SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MAY 3, 2003 PAGES 273-288 VOL. 163, NO. 18

prune the hominid tree?
looking technology in the eye
heavy metal quasars
charged-up ion channels

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revival?

WORKING TO RESTORE THE CHESTNUT

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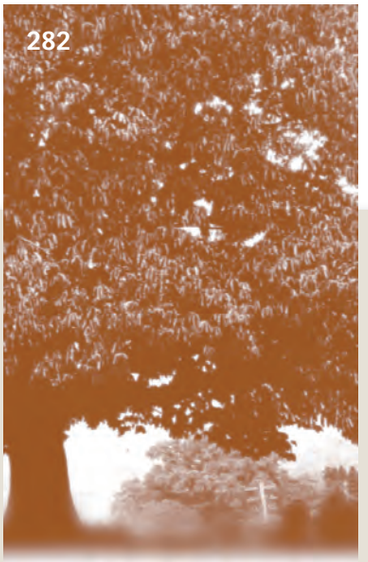

Features

This Week

Of Note

Departments

Cover American chestnut trees like this one towered over much of eastern North America until blight devastated the species, starting in 1904. Rare specimens and determined preservationists struggle on. (The American Chestnut Foundation)
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Elemental defense Dietary selenium may protect men against prostate cancer. See Janet Raloff's Food for Thought.

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

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

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

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

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Ancestral Bushwhack

Hominid tree gets trimmed twice

Many anthropologists suspect that hominids, ancient members of the human evolutionary family, branched into as many as 20 different now-extinct species over roughly the past 6 million years. At scientific meetings in Phoenix last week, two skeptical researchers took different approaches to pruning this species-laden scenario.

Their handiwork expands debate over how to identify hominid species in the fossil record. Still, proponents of what might be dubbed humanity's family bush remain steadfast.

In a controversial presentation, Tim D. White of the University of California, Berkeley accused many of his colleagues of ignoring geological forces that have substantially distorted the shapes of key hominid fossils and given them a false appearance of anatomical uniqueness.

"The metaphor of a bush seems to be seriously misplaced with regards to the evolution of hominids," White said at the annual meeting of the Paleoanthropology Society. His talk elaborated on his commentary published in the March 28 *Science*.

As a case in point, the Berkeley anthropologist cited a 3.5-million-year-old hominid skull that has been assigned to its own genus and species, *Kenyanthropus platyops* (*SN: 3/24/01, p. 180*). Many of the specimen's apparently unique traits actually result from distortion caused by compacted sediment inside the skull that has expanded and pushed against surrounding bone, White asserts.

On close inspection, he says, the *Kenyanthropus* face contains about 1,100 small pieces of bone separated by a latticework of mortarlike sediment.

White and his coworkers identified varying levels of this geological deformation in 60 fossilized oreodonts, North American pig relatives that lived from 34 million to 24 million years ago. *Kenyanthropus* displays bone cracking and twisting comparable to that in the most distorted oreodont fossils, White contends.

In his view, *Kenyanthropus* may actually have been a form of *Australopithecus afarensis*, the 3-million-to-4-million-year-old species that includes the famous partial skeleton called Lucy, which White codiscovered.

Advocates of a hominid family bush reject White's charges. Researchers have long noted the deforming effects of sediment on hominid fossils, says Ian Tattersall of the American Museum of Natural History in New York. The *Kenyanthropus* skull exhibits extensive cracking but remains symmetrical and thus provides a reliable view of the ancient hominid, Tattersall says.

Ironically, a second researcher aiming to stem the tide of hominid species agrees with Tattersall that geological distortion of fossils has been adequately accounted for. However, data from living mammals indicate that early members of the *Homo* lineage—often sorted into six or more species—probably didn't make up more than two or three species, says Glenn C. Conroy of Washington University Medical School in St. Louis.

Conroy, who spoke at the annual meeting of the American Association of Physical Anthropologists, used a worldwide data set on mammalian anatomy to identify the number of current species in genera falling within the estimated weight range of early *Homo*—66 to 143 pounds.

To Conroy's surprise, only 38 of 1,116 mammalian genera include any members tipping the scales in that range. "I have no idea why," he says.

These groups usually consist of one to three species. Primate genera, even many of those below the *Homo* weight range, contained only one to three species.

These data indicate that the hominid evolutionary tree has never been bushy, Conroy holds.

Conroy's focus on mammals of appropriate body weight is "a reasonable criterion" for estimating numbers of hominid species, remarks Bernard Wood of George Washington University in Washington, D.C. —B. BOWER

Nanoscale Networks

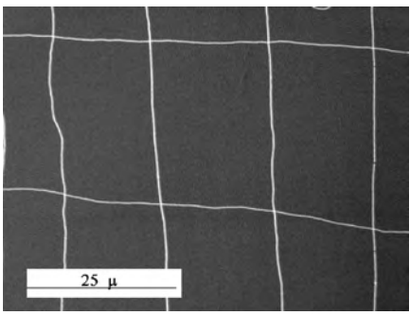
Superlong nanotubes can form a grid

For a decade, materials scientists have dreamed of using cylinders of carbon with walls just one atom thick as the building blocks for a new generation of sensors, transistors, and other tiny devices. Before that happens, however, researchers must find better ways to grow and align these carbon nanotubes.

Jie Liu and his colleagues at Duke University in Durham, N.C., now report growing the longest individual carbon nanotubes ever and aligning them in a two-dimensional grid.

Other researchers have used strong electric fields to orient nanotubes, notes Liu. But the new technique may prove more useful, he suggests, because it doesn't require strong external forces and can align tubes in multiple directions. Since the new process creates extraordinarily long nanotubes—up to 4 millimeters in length—researchers may also create many different nanoscale devices along a single tube.

"Simultaneous growth and alignment of ultralong, single-wall nanotubes is an important development," comments Ray Baughman of the University of Texas at Dallas. Liu's work "joins an avalanche of recent advances on the assembly of nanotube architectures," he adds.



GRID WORK Extraordinarily long carbon nanotubes crisscross one another.

LIU AND S. HUANG/DUKE UNIV.

The Duke researchers used a simple variation on a common nanotube-production method called chemical-vapor deposition. In the standard process, carbon nanotubes grow in a stream of carbon monoxide and hydrogen gas blown across catalysts on silicon wafers. In a furnace slowly warming from room temperature to 900°C, the gases typically produce a tangled mass of nanotubes, each one no longer than about 20 micrometers.

Liu and his colleagues changed this procedure by preheating the furnace to 900°C before placing the catalyst-bearing wafers inside. That way, the catalysts warmed to 900°C within seconds, instead of the typical 10 minutes. The tweak was intended to reduce the aggregation of catalysts on the silicon wafers, but the researchers achieved something even better: 2-to-4-mm-long tubes anchored in the catalysts and aligned parallel to one another in the direction of the blowing gases.

After the wafers and their newly formed tubes cooled, the team rotated them 90 degrees and returned them to the oven. A second set of tubes grew perpendicularly to the first set, says Liu. He and his col-

leagues describe the technique in an upcoming *Journal of the American Chemical Society*.

Already, the researchers have used their new method to create experimental carbon nanotube–based devices including transistors and sensors for detecting chemical and biological agents.

"With all the nanotube work, one of the important problems we still have is how to make them in a controlled fashion," says Otto Zhou of the University of North Carolina at Chapel Hill. "I would say that this is an important step toward the controlled fabrication of carbon-nanotube structures." —J. GORMAN

Sensing a Vibe

Seismic-alert system could give Los Angeles a few seconds' warning

A sprawling network of seismometers that covers the Los Angeles area could be adapted to provide warning of damaging ground motions from earthquakes in the seconds before those seismic vibes arrive, according to a new analysis.

Some other quake-prone regions already have early-warning systems. For example, seismic instruments about 300 kilometers southwest of Mexico City detect the vibrations spreading from large temblors that occur even farther to the southwest. That gives residents in the metropolitan area about 70 seconds' warning.

Could an alert system work in cities, such as Los Angeles, that rest right on top of active fault zones? Most parts of even those at-risk areas could receive a few seconds' warning, says Richard M. Allen, a seismologist at the University of Wisconsin–Madison.

