

SCIENCE NEWS

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hpv's newfound threat
on improvement
supernova spectacular
antimatter matters

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avian family
planning

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Cover The degree of splendor of a male peacock's tail might influence whether he fathers extra sons or daughters. Paternal attractiveness is just one possible influence on the ratio of males to females among chicks in birds' nests. (iStockphoto) [Page 298](#)

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Risk Factor

Throat cancer linked to virus spread by sex

Cancer of the throat and tonsils can arise from infection with a sexually transmitted virus, a new study suggests.

Researchers report that the human papillomavirus (HPV) is much more likely to turn up in the throat cells of people with a malignancy called oropharyngeal cancer than in the throat cells of others. Moreover, the cancer patients were more apt to have engaged in oral sex with multiple partners over past years, suggesting a route of infection, the scientists report in the May 10 *New England Journal of Medicine*.

HPV infections, which often produce no immediate symptom, were already known to cause cervical cancer. The virus produces localized infections. "It doesn't spread through the bloodstream," says oncologist Maura L. Gillison of Johns Hopkins University in Baltimore. Therefore, an HPV infection acquired through sexual intercourse affects only the genital region, she says, and oral sex may expose the throat and tonsils to a similar viral infection and cancer.

Gillison and her colleagues analyzed throat swabs from 100 people who had oropharyngeal cancer and 200 people without the disease. The cancer patients were 12 times as likely as the others to have an active HPV infection. Moreover, the cancerous cells were 32 times as apt to carry proteins from the viral strain called HPV-16 as were throat cells obtained from healthy individuals.

HPV-16 proteins serve as signs of a past infection by the virus. HPV-16 inserts its DNA into cells that then produce proteins that disable the brakes on cell growth.

HPV-16 is the strain of the virus considered most likely to cause cancer. In a separate test on the same samples, Gillison's team found that HPV-16 DNA showed up in 72 percent of the throat cancers.

Previous work had suggested a biological link between HPV and throat cancer (*SN*: 4/14/01, p. 229). The new study goes a step further by analyzing behaviors that

might connect the two. Gillison and her colleagues report that the throat cancer patients were three times as likely as the other people to have had six or more partners on whom they had performed oral sex at some time. And patients whose throat cancers contained the HPV-16 DNA were nearly nine times as apt to have had six or more such sex partners.

"It's worth considering the possibility that some oral, oropharyngeal, and laryngeal cancers might be prevented by HPV vaccination," dentist Stina Syrjänen of the University of Turku in Finland says in the journal issue carrying the new study. Merck is currently marketing a vaccine against HPV under the name Gardasil.

That vaccine is being recommended to protect girls and young women against cervical cancer. The link between HPV and throat cancers suggests that boys, too, might benefit from the vaccine, Gillison says.

The Merck vaccine targets HPV-16 and HPV-18—which cause most cervical cancers—plus HPV-6 and HPV-11, which cause genital warts. GlaxoSmith Kline is seeking approval in the United States and Europe for its vaccine Cervarix, which protects against HPV-16, HPV-18, and two other cancer-causing strains.

Two studies also released in the same journal indicate that over several years, the Merck vaccine prevented nearly all precancerous growths in the genital and anal regions of women who hadn't been exposed to HPV-16 and HPV-18 before receiving the inoculations.

However, the vaccine "is not nearly as impressive" for women whose HPV history is unclear, comments gynecologist Karen Smith-McCune of the University of California, San Francisco. —N. SEPPA

No Place Like Om

Meditation training puts oomph into attention

Intensive meditation training does more than foster inner peace and relaxation. Mental practice of this type boosts control over attention and expands a person's ability to notice rapidly presented items, at least during a laboratory test.

The new results demonstrate that mental resources devoted to attention can be amplified through mental training, say psychologist Richard J. Davidson of the University of Wisconsin-Madison and his colleagues.

Davidson's team studied a phenomenon

known as the attentional blink. Because visual perception requires time and effort, paying close attention to one object flashed on a computer screen often causes a person to overlook a second object presented within the next half second. Scientists suspect that attention momentarily shuts down as the first image is perceived. During that attentional blink, the second image sneaks by unnoticed.

"The previous practice of meditation improves performance on this task," Davidson says. "Attention capabilities can be enhanced through learning."

His team studied 17 volunteers, ages 22 to 64, who attended a 3-month-long meditation retreat. They spent most of each day practicing *Vipassana* meditation, which focuses on reducing mental distractions and heightening sensory awareness.

Before and after the retreat, participants performed a task in which they looked for one or two numbers mixed into a series of letters flashed on a computer screen. Electrodes placed on each person's scalp measured

neural activity on the brain's surface during the task. In some trials, two numbers appeared less than one-half second apart.

Before meditation training, volunteers reported seeing the second of two rapidly presented numbers about 60 percent of the time. After training, they detected the second number, on average, 80 percent of the time, Davidson's group reports in the June *PLoS Biology*.

The participants with the greatest meditation-related improvement detected the second number about 90 percent of the time. They showed less neural activity as they viewed the first number than they had before the training.

By devoting less of their neural resources to perceiving the first number, participants could attend to a number presented a fraction of a second later, Davidson posits.

Another 23 adults completed a 1-hour meditation course and then meditated for 20 minutes daily for 1 week before taking their first attention test. Three months later, recipients of the bare-bones training repeated the week of meditation before retaking the test. Performance on the attentional-blink task rose from 60 percent to 70 percent correct. However, no sign of decreased neural activity appeared.

The new findings support the view that intensive meditation training boosts the efficiency of attention-related mental operations, remarks psychologist Clifford Saron of the University of California, Davis.

Saron directs an ongoing project in which some participants learn meditation techniques at a 3-month retreat led by a Buddhist monk. The researchers plan to analyze

STATS

11,800

Predicted number of new U.S. cases of oropharyngeal cancer in 2007

whether the meditation training influences attention, emotional regulation, and various brain measures. —B. BOWER

Degrees of Quantumness

Shades of gray in particle-wave duality

Is light made of particles or waves? The answer, according to quantum physics, is both. Depending on the situation, particles of light—and particles of matter too—sometimes contradict themselves and act like waves. But between these two extremes, there's a range of behaviors. Scientists have now demonstrated those intermediates in a conspicuous way.

The new research is a variation on the so-called double-slit experiment, a staple of introductory quantum theory courses. In the classic version, light passes through two slits in an opaque screen and hits another screen some distance away. Crests and troughs of light waves emerging from each slit add together or cancel each other out, depending on how they overlap, and create an interference pattern of light and dark stripes on the screen. This phenomenon has been demonstrated not only with photons but also with electrons, and even whole atoms.

From the quantum perspective, however, light is a stream of photons. To explain the interference pattern, physicists say that each photon travels through both slits simultaneously and then interferes with itself on the other side.

The additional twist is that, according to quantum theory, the interference pattern—a wave phenomenon—would disappear if one knew for sure through which slit each photon went. In principle, detectors at the slits would register a photon's passage without capturing the particle. In that situation, the photon would have chosen one slit or the other, thereby behaving like an old-fashioned, classical-physics particle.

Physicists suspected that it's possible to extract only partial information about a particle's route. They predicted that different degrees of certainty about the path would blur the interference pattern by different amounts.

In the mid-1980s, theoretical physicist Wojciech Zurek of the Los Alamos (N.M.) National Laboratory proposed a way to use beams of electrons to explore this idea. More than 20 years later, Franz Hasselbach and Peter Sonnentag of the University of Tübingen in Germany have put Zurek's idea to the test.

In their setup, electric fields play the role of the slits, steering electrons along two possible paths parallel to an underlying horizontal plate. As each electron passes, its electrostatic field moves charges inside the plate. Those movements, acting against the plate's electrical resistance, generate a tiny amount of heat.

By detecting that heat, an experimenter could locate the electron's path and make it lose its wavelike behavior. But this detection can be accomplished to different degrees. The closer the beam is to the plate, the larger the dissipation, and the easier it will be to tell apart the two trajectories. The Tübingen team's images reveal that with increasing certainty, the interference fringes become progressively blurred.

"The visibility of the fringes changes," Sonnentag says. The results appear in an upcoming *Physical Review Letters*.

Zurek says that he's pleased to see his predictions confirmed. "The nice thing is that you can quantify this leakage of

information," he says. "You can turn the knob and vary the quantumness of the system." —D. CASTELVECCHI

Cells' Root

Adult stem cells have a master gene

A person's body constantly sheds dead skin cells, and new cells well up to take their places. Stem cells in the skin generate this continuous stream of biological units. Now, researchers have identified a master gene that enables these stem cells to retain their regenerative capacity.

