can still teach us," she says.

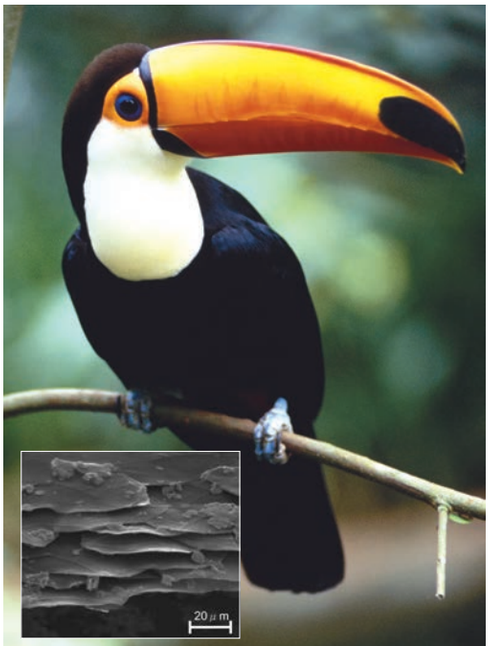
"This is probably the strongest glass structure that one can imagine," she continues. "In a way, it's a glass house at which you can throw stones."

A BETTER BEAK The Toco toucan (*Ramphastos toco*) has a thick, roughly 20-cm-long beak that makes up a third of the bird's length. The Toco, which lives in the jungle canopies of South America, dines on tree fruits growing at the ends of branches. The birds perches on sturdier portions of a branch and relies on its beak's length to reach a meal. Once the toucan secures a piece of fruit in the tip of its beak, the bird tosses the food into the air and catches it closer to its throat.

The beak must be rigid enough to resist bending and twisting forces, and yet this stiffness can't come with great weight, or the bird couldn't get off the ground, says Meyers. Indeed, despite its dominating size, the beak makes up only one-twentieth of the toucan's body mass. In the December 2005 *Acta Materialia*, Meyers and his colleagues described how the toucan beak accommodates the need for both strength and agility.

The outer shell of the beak is a 0.5-millimeter–thick layer of the protein keratin, the same material found in human fingernails. As tough as keratin is, a uniform layer the size of a toucan beak would be subject to cracks, says Meyers.

To prevent such damage, the toucan adopts a strategy that's analogous to the layering of the glass sponge. The beak's outer shell is made of hexagonal keratin tiles—each about 50 μm in diameter and 1 μm thick—cemented together with an organic glue and piled in several staggered layers. As among the rings in the thin cylinders of Aizenberg's glass sponge, this arrangement diverts cracks along the path of the glue, making them less likely to penetrate deep into the beak.



TILE PILE — A scanning electron micrograph (inset) of the layered and staggered keratin tiles that make up the outer shell of a Toco toucan's beak.

The beak's internal structure is also critical to its strength, the researchers found. It consists of a scaffold made of calcium-rich beams draped with keratin membranes. The scaffold's closed, air-filled spaces reduce overall weight without loss of rigidity, says Meyers. Without its scaffold, the long, almost tubular beak would collapse under bending forces, much as an aluminum cylinder would.

Engineers use a similar strategy when they create light-but-sturdy structures by packing synthetic foam between hard layers in car bumpers and some construction materials. But the toucan's calcium scaffold is lighter and stiffer than that foam, notes Meyers.

If engineers could develop foams with some of the scaffold's characteristics, they might create stiffer, yet lighter, crash-resistant car panels than those that exist today, says Meyers.

SHELLS NOT SHOCKED Since researchers described the source of the surprising toughness of most mollusk shells almost 3 decades ago, the shells have become a model for bio-inspired materials research. The source of their strength is nacre, which makes up their inner layer. Current research is providing nanoscale details that indicate how parts of this layer contribute to nacre's strength.

Nacre is made of about 95 percent aragonite, a form of a calcium carbonate, and 5 percent organic material (*SN: 1/28/06, p. 51*). On its own, calcium carbonate—which is basically chalk—is brittle, says Christine Ortiz of the Massachusetts Institute of Technology.

In nacre, 3,000 to 4,000 layers of offset, aragonite bricks are locked together by thin layers of organic glue. Most bricks are hexagonal, with thicknesses between 0.3 and 1.5 μm and diameters ranging from 5 to 20 μm. Each layer of glue is just tens of nanometers thick. This structure makes nacre 3,000 times as fracture resistant as calcium carbonate alone.

Ortiz and her colleagues have tested mechanical properties of an individual nacre brick by pressing on it with the tip of an instrument called an atomic-force microscope. The force left an impression in the brick, but it didn't cause a fracture. The integrity of each brick enhances the structure's overall strength, further encouraging cracks to follow the energy-sapping, zigzag path of the mortar, says Ortiz. The researchers reported their results in the September 2005 *Journal of Materials Research*.