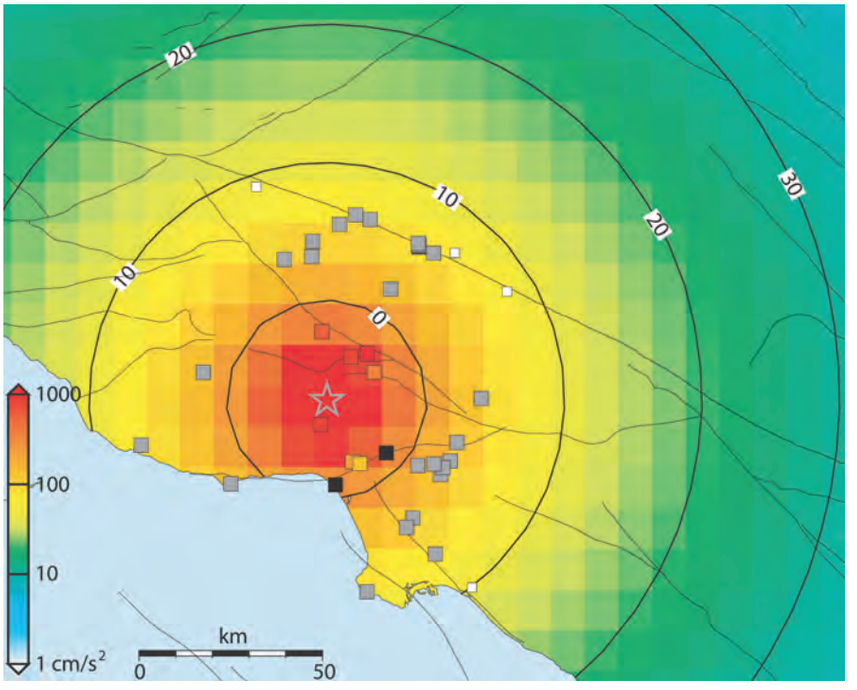
Earthquakes create several different types of seismic vibrations. The waves that travel most quickly through Earth's crust—the so-called P waves—are similar to sound waves, and they push and pull the ground in the direction of the waves' trajectory. These waves don't typically cause damage to buildings or other structures because of their high frequency and small magnitude, says Allen. However, these vanguard vibrations contain information that scientists can use to predict the size of the more dangerous S waves that follow. Those shudders, which shake the ground from side to side at low frequencies, travel at about half the speed of the P waves.

Allen and his colleague Hiroo Kanamori of the California Institute of Technology in Pasadena studied the ground motions for the 53 earthquakes with Richter scale magnitudes above 5.0 that have occurred in the Los Angeles area since 1995. The pair found that they could reasonably predict the magnitude of an earthquake's yet-to-arrive S waves by looking at the first second of P waves detected by a seismometer. The best estimates needed only 4 seconds' seismic data, Allen and Kanamori report in the May 2 *Science*.

A warning system that pulled data from the existing network of seismometers around Los Angeles and performed similar analyses in real time could provide at least some residents with a few moments' warning—possibly by way of sirens or the Internet—of the shaking to come. For example, at locations 60 km from a temblor's epicenter, the magnitude of an impending quake could be known about 16 seconds ahead of time.

That may not sound like much time, but it could avert some catastrophes, says Allen. Utility companies might be able to turn off pipelines, manufacturers could shut down the flow of toxic chemicals, and trains could be automatically slowed or stopped before the most damaging ground motions occurred. Also, rescue workers digging through unstable rubble in the wake of a major quake could be warned of aftershocks that are on their way.

One particularly valuable application might be to minimize casualties by having school children dive under their desks, says John R. Filson, manager of the U.S. Geological Survey's earthquake hazards program in Reston, Va. —S. PERKINS



WHOLE LOTTA SHAKIN' **A warning system could predict ground motions from an ongoing quake. This map depicts predicted peak ground accelerations (color scale) in Southern California as if estimated 10 seconds after the 1994 Northridge quake began. Numbers in white boxes indicate warning time in seconds until arrival of peak ground motion.**

ALLEN

Crystal Bash

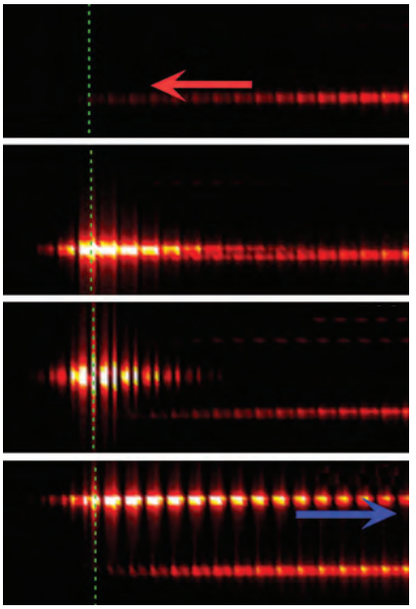
Shocking changes to light's properties

Sometimes a good, hard whack makes things work better. That's what a new study suggests about light-manipulating microstructures known as photonic crystals.

Those orderly arrangements of tiny films, rods, balls, or even holes exclude specific wavelengths of light—a trait of growing importance for many optical components, including lasers and optical fibers.

Given the potential of photonic crystals, researchers are racing to find better ways to make the structures (*SN: 5/25/02, p. 334*). Now, a team at the Massachusetts Institute of Technology (MIT) suggests potential capabilities of photonic crystals that nobody had suspected.

Evan J. Reed and his colleagues have calculated the effects of smacking a photonic crystal to launch a wave of compression—a shock wave—through the structure. To simplify the calculations and computer simulations based on them, the team considered a so-called one-dimensional pho-



GOING UP Simulated light pulse speeding to the left through a photonic crystal (top to bottom) hits a shock wave (dotted vertical line) that's heading right, gets a frequency boost (shown as higher position in bottom two panels), and reflects back (blue arrow).

REED ET AL./PRL; ROCKEFELLER UNIV.

tonic crystal—a stack of thin alternating sheets of materials that differ in how quickly light traverses them.

Analyzing what would happen when a laser pulse enters a crystal and hits a shock wave, the scientists find that the light changes in unexpected and technologically interesting ways.

A Doppler shift of light underlies the new effects. Imagine a beam rebounding from a mirror that's rushing toward the light source. The reflected light's frequency is shifted slightly upward.

A related effect should occur in head-on collisions between light pulses and shock waves in photonic crystals, report Reed, Marin Soljačić, and John D. Joannopoulos in an upcoming *Physical Review Letters*. However, the frequency shift can be tens of thousands of times as large as normal Doppler shifts, Reed says.

In the MIT scenario, light becomes trapped and bounces around within the thin, moving zone where the shock wave is compressing the crystal. Every time the light beam bounces, "it's picking up a little bit of Doppler shift," Reed explains. Because the surrounding crystal is designed to reject the light's elevated frequency, the light remains in the compression zone until its ever-increasing Doppler shift has moved its frequency into a higher range that the crystal accepts. The pulse can then reemerge into the rest of the crystal.

"This ability to move around the frequency of a pulse more or less to order . . . has many potential applications," comments John B. Pendry of the Imperial College London in England. Yet the "elevator effect," as Pendry calls it, is only one of several new tricks a shocked photonic crystal should perform.

Others include transforming a steady light beam into pulses, slowing light to the speed of the shock wave (*SN: 4/19/03, p. 252*), and funneling a broad light pulse into a narrower frequency range, the MIT team finds.

"All of these effects could be useful in manipulating modern optical signals," comments David J. Norris of the University of Minnesota, Twin Cities.

Implementing the effects may prove challenging, however. Scientists at Lawrence Livermore (Calif.) National Laboratory are preparing to use high-velocity projectiles to produce shock waves in crystals and test the MIT predictions. Even if those experiments succeed, the practicality of using strong shock waves remains limited. Not only are their effects short-lived, but they also would destroy the crystals.

Fortunately, Reed notes, there are gentler ways of creating shock waves. Moreover, using laser patterns projected onto so-called nonlinear crystals, researchers may be able to mimic a shock wave passing through a photonic crystal. That may achieve the newfound powers without applying a hard whack. —P. WEISS

Paddle Power

Surprising shape of key cellular pore unveiled

Underlying every thought and bodily motion are nerve and muscle cells sending or receiving electrical signals. Driving this activity are voltage-gated ion channels—pores that quickly open or close to various ions depending on the electrical properties of the cell's membrane.

A research team has now obtained the first atomic-scale portrait of one of these crucial gatekeepers, a voltage-dependent potassium channel. "It looks very different than any of us expected," says team leader Roderick MacKinnon, a Howard Hughes Medical Institute (HHMI) investigator at Rockefeller University in New York

Over the past 6 years, in work that some scientists predict will earn a Nobel prize, MacKinnon's team isolated the proteins that make up various kinds of ion channels, coaxed them into forming stable crystals, and beamed X rays through the crystals to locate the positions of atoms within the pores. From such data, the researchers uncovered often-unexpected structures for channels that regulate the flow of potassium, sodium, calcium, and other ions (*SN: 3/9/02, p. 152*).

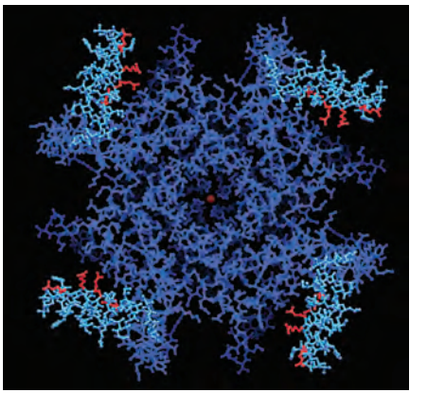
However, voltage-dependent ion channels resisted the team's attempts at crystallization. MacKinnon and his colleagues finally circumvented that obstacle by binding an antibody to each of the four subunits that make up a voltage-dependent potassium channel. This stabilized the structure enough to form crystals that the investigators could analyze.

