SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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one-two punch vs. anthrax
too much materialism?
scouring for comet source
frogs upgrade prey's toxin

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SEPTEMBER 6, 2003 VOL. 164, NO. 10

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Of Note

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Cover Late last month, NASA launched the Space Infrared Telescope Facility, which will join other powerful telescopes in a project designed to explain how galaxies assemble. The background of this drawing depicts an infrared view of the Milky Way. (NASA/JPL-Caltech) Page 155

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Double Shot

Anthrax vaccine gets makeover

Anthrax, a scourge once confined to farmers and wool handlers, has become a member of the rogues' gallery of biological weapons. Although there's a vaccine against anthrax, it's been the target of such strong criticism that a government-funded panel last year recommended that researchers find an alternative.

Scientists now report that in mice, a dual-purpose experimental vaccine appears to spur the immune system to disable anthrax's lethal toxin at the same time it kills the bacterium. The current vaccine targets only the toxin.

Meanwhile, another group presents new findings about how anthrax toxin kills.

Researchers at Harvard Medical School in Boston gave mice three injections of either the vaccine or an inert substance over 4 weeks. Two weeks after the last shot, the animals received an injection of anthrax toxin. All vaccinated mice survived, having formed antibodies that recognized and disabled the toxin. The other mice all died within a day of receiving the toxin.

In another part of the experiment, the researchers drew blood from vaccinated mice and exposed it to the bacterium *Bacillus licheniformis* as a stand-in for the more dangerous *Bacillus anthracis*, which causes anthrax. The vaccinated mice made antibodies that surrounded and killed *B. licheniformis*, suggesting that the new vaccine would do the same to *B. anthracis*, says study coauthor Julia Y. Wang. The findings will appear in an upcoming issue of the *Proceedings of the National Academy of Sciences*.

"It's a double whammy," says Vincent A. Fischetti of Rockefeller University in New York. The new vaccine will include material from the capsule that normally shields *B. anthracis* from the immune system. To make the two-part experimental vaccine, Wang and her colleagues chemically attached *B. licheniformis* capsule material to a portion of the *B. anthracis* toxin. The combination made the bacterium "visible" to the mouse immune system, Wang says.

This same strategy works in a pneumonia vaccine already in use, Fischetti says.

The current anthrax vaccine requires six shots over 18 months. The panel of the Institute of Medicine (IOM) in Washington, D.C., last year cited this regimen as a major drawback. The new dual-action vaccine could require half as many shots, Wang says.

However, the new vaccine would contain the same antitoxin ingredient that constitutes the existing vaccine. So it's unclear whether it would avoid the fatigue, memory loss, malaise, and other symptoms reported by some of the roughly 2 million military and other personnel who have received the current anthrax inoculations.

The IOM panel found no more adverse effects with the existing vaccine than with several of those for other diseases.

Even as Wang and her colleagues strive to develop a better anthrax vaccine, other scientists are still trying to decipher the details of how the microbe's toxin kills. New findings indicate that the toxin causes harm distinctive from that of other bacteria. It triggers "a unique kind of shock," says Stephen H. Leppla of the National Institute of Allergy and Infectious Diseases in Bethesda, Md.

Researchers have known that anthrax toxin damages blood vessels, resulting in internal bleeding and a buildup of fluid around the lungs that impedes breathing. One school of thought holds that the toxin attacks immune cells called macrophages and that this assault unleashes inflammatory proteins that damage the blood vessels. Leppla and his colleagues observed hundreds of mice reacting to anthrax toxin. In the September *Journal of Clinical Investigation*, the researchers report that two primary suspects among the inflammatory proteins don't seem to play a large role in the disease.

However, the team found that the animals' tissues become starved of oxygen. Damage was greatest to the liver, spleen, and bone marrow, says Leppla. Liver damage can release chemicals that do wide-ranging harm. "I'd like to know the molecular events causing liver cells to die," Leppla says. The new findings might spur research into the toxin's effect on liver cells, he adds. —N. SEPPA

Art on the Rocks

Dating ancient paintings in the caves of Borneo

The matchstick figures and images of hands lining the Gua Saleh Cave in southeast Borneo were made at least 9,900 years ago, a team of French archaeologists has deter-

L-H. FAGE

HANDIWORK These two hand shapes are joined by a symbol-adorned path. The artist applied pigment around a hand, then painted the lines.

mined. That date suggests that people inhabited the Asian island, the third largest in the world, some 4,000 to 5,000 years earlier than scientists had previously believed.

"It's difficult to know exactly how old the paintings are," says Jean-Michel Chazine of the National Center for Scientific Research in Marseille, France. He and his team established the artworks' minimum age by estimating when a mineral coating on the paintings had begun to form.

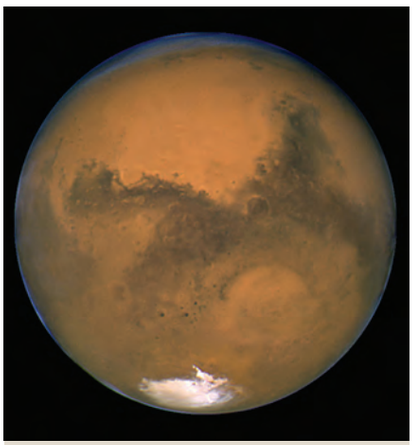
Paul Tacon of the Australian Museum in Sydney comments that the study is "extremely important, [providing] the first significantly old and reliable date for rock art of the region." He's not surprised by the early date for the artwork, however. It's "consistent with recent research by a range of scholars in nearby Timor and other parts of southeast Asia," he says.

Usually, archaeologists date rock art by evaluating the carbon content of organic pigments. However, the Gua Saleh Cave artists used pigments containing no carbon; they're made of pure hematite, an iron-ore mineral. So, Chazine and his colleagues used carbon dating on the calcite coating the paintings. Calcite, or calcium carbonate, is the main constituent of limestone and of cave formations such as stalagmites and stalactites.

Chazine and his team dated the calcite that had deposited over two hand shapes applied to the cave walls by the ancient artists. The researchers used a method known as uranium-thorium dating to cross-check the carbon-dating estimate of the calcite layer's age. Both methods rely on measuring the extent of radioactive decay of elements normally interspersed within the calcite.

In their study, published in the September *Quaternary Research*, the researchers use dates from both methods to estimate that the calcite veil is about 9,900 years old. Therefore, the paintings must be at least that old. Still unknown is how much time passed between the creation of the paintings and the formation of the calcite covering.

Because the Gua Saleh Cave and others like it are in limestone outcrops—some as high as 1,000 meters above Borneo's forests—the island's prehistoric inhabitants probably didn't live in the caves, but only visited them for important rites, Chazine says. Making images of hands was probably part of rituals such as healing ceremonies, he says. —S. MCDONAGH



Cozying up to Mars

The Hubble Space Telescope took this color-composite portrait of Mars on Aug. 26, just 11 hours before the Red Planet passed within 56 million kilometers of Earth, its closest approach in 59,619 years. The image, which shows Mars' south polar ice cap (bottom) and the huge Hellas basin impact crater (circular feature below and right of center), is the sharpest global picture of the Red Planet ever taken from Earth's vicinity. Mars and Earth approach each other unusually closely about every 17 years, but the two orbs won't reach last week's proximity again until 2287. Through September, Mars will rise in the southeast at sunset and set in the southwest at dawn. Luminous in the night sky, the planet resembles a butterscotch-colored star that doesn't twinkle. —R. COWEN

Hubble Highlights a Riddle

What's the source of quick-return comets?

New observations from the Hubble Space Telescope are demonstrating that scientists don't know where a major class of comets comes from.

