SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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tracking insect travels

methane-producing plants

obesity risks quantified

desert dirt teems with life

on the edge

THE SOLAR SYSTEM'S ICY FRONTIER

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This Week

Of Note

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Cover Among a slew of recently discovered objects at the far reaches of the solar system, an icy body dubbed Sedna is providing scientists with new clues about the origin and evolution of that distant region. (M. Brown, *et al.*/ California Institute of Technology) Page 26

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Greenhouse Plants?

Vegetation may produce methane

Lab tests suggest that a wide variety of plants may routinely do something that scientists had previously thought impossible—produce methane in significant quantities.

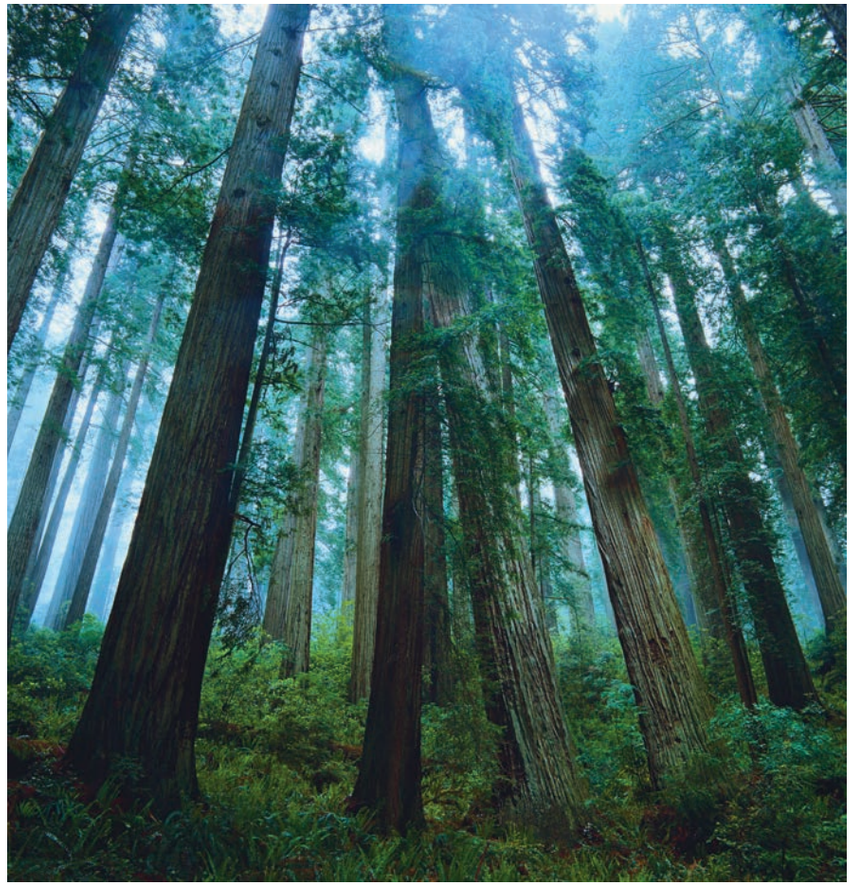
Methane, like carbon dioxide, traps heat in Earth's atmosphere. Scientists have been studying natural sources of methane for decades but hadn't pegged plants as a producer, notes Frank Keppler, a geochemist at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany. Previously recognized sources of methane include bacterial action in the digestive systems of ruminants such as cows and in the saturated soils of swamps and rice paddies.

Now, Keppler and his colleagues find that plants, from grasses to trees, may also be sources of the greenhouse gas. "This is really surprising," Keppler says, because most scientists assumed that methane production requires an oxygenfree environment.

In its experiments, Keppler's team scrutinized the gaseous emissions of a variety of plants and their debris at normal atmospheric oxygen concentrations. A gram of dried plant material, such as fallen leaves, released up to 3 nanograms of methane per hour when the temperature was about 30°C. Each 10°C rise above that temperature, up to 70°C, caused the emission rate to approximately double.

Living plants growing at their normal temperatures generated even larger quantities of methane, as much as 370 ng per gram of plant tissue per hour. Methane emission more than tripled when the plants, either living or dead, were exposed to sunlight.

The team's experiments took place in sealed chambers with a well-oxygenated atmosphere, so it's unlikely that bacteria that thrive without oxygen generated the methane, says Keppler. Experiments on plants that were grown in water rather than in soil also resulted in methane emissions, another strong sign that the gas came from the plants and not soil microbes.



CORBIS

BREATHING OUT Trees and other plants may emit substantial quantities of the potent greenhouse gas methane, according to a recent battery of lab tests.

From their data, the researchers estimate that the world's plants generate more than 150 million metric tons of methane each year, or about 20 percent of what typically enters the atmosphere. They report their findings in the Jan. 12 *Nature*.

"This is some pretty strange chemistry," says David C. Lowe, an atmospheric chemist with the National Institute of Water and Atmospheric Research in Wellington, New Zealand. One reason that scientists hadn't considered plants as a source of the gas is that the laws of thermodynamics don't favor methane production in an oxygen-rich environment. However, Lowe notes, many plants produce volatile hydrocarbons that contribute to haze and smog (*SN: 12/7/02, p. 360*).