The group is now investigating how the mortar adheres to the bricks. Ortiz suggests that this design information could lead to improvements in body armor and other impact-resistant materials.

BEYOND BLUEPRINTS Among the design principles displayed by the sea sponge, toucan beak, and seashell, a common theme is the diversion of crack-causing energy into the adhesive holding subunits together. If this principle could be brought to bear on building designs, says George Mayer of the University of Washington in Seattle, it could make structures more resistant to earthquakes or explosions. The more that a structure can absorb such intense energy, the longer it should hold up, and the more time that its occupants would have to get out before its collapse, he says.

With that in mind, Mayer's group designed a 20-cm-long prototype beam with a structure mimicking the brick-and-mortar design of nacre. The researchers chose aluminum oxide, a material tougher than nacre's calcium carbonate, for 5-to-7.5-cm-long bricks. They also tried out several materials for the mortar.

Their best brick-and-mortar beam, with each layer of bricks offset from the next, was six times as tough as a beam of solid aluminum oxide is. This improvement occurred in what is just a crude approximation of nacre, Mayer points out. "We built beams with six layers," he says, which doesn't get down to the scale of thousands of layers in a seashell. He and his team describe their results in an upcoming *Materials Science and Engineering C*.

It will be no small feat to copy all the elements of natural structures, especially features at minute scales. While scientists can manufacture nanosize components, incorporating them into the macrosize structural materials necessary for machines and buildings isn't yet cost-effective, notes Mayer.

Engineers must also consider the conditions under which natural structures form and thrive. For instance, the proteins in the organic glue holding together glass rods in the sea sponge *E. aspergillum* wouldn't withstand the high temperatures that engineers use to manufacture glass, says Mayer.

But researchers remain enthusiastic about the natural blueprints they now have and those still to be unrolled. Meyers plans to study bird beaks other than the toucan's, while Ortiz is interested in what lies behind the strength of antlers. Aizenberg is comparing the glass sponge's structure with that of sponges living in other habitats.

"I do believe that fundamental studies are very important," Aizenberg says. "They will ultimately lead to new materials." ■

KEVIN SCHAFER/VIREO; (INSET) MEYERS

THAT'S ONE WEIRD TOOTH

And other bulletins on the elusive narwhal

BY SUSAN MILIUS

What Martin Nweeia noticed first when he encountered narwhals, he says, was the sound. In May 2000, as spring was just reaching Baffin Island in the Canadian Arctic, a famed local hunter took Nweeia out on the ice searching the open water for those tusk-bearing, high-Arctic whales. "I was sitting on a bucket out on the ice doing polar bear watch," he says. At that time of year, daylight lasts around the clock, and at 3 a.m., the gray sky had orange streaks. "The water was like glass, and a light mist was rolling in," he says. "Then, I heard the breathing."

Nweeia soon traced the sound to the dark bodies of at least 10 narwhals that had risen to the surface out in the open water. Their heavy, low-frequency, methodical breaths carried through the night as if "they were breathing in my ear," Nweeia says. It took considerable discipline, he says, to break the spell of their arrival and wake the hunter to go after them.

Many people have searched for narwhals, but Nweeia may be the only Connecticut dentist to have done so. He practices in that state and teaches at Harvard School of Dental Medicine in Boston. And what's there for a dentist not to love about an animal with a 3-meter-long tooth—and the only spiraling tooth ever reported?

LEFT OUT — In male narwhals and a very few females, the left tooth grows to more than half an adult's body length.

Since that first encounter in 2000, Nweeia has spent four field seasons in the Arctic observing narwhals, and he's worked with diverse experts to examine the creatures' tooth structure in detail. He and his collaborators' most recent finding suggests that the tusk is "exquisitely sensitive," says Nweeia. He proposes that it might sense pressure, temperature, and even changes in water chemistry. General ideas about tooth function are going to have to do some growing to make sense of this new twist.

The narwhal tooth is what collectors in bygone centuries got when they bought a unicorn horn. And narwhals might as well be unicorns, as far as knowledge about their biology goes. Famously hard to study, they don't tolerate captivity, and they spend 6 months of the year in forbidding offshore ice fields where even Inuit hunters seldom venture.

Nweeia is one of several researchers now focusing on narwhals. Advances in tagging whales with instruments that send data to satellites are finally giving scientists a picture of narwhals' migration and hunting habits. Such advances are also revealing these whales' vulnerabilities to humanity's effects on the planet.

EXQUISITE CORPSES Narwhals, which are medium-size whales, typically spend their lives within the Arctic Circle. The world population numbers some 50,000 individuals, many of them living between Canada's Baffin Island and Greenland.