The gene, called *p63*, is crucial for the maintenance of stem cell lines in epithelial tissues including skin, thymus, prostate, and breast, say Frank McKeon of the Harvard Medical School in Boston and his coworkers. An adult stem cell spawns a daughter cell that then develops into one of the various cell types within a particular organ. This process raises the possibility of treatments in which doctors would use stem cells to regenerate damaged tissues.

But each time a stem cell divides, only one daughter cell matures into a specific cell type. The other must retain its flexibility and remain in the reservoir of adult stem cells in an organ. The *p63* gene orchestrates this action in epithelial tissue, the researchers say. Earlier work identified other master genes for stem cells for blood and for sperm.

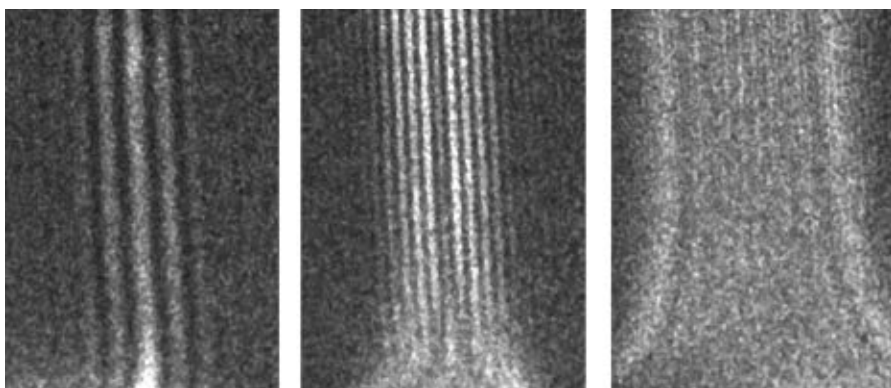
The team found that mouse embryos lacking *p63* began forming skin but soon stopped. In early stem cell divisions, both daughter cells matured into specialized skin cells, thereby depleting the supply of skin stem cells. Many of these mice were born almost skinless, the researchers report in the May 4 *Cell*.

"It's a very dramatic effect," says McKeon. "I think we've definitely shown now that *p63* is the crux of stemness."

The gene acts as a master regulator, controlling the activity of about 2,000 other genes in the stem cells. Scientists don't yet know the pattern of gene activity that *p63* triggers or how that activity makes a cell capable of spawning another stem cell.

The role of *p63* in epithelial stem cells has been controversial. Other research groups had concluded that *p63* is essential for the maturation of the daughter cells, not for the maintenance of the stem cell lineage. But those groups had looked at newborn *p63*-deficient mice delivered vaginally. McKeon says that the mice's passage through the birth canal had sloughed off the small amount of skin that had formed, leading the scientists to conclude that no skin cells had matured.

McKeon and his colleagues looked instead at the skin and thymus of mid- to



FRAYING FRINGES Electrons traveling via two possible paths act like waves, forming interference fringes. As the beams pass increasingly closer to a surface (top to bottom of each image), their paths are revealed with greater certainty, smearing out the fringes. The effect increases (left to right images) with increasing separation of the paths.

full-term fetal mice surgically removed from their mothers. The scientists found some mature skin and thymus cells but a lack of epithelial stem cells.

"I think this paper will be cited in the field for having resolved the question" of *p63*'s role, comments Elaine Fuchs of Rockefeller University, who studies epithelial stem cells.

McKeon says that information about the genetics of stem cells might suggest new therapies for several diseases. —P. BARRY

Stellar Spectacular

Brightest supernova

Astronomers this week described the brightest stellar explosion ever recorded. In just 2 months, the eruption—the catastrophic death of what was probably a freakishly massive star—has thrown out as much radiation as the sun will during its entire 10-billion-year lifetime. One hundred times as energetic as a typical supernova, the outburst may belong to a rare, new class of explosions that's been predicted by theory but never before observed.

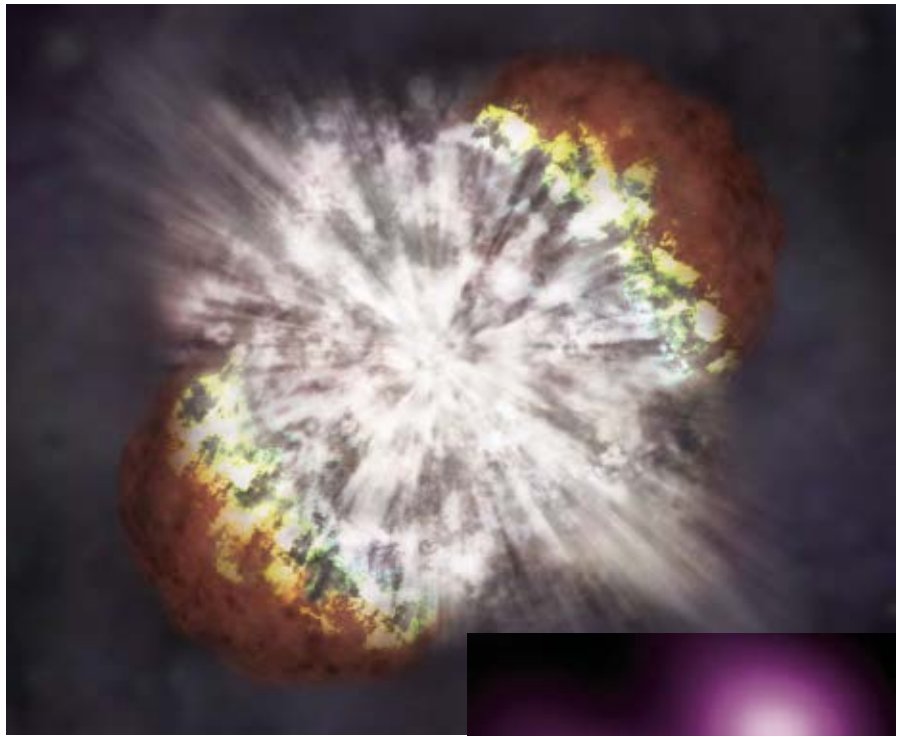
According to that theory, the star that exploded must have been the heaviest on record, tipping the scale at more than 150 times the mass of the sun, says astronomer Nathan Smith of the University of California, Berkeley.

Smith's team announced the findings on May 7 at a NASA press briefing and also reports its observations in an upcoming *Astrophysical Journal*. Another group of astronomers, led by Eran Ofek of the California Institute of Technology in Pasadena, describes the same supernova, now dubbed SN 2006gy, in the April 10 *Astrophysical Journal Letters*. The blast was discovered last September.

In a galaxy 240 million light-years from Earth, SN 2006gy remained brighter than any previously observed supernova for 3 months. Its "absolutely stupendous" brightness forced astronomers to consider alternatives to the usual scenarios for exploding stars, says Smith.

One standard type of supernova explosion occurs when a star at least 10 times as heavy as the sun exhausts its fuel supply. The star's core abruptly crumples to become a neutron star or black hole, while the outer layers blow outward. But this core-collapse model can't come close to explaining the brightness of SN 2006gy.

The teams led by Smith and Ofek propose that SN 2006gy marks the death of a star that was between 150 and 240 times as heavy as the sun. In such a star, energetic gamma rays push out from the core and resist gravity's pull. Instability sets in when gamma rays



BANG! Supernova SN 2006gy, depicted in an artist's illustration (top), is the brightest stellar explosion ever recorded. X-ray image (right) of the supernova (upper right) shows that it's as bright as the center of its home galaxy (lower left).



annihilate each other and become pairs of electrons and positrons. As the rays vanish, the entire star collapses and then blows up, leaving behind no black hole or neutron star. This type of explosion, known as a pair-instability supernova, can produce an outburst as bright as SN 2006gy, the two teams suggest.

One problem with the model, says Smith, is that massive stars that are rich in heavy elements have fierce winds, which expel much of their material during their normal lifetimes. Too much lost mass could prevent such a star from exploding as a pair-instability supernova.

Star-formation theory suggests that the first stars in the universe were extremely massive but lacked heavy elements. Pair-instability supernovas might therefore have been common then. The star that exploded as 2006gy may be a rare, modern example, says Smith. In our own galaxy, the heavyweight star Eta Carinae (*SN: 9/23/06, p. 200*) could be ready to undergo a similar explosion, he notes.