The new finding is an "interesting observation," says Jennifer Y. King, a biogeochemist at the University of Minnesota in St. Paul. Because some types of soil microbes consume methane, they may prevent plant-produced methane from reaching the atmosphere. Field tests will be needed to assess the plants' influence, she notes.

The Keppler team's results may partially explain the large methane plumes recently observed over some tropical forests by Earth-orbiting satellites, says John B. Miller, an atmospheric scientist at the Earth System Research Laboratory in Boulder, Colo. Although such plumes are unsurprising during the rainy season, when methane-producing soil microbes are most active, they also appeared during the dry season.

The new findings will probably spur researchers to revise their models of where and how methane is generated as well as their interpretations of the gas' concentrations measured in ancient ice cores. "This is a big deal if it's real," says Stanley C. Tyler, an atmospheric chemist at the University of California, Irvine. —S. PERKINS

Masters of Disaster

Survey taps resilience of post-9/11 New York

In the months after the Sept. 11, 2001, ter-rorist attacks on the World Trade Center, rates of stress-related symptoms and post-traumatic stress disorder (PTSD) soared among survivors and emergency workers. Nonetheless, a large majority of people liv-

ing in and around New York City experienced no more than one stress symptom during the 6 months after the devastating strike. That's a sign of widespread psychological resilience, according to a new survey. Even among people injured in the attack, one-third displayed resilience.

The results "provide the most convincing data to date that resilience is prevalent even following the most pernicious and potentially traumatic levels of exposure," says psychologist George A. Bonanno of Columbia University. Previous resilience research had focused mainly on recovery from personal traumas, such as a spouse's death (*SN: 3/2/02, p. 131*).

Bonanno's team conducted telephone interviews with 2,752 randomly selected adults living in or near the city about 6 months after 9/11. Resilience was defined as reporting either no stress-related symptoms or one such symptom since the attack.

PTSD consists of up to 17 stress symptoms that include intrusive memories of a traumatic event, a need to avoid reminders of the event, detachment from others, sleep difficulties, and an exaggerated startle response. Since sleep problems and some other symptoms can occur without exposure to a traumatic event, the researchers allowed for one PTSD symptom in resilient individuals. A diagnosis of PTSD rests on the number, type, and severity of symptoms.

Resilience characterized 1,672 participants, or 65 percent of the total, Bonanno and his coworkers report in the March *Psychological Science*. About 6 percent of the interviewees had PTSD, a figure comparable to the disorder's lifetime prevalence in U.S. adults. The rest reported two or more stress symptoms that fell short of PTSD.

Even New Yorkers most affected by 9/11 events frequently displayed resilience. For instance, more than half of the people who saw the attack in person or who lost a friend or relative in the attack fit the definition of resilience. Although about one-quarter of the 59 survey participants with 9/11–related injuries suffered from PTSD, a large fraction of them were resilient. Among 22 participants who had been in the World Trade Center during the attack, 6 developed PTSD, while 12 showed resilience.

Resilience was tougher to achieve for people who had been exposed to 9/11 in two or more ways. For example, a resilience rate of 51 percent among those involved in rescue efforts fell to 40 percent for rescue workers who had seen the attack in person.

The findings confirm that psychological interventions after disasters need to be targeted to people who truly need them, Bonanno holds. "There are still a lot of unknowns about how best to help people emotionally," he says.

Psychologist Glenn I. Roisman of the University of Illinois at Urbana-Champaign agrees that people's resilience after traumatic events is often underestimated. However, since the new study doesn't address whether people with one or no PTSD symptoms had work or family problems, the findings may overstate resilience's reach, Roisman says.

Researchers now need to examine whether exposure to 9/11 undermined people's capacity to cope with ensuing adversity, remarks psychiatrist Rachel Yehuda of Mount Sinai School of Medicine in New York City. —B. BOWER

Faked Finds

Human stem cell work is discredited

DNA evidence indicates that South Korean scientist Woo Suk Hwang fabricated data in studies purporting to show that he had cloned human embryos and derived stem cells from them, Seoul National University investigators say. A March 12, 2004 *Science* paper vaulted Hwang to fame, but the DNA in stem cells remaining from that experiment doesn't match that from the embryonic cells shown in the report, indicating that the results were faked. The university investigators also discredited a related article published in the June 17, 2005 *Science*.

Last month, Hwang offered to retract the two papers (*SN: 12/24&31/05, p. 406*). An Aug. 4, 2005 *Nature* paper, in which Hwang's team claimed to have cloned a dog (*SN: 8/6/05, p. 83*), is legitimate, the university investigators say. —N. SEPPA

Little Professor

Ants rank as first true animal teachers

No insult intended to human teachers, but a research team in England says that the first clear demonstration of true teaching among other animals comes from a species without much of a brain—an ant.

A variety of animals do things that onlookers learn to copy, but biologists have a stricter definition for true teaching, explains Nigel R. Franks of the University of Bristol in England. First, teachers do a task less efficiently than they would outside the classroom. Second, pupils of a true teacher learn faster than they would by themselves.

Franks and his Bristol colleague Tom Richardson added another requirement:

ANT SCHOOL A *Temnothorax albipennis* ant (right, with red paint) that knows where food lies guides an inexperienced forager (left, dabbed with white), which keeps in touch with antenna taps.

FRANKS AND RICHARDSON

feedback between teacher and student.

