SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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next?

WEST NILE THREATENS WILDLIFE

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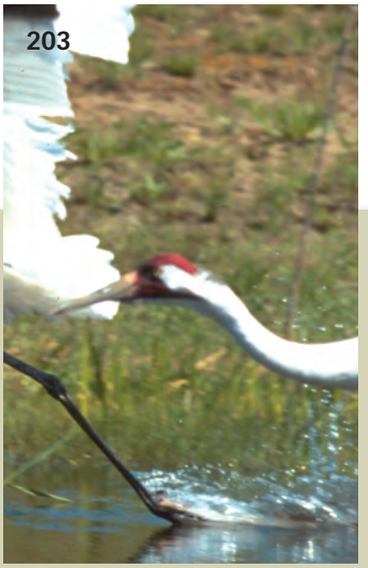

Features

This Week

Of Note

Departments

Cover Whooping cranes can get West Nile virus, though there's no evidence yet that the disease has done permanent harm to the endangered species. Nevertheless, biologists worry that these and other animals with small populations could take big hits from the spreading disease. (International Crane Foundation) Page 203

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Three-point shot Measures of shooting performance in basketball need tweaking. See Ivars Peterson's MathTrek.

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Prime Finding

Mathematicians mind the gap

A mathematical duo has made a surprising advance in understanding the distribution of prime numbers, those whole numbers divisible only by themselves and 1. The new result is the most exciting work on prime numbers in more than 3 decades, says mathematician Hugh L. Montgomery of the University of Michigan in Ann Arbor. However, he cautions that experts are still checking the details of the proof.

Among small numbers, primes are common. Of the first 10 numbers, for instance, 4 of them—2, 3, 5, and 7—are prime. But among larger numbers, primes thin out. Around a trillion, for instance, only about 1 in every 28 numbers is prime.

In the late 19th century, mathematicians proved that the distribution of primes follows an amazingly simple pattern: The average spacing between primes near a number x is the natural logarithm of x, a number closely related to the number of digits in x.

This formula is true only on average, however. Sometimes, the gap between primes is much smaller, other times much larger. The twin-primes conjecture, one of the most famous unsolved problems in number theory, speculates that there are infinitely many pairs of primes that differ by only two. Examples of twin-primes abound—17 and 19, for instance—but for more than a century, mathematicians have struggled without success to prove the conjecture.

However, mathematicians have had some success in considering the more general case of primes that are closer together than predicted by the average-spacing formula. In 1965, Enrico Bombieri of the Institute for Advanced Study in Princeton, N.J., and the late Harold Davenport proved there are infinitely many pairs of primes that are closer together than one-half the average spacing. In the late 1980s, that was whittled down from one-half to one-quarter.

Now, Daniel A. Goldston of San Jose (Calif.) State University and Cem Y. Yildirim of Bogaziçi University in Istanbul have proven something much stronger: Given any fraction, no matter how small, there are infinitely many prime pairs closer together than that fraction of the average.

"This result blows out of the water a whole line of previous records, as if someone were to run a 3-minute mile," says Carl Pomerance of Bell Laboratories in Murray Hill, N.J. "It's an end-run around the big plan for development in the field."

Brian Conrey, director of the American Institute of Mathematics in Palo Alto, Calif., agrees. "It's an incredible breakthrough," he says.

Goldston and Yildirim's novel idea was to examine the distribution not just of pairs of primes, but also of triples, quadruples, and larger groupings. Studying this wider question simplified the formulas estimating the spacing of primes, and to the team's surprise, the new result about smaller-than-average prime gaps fell out.

"The result was so much better than what we expected, I almost thought we had made a mistake," says Goldston, who has been working on prime gaps for 20 years. "I'm as amazed as anyone else that this could be proved so easily."

The distribution of primes is closely related to one of the most renowned questions in mathematics, the Riemann hypothesis, which concerns an infinite sum called the zeta function. In 2000, the Clay Mathematics Institute in Cambridge, Mass., offered $1 million to anyone who could settle the Riemann hypothesis. Goldman is optimistic that the new result will say something about the zeta function. "Whether it will say something significant is pretty speculative," he notes. —E. KLARREICH

By a Nose?

Human sperm may sniff out the path to an egg

A man's sperm seek out a variety of floral scents, suggesting that these microscopic swimmers possess a primitive kind of nose that enables them to navigate to a woman's egg. This discovery could inspire new forms of contraception or improvements in in vitro fertilization, say researchers.

It's long been suspected that human sperm sense chemicals secreted by an egg. More than a decade ago, for example, investigators found that human sperm sport proteins called olfactory receptors, the same molecules that nerve cells in the nose use to detect smells.

Yet it's been difficult to identify what binds to these receptors or to confirm that human sperm sense and swim toward any chemical. In the March 28 *Science*, however, Marc Spehr of Ruhr University Bochum in Germany and his colleagues describe a new olfactory receptor on human sperm and report that its response to several chemicals can direct a sperm's swimming behavior.

After identifying the new sperm protein, known as hOR17-4, the researchers added its gene to human kidney cells growing in a lab dish. By monitoring the flow of calcium ions within the modified kidney cells, the scientists could determine whether a substance triggered the new olfactory receptor.

SWIM THIS WAY
Human sperm may sense chemicals from an egg.

E. NEUHAUS AND SPEHR/SCIENCE

After testing hundreds of synthetic compounds, many of which provide floral scents to commercial products, the researchers homed in on a chemical called cyclamal. They then found similar compounds that also activate the receptor. One of these, a floral scent called bourgeonal, is the most potent signal identified so far.

Human sperm were even more sensitive to this compound than were the kidney cells used in the original experiment, the researchers report.

"Bourgeonal has two effects on sperm behavior. It speeds up sperm and changes undirected swimming behavior to direct movement toward the compound," says Spehr. In fact, at certain concentrations of bourgeonal, sperm speed almost doubled—to 30.1 micrometers per second from a normal 18.3 μm/sec.

Since the scientists don't think that eggs make bourgeonal, they're now searching the fluid from women's reproductive tract for a natural stimulus for the new sperm receptor. "The natural sperm attractant might be structurally related to bourgeonal," says Spehr. "One can only speculate if it is secreted by the egg itself or the cumulus cells surrounding the egg or even by cells lining other parts of the female genital tract."

Bourgeonal or other sperm attractants might someday be used in a fertility test to identify sperm with the best chance of arti-

ficially inseminating an egg, the researchers suggest. The investigators also identified a compound, called undecanal, that somehow blocks bourgeonal's attractiveness to sperm. They speculate that undecanal could provide a lead for a new form of contraception that prevents sperm from sniffing their way to the egg.

The identification of a novel sensory receptor on human sperm, along with compounds that trigger it or block its action, constitute a "landmark event," says Donner F. Babcock of the University of Washington in Seattle in a commentary published with the new report. —J. TRAVIS

Clean Casualties

Everyday chemicals may shift ecosystems

Chemical concoctions used to battle bacteria in kitchens and bathrooms may have unintended victims. The traces of these products that wend their way into U.S. streams may kill off algae, researchers report. Since algae are at the bottom of the aquatic food chain, this effect could have far-reaching consequences.

Over the past decade, household and personal-hygiene products have been made more lethal to bacteria. The antimicrobial agent triclosan pervades products ranging from window cleaner to toothpaste, for example. Scientists suspect that such chemicals may hasten the ascent of drug-resistant bacteria, perhaps worsening the problem already posed by the overuse of antibiotics (*SN: 5/27/00, p. 342*).

Now, environmental scientist Brittan A. Wilson of the University of Kansas in Lawrence and her colleagues find that antimicrobial-chemical cocktails may also have environmental consequences.

Wastewater-treatment plants often don't remove household chemicals. Therefore, these substances make their way from household drains to natural bodies of water (*SN: 8/17/02, p. 101*). Treated wastewater has been known to contain up to 40 such chemicals, among them drugs, solvents, and detergents, says hydrologist Dana W. Kolpin of the U.S. Geological Survey in Iowa City. "And that's just the chemicals that we're measuring," he says.

To find out how some of these chemicals may affect freshwater ecosystems, Wilson's team collected algae species from a Kansas stream. In the lab, they treated the algae with one of three household chemicals: triclosan, the antibiotic ciprofloxacin, or tergitol, a spermicidal lubricant and hair dye ingredient. The scientists used the average concentrations of triclosan and ciprofloxacin found in U.S. streams, and an estimated concentration for tergitol. Control samples of algae were left untreated. For 2 weeks, the scientists monitored the number of each algal species in the samples.