Theorist Stan Woosley of the University of California, Santa Cruz prefers a less extreme version of the pair-instability model to explain SN 2006gy. He suggests that instead of only one explosion, repeated instabilities in the star hurled material outward for about a year before the final outburst. All the energy of that final blast would then go into heating the expelled material, rather than into pushing out material. The

result would be a superbright explosion from a moderately massive star. —R. COWEN

Invisible Trail

Analyzing the vortices in the wake of a bat

Experiments that reveal the swirling air around a flying bat indicate that those mammals generate lift and thrust with their wings much differently than birds do.

At first glance, birds and bats seem to move through the air in similar fashion. However, aerodynamic details of the two groups' flapping techniques, particularly at low flying speeds, are quite different, says Anders Hedenström, a biomechanicist at Lund University in Sweden. On the upstroke, a bird can separate the large feathers on its wings, permitting air to flow cleanly through and minimizing any downward, altitude-robbing force. Bats can't do that, he notes, because their wings are continuous, although flexible, membranes.

Hedenström and his colleagues studied the flight techniques of *Glossophaga soricina*, a 5-centimeter-long, nectar-feeding bat that ranges from Mexico to northern Argentina. The team used a wind tunnel similar to the tunnels employed by engineers to evaluate

scale models of aircraft. During the experiments, the bats drank a sweet solution from a tube dangling in front of cameras as they hovered facing a headwind.

Laser pulses illuminated tiny liquid droplets delivered into the airflow and enabled the researchers to calculate the strength and rotation of the eddies that the bats' flapping wings created, says Hedenström. The researchers describe their findings in the May 11 *Science*.

When flying at slow speeds, about 1.5 meters per second, the bats turned their wingtips upside down and quickly flicked them backward during an upstroke. Scientists had surmised that this trick, previously seen in high-speed movies, provides lift and thrust, says Hedenström. By revealing vortices that signify lift, the new experiments bear out that theory, he notes.

At higher speeds, the backward flick during the upstroke disappears, and the configuration of vortices downstream of the bat indicates a more complex airflow over the wings. During some parts of a wing beat, the data suggest, airflow across the inner portions of the wing causes a force that pushes down on the membrane there. Nevertheless, says Hedenström, the strength of the vortices indicates that the bat's wings, as a whole, generate more lift than aerodynamic models suggest.

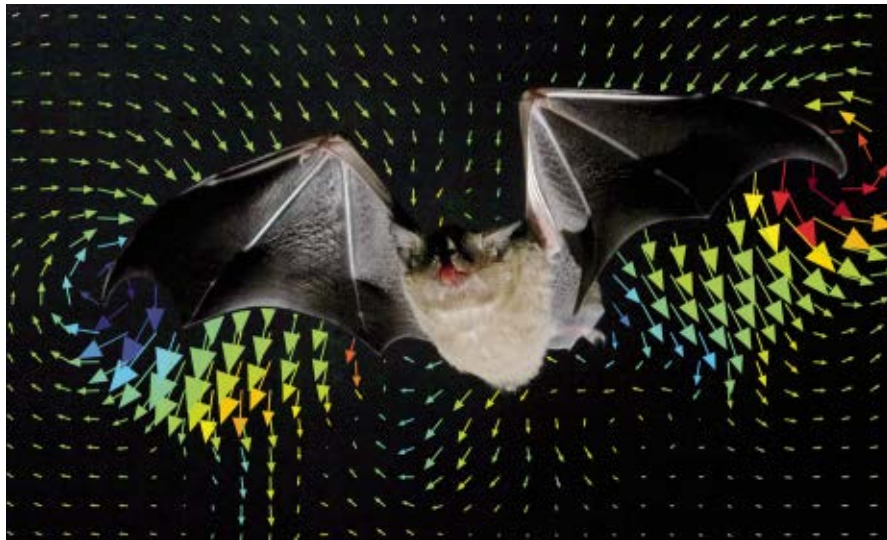
The team's laser-illuminated experiments "provide a beautiful look" at the aerodynamic wake behind a flying bat, says Douglas R. Warrick, a biologist at Oregon State University in Corvallis. "It's the only way to actually know what's going on with the airflow over a flapping wing, and even then it's difficult," he notes.

It's clear that these bats are employing unknown tricks of aerodynamics to generate lift, says Sharon Swartz, an evolutionary biologist at Brown University in Providence, R.I. She and her colleagues recently reported similar findings from wind tunnel experiments on a larger species of bat. —S. PERKINS

Extreme Encyclopedia

Every living thing will get its own page

An international team of weighty institutions this week announced that it's developing the weightiest encyclopedia



MOTION PICTURE The sizes of the arrows in this image indicate the speed of the airflow in the wake of a flying bat. Blue represents clockwise circulation; red represents counterclockwise.

of biology yet. The free, multilingual, Web-based guide will cover the 1.8 million living species known, plus new discoveries, say researchers from the Smithsonian Institution, Harvard University, the Field Museum in Chicago, and other organizations.

The John D. and Catherine T. MacArthur Foundation is putting up \$10 million for the project, and the Alfred P. Sloan Foundation is adding \$2.5 million. If the project meets its goals for the next 2.5 years, those foundations will repeat their grants. Also, the six institutions that started the project have pledged to raise \$50 million for the work.

The Encyclopedia of Life (EoL) will combine the authority of a traditional print behemoth with the collaborative spirit of the Web's user-created Wikipedia, says James Edwards, EoL's Washington, D.C.-based executive director. In the Wiki spirit, EoL will eventually have a section inviting contributions from everyone, says Edwards.

At first, the creators will take information from established scientific databases and present it in the EoL format. As the project grows, says Edwards, bird-watchers will be invited to record their sightings, and gardeners will contribute the first dates for blooms.

The EoL team is planning to offer special tools to school classes studying their neighborhoods. Combining all sources, a species' entry might include its genetic sequence, recordings of noises it makes,

and videos of it "doing something interesting," Edwards says.

The encyclopedia's creators also say that they want to supply the authority of traditional print volumes. Scientists will approve certain content, and viewers will have the option of filtering out entries that haven't been reviewed.

The prototype pages (<http://www.eol.org>) show that viewers may also set the level of complexity they'll encounter. On a polar bear page, a "novice" setting reveals basic

biology suitable for a school report. Meanwhile the "expert" viewer will find—from an original 1774 document—Constantine John Phipps report that "feamen" exploring the Spitsbergen islands of Norway ate bear meat but found it "exceeding corfe."

Easing access to such literature could help taxonomists in the "tedious" parts of describing species, says David Patterson, a taxonomist and biodiversity-informatics specialist at the Marine Biological Laboratory in Woods Hole, Mass., an EoL partner. Collecting descriptions of related organisms for analysis sometimes takes years. Patterson adds that

he hopes EoL will encourage taxonomists to use electronic tools.

Eminent biologists such as E.O. Wilson have been calling for a grand encyclopedia of life for years, but Patterson says that only recently have new Internet tools made it feasible. The first pages should be available in 2008, and the 1.8 million basic entries could be online as early as 2017. —S. MILIUS



MEET HAIRY A prototype page for the Encyclopedia of Life enables viewers to browse information about the recently discovered Yeti crab. Eventually, readers will be able to add their own comments.

The Glory That Was Greece and Rome Is Closer Than You Think

Learn how Classical archaeologists found ancient cities and invented the methods of archaeology

Classical archaeology had a spectacular birth. In 1738, a military engineer had himself lowered down a well to begin the first systematic study of the astonishingly intact ruins of the Roman city of Herculaneum, buried in the eruption of Vesuvius almost 1,700 years earlier. The excavation of the neighboring city of Pompeii followed a decade later.

Classical Archaeology of Ancient Greece and Rome gives a superb sampling of an exciting field, showing that this single discipline combines ancient history, anthropology, ethnography, comparative religion, art history, experimental engineering, historical linguistics, paleobotany, and other pursuits—along with a dose of Indiana Jones adventure.

In these 36 half-hour lectures, archaeologist James R. Hale of the University of Louisville guides you through dozens of ancient sites with the skill of a born storyteller. Dr. Hale mixes the exotic adventures, unexpected insights, and abiding mysteries of archaeology's fabled history with anecdotes of his own extensive fieldwork to create a fast-paced narrative that unfolds like a series of detective stories.

You will study Herculaneum and Pompeii, along with Troy, Delphi, Olympia, Thera, the Agora in Athens, and many other sites, including underwater shipwrecks that have shed intriguing light on ancient Mediterranean commerce. You will also learn about discoveries such as the Rosetta Stone and Linear B tablets that led to the deciphering of ancient scripts that had until then been enigmas.