Most scientists had thought that the voltage-sensing regions of the pore would be hidden within the ion channel, but instead they jut out as hinged projections that MacKinnon calls "paddles." In hindsight, he adds, it's clear that the free-moving nature of these four, positively charged paddles accounts, at least in part, for the difficulties in crystallizing the pores.

Taking into account the new structure and several follow-up experiments, all described in the May 1 *Nature*, MacKinnon's team has offered a proposal for how voltage-gated ion channels work. When the inner portion of a cell membrane has a negative charge, the paddles of the pore are attracted to it and extend horizontally along that inner membrane, keeping the channel closed. If the outer half of the cell membrane becomes negatively charged, however, the paddles assume a vertical position by swinging on their hinges toward that charge. "That moving up pulls the pore open," suggests MacKinnon.

"The structure is a complete surprise to the field," says David Clapham, an HHMI investigator at Children's Hospital in Boston. Most ion-channel researchers had never envisioned such large movements by the voltage-sensing parts of the pores. "I am awed by the high quality of the work and the courage of the interpretation," says Clapham.

The potassium channel that MacKinnon's team probed actually comes from a bacterium, so scientists don't yet know whether its structure reflects a general shape for all voltage-gated ion channels, notes Clapham, who studies a voltage-sensitive sodium channel.



CHARGED-UP GATEKEEPER This overhead view of a cellular pore through which potassium ions flow reveals four voltage-sensitive regions (light blue and red).

Because the amino acid makeup of the bacterial potassium channel is similar to that of other voltage-gated channels, especially in the paddle regions, it's likely that all such channels operate in the same way, predicts MacKinnon.

The discovery that the voltage sensors of the ion channel are more exposed than scientists had expected may interest those looking for drugs that influence nerve or muscle activity. "I'm thinking now very differently about potential targets for drugs," says MacKinnon. "I think these paddles are very promising targets." —J. TRAVIS

Chemistry of the Cosmos

Quasars illuminate the young universe

BIG BEACON Artist's impression of a quasar (white disk at center) in a galaxy just 900 million years after the Big Bang. The quasar's composition suggests surprisingly early star birth.

Measuring the composition of some of the earliest structures in the universe, two teams of astronomers have unveiled new findings about star formation when the cosmos was young.

In one study, astronomers used the Hubble Space Telescope to examine three of the most distant quasars known. These brilliant beacons are so remote that it takes their light 12.8 billion years to reach Earth. The observations therefore show how the quasars appeared when the universe was only 900 million years old.

Even so, spectra taken with Hubble's near-infrared camera and multiobject spectrograph reveal that quasars back then already contained iron and magnesium. Because heavy elements such as these can be made only inside stars, their presence requires that an early generation of stars preceded the quasars. More significantly, the much higher abundance of iron relative to magnesium provides a time marker for when these first stars would have blazed into existence, notes Wolfram Freudling of the European Southern Observatory in Garching, Germany.

Iron can be produced by two classes of stars: massive ones that last only a few million years and intermediate-mass stars that live a hundred times longer. When stars of these masses die, they spew their contents into space.

However, only intermediate-mass stars produce a high abundance of iron relative to magnesium, so these longer-lived stars are the likely source of the metals found in the quasars, say Freudling and his colleagues Michael R. Corbin of the Space Telescope Science Institute in Baltimore and Kirk T. Korista of Western Michigan University in Kalamazoo. Their study appears in the April 20 *Astrophysical Journal Letters*.

The data suggest that the first stars in the universe were already in place when the cosmos was only 200 million years old. That's extraordinarily early in cosmic history yet it's consistent with recent signs of early stars in measurements from the Wilkinson Microwave Anisotropy Probe, a satellite that examines the radiation left over from the Big Bang (*SN: 2/15/03, p. 99*).

Fred Hamann of the University of Florida in Gainesville says the new report is intriguing but not conclusive. Theorists aren't sure how to link the light emitted from iron and magnesium ions to the actual abundances of these elements, he notes. "The result is nonetheless tantalizing," Hamann says.

In a second study looking at the composition of the early universe, reported in the May 1 *Nature*, Jason X. Prochaska of the University of California, Santa Cruz and his colleagues used the light from a background quasar to probe the composition of a dense gas cloud—a probable galaxy in the making—that lies directly between the quasar and Earth. The so-called protogalaxy resides about 11 billion light-years from Earth.

Quasar light absorbed by gas in the protogalaxy has revealed the fingerprints of 25 star-forged elements. These include atoms heavier than iron, such as germanium and lead, that had never before been detected in such a distant body. The relative abundance of some of these elements could only have arisen in massive stars.

The protogalaxy probably has since coalesced into a giant elliptical galaxy, says David N. Spergel of Princeton University. "These observations reveal [that galaxy's earliest] star-formation history," he notes.

Prochaska says the findings suggest that his team can use the same quasar technique to measure the composition and trace the star-formation history of 100 other distant galaxies. —R. COWEN

Upsetting a Delicate Balance

One gene may underlie various immune diseases

One form of an immune-system gene shows up more frequently in people with three different diseases than in people

Continued on page 281

FREUDLING/EUROPEAN SPACE AGENCY

MINDING YOUR BUSINESS

Humanizing gadgetry to tame the flood of information

BY PETER WEISS

A telephone call to Roel Vertegaal's lab may cause a pair of plastic-foam eyeballs to wiggle. Those peepers are attached to a desktop gadget that Vertegaal says could presage a generation of what you might call digital secretaries—particularly insightful ones at that. If Vertegaal looks at the shaking eyeballs, they'll suddenly stop and stare back at him and then patch the call through. If instead, Vertegaal doesn't establish eye contact with the little pop-eyed gizmo on his desk, an answering machine kicks into gear. That's because his digital secretary could tell in a glance that Vertegaal wasn't interested in taking the call.

Such interactions between Vertegaal, director of the human media lab at Queen's University in Kingston, Ontario, and the gadget, known as eyePROXY, are an experiment in a new style of human-machine interactions. Known as attentive-user interfaces, these combos of gadgetry and software are designed to make our growing staff of machines accommodate human behaviors. The goal is to render that entourage of technology more helpful and less annoying.

Cell phones, pagers, personal digital assistants (PDAs), laptops, and car navigation systems—the list of these devices lengthens as electronic intelligence and communications links infiltrate household and office items. There are now even prototype cooking spoons that tell you what temperature the batter is. As this corps of gizmos swells, a barrage of blinking lights, ring tones, beeps, vibrations, and other cues calls out for attention. "The volume of notifications . . . is becoming so large that people are having trouble dealing with it," Vertegaal says.

Consider the demands placed, for example, on nurses, with their many patients and even more health-care gadgets to mind. Add their family, community, and social obligations, and they're often at the edge of information overload, he says.

To alleviate this type of problem without having people limit their access to information, Vertegaal and other computer scientists are designing new software and hardware. "We are on a mission to change the way it feels to work with computers," says Eric Horvitz of Microsoft Research in Redmond, Wash. The fruit of all these efforts will be that digital devices "become a lot less like tools and a lot more like companions and collaborators who understand your intentions and goals," Horvitz predicts.

The scientists want to create the equivalent of the ideal personal human assistant, a flesh-and-blood helper who would recognize what input you need or want at any moment.

One way that researchers are pushing toward that goal is to develop attentive systems, such as eyePROXY, that monitor a person's eyes. Other systems scan a person for position, motion, gestures, and other body language. Yet others tune in to electronic sources, including schedules and sensors indicating where in the world the person is and what he or she is doing. With such information, the system then can ask itself questions about its user: Does he want to take an incoming phone call? Is she too wrapped up in a videoconference to bother?

STARE MASTER — An eyePROXY telephone controller seeks eye contact as the go-ahead to put through an incoming call.

S. WILD

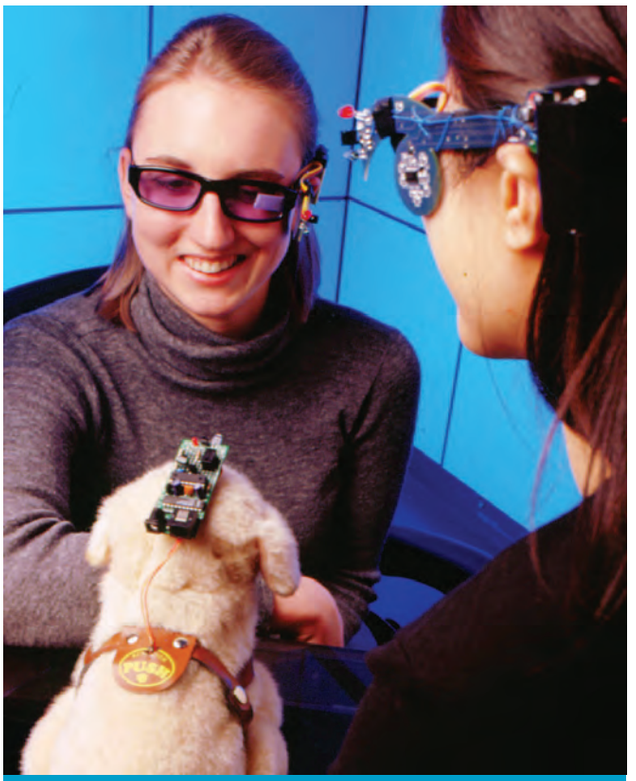
EYE'LL BE WATCHING YOU Despite the current enthusiasm for multitasking and the proliferation of gadgets that demand a chunk of our attention, most people can effectively handle only a few inputs at a time. Psychologists find that an average person can hold only about seven unrelated chunks of information in his or her mind at any one moment.