Treatment with the chemicals shifted the structure of the algal communities compared with the untreated algae communities, the researchers report in an upcoming *Environmental Science and Technology*. The number of algal species and overall algal growth dropped in samples treated with each of the chemicals, but not in control samples.

"In the real world, algae are exposed to a complex mixture of these and other chemicals," says ecologist Val H. Smith, a study collaborator also at the University of Kansas. Under those conditions, the effects found for single chemicals may be "greatly aggravated," he notes

"The study is quite significant—maybe even pioneering," says ecologist Ray Drenner of the Texas Christian University in Fort Worth. Wilson and her colleagues "make a case that real-world concentrations of these chemicals likely have effects on the base of the food chain," he adds.

"It's stupid to think that chemicals that keep toothpaste safe from bacteria won't have an effect at the other end of the sewer pipe," says ecologist Stanley I. Dodson of the University of Wisconsin–Madison. "I'm amazed at the effects from such low [chemical] concentrations." —K. MORGAN

Secret Signal

Fish allurement that predators don't see

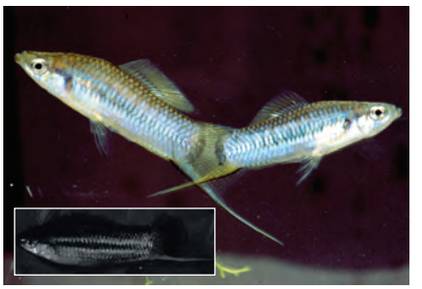
In a rare demonstration of secret messaging in animals, a swordtail fish uses ultraviolet (UV) wavelengths as a private courtship channel, biologists now report.

Males sport bold UV-reflecting horizontal stripes that attract feminine interest, says Molly E. Cummings of the University of Texas at Austin. She and her colleagues also found that the fish's main predator doesn't see this UV finery. Males, therefore, can court conspicuously without increasing the danger of becoming somebody's dinner, Cummings and her colleagues report in an upcoming issue of the *Proceedings of the Royal Society of London B*.

"We are the first group to provide direct behavioral evidence of a private visual communications channel," Cummings says.

Studies in the 1980s showed that if researchers stocked artificial streams with aggressive predators, populations of guppies there shifted during 14 generations to subdued coloration. In comparable setups with less-threatening predators, however, flashy, golden spots became prominent in guppy populations.

Cummings and her colleagues discovered that male *Xiphophorus nigrensis* swordtails sport sexy, UV-reflecting stripes. Cummings says this probably explains why some 14 years of earlier experiments by her Austin collaborator Michael J. Ryan and his associates hadn't yielded clear indications of female



SWORDED AFFAIRS Male swordtails trail their exaggerated tails. Inset shows the bright horizontal stripes, in the ultraviolet spectrum, that entice females.

RYAN/G. ROSENTHAL

preferences for swords. The old setups inadvertently blocked UV signals, she says.

In new tests, she and her colleagues placed a female in a tank with a male visible in a compartment at each end. A filter blocked the UV wavelengths from the markings on one of the males. The male revealed in full UV glory was twice as likely to attract the female as the filter-blocked male was, the researchers report.

The researchers used the same setup—and the same males—to test preferences of swordtail-hunting Mexican tetras. These predatory fish, however, didn't pay extra attention to UV-bedecked males. Cummings also reports that the eye lenses of the predators block UV light.

Xiphophorus malinche, the only close relative of *X. nigrensis* that lives far from Mexican tetras, doesn't seem to bother with UV signaling, Cummings reports.

This hint that UV signaling imposes demands on the fish interests Philip Stoddard of Florida International University in Miami, who studies courtship signals of electric fish and how predators eavesdrop on them (*SN: 7/17/99, p. 37*). "If UV's so great, why doesn't everybody do it?" he asks. He speculates that maintaining sensitivity to such signals may hamper long-distance vision.

John Endler of the University of California, Santa Barbara, who pioneered the guppy studies, sighs over "this huge brouhaha over UV signals." He laments that

people, with their feeble human vision, have been slow to take seriously the UV signals of so many other creatures. Still, he welcomes the new work as "a nice, clean experiment." —S. MILIUS

Dioxin Dumps

Burning exposed trash pollutes soil

In poor urban areas of underdeveloped countries, people frequently set fire to refuse that accumulates along streets and in unofficial dumps. Research now suggests that this form of trash incineration leaves behind prodigious quantities of dioxins and related compounds, which other studies have shown can cause cancer and damage the liver and immune system.

As a consequence, open trash piles may expose people who live in the vicinity and scavenging animals to serious health risks, says Shinsuke Tanabe of Ehime University in Matsuyama, Japan. Other scientists note that the combustion products could be dispersing across borders on wind currents.

The chemicals can move from soil to body tissues by several means. They may be attached to dust that's kicked up and inhaled by animals and people. The substances may also be consumed accidentally or enter the body through the skin.

At open trash-burning sites in Cambodia, Vietnam, the Philippines, and India, Tanabe and his colleagues set out to measure five polychlorinated dibenzo-*p*-dioxins (dioxins) and eight related compounds mostly in the category of polychlorinated dibenzofurans (furans). Studies in industrialized nations have implicated ash and gases from municipal trash incinerators as sources of these chemicals. Furthermore, because open fires typically burn at lower temperatures than incinerators do, they're more likely to produce the compounds.

Tanabe's team tested 48 soil samples from five dumps where trash had been burned. The researchers also tested 13 soil samples from locales at least 30 kilometers from these dumpsites.

Soil from the dumps had much higher concentrations of the dioxins and furans than the other sites did. For example, at a dump in Phnom Penh, Cambodia, concentrations of 9 of the 10 studied dioxins and furans were at least 100 times greater than they were in soil away from the dump. The chemicals' concentrations in soil at this site and one in Hanoi, Vietnam, exceeded a threshold that in the United States and Japan triggers government intervention, Tanabe and his colleagues report in an upcoming issue of *Environmental Science and Technology*.

The study didn't include enough soil samples to give a reliable estimate of the magnitude of the problem caused by these dumps, says Karl-Werner Schramm, a dioxin researcher at the Institute of Ecological Chemistry in Neuherberg, Germany. Nevertheless, Schramm adds, the work supports a relationship between the incineration of junk and environmental problems.

This study appears to be the first to document that common methods of trash elimination in Asia are creating hazardous environmental concentrations of dioxins and related contaminants, says Johan Nouwen, who studies soil pollutants at the research institute Vito in Mol, Belgium. Trash burning "also could be an important problem in African and South American developing countries," he says.

Because diseases unrelated to pollution keep life expectancy short in many poor countries, the newly documented threat may not become a high-priority health issue for the countries studied, Nouwen adds. However, air currents can carry dioxins and furans across national borders, so the health implications of small-scale trash burning deserve international attention, he says. —B. HARDER

TANABE ET AL./EHIME UNIV.

DIOXIN RISING Burning trash in the open, a common practice in many underdeveloped countries such as Cambodia, may create large quantities of illness-causing contaminants.

A Hard Little Lesson

Squeezed nanospheres grow superstrong

Small is different. That's a fact of life for scientists studying virus-size chunks of matter called nanoparticles.

Now, the first-ever experimental determinations of the hardness of individual silicon nanospheres reveal just how different mechanical properties can be. The nanospheres are up to four times as hard as bulk silicon, such as the silicon wafers from which computer chips are made, report William W. Gerberich of the University of Minnesota, Twin Cities and his coworkers in the June *Journal of the Mechanics and Physics of Solids*. The diameter of the spheres ranged from 40 to 100 nanometers.

Gerberich's team, which includes researchers at Los Alamos (N.M.) National Laboratory, squished silicon nanospheres beneath a diamond point and caused atomic rearrangements to take place inside the spheres. From readings of the force on the spheres, as well as computer simulations of the squeezing process, the scientists calculated that the hardness of the silicon ranks between that of sapphire and diamond, two of the hardest materials known. Bulk silicon's hardness isn't in that ballpark.

If this hardness boost occurs in silicon when it's formed into nanospheres, says Gerberich, perhaps materials that are already extremely hard could be recast into yet harder forms. "I would like to try sapphire and silicon carbide," he says. The result could be new superhard materials for such uses as industrial polishing processes and making micromachines (*SN: 7/22/00, p. 56*).