Until recently, most planetary scientists had assumed that comets that take less than 20 years to orbit the sun originally resided in the Kuiper belt, a doughnut of icy material left over from the formation of the planets 4.5 billion years ago. The belt lies just beyond the orbits of Neptune and Pluto. But new observations suggest that to serve as a storehouse for comets, the Kuiper belt is too thinly populated with suitable objects.

Last winter, Hubble's Advanced Camera for Surveys stared for 200 hours at a tiny region of sky, just 10 percent the size of the full moon as seen from Earth. Gary M. Bernstein of the University of Pennsylvania in Philadelphia used a bank of 10 computers for 6 months to search the resulting images for faint objects moving in the Kuiper belt.

The study revealed three such objects, the brightest of which was subsequently recorded by the Keck 1 Telescope atop Mauna Kea in Hawaii. Ranging in diameter from 25 to 45 kilometers, the bodies are the smallest objects ever detected at the fringes of the solar system and are one-billionth as bright as the dimmest celestial objects visible to the naked eye. Theoretical predictions about the origin of short-period comets, which traverse the inner solar system, had led Bernstein and his colleagues to expect to find about 85 of these bodies in the Hubble images. At press time, Bernstein was scheduled to report the findings Sept. 6 at a meeting of the American Astronomical Society in Monterey, Calif.

For the Kuiper belt to be the supplier of the short-period comets, it ought to contain hundreds to thousands of times as many bodies as the images suggest, Bernstein's team calculates. A few years ago, Hal F. Levison of the Southwest Research Institute in Boulder, Colo., and a colleague suggested an alternative source for short-period comets. They proposed the group of objects known as the scattered disk, which extends from the outer edge of the classical Kuiper belt.

The new observations suggest that even this population of fringe objects might not be sufficiently massive to spawn the short-period comets, says Bernstein.

His team has proposed an explanation for the dearth of appropriate-size Kuiper belt objects: Many of the larger bodies there may have been shattered into bits by collisions. In fact, other researchers have suggested that the outward migration of Neptune or some other planet early in the history of the solar system triggered collisions within the Kuiper belt.

The new work is "spectacular," says Levison, because it provides the first data on the size of objects in the Kuiper belt. The study not only highlights the uncertainty about the origin of comets but also provides important clues about the formation and evolution of the outer solar system, he says. —R. COWEN

Skin Chemistry

Poison frogs upgrade toxins from prey

For the first time, scientists have found a poisonous frog that takes up a toxin from its prey and then tweaks the chemical to make it a more deadly weapon.

NASA, J. BELL, M. WOLFF

At least three species of the 4-to-5-centimeter-long *Dendrobates* frogs of the New World tropics modify an alkaloid to create one that's about five times as poisonous, according to a team led by John W. Daly of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) in Bethesda, Md. The souped-up poison, one of a class called pumiliotoxins, ends up as a protective agent in the frogs' skin, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*.

"It's an important thing, showing how chemistry connects the life of one organism to another," comments chemical ecologist Jerrold Meinwald of Cornell University. Although scientists have found that some creatures other than frogs customize a basic toxin for various purposes, "I don't know of any other examples of improving a defensive weapon," Meinwald says.

The new work grows out of years of research that started with a puzzle regarding dart-poison frogs, which belong to the family that includes *Dendrobates*. Frogs in three other families in South America, Australia, and Madagascar also carry poisons in their skin. However, when zoos and aquariums raise these supposedly deadly creatures, frogs from all but one Australian genus grow up harmless.

Daly and his collaborators in the early 1990s proposed that the wild frogs must be picking up the toxins from food and storing them in their skins. Since then, the scientists have found that ants and other arthropods in the frogs' habitat carry most of the poisons that show up in frogs' skin.

The finding that some frogs change the toxins they have eaten came as an unexpected twist of a theoretical study. NIDDK chemists Jingyuan Ma and Herman Ziffer were working with an alkaloid called pumiliotoxin 251D, one of the skin toxins of the frog *Dendrobates auratus*. The scientists produced both the form of the alkaloid found in nature plus a mirror-image form.

Daly and Valerie Clark dusted these substances onto termites and fruit flies and fed the spiced prey to captive frogs. When Thomas F. Spande and another NIDDK chemist, H. Martin Garraffo, analyzed the skins of these frogs, some 80 percent of the natural form of 251D had been converted to another toxin, allopumiliotoxin 267A. It has an extra hydroxyl group on one of its two rings. The unnatural form of 251D, however, showed up unchanged in frog skin.

The frogs must have a specific enzyme that retrofits just one form, the researchers conclude. Two other *Dendrobates* species modified the natural form, but two species in related genera didn't.

When the scientists tested allopumiliotoxin 267A on mice, they found it a much more potent poison than its precursor.

"It's the first case found where a frog is clearly modifying one of the sequestered alkaloids," says Spande. "We were very surprised." —S. MILIUS

PNAS, NATIONAL AQUARIUM IN BALTIMORE

LITTLE CHEMIST This 4-centimeter-long frog, *Dendrobates auratus*, can enhance the power of a particular form of toxin that it picks up from its food.

Zealous Adherence

Erratic HIV therapy hasn't fueled resistance

Among people infected with HIV, those who don't consistently take their antiretroviral drugs as prescribed are no more likely to develop drug-resistant HIV than are patients who adhere to their treatment schedule, researchers report. This result contradicts a widely held assumption among health professionals that irregular use of HIV therapy has been a factor in spreading drug-resistant strains of HIV, says David R. Bangsberg of San Francisco General Hospital.

The assumption arose in part because poor adherence to drug regimens, particularly among indigent and homeless populations and illegal-drug users, has contributed to epidemics of drug-resistant tuberculosis, Bangsberg says. A similar situation for HIV treatment would create an ethical dilemma, he notes, because giving HIV drugs to people who are likely to take them sporadically might increase disease risk for the rest of the population.

To assess the relationship between treatment adherence and drug resistance, Bangsberg and his colleagues followed 148 impoverished, HIV-infected residents of San Francisco who lacked permanent housing or received government-provided meals. The researchers measured adherence by seeking out the volunteers without warning and comparing the number of pills they had at hand to the number they should have had if they were complying with their prescriptions. The scientists also took monthly blood samples over 6 months of treatment to monitor the volunteers' concentrations of HIV and to determine how many drug-resistant mutations the virus had developed.

Many people who took their pills consistently had no detectable blood concentrations of HIV and therefore no apparent drug-resistant mutations.

Among the minority of good adherers who did have detectable viral loads, however, drug-resistant mutations of the virus were more common than they were in poor adherers, Bangsberg and his colleagues found. Over a 6-month period, 23 percent of the drug-resistant mutations arose in the one-fifth of volunteers who took their medication most consistently; only 12 percent of the mutations cropped up in the one-fifth of the volunteers who complied least consistently with their prescriptions, the researchers report in the Sept. 5 *AIDS*. As a group, therefore, good adherers contribute at least as much to the rise of drug-resistant HIV as poor adherers do.

The finding "in no way suggests that patients should take less of their drugs," Bangsberg says. Taking antiretroviral drugs religiously is the best way to keep viral loads low and to stave off the onset of AIDS, he adds.

"There's probably an over-exaggerated risk of resistance in [poor and drug-abusing] populations," comments Gerald H. Friedland, a Yale University researcher who studies adherence to HIV-drug regimens. Because fear that drug-resistant HIV arises most rapidly in those populations is apparently misplaced, "we shouldn't exclude patients [from therapy] who are thought to be nonadherent," he says.