The tiny ant, *Temnothorax albipennis*, from England's southern coast, meets the criteria, Franks and Richardson report in the Jan. 12 *Nature*. In lab tests, the species' teachers guided nest mates to a food source (*for video, see www.sciencenews.org/articles/20060114/antteach.avi*).

"One would have expected to see teaching in chimpanzees or [some other primate], but for the first fairly strong evidence of it to come from ants is surprising and interesting," says Bennett G. Galef Jr. of McMaster University in Hamilton, Ontario. Last year, Galef and his colleagues reported that mother rats didn't teach their young to tell good food from bad in a lab test.

In earlier work, Franks watched ants take their nest mates to a new home. An ant that knows the new address either carries an uninformed nest mate or guides her by trotting in front of her.

Other researchers have observed such tandem running in several-dozen ant species, although an ant can run much faster alone, even when carrying a nest mate. During the guided tour, the follower ant repeatedly calls a halt and turns in loops, "as if it's having a jolly good look around," Franks says.

Richardson videotaped lab colonies that had a sugar solution located some 15 centimeters from their nests. During hundreds of hours of analyzing videos, he found evidence for all the true-teaching criteria. As a cost to the teacher, tandem running took four times as long to reach the sugar as traveling solo does.

For feedback, the follower ant tapped her antennae against the leader's body to keep her moving forward. Also, if the distance between the ants shrank or stretched, both adjusted their speeds.

As evidence that the lessons helped, the researchers say that the guided newcom-

ers found the food in two-thirds the time that they would otherwise take. In contrast, when ants of this species carry their nest mates, the novices travel upside-down and backwards, giving them little opportunity to learn a route.

For small colonies, teaching also avoids reliance on scent trails that fellow ants might not find, says Franks. —S. MILIUS

Put Down That Fork

Studies document hazards of obesity

Being overweight or obese in middle age hikes a person's risk of severe heart and kidney problems later in life, even in people whose blood pressure is normal, two new studies show. The reports provide empirical, if observational, evidence that carrying excess pounds causes long-term damage to the body's organ systems.

In one study, researchers analyzed lifestyle and health data—including weight—collected between 1967 and 1973 from adults in the Chicago area. Periodically until 2002, the scientists got medical updates or death information for about 18,000 of the participants who hadn't had heart disease or diabetes when they enrolled about 3 decades earlier. On the basis of their initial checkups, those people were classified as normal weight, overweight, or obese.

QUOTE

"This is the definitive study linking obesity to cardiovascular disease."
S. JAY OLSHANSKY, University of Illinois at Chicago

Among people with no other heart-risk factors, obese people were four times as likely to be hospitalized for heart problems after age 65 as people of normal weight were, the researchers report in the Jan. 11 *Journal of the American Medical Association*. Among participants with moderate health risks—including blood pressure at the high end of normal and total cholesterol just over 200—the risk of being hospitalized for heart problems was double in the obese group compared with the normal-weight people, says study coauthor Lijing L. Yan, an epidemiologist at Northwestern University School of Medicine in Chicago and at Beijing University.

Death records of study participants who died after age 65 showed that people who were obese at their initial checkups were also more likely to die from heart attacks or strokes than thinner people were.

"This is the definitive study linking obesity to cardiovascular disease," says S. Jay Olshansky, a gerontologist at the University of Illinois at Chicago.

In a second study, using a health database of northern California residents, scientists at the University of California, San Francisco (UCSF) teamed with researchers at Kaiser Permanente in Oakland to look at the effect of body weight on kidney health. They found that people in the overweight category at checkups conducted between 1964 and 1985 were twice as likely as normal-weight people to have developed kidney failure 15 to 35 years later.

Compared with the normal group, the obese people showed threefold-to-sevenfold the risk of kidney failure, with the most-obese individuals having the greatest risk, says UCSF nephrologist Chi-yuan Hsu. The researchers compared people of similar age, race, gender, smoking habits, cholesterol readings, and heart health. The kidney-disease risk remained strong after the team accounted for diabetes status and blood pressure.

The report appears in the Jan. 3 *Annals of Internal Medicine*.

Each kidney has about 1 million blood-filtering units called nephrons. As body fat increases, each nephron must handle a greater volume of blood, Hsu says. "This overworking of the nephrons wears them down," he says, perhaps contributing to kidney failure.

Olshansky notes that people in these studies typically became obese in adulthood. "Today, we have many people acquiring obesity as children," he says. If gaining weight in middle age leads to health problems, then getting fat in childhood "might be far worse," he hypothesizes. —N. SEPPA

The Fat Track

Signals between cells keep creatures lean

Fat is a fact of life for creatures great and small, but researchers know little about why some stem cells transform into fat cells rather than, for example, muscle or bone. Now, a team of researchers has found a clue: A series of signals between cells that is common to insects and mammals appears to influence fat formation.

The finding could offer new avenues for research into treating conditions such as osteoporosis and obesity. It also supports biologists' use of the simple fruit fly as a model for mammals in fat research.

Stem cells develop into different types of cells with the guidance of signals from, for example, hormones or nutrients sent by other types of cells. One such series of signals, known as the hedgehog signaling pathway, occurs in a variety of creatures, from insects to people. Hedgehog signaling plays an important role in determining the form that cells take as they mature and also sets patterns for the structure of tissues and organs.