Gerberich says that the surprising boost in hardness results from a familiar metallurgy process called work hardening. It's normally achieved by operations such as hammering and rolling. However, unlike the ductile metals that are typically work hardened, bulk silicon is brittle, so it would shatter if subjected to those operations.

Besides hinting at practical payoffs, the new results "do a good job of extending our understanding of material behavior to a size range that has not been well studied before," comments Richard P. Vinci of Lehigh Uni-

versity in Bethlehem, Pa.

Particularly intriguing, he says, is that the number of atoms in the actual nanospheres approaches the number that can be included in a computer simulation. This near match suggests that researchers will soon be able to confidently predict from computer models how materials behave. "This . . . opens up a world of possibilities for virtual-materials design," says Bob R. Keller of the National Institute of Standards and Technology in Boulder, Colo. —P. WEISS

Morbid Mystery Tour

Epidemic from China is encircling globe

An outbreak of deadly pneumonia that seems to have begun in southern China spread this month to at least two other continents, including North America. Initial tests have given clues to the identity of the pathogen involved in the infection, which health officials have dubbed severe acute respiratory syndrome (SARS).

At least 300 cases of SARS have been tallied in mainland China, where the epidemic has apparently been smoldering since last November. Elsewhere, more than 450 cases and at least 17 deaths have been attributed to the disease, according to the World Health Organization (WHO) in Geneva.

The new epidemic "reminds us that . . . an emerging problem in one part of the world will soon be a problem for all of us," said Julie Gerberding, director of the Centers for Disease Control and Prevention (CDC) in Atlanta.

Beyond mainland China, Hong Kong has thus far borne the brunt of the outbreak, with at least 10 deaths among 286 cases. Epidemiologists have traced many of the other infections to a man who was hospitalized on Feb. 26 in Hanoi, Vietnam, after traveling from mainland China via Hong Kong. Several doctors who treated that patient later became ill. From Hanoi and Hong Kong, infected people traveling by airplane spread the disease to Europe, North America, other parts of Asia, and possibly Australia. At least 40 suspected cases have been identified in the United States.

Infections have occurred primarily through close and prolonged contact with sick individuals, WHO officials say. From 2 to 7 days after being exposed, an infected person suddenly develops a high fever and other flulike symptoms and suffers difficulty breathing. In some cases, respiratory problems are so severe that patients need artificial ventilators.

WHO, CDC, and numerous national health agencies have deployed teams of disease investigators and laboratory scientists to identify the pathogen and develop means to contain the outbreak. Investigators, who initially examined tissues from infected people for known viruses, bacteria, and other pathogens, suggest that a novel pathogen lies behind the epidemic.

Two candidate viruses had been identified by press time, one belonging to the paramyxovirus family and one to the coronavirus family. Paramyxoviruses produce well-known contagions such as measles and mumps. That family also includes the rare Nipah and Hendra viruses, both of which were discovered in the past decade after they emerged as deadly infections. Some coronaviruses commonly cause minor colds in people, but none has previously been linked to an outbreak as serious as the current one. —B. HARDER

Fine Toothcomb

New fossils add to primate-origins debate

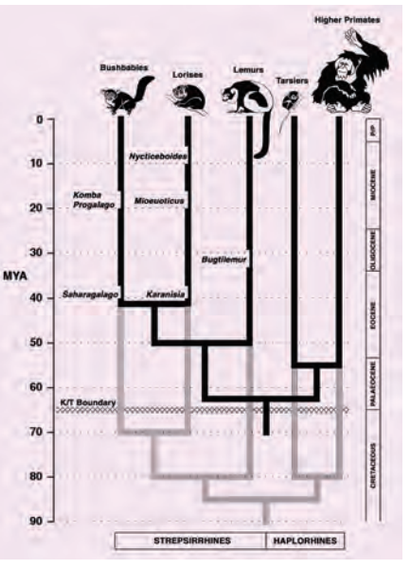
Fossil hunters working in Egypt have unearthed jaw fragments and teeth belonging to the oldest known members of one of the main evolutionary branches of primates.

The 40-million-year-old specimens represent two ancient groups, one an ancestor of modern lorises—complete with a comblike set of lower front teeth that confirms its identity—and the other, of bushbabies, say anthropologist Erik R. Seiffert of Duke University in Durham, N.C., and his colleagues. These new finds double the age of the sparse fossil record for lorises and bushbabies, which with lemurs make up a primate group called the strepsirrhines. It originated in Africa at least 50 million years ago, the scientists conclude in the March 27 *Nature*.

"The new fossils date to near the evolutionary split of lorises and bushbabies from lemurs, which occurred perhaps 45 million years ago," Seiffert says.

Such estimates fit with the traditional notion that the first primates appeared around 65 million years ago. However, other researchers using DNA analyses have concluded that primates arose approximately 90 million years ago (*SN: 4/20/02, p. 243*).

In a comment published with the new report, Robert D. Martin of the Field Museum in Chicago cites the genetic data in support of his view that strepsirrhines originated in southern Asia around 80 million years ago. In his view, lorises and bushbabies took a unique evolutionary route 10 million years later, perhaps when lemurs became isolated on the island of Madagascar after it separated from India.



TANGLED TREE **Primate evolutionary diagram shows the two main living groups, strepsirrhines and haplorhines, with known fossil forms of strepsirrhines. Traditional model of primate evolution (dark lines) contrasts with DNA-based version (shaded lines).**

"The timing and location of primate origins remains a complex problem," cautions evolutionary biologist Anne D. Yoder of Yale University, who has conducted primate-DNA studies. "Still, the new fossils from Egypt are terribly exciting."

Seiffert's group excavated a site in the Fayum Depression on the eastern edge of the Sahara Desert. They assign some of their finds to the genus *Saharagalago*, an ancestor of living bushbabies that weighed around 1/4 pound. The rest come from the genus *Karanisia*, an ancient loris that tipped the scales at an estimated 2/3 pound.

Of particular interest, the researchers say, are teeth at the front of a *Karanisia* lower-jaw fragment that form a toothcomb like that of today's strepsirrhines. The toothcomb consists of elongated, flattened teeth that angle sharply forward. Microscopic grooves on the fossil teeth indicate that *Karanisia* used its toothcomb for grooming, just as its living relatives do, Seiffert says.

Despite an intriguing find in Pakistan several years ago, no definitive lemur fossils have been found, Martin holds (*SN: 10/20/01, p. 245*).

"We need to find lemur fossils [at Fayum]," Seiffert says. Without such a find, he notes, fossil reconstructions of primate origin will remain shaky. —B. BOWER

FIELD MUSEUM/BEERLI-BIELER/SEAGARD

PICTURES ONLY A COMPUTER COULD LOVE

New lenses create distorted images for digital enhancement

BY PETER WEISS

Two thousand years ago, Roman Emperor Nero peered through an emerald monocle to better see his gladiators in combat. Twelve hundred or so years later, eyeglasses started to adorn faces. Up to the present, lenses have primarily served one purpose: to render the world more visible—to people, that is. Now, there are inanimate observers that can also benefit from lenses. More and more, computers are being tasked with making sense of the visual world in ways that people can't.

With a new generation of optics, engineers are recasting visual scenes for computers' consumption. To the human eye, these pictures are visual gibberish, hardly worth a single word, let alone a thousand. To computers, such data can be worth more words than you'd care to count.

Central to it all are new styles of lenses. Instead of the familiar concave and convex disks, optical engineers are making oddly shaped, radically different lenses tailored to the strengths of computers.

"Once you break away from thinking that the optics have to form something [people] recognize as an image, there are many things that you can do," says Joseph N. Mait of the Army Research Laboratory in Adelphi, Md., and the National Defense University in Washington, D.C.

"There's no reason to go ahead and form an image," agrees Eustace L. Dereniak of the University of Arizona in Tucson. Even in nature, there are beetles that navigate by detecting certain colors or the polarization of light in space without making an image out of the data. People have been slow to explore such alternatives, however, because we've modeled optical instruments such as cameras after our own, image-making eyeballs, says Dereniak.

By weaning themselves away from conventional optics, some researchers are bestowing microscopes and other optical instruments with extraordinarily crisp focusing powers across their entire field of view—a characteristic known as extended depth of field. The lenses under development for these purposes point to many other promising prospects, optics developers say, including cameras no thicker than business cards and improved iris-scanning devices for detecting terrorists in airports.

Other optical engineers are developing novel lenses to help computers sense motion and the physical properties of remote objects.