"The patient might do harm to himself or herself by not taking the drugs . . . but they wouldn't add to the total cumulative pool of resistant virus." —B. HARDER

Sopping Up Heavy Metal

Hybrid material removes mercury from water

Endowed with resourceful molecular machinery, microbes can adapt to environments as unappealing as oil slicks and toxic-waste dumps. Some bacteria can even bind to heavy metals such as mercury—a trick that researchers at the University of California, Riverside are now exploiting for treating contaminated water.

When exposed to mercury, the bacterium *Escherichia coli* synthesizes a protein that binds specifically to the heavy metal. Wilfred Chen and his colleagues set out to take advantage of that protein for cleanup operations.

First, the scientists genetically engineered bacteria to create a molecule containing both the bacterial protein and an artificial form of the muscle protein elastin. This form tends to clump when heated. The scientists next extracted the resulting compound.

When added to a sample of contaminated water, the compound bound the mercury. And when the temperature was raised to 35°C, the complex clumped into aggregates that were easily separated from the water with a short spin in a centrifuge.

The Riverside team tested the material on samples of water doped with mercury and hundredfold-higher concentrations of other heavy metals, including zinc, nickel, and cadmium, which the compound doesn't bind. Not only did the new material reduce the amount of mercury to concentrations permitted in drinking water, but its remedial action wasn't hindered by the other heavy metals. The findings are slated to appear in an upcoming *Environmental Science & Technology*.

"This is a very exciting and important advance," says Anne Summers of the University of Georgia in Athens.

Chen's technique could offer a safer, cheaper, and more efficient alternative to other mercury-remediation technologies, such as costly filtration systems that employ toxic materials, adds Tamar Barkay of Rutgers University in New Brunswick, N.J. What's more, the complexes are recyclable because the mercury can be easily stripped off.

Using extracted compounds, rather than intact bacterial cells, for remediation avoids the risks associated with genetically modified organisms that could escape into the environment, says Chen.

While other groups are studying elastin-like polypeptides (ELPs) for delivering drugs to the body or for growing new tissues in the lab, "using ELPs for bioremediation is really novel," says Barkay.

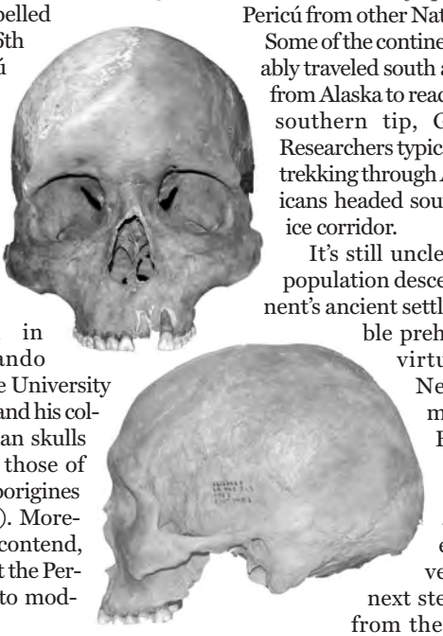
Chen's group is currently adapting the technique for use with bacterial proteins that bind other heavy metals, such as arsenic. "It's such a flexible technology," says Chen, adding that the next big challenge is to scale up the process for treating large volumes of water. —A. GOHO

Continental Survivors

Baja skulls shake up American ancestry

Around 600 years ago, the Pericú people roamed the southern tip of what is now Mexico's Baja peninsula, a finger of land that extends below California. Although the Spanish conquest spelled their demise in the 16th century, the Pericú were living links to America's first settlers, according to a new anthropological study.

Pericú skulls closely resemble 8,000- to-11,000-year-old human skulls unearthed in Brazil, say Rolando González-José of the University of Barcelona, Spain, and his colleagues. The Brazilian skulls look strikingly like those of today's Australian aborigines (*SN: 4/7/01, p. 212*). Moreover, the scientists contend, the data indicate that the Pericú were unrelated to modern Native American and eastern Asian groups.



FACING BACK Two views of a skull from a Baja population that may illuminate the settlement of the Americas.

GONZÁLEZ-JOSÉ

These findings support the scientists' theory that both the first Americans, who arrived at least 12,000 years ago, and the first Australians, who showed up down under around 40,000 years ago, have a common root in southern Asia. A second wave of American settlers, the ancestors of present-day Native Americans, immigrated from northeastern Asia a mere several thousand years ago, González-José's group concludes in the Sept. 4 *Nature*.

That scenario clashes with the traditional view that both the initial and later waves of American settlers came from northeastern Asia.

"Slowly, we are realizing that the ancestry of the Americas is as complex and as difficult to trace as that of other human lineages around the world," comments anthropologist Tom D. Dillehay of the University of Kentucky in Lexington.

González-José and his coworkers compared measurements of 33 Pericú skulls housed at a Mexican museum with those of 22 ancient Brazilian skulls and hundreds of skulls from a worldwide sample of contemporary groups.

The Baja and Brazilian skulls exhibit telling similarities, the investigators say. These include long, narrow braincases and short, thin faces, a pattern akin to that of modern inhabitants of southern Asia and South Pacific islands.

The Pericú and the ancient Brazilians were descendents of America's initial settlers, the scientists propose. After the last ice age ended around 10,000 years ago, they add, the expansion of a desert across the middle of the Baja peninsula isolated the Pericú from other Native American groups.

Some of the continent's first arrivals probably traveled south along the Pacific coast from Alaska to reach the Baja peninsula's southern tip, González-José says. Researchers typically theorize that after trekking through Alaska, the first Americans headed south through an inland ice corridor.

It's still unclear whether the Baja population descended from the continent's ancient settlers or grew to resemble prehistoric Brazilians by virtue of adapting to a New World environment that's similar to Brazil's, Dillehay says.

According to archaeologist David J. Meltzer of Southern Methodist University in Dallas, the next step is to extract DNA from the Baja and Brazilian skulls and determine whether the two groups had close genetic ties. For now, Meltzer remains convinced by skeletal and archaeological evidence that points to Siberia as the homeland of America's first settlers. —B. BOWER

BUYER BEWARE

Some psychologists see danger in excessive materialism

BY BRUCE BOWER

California psychologist Allen Kanner often asks the children he treats for emotional and behavioral problems to talk about what they want to be when they grow up. Until about 10 years ago, kids told Kanner they wanted jobs such as astronaut, physician, baseball player, and ballerina. Then, their aspirations took a sharp turn for the purse. Gap-toothed grade-schoolers and gangly middle-schoolers started telling Kanner that they just wanted to be rich.

A striking behavioral development accompanied the rise of this show-me-the-money attitude, Kanner says. Children brought in for treatment frequently turned up their noses at conventional toys that the psychologist kept on hand, and demanded electronic games or other "better, newer" toys. Otherwise, the children saw no reason to play. And playing forms the core of psychotherapy with children.

From Kanner's perspective, these kids represent the tip of a materialistic iceberg that's increasingly freezing the joy out of many people's lives in Western societies. Modern citizens are consumed by life, liberty, and the pursuit of more and better stuff, prodded on by the relentless flow of advertisements (see sidebar) designed to create a flood of retail desires. The single-minded quest for profit in large corporations demands more and more hours of work from employees by fostering the belief that if you're rich, you're happy, Kanner says.

GIMME MORE — Some research suggests that personal happiness plummets among people obsessed with being rich and buying lots of expensive stuff.

Meanwhile, one line of psychological research that he and others are pursuing suggests that feelings of satisfaction and happiness decline among people driven by a need for financial success and fancy possessions.

The data reflect a two-pronged problem, Kanner argues. In some cases, people who buy into the values of consumer culture end up starved for close friends, family, or any deeper meaning in their lives. For others, he says, money and possessions are hollow compensations for doubts about self-worth, worries about life's uncertainties, and, especially, fears of death.