Catching sight of a surfacing narwhal, says whale biologist Kristin Laidre of the Greenland Institute for Natural Resources in Nuuk, usually means seeing a "black blob"—just the rounded back. The whales have rounded heads and a roughly sausage-shaped profile that tapers at the tail end. Females grow to about 4 meters in length. Males tend to grow about half a meter longer, excluding the length of their tusks. The animals can weigh as much as 1.5 tons.

Up close, live narwhals remind Laidre of the wet, smooth inner tubes in which people float down rivers. Narwhal skin is "taut, very slippery," she says. Adults develop a scattering of gray-and-white patches over their dark backs. Whale lore cites the ghoulish mottling of pale grays and blues to explain why narwhals are sometimes called "corpse whales." Laidre, though, says that she finds the skin coloring "really quite beautiful."

To a dentist, the narwhal poses serious questions. "You can't find a more asymmetric tooth," Nweeia says.

Narwhals have only two fully developed teeth, and often just the left one is visible. In males and a few females, that tooth grows into the remarkable tusk. It often becomes more than half as long as the rest of the narwhal's body. The other tooth usually stays embedded within the bone.

The elongating tooth spirals to the left, from a whale's-eye view. In the rare cases of double-tusked narwhals, perhaps 1 out of 500 males, the right tooth doesn't grow in a mirror image. Disdaining the symmetry of other animals' teeth, the narwhal grows another left-handed spiral.

In the years after that first encounter with the animals, Nweeia enlisted several scientific collaborators and collected samples of tusks. He went to much trouble to keep them fresh. For example, Frederick Eichmiller, who works on dental materials at the U.S. National Institute of Standards and Technology in Gaithersburg, Md., advised that tusk samples be preserved in an extremely dilute solution of sodium azide. That's the stuff that explodes to puff out a car's air bag.

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Nweeia therefore had to get some new certifications unusual for a dentist. "I was taking courses with guys who were shipping hazardous waste," he says. Coming home from the field, he avoids flying into U.S. airports with their post-9/11 security procedures. He flies from the Arctic to southern Canada and then tenderly drives his samples across the border.

In December 2005, Nweeia's team released the first findings from its work. The narwhal tusk reverses the arrangement of material in the teeth of most animals, the researchers reported in San Diego at the 16th Biennial Conference on the Biology of Marine Mammals. They found that the narwhal tusk has its harder material, dentin with extra high mineral content, near the core and softer layers of dentin toward the outside.

Also, a scanning electron microscope revealed abundant tiny tubules that run from nerve endings near the tooth's core all the way to its surface. Similar tubules lie inside human teeth, but tooth enamel normally protects them from the outside world. When some dental mishap, such as receding gum tissue, exposes these tubules, the human tooth gets sensitive, making a person wince at the chill of a soda.

Narwhal tusks have a lot of tubules, each about a micron wide, Nweeia reports. Scaling up from the samples that the researchers examined, he estimates that a two-and-a-half meter stretch of narwhal tusk would have more than 10 million of those small structures.

TOOTH WISDOM — The narwhal tusk grows out twisting to the left (from the narwhal's point of view), the only known spiral tooth. Unlike people's teeth, the mineralized layers are hardest close to the living tissue (dark cylinder) at the core and become softer toward the outside.

The tubules probably create some kind of sensitivity in narwhals, says Nweeia. "Why would you want that in the Arctic and in cold water, no less?" he asks.

The function of narwhal tusks has inspired plenty of speculation over the years. Some people have proposed that narwhals skewer fish, poke holes in the ice, or jab at the ocean bottom to scare up prey. In recent years, whale biologists have been inclined to link the tusk in one way or another to males finding a mate. They consider the tusk a product of sexual selection, along with the peacock tail. One version of this idea, says Nweeia, has male narwhals dueling with clashing tusks, in the same way that moose butt antlers.

Nweeia says that his predictions about the tooth's great sensitivity argue against the tusk as this kind of dueling tool. "When you have something so exquisite, you don't bring that on the battlefield," he says.

So, could the tusks help narwhals find fish and squid in the deep or sense when ice is closing in around them? "Then why would only adult males have them?" asks Pierre Richard, a narwhal biologist at the Canadian Fisheries and Oceans Department in Winnipeg. Females, too, need to find food and breathing holes in the ice. Richard says that he's often seen females and their young foraging separately from males.

Also, if the tusk were solely a sensor, why would a male need 2 or 3 meters of it? Randall Reeves, a marine mammal biologist in Hudson, Quebec, says, "It's sexually selected all right—you can take that to the bank." However, he notes, that doesn't mean it has to be something for rough-and-ready dueling.