Some computer scientists and engineers now see a chance to infuse psychological savvy into interactive devices. "We can take the results from psychology . . . and leverage them" by incorporating them into information tools that people use, Horvitz says.

New technologies, like eyePROXY, may provide machines with the power to observe, interpret, and communicate with their users on human terms. Some investigators say that there's no better place to start than with the face.

"A huge amount of information can be gleaned from watching someone's eyes," says Daniel Russell of IBM's Almaden Research Center in San Jose, Calif. For example, people often vie for one another's attention by means of a complex interplay of glances that make and break eye contact.

In the late 1990s, the IBM group that Russell now leads developed a compact video camera that determines where a person's eyes are pointing at any moment. The system exploits the red-eye effect



WATCHDOG WIRING — Simple eye-monitoring sensors, called eye aRe devices, observe their wearers' eyes while also looking outward to detect like devices. Here, a glance from an eye aRe wearer makes a stuffed dog bark.

that wrecks many a snapshot. In this context, light reflecting from the retina renders conspicuous the pupil's location, which a machine can then use to track the person's gaze.

Russell's lab has incorporated the camera into a prototype computer interface that he says could make the Web more effective as an educational tool. The system observes exactly what sentence or image on a Web page a person is focused on and how long he or she may be spending on a particular item—say, a division problem. With those data, the interface might then direct the student toward help with long division rather than with multiplication.

Such systems may enable computers to become better tutors for educational courses disseminated over the Web, Russell says. Anticipating only a small market for the camera, IBM made its design available for free to other researchers interested in eye-gaze tracking.

Vertegaal's group took up IBM's offer. The researchers have increased the camera's resolution and miniaturized its electronics so that the whole unit is now small enough to be mounted on a computer, a hat, or even a pair of eyeglasses.

The team has built the same technology into eyePROXY and communications devices, including cell phones, that recognize when a person is engaged in a face-to-face conversation. That way, even if his or her cell phone is on, it can take a message instead of permitting the phone to ring. This application might be considered a rudeness blocker.

Vertegaal's group has also incorporated the camera into gadgets that it calls "eyePLIANCEs." One of them, a floor lamp, turns on or off by voice command only when a person is looking at it. Another is a television that recognizes whether someone is watching it and, if not, pauses the action on its display. Such attentive devices can sum into an environment that can respond to or even anticipate a person's needs, Vertegaal's group proposes in the March *Communications of the ACM*.

A simpler sensor that can pick up information about eye behavior has been developed at the Massachusetts Institute of Technology (MIT). A small diode produces infrared light that's reflected off the eyeball and detected by a photodiode. The device was created by a team led by Ted Selker, director of MIT's Context-Aware Computing lab and former director of the IBM lab that created the eye-gaze tracker.

Named eye aRe units—a takeoff on the abbreviation for infrared—the devices can monitor such eye characteristics as the rate at which a person blinks. That can provide a window onto a person's mental and emotional state, Selker says. For instance, a rate near the high end of the typical range of 1 to 6 blinks per minute may indicate that the person is experiencing stress or fear.

Selker has several ideas about how such a sensing ability might be used. In one test, he and his colleagues programmed an eye-monitoring digital assistant to use blink-rate to infer whether someone preferred one type of music to another. In another experiment, they monitored people having conversations and found indications of which ones got along well.

MINDFUL MACHINES Besides eye-monitoring technologies, interface designers are also experimenting with methods for gauging other aspects of a person's state of being. Those include video systems that determine body position and head orientation and audio interfaces that listen to and interpret speech and other sounds in the environment.

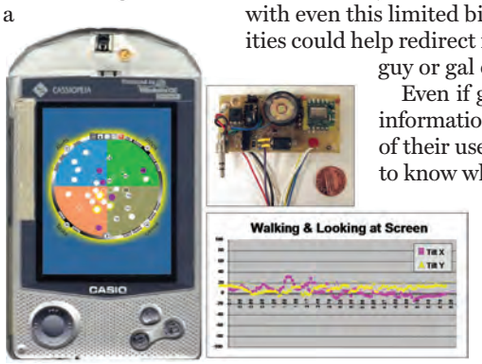
For instance, for mobile individuals, Microsoft Research has made a prototype PDA souped-up with several sensors to automatically detect how the user intends to use it. These sensors include an accelerometer that tells the device whether it's upright, a touch sensor that indicates whether the device is being held, and a proximity sensor that reports whether there's a solid body—for example—a head, within arm's length of the device. With the accelerometer, this prototype can also determine whether its user is walking.

If wirelessly networked to the person's office gadgets, a PDA with even this limited bit of awareness about the person's activities could help redirect messages and other information to that guy or gal on the go.

Even if gadgets become better at discerning the information, computing, or communications needs of their users, they—like able assistants—still need to know when and how to get the user's attention.

For example, Selker and Ernesto Arroyo, also of MIT, compared whether brightening a light or heating up a mouse pad is the better way to grab a person's attention. They found that the light was good at quickly producing awareness. The heated pad, although it took longer to attract interest, was better at holding that attention, says Selker. Actually, he adds, the heat might be especially effective for getting a visually overloaded person's attention, say, when an emergency arises. The researchers reported these results in Miami last January at the International Conference on Intelligent User Interfaces.

Selker, Russell, and their respective teams have also been developing automotive versions of attentive interfaces. The systems are on the alert for signs of drowsiness, for example, and may blare the car radio, make the steering wheel quiver, or provide other feedback to jar the driver back into a more alert or safety-conscious state.

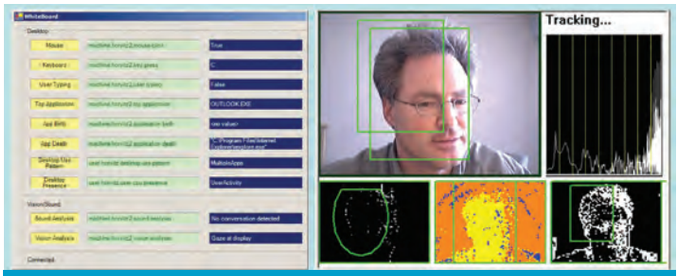


POCKET ROCKET — Sensor-packed personal digital assistant automatically recognizes certain user gestures. For example, holding the device to the mouth prompts it to record a voice memo.

WEBB CHAPPELL ; HORVITZ

ALL IN THE FAMILY Some skeptics, such as artificial intelligence pioneer John McCarthy, emeritus professor at Stanford University, ask whether making devices more attentive could make them more annoying. "I feel that [an attentive interface] would end up training me" to accommodate it rather than providing a worthwhile service, McCarthy says.

Rather than adding people-reading senses to machines, Microsoft Research's Horvitz and his colleagues favor developing sophisticated software tools to analyze the continuous stream of personal information that's already flowing through the computers and other digital equipment that people routinely use. This software sifts out signs of what the user is doing or might want to do in the near future.



ON TARGET — Using images to check its user's head orientation, an attentive interface simultaneously monitors his computer activity and listens for telltale sounds.

HORVITZ

The Microsoft researchers, for example, are developing ways to analyze and disseminate data to create systems that hold back low-priority distractions, such as an e-mail notice for discount Viagra, while—in a sensitive, courteous manner—pushing through urgent messages, such as the arrival of a crucial document in the mail room.

The team recognizes that examples abound of smart gadgets or software functions that aren't smart enough. An overzealous digital assistant, such as the infamous animated paperclip that pops up in the word-processing program Microsoft Word, can annoy and get in the way.

Horvitz and his team recently developed a system, represented to computer users by a cartoon genie, that scans incoming e-mail, recognizes whether the message might require scheduling of an appointment, and offers to set one up. By slightly increasing the time delay before the genie sprang forward to volunteer its services, the interface transformed from something "terrible" to a seemingly "smart, intuitive person," Horvitz recalls.

These researchers are also developing software systems that mine such information troves as e-mails, calendar appointments, logs of network use, and organizational charts identifying someone's bosses and underlings. If unobtrusive information from passive observations by cameras and microphones is available, that's included, as well.

The forte of the Microsoft Research group is developing mathematical models that can incorporate such information and—even without full knowledge about a person's present location and activities—calculate probabilities of what he or she will want to do or might want to know. To do this, the researchers are trying to make the model assess the information in the less-than-precise way that people do.