"When money becomes the focus of what you think is important, your motivation and well-being suffer," concurs psychologist Tim Kasser of Knox College in Galesburg, Ill. "Increases . . . in one's own salary don't equate with increases in happiness."

Kanner and Kasser have edited a book on this theme titled *Psychology and Consumer Culture: The Struggle for a Good Life in a Materialistic Society* (2003, American Psychological Association).

Not everyone is ready to take these psychologists' message to the bank. For example, some researchers contend that the amount of money people seek is usually irrelevant to their personal happiness, unless they're trying to substitute material goods for self-esteem. And some investigators argue that the promise of more money can boost creativity and motivation to achieve goals, both of which play into the happiness equation.

MATERIAL WOES It comes as no surprise that poor people often regard wealth, possessions, and status as keys to happiness. Political scientists have found that residents of poor countries hold stronger materialistic values than those in rich countries do. They've also found that generations raised in bad economic times are more money oriented than those raised in prosperous times, and that national recessions usually herald spikes in people's materialistic concerns.

But among people with decent roofs over their heads and meals assured, the hunger for wealth reflects a different, graver kind of concern, Kasser proposes. Think of it as beating back death with a designer cane.

In an investigation directed by Kasser, college students were assigned to write an essay either about their own death or about music. In a survey taken after the essay was completed, students who wrote about death reported higher expectations for their future salaries and spending than did their peers who were told to write about music. After writing about death, students also turned greedier when playing an experimental game in which they had to divvy up resources with partners.

Kasser's work builds on studies directed by psychologist Jeff Greenberg at the University of Arizona in Tucson, in which peo-

ple who are asked to think about themselves dying then report temporarily stronger religious and political beliefs. Death-pondering volunteers also show signs of trying to bolster their self-image: They cite newfound desires to improve their romantic relationships and contribute to charities, for example.

Another study found that people who think about death exhibit markedly increased preferences for pictures of well-manicured gardens and other scenes of cultivated nature versus wilderness scenes.

Greenberg and his colleagues view such findings as consistent with the notion, advanced 30 years ago by anthropologist Ernest Becker, that those who chase after wealth in modern societies are trying to deflect their fear of death. In the garden-scenes study, they argue, images of tamed nature soothe mortality concerns and create an illusion that the natural course of life and death can be conquered.

Greenberg asserts there's another reason materialism has broad appeal as a balm for death fears: It serves as a secular religion in a time marked by widespread loss of faith in traditional forms of worship.

Much more research is needed to explore that provocative possibility, says psychologist Edward Diener of the University of Illinois in Urbana-Champaign. Still, there's good reason to suspect that materialism can be "toxic to subjective well-being," Diener says.

In a new study, he and his coworkers found that people who identified themselves closely with expensive possessions, such as diamonds, reported more negative and fewer positive moods when contacted at various times over a 7-day period than did volunteers who identified themselves with inexpensive objects, such as flowers.

Additional evidence gathered by Diener's group points to three reasons that materialistic people may report more than their share of dissatisfaction and foul moods. First, they often maintain distant and unfulfilling relationships, according to interviews with their families and friends. Second, materialistic people generally report less enjoyment from activities undertaken to further their own financial goals than from activities having other goals, such as volunteering in the community or trying to become more popular.

Finally, materialistic people describe an especially large gap between what they have and what they want financially, compared with the differences they perceive between their wants and haves in other arenas, such as their home and work lives.

To be sure, no one is advocating poverty as the pathway to happiness. Overall, people living in rich countries describe themselves as being happier and more satisfied with their lives than those living in poor nations do, Diener notes.

The challenge for wealthy nations, in Diener's view, is to nurture economic development, which should raise the citizenry's standard of living, without encouraging the worship of money and possessions. Rampant consumerism doesn't just pose a risk to individual happiness, Diener adds. It threatens a person's work ethic and ability to be creative.

Kanner and Kasser would like to see a radical shift in public attitudes toward materialism. In their book, they call for a "voluntary simplicity" movement based on the principle that people need to slow down, reduce wasteful consumption, and emphasize family and relationships.

BUCK UP Not everyone buys the argument that people pay an emotional price for celebrating materialistic values. According to an article on the pursuit of wealth and psychological well-being that appeared in the *Journal of Personality and Social Psychology* in 2001, the problem is not the money, but the motivation.

The authors of that article, Abhishek Srivastava of the University of Maryland in College Park and his colleagues, had developed a survey that asked questions identifying different motives for making money. They administered the survey to 266 business students and 145 successful entrepreneurs.

In both groups, those who indicated they wanted a lot of money to overcome self-doubt, obtain better possessions than others, and seek power also reported relatively little happiness and satisfaction with their lives. In contrast, individuals who sought big bucks to enhance family security, to enjoy greater freedom in and out of work, to make a mark on society by giving to charities, or to achieve a sense of personal pride, reported being generally happy and satisfied with their situations.

Although attempts to bolster one's self-esteem by seeking money ultimately fail, "money itself is not harmful," says study coauthor and psychologist Edwin A. Locke, now retired from the University of Maryland.

What's more, other evidence indicates that the judicious use of money and other external rewards actually boosts people's feelings of competence, interest in what they're doing, and creativity, according to investigations directed by Robert Eisenberger of the University of Delaware in Newark.

For instance, Eisenberger and his colleagues found that grade-schoolers given small amounts of money for thinking up creative uses for everyday objects then generated more creative titles for movies and short stories than did children who had first thought up creative uses for the objects without getting paid or who didn't perform the initial task. Similarly, college students devised more-creative short story titles when promised a finan-

Pricey Pursuits Take Charge

The making of a consumer nation

Social scientists have long looked at the United States as a crucible of mass consumption. In 1899, economist Thorstein Veblen wrote of the "conspicuous consumption" of goods and services by people who could afford them. Other scientists soon noted a tendency for people to make purchases on the basis of comparisons with what their friends and neighbors bought.

After World War II, a consumer ethos sank deep roots into the U.S. economy, politics, and culture, asserts Harvard historian Lizabeth Cohen in *A Consumer's Republic* (2003, Knopf). Mass consumption and prosperity became basic components of citizenship as people were encouraged to buy for the good of the country, as well as for themselves. Self-interested citizens increasingly treated government policies as market transactions, to be judged solely by the personal benefits that flowed from the policies, Cohen asserts.

The economic boom of the 1990s shifted consumer practices and attitudes into materialistic overdrive, says Boston College sociologist Juliet B. Schor. No longer content to "keep up with the Joneses" in their own neighborhoods, a wide array of people sought fancy homes, luxury cars, and other trappings of upper–middle-class life.

Training for the consumer culture begins early. Corporations currently spend about $12 billion annually on efforts to influence what kids buy, often pitching the products directly to children rather than to their parents. With such a media blitz on their kids, parents trying to keep materialism in check may feel outgunned.

Sociologist Daniel T. Cook of the University of Illinois at Urbana-Champaign says that the trick for concerned parents is "to incite children to adopt a critical posture toward media and consumption." —B.B.

cial reward for creativity.

In surveys at retail outlets of an electronics and appliance company, Eisenberger also learned that employees who expected financial or other rewards for superior performance found their jobs more interesting and enjoyable than did those who didn't link performance to external rewards. Supervisors rated on-the-job creativity as higher among reward-oriented employees.

However, financial success by itself has its downsides, according to a report in the June *Personality and Social Psychology Bulletin*. Ariel Malka and Jennifer A. Chatman, both of the University of California, Berkeley surveyed 124 individuals in the first year of a 2-year master's program in business administration. Follow-up responses were obtained 4 to 9 years later, when most of the participants worked in jobs that paid from $80,000 to $2 million annually.