Laidre says that when she's seen males confront each other at tusk point, they don't really bash around. They raise their heads and sway. "It's like a slow-motion ballet," she says. "They do touch their tusks, but they're really gentle."

Nweeia says that it's too early to get attached to explanations for the sensitive, extralong tooth. He and his group plan to look for environmental cues that trigger tusk responses.

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WHALE WHEREABOUTS Many things about the narwhal remain a puzzle to scientists. Whales, in general, are hard to examine because they spend so much time underwater. And narwhals specialize in living around sea ice.

The big, Canada-Greenland populations choose a winter haven under Baffin Bay's pack ice, acres of jostling ice chunks. The 24-hour darkness of the Arctic winter and the fast-shrinking bits of open water make this a dangerous place for just about all forms of life.

When spring comes and ice along the coast melts, the narwhals swim toward land. They summer in the bays and fjords that filigree the coasts of Baffin Island and Greenland.

Biologists knew only the broad outlines of narwhals' movements until the 1990s, when scientists began tagging the whales with devices that relay information to polar-orbiting satellites. "We can sit in our offices and download data," Laidre says. "That's revolutionized the study of narwhals."

Getting the tags on the whales can't be done from an office, though. Some tags have been placed by Inuit harpooners. Researchers including Laidre have tagged narwhals in the Greenland and Canadian summering grounds. The scientists set nets in the water where narwhals might blunder into them. Because an entangled whale could drown if the researchers didn't pull it to the surface soon enough, team members on shore take shifts around the clock watching the inflatable white buoys on top of the net.

When a watcher sees the buoys slip underwater, he or she shouts for action. "You have people stumbling out of their sleeping bags," says Laidre. The crew pulls the panicky whale to the surface. The animal usually stops struggling when it emerges from the water and can breathe. The team members wire or pin tracking devices to the whale's blubber. Richard calls them "body jewelry for whales."

During the past 5 years, Laidre and others have published analyses of their satellite-transmitted data, sometimes combined with satellite measurements of sea ice coverage. Populations of narwhals seem to migrate along the same corridors each year. Each group travels from a specific summering haunt to a particular winter area in Baffin Bay.

Narwhals arrive at their wintering spots when ice covers only some 40 percent of the area, Laidre and polar biologist Mads Peter Heide-Jørgensen of the Greenland Institute of Natural Resources reported in the February 2005 *Biological Conservation*. By the end of March, as little as 0.5 percent of the area is open water.

The narwhal tags record depths of diving as well as positions. The deepest diver recorded so far reached almost 1,800 meters. Although sperm whales and beaked whales may go slightly deeper, narwhals are among the deepest-diving mammals. "I don't think people had imagined that," says Laidre.

In another part of the research, she put out the word among traditional hunters that she'd appreciate them tucking narwhal stomachs into their freezers until she could pick them up. Laidre examined 121 of these organs. Depending on the animal's size and recent dinners, a narwhal's stomach can weigh between 2 kilograms and 30 kg, she says.

The stomachs' contents and other data are finally telling their story, she says. In the January 2005 *Marine Mammal Science*, she and Heide-Jørgensen concluded that narwhals reverse the usual whale lifestyle. It's winter, rather than summer, that seems

to bring abundant dining, particularly on Greenland halibut, according to the stomach analyses. Halibut hug the depths, where temperatures hover just a few degrees above freezing. Winter-caught narwhals typically have dined recently, but the stomachs of many animals caught in summer are empty.

NARWHAL WORRIES Remote as narwhal territory looks on a map, it's all too close to pollution. As air currents sweep up to the pole, contaminants tend to waft down to Earth there. Among the most recent pollutants to attract attention are polybrominated diphenyl ethers, or PBDEs (*SN: 3/26/05, p. 206*).

Toxicologist Hans Wolkers of the Norwegian Polar Institute in Tromsø reports on a team that was studying marine mammals off the coast of Norway in the late 1990s when several narwhals showed up. The team called a government official from shipboard to get permission to collect narwhal tissue samples.

The researchers then restrained three of the animals, much as the taggers do. Using a retrofitted electric drill, the team bored out a little plug of narwhal blubber from each whale.

Tests found about 170 parts per billion of PBDEs in fat, Wolkers and his colleagues report in the January 2006 *Archives of Environmental Contamination and Toxicology*. Such concentrations rank among the highest measured in mammals in the area. These are the first PBDEs recorded in narwhals, Wolkers says. "Whales are very poor at breaking down these contaminants," he adds.

YOUR POINT? — Whale biologists have speculated that the long male tusk has something to do with winning a mate, but new observations of its structure raise the possibility that the tusk's main function is to sense its environment.

Inuit have hunted narwhals for centuries, but recent declines in the populations have inspired Greenland to impose its first quota ever on narwhal hunting by the native people.