Going beyond optical phenomena, engineers anticipate making similar lenses that can process other portions of the electromagnetic spectrum, says David J. Brady of Duke University in Durham, N.C. "It's a general change in the way you think about sensing," he says. Among the technologies that may be strengthened are radar, computerized axial tomography (CAT) X-ray scanners, and magnetic resonance imaging (MRI) systems.

HOCUS FOCUS — A blurry image (middle) from a new type of lens is better for computer processing than a conventional image (top). An in-camera computer can erase all blur from the middle image, yielding the one at bottom.

CDM OPTICS

GETTING THE POINT Using computers to manipulate images is old hat. Anybody with a copy of Photoshop or other image-processing programs can do it routinely on his or her desktop. However, what's new is the strategy of modifying images first to make them better suited for the computer mind.

When Edward R. Dowski Jr. arrived at the University of Colorado in Boulder as a Ph.D. candidate in 1990, he already was thinking along those lines. A radar engineer, Dowski was coming from a stint at the Japanese photography firm Konica. For his dissertation topic, he decided to see what it would take to devise a new type of lens that would make autofocusing work better.

Conventional cameras, microscopes, and other optical instruments use sets of convex and concave lenses to focus light onto flat pieces of film or electronic detectors. An autofocus camera typically shifts the positions of some of those optical elements forward and backward until a sensor that monitors contrast differences in the field of view detects sufficient detail.

Dowski's idea was to do away with that little dance by inserting an additional lens between the camera's built-in set of lenses and the detector. It would generate a computer-readable pattern of

light that indicated how far out of focus the camera's subject was. The in-camera computer could then calculate how far to move the motor-driven lens.

The idea worked, and Dowski earned his Ph.D. But camera companies didn't show any interest. Dowski's graduate advisor, W. Thomas Cathey then realized that there might be more promise in doing just the opposite of what Dowski had done. He suggested this surprising turn of thought to Dowski, and they decided to give it a whirl.

Cathey and Dowski began by imagining any scene observed through a lens as a mosaic of tiny points of illumination. Ironically, to eliminate autofocusing systems, they devised a defocusing lens. Rather than having to rely on a movable lens to focus light, they came up with a saddle-shaped lens that stays put. It presents what appears to be a blurry image to a computer, which then runs an algorithm that can reconstruct the image point by point. The result is an image in sharp focus in both the foreground and background—that is, with great depth of field.

Cathey confesses that the extended depth of field, which he claims is at least 10 times greater than it is for conventional lenses, does have its tradeoffs. As the computer removes the overall blurring introduced by the ray-altering lens, it introduces a smattering of random errors, or noise, which may show up as subtle roughening of smooth surfaces. However, the improvement in overall focus far outweighs the effect of that misinformation, Cathey says. Moreover, additional computer processing can remove that noise, Dowski adds.

In 1996, Cathey and Dowski founded a company, CDM-Optics, to develop and commercialize products based on the new optical technique, which they call wavefront coding. Lately, their patience has been paying off.

Last year, for example, optics industry giant Carl Zeiss of Oberkochen, Germany, announced the first commercial products: new modules for microscopes that incorporate the CDM-developed technology. Olympus Optical of Tokyo, also is licensing the Boulder company's technology for use in extended depth-of-field endoscopes, which are camera-equipped catheters that doctors use to look inside a patient's body.

Similar, extended depth-of-field improvements will also benefit machine-vision systems, such as those for reading barcodes, sorting packages, and assembling and inspecting electronic circuits, Dowski predicts.

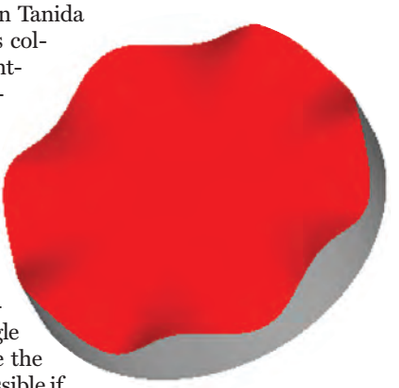
Another research team, led by Robert Plemmons of Wake Forest University in Winston-Salem, N.C., is collaborating with the National Security Agency and the Immigration and Naturalization Service on wavefront-coded, extended-depth-of-field cameras. The goal here is to develop systems that can successfully capture iris images at a greater range of distances than current identification technology can.

Because computers can also correct for common lens aberrations as they deblur, the wavefront-coding approach offers a way to slash the number of aberration-correcting optical elements found in typical cameras and other devices. "We think there is great potential to revolutionize the way you design lenses," says Cathey.

Among the more exotic projects under development by CDM Optics' engineers are designs for lightweight space telescopes with relatively forgiving construction tolerances. The goal of another highly speculative project is to restore visual acuity in elderly people even though their ocular lenses no longer focus adequately. The idea, says Dowski, is to use waveform-coding optics built into contact lenses—or perhaps even eventually carved into corneal tissue by a laser—not to render everyday scenes as recognizable images but as patterns that the brain could learn to decipher.

DIFFERENT STROKES The saddlelike lens and other wavefront-coding lenses that Dowski and his colleagues have come up with represent only a few of the countless possible forms for such computer-oriented optical elements.

In Japan, for instance, Jun Tanida of Osaka University and his colleagues have been experimenting with arrays of tiny conventional lenses, known as lenslets. Each lenslet focuses a small, low-resolution image onto a portion of an electronic detector behind the array. By taking advantage of all of the lenslets' different perspectives, a computer can then calculate a single large scene at roughly twice the resolution than would be possible if one conventional lens had been used.

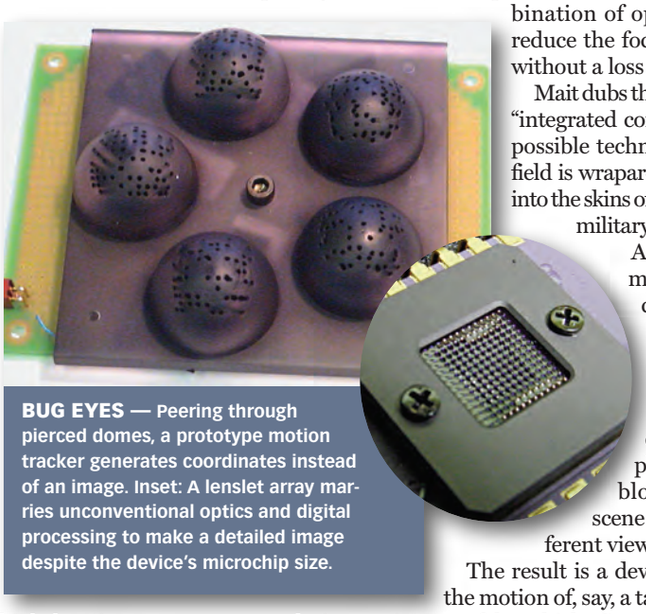


FUNNY FACE — Ripples pucker the surface of a lens designed to uniformly blur microscope images prior to computerized blur removal. For visibility, the diagram magnifies the ripples 10,000 times.

A particular advantage of the Japanese approach is that the thin lenslet array can focus light onto a detector less than a paper's thickness away. In collaboration with Minolta, Tanida and his colleagues have exploited this radical abbreviation of focal length to develop a prototype of a credit-card-thin camera. Normal camera focal lengths range around a few centimeters.

Some other extremely thin cameras use tricks such as bouncing light off internal mirrors to attain the required focal length in a small package. Instead, the Japanese team devised "an insightful combination of optics and electronics to reduce the focal length of the system" without a loss in resolution, says Mait.

Mait dubs this emerging field of optics "integrated computational imaging." A possible technological outcome of the field is wraparound cameras integrated into the skins of robotic airplanes or other military vehicles, he suggests.



BUG EYES — Peering through pierced domes, a prototype motion tracker generates coordinates instead of an image. Inset: A lenslet array marries unconventional optics and digital processing to make a detailed image despite the device's microchip size.

Also experimenting with multiple perspectives culled by one sensor, Duke's Brady and his colleagues have invented a matchbox-size plastic block riddled with precisely angled holes so that photodetectors behind the block receive light from a scene simultaneously from different viewpoints.

The result is a device that can reconstruct the motion of, say, a tank without capturing or analyzing any images of the vehicle. Currently, most motion-tracking devices capture images of a two-dimensional scene and then analyze pixel patterns in search of changes indicating motion. It's a slow, computer-intensive process and prone to error, Brady notes.