Those who were working mainly for intellectual stimulation, opportunities for innovation, and other intrinsic values reported lower job satisfaction and less happiness in their lives as they earned higher salaries, say Malka and Chatman. In contrast, people who entered the business world with the up-front, brazen goal of making lots of money felt better about their jobs and generally happier as their paychecks grew fatter.

Making major money at a job chosen for intrinsic reasons causes people to question their motives for accepting the position and to lose the joy in their work, Malka theorizes. Money-oriented folk may instead bask in the glow of a high income, since they regard it as the primary sign of success and personal worth.

No one has come up with a formula for happiness and well-being that works for everyone, and any factor, including material reward, will have different effects on different people. This much is clear: Money and possessions hold a place of honor in our society that they are unlikely to lose any time soon. And that means research into materialism's effects on well-being represents a growth industry. ■

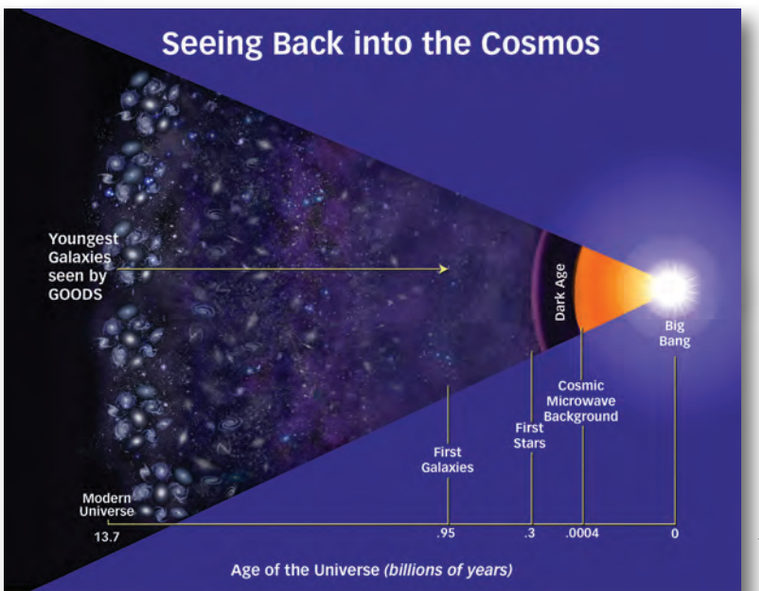
GETTING THE GOODS ON GALAXIES

A telescope views patches of the universe in a rainbow of colors

BY RON COWEN

Over the past decade, the Hubble Space Telescope has literally changed our view of the universe. Much of what we now understand about galaxy formation has been gleaned from Hubble staring for 10 days at a single tiny patch of sky. Within this region, the Earth-orbiting telescope has catalogued the shape, brightness, and color of galaxies that are only 500-millionths as bright as the eye can see. But if one sharp eye on the universe is good, then two, three, four, or more are better.

In an ambitious new program, Hubble recently joined forces with NASA's orbiting Chandra X-ray Observatory and several of the world's largest ground-based telescopes to expand astronomers' view to a panoply of wavelengths. These observatories, which are about to be joined by the Space Infrared Telescope Facility, launched late last month, are shedding light on galaxy assembly in a way that no single telescope, looking at the sky at a limited set of wavelengths, could ever manage. It's the difference between viewing a photograph in color versus black-and-white, except that the range of wavelengths is millions of times larger than those depicted in a color photo.



COSMIC TIMELINE — Observatories are peering far back in time to study the evolution of stars and galaxies. As part of a survey called GOODS, the Hubble Space Telescope's Advanced Camera for Surveys and the Chandra X-ray Observatory are searching the same part of the sky for some of the first galaxies.

NASA, A. FEILD/STSCI

Known as the Great Observatories Origins Deep Survey (GOODS), the coordinated effort focuses on two regions of the heavens. One swath, known as the Hubble Deep Field North, was originally examined by Hubble's wide-field and planetary camera in late 1995 and has recently has been scanned by an even more-sensitive instrument, Hubble's Advanced Camera for Surveys, installed 2 years ago. This camera has more than twice the field of view of the older detector. The other section of sky is known as Chandra Deep Field South. The area encompassed by the two regions is nearly half the size of the full moon as viewed from Earth and 70 times the original Hubble Deep Field North.

Each of the two fields examined by GOODS contains tens of thousands of galaxies, some so distant that they hail from a time when the 13.7-year-old universe was only a billion years old.

"This is the first time that the cosmic tale of how galaxies build themselves has been traced reliably to such early times in the universe's life," says GOODS researcher Mauro Giavalisco of the Space Telescope Science Institute (STScI) in Baltimore.

DISTANT OR DUSTY? After comparing recent Chandra and Hubble images of the Chandra Deep Field South, astronomers are faced with a mystery. Chandra found seven strong X-ray sources that can't be seen at all in visible light. Usually when astronomers have detected such intense X rays, the source has been the whirlpool of matter spiraling into a supermassive black hole. However, supermassive black holes lie at the centers of galaxies, where stars produce great amounts of visible and ultraviolet light.

"We should see the optical galaxies in our Hubble images . . . but we don't see anything," notes Anton Koekemoer of STScI, who will describe his team's study in an upcoming *Astrophysical Journal* devoted to early findings from the GOODS survey.

One explanation is that the X rays that Chandra recorded come from the most distant supermassive black holes known in the universe, dating from a time when the cosmos might have been only about 600 million years old, or just 7 percent of its current age. In that case, Hubble wouldn't detect the remote galaxy housing the black hole because the expansion of the universe would have shifted all of the galaxy's ultraviolet and visible light to wavelengths much redder than the telescope can record. Such ancient supermassive black holes are of keen interest because recent evidence suggests that they're intimately connected to the growth of the galaxies in which they reside (*SN: 4/5/03, p. 214*).

There could be, however, a more mundane explanation for the X-ray findings, cautions Koekemoer. The X-ray sources could be

supermassive black holes that lie much closer to Earth but whose small host galaxies are shrouded in so much dust that they can't be seen in visible light. If so, calculations show that the galaxies would have to be dustier than any other group of galaxies known. In fact, the dust would have to be so implausibly thick that some astronomers favor the first explanation.

Scientists may soon have a solution to this puzzle. "The next steps really will be to see what the Space Infrared Telescope Facility can tell us about these objects," notes Koekemoer. If the X-ray sources come from remote galaxies, the visible starlight that these galaxies have radiated will have been shifted into the midinfrared, exactly the wavelength range in which the new infrared telescope is sensitive. On the other hand, if the galaxies are nearby, the abundant dust would radiate large amounts of infrared radiation, and the telescope "should be able to measure how much dust they contain," says Koekemoer. Results from the newly launched observatory are expected within a year.

BUILDING GALAXIES Combining GOODS observations taken by Hubble with near-infrared and visible-light images taken from the ground has already given astronomers the first evidence that galaxies were forming substantial numbers of stars early in the universe. Casey Papovich of the University of Arizona in Tucson and his colleagues report in the special issue of *Astrophysical Journal* that when the universe was 2 to 3 billion years old, galaxies bulked up, increasing their stellar mass by about 40 percent.

That number is only a rough estimate, notes Papovich, because it's not based on a galaxy-by-galaxy measurement. Instead, he and his colleagues added up all the near-infrared and visible light from two sets of galaxies observed in the GOODS survey. In one set, galaxies were observed as they appeared 12 billion years ago; in the other, a billion years later. The increase in light output over this interval indicates that the latter group has more stars.