Climate studies find a trend toward increased variability in weather conditions in the Arctic, and narwhals may be especially sensitive to such unpredictability. They don't seem to make adjustments in their migrations to avoid hunters or to reach more-abundant fishing grounds.

Laidre is concerned that under some conditions, the ice may freeze over so that the narwhals can't breathe or the fish that they eat may become less abundant. If climate warms, sub-Arctic species may move north and compete with narwhals for food, and killer whales, which attack narwhals, might move into previously ice-covered waters.

To better predict what's in store for these unicorns of the sea, scientists need to know more about their biology, especially what's going on in the winter darkness under the ice. Laidre reports that she and her colleagues have gotten a grant for a winter study and are now figuring out the logistics.

"Call me in 6 months," she says. ■

J. MEEHAN

OF NOTE

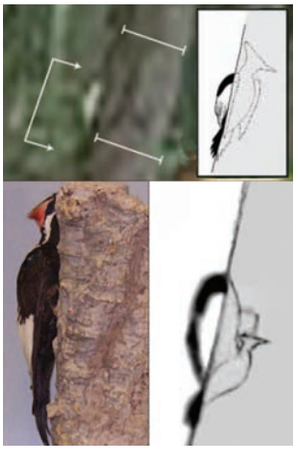
ZOOLOGY

Woodpecker video is challenged and defended

The most famous bird video in the United States—a blurry 4 seconds released last year as evidence that the ivory-billed woodpecker still exists—probably just shows a common pileated woodpecker, argues a team including David Sibley, author of the popular Sibley bird guides.

Oh no, it doesn't, says the Cornell University team that originally identified the bird. John Fitzpatrick and his colleagues stand by their interpretation that the video caught an ivory-billed woodpecker flapping off into the woods.

Both groups present their case in the March 17 *Science*. That's the journal that in April 2005 rocked the birding world by publishing the Cornell group's contention that at least one of the big, showy birds survives in flooded lowlands of Arkansas' Big Woods (*SN: 5/7/05, p. 291*). The search team has built its case on fleeting sightings by experienced bird-watchers, sound recordings, and the video.



ALL A BLUR A frame from last year's woodpecker video (top left) was originally seen as the white patch on top of an ivory-billed's wing (top right). Mounted specimen (bottom left) shows limited white in that position, says a skeptic, who suggests that the video frame shows the wing underside of a pileated woodpecker (bottom right).

SCIENCE; S. PERRY

Now, Sibley and his colleagues present alternative interpretations of the images. For example, the Cornell team interprets a white smear beside a tree trunk as the distinctive topside wing patch on a partially hidden, perching ivory-billed.

Sibley, however, proposes that it could be the underside of a wing of a pileated woodpecker launching itself away from the tree. If the bird is flying instead of perching, Sibley argues, the Cornell group's calculations of bird size no longer work. Fitzpatrick counters that a flying pileated woodpecker would show more black than is visible in the video.

Such debate makes for healthy science, says woodpecker researcher Jeffrey Walters of Virginia Polytechnic Institute and State University in Blacksburg. However, the only way to settle the debate is to find more evidence out in the woods. —S.M.

ASTRONOMY

Glassy galaxies

Clouds of sand crystals resembling crushed glass envelop 21 infrared-bright galaxies, astronomers report.

Observed by NASA's infrared Spitzer Space Telescope, the silicate crystals are the first recorded beyond the Milky Way. The galaxies that the crystals coat are known as ultraluminous infrared galaxies and are the product of a collision of two or more spiral galaxies.

Shock waves from the galaxy mergers triggered the birth of a huge population of massive stars, which ended their short lives in titanic explosions called supernovas, says Henrik Spoon of Cornell University. He and his colleagues propose in the Feb. 20 *Astrophysical Journal* that the silicate crystals were produced by the stars just before or during their explosions. Because the glassy crystals are fragile, they would quickly transform into an amorphous structure, say the researchers.

That suggests that Spitzer spotted the crystalline silicates around 21 of 77 infrared-bright galaxies because the craft looked at just the right time and the galaxies produced copious amounts of material. The team speculates that the galaxies that showed no evidence of the crystals either hadn't yet produced much of the material or had already converted it to a noncrystalline form. —R.C.

ANTHROPOLOGY

Capuchins resist inbreeding chances

Among wild capuchin monkeys, the highest-status father often retains his position in a group long enough for his daughters to reach sexual maturity, yet inbreeding is rare, a new study finds.

It's not yet clear whether capuchin fathers, daughters, or both take measures to prevent incest, according to a team led by geneticist Laura Muniz of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

For most social animals, either males or females leave their birth group at adolescence, so opportunities for inbreeding seldom arise. In capuchins, however, females never leave their birth group.