More specifically, these models work by assigning the equivalent of dollar values to pieces of information to be delivered to someone and to the cost of interrupting that person to present the information. By these calculations, the software may opt to interrupt a person if he is gazing out the window but not if he is briefing the CEO.

"The magic of the kind of work we do here is that we do not change the way people work," Horvitz says. "We don't say, Hold your eyes in a certain way, but we pick up on all the things going on in your life."

Even if attentive devices work seamlessly, all these possibilities for scrutiny may smack of Big Brother to some people. "That can be a potentially sensitive issue," acknowledges Horvitz. ■

Continued from page 278

free of those illnesses, a new study shows. The findings suggest that this subtle genetic difference plays a role in two thyroid diseases and diabetes.

The gene in question encodes a protein that normally moderates the aggressiveness of immune cells called T cells against an invading pathogen. In an autoimmune disease, such as the two thyroid diseases and diabetes, a person's immune system attacks the body's own tissues.

Linda S. Wicker of the University of Cambridge in England and her colleagues report that the presence of one variant of the gene corresponds with lowered production of the protein called cytotoxic T lymphocyte antigen-4 (CTLA-4). That, in turn, may explain why some immune reactions go unchecked and cause damage in people with that variant, she says.

In one part of the study, the researchers recorded the form of the *CTLA-4* gene in blood samples from 1,110 people in British families with abnormally high incidences of either Graves' disease or autoimmune hypothyroidism. Both disorders are caused by immune-system attacks on the thyroid. Graves' disease is marked by an enlarged, overactive gland and, sometimes, protruding eyeballs. In contrast, autoimmune hypothyroidism kills cells in the thyroid. Another 844 blood samples, from people without thyroid problems, served as a comparison.

The scientists identified one particular version of the *CTLA-4* gene, called *CT60*, that was much more common in families prone to one of the autoimmune thyroid diseases than in healthy people. They report the finding in the April 30 *Nature*.

The researchers also analyzed blood samples from 3,671 families with a history of type I, or juvenile-onset, diabetes. Although the data were not as convincing as those from the thyroid group, there were hints that *CT60* crops up more often in families marked by this form of diabetes than in people without the disease.

Together, the results provide evidence that these autoimmune diseases are caused in part by one form of *CTLA-4*, Wicker and her colleagues conclude.

In the immune system, the CTLA-4 protein works by competing directly with its alter ego, a molecule called CD28. These two signaling molecules bind to the same docking sites on cells, but CD28 enhances immune responses whereas CTLA-4 slows them, says Jeffrey A. Bluestone of the University of California, San Francisco.

When less CTLA-4 is available, CD28 can gain the upper hand and rev up an immune response, contributing to autoimmune disease, Wicker and her colleagues hypothesize. The new findings suggest that "the immune system is on a fine balance," she says.

Despite its apparent disadvantages, the genetic variant identified in this study may have conferred an evolutionary advantage, Wicker says. Perhaps the revved-up immune systems of people producing less CTLA-4 more aggressively attack viruses and other disease pathogens, she speculates. In the "hyperclean" environments of some of today's developed countries, however, immune agents may attack people's own cells instead of legitimate foes, Wicker says (*SN: 8/14/99, p. 108*).

"If we could harness the profound regulatory attributes of CTLA-4 or effectively block CD28, we might be able to modify the immune response" in people with autoimmune diseases, Bluestone says.

Wicker says that the next logical step would be tests in diabetes-prone mice to see whether genetically engineering the animals to make extra CTLA-4 enables them to overcome the disease. —N. SEPPA

ANY HOPE FOR OLD CHESTNUTS?

Can't see the forest, but there are still some trees

BY SUSAN MILIUS

Ron Bockenhauer sounds remarkably cheerful for a man living among orphans of one of the country's most infamous ecological tragedies. He resides in the largest remaining stand of American chestnut trees. The straight-trunked giants once accounted for a third or more of the trees covering the Appalachian chain, and wags claimed that a squirrel could go from Maine to Georgia by jumping from chestnut to chestnut and never touching the ground. In 1904, a killer fungus showed up in New York and swept throughout the range. The chestnut forests vanished.

Devastating as the chestnut blight was, it missed some trees. Bockenhauer's grandfather lived in Wisconsin, outside the normal range of the American chestnut. Around the beginning of the 20th century, a neighbor planted a grove of American chestnuts. For years, separated from the epidemic's hot zone, the stand expanded to some 60 acres, moving onto Bockenhauer's property.

"Basically, they grow like a weed," Bockenhauer says. Now, the fungus is moving through his patch.

The chestnut's last stands—far-flung patches like Bockenhauer's, some two dozen or so sick trees in the traditional range, and many stumps that keep sprouting—have attracted optimists trying to bring back the chestnut forests after 99 years of blight. Make that extraordinary optimists. None of the chestnut varieties bred to resist blight so far has the shoot-the-sun height of the pure American chestnut and its famed scrappiness for competing in a forest canopy. The Department of Agriculture ended its chestnut-breeding program decades ago, so private citizens have largely financed recent decades of work.

What's more, a major test of biological control for the disease turned in less-than-hoped-for results last year (*SN: 8/10/02, p. 94*).

Yet the work to restore chestnuts in the United States, both by breeding hardier varieties and controlling the fungus, goes on passionately. Scientists soar to heights of administrative creativity in finding budgetary and schedule cracks in which to squeeze chestnut projects. Champion tree-climber teams donate aerial labor to apply experimental treatments. Volunteers from unwoodsy professions give first aid to individual diseased trees and drive hundreds of miles to care for venerable specimens. These fans' dedication is surprising given that the great chestnut woods had already disappeared before most of today's chestnut savers were born.

Bockenhauer, however, did grow up in a chestnut grove and can describe the goal from his personal experience. "They're the prettiest trees you've ever seen," he says.

ALL-AMERICAN — The burrs of an American chestnut form at the ends of dangling strings of male flowers.

THE AMERICAN CHESTNUT FOUNDATION

WELL BRED Strategies to beat the chestnut blight fall into two main groups: attempts to breed trees that resist it and attempts to enlist one of its biological enemies to quash it. The goal of the foremost efforts to breed a fungus-resistant tree is a chestnut that looks American but fights Chinese-style when it comes to disease.

The blight seems to have originated in Asia, and some trees of the Chinese chestnut species don't even develop cankers when they encounter the fungus.

Decades ago, the USDA did create blight-resistant hybrids of American and Chinese species, explains Fred Hebard of the American Chestnut Foundation's breeding farm near Meadowview, Va. These trees, however, achieved only modest height, as the Chinese species does, and dwindled away in the ruthless competition for light that determines the king of the forest canopy.

Some 20 years after the USDA program ended, the late Charles Burnham, a corn geneticist, decided to take up the cause. He founded the American Chestnut Foundation to approach the problem from a different angle. The USDA had started by crossing an American tree with a Chinese species and then crossing each successive generation of their progeny with another Chinese tree. No wonder the final products looked too Chinese, Burnham concluded. He decided to cross each generation of progeny with American trees instead.

Hebard is carrying on with this general plan. The big moment came for him, he says, in the mid-1990s, "when I realized it would work." Hebard made various crosses of Chinese and American trees and methodically exposed them to blight fungus. By keeping track of how many out of each generation showed resistance to the disease, he determined that only two or three main genes control resistance. Therefore, he predicts that if he starts by crossing a Chinese tree with an American one, crosses their offspring

with American chestnuts for three generations, and interbreeds the progeny he should have a 1 in 64 chance of finding high resistance to the disease among the offspring.

He's also succeeded in tricking the plants into flowering years sooner than they normally would. The original plan assumed 10 years per generation, but by pampering trees, Hebard has squeezed it down to 6 years. He's finished his third generation of back crosses and hopes to harvest nuts as early as 2008 that will grow into soaring hybrids resistant to chestnut blight.

His research program is a bit ambitious for one lifetime. "I'll know whether we've got blight resistance," he says, but the full test of his work will take another century. That's because he's trying to create a resistant tree that not only looks American, but also can dominate a forest.

Another breeding effort, also funded mostly by private donations, skips the Chinese genes entirely. Gary Griffin of the Virginia Polytechnic Institute and State University in Blacksburg runs breeding programs for the American Chestnut Cooperators' Foundation. This band of enthusiasts has located a few dozen old survivors, as they call them—trees that are hanging on in the historical range of the American chestnut. Griffin, his wife, Lucille Griffin, and other volunteers graft branches from the old trees onto healthier rootstock to create a reservoir of genetic material for crossing the sturdiest of the old chestnuts with each other to bring out resistance.

Instead of conventional plant breeding, William A. Powell and Charles Maynard of the State University of New York at Syracuse are trying to genetically engineer an American chestnut for homeowner yards. So far, the researchers have constructed several dozen promising bits of genetic material—modeled after genes from wheat, amaranth, and frog—that should bring resistance. The hard part, however, has been getting a lump of chestnut tissue in a laboratory dish to grow into a tree.