With the new hole-riddled device, light from a tank or other object reaches detectors as a distinctive optical code from which a computer can quickly reconstruct motion with minimal computations. Brady says that he got the idea for the device as he drove through the forests around Durham and observed the shifts in position of lighted houses

N. PITSIANIS/DUKE UNIVERSITY; INSET: J. TAMIDA

deep in the woods with respect to the foreground trees.

The U.S. military, which funds some of Brady's work through the Defense Advanced Research Projects Agency, is seeking cheap, fast motion sensors for surveillance. "What the military wants to see are mobile threats," such as mobile missile launchers, says Mait.

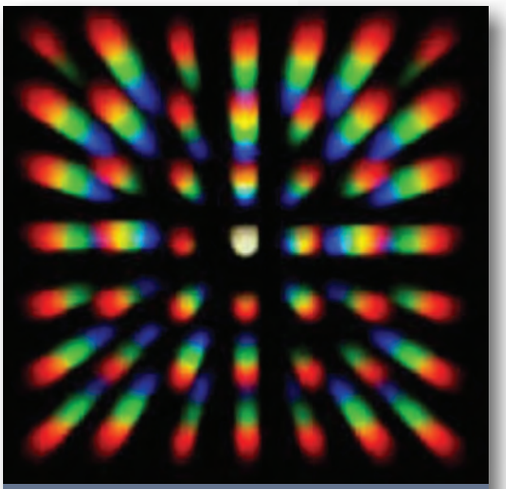
Such sensors might also bestow a new kind of spatial awareness on robots and computers that would help them to interact with people more naturally, says Brady, who plans to describe the devices at an optics and lasers meeting in Baltimore in June.

Developing yet another type of computer eyewear, Dereniak, Michael R. Descour, also at the University of Arizona, and their colleagues have created an optical element for simultaneously recording light spectra across an entire scene. Such spectral information may reveal camouflaged weapons in a satellite image or, with the help of fluorescent labels that attach to specific cellular structures, biological behavior under a microscope.

The spectra-capturing lens yields a pattern in which a 30-color spectrum associated with each point in a scene is mapped onto an electronic detector. It's "not an image at that [stage], just a scrambled mess," Dereniak says.

However, a computer summoning a type of processing that's standard in radiology procedures such as CAT scans can transform this seeming visual cacophony into an image of the scene at any specific color, he adds. Such multiwavelength data are one of the primary means by which scientists analyze the physical and chemical properties of subjects ranging from atoms to landscapes.

Having spent several years already devising their visible-light system, the Arizona team is now developing versions that work at infrared wavelengths for military surveillance and at ultraviolet frequencies for studying fluorescently tagged biological samples.



FOREST OF RAINBOWS — Light splinters through a novel optical grating into a computer-readable, spectral pattern.

OPTICAL SCIENCES CENTER/U. ARIZONA

ALL TOGETHER NOW Earlier attempts to use lenses to go beyond mere imaging weren't fruitful. In the 1960s, for instance, the military tried to develop so-called optical correlators that could detect threats by optically comparing reconnaissance images with patterns of enemy vehicles stored holographically.

"When digital processing was in its infancy, the most elegant way to process the information was optically," notes Mait. Yet the approach failed because "optics doesn't provide the kind of accuracy that is needed for detecting threats in complex and cluttered military scenes."

Technology has changed dramatically since then. Most obviously, the data-crunching capabilities of electronic devices have soared. But there have also been major strides in mathematical analytical tools and advances in optics fabrication that permit more complex lenses to be made—like wavefront coding lenses and Brady's blocks pierced by light pipes.

Now, says Mait, all the tools are in place to unlock a world of possibilities that have long been hidden to the human eye. ■

AFTER WEST NILE VIRUS

What will it do to the birds and beasts of North America?

BY SUSAN MILIUS

The alligators at Clabrook Farm were under the weather last fall. Some seemed depressed, others were wobbly, and a few crawled in circles. Within a few days of first showing such symptoms, alligators at the farm near Christmas, Fla., sank into neurological meltdown and died. During September and October, the farm lost about 300 of the 9,000 gators that it was raising for meat and hide.

In mid-October, one of the farm's baffled owners took three of his sick hatchlings, to reptile veterinarian Elliott R. Jacobson of the University of Florida in Gainesville. Recognizing that they had some kind of brain malady, Jacobson ordered tests for West Nile virus and several other pathogens.

No North American alligator had ever been diagnosed with the infection, but then again North American alligators hadn't had much of a chance to catch it. The virus was reported in the Western Hemisphere for the first time in August 1999 in New York City, where it caused a cluster of human cases of flulike symptoms, some of which turned into fatal brain inflammation. The first West Nile cases confirmed in Florida were a horse's and crow's demise reported in July 2001.

Moreover, people pick up the disease from the bite of an infected mosquito, so the notoriously tough-skinned alligators didn't seem an obvious candidate for that infection route.

Yet when Jacobson tested the animals' blood and organs, West Nile virus was evident. Although scientists are still debating how the North American alligator catches the disease, the species now appears on the official roster kept by the National Wildlife Health Center in Madison, Wis., that lists the more than 200 "species found positive for West Nile virus."

CAN'T HIDE — The American alligator's thick skin doesn't protect it from West Nile virus, at least not on gator farms in Florida.

This month, biologists report that the disease has reached birds in the Caribbean. A bananaquit in Jamaica has turned up with West Nile–virus antibodies in its blood, says Peter P. Marra of the Smithsonian Environmental Research Center in Edgewater, Md. This bird doesn't migrate, so it must have caught the virus locally.

Because New World wildlife has not had to contend with the virus before, defenses aren't in place. Some species are experiencing what appears to be an animal version of the epidemics of smallpox and other new diseases that devastated native peoples when Europeans arrived.

West Nile virus is hardly kind to its human victims. Of the 2,300 people in the United States known to have caught the virus in 2002, more than 4 percent died. Wildlife mortality sometimes runs much higher. Two field studies of the American crow estimated local losses in New York and Oklahoma last year at 30 percent and 50 percent, respectively. In one lab test, crow mortality hit 100 percent.

Biologists are debating how such drastic mortality will affect the fauna of the Western hemisphere. Dozens of scientists presented data at a workshop in early February at the Smithsonian Environmental Research Center. The crows and other abundant species that are sustaining great losses worry the biologists less than the species with only small populations. However, as the fate of the farm alligators suggests, biologists are almost certainly in for plenty of surprises.

POTENT PATHOGEN Greater travel and commerce in the modern world encourage the emergence of new diseases in animal populations, as well as among people, argues parasitologist Peter Daszak of the Consortium for Conservation Medicine in Palisades, N.Y. He sees the West Nile–virus invasion of the Western Hemisphere as an excellent example. "The surprising speed of its spread, its impact on human populations, and its impact on wildlife populations have caught many of us off guard," Daszak said at the annual meeting the American Association for the Advancement of Science in Denver last month.

Scientists first recognized West Nile virus as a distinct organism in 1937, when they isolated it from the blood of a woman in the West Nile region of Uganda. The pathogen belongs to a family of viruses that can cause brain inflammation, such as Japanese encephalitis and North America's St. Louis encephalitis. West Nile virus had spread through Africa, the Middle East, and the warmer parts of Europe and Asia before it landed in New York. Animals as well as people in the Old World can get the disease, but researchers—perhaps because they missed the initial invasion—haven't documented big die-offs of animals there.

Geneticists have worked out the path that the virus probably followed to the New World. Comparing a particular section of the genome of the virus identified in the New York outbreak with that of viruses collected around the world, researchers found the New World invader to be virtually identical to a strain from a bird in Israel and distinctly different from the Far Eastern strains. They

conclude that the Americas' invader originated in the Middle East. How it got here remains uncertain, but researchers spin plenty of scenarios. An infected mosquito might have caught a plane ride to a New York airport, or a bird shipped either legitimately or smuggled might have brought in the infection.

After reaching New York about 4 years ago, the virus' impact was small at first. During an outbreak, many people don't even notice that they've been infected with the virus, and others just drag around with flulike symptoms for a few days. By the time the first New York outbreak subsided in the fall of 1999, however, doctors had confirmed 62 cases of severe illness and 2 deaths. The next summer brought a similar number of cases but more deaths and an expanded geography: 66 cases of severe illness and 9 deaths in the eastern United States.