"It looks like you are actually seeing galaxies build up their stellar mass, and we hadn't actually seen that" so early in the universe, says Harry Ferguson of STScI. A large sample of galaxies hailing from 12 billion years back in cosmic history had never been detected before the Advanced Camera for Surveys was installed on Hubble, he notes.

Previous studies had indicated that about 7 billion years ago, star formation dropped to about one-tenth its earlier rate. This indicates that galaxy assembly trailed off when the universe was about half its current age.

The Space Infrared Telescope Facility is likely to refine these numbers, as that observatory will conduct a more representative census of stellar mass among distant galaxies, which date from a time when the universe was young. The bulk of stars radiates at visible and near-infrared wavelengths, and for distant galaxies, this radiation is shifted into the infrared.

In a related result, Ferguson and his colleagues used GOODS data to find that galaxies have continuously increased their size since the time the universe was about 1 billion to 6 billion years old. Both the buildup of stars and galaxy size are consistent with the standard, bottom-up model of galaxy formation, Ferguson notes.

In that model, galaxies start out small and grow by merging with other, similar-size galaxies and capturing smaller, satellite ones (*SN: 8/16/03, p. 99*). Driving that activity is the unseen but ubiquitous material dubbed dark matter. In the bottom-up model, dark matter is the universe's first stuff to coalesce, and the gravity that results then drives ordinary, visible matter to gather into galaxies.

SUPER FINDINGS Astronomers expect GOODS observations to answer another question: Is the mysterious force called dark energy causing the universe to expand at an ever-faster rate? Until 1998, the standard theory of cosmology held that, ever since the Big Bang, gravity's tug has slowed the expansion of the universe. Then, measurements of the intensity of distant, exploding stars called type 1A supernovas caused a scientific sensation by describing a universe whose expansion is accelerating (*SN: 4/7/01, p. 218*).

Now, by repeatedly observing the two patches of sky in the GOODS survey, Hubble's Advance Camera for Surveys has identified 10 extremely distant type 1a supernovas. These remote supernovas should put dark energy to the ultimate test, says Adam Riess of STScI.

Astronomers refer to these supernovas as standard candles because they all have about the same intrinsic brightness, like light bulbs of the same wattage. Most previous observations recorded type 1a supernovas that were several billion light-years from Earth, so astronomers see the supernovas as they appeared when the universe was several billion years younger than it is today.

> "We definitely have the data in the can, enough to tell us the expansion history [of the universe]."
>
> —ADAM RIESS

If gravity had continuously slowed cosmic expansion, the distance between Earth and those supernovas ought to be less than if the expansion rate had remained constant or sped up. Because the supernovas wouldn't lie as far away, they should appear brighter.

Yet two teams of astronomers announced in 1998 that they had found just the opposite. Supernovas were 20 percent dimmer than expected if cosmic expansion had remained constant. That suggested that cosmic expansion had in fact sped up and that the space between Earth and those supernovas had stretched out more than anticipated.

Researchers ascribe this strange state of affairs to dark energy, an entity that's the flip side of gravity. Where ordinary gravity pulls objects together, dark energy pushes them apart.

Not everyone has been convinced by the supernova data. Some astronomers worry that supernovas were intrinsically different in the past or that cosmic dust could make the supernovas appear dimmer than they really are.

But there is a test that could allay such concerns. According to some theorists, dark energy has remained constant in strength throughout the history of the universe. In contrast, the density of matter, which gives rise to gravity's familiar tug between objects, was much higher in the past, when the universe was smaller.

In fact, more than 5 billion years ago, the density of all the matter in the universe would have been so great that its pull would have overwhelmed dark energy's push. During that early time, ordinary gravity was at the helm, slowing cosmic expansion.

If all this holds true, then supernovas that are extremely remote and hail from the distant past ought to be slightly closer to Earth and thus appear brighter than they would if the universe has been expanding at either a constant or accelerated rate. That's not an effect that dust, for example, could mimic.

Astronomers have observed only a few supernovas that are distant enough to qualify for this test, but their brightness supports the hypothesis that dark energy is driving cosmic expansion.

"We definitely have the data in the can, enough to tell us the expansion history [of the universe] and whether there was a deceleration phase prior to an accelerated expansion or whether there's some strange surprise in store," Riess says. His team expects to have preliminary results in October.

Next year, the Hubble camera will take an even deeper look at the two sky regions already examined by GOODS. By including the most powerful telescopes on Earth and in space, "the survey is giving us a uniquely comprehensive history of galaxies from early epochs to the relatively recent past," says Mark Dickinson of STScI.

The findings, he adds, will also serve as a bridge to future explorations with Hubble's proposed successor, the James Webb Space Telescope. Scheduled to be launched a decade from now, it will have the capability to peer even farther back in time to see the very first galaxies and stars in the universe. ■

OF NOTE

ASTRONOMY

A phoenix on Mars

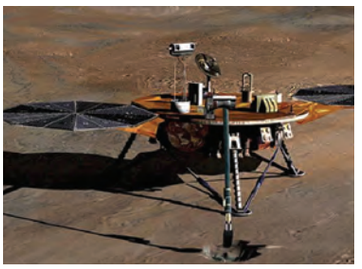
If all goes well, in 2008, a spacecraft will land on the north polar region of Mars and scoop up samples of the icy terrain. Analyzing those samples on the spot, the $325-million probe that NASA approved early last month will look for minerals and organic matter that may indicate whether Mars could ever have harbored life—and whether it still does.

This region may be a promising place to answer such questions because recent studies on Earth have shown that colonies of microbes that have been dormant for years in frozen soil can revive in melting water ice, notes lead scientist Peter H. Smith of the University of Arizona in Tucson.

The lander for the aptly named Phoenix mission was intended for the 2001 Mars Surveyor program, which was scrapped after NASA lost the Mars Polar Lander as it reached the planet in December 1999.

Scheduled for launch in 2007, Phoenix will carry improved versions of the wide-field cameras and gas analyzer from the lost mission, a trench-digging robotic arm, and hydrology equipment.

The mission may reveal whether Martian soil contains chemicals that would either destroy or support life. —R.C.



MARTIAN INVASION Artist's drawing of Phoenix landing on Mars.

PHOENIX TEAM/UNIV ARIZONA; PNAS

BEHAVIOR

Flag raised for kids' mental health

No nationwide study of psychiatric disorders has been conducted among children and teenagers in the United States. However, a 7-year study of kids living in North Carolina indicates that at any given time 1 in 6 children had a psychiatric ailment. What's more, at least 1 in 3 of the youngsters developed one or more psychiatric disorders by age 16, say epidemiologist E. Jane Costello of Duke University Medical School in Durham, N.C., and her coworkers.

These findings are worrisome, the researchers maintain in the August *Archives of General Psychiatry*. As children grow older, psychiatric disorders more often interfere with the ability to function well at home, at school, and with peers.

Costello's team studied 1,420 children living mainly in rural areas. The kids, ages 9 to 13 at the beginning of the study, completed annual mental-health surveys through age 16.

Once children developed a psychiatric disorder, their odds of continuing to have one were much greater than those of peers with no prior psychiatric diagnosis. This trend was especially strong among girls.

For both boys and girls, by around age 15, childhood ailments, including attention-deficit hyperactivity disorder, had largely been replaced by adult disorders such as depression, panic disorder, and substance abuse. —B.B.