To see how hedgehog and other signaling pathways might affect fat development, endocrinologist Jonathan Graff of the University of Texas Southwestern Medical Center in Dallas and his colleagues studied the effects of activating and blocking the hedgehog and other pathways.

In both fruit flies and mice, activating the hedgehog pathway resulted in low-fat animals. Blocking the signals stimulated fat cell development, the team reports in the January *Cell Metabolism*. Since the pathway controls a cell's potential fate, active hedgehog signaling may reduce fat formation by designating a cell as bone, for example, rather than fat, Graff says.

The simplicity of the relationship suggests that it might be possible to manipulate hedgehog signaling with drugs and thus treat conditions such as obesity, diabetes, and osteoporosis, Graff says. "From the beginning, these studies were thought of as a potential way to alleviate an enormous crisis we're facing. The health implications are enormous," he adds.

The study results also suggest that findings on fat formation in fruit flies could be applied to people. "It's this common connection between insects and mammals that's provocative," Graff says.

"It's an important paper," says endocrinologist Evan Rosen of Beth Israel Deaconess Medical Center in Boston. But he says he's uncertain whether hedgehog signaling will ever provide an avenue for treatment. If it does, it won't be soon, Rosen warns.

The hedgehog pathway contributes to the development of some cancers, he notes, so researchers would need to isolate the effect of hedgehog signaling on fat cells. If a treatment reduced fat cell development but increased cancer risk, "most people wouldn't make that trade," he says in the same issue of *Cell Metabolism*.

Even for obesity, Rosen adds, "blocking fat cell formation is a very bad way to treat [the problem]." He says that excess fat can best be prevented by balancing calorie intake and energy expenditure—also known as dieting and exercising. —C. GRAMLING

Life Underfoot

Microbial biodiversity takes surprising twist

To the naked eye, a tropical rainforest bursts impressively with biodiversity, and a desert is just as impressively short on it. But a new study suggests that at the microscopic level in soil, the situation is reversed. Dirt in a

rainforest is a veritable desert of bacterial species, whereas bacterial biodiversity blooms in desert dirt.

Scientists know little about the distribution of microbial species across the globe, says Noah Fierer, a soil microbiologist at the University of Colorado at Boulder. "There are all these papers on plant and animal diversity at continental scales going back to Darwin," but similar surveys hadn't been carried out for bacteria and other microscopic life forms, he says.

To gather more information on how microbial species are spread out over large geographic distances, Fierer and his colleague Robert Jackson of Duke University in Durham, N.C., collected soil samples from 98 sites throughout North and South America. They chose a wide variety of environments, including rainforests, tundra, grasslands, and deserts. Fierer and Jackson specifically selected locations that were well studied, so that data about average seasonal temperatures, rainfall, and other characteristics would be available.

They then subjected each soil sample to a DNA-fingerprinting technique. This technique scrutinizes a specific segment of the microbes' genomes, called 16S ribosomal DNA, that tends to vary from species to species but is similar in closely related species. Rather than telling exactly which or how many microbial species are present in each sample, the technique gives a relative index of the diversity of species.

Fierer and Jackson had hypothesized that microbial biodiversity would mimic that of plants and animals in each location, with a variety of environmental conditions determining which species live where. However, notes Jackson, "the results were really surprising. None of the things that we think about being important for the diversity of animals and plants were important in this case—not latitude, temperature, or moisture."

The only factor that seemed to affect microbial biodiversity was soil pH. Soils that are acidic, such as those in the Amazonian rainforest, tended to harbor fewer species. Soils closer to neutral pH, such as those in the Arizona desert, showed considerably greater biodiversity. The researchers also found that environments with similar soil pH tended to have similar communities of bacteria, even when sites were separated by large geographic distances, such as that between conifer forests in the northeastern United States and those in the Pacific Northwest.

QUOTE

"If it holds true, it suggests that bacteria are fundamentally different from plants and animals."
JESSICA GREEN, University of California-Merced

Fierer and Jackson report their findings in the Jan. 17 *Proceedings of the National Academy of Sciences*.

The new study "adds to evidence suggesting that all microbes are everywhere, and if they find the right environment, they will prosper," says Eddy Rubin, director of the Department of Energy's Joint Genome Institute in Walnut Creek, Calif. "If you have the same pH, you'll get the same ones throughout the planet."

Jessica Green, a soil microbiologist at the University of California, Merced, agrees. "If it holds true, it suggests that bacteria are fundamentally different from plants and animals." —C. BROWNLEE

Robo Receptor

Researchers engineer a brain ion channel to take its cues from light

Teasing apart the complex circuitry of the brain might someday proceed with the flip of a switch, now that scientists have invented a light-responsive version of a common class of cell-surface proteins. The design permits precise control over whether channels into neurons are opened or closed to the ions that propagate nerve impulses.

To send information quickly, the brain relies on the neurotransmitter glutamate. This chemical attaches to the inside of a clamshell-shaped part of the glutamate receptor, a protein on the surface of nerve cells. Once that occurs, the clamshell closes and the receptor's ion channel opens.

Researchers had previously constructed a few examples of light-controlled receptors. But Ehud Y. Isacoff, Dirk Trauner, and their colleagues at the University of California, Berkeley wanted to create a system that was applicable to the many kinds of receptors with clamshell shapes like that in the glutamate receptor.