About Your Professor

Dr. John R. Hale is the Director of Liberal Studies at the University of Louisville. His writing has been published in the journal *Antiquity*, the *Classical Bulletin*, the *Journal of Roman Archaeology*, and *Scientific American*. He is also the author of *Lords of the Sea* and has received many awards for distinguished teaching, including

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THE HUNT FOR ANTIHELIUM

Finding a single heavy antimatter nucleus could revolutionize cosmology

BY PATRICK BARRY

When summer comes to Antarctica this December, a group of physicists there will launch an enormous balloon carrying a scientific instrument through Earth's atmosphere to the edge of space. If all goes well, the detector will count cosmic rays for 20 days. The researchers hope to find among those rays, evidence of galaxies that are millions of light-years away and made entirely of antimatter.

The idea may sound far-fetched, but antimatter regions of the universe wouldn't contradict any laws of physics. In fact, such antigalaxies would address one of the great unanswered questions of cosmology—why the Big Bang seems to have produced more matter than antimatter.

Several teams of scientists around the world are engaged in the search for far-off antimatter galaxies, which has been going on for almost 30 years. The clue that they seek is tiny: a single helium nucleus made of antimatter that has drifted intact across the gulf of intergalactic space. Physicists agree that finding even one stray antihelium would be compelling evidence of antimatter galaxies.

While the odds of success are slim, “the scientific payoff ... would be very large,” says John Mitchell, lead scientist for the upcoming Antarctic mission, called the Balloon-Borne Experiment with a Superconducting Spectrometer (BESS).

And there's urgency in the search for antihelium. Given the expense and sensitivity of the three current research programs, failure to find an antihelium would make it hard to justify another generation of bigger, better, and costlier instruments, says Robert Streitmatter, a colleague of Mitchell at NASA's Goddard Space Flight Center in Greenbelt, Md.

So, the current efforts could be the best hope for discovering antimatter galaxies—if they exist.

IN THE BEGINNING The possibility of stars and planets made of antimatter arose after 1930, when the British physicist Paul Dirac theorized that electrons should have twins with the same mass but an opposite spin and electric charge. Two years later, physicists confirmed the existence of these particles, called

positrons. According to current theory, all fundamental particles have twins, known as antimatter, with some of their properties reversed.

Further experiments supported the idea that particles and their antimatter twins are always created in pairs, which in turn suggested that the universe must contain equal amounts of matter and antimatter. When Dirac received the Nobel prize in 1933, he said, “We must regard it rather as an accident that the Earth ... contains a preponderance of negative electrons and positive protons. It is quite possible that for some of the stars it is the other way about.”

Through the 1950s, “it was absolutely the belief that there were equal amounts of matter and antimatter in the universe, possibly

separated,” Streitmatter says. By the mid-1960s, however, work on the Big Bang theory had begun to cast doubt on that idea. When a particle and its antiparticle meet, they annihilate each other in a flash of energy. So if, in the hot, dense, early moments of the Big Bang, particles and antiparticles had existed in equal numbers, they would have subsequently destroyed each other, leaving a universe filled with only radiation.

Today, most physicists argue that production of matter in the newborn universe must have slightly outpaced the production of antimatter. With even a small excess of matter, some would have been left over after all the antimatter had been annihilated.

Scientists propose that the asymmetry responsible for the initial imbalance also shows up when exotic particles called kaons and B mesons decay into other particles in an accelerator (*SN: 8/5/00, p. 86*). But the degree of asymmetry detected in accelerator experiments is too small to explain the cosmic preponderance of matter. The measured asymmetry would produce enough surplus matter for only about one galaxy in our entire visible universe.

The asymmetry, however, might have been much larger at the high energies of the early moments of the Big Bang. But theories of high-energy particle physics don't make strong predictions about the size of the asymmetry, and no experimental data pins it down. So, physicists don't know whether such an asymmetry could create the universe as a matter-only place.

AN ANTIGALAXY FAR, FAR AWAY Another way to solve the problem of the predominance of matter in the nearby universe is to suppose that the antimatter might still be around but sequestered in distant antimatter-dominated regions.



THE HUNT — Launch of a high-altitude balloon over Antarctica in December 2004. The balloon carried an instrument to detect antiparticles.

In 1979, Floyd Stecker of the Goddard Space Flight Center suggested that the matter-antimatter asymmetry could have arisen spontaneously in the first moments after the Big Bang, swinging one way in some regions of the universe and going the opposite way in other regions. That would have produced an excess of matter in some places and an excess of antimatter in others. As the universe rapidly expanded, each of those regions would have ballooned.

"All of [these scenarios] are viable options right now, and I don't think there's anything to choose between them," comments physicist Mark Trodden of Syracuse University in New York. "I think it is entirely reasonable that there were mechanisms [in the first moments after the Big Bang] that would have led to very large regions of matter and antimatter."

Because light interacts with matter and antimatter in the same way, planets, stars, and galaxies made of antimatter would look exactly the same as those made of normal matter. "You can't tell whether you're looking at a galaxy or an antimatter galaxy," Stecker says.

However, detecting even a single nucleus of antihelium near Earth would be strong evidence that antimatter stars and galaxies are out there somewhere. Energetic collisions among the cosmic rays—each a high-speed proton or other nucleus that flies about the universe at nearly the speed of light—can produce occasional antiprotons. "There's even a small chance of making antideuterium," Stecker says, "but it's almost impossible to make an antihelium. It would be a very small probability over the whole lifetime of the universe."

To make an antihelium near Earth, cosmic-ray collisions would have to create four particles—two antiprotons and two antineutrons—at nearly the same time. Those particles would have to converge on a single point, traveling slowly enough to join into a nucleus rather than bounce apart.

In 1997, Pascal Chardonnet of the Theoretical Physics Laboratory in Annecy-le-Vieux, France, calculated the odds of this happening. One antihelium nucleus would be created for every million trillion or so cosmic-ray protons, which themselves are rare. At that rate, one of the current experiments would take 15 billion years on average to encounter a single antihelium made that way. Since the universe is only about 13.7 billion years old, any antihelium that experiments might detect is far more likely to come from a region of primordial antimatter than from a cosmic ray collision.

"If they did see an antihelium, it would be very dramatic evidence" that distant antimatter galaxies do exist, Stecker says.

NEEDLE IN A HAYSTACK The search for cosmic antihelium began in 1979. The late Robert L. Golden, founder of the Particle Astrophysics Lab at New Mexico State University in Las Cruces, launched a high-altitude balloon carrying a detector designed to look for antiparticles, especially antiprotons. The flight was the first to find antiprotons among the cosmic rays, but it turned up no trace of antihelium.

Scientists knew that stumbling upon an antihelium was a long shot. Fortunately, such missions detect antiparticles of all kinds, so the flights gather useful data about antiprotons and other particles.

The antiparticle detectors work by recording the paths of cosmic rays passing through the instrument. The particles either leave a trace on layers of silicon, or the ionized gas that they produce

affects the voltages within grids of wires. A strong magnetic field bends the paths of charged particles, with positive charges going one way, negative the other. By measuring the direction and degree of curvature and other characteristics, the scientists distinguish between oppositely charged particles with the same mass and thus distinguish matter from antimatter.

Searches for antiparticles continued with a series of balloon flights beginning in the mid-1980s as well as a 1998 space shuttle mission. With stronger magnets, larger collecting areas, longer flights, and improved electronics, these experiments had steadily increasing sensitivity and detected more and more antiprotons, but none detected antihelium.

Therefore, no more than one antihelium per 1.5 million cosmic rays of normal helium could be reaching Earth, concluded a 2002 analysis by Makoto Sasaki of the BESS team.

Last June, a team of Italian researchers led by Piergiorgio Picozza of the University of Rome launched an antimatter-observing satellite into Earth orbit. The researchers designed the satellite, called the Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics (PAMELA), to steadily gather antiparticles for 3 years. They calculated its sensitivity at one antihelium among roughly 100 million nuclei of normal helium.

The next flight of the BESS instrument, scheduled for December, will have similar sensitivity. The detector will circle above Antarctica for only 20 days, but its collection area is 300 square centimeters, compared with PAMELA's 21 cm².

The largest and most sensitive of the current detectors, the Alpha Magnetic Spectrometer 02 (AMS-02) with its 500-cm² collection area, may never get a chance to fly. An international team of researchers, led by physicist Samuel Ting of the Massachusetts Institute of Technology, designed the \$1.5 billion instrument to ride to orbit aboard the shuttle and attach to the International Space Station.