The 2002 season was strikingly different, with 2,530 North American cases and 125 deaths. Also, the disease revealed some nasty twists in the way it's transmitted. The Centers for Disease Control and Prevention (CDC) in Atlanta confirmed that three people acquired it from blood transfusions (*SN: 1/25/03, p. 59*) and that a baby probably contracted the virus from its mother's milk. Another infant appeared to have received the virus before it was born. By October, the disease had moved into 32 states and Washington, D.C.

With every surge in human disease, a wave hit wildlife, too (*SN: 12/11//99, p. 378*). By the end of 2002, the virus had struck a remarkable range of animals, including both dirt-common ones and nearly extinct species. It infected at least 186 wild and captive bird species, including pigeons, house sparrows, chickens, cardinals, mockingbirds, mallards, parakeets, peacocks, macaws, flamingos, bald eagles, and whooping cranes. The virus had also turned up in 17 other vertebrate species, including cats, dogs, chipmunks, striped skunks, bats, and alpacas.

The range of animals that pick up the virus and the breadth of its geographic spread have squelched any hope of getting rid of it. Even though it appeared in New York only 4 years ago, Daszak concludes, "West Nile virus is here to stay in North America."

CROW TESTS — A pathologist in protective gear at the National Wildlife Health Center in Wisconsin dissects a crow to check for West Nile virus.

BAD NEIGHBOR — A prime carrier of West Nile virus (inset) in the southern United States is the mosquito *Culex pipiens quinquefasciatus*.

USGS; S. HIGGS/UTMB/CDC

WHAT'S THE CATCH? To start figuring out how the virus will transform wildlife of the Americas, researchers have been delving into the details of how animals pick up the virus. Although biologists have known for decades that mosquitoes are an important carrier, it now looks as if mosquito bites don't tell the whole story.

Mosquito transmission of viruses results from a quirk of the insect's nutrition. A female mosquito needs to find a blood meal to provide nourishment for the big job of creating eggs. At the beginning of a cycle of egg making, she homes in on some unlucky hunk of walking nutrition, jabs in her sucking equipment, and dines.

If the nutrition provider carries at least a certain concentration of West Nile virus in its bloodstream, the mosquito picks up the virus, too. The next time she bites, some of the virus is transferred to her second victim's blood.

What then happens to that animal depends on its species and the individual's physical condition. Some animals get sick more readily than others do. From the start of the West Nile virus invasion of the United States, American crows have developed severe symptoms and died by the hundreds, dropping on roadsides and at least twice on the White House lawn. Yet health officials didn't confirm that the disease had killed a single dog until September 2002, when an 8-year-old mixed breed died in Illinois.

Also, some species may get sick but not build up enough viruses in their blood to turn a biting mosquito into a disease spreader. Such dead-end hosts include people and adult chickens. Newly hatched chicks, however, transmit virus to a mosquito when bitten. And Jacobson now reports the high virus concentrations in the blood of North American alligators.

To identify particularly important species in the mosquito spread of West Nile disease, a research team let infected insects bite captive birds of 25 U.S. species. The five species that showed the highest virus concentrations in these tests—the "most competent reservoirs," as epidemiologists put it—are widespread birds, Nicholas Komar of the CDC branch in Fort Collins, Colo., said at the recent Edgewater meeting. The list: blue jays, common grackles, house finches, American crows, and house sparrows.

That's not good news. Abundant, broadly distributed reservoirs mean that mosquitoes are likely to happen upon a virus-hot meal and then spread the disease.

Komar and his colleagues also documented mosquito-free ways for birds to catch the virus. It passed by direct bird-to-bird contact in four species—blue jay, American crow, black-billed magpie, and ring-billed gull—Komar says. His team also observed birds in five species—great horned owl, common grackle, house finch, American crow, and house sparrow—picking up the virus just by eating a bit of infected flesh or even infected mosquitoes.

Biologists suspect that migrating birds are spreading West Nile virus. They are "excellent candidates," says Marra, but "there has yet to be an actively migrating bird found with live virus."

Sampling some 800 birds last fall in Alabama turned up no migrators that tested positive for West Nile virus, Jennifer Owen of the University of Southern Mississippi in Hattiesburg reported at the Edgewater meeting. Perhaps sick birds just don't survive for long during the rigors of migration, or maybe they get too sick to even begin the journey.

In her presentation, she outlined a different approach to studying the interplay between migration and disease. She and her colleagues collected a total of 30 individuals from among gray catbirds, Swainson's thrushes, and wood thrushes. By using artificial lighting to prolong day in the laboratory, the researchers plan to rev up the birds into migratory form. Then the team will expose some of the travel-ready birds to West Nile virus and see whether they lose the urge.

BAD SPOTS Even without many of the details of viral spread, researchers are starting to make some guesses about the ultimate impact of West Nile disease. The broadest data on bird populations come from the North American Breeding Bird Sur-

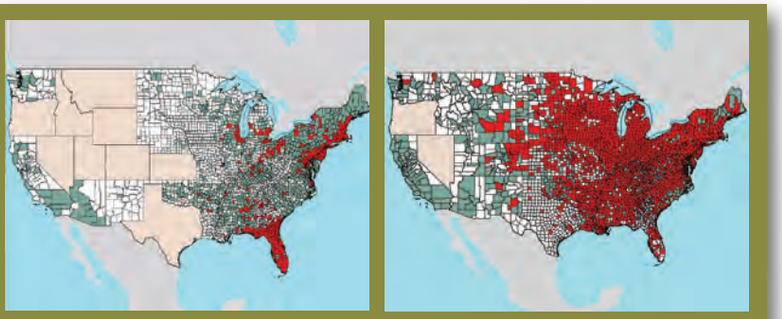
vey, which began in 1966. Since then, volunteers across the continent have spent one morning each June counting birds at prescribed roadside points along some 4,000 migration routes.

Marra and his USGS colleague John Sauer checked the survey for population declines as West Nile virus moved into a region. The researchers indeed found temporary declines in some areas but no overall decline for any species.

These and other data, have led Jeff Burgett of Hawaii's Hakalau Forest National Wildlife Refuge to predict that West Nile virus won't wipe out the American crow or other common species, despite their susceptibility to the disease. The virus may temporarily fell all individuals in some locales, but Burgett suspects that such species will hang on while they develop resistance to the disease.

Much more worrisome, he says, are the animal populations that are already small. Blast a hole in them, and there may be nothing left.

Burgett's thoughts run to such scenarios because he works with endangered birds in Hawaii, where the West Nile virus hasn't yet reached. He serves as recovery team leader for the endangered species called the Hawaiian crow. While mainland crows are falling out of the sky by the hundreds and yet surviving as a species, Hawaiians don't have many crows to lose. Only 39 Hawaiian crows currently remain.



JUST ONE YEAR — West Nile virus may have started small in 1999, but it swept rapidly through the bird population between 2001 (left) and 2002 (right). Counties in which the virus turned up in birds are marked in red.

USGS AND CDC

Other Hawaiian birds, such as the 20 or so diverse and colorful honeycreepers, face equally grim prospects if the disease hits, Burgett predicts. Roughly a third of the birds on the U.S. Endangered Species list live in Hawaii, so Burgett says that preventing the disease from reaching the islands is his top priority. "If we didn't do anything about West Nile virus, the other things are moot," he says. Once the virus arrives in Hawaii, "there's no conceivable program short of a neutron bomb that could keep it from becoming established."

And the virus is moving toward him rapidly. "It took the Midwest in 1 year, and, bang, it's in Seattle," says Burgett.

He's fighting hard, though. He notes that an obvious loophole through which the disease could reach the islands was the U.S. Postal Service policy of permitting shipments of live birds as first-class mail. Poultry chicks and gamecocks entering Hawaii in this way skipped the regular agricultural inspections. But Burgett led negotiations for increased protection. In the most promising step toward protecting Hawaii from West Nile disease so far, says Burgett, the post office last year stopped bird mail to the islands.

Daszak agrees that wherever they're struck, small populations will suffer from West Nile virus. "There will be extinctions," he says.

He, too, calls for more rigorous inspection and control of shipped birds, and he argues that it's not just for this invading disease but the next one and the one after that. ■

OF NOTE

ENVIRONMENT

Composted sewage captures dirt's lead

Lead-contaminated soil in urban parks, gardens, and schoolyards could be made safer by adding composted organic waste, new research suggests. The tactic could reduce the quantity of the toxic metal that moves from the soil to people, especially children, says Sally Brown of the University of Washington in Seattle.