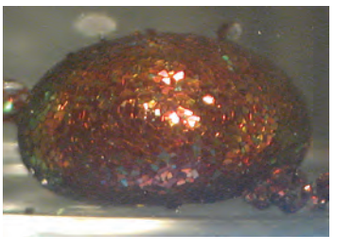
TECHNOLOGY

Smart dust can swarm target

Scientists have fabricated micrometer-size silicon mirrors, or "smart dust," that can swarm and stick to a target—conceivably, contaminants in drinking water or a cancer cell—and then relay information about that target to the outside world.

To make the mirrors, researchers at the University of California, San Diego etched each side of a silicon chip so that one side appeared green and the other red. They also coated the red side with a hydrophilic (water seeking) chemical and oxidized the green side, making it water avoiding, or hydrophobic. Applying ultrasound shattered the silicon chip into micrometer-size particles.

In an upcoming *Proceedings of the National Academy of Sciences*, the researchers report adding the particles to a vial of water tainted with a drop of oil. The particles clustered around the oil with their hydrophobic sides facing the oil and their hydrophilic sides facing out. As a result, the oil drop glittered red, "sort of like a disco ball," says UC–San Diego's Michael Sailor. Some of the oil seeped into the porous mirrors. That changed the pattern of light reflected. Since different substances have the potential to yield different optical signatures in this technique, micromirror swarms could have the smarts to discern many targets. —A.G.



DISCO YUCK Microscopic mirrors self-organize around a drop of oil, making the oil easy to detect.

CHEMISTRY

Amino acid lends a heavy hand

Billions of years ago, a simple amino acid may have triggered all other amino acids to adopt a left-handed configuration, determining the chemical fate of these biological building blocks and influencing the emergence of life on Earth.

Amino acids, the basic units of proteins, come in either right- or left-handed configurations—mirror images of each other. However, the amino acids in living organisms are all lefties. To find out why, R. Graham Cooks and his colleagues at Purdue University in West Lafayette, Ind., analyzed all 20 natural amino acids and found that only serine forms highly chemically stable clusters.

"Even more dramatic, the amino acids in each cluster were either all in the right or left form," says Cooks. In contrast, clusters of other amino acids were less stable and contained a mixture of both left and right configurations, Cooks and his colleagues report in the Aug. 4 *Angewandte Chemie International Edition*.

When the researchers mixed clusters of eight left-handed serines with other amino acids, the clusters bound only to other left-handed amino acids. Similarly, right-handed serine clusters bound only to right-handed amino acids. When the researchers exposed serine clusters to simple sugars, just the opposite occurred. Left-handed serine bound only to right-handed sugars and vice versa.

Serine clusters' high stability and selectivity have convinced the researchers that left-handed serine must have forced its chemical siblings to follow its lead. What caused serine's left form to become dominant in the first place remains an open question. Some scientists say that ancient minerals may have favored one form over the other (*SN: 5/5/01, p. 276*). Others point to

OF NOTE

the effects of radiation hitting primordial Earth. Or, says Cooks, it could have happened by chance. —A.G.

ASTRONOMY

Lights out

Prophets of gloom might be right. The universe is gradually growing darker. That's the conclusion of astronomers who have conducted a detailed analysis of the colors of some 37,000 nearby galaxies.

A galaxy's spectrum is a good indicator of the rate of past star birth because most of the light from newly minted stars is blue. In contrast, older stars are redder. Galaxies with an overall reddish tinge therefore contain mostly old stars.

The new analysis, based on galaxies studied at many wavelengths by the Sloan Digital Sky Survey, reveals that the rate of star formation today is only one-thirtieth of what it was 6 billion years ago. With that pace of dimming, an observer 5 billion years from now would see a universe about twice as dark as today. Alan F. Heavens of the University of Edinburgh in Scotland and his colleagues describe their findings in the Aug. 21 *Monthly Notices of the Royal Astronomical Society*.

Other studies had already found similar results, but they relied on observations of galaxies so distant that the light that telescopes record today shows what the galaxies looked like billions of years ago. In contrast, Heavens' team looked only at nearby galaxies. The study is the "first time that star-formation history has been determined from the fossil record of the present-day spectra of galaxies," says Heavens. —R.C.

BEHAVIOR

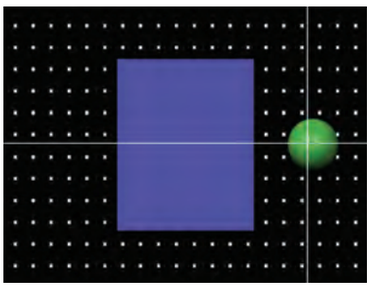
Babies show eye for object lessons

Between 4 months and 6 months of age, babies parlay their visual experience into the insight that objects exist as permanent entities, even when hidden from view, a new study finds.

The results challenge the influential notion that such knowledge is innate. Advocates of the innateness hypothesis argue that babies up to 6 months old can't systematically track objects with their eyes, even though babies of that age do realize that, say, a ball that rolls behind a screen should be visible when the screen is removed.

According to Scott P. Johnson of New York University and his colleagues, however, 4-month-olds indeed monitor moving objects and learn from these experiences to expect that moving objects will emerge from behind barriers.

The researchers tested 48 4-month-olds and 32 6-month-olds. Each child sat in a parent's lap and watched an animated computer scene as an infrared camera tracked the baby's eye movements. On the screen, a green ball moved horizontally, periodically disappearing behind a blue box and then reemerging.



BALL GAME When shown a ball disappearing behind the box, 4-month-old babies can learn to expect the ball's reemergence.

Although 6-month-olds frequently looked at the box's opposite side in expectation that the ball would reappear there, 4-month-olds rarely did so, at least at first.

If allowed to watch a ball move across an otherwise clear screen for a few minutes, 4-month-olds subsequently shown the scene with the blue box often looked to where the hidden ball was about to emerge. This tactic hastened the process of learning about the permanence of objects for younger infants, Johnson and his coworkers propose in an upcoming *Proceedings of the National Academy of Sciences*. —B.B.

EARTH SCIENCE

Indonesian reefs fell prey to fires

The fires that swept through Indonesian rain forests late in 1997 apparently laid waste to some marine ecosystems in the area, as well.

Before 1997, more than 100 species of hard corals made up the reefs surrounding the Mentawai Islands, an archipelago that runs parallel to the southwestern coast of Sumatra. In December of that year, a massive bloom of phytoplankton known as a red tide occurred in the region, says Nerilie J. Abram of the Australian National University in Canberra. After the bloom had run its course, the phytoplankton's rapid decomposition robbed the water of its dissolved oxygen. The effect asphyxiated almost all the fish and corals in the reefs fringing a 400-kilometer-long stretch of the Mentawai Islands.

Upwelling currents of cool, deep water—chock-full of algae-nourishing nitrates and phosphorus—fueled the red tide. However, analyses of chemical isotopes in coral samples show that the reefs experienced similar water temperatures—and therefore probably similar nitrate and phosphorus concentrations—without ill effects on several occasions during the past 7,000 years.

In 1997, however, strong winds brought dense plumes of smoke from the wildfires to the reef. Besides sending millions of tons of planet-warming carbon dioxide into the atmosphere (*SN: 11/9/02, p. 291*), the fires released about 11,000 metric tons of iron, another algal nutrient, says Abram. Even if only a fraction of 1 percent of that iron rained down on the Mentawai Islands region, it would have been enough to fuel the reef-killing red tide. Abram and her colleagues report their analyses in the Aug. 15 *Science*. —S.P.

CHEMISTRY

Catalyzing green chemistry

With a new, recyclable catalyst, chemical firms could cut down on the amount of waste generated in the manufacturing of products, according to researchers at Brookhaven National Laboratory in Upton, N.Y.

Industrial processes used for making products ranging from pharmaceuticals to pesticides rely heavily on catalysts, which speed the transformation of reactants into the desired chemical. But separating catalysts from final products typically requires expensive and sometimes-toxic solvents that companies later have to dispose of.