AMS-02 is nearing completion at the European particle physics laboratory near Geneva, Switzerland. But NASA administrator Michael Griffin announced in February that the agency needs all remaining shuttle flights through the scheduled end of the shuttle program in 2010 to complete construction of the space station.

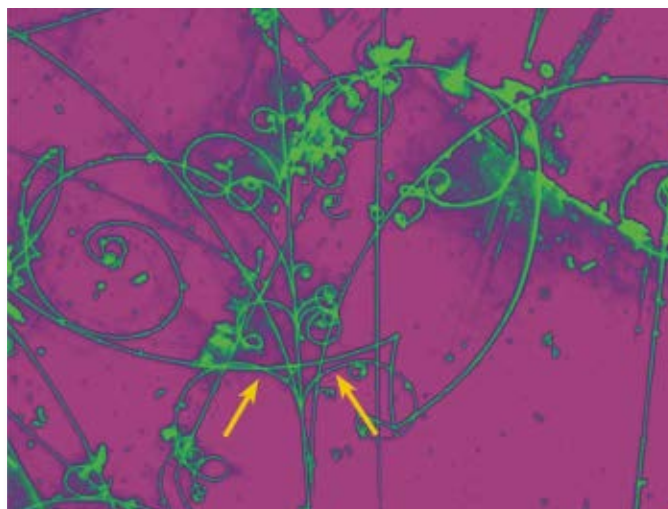
The managers of AMS-02 are searching for another launch vehicle, and the retrofitting and launch would add another \$250 million to \$1 billion to the cost of the mission. Or the test may be delayed indefinitely. If it ever flies, AMS-02 will improve the sensitivity of the search to about one antihelium in a billion helium nuclei.

A PERILOUS JOURNEY Extreme sensitivity is necessary because antimatter stars and planets, if they exist, are certainly far away. An antihelium nucleus found in Earth's vicinity would have had a long and arduous trip.

At the boundary between a matter-dominated region of the universe and an antimatter region, some of the particles and antiparticles would meet and annihilate each other. That process would create gamma rays, which would emanate from the boundary.

Yet "we see no big ridges of gamma rays from any of the gamma-ray telescopes," says Steve Stochaj of New Mexico State University in Las Cruces.

(continued on page 300)



ANTICREATION — Collisions of high-speed cosmic rays create showers of particles similar to those traced in this accelerator detector. Arrows point to a particle-antiparticle pair.

EGG SHELL GAME

Chicks' sex isn't just a matter of chance

BY SUSAN MILIUS

In 1939, a man walking his dog in Brooklyn noticed Hollywood finches for sale in a store. The reddish-brownish seed eaters are native to the dry Southwest, including Southern California. A 1918 law was supposed to have protected such North American migratory birds from capture and sale as caged birds—though the rule was seldom enforced. The dog walker complained to authorities, and this time they began a crack-down. When some store owners around the city realized that they would get in trouble, they opened the cages and let the evidence fly away.

The odds would seem to be against desert birds from the other side of the continent surviving in New York City, but the finches settled into Central Park. From there, the population spread to New Jersey, and then—watch out, world.

During the next 60 years, what are now called house finches (*Carduelis mexicanus*) moved into all the other lower-48 states and beyond. They now thrive in places as different climatically as Ontario and Florida. With such extreme adaptability, they're "like birds made of interchangeable plastic parts," says Alex Badyaev of the University of Arizona in Tucson.

One of the differences that Badyaev has observed among the widely scattered house finches shows up in their egg laying. The order in which mothers lay eggs containing male and female embryos isn't random, he finds.

Other birds also have ways of beating the offspring-sex odds. Species as diverse as gulls and peacocks have been reported as boosting or shrinking the ratios of sons to daughters.

Badyaev's work and other studies are exploring how a species might benefit from such skews. Among their ideas: Fixing the odds on offspring makes the best of ups or downs in Mom's health, Dad's sex appeal, and the quirks of the neighborhood. Scientists are now beginning to attack the looming question of what mechanism triggers such biases.

TO MOM'S HEALTH From a mammal's point of view, birds determine sex backwards. From apes to zebras, two copies of the X version of the sex-determining chromosome yield a female, and a mismatched pair, XY, makes a male. In birds, though, the pair

of similar chromosomes, called ZZ, makes the sperm-producing male. The egg-laying female carries the mismatched ZW. So, it's Mom's genetic contribution that determines a chick's sex.

Toward the end of the 1990s, researchers worked out sets of genetic markers that would identify a bird's sex. With them, researchers could figure out the sex of eggs that didn't hatch and of chicks that died before any revealing characteristic emerged. These techniques inspired research teams to test a decades-old prediction that a mother's physical condition, be it robust or pathetic, leads her to produce more of one sex of offspring than the other.

"Peacock farmers say there's a tendency for daughters to increase throughout the season," says Thomas W. Pike, now at University of Glasgow in Scotland. This observation would fit the biologists' theory if the later hatchlings came from mothers worn out as the egg-laying season drags on.

Pike spent two summers on a peacock farm testing ideas about sex-ratio bias. The farmer wouldn't permit experiments that would turn female birds into scrawny wrecks. So, Pike and Marion Petrie of the University of Newcastle upon Tyne in England took advantage of natural variations among birds.

The researchers penned each of six males with three females of different conditions, from thriving to weak. The males mated with them all. The proportion of daughters in the resulting clutches ranged from 25 percent to 87 percent. As predicted, the least robust females had the largest proportion of daughters,

and the most robust females had the smallest proportion.

Why might it be advantageous for a sickly mother to have lots of daughters when sons—by fertilizing many females—could give her a bonanza of grandchildren?

For peacocks, as for many birds, only spectacular sons succeed, and a weak mother is unlikely to produce such champs. Males that rank ho-hum or worse can end up siring no grandchildren for Mom. Although daughters won't give their mothers a bonanza of descendants, mediocre daughters have a better chance than mediocre sons do of raising at least a few chicks.

In the first test of this idea in the wild, scientists provided meals on wheels to lesser black-backed gulls (*Larus fuscus*). Ruedi Nager, of the University of Glasgow, and his colleagues delivered cooked chicken egg to some of the females every night starting 3 weeks before they started laying eggs and continuing until they finished. The females that had received the supplement-



ADAPTATION — A female house finch (right), pictured with a male, tends to lay eggs for sons and daughters in an order that depends on where she lives.

tal meals went into motherhood in top condition. Researchers stressed the females by tricking them into laying extra eggs.

Among the first eggs laid by all the females in the experiment, the sex ratio was roughly 50:50, as determined by blood tests on chicks at hatching. The well-fed birds kept that ratio of the sexes in the eggs that they laid later. But the other birds began producing more daughters, which survived better than sons did. By the 15th egg, almost three-quarters of the offspring from the unsupplemented group were female. The difference between the nutritionally challenged and the supplemented groups supports the view that physically stressed moms have more daughters, Nager's group concluded.

FLASHY DADS It's not all about the moms, though. One of the early experiments on the influence of dads was inspired by a setback in establishing a lab colony of zebra finches. Nancy Burley, now of the University of California, Irvine, had found that the color of the leg bands she'd used to identify her birds could enhance or cut their chances of attracting a mate.

In 1981, Burley reported that dads sporting glamorizing red bands fathered chicks with a higher-than-average chance of being male. A dad rendered undesirable by an ugly green band tended to have extra daughters. One interpretation of the results is that if Dad is obviously sexy, then he's a good bet for siring a son that will provide a grandchild bonanza.

Some other studies haven't shown the same effect. For example, Alison N. Rutstein of the University of New South Wales in Sydney, Australia, and her colleagues reported in 2005 that, using variations on Burley's protocols, they found no correlation between a dad's sex appeal and a nest's male-to-female egg ratio.

For studying the power of handsome fathers, what better birds to test than peacocks? Males don't share the care of the chicks, so the females "use them only for their sperm," says Pike.

To reversibly sabotage sex appeal, Pike cut 20 of the 120-to-200 tail feathers of each of 14 males, leaving the stubs of the feather shafts in place. To restore a male's appeal for half the season, Pike later reattached the feathers.

When males could flaunt all their feathers, their proportion of sons ran 47 to 57 percent. When displaying tattered tails, males fathered only 28 to 35 percent sons.

Another species that's starred in several studies of male charisma and sex ratio is the blue tit (*Cyanistes caeruleus*). The crests of the males look blue to human eyes but flash ultraviolet (UV) to other birds. Females prefer males that are UV bright. In studies of a male's appeal, scientists have smeared some tit crests with a sun-blocking chemical.