The researchers assembled a string of compounds with glutamate at one end. In the middle of the string, they put a chemical called azobenzene, which changes its shape when illuminated by certain wavelengths of light. At the other end, the team placed maleimide, a compound that binds tightly to sulfur.

The next step was to tether the string-bound glutamate to its receptor. The group genetically engineered a version of the receptor with the sulfur-containing amino acid cysteine at a strategic spot near the lip of the clamshell. After growing lab cultures of nerve cells bearing the altered receptors, the researchers added their modified glutamate. The maleimide end of the string attached to the cysteine, anchoring the glutamate near the shell.

The string operates as a robotic arm does, says Trauner. In the dark, the arm stretches out, such that the glutamate stays far from the receptor. Upon irradiation with ultraviolet light, the arm bends, bringing the glutamate end to the clamshell site on the receptor.

The glutamate binds inside the clamshell and the ion channel opens, the researchers report. When hit with green light, the arm stretches back out, causing the ion channel to close.

The researchers turned the channel on and off with repeated switching between ultraviolet and green light for more than 30 minutes, they report in the January *Nature Chemical Biology*.

With the optical switch in place, researchers could use focused light signals to open ion channels in specific areas of brain tissue, a potentially powerful technique for determining how neuronal networks function, Isacoff says. "You could isolate specific cells in a neural circuit … and ask what they do for the operation of the circuit," he says.

The group plans to test the system in animals such as fruit flies and to extend the design to additional receptors. The researchers are also tweaking their system to tether glutamate to normal receptors without a cysteine mutation, notes Trauner.

Neurobiologist Edward M. Callaway of the Salk Institute for Biological Studies in La Jolla, Calif., calls the new findings "a really exciting development" that researchers could apply to studies of various types of neurons. —A. CUNNINGHAM

THE TROUBLE WITH CHASING A BEE

Radar struggles to track backyard bugs

BY SUSAN MILIUS

Randolf Menzel runs a sophisticated insect-neurobiology lab in Berlin, but he puzzled for years over how to follow a bee. "Running behind a bee doesn't help very much," he says. Racing along, an observer can keep a tiny spot against the sky in sight for a good distance, but sooner or later the person glances away from the bee for a second. "If you have lost it from sight, you will never find it again," says Menzel.

One athletic student could keep up for record distances of some 50 meters, "but he was falling down a lot," Menzel recalls. So, Menzel gave up on runners and instead maximized conditions for stationary observers to track the bee. "We had lots of students lying on the ground, following it with their fingers," he says.

Finger-pointing didn't help much beyond 30 meters, but the students could at least estimate the direction in which the bee was heading when last seen, which bee researchers refer to as "the vanishing bearing." Menzel's group even instrumented this approach, attaching direction detectors to the arms of three pointing students lying on the ground in various spots. The devices linked to a computer that triangulated the bee's location in the sky and drew a flight path.

Recently, Menzel replaced pointing students with radar equipment. For decades, entomologists have used radar to pick out masses of migrating insects at high altitudes, but the technology proved even less effective than the naked eye at tracking a single insect closer to the ground.

Starting in the 1980s, however, several research groups zeroed in on single insects in flight by modifying a commercially available system used for rescue operations. That method indicated only the direction of flight. Then, a team that's now at Rothamsted Research in Harpenden, England, built a larger, more powerful system that tracked an insect with true radar, which reveals both direction and distance.

Instead of tripping over rocks or squinting into the sky, Menzel and his colleagues could then use radar to see a bee as a little blip on a tracking screen. "It was absolutely exciting," he says.

Such tracking studies are now enabling researchers to ask new kinds of questions, and the past several years have seen radar documentation of the travels of butterflies and beetles. Menzel is tackling decades-old questions about bee behavior as he finally learns where those specks go when the finger-pointing is over.

ROTHAMSTED RESEARCH

BEE WHERE — The device fastened to the back of this insect changes an incoming radar frequency in a predictable way and reflects it. Trackers at ground level listen for the predicted frequency and ignore the chaos of other reflected signals.

FIGHTING CLUTTER Radar does such a fine job of detecting invisible things—faraway planes or sky-high clouds of insects—that it's hard to believe that a backyard bee would stump the technology.

The problem, says Rothamsted's Alan Smith, comes from the backyard. Basically, radar works by sending out radio waves and listening for any that bounce back. By analyzing the delay and direction of those returning signals, trackers pinpoint the object that sent them back.

Radio waves sent out close to the ground, though, bounce off the ground, trees, houses—just about everything. The result is a chaos of returning waves. A signal returning from a tiny insect gets lost in the clutter.

A strategy to get around this problem comes from harmonic radar. Trackers fit the object that they want to follow with a device called a transponder, which distorts the incoming wave so that the energy is radiated back at a multiple of the original frequency, what a musician would call a harmonic. Trackers listen for that particular responding frequency and ignore the rest of the radio cacophony.

The idea has appealed to people tracking all kinds of things, including large animals. Traffic-safety visionaries have worked with it in attempts to invent technologies to avoid car crashes.

Harmonic radar appealed to entomologists because the transponder doesn't need its own power source: The energy in the incoming radio wave drives the outgoing wave. No longer having to include a battery, designers saw an opportunity to slim down the device to fit an insect.