Brown and her colleagues added biosolids—the polite term for byproducts of treated sewage that are blended into fertilizers—to lead-tainted soil from a home garden in Baltimore. Then they fed rats food tainted with various soil-biosolids mixtures. Of nine recipes, eight reduced the amount of lead absorbed into the animals' bones.

Composted, iron-rich biosolids were most effective. When blended with nine times their mass in soil, these reduced by about 40 percent the quantity of lead later detected in the rats' bones, the researchers report in the January-February *Journal of Environmental Quality*.

While it isn't yet clear how biosolids bind lead in soil, Brown suggests that heavily leaded urban yards could be rendered less dangerous with the addition of composted biosolids. The metal poses developmental risks for children, who inevitably consume some dirt as they play. —B.H.

NEUROSCIENCE

Uncertainty fires up some neurons

A small set of brain cells that transmit the chemical messenger dopamine to various neural destinations works as an uncertainty meter, at least in monkeys, a new study finds. The electrical activity of these cells rises sharply when monkeys find themselves unable to predict whether a familiar visual signal heralds a food reward, say Christopher D. Fiorillo of the University of Fribourg in Switzerland, and his coworkers.

This brain response may stimulate risky, exploratory acts in natural settings where such behaviors can reap big rewards, Fiorillo's group theorizes. In people, they add, it may also contribute to the allure of gambling.

Electrodes implanted in the brains of two adult monkeys tracked electrical responses of 188 dopamine-making neurons in an area called the midbrain. Over a series of trials, the monkeys learned to associate each of five distinctive visual patterns shown for 2 seconds on a computer screen and the probability of receiving a taste of syrup from a dropper. Specific patterns were accompanied by a dose of syrup either in all, three-quarters, half, one-quarter, or none of the presentations.

After training, dopamine neurons displayed peak electrical activity as monkeys

OF NOTE

viewed the most unpredictable pattern, which denoted a 50-50 chance of reward, the scientists report in the March 21 *Science*. Smaller surges in neuron activity occurred in response to patterns that predicted a reward three-quarters and one-quarter of the time. Dopamine neurons showed no response to patterns that signified certain reward or denial. —B.B.

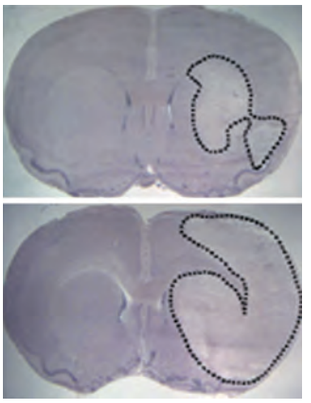
BIOMEDICINE

Protein protects rat brains from strokes

A protein related to oxygen-carrying hemoglobin in blood cells may protect the brain during strokes.

Scientists discovered the hemoglobin cousin several years ago and dubbed it neuroglobin because only nerve cells in the brain of vertebrates make it.

Seeking to uncover neuroglobin's role, David A. Greenberg of the Buck Institute for Age Research in Novato, Calif., and his colleagues recently induced strokes in rats whose brains had been injected with viruses genetically engineered to churn out the protein. The amount of brain tissue damaged by the strokes was significantly less in those animals than in rats not given the virus, or in rats whose brains had less-than-normal amounts of neuroglobin, the investigators report in the March 18 *Proceedings of the National Academy of Sciences*.



BRAIN SHIELD A rat with extra neuroglobin in its brain (top) suffers less tissue damage (outlined areas) after a stroke than a typical rat (bottom) does.

Greenberg and his colleagues conclude that neuroglobin naturally protects brain cells faced with too little oxygen. They speculate that drugs that increase the production of neuroglobin could become a new stroke therapy. —J.T.

ASTRONOMY

By the light of a starry eruption

It was probably the brightest stellar event witnessed in recorded history. On May 1, 1006, a star made its debut in the southern sky and awed observers for months.

Astronomers long ago concluded that the display was generated by a supernova, the explosion of a massive star. But the brightness of that explosion has been uncertain. Until now.

Using telescopes at two observatories in Chile, researchers recently identified a faint shell of glowing hydrogen gas surrounding the explosion site. The shell was produced as the cataclysm's shock wave raced outward, sweeping up and setting aglow gas from the surrounding medium.

P. Frank Winkler of Middlebury College in Vermont and his colleagues set out to measure the exact distance to the supernova, because from that measurement they could calculate how bright the explosion appeared in 1006. To get the distance, the group first measured how much the shell appears to have expanded during 11 years of observations. They also measured the speed of the shock wave. With these data, the team determined that the shell lies 7,100 light-years from Earth.

Winkler's team then adopted the common assumption that the supernova belongs to a class, dubbed 1A, that has a special property: All of its members have about the same luminosity, like light bulbs of similar wattage. Knowing the supernova's distance and its luminosity, "we can calculate... just how bright the [explosion] must have appeared to 11th-century astronomers," Winkler says. In the March 1 *Astrophysical Journal*, his team reports that the supernova appeared about halfway between the brightness of Venus and that of the full moon.

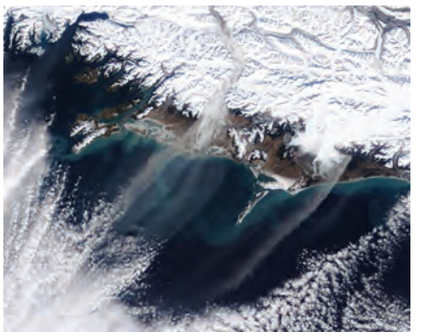
Says Winkler, "People could probably have read manuscripts at midnight by its light." —R.C.

EARTH SCIENCES

Dust up north

Strong northeasterly winds blowing across coastal regions of southern Alaska launched massive clouds of dust over the Gulf of Alaska in mid-March. Most of the material in these plumes is known as rock flour, a fine-grained sediment that glaciers create in prodigious quantities as they grind their way to the sea.

Early melting of snow this year exposed the silty areas, according to NASA. The agency released an image of dust clouds taken by the Terra satellite on March 13. Wind gusts in the area reached nearly 160 kilometers per hour, and stiffer gusts of about 175 km/hour at Anchorage International Airport shut down the facility for about 9 hours on the day the image was captured. —S.P.



MIGHTY WIND A large stream of dust, near the center of this satellite image, wafts from Alaska's Copper River delta, located about 200 kilometers east of Anchorage. A thinner plume to the east stems from silt deposited at the foot of the Bering Glacier.

ZOOLOGY

At last, a bird that nails killer chicks

For the first time, scientists have found a bird species—Australia's superb fairy-wren—that can spot a murderer.

The killers are chicks of a particularly aggressive cuckoo species. The crime begins when the cuckoo mothers sneak an egg into a non-cuckoo nest, duping foster parents into all the work of childcare. After the intruder chick hatches, it kills its young nestmates by shoving them overboard.

Any human being can spot that something's wrong in the invaded nest, since the cuckoo chick quickly grows ridiculously big, up to six times the size of its foster parent. Some victimized species catch the fraud in the egg stage and roll the cuckoo egg out of the nest. Yet to the bemusement of biologists, no bird had been known to catch the obvious cuckoo once the chicks hatched.

Now an international team of researchers reports that nearly half of superb fairy-wren mothers (*Malurus cyaneus*) actually do have a clue. If a chick of Horsfield's bronze-cuckoo (*Crysococcyx basalis*) hatches in a superb fairy wren nest and heaves out the rightful chicks, about 40 percent of mother fairy-wrens desert the nest. The cuckoo chick is left to starve while the mother starts another nest, report Naomi E. Langmore of Australian National University and her colleagues.

This ability might represent an escalation in an arms race between superb fairy-wrens and cuckoos, the researchers suggest in the March 13 *Nature*. The cuckoos lay eggs that usually fool the fairy-wrens, so an ability to detect phony chicks may have evolved as a countermeasure. —S.M.