Much of the energy for creating new chestnuts comes from volunteers. For example, Carl Mayfield of Springfield, Va., has appointed himself guardian of the largest known old survivor in the blight zone, a chestnut 14 inches in diameter that still stands in a farmer's field in southwestern Virginia. Mayfield drives more than 200 miles to cut brush around the tree, and when the farmer moved draft horses onto the field, Mayfield built a sturdy fence to protect his charge.

He visits other chestnut trees, too, packing mud on their cankers and clipping flowers for use in breeding programs. He's working on the next chestnut generation himself and coddles several dozen grafted plants in his basement.

"I quit working for money at [age] 76, and I devote myself to this," he says. "It'll work—there's no doubt." Then Mayfield mischievously offers an invitation to the celebration he'll throw when a field of his seedlings matures. He'll be 126, he says, but restoring the American chestnut is a job for optimists.

KILLER — The fungus that wiped out the great forests of American chestnuts erupts in characteristic orange cankers.

THE AMERICAN CHESTNUT FOUNDATION

KILLER FUNGUS KILLER While some scientists have staked their efforts on breeding blight resistance into the giant trees, others are contemplating a biological attack. The largest test of the biocontrol strategy is taking place in the grove owned by Bockenhauer and his neighbors.

Scientists first discovered signs of an interesting enemy of chestnut blight in Italy during the 1950s, says William McDonald of West Virginia University in Morgantown, one of the U.S. leaders in biological blight control. The European species of chestnut catches the disease, too, and early researchers noticed some Italian trees that seemed to have spontaneously recovered their health. In general, European chestnut trees haven't suffered as devastating an outbreak as their American cousins.

At first, observers wondered whether the Italian trees had acquired resistance to the blight. It turned out, though, that the fungus itself had caught a disease-causing virus.

Since then, MacDonald and other pioneers have been looking for particularly useful strains of the virus and investigating how to deploy them. The basic plan depends on dosing trees with sick, so-called hypovirulent fungus in expectation that its strands will fuse with those of wild blight, something that fungi often do when they encounter their own species. Once the strands unite, the wild blight fungus contracts the disease and its killing power wanes.

The idea may be elegant, but it hasn't been easy to implement, according to MacDonald. In one of his early experiments, "the particular virus that we chose made the fungus so sick it didn't reproduce so well." A wimpier virus turned out to make a better control agent because it left infected fungus with enough vigor to spread.

MacDonald's system got its big test after a plant pathologist, Jane Cummings Carlson of the Wisconsin Department of Natural Resources, officially diagnosed chestnut blight at the Bockenhauer grove in 1987. She says that she's not sure how the disease reached the remote patch. The spores might have hitchhiked in on birds or even on some of the many people who visit the grove each year.

At first, Cummings Carlson tried stamping out the infection by taking down the sick trees, but the blight flared up anew each year. Starting in 1992, she, MacDonald, and other concerned workers organized volunteers to test the virus-infected fungus as a biological control. They located chestnut trees with ominous breaks in the bark revealing blobs of orange fungus. As the disease progresses, the fungus clogs a tree's water-conducting tissues and kills the branches and trunk above the infection.

Punching holes around each canker, Cummings Carlson's team inoculated the tree with a slurry of hypovirulent fungus. The volunteers treated each sick tree they could find. Cankers often were at inconvenient heights, so a team of climbers who had won championships in Wisconsin's tree-work competitions donated their services for the high jobs.

The first step of the scheme seemed to work. Fungus that received dollops of hypovirulent fungi would pick up the virus. "We were getting a reasonable level of biocontrol on treated trees," says MacDonald. However, cankers of uninfected, vigorous fungus burst out on new trees each year.

After 1997, the researchers decided to go for the decisive test of their system. They stopped treating any new cankers. "If it's going to work, this virus has got to spread on its own," says MacDonald.

Alas, the biocontrol virus doesn't seem to be spreading as widely as the healthy blight fungus, MacDonald and Cummings Carlson reported last year at the annual meeting of the American Phytopathological Society in Milwaukee. "The verdict is still out," MacDonald cautioned at the time, speculating on scenarios that could improve the outcome. Still, he says, "I think we're going to lose a lot of trees." This spring, the researchers will start treating trees again.

"The biology is fascinating, which is why I've stuck with it for

years," says another collaborator, Michael Milgroom of Cornell University. He was ruminating about population diversity in fungi during the 1980s when he started studying the blight organism. Like many other fungi, this species displays what biologists call vegetative incompatibility, an apparent mismatch of certain strains of the fungus that for some reason refuse to fuse when they meet. This has implications for biocontrol because when the killer strains of the fungus and its virus-carrying relatives don't fuse, the desired virus doesn't spread well.

Milgroom and his colleagues have so far described six genes in the blight fungus for which a clash of two possible forms nixes union. So, the blight fungus can splinter into a least 64 incompatible types, and Milgroom strongly suspects that there are even more.

Other scientists have noted, and Milgroom agrees, that North America bristles with a lot more diversity in blight-incompatibility types than Europe does, creating a tougher challenge for viral biocontrols.

Recent research from his lab fuels speculations about the forces underlying incompatibility. Strands of incompatible fungal types actually do fuse briefly, but then a preset program of cell death breaks the connection. If the program ends that connection slowly, more viruses can creep over the bridge to the previously uninfected organism, he and his colleagues said in the Nov. 7, 2002 *Proceedings of the Royal Society of London B.* This difference might mean that the virus has evolved to slow the programmed cell death and enhance its own spread.

IN THE BAG — To make controlled crosses between trees in hopes of breeding a chestnut blight–resistant strain, workers hand pollinate flowers and cover them with bags to keep out other pollinators.

MIX AND MATCH Other scientists see value in a combination of breeding and biocontrol. Sandra Anagnostakis at the Connecticut Agricultural Experiment Station in New Haven says that inoculating trees with the strains doesn't cure them of chestnut blight or save their value as timber. However, "it keeps trees alive, preserving valuable germ plasm," says Anagnostakis.

For example, 17 years ago, she and her colleagues planted 75 small trees raised from nuts collected in the blight zone. Within 2 years, blight struck, and during the next 4 years, the researchers treated every canker they could find with a mix of hypovirulent fungus strains. Many of the trees died back to stumps, which continue to send up sprouts. Still, about a third of the trees have their original trunks, even though some have cankers from ground level to about 30 feet.

"I am amused that the feeling folks got from the [American Phytopathological Society] meeting was that hypovirulence 'wasn't working,'" she says. "I think it is working very well. The problem is people's expectations."

Because her treated trees flower abundantly each year, she has high hopes. "If we can keep populations alive and flowering, we can plant our resistant trees in their midst," she says. Over the generations, those resistance genes can migrate into the old chestnut lineages.

Even if those genes originate from the disease-resistant Chinese species, the ultimate chestnuts could end up an only slightly altered version of the American classic. ■

THE AMERICAN CHESTNUT FOUNDATION

Letters, continued from page 287

ing children ("Working Out: Welfare reform hasn't changed kids so far," *SN: 3/8/03, p. 149*). The study dealt with the atypical welfare mothers able to find sustainable employment. For them, I don't doubt that having enough money rather than too little would be an improvement. Unmentioned are the many unskilled people arbitrarily deprived of aid and forced into a desolate job market. Many social workers for private charities can bear witness to the emotional condition of children coming from this kind of ordeal.

FORREST CURO, WALLINGFORD, PA.

Another solution?

"A Safe Solution" (*SN: 3/1/03, p. 136*) on home-water disinfection in Africa reminds me of a water treatment method proposed a long time ago. It consisted of a long (200-foot), U-shape tube sunk in the ground as part of the water-delivery system. No organism could survive the pressure at the bottom of it.

LAWRENCE ELDEN, DEARBORN, MICH.

Old way, good way

I read "Brain training aids kids with dyslexia" (*SN: 3/15/03, p. 173*) with both amazement and bemusement. The technique you describe has been in practice for decades, but without a computer. Samuel T. Orton realized that dyslexics needed to be explicitly taught letter-sound relationships, a knowledge that most of us acquire automatically.

I have been in private practice as an educational therapist for 30 years, and the results using Orton's techniques (sometimes termed synthetic decoding) with dyslexics are consistently highly successful.

KARLA SMITH, ALAMO, CALIF.

It's in decay

The hominid dating puzzle is continually being pieced together due to interdisciplinary work between anthropologists and geologists ("Ancient people get dated Down Under," *SN: 3/15/03, p. 173*). I would note, however, that radiation decays (not accumulates) at a known rate in buried minerals, per the radiation half-life law.

BRUCE M. RUCKER, BERKELEY, CALIF.

Correction *"Ancestors Go South"* (SN: 4/26/03, p. 261) *incorrectly referenced a previous article on* Australopithecus *fossils in eastern Africa that date to 4.1 million years ago. The article was from 1998,* (SN: 5/16/98, p. 315)*, not 1999.*

OF NOTE

BIOMEDICINE

Protein implicated in Parkinson's disease

The protein cyclooxygenase-2 (COX-2) appears in high concentrations in parts of the brain ravaged by Parkinson's disease, a new study shows, suggesting that this molecule plays a role in the disease. Scientists made the finding, which appears in the April 29 *Proceedings of the National Academy of Sciences,* by studying the brains of deceased Parkinson's patients.