The first crest-masking test to look at sex ratios in the wild came from Ben Sheldon at Oxford University in England and his colleagues in 1999. Obscuring the UV reflections of blue tits with particularly flashy crests produced extra daughters. But a group with superior crests unaltered by the researchers fathered plenty of sons. The difference supports the idea that more attractiveness in males yields extra sons, Sheldon concluded. More recently, Peter Korsten of the University of Groningen in the Netherlands repeated Sheldon's study but ran it twice as long. Korsten and his colleagues observed the effect that Sheldon had noted, but only during the second year, the team reported in the July/August 2006 *Behavioral Ecology*. And males that had dull

crests to begin with showed a hard-to-explain increase in sons after their UV-blocking treatment.

No effect of crest-UV reflection showed up in sex ratios in a 2005 study of blue tits by Amelie Dreiss of Pierre and Marie Curie University in Paris and her colleagues.

Dreiss says that studies haven't addressed many factors that may influence egg laying. "[Crest] color may not have the same attractiveness in different populations because of the light environment," she says. Also, the birds' ages and ratios of males to females in an overall population may have an influence.

Territory effect has been considered in studies of a Seychelles warbler (*Acrocephalus sechellensis*) that's found on only a few islands in the Indian Ocean. These birds typically produce a single egg in each round of nesting. Youngsters, especially daughters, linger in their parents' territory and help feed chicks from later nests.

In a test of females that had no helpers, within territories buzzing and crawling with insects to eat, 87 percent of the chicks were female, Jan Komdeur of the University of Groningen reported in 1997. Within insect-poor territories, only 23 percent were daughters.

Komdeur then switched nestlings between good and lousy territories. Daughters in poor territories invited disaster, he found. Because they hung around, they ended up eating more than they were worth and reduced the parents' chances of raising future chicks. Yet in good territories, extra daughters strengthened the parents' chances of raising later offspring.

ORDER, ORDER Badyaev has looked beyond ratios of daughters to sons and considered their positions in families. He and his collaborators have been watching the house finch populations that moved into Alabama and Montana 20 to 30 years ago.

Among the differences between finches in the two states is the egg-laying order of the sexes. The first egg that a Montanan finch lays holds a male embryo about a quarter of the time. In Alabama, roughly two-thirds of the first eggs hold males.

By the last egg in the typical clutch of five, the slant reverses: more than three-quarters male in Montana and about a third in Alabama.

So do those quirks make any difference? The researchers tracked survival of the chicks by sex and by position in the laying sequence. In Montana, female chicks from the first egg had double the survival rate of male first-egg chicks. That skew fit the trend in sex bias: First eggs in Montana often held female chicks.

The other survival trends of first and last eggs likewise matched the sex bias for the location. Somehow, finches skewed the sex of their eggs for greater chick survival. Badyaev calculates that this pattern cuts chick death some 10 to 20 percent from what it would be if birds produced sons and daughters in a 50:50 ratio.

He wondered whether the laying order itself caused the effect. Or did the differences come from the hard scrabble world of the nest, where the last-laid chick struggles out of its egg to find a miniflock of older and larger siblings already competing for food?

To separate the effects, the researchers switched newly hatched chicks among nests. Some chicks were exchanged between nests where the females had started laying eggs at the same time, and so the transplanted chicks kept their original sibling ranks. However, the researchers also chose nests where the mothers had started laying eggs at different times. There, the transplants took the place of youngsters that had hatched in a different family position.

Badyaev and his colleagues conclude that what they see is not



FULL HOUSE — These nearly grown blue tits are in a nest box with its cover temporarily removed for observation. To study whether the dad's attractiveness affected the sex ratio among the youngsters, researchers sabotaged the sheen of a male's crest (inset) with a dab of sunblock cream.

just an effect of sharing a nest with bigger or smaller chicks. The order in which the eggs were laid itself has an effect, though the result is different between the sexes and in different places.

The team then discovered a similar sex-skewing trick in the birds' native range. Around Tucson, house finches breed twice a year. In late winter, they lay roughly half sons throughout the sequence of egg laying. In late spring, more than 80 percent of the last eggs in the sequence hold male embryos. Chick-survival trends work that way, too, favoring late females in fall and late males in spring.

What drives the change, Badyaev proposes, are blood-sucking mites. In the absence of mites, male chicks tend to do best when they hatch early with plenty of time to grow in the nest. However, "male nestlings have no tolerance for mites," he says.

The pests are scarce in late winter, but by late spring, nests are crawling with mites. At that time, the males' best bet is to hatch late and grow fast, the Badyaev group said in the Sept. 26, 2006 *Proceedings of the National Academy of Sciences*.

HOW TO These reports all raise the question of how birds might skew the sex ratio of their offspring. "We really don't know," says Hubert Schwabl, now of the Washington State University in Pullman. However, something he discovered in the early 1990s has been giving people ideas.

Schwabl startled ornithologists by finding a hormone, testos-

terone, in canary eggs. The later an egg fell in the laying sequence, the more concentrated the testosterone was. That pattern held regardless of the sex of the embryo, Schwabl reported.

Since then, researchers have found that eggs are loaded with hormones and other factors that affect a chick's development and later characteristics.

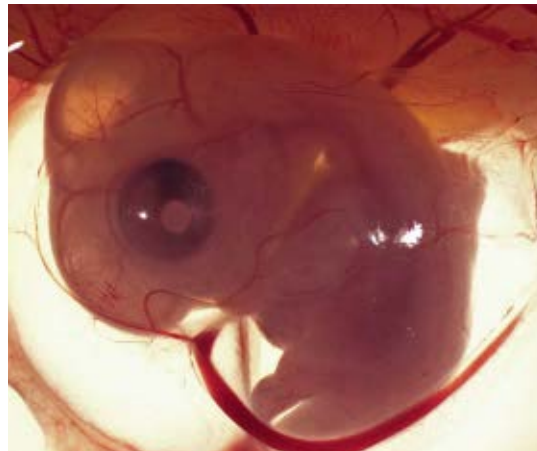
After hormones were discovered in eggs, scientists became interested in possible effects of mothers' hormones on eggs. Among the many ideas was a suggestion that a female bird's hormones influence sex determination.

The idea isn't easy to test directly, but in 2005, Stephanie M. Correa of Cornell University and her colleagues reported that hens injected with high concentrations of progesterone, one of the female reproductive hormones, laid eggs with female embryos 75 percent of the time, as compared with 37 percent among hens not getting the hormone shots.

Pike and Petrie tested various other hormone implants in captive Japanese quail. Females dosed with extra

corticosterone, a hormone that spikes during stress, laid eggs with female embryos almost 70 percent of the time, as compared with 45 to 50 percent among other females' nests, the researchers reported in the May 7, 2006 *Proceedings of the Royal Society B*.

However the sex biases happen, they represent a legacy from the mother that goes beyond classical genetics. "The biggest challenge," says Badyaev, "is to figure out the place of such maternal effects in the grand scheme of evolutionary processes." ■



BIRD TO BE — This 4-day-old male finch embryo may develop outside its mother's body, but maternal influence persists in the egg through hormones and antibodies that Mom had deposited in the yolk.

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Given the sensitivity of these telescopes, an antimatter-dominated region of the universe couldn't be closer than about 65 million light-years. That places the antimatter not only well outside the Milky Way but also far beyond the Local Group, which contains the Milky Way and about 50 other galaxies.

"It wouldn't be easy for antimatter nuclei to get here from a very distant galaxy," Stecker says. After escaping its galaxy, the particle would follow the magnetic field lines emanating from the galaxy. Scientists know little about the magnetic fields between galaxies—the field lines might be twisted into knotty loops, so that antimatter particles could never get far from their galaxies of origin.

If it did traverse intergalactic space, the antihelium nucleus would eventually cross a threshold between the antimatter region and the neighboring matter region. Then, the antihelium would be in constant danger of annihilation. However, "it would have to hit another nucleus to annihilate, and that's a rare event," Stochaj says.

Finally, if an antihelium nucleus is to be recorded, it must approach the neighborhood of the Milky Way. There it would have to contend with the stream of particles flowing out of our galaxy. And once inside the Milky Way, after traveling for millions of years, the nucleus would still have to encounter a detector that's less than a meter across—quite a small target to hit from so far away.

Even with the enormous number of particles that would be flowing out of an antimatter galaxy, the odds of an antihelium nucleus reaching a detector near Earth are small. But because so much is uncertain about the conditions in deep space between galaxies, "there simply is no good calculation" of those odds, Streitmatter says.