OVER THERE The first success using direction-finder radar to track insects came from adaptations of equipment sold by the Swedish company RECCO for locating skiers buried in avalanches. The pulses of radio waves penetrate snow and locate any people wearing transponders.

The equipment was already portable because rescue teams had to lug it out onto the slopes. A device that looks like a flattened hair dryer sends the outgoing radio waves. Its detectors pick up return signals and discern the direction of the buried transponder.

Technically, that's not radar, notes Smith. The word *radar* comes from "radio detection and ranging," and these systems don't give a distance reading. However, the researchers who use these systems still refer to them as a special kind of harmonic radar.

In the 1980s, Henrik Wallin and Daniel Mascanzoni, both at the Swedish University of Agricultural Sciences in Uppsala, modified a skier-rescue system to track individual carabid beetles. The original system had included transponders made of a sturdy metal diode and a pair of antennas. Designed to be sewn into ski clothes or fastened onto boots, the transponders were far too big for a beetle.

Wallin, now at SIK in Uppsala, and Mascanzoni created a daintier transponder by substituting a diode weighing less that 0.1 gram and fashioning an antenna from just a few centimeters of fine copper wire. The beetles had the reputation of sticking close to home and walking wherever they needed to go, and they walked readily enough with their new decorations in place.

However, the first field test, with night-active beetles, was "a total failure," says Wallin. "Daniel and I came up with this brilliant idea that we could release a whole bunch of them at a convenient time before sunset and then detect the positions next morning—after breakfast, of course." But when they checked, the beetles were nowhere to be found. That clue led to tests in which the researchers discovered that these carabids move considerably farther and faster than anyone had suspected.

START SMALL — A diode (the rectangle above the penny in the image on the left) responds to harmonic radar but is small enough for an insect to wear. Wires attached to the diode serve as an antenna. No batteries required. A woman (right) holds a commercial direction-finding device that sends out a signal and listens for a particular multiple of that signal bouncing back. Designed for rescue work, the device has been modified to look for insects.

Getting the transponders right for the beetles can be a considerable trick, according to Matt O'Neal of Iowa State University in Ames. He and his colleagues worked with the RECCO system to modify transponders for several beneficial beetles that crawl around corn and soybean fields. The transponders that the research team developed tended to snag on weeds and plants, the group reported in 2004.

David W. Williams, however, had more success tracking Asian long-horned beetles. This tree-boring species first showed up in the United States in New York in 1996. Entomologists wanted better information about beetle movements so that they could make decisions about quarantine zones for cutting trees. Williams, now at the U.S. Department of Agriculture's Animal and Plant Health Inspection Service lab on Cape Cod in Massachusetts, says that he heard about harmonic radar for insects through the professional grapevine in the late 1990s and eventually contacted Jens Roland of the University of Alberta in Edmonton.

Williams faced a new design challenge because Asian long-horned beetles do more flying than the carabid beetles did in Wallin and Mascanzoni's earlier studies. The transponders used for carabid beetles were too heavy for flight. However, Roland was working on an even tougher challenge: to get transponders light enough to work on butterflies.

Roland had commissioned a specialty-electronics firm to fabricate gossamer transponders, and the firm sent several samples to Williams. The maker had indeed shrunk the transponders to "hair-fine wires and a diode like a grain of sand," says Williams. In the treacherous world of insect tracking, though, this marvel of weight reduction didn't help Williams. Those transponders worked on dainty butterflies, but for roughhousing beetles, they were too fragile. "You look at them cross-eyed, and they break," Williams says.

Finally, Williams found a USDA lab in Texas with the equipment for making a transponder with a diode just 1 millimeter square—substantial, but not too heavy for beetle flight.

Williams then hit an unexpected hitch. Asian long-horned beetles have such smooth bodies that glues didn't hold well, and the transponders soon fell off. Even superglue didn't stick long.

"I lay awake tossing and turning a few nights worrying about whether the transponders would ever stay on," Williams says. Then, he remembered a trick from his graduate student days. Dental floss is the entomologist's version of duct tape, he says.

Sure enough, Williams found that he could tie the transponder onto a beetle "as a necklace," he says. The beetles even have horn-like projections near their necks that keep the floss from slipping over their bodies. That was "one of the few convenient things about them," says Williams.

He practiced knots on dead specimens but wanted to try the transponders on live beetles before he carried them halfway around the world to perform an experiment on the insects in their native habitat. He took his floss to a quarantine facility in Newark, Del., that had live beetles. His method worked, but not easily. Getting the necklace on a beetle, he says, "takes two full-grown men."

Once Williams reached China, entomologists Guohong Li and Ruitong Gao of the Chinese Academy of Forestry in Beijing took him out to a country road lined with miles of regularly spaced willows. Because China already had plenty of Asian long-horned beetles, the researchers could release 55 necklace-wearing ones over several days without disrupting an ecosystem.

The radar permitted a new twist on an old method of studying dispersal. In the traditional procedure called mark-recapture, researchers mark and release many individuals and later try to recapture them. Researchers extrapolate the fate of the large group on the basis of the usually small percentage that gets recaptured.

Williams and his colleagues, however, adopted an individualized mark-recapture strategy to chart the beetles' paths. The scientists tied transponders onto a few-dozen beetles and then looked for them every day both by eye and by radar. By the end of the 2-week study, the researchers had recaptured almost two-thirds of the beetles. This method found a somewhat slower rate of beetle spread than an earlier study had, Williams and his colleagues reported in the June 2004 *Environmental Entomology*.