The researchers also found that a COX-2–inhibiting drug preserves brain cells in live mice that have a version of Parkinson's disease.

Taken together, the findings suggest that COX-2 inhibitors should be tested on Parkinson's patients immediately, says study coauthor Serge Przedborski, a neurologist at Columbia University.

COX-2 inhibitors, such as the arthritis drug celecoxib (Celebrex), are already among the largest-selling anti-inflammatory agents on the market. However, the new research suggests that the drugs might not slow Parkinson's by stopping inflammation, Przedborski says. Rather, the drugs stop COX-2 from converting dopamine—a major neurotransmitter that's in short supply in Parkinson's patients—to a toxic form suspected of playing a role in killing brain cells, he says. —N.S.

EARTH SCIENCE

Seismic waves resolve continental debate

Analyses of seismic waves that travel deep within Earth may resolve a decades-old debate about the thickness of the planet's continents.

Some studies have suggested that the major landmasses in Earth's rigid outer shell—including the planet's crust and the upper layers of its mantle—are between 200 and 250 kilometers thick. To arrive at those estimates, researchers considered phenomena such as heat flow from within the planet.

Other investigations, particularly analyses of seismic waves traveling through and just under those landmasses, have indicated that the continents may be up to 400 km thick.

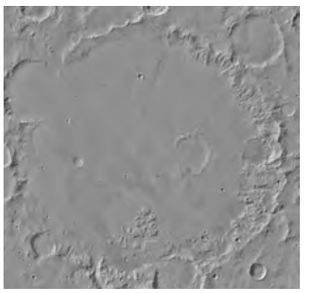
Now, Barbara Romanowicz, a geophysicist at the University of California, Berkeley, and her colleagues contend that some of those seismic-wave studies missed an important factor known as seismic anisotropy, a phenomenon in which some earthquake waves travel more quickly than others. Specifically, earthquake waves with side-to-side ground motions tend to travel faster through Earth's shell than do those with up-and-down movements, Romanowicz explains.

With their new model, which incorporates seismic anisotropy and is described in the April 17 *Nature*, Romanowicz and her coworkers estimate that Earth's continents are 200 to 250 km thick. Previous estimates typically had considered only the faster, side-to-side seismic waves, Romanowicz says. —S.P.

ASTRONOMY

Roving on the Red Planet

Last month, NASA selected the landing sites for identical rovers scheduled to begin exploring the Martian surface next January. Both sites show evidence they once contained liquid water and might therefore harbor fossils of primitive life.



ROVER TARGET Image of Gusev Crater on Mars.

MALIN SPACE SCIENCE SYSTEMS/NASA

The 150-kilometer-wide Gusev Crater will be examined by a rover scheduled for launch May 30 and set to parachute onto the Red Planet on Jan. 4, 2004. Located 15° south of the Martian equator, the crater has what appears to be a dry riverbed flowing into it, suggesting "there had to have been a lake [there] at some point," notes principal investigator Steven W. Squyres of Cornell University.

The other rover, set for launch June 25 and to arrive on Mars on Jan. 25, 2004, will explore Meridiani Planum, an area with deposits of an iron oxide called gray hematite. This material, coarser than the reddish hematite that gives Mars its rusty color, usually forms after hot water flows through and dissolves iron from rocks. As the water cools, the gray oxide precipitates out and collects in the cracks and veins of rock. Meridiani lies about 2° south of the equator and halfway around the planet from Gusev.

The solar-powered rovers are designed to last at least 90 Martian days. After that, dust accumulation on solar panels may diminish their power. —R.C.

TECHNOLOGY

Tipping tiny scales

Because even minuscule amounts of chemical or biological warfare agents can be harmful, sensor developers are striving to build devices to detect those weapons at the molecular level. It's difficult to make such detectors adequately sensitive to noxious agents while operating in ordinary, often-contaminated air and at everyday temperatures.

Now, researchers at Oak Ridge National Laboratory in Tennessee report that they have dramatically improved the sensitivity of certain room-temperature detectors operating in air. The detectors work by weighing contaminants by means of miniature silicon cantilevers. If particles or microorganisms adhere to one of the little springboards, the structure's oscillation frequency changes, revealing the mass of the material that landed.

In the April 21 *Applied Physics Letters,* Nickolay V. Lavrik and Panos G. Datskos describe the prototype cantilever-based system with which the researchers measured a mere 5.5 femtograms (million-billionths of a gram) of an acid. That's less than a millionth the mass of a bacterium, yet still millions of times the mass of an average molecule.

The unusual thinness of the new cantilever and the use of a laser to make the tiny board vibrate contribute to what amounts to a roughly 1,000-fold boost in sensitivity for similar microscopic mass-measuring systems, Datskos says. —P.W.

EARTH SCIENCE

Harbor waves yield secrets to analysis

New findings by ocean scientists may help port officials in Rotterdam, the Netherlands, predict potentially destructive waves in the city's harbor.

Most of Rotterdam lies below sea level,

OF NOTE

and movable barriers near the mouth of the port's main channel protect the region from storm surges originating in the North Sea. However, sloshing waves called seiches can arise within the harbor and cause water levels to vary as much as 1.8 meters in as little as 45 minutes. Those waves could damage the barriers if the gatelike devices were deployed at the wrong time, says Martijn P.C. de Jong, a civil engineer at Delft University of Technology in the Netherlands.

Several phenomena can cause seiches, including weather changes, earthquakes (*SN: 7/7/01, p. 5*), and tsunamis (*SN: 6/10/00, p. 378*). De Jong and his colleagues discovered that each of the 51 seiches in Rotterdam's harbor from 1995 to 2001 that sloshed higher than 25 centimeters occurred as a cold front passed through the area.

Initially, the scientists found that their computer models could have predicted the five seiches associated with strong cold fronts but not the others, which occurred in conjunction with cold fronts marked by gradual changes in wind speed and direction. These findings will be reported in an upcoming *Journal of Geophysical Research (Oceans)*.

De Jong's team recently solved the mystery of the other seiches. When the air about 1.5 kilometers over the North Sea is more than 15°C colder than the surface waters, lower-atmosphere instability produces waves in the North Sea with the same sloshing frequency that a seiche in Rotterdam harbor would have. When those waves sweep into the port, they resonate within the harbor and trigger the seiches. —S.P.

PHYSICS

Not even bismuth-209 lasts forever

Many heavy elements radioactively decay into lighter ones, although some do it faster than others. For decades, textbooks have listed bismuth-209 as the heaviest naturally occurring atom that never decays. A new experiment shows that the textbooks are wrong.

Using exquisitely sensitive, heat-detecting instruments known as bolometers, Pierre de Marcillac and his colleagues at the Institute for Space Astrophysics in Orsay, France, chanced upon signs that more than 100 bismuth-209 atoms had each spat out a helium nucleus—also known as an alpha particle—to become a lighter atom of thallium-205.

Theorists had predicted this particular decay more than 50 years ago. However, after a series of experiments conducted between 1949 and 1972 failed to turn up any evidence of the breakdown, those predictions faded into obscurity.

The rare disintegrations, reported in the April 24 *Nature*, were finally spotted as de Marcillac and his coworkers searched for something else—a hypothetical particle, the neutralino, that might be a component of the universe's so-called dark matter (*SN: 1/25/03, p. 51*).

During a routine check for contamination in their bolometers, which happen to be built around crystals containing bismuth, the team noticed an unexpected alpha decay not listed in any reference tables.

Even so, those disintegrations occur so infrequently that an atom of bismuth-209 can still last just shy of forever. On the basis of the new decay data, the team calculates a half-life for bismuth-209 of some 19 billion billion years—roughly 1.4 billion times the current age of the universe.

Researchers didn't have to wait anywhere near that long to detect the telltale alpha decays because the huge number of bismuth atoms in even a single bite-size bolometer crystal guarantees that some atoms will break down in a matter of days, if they break down at all, de Marcillac says. —P.W.

BIOLOGY

Egg's missing proteins thwart primate cloning

Don't go ordering your clone just yet. A new study indicates that it's almost impossible to clone a person by using the same techniques that work in mice and other nonprimates.

Although scientists can now routinely clone mice, sheep, cattle, and many other animals, they've struggled to clone monkeys and other primates (*SN: 10/20/01, p. 251*). One research group has reported cloning a monkey, but neither those scientists nor others have replicated that success (*SN: 3/8/97, p. 142*). Moreover, researchers seeking to use cloning to produce human embryos as a source for multipurpose stem cells have failed in all their attempts so far.

In the April 11 *Science*, Calvin Simerly of the University of Pittsburgh School of Medicine and his colleagues describe more than 700 futile attempts to clone rhesus monkeys. They found that in the few monkey embryos that began to grow after eggs were put through the cloning procedure, cells contained abnormal amounts of chromosomes and eventually stopped dividing.