This uncertainty makes it difficult for the researchers to know when to stop looking. There's always the possibility that an instrument just slightly more sensitive would make the discovery.

END GAME? Some of the researchers say that the current round of experiments is probably the last. "[We've reached] the practical limit to the effort that anyone's ever going to put into this problem," Streitmatter says. "Unless [an antihelium] is found," he adds, "and then the race is on."

Some physicists doubt whether anything will ever be found. "I don't see any reason why, in our conventional understanding of cosmology, we would see any antihelium in the universe," says Sean Carroll of the California Institute of Technology in Pasadena.

"It wouldn't be easy for antimatter nuclei to get here from a very distant galaxy."

— FLOYD STECKER,
GODDARD SPACE
FLIGHT CENTER

Carroll agrees that the known laws of physics don't rule out the possibility of distant antimatter galaxies, but he says that available observations of the cosmos don't compel him to wonder whether they do. Some scientists have suggested that any region of antimatter might be so large that antihelium particles would never make it to Earth.

However, Carroll notes, "we're often surprised in physics," and physicists shouldn't avoid long-shot experiments. "I think [searching for antihelium is] an interesting observation to do," he says. "You never know. And if they do find it, it would be tremendously exciting."

Most important, evidence of distant antimatter galaxies would shape scientists' understanding of the first few moments after the Big Bang, when small and poorly understood asymmetries assured that matter would survive long enough to form stars, planets, and ultimately life.

"A solid detection of an antihelium would send the theorists scrambling," Stochaj says. ■

R. YOUNG, BADYAEV

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BIOCHEMISTRY

Alzheimer's marker yields blood test

Despite memory-test and brain-imaging advances in recent years, diagnosis of Alzheimer's disease remains a challenge. Usually, only the presence of clumps of the protein amyloid-beta in the brain at autopsy confirms that a person's dementia was Alzheimer's. A study in mice, however, suggests that a test for excess amyloid-beta in the blood could signal Alzheimer's even before any symptoms show up.

If the scientists can adapt the test for use in people, Alzheimer's screening might someday identify individuals eligible for preventive therapies, says Stina M. Tucker of the Johns Hopkins University School of Medicine in Baltimore. Such therapies, now under development, would slow the body's amyloid-beta production or clear the proteins from the brain before cognitive impairment occurs.

The new test is based on antibodies that bind to the amyloid-beta proteins. After Tucker's Johns Hopkins colleague Juan C. Troncoso created the mouse antibodies, the researchers devised a way to use them to quantify amyloid-beta in a mouse's blood.

The scientists injected the antibodies into mice, then several hours later drew blood, filtered out the antibodies, and measured the amount of amyloid-beta collected.

The researchers worked with healthy, normal mice and with animals genetically engineered to produce amyloid-beta to model human Alzheimer's disease. The normal mice showed no excess amyloid-beta protein in their blood, but neither did engineered mice that had already developed moderate-to-advanced amyloid-beta clumps in their brains.

Only engineered mice with beginning Alzheimer's-like disease had excess protein in their blood. Tucker and Troncoso say that they suspect that once amyloid-beta clumps start forming, those deposits collect whatever protein is available, leaving little or none to circulate in the blood. —J.R.

IMMUNOLOGY

Cancer patients aided by yoga

A pilot study in breast cancer patients suggests that Iyengar yoga—stretching and relaxing aided by straps, wooden blocks, and other props—can improve patients' feelings of well-being and even reduce the inflammation triggered by therapy.

Pamela E. Schultz from Washington State University in Spokane and her colleagues recruited 19 women who had recently completed cancer treatments. The researchers randomly assigned 10 of the volunteers to take part in 90-minute yoga sessions three times a week for 8 weeks and the rest to continue their normal routines without extra exercise. The researchers compared results of blood tests and quality-of-life questionnaires administered at the beginning and end of the trial.

Before the trial, Schultz notes, "the majority of our subjects were clinically depressed." By the trial's end, "depression had gone down in the yoga group [but] worsened" among the women who didn't exercise. The yoga practitioners also reported less fatigue and less trouble with the "demands of illness" than did the other women.

A dramatic immune system change was responsible for improvements in the yoga group, Schultz suspects. By the trial's end, these women had roughly 40 percent less of the immune system agent NF-kappa-B in their blood cells than did women who didn't do yoga. The substance has been linked to the production of inflammation-aggravating chemicals, Schultz notes. —J.R.

BIOMEDICINE

This trick boosts cancer's spread

A molecule on the surface of most cells keeps them tightly stitched together into well-organized tissues. Because such order prevents the cells from growing excessively or leaving the tissue, spreading cancer cells turn off the production of this molecule, called E-cadherin. A new study shows that, contrary to conventional medical wisdom, that shutdown isn't permanent.

And that could be bad news.

The loss of E-cadherin makes a cancer cell resemble a stem cell in its capacity to assume any tissue type, notes University of Pittsburgh pathologist Alan Wells. It also makes those cells look different from those in normal tissues.

However, once a spreading, or metastatic, cell lands in a hospitable new tissue, it can reboot E-cadherin production and take on the appearance of a well-behaved neighbor, Wells and his coworkers have found. In fact, the spreading cells are anything but model neighbors.

Triggered by as-yet-unrecognized signals, the cancer cells can resume unchecked

growth in their new homes and then spread farther, notes Wells' Pittsburgh colleague, Christopher R. Shepard.

The team experimented with breast cancer cells excised from 11 women. All the cells were initially free of E-cadherin, but within 6 days of being incubated with healthy liver cells, the cancer cells from three women resumed E-cadherin production.

In the April 23 *British Journal of Cancer*, the Pittsburgh team reports similar behavior in prostate cancer cells following their incubation with liver cells.

Wells says that although the re-emergence of E-cadherin makes cancer cells look "almost benign," that's just a "disguise." It might even protect cancer cells against elimination by chemotherapy agents that target rapidly proliferating cells. —J.R.

NUTRITION

A smart pill for seniors?

Many people approaching retirement age find that memories fade and quick-wittedness flags. Scientists at the University of Massachusetts in Lowell have formulated what they call a "smart pill" to optimize brain health in such people. In pilot trials, its combination of dietary supplements boosted performance on simple mental tests by middle-aged and elderly adults.

Throughout life, the brain and other tissues are assaulted by biologically damaging oxidative chemical reactions triggered by pollutants, disease, and more. Although the body makes protective antioxidants, its capacity to do so wanes with age.

Thomas Shea and his colleagues recruited 100 healthy men and women for their smart-pill trial. Half received a placebo. The rest got the patent-pending supplement combination, which included the antioxidant vitamins folic acid, B₁₂, and vitamin E. The pills also contained a building block for glutathione, an antioxidant made by the body; acetyl-L-carnitine; and S-adenosyl methionine. The dose of each ingredient was typical of that in existing off-the-shelf products, Shea says.

Prior to the trial and then at 3-month intervals, participants performed a pair of connect-the-dots tests that indicated their decision-processing speeds.

Test times for those getting the smart pill "improved by an average of 10 percent in 3 months, and 20 percent in 6 months," Shea told *Science News*. People given the sham pills showed no improvements.

Such supplements might help aging adults stay sharp and fight the ravages of oxidants, Shea concludes. —J.R.

OF NOTE

SCIENCE AND SOCIETY

Lethal injection is inhumane, say researchers

Prisoners killed by lethal injection may be conscious and may experience excruciating pain and burning sensations while they asphyxiate, according to a new report.

“The design of the lethal-drug scheme itself is flawed,” say Leonidas Koniaris of the University of Miami and his colleagues in the April *PLoS Medicine*.

The researchers point to low post-mortem blood concentrations of sedatives and several reports of prisoners who required a second round of injections.

No ethical board or oversight group has ever evaluated the three-drug cocktail used by the federal government and by most of the 37 states that execute prisoners, say the researchers.

The cocktail includes the barbiturate sodium thiopental, the paralytic pancuronium bromide, and potassium chloride to stop the heart. Oklahoma’s state medical examiner concocted the mix in 1977 as a more humane alternative to electrocution.

But insufficient sodium thiopental might leave the prisoner aware as the other two drugs take effect, the researchers say, violating the United States Constitution’s Eighth Amendment prohibiting cruel punishment.

The authors based their report on information from North Carolina and California. The two states that execute the most prisoners, Texas and Virginia, refused to participate in the research.

Since the reinstatement of capital punishment in 1976, 891 prisoners have been executed by lethal injection. —B.V.