MAKING TRACKS To follow an insect, a radar instrument must measure distance as well as direction. Development of such a device began during the 1970s by scientists funded by British foreign aid.

While studying large migrations of pests, such as swarms of locusts sweeping through West Africa, the researchers turned their attention to the tsetse fly. However, a tsetse fly doesn't get even as big as a housefly. "It was a pretty daunting task," says Smith.

He began by modifying commercial radar systems made for ship navigation. They rely on relatively short wavelengths, which unfortunately can't travel through objects such as trees and houses. However, transponders that respond to short wavelengths can stay correspondingly small, increasing the chances of developing something light enough for a small flying insect. The receivers, though, would be much heavier than the handheld units used in the avalanche-rescue system.

Working on the project intermittently for about 4 years, Smith and his colleagues tried out various designs. By the time that the research team got the system going, funding had dried up. Yet other scientists expressed interest in trying out the technology—on bees, for example.

(continued on page 28)

O'NEAL/AMERICAN ENTOMOLOGIST

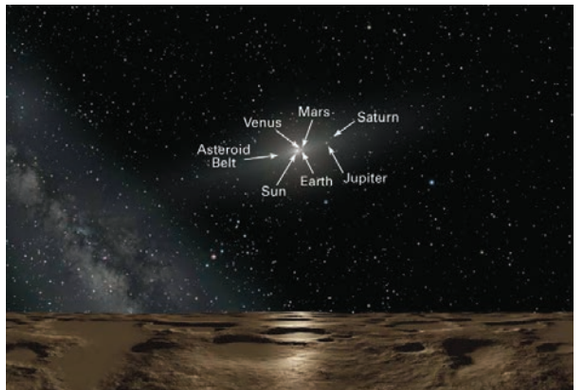
OUTER LIMITS

Solar system at the fringe

BY RON COWEN

Planetary scientist Mike Brown has had plenty of practice finding objects at the fringes of the solar system. In sky images spaced an hour apart, he and his colleagues have identified several of the solar system's most distant denizens, revealed by their motion relative to the background of fixed stars. Early in 2004, soon after his team began using a new version of their discovery software, Brown was in his office at the California Institute of Technology in Pasadena reviewing images on his computer screen. He came across a sequence of pictures, taken by the Samuel Oschin telescope on Palomar Mountain near Escondido, Calif., showing a faint object moving so slowly that it must have been in the outer solar system, far beyond Pluto. "I think I fell out of my chair," says Brown.

The extremely slow motion of the object, now dubbed Sedna (*SN: 3/20/04, p. 179*), indicates that the body lies so far out that "there is nothing in the solar system today that could have ever made it ... and if you run time backwards, there's nothing in the solar system today that can put [a body] in this orbit," says Brown. Finding Sedna, he adds, "just blew our minds."



REMOTE VIEW — The sky as seen from the proposed surface of the recently discovered Sedna, which strays farther from the sun than any other known solar system body.

A. SCHALLER, NASA, STSCI

Sedna is the strangest of a recently discovered batch of outer solar system residents, but other finds are also surprising in their size, spin speed, or location. The new discoveries, which include the first planet-size body found beyond Pluto, are forcing astronomers to retool their ideas about the evolution and origin of the outer solar system—just as NASA prepares to launch the first spacecraft targeted to explore Pluto and its outlying neighbors.

"We're really not at the stage yet of making small refinements in our understanding [of the outer solar system]," says Matt Holman of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. "It's still the case that the discovery of one or two new objects is changing our views."

SOLAR SYSTEM SPRAWL The outer solar system used to be such a simple place. Beyond Neptune lay Pluto, the ninth planet, and that, it seemed, was that. Although theorists had suggested since the late 1940s that the solar system's outer reaches contain an abundance of frozen, cometlike objects, it wasn't until 1992 that astronomers found the first members of this proposed population.

Scientists now divide the outer solar system into two distinct regions, both of which serve as reservoirs for comets. The Kuiper belt extends outward from the orbit of Pluto to about 70 times the Earth-sun distance, which defines an astronomical unit (AU). The pancake-shaped belt contains a population of some 100,000 objects, with about 1,000 known members. It is the source of Halley and other comets that visit the inner solar system at least once every 200 years. According to theorists, a second, more remote reservoir surrounds the Kuiper belt. This proposed reservoir, the Oort cloud, would be the home of longer-period comets.

The recent far-out discoveries include an object that is not only unusually big—about three-quarters the diameter of Pluto—but also spins faster than any other large body in the solar system. That object, called 2003 EL61, resides in the Kuiper belt, where it now orbits the sun at a distance of 52 AU.

In July 2005, scientists announced another find: the first member of the Kuiper belt larger than Pluto (*SN: 8/6/05, p. 83*). Dubbed Xena, the object has a diameter 1.5 times as great as that of Pluto, making it the largest body found in the solar system since 1846, when Neptune and its moon Triton were discovered. Astronomers are informally calling Xena the tenth planet, pending a final ruling by the International Astronomical Union.

Xena is now located 97 AU from the sun but spends most of its time in the Kuiper belt. Its path tilts 44° relative to the plane in which most planets orbit the sun.