NO MONKEYING AROUND A capuchin alpha male accepts grooming from a female and their grown daughter, with whom he is unlikely to breed.

The team used DNA analyses to determine the fathers of 41 capuchin youngsters conceived during the 7-to-13 year tenures of three alpha males in Costa Rica. These males sired 19 of 24 infants born to females other than their daughters, compared with 1 of 17 infants born to their daughters, the researchers report in the March 7 *Current Biology*. —B.B.

CHEMISTRY

Busted bonds

The tenacious bonds between two carbon atoms can be broken in a surprisingly simple process, a new study finds.

Sergei S. Sheiko of the University of North Carolina at Chapel Hill and his colleagues synthesized molecules with a carbon backbone and long, densely packed side chains arranged as bristles on a bottle brush are. When the researchers put these molecules on solid surfaces, such as graphite or silicon, they found that the molecules' carbon backbones snapped into pieces.

The culprits, says Sheiko, are the bristle-like side chains. When the molecules are put onto certain types of surfaces, the side chains are attracted to them. The carbon backbone extends to accommodate this interaction, but even when it's fully stretched, "50 percent of the bristles do not have a parking spot, but they desperately want one," says Sheiko.

The competition for surface contact continues to impose tension on the carbon backbone, breaking its carbon bonds, the researchers report in the March 9 *Nature*. The team is now calculating the tension that ruptures the new bonds. —A.C.

NEUROTOXICOLOGY

Moldy whiff kills brain cells

Watch out, Hurricane Katrina and Rita cleanup crews. A common black mold that blooms on moist cellulose-based materials—from wallboard and ceiling tiles to cardboard—creates a toxin that can kill certain brain cells. In an experiment with mice, the chemical, satratoxin, targeted neurons running from the inside of the nose to the brain's smell center.

"This is the first demonstration that a neuron can be killed by satratoxin," notes Jack R. Harkema of Michigan State University in East Lansing.

The fungal toxin's "specificity is what's really unique," notes Harkema's Michigan State colleague James J. Pestka. Among the exposed nasal cells, the toxin proved lethal only to those that sense odors.

The black mold *Stachybotrys chartarum*, commonly found in water-damaged buildings, had already been linked to people's respiratory irritation and asthma. To identify nasal effects, Harkema, Pestka, and Zahidul Islam, also of Michigan State, made mice inhale a single dose of satratoxin and then monitored tissue changes over the next month.

Within a day of exposure, 75 to 80 percent of the olfactory neurons in the animals' noses had died, Harkema notes. Although these cells can regenerate, he says, even after a month, many had still not been replaced.

As little as 25 micrograms of toxin per kilogram of mouse-body weight elicited this neural toxicity. The scientists now plan to evaluate whether prolonged exposure to even lower doses—as could be assaulting hurricane-cleanup crews—might trigger similar changes.

A full report of the findings will appear in an upcoming *Environmental Health Perspectives*. —J.R.

ENVIRONMENT

Leaden streets

When Arlene L. Weiss and her colleagues found that urban house dust tends to contain more lead the closer it is to a frequently opened window, they reasoned that most of the heavy metal arrives from outside. Their new survey now confirms that street grit is the probable source of lead in urban homes and that flaking paint from overpasses and bridges is a major contributor.

The researchers sampled soil and street sweepings from 255 sites throughout New York City's five boroughs. The highest lead contamination occurred directly beneath elevated train trestles, where concentrations of the metal routinely reached many thousands of parts per million (ppm). The federal limit for lead in U.S. soil is 400 ppm.

Samples of outdoor dust were much less tainted just two to three blocks away from bridges and trestles, with lead loads in the range of 200 to 500 ppm, notes Weiss, a consulting toxicologist with Environmental Medicine in Westwood, N.J. Still, her team found, even among outdoor soil samples taken where there was no apparent structural source of lead, 20 percent exceeded the federal limit.

The federal limit for lead in house dust is 40 micrograms per square foot of swabbed area. Weiss and her colleagues report in the February *Environmental Research* that this amount can be exceeded on surfaces near windows in New York City after only 3 weeks of dust accumulation. Frequent cleaning of interior surfaces is necessary, they argue, to limit children's indoor exposure to the outdoor pollutant. —J.R.

BIOCHEMISTRY

Drinking increases skin's permeability

People should avoid alcoholic drinks before working with toxic compounds, new research suggests. At least in laboratory rats, drinking ethanol compromises the skin's barrier to chemicals.

Researchers at Northwestern University's Feinberg School of Medicine in Evanston, Ill., fed alcohol to rats in amounts ranging from the equivalent of half a drink taken by a person to more than enough to make a person legally drunk. Beginning 2 hours later, team members took a patch of skin from each animal, applied a chemical to it, and measured how much passed through.