Morris Bullock and Vladimir Dioumaev at Brookhaven developed a tungsten-based catalyst for combining a ketone and an organic silicon compound to form an alkoxysilane. The tungsten catalyst automatically separates from the final product, which is a typical precursor used in making ceramics, drugs, and pesticides.

The researchers report in the July 31 *Nature* that as the reaction progressed in a test tube, the tungsten catalyst remained suspended in the mixture as an oily liquid. When the reaction was complete, the catalyst congealed into a sticky solid and settled to the bottom of the test tube. The researchers simply poured off the alkoxysilane and reused the catalyst. "This could save a lot of time and money," says Bullock.

So far, the researchers have tested the catalyst only on one type of chemical reaction, but they plan to apply the catalyst to other types of reactions. —A.G.

JOHNSON/PNAS

Books

A selection of new and notable books of scientific interest

THE BEST AMERICAN SCIENCE WRITING 2003

OLIVER SACKS AND JESSE COHEN, EDS.

This compendium of previously published articles spanning all fields of science is the fourth in a series. Authors from publications such as *Harper's Magazine*, the *New Yorker, Discover, Science News*, and the *New York Times Magazine* are featured. Lawrence Osborne explains how a genetically modified goat can produce milk containing spider silk. Floyd Skloot writes about his 90-year-old mother and her struggle with Alzheimer's disease. Michael Klesius attempts to solve what Darwin called "an abominable mystery": How did flowers originate? Natalie Angier considers the challenge of traveling to distant stars. And *Science News*' Susan Milius considers why leaves turn bright red in autumn. Captivating writing on such diverse topics makes this book a page-turner. ***Ecco, 2003, 272 p., hardcover, $27.50.***

HUMAN WILDLIFE: The Life That Lives on Us

ROBERT BUCKMAN

Roughly 90 percent of the cells that a human body carries aren't human. They belong to the bacteria, fungi, viruses, and parasites that live on or in us. Most coexist with us and are beneficial in fending off disease or aiding our digestive process. Others, such as the cholera bacillus, are dangerous. Buckman introduces scores of these human-dwelling life forms and establishes which are long-term residents and which are itinerant visitors, as well as makes clear who is friend and who is foe. Particularly useful and entertaining are hundreds of photographs, including micrographs that make incredibly tiny things very large. These, combined with a witty and fascinating text, bring many interesting facts to light. For instance, bad breath is caused by sulfur in the protein we eat, fresh sweat is odorless, and the average kitchen cutting board has more bacteria than the top of a toilet seat. Originally published in Canada in 2002. ***Johns Hopkins, 2003, 203 p., color photos, paperback, $21.95.***

MEASURE FOR MEASURE: The Story of Imperial, Metric, and Other Units

ALEX HEBRA

Believe it or not, the United States is officially a metric nation. In 1893, the secretary of the treasury declared it so. But the idea never caught on here, and we have clung to the pound, gallon, and mile. Those imperial units were introduced 300 years ago by the British, but that country long ago forgot them in favor of kilogram, liter, and meter. Hebra considers why this is so, as he surveys these two systems of measurement, as well as countless other methods that people have devised to measure everything from a strip of cloth to the brightness of a candle to the sound at a rock concert. His approach, however, is far less anthropological than mathematical. Many equations come into play as Hebra explains the physics behind devices such as the Jefferson pendulum and the grease-spot photometer. He details, for instance, how a person on the ground can measure the height of a tall building and how Boyle's law defines the relationship of volume and pressure for a perfect gas. The book relates how units of measurement are applied in such fields as mechanical engineering, physics, optics, and astronomy. ***Johns Hopkins, 2003, 215 p., b&w illus., hardcover, $24.95.***

SIGNOR MARCONI'S MAGIC BOX: The Most Remarkable Invention of the 19th Century and the Amateur Inventor Whose Genius Sparked a Revolution

GAVIN WEIGHTMAN

Those who witnessed the first public demonstrations of Signor Guglielmo Marconi's magic box in 1896 thought they were being duped. After all, Marconi himself couldn't definitively explain how he was able to transmit messages through the "ether." It was another 7 years before anyone knew just how far the radio waves could travel, when Theodore Roosevelt exchanged a Morse code message with King Edward VII. Wireless telegraphy would change the world in ways never imagined at the time. Ships could always be in contact with land. Societies were united. Mass media were invented. All that—as well as text messaging on cell phones today—is an indirect result of Marconi's invention. Weightman takes readers back to a time when people lived literally in the dark and examines how a young boy's fascination with electricity would change the world. ***DaCapo, 2003, 312 p., b&w plates, hardcover, $25.00.***

THE SHADOW CLUB: The Greatest Mystery in the Universe—Shadows—and the Thinkers Who Unlocked Their Secrets

ROBERTO CASATI

While watching a lunar eclipse years ago, Casati had an epiphany: Shadows don't hide; they reveal. For the next few years, he set about discovering how ancient and modern philosophers, astronomers, and artists manipulated and understood shadows. Casati points out that vision can't do without shadow and explains how biological systems adapt to levels of darkness, usually to defend against predators. Two thousand years ago, Plato reflected on how an object's shadow can be a tool of knowledge. Modern astronomers agree, as they use shadows for deducing sizes of and distances between planets. Casati breaks down the mystery of shadows in an effort to reconcile their mystique with the scope of the knowledge that scientists can glean from them. ***Knopf, 2003, 230 p., b&w photos/illus., hardcover, $24.00.***

HOW TO ORDER To order these books, please contact your favorite bookstore. *Science News* regrets that at this time it can't provide books by mail.

LETTERS

Stress aplenty

Family members who perform the caregiver function usually pay a price because of the stresses involved ("Till IL-6 Do Us Part: Elderly caregivers show harmful immune effect," *SN: 7/5/03, p. 5*). If "chronic adversity" is theorized to be the cause of a rise in a person's IL-6, then questions for research include whether the IL-6 effect also applies to younger spouses and other family members, such as a child caring for a parent.

FRANCIS LEUNG, ATLANTA, GA.

Utter shame

Regarding the article on udder tampering in livestock competitions ("Udder Beauty," *SN: 7/12/03, p. 24*), it's sad that the push for easy success is so pervasive. Although colleges and universities receiving federal research funds must require research-ethics education of their students, I don't see an impact on plagiarism. How might we encourage future generations of students in all disciplines to internalize a more positive ethical code? Perhaps we need some brainstorming on this issue in scientific journals.

DORIS AARONSON, WEST MILFORD, N.J.

What's the problem here?

Since "most pleural abnormalities don't actually interfere with lung function," the statement that dangerous asbestos exposures extended beyond the workplace in Libby, Mont., must be considered an opinion or assumption, not something confirmed by scientific studies ("More Than a Miner Problem: Asbestos exposure is prevalent in mining community," *SN: 7/12/03, p. 21*). The heading for the article could just as well have ended "may only be a minor problem."

BUD MARCHETTE, PEBBLE BEACH, CALIF.

While the risk is obviously great for those living in Libby, such cases have unfortunately proved to be a wedge for legal actions by individuals exposed peripherally to other forms of asbestos but not shown to be harmed. The lawsuits have proved to be a bonanza to the legal profession and the death knell to a number of companies only remotely connected to the problem.

NELSON MARANS, SILVER SPRING, MD.

Correction

The description of the book The Black Hole at the Center of Our Galaxy *(*SN: 7/12/03, p. 31*) put Earth too close to the Milky Way's center. The theorized black hole there would be about 28,000 light-years from Earth, not 28 light-years.*

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