Y. SUN ET AL./PNAS; J. DESCLOITRES/NASA GSFC

Books

A selection of new and notable books of scientific interest

APOLLO: The Epic Journey to the Moon

DAVID WEST REYNOLDS

With the benefit of hundreds of illustrations and color photographs taken both in space and on land, Reynolds presents a remarkably complete reconstruction of the key events and personalities of the Apollo space program. Reynolds's clear and compelling narrative includes perspectives from engineers, mission-control officials, and the astronauts themselves, who offer personal viewpoints of history. Fascinating pullouts feature cut-away drawings of the spacecraft. Other images depict components of the rockets, spacesuits, and launch sites. ***Harcourt, 2002, 272 p., color photos/illus., hardcover, $35.00.***

THE CONSTANTS OF NATURE: From Alpha to Omega—The Numbers that Encode the Deepest Secrets of the Universe

JOHN D. BARROW

The constants of nature are fundamental to the laws of physics governing gravity, electromagnetism, and quantum phenomena. They encode the deepest secrets of the universe and define mathematically, for instance, why every electron seems to be the same as every other electron. Barrow, a mathematician and noted popularizer of astrophysics, considers how we have attempted to understand these constants of nature and their role in our understanding about the nature of the universe. Then he questions whether those numbers are really constant at all and considers whether they're all linked. Barrow theorizes that if some of them were even slightly different, we wouldn't be here at all. As scientists grapple with defining a Theory of Everything, Barrow details the role important numbers play in answering questions about the makeup of the universe. ***Pantheon, 2002, 352 p., b&w photos/illus., hardcover, $26.00.***

MIND OVER MATTER: Conversations with the Cosmos

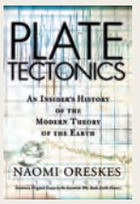
K.C. COLE

This compendium of quick, insightful, and often witty essays is culled mostly from the author's regular contributions to the Los Angeles Times. It features reflections on the universe—the stuff it's made of and the people who explore it. With a distinct emphasis on astronomy and physics, Cole examines how scientists formulate models for testing their ideas, how statisticians tell the difference between coincidences based on cause and those based on chance, and what some of the thorniest problems in physics are. ***Harcourt, 2003, 319 p., hardcover, $25.00.***

PLATE TECTONICS: An Insider's History of the Modern Theory of the Earth

NAOMI ORESKES

Just 35 years ago, the idea of plate tectonics was novel. Now, it's the pervasive theory of how the major features of Earth came to be. After a short history of the theories that led to this revolution and a primer on plate tectonics, Oreskes presents a series of essays written by 17 scientists who have been influential in advancing this concept. Although many people collaborated on this theory, most were at just four institutions: the University of Cambridge, Princeton, Lamont Doherty Geological Observatory, and Scripps Institute of Oceanography. Together, authors including Dan McKenzie and John Dewey provide perspective on the birth and development of this idea, as well as how scientific ideas come to fruition. Originally published in hardcover in 2002. ***Westview Pr, 2003, 424 p., b&w photos/illus., paperback, $30.00.***



SECRET EMPIRE: Eisenhower, the CIA, and the Hidden Story of America's Space Espionage

PHILIP TAUBMAN

During World War II, the United States relied almost exclusively on human spies for intelligence. At the onset of the Cold War, President Eisenhower grew frustrated by this focus and turned to science and industry to forge a new strategy. This initiative gave birth to the space-espionage program—specifically, reconnaissance satellites and high-altitude spy planes such as the U-2 and supersonic SR-71. Taubman, an award-winning New York Times writer, delved into countless declassified documents and conducted interviews with White House, CIA, and Pentagon officials of the day to uncover a program that not only protected the United States from surprise attack, but also facilitated its verification of arms arsenals abroad. Taubman argues that while this type of reconnaissance is still invaluable, we also need more old-fashioned human spying if we're to foil the modern threat of terrorist attacks. ***S&S, 2003, 441 p., b&w plates, hardcover, $27.00.***

THE WAY SCIENCE WORKS: Discover the Secrets of Science with Exciting, Accessible Experiments

ROBIN KERROD AND SHARON ANN HOLGATE

Students reading this book can gain insight into basic scientific principles through brief descriptions of concepts and quick experiments that illustrate them. For instance, directions for making an underwater volcano accompany general information about liquid density. A section on magnetism tells how to make a compass, and one on friction details how to make a hovercraft. Every topic is illustrated with brilliant color photographs that bring these ideas to life. Recommended for ages 8–12. ***DK, 2002, 160 p., color photos, hardcover, $24.95.***

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LETTERS

Old what's-its-name

After reading "Unnatural Biochemistry: Bacteria make and use an alien amino acid" (*SN: 1/25/03, p. 53*), I couldn't believe that the manuscript didn't identify the chemical substance involved.

ECK PRUD'HOMME, FORT WORTH, TEXAS

The amino acid mentioned in the story is p-*aminophenylalanine.* —J. GORMAN

Yellow caution?

I wonder whether researchers offer any recommendations based on a difference in effect between ingesting vitamin A and beta-carotene ("Too Much of a Good Thing: Excess vitamin A may hike bone-fracture rate," *SN: 1/25/03, p. 52*). Do people who consume large amounts of yellow vegetables, for example, put themselves at risk?

MARY A. TURZILLO, BEREA, OHIO

Yellow fruits and vegetables contain large amounts of the vitamin A precursor beta-carotene. However, says Margo Denke of the University of Texas Southwestern in Dallas, only a fraction of precursors are converted to vitamin A in the body, so eating them is unlikely to cause a vitamin A overdose and weaken bone. —N. SEPPA

Freaky speed

You are usually pretty good at explaining things to those of us outside the hard sciences, but the speed of gravity ("Clocking gravity," *SN: 01/25/03, p. 61*)? Speed of light OK, but what is the speed of gravity?

ROBERT L. SCHRAG, NORTH CAROLINA STATE UNIVERSITY, RALEIGH, N.C.

An object with mass creates a gravitational field around itself. Imagine that the object moves; then, the strength of its field everywhere in space changes. The speed at which that change ripples through space is the speed of gravity. —P. WEISS

It would seem to me that the shift in the apparent position of the quasar was due to the bending of light by Jupiter's gravity. I would conclude that it is proof of Einstein's proposal that gravity is due to the bending of space around a massive object, but I fail to see how this can be construed as an indication of the speed of gravity.

STEPHEN MOODY, RICHMOND, VA.

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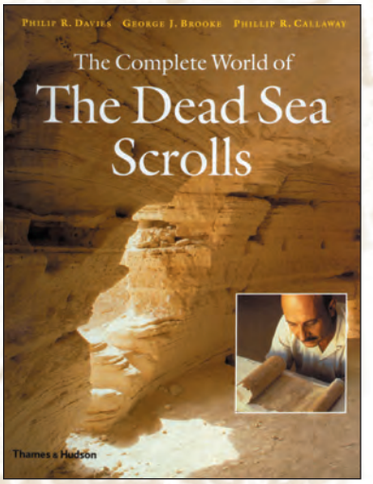
discovery... meaning... significance

The Dead Sea Scrolls



Ever since a Bedouin shepherd found the first scrolls in the Judean desert in 1947, the Dead Sea Scrolls have been the subject of passionate speculation and controversy. The possibility that they might challenge many assumptions about ancient Judaism and the origins of Christianity, coupled with the extremely limited access to the scrolls imposed for many years, only fueled debate on their meaning.

With all the scrolls—more than 800 documents from 11 caves—now finally available in translation, conclusions can at last be drawn as to their authorship and origins, their implications for Christianity and Judaism, and their link with the ancient site of Qumran. This timely book, written by three noted scholars in the field, draws together all the evidence and presents the first fully illustrated survey of every major manuscript, from the Copper Scroll, the Community Rule and the Temple Scroll to less well-known scripts such as the Angelic Liturgy and Reworked Pentateuch.

- "The Scrolls Reveal" takes the readers through the discovery of the scrolls, culminating in the great finds of 1947–53.
- "The Ancient World of the Scrolls" presents the dramatic historical backdrop against which the scrolls were written and describes Jewish religious life, the pivotal role of the Jerusalem Temple, and competing Jewish sects.
- "Inside the Scrolls" provides a unique illustrated catalog of the contents of all 11 caves, including detailed analysis of every major scroll, and considers the methods of interpretation employed, including carbon-14 dating, paleography, and computer reconstruction.
- "The Qumran Settlement" discusses recent archaeological work at the ancient site, where it is believed that the authors of the scrolls lived, revealing differing theories about its inhabitants and exploring possible links between the caves and Qumran.
- "The Meaning of the Scrolls" examines the heated debates over various interpretations of the scrolls and draws conclusions on the controversy surrounding their authorship.
- With numerous reconstructions, scroll photographs, and a wealth of other illustrations, this book offers the most comprehensive and accessible account yet published of the Dead Sea Scrolls.

—from Thames Hudson

Thames Hudson, 2002, 216 p., 7 ¾" x 10 ⅛", hardcover, $34.95.

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