Almost all the alcohol doses increased skin permeability, reports Rhonda M. Brand, and the effect usually lasted at least 24 hours. In general, the greater the alcohol intake, the leakier an animal's skin became. Two to three times as much paraquat, an herbicide, or DEET, a mosquito repellent, passed through the skin of rats that had received the highest alcohol doses as passed through the skin of the teetotaler rats.

Two years ago, Brand's team reported similar findings for herbicide-exposed rats that were continually and heavily consuming alcohol. Skin from chronically drunk rodents transmitted two to five times as much paraquat, atrazine, and 2,4-dichlorophenoxyacetic acid (2,4-D) as did the skin of sober animals.

Concludes Brand, "Extra care needs to be taken when handling chemicals if you've been drinking, even if it was a day earlier." —J.R.

BEHAVIORAL SCIENCES

Nonstick chemicals upset behavior

A study in mice finds that early-life exposure to the fluorinated chemicals used in nonstick products, such as fry pans, can rewire the brain in ways that dramatically affect behavior.

Niclas Johansson and his coworkers at Uppsala (Sweden) University exposed 10-day-old male mice to a single oral dose of a nonstick agent, either PFOS (perfluorooctanesulfonic acid) or PFOA (perfluorooctanoic acid). That stage of mouse life roughly corresponds to a major brain-development period in children, which lasts from shortly before birth to about age 2 years. Some groups of animals in the experiment ingested 9 to 11 milligrams of a nonstick chemical per kilogram of body weight; other groups got less than 10 percent of that amount.

At 2 and 4 months of age, each mouse was put in an unfamiliar cage. Untreated animals and those from the low-dose groups initially appeared agitated and were active, but within an hour they relaxed and fell asleep. Coauthor Per Eriksson says these animals integrated the environmental information and realized that the new cage wasn't much different from their home pens.

Mice from the high-dose groups, however, never settled down, which suggests that their brains didn't process the new stimulus appropriately, says Eriksson.

In another test, the researchers injected the mice with nicotine. The stimulant increased activity in all animals except those in the high-dose -PFOS and -PFOA groups; nicotine put those mice to sleep. The difference suggests, Eriksson says, that the early, high doses altered a brain-communications system that's affected by nicotine and that shapes behavior.

PFOS and PFOA have been showing up throughout the environment and in people's bodies. Johansson notes that doses in the new mouse study, although "quite low," did exceed those few values recently measured in babies and breast milk (*SN: 11/26/05, p. 341*). —J.R.

Books

A selection of new and notable books of scientific interest

ENCYCLOPEDIA OF GARDEN DESIGN AND STRUCTURE: Ideas and Inspiration for Your Garden

DEREK FELL

Carefully selected flowers, plants, structures, and other design elements lie at the heart of the world's most beautiful gardens. With more than 800 color photos, Fell compiles examples of gardens such as Monet's garden at Giverny, Dumbarton Oaks in Washington, D.C., and his own award-winning garden at Cedaridge Farm in Pennsylvania as helpful references and sources of inspiration for gardeners in their own backyards. Fell opens the guide with an overview of the history of gardening trends in formal and informal landscapes. Most of the book is an encyclopedic list of more than 150 garden-design features including bridges, courtyards, fences, and ground cover, and whimsical elements such as mirrors, labyrinths, topiaries, and garden gnomes. Furthermore, Fell explains the differences among English, French, Italian, and Japanese gardens and provides insightful commentary on selecting the best design elements, planting, and maintaining year-round interest. ***Firefly, 2006, 224 p., color photos, hardcover, $29.95.***

SIMPLE STARGAZING

ANTON VAMPLEW

Some books on the night sky are complex and meant for experts, but *Simple Stargazing* makes the sights above comprehensible to the novice sky watcher. Vamplew's book is jargonfree, written in a conversational style, and meant to be taken with you when stargazing. Constellations are given brief but thorough attention, as are other celestial bodies. The discussions include constellation names in both Latin and English; a short description of the history and significance of each constellation and how it got its name; and relevant details of the primary objects, such as stars, nebulae, galaxies, or galactic clusters. Each stellar feature is shown both with and without constellations marked, easing the transition from looking at the book to looking at the skies. The book is divided into sections covering both the Northern and Southern Hemispheres, so beginning skywatchers everywhere can enjoy this book. ***HarperCollins, 2006, 160 p., color photos and illus., paperback, $16.95.***