ZOOLOGY

Sex—perhaps a good idea after all

A family of beetle mites may be the first animal lineage to have abandoned sexual reproduction and then reevolved it.

That’s the conclusion of a study of the mites’ evolutionary history as determined by DNA analysis, says Roy Norton of the State University of New York in Syracuse.

The Crotoniidae mites perpetuate their species through the usual joint efforts of males and females. Yet when Norton and researchers from Darmstadt Technical University in Germany studied DNA to trace a family tree for certain mites, the Crotoniidae ended up as a relatively recent twig on a bigger branch bristling with asexual lineages. Analyzing the physical structures of the mites leads to the same conclusion, says Norton.

The tidiest way to explain the tree’s pattern is that Crotoniidae sex disappeared long ago and then somehow reemerged, he and his colleagues say in a paper published in the April 24 *Proceedings of the National Academy of Sciences*.

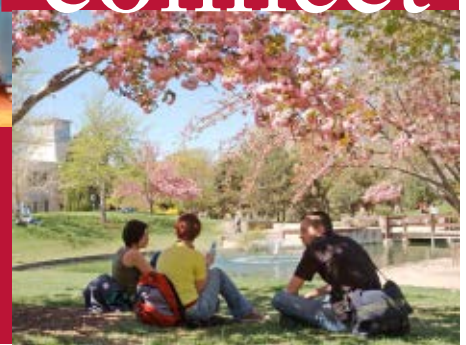
The team concludes that the mites represent “a spectacular case” of breaking a supposed law of evolution that says that when complex traits disappear, they’re gone forever. However, researchers have claimed other exceptions. Another team reported the reemergence of sex in a plant—a hawkweed (*Hieracium pilosella*).

Norton, Darmstadt’s Katja Domes, and their colleagues analyzed three genetic sequences from each of 30 species of beetle mites. The study focused on the Desmonomata group, including Crotoniidae and large clusters of asexual species. In the asexual mites, mothers have daughters almost exclusively. The males that occasionally turn up don’t participate in procreation. —S.M.

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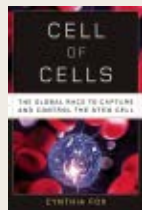
Books

A selection of new and notable books of scientific interest

CELL OF CELLS: The Global Race to Capture and Control the Stem Cell

CYNTHIA FOX

Despite a ban on the use of U.S.–government funds for creating and experimenting on new lines of human embryonic stem cells, progress is occurring in this highly promising field, Fox asserts. A science writer, she surveys current efforts to harness stem cells to cure diseases ranging from heart ailments to blindness, dementias, and cancer. The international race to isolate the first embryonic stem cell began only within the past decade, the author points out. Fox reviews the political climate affecting this area of science and notes how it leads to an unusual interplay among scientists at conferences, where researchers who work on adult stem cells seem pitted against those who study embryonic stem cells. Stem cell science is robust, Fox concludes, despite strong religious and political pressures against it. **Norton, 2007, 546 p., hardcover, \$26.95.**



WHAT IS YOUR DANGEROUS IDEA? Today's Leading Thinkers on the Unthinkable

JOHN BROCKMAN, ED.

Modern science includes many concepts that were once considered socially or morally unacceptable, or even dangerous. The ideas that human beings evolved from ancestral species and that Earth revolves around the sun are two notable examples. Dangerous ideas can be critical to understanding how the world works, this book posits. Brockman, publisher and editor of the Edge Web site for “third-culture” thinkers, presents dozens of authors and their edgy ideas. The thought-provoking essays—some shorter than a page and others five to six pages long—are by Irene Pepperberg, Steven Pinker, David Buss, Freeman Dyson, and other scientists. Included are essays that reject the concept of a soul, propose that the most dangerous idea stemming from modern genetics is that races differ in their talents and temperaments, and despair that the fight against global warming has already been lost. **Harper Perennial, 2007, 301 p., paperback, \$13.95.**

SOARING WITH FIDEL: An Osprey Odyssey from Cape Cod to Cuba and Beyond

DAVID GESSNER

With limited resources but boundless enthusiasm, Gessner follows osprey during their yearly migration cycle from Cape Cod, down the East Coast, over Cuba, into South America, and back. Gessner, an environmental writer, dispenses the information he acquired from experts on the eagle-size bird

known for its spectacular diving. He reveals that, unlike most raptors, ospreys migrate along an over-ocean route. Early on his trip along that path, the author learned that a BBC crew had, coincidentally, embarked on the same voyage for a documentary. Thanks to the network’s technology and the Internet, Gessner followed birds tagged with satellite trackers. Thus he discovered that the birds do test flights before embarking on their big migrations. Gessner documents his journey—via car, ferry, and plane—and the help of many sympathetic locals along the route down the U.S. coast, to Havana, and to the birds’ wintering grounds in Venezuela. **Beacon, 2007, 289 p., hardcover, \$24.95.**



DIRT: The Erosion of Civilizations

DAVID R. MONTGOMERY

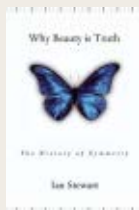
Dirt supports more than the objects that sit atop it. It supports civilizations, Montgomery points out. People obviously rely on dirt for agriculture and therefore sustenance. But history is full of examples of civilizations displaced or destroyed because they depleted their soil. Montgomery, a professor of earth and space sciences, provides a history of people’s reliance on soil and warns that current methods of cultivation are exposing fertile dirt to the eroding effects of wind and rain. The author provides an overview of soil formation before and after life on Earth began. Since that turning point, soil formation has been a complex interplay of water, climate, minerals, vegetation, and soil-dwelling organisms. Today, most of the world’s nations are losing soil faster that nature can make it. The answer to reversing that trend lies not in fertilizers and the cheap oil needed to produce them, the author asserts, but in no-till farming and other soil-conservation methods, such as reincorporating organic debris into existing soil. **Univ. Calif. Press, 2007, 285 p., b&w photos, hardcover, \$24.95.**



WHY BEAUTY IS TRUTH: A History of Symmetry

IAN STEWART

The concept of symmetry has been pondered for thousands of years. Its elegance and beauty have their roots in mathematics, writes Stewart, a professor of mathematics at the University of Warwick. The ancient Babylonians developed quadratic equations, the first mathematical representations of symmetry. Starting there, Stewart traces the timeline of mathematical discovery and innovation relating to symmetry, introducing important mathematical concepts and the historic figures behind them. Stewart uses clear language to explain the often-complex mathematics behind symmetry. He even guides readers through the intellectual maze of how symmetry might reconcile Albert Einstein’s general theory of relativity with quantum theory. Finally, he explains the concepts behind supersymmetry and superstrings, which may eventually yield a theory explaining all the forces of the universe. **Basic, 2007, 290 p., b&w illus., hardcover, \$26.95.**



LETTERS

Saw right through it

E. Fred Schubert and his colleagues are to be congratulated for developing an improved antireflective coating (“The New Black: A nanoscale coating reflects almost no light,” *SN*: 3/3/07, p. 132). But the coating would not make a lens “absorb” more light. Rather, it would help the lens “propagate” the light.

NATHANIEL L. COHEN, SAN DIEGO, CALIF.

“Absorb” probably was a poor word choice in reference to a lens. The point is that the coating reduces the amount of light reflected at the lens’ surface, thereby increasing the transmission of light through the lens. —P. BARRY

Like dog years?

You report on new age dates for Clovis sites (“New age for ancient Americans,” *SN*: 3/3/07, p. 141). It may be of interest to your readers that the dates given (11,050 to 10,900 years ago) are in “radiocarbon years” and are not in real or “calendar years.” As a result of variations in the production of carbon-14 in the atmosphere through time, radiocarbon years have a certain percentage of error, depending on age and type of material. For example, the radiocarbon date of 11,000 years is actually equal to approximately 13,000 calendar years.

BRUCE BARTLESON, GUNNISON, COLO.

Poacher prevention

To discourage poaching, authorities in Zambia should subdue every elephant they can find, sedate it, harvest the ivory themselves, and sell it for revenue for animal-protection programs (“DNA pinpoints poached ivory tusks,” *SN*: 3/10/07, p. 158). That’s better than dead.

BUZ CRAFT, WILLS POINT, TEXAS

A lot of living to do

Regarding “Living Long on Less? Mouse and human cells respond to slim diets” (*SN*: 3/10/07, p. 147), what were the ages of the people in the study?

HENRY DIETER WEINSCHTEL, LAS CRUCES, N.M.

The participants, whose muscle cells showed several more-youthful signs if they ate fewer calories, were 35 to 38 years old. —P. BARRY

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