The investigators traced this problem to aberrant spindles, the meshwork of proteins that a dividing cell uses to partition chromosomes into two new cells. When scientists remove the DNA from an unfertilized primate egg, an initial step in cloning, they also apparently strip the egg of certain proteins that enable spindles to function properly. In other animals, these spindle proteins aren't as tightly bound to the egg's DNA and remain in the egg after the DNA is removed.

Simerly and his colleagues are already investigating new cloning techniques that might bypass the roadblock they've discovered. In theory, for example, a researcher could replenish the egg's missing spindle proteins. —J.T.

ZOOLOGY

Ballistic defecation: Hiding, not hygiene

Evading predators may be the big factor driving certain caterpillars to shoot their waste pellets great distances.

Caterpillars of the silver-spotted skipper (*Epargyreus clarus*) can fire their feces as far as 153 centimeters, reports Martha R. Weiss of Georgetown University in Washington, D.C. Accounts from other researchers record tales of shots by caterpillars of other species of up to a meter.

To compare three theories of what evolutionary force drove the development of such firepower, Weiss set up challenges for groups of silver-spotted skippers, a species in which a caterpillar builds a series of shelters out of curled leaves and silk lines as it grows.

One hypothesis proposed that blasting the waste far away lowers the risk of disease. To test this, Weiss let feces build up in little containers housing some of her caterpillars. As they developed, she found no obvious difference between them and caterpillars in pristine containers.

Another hypothesis proposed that the waste ejection keeps sewage buildup from crowding the caterpillars out of their homes. Yet when Weiss forced caterpillars to build new shelters more often than normal, she saw a significant drop in caterpillar welfare only in the most extreme version of this test—when evicted caterpillars constructed 32 shelters, instead of the usual 9, as they grew and developed.

In contrast, Weiss found support for the hypothesis that waste draws a predatory wasp to the caterpillars. For example, wasps killed 14 out of 17 caterpillars on leaves where she had put waste pellets but only 3 of 17 caterpillars on leaves she had adorned with glass beads. In the April *Ecology Letters*, Weiss reports that predators are the most likely force behind pellet ballistics. —S.M.

Books

A selection of new and notable books of scientific interest

THE ART OF THE INFINITE: The Pleasures of Mathematics

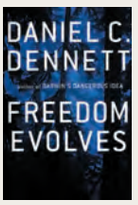
ROBERT KAPLAN AND ELLEN KAPLAN

In *The Nothing That Is*, Robert Kaplan considered the relevance of zero to the history of mathematics. Now, along with his wife, Ellen Kaplan, he addresses infinity. Beginning with natural numbers and covering the realms of infinity from prime numbers to parallel lines, the authors explore how mathematicians have tried to grasp the ungraspable. Profiles of individuals range from Pythagoras, who theorized about irrational numbers, to Georg Cantor, who proved that infinity can come in different sizes. These stories illustrate the two modes of mathematical thinking: the "intuitionist" notion that mathematical truth is discovered as it exists and the "formalist" belief that math is true because we invent consistent rules for it. These seemingly opposed approaches actually intersect in the concept of infinity, the Kaplans write. In making such points, the authors don't shy away from equations, theorems, and graphs. They provide hundreds of them to describe the role of infinity in various areas of mathematics. However, most topics in this book require little more of a reader than a background in algebra and geometry. ***OUP, 2003, 324 p., b&w illus., hardcover, $26.00.***

FREEDOM EVOLVES

DANIEL C. DENNETT

Can there be freedom in a deterministic world? If you are free, are you responsible for being free or just lucky? Dennett, the acclaimed author of *Consciousness Explained* and *Darwin's Dangerous Idea*, answers these questions and ultimately explains how our knowledge of evolution informs our understanding of how we naturally develop morals. As science advances, the concept of the soul as an immaterial bastion of our suffering, joy, and glory has faded, and some people now believe that we don't really have free will and that nothing really matters. In what is surely to be a hotly contested argument, Dennett challenges the idea that determinism implies inevitability. He argues against the idea that in a deterministic world, there are only apparent options. Drawing on ideas from evolutionary biology, cognitive neuroscience, economics, and philosophy, Dennett argues that by applying Darwinism, we can chart the evolutionary course of free will and morality from the smallest organisms on up. ***Viking, 2003, 347 p., hardcover, $24.95.***



THE SECRET LIFE OF DUST: From the Cosmos to the Kitchen Counter, the Big Consequences of Little Things

HANNAH HOLMES

In just a couple of breaths, each person inhales hundreds of thousands of dust specks. Some lodge in the nose, while others make their way to the lungs. Depending on the locale, these particles could contain skin flakes, disintegrating clothing, tree bark, bicycle paint, ant legs, or volcanic ash. Of course, we rarely notice these specks because of their size—the biggest are two-thirds the width of a human hair, and the smallest, about one-ten-thousandth that size. Studying such minutia provides a challenge. As Holmes investigates the dust realm, she describes how scientists from wide-ranging fields study dust. She points to both the cosmos, where dust begets stars and planets, and Earth, where dust plays an integral role in the water cycle. Epidemiological studies, she reports, suggest that children who grow up in dusty houses are less likely to get asthma than others are. From various vantage points, Holmes provides a compelling and enjoyable look at the world of these tiny flecks. Originally published in hardcover in 2001. ***Wiley, 2003, 240 p., paperback, $14.95.***

THE SILVER LINING: The Benefits of Natural Disasters

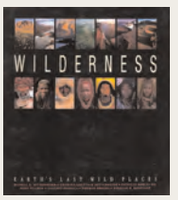
SETH R. REICE

Almost instinctively, we do what we can to prevent floods and forest fires. While these events sometimes take a toll in human life and property, many ecologists argue that such disturbances are actually a boon to biodiversity. Reice introduces readers to disturbance ecology, as it's called, and illustrates its role in nature. He points to the significant benefits that disturbances have on both the ecosystem and people, not the least of which is helping natural systems produce clean air and water. He encourages policy shifts that would embrace this thinking and argues that the U.S. Forest Service's campaign against natural forest fires and the Army Corps of Engineers' flood-prevention policy are just two examples of ecologically unsound approaches to natural disasters. Originally published in hardcover in 2001. ***Princeton U Pr, 2003, 217 p., paperback, $15.95.***

WILDERNESS: Earth's Last Wild Places

RUSSELL A. MITTERMEIER, CRISTINA GOETTSCH MITTERMEIER, PATRICIO ROBLES GIL, ET AL.

More than just an oversized, coffee-table book filled with fantastic photographs of the plants, animals, and peoples that inhabit the world's wild places, this opus also provides significant data about the nature of these ecosystems and efforts to protect them. This information stems from a study produced by Conservation International in 2002, which inventoried wilderness areas around the globe. The authors define a wilderness area as having at least 70 percent of its original vegetation, covering at least 10,000 square kilometers, and containing fewer than five people per square kilometer. The 37 areas that qualified for wilderness status include tropical rain forests, wetlands, deserts, and arctic tundra. Each area's biodiversity, key species, human cultures, threats to survival, and conservation efforts are clarified through beautiful images that take readers to these exotic locales. Originally published in Mexico in 2002. ***U Ch Pr, 2003, 2002, 573 p., color photos/illus., hardcover, $75.00.***



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LETTERS

More promise

Another new anti-HIV drug in the nonnucleoside reverse transcriptase inhibitor (NNRTI) class that has shown promise ("Full Pipeline: Success of experimental AIDS drugs offers promise of future therapies," *SN: 2/22/03, p. 117*) is TMC125. You don't mention this drug, but it has been shown in trial studies to have replaced five drugs for drug-resistant patients, it produces a large drop in viral load, and it has been shown to have very mild side affects. I found this particularly interesting because the current protease inhibitors and some NNRTI drugs are known to cause abnormal redistribution of body fat and potentially fatal liver toxicities.

G. DAVID BACA, COLORADO SPRINGS, COLO.

Slick stuff

The article on waterproof coats was interesting ("Waterproof Coats: Materials repel water with simplicity, style," *SN: 3/1/03, p. 132*), but the process used by the Turkish scientists would require evaporating the solvent. Should not possible harmful environmental side effects be considered before a new industrial process is created?

KENNETH CROOK, SAN JOSE, CALIF.

I believe this same phenomenon occurs on the leaves of the common perennial lady's mantle (*Alchemilla mollis*), to a very pleasing visual effect.

NANCY P. DURR, COLD SPRING, N.Y.

I have a question regarding the properties of this superhydrophobic film. Could it be applied to aircraft wings and other surfaces to prevent icing?

MICHAEL KULHANEK, WASHINGTON, D.C.

According to the researchers, superhydrophobic coatings could potentially prevent icing on aircraft wings. However, the coatings would need improvement before they could be used for this purpose. —J. GORMAN

It's not working

I was dismayed to see you publish an unsubstantiated and highly misleading claim that welfare "reform" is not harm-

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