FISH ON FRIDAY: Feasting, Fasting, and the Discovery of the New World

BRIAN FAGAN

According to historical lore, Christopher Columbus sailed the ocean blue in 1492 in search of a shorter, more economical route to spice-rich India and China. Fagan asserts that Columbus' voyage and John Cabot's 5 years later were the inevitable culmination of a long history of exploration by fishing vessels in the North Atlantic. The early-European diet depended on fishing because the widely observed Christian doctrine dictated that no meat be consumed on any holy day, Wednesday, or Friday or at any time during Lent. Religion was so entwined with the fishing industry that clergymen helped develop many techniques for catching, farming, and preserving this precious commodity. With the advent of the Little Ice Age in the 13th century, fishing became increasingly difficult in the treacherous waters off Norway and Iceland, requiring that vessels forge farther from Europe. Fagan, an anthropologist, asserts that these sailors were the first Europeans to spot land in Newfoundland and other parts of North America. Combining history, social commentary, scientific hypothesis, and fishing and sailing lore, as well as recipes for fish dishes in the ancient style, Fagan presents a refreshing and intriguing look at the discovery of America. ***Basic, 2006, 368 p., hardcover, $25.00.***

PINHOOK: Finding Wholeness in a Fragmented Land

JANISSE RAY

One of the last vestiges of the American wilderness is the swamp that connects the Okefenokee National Wildlife Refuse in southern Georgia with the Osceola National Forest in northern Florida. The area is called Pinhook Swamp. With water too plant tangled for the passage of boats, this beautiful landscape is a source of mystery. The once-fragmented swamp was reconnected after the federal government purchased Pinhook's 170,000 acres in 1988. To Ray, an environmental activist, the swamp represents something larger than itself: an example of how wildlife responds when threatened by human activity. Pinhook's story includes past and present wildlife such as woodpeckers, red wolves, black bears, and panthers. The author details both the logging and strip mining that despoiled the area and the conservation work by organizations such as the Audubon Society and the Florida Wildlife Federation. Ray's story reveals how some people have made it their lives' work to preserve Pinhook. ***Chelsea Green Pub., 2005, 155 p., paperback, $12.00.***

PROGRAMMING THE UNIVERSE: A Quantum Computer Scientist Takes On the Cosmos

SETH LLOYD

The universe is a quantum computer. Every atom and particle of everything, be it a star or a DNA segment, is a bit of information that is being processed. Lloyd, a professor of quantum mechanical engineering, posits this unique theory about the physical world. In clear language, he describes information processing, starting with how strings of 0s and 1s can encode any amount of information. Small, simple operations build into complicated ones on the scale of the entire universe. After a primer on quantum mechanics and physical laws, Lloyd explains the history of the universe from the Big Bang to its current state. In doing so, he demonstrates how the laws of physics can be used to perform quantum computations. Lloyd presents for the layperson a new way to conceive of the origin and nature of the universe. ***Knopf, 2006, 240 p., b&w illus., hardcover, $25.95.***

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LETTERS

Bee movie?

In the article about using harmonic reflected signals to track bees ("The Trouble with Chasing a Bee," *SN: 1/14/06, p. 23*), I thought it was interesting to note that the original technology was created by the Russians as a spy device. The technology is still being used for a form of spying.

DWIGHT ELVEY, SANTA CRUZ, CALIF.

Birdy gurdy

I was surprised to read nothing about the timing of the songs when the birds are separated by distance ("Just Duet: Biologists puzzle over birds' ensemble vocalizations," *SN: 1/28/06, p. 58*). The ABCD duet would become A—BC—D (where the dashes represent the time delay due to distance) to the male and AB—CD to the female. The duet could be a distance-measurement tool for pairs wanting to keep track of how far apart they are.

JOE HEAGNEY, ARLINGTON, WASH.

When I read the article, the behavior of my pet yellow-naped Amazon, Wellington, suddenly became less surprising. He often likes to whistle the four phrases of "How Much Is that Doggie in the Window?" However, sometimes he indicates, by pausing after phrase A, that he wants me to whistle phrase B. He then whistles phrase C and pauses for me to whistle phrase D. Other times, if I whistle phrases A and C, he whistles phrases B and D.

ANDREA BORR, LA JOLLA, CALIF.

In the wild, yellow-naped Amazon parrots perform duets in which a male and a female take turns calling, says Timothy Wright of New Mexico State University in Las Cruces. —S. MILIUS

Missed step

"First Steps: Modern science investigates the initial stages of how fossils form" (*SN: 1/28/06, p. 56*) made no mention of the Clarno fossil beds and others nearby in north-central Oregon. Everything from pollen to midsize extinct mammals has been perfectly preserved and looks exactly like freshly exposed matter, not fossil rock. The living matter was entrapped by an enormous mudslide.

HERMAN GELBACH,
NORMANDY PARK, WASH.

Correction *"Tiny planet orbits faraway star"* (SN: 2/25/06, p. 126) *dropped a minus sign for the surface temperature of the newly discovered planet and comparably cool Pluto. It should have been –220°C.*

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