Researchers recently found yet another large object in the Kuiper belt. Dubbed Buffy, the body is nearly as big as Pluto, astronomers announced on Dec. 13, 2005. Buffy's orbit has an even more extreme incline of 47°, Christian Veillet of the Canada-France-Hawaii Telescope on Mauna Kea and his colleagues report. That Kuiper belt object now is located 58 AU from the sun, or nearly twice as far from the sun as Neptune is.

Objects such as Xena and Buffy had eluded detection precisely because planetary scientists had concentrated their search for distant solar system bodies on objects orbiting in the same plane as the planets. Had a body as massive as Pluto resided in that plane, "we would have found it long ago," Brown says.

While Buffy, Xena, and 2003 EL61 all belong to the Kuiper belt, remote Sedna, whose orbit extends from 76 to 126 AU, may be the first known member of the Oort cloud. No other known solar system object has such a remote orbit.

Individually, each of these newfound objects tells its own story about the solar system's outlying regions. Collectively, the new discoveries—along with Pluto—speak volumes about planet formation throughout the solar system, says Brown. He and his colleagues, Chad Trujillo of the Gemini Observatory in Hilo, Hawaii, and David L. Rabinowitz of Yale University discovered or codiscovered three of the four newfound bodies.

With the spate of discoveries, Pluto is no longer an oddball. "Suddenly, we have all these [Plutolike] objects, and we can study how they appear at different temperatures and distances from the sun and at different sizes," says Brown. "We're getting a new window into planet formation."

FULL STORY Among the newfound objects, astronomers have gathered the most details about the Kuiper belt object 2003 EL61. Thanks to its record-breaking spin—it rotates once every 4 hours—along with observations of its moons, "we're learning more about this object and its internal structure than anything else out there," notes Brown.

When researchers discover a Kuiper belt object, they usually can't determine how big it is, only how bright. That's because a small object that reflects a lot of sunlight looks just as bright as a large object that reflects only a tiny amount. In the case of 2003 EL61, however, "we got lucky," says Brown.

Last summer, he and his colleagues discovered a moon orbiting the body. The orbit depends solely on the mass of 2003 EL61. By tracking the moon's orbit for 6 months, the researchers determined that 2003 EL61 has one-third the mass of Pluto.

But determining mass doesn't reveal the size of a body. It could either be small and dense, like rock, or large and porous, like ice. The rapid spin of 2003 EL61 provided the team with the answer.

Any extended object that spins becomes stretched like pizza dough tossed into the air, notes Brown. A high-density object elongates less than a low-density object does. Observations of 2003 EL61's varying brightness show that its longest axis is only about the same length as Pluto's diameter. Therefore, it must be as dense as solid rock.

Brown says, "Nothing else so large and so elongated or so quickly rotating is known anywhere in the solar system."

That's not all. Spectra recently taken by Brown and his colleagues with the Keck 1 Telescope atop Hawaii's Mauna Kea reveal that the surface of 2003 EL61 harbors an abundance of frozen water. Taken together, the spectra and rotational data suggest that the object resembles a "rocky, squashed football that's been sprayed with a frosting of water-ice," says Brown.

Fleshing out the story line, researchers have also obtained spectra of the moon. The spectra indicate that the moon is a chunk of pure water ice, matching the surface composition of its parent body.

The similarity suggests that the moon came into being when a giant impactor struck 2003 EL61 soon after it coalesced from the same swirling disk of dust, gas, and ice that swaddled the infant sun and gave birth to the planets. Such a collision would have knocked icy material off the frosty surface of 2003 EL61 to form a cloud of vaporized debris around the main body. Over millions of years, debris from the cloud would have reassembled into an icy moon. The same collision would also have increased the spin speed of 2003 EL61.

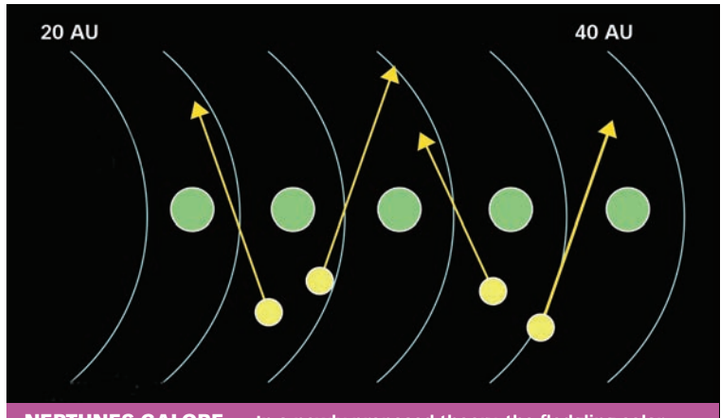
"It's a beautifully consistent story," says Brown. "As we get more detail with bigger and better telescopes, we'll learn even more about this object."

In a Nov. 29, 2005 circular of the International Astronomical Union, he and his colleagues announced that they had found a second moon orbiting 2003 EL61. Brown says that he's betting that spectra of the newly found moon will reveal that it's also a chunk of pure water ice.

KUIPER ENIGMAS Collisions must have been common in the Kuiper belt's early history. That's the only way to account for the abundance of moons, says theorist Martin Duncan of Queen's University in Toronto. Eleven percent of known Kuiper belt objects, including three of the four largest, have small orbiting partners.

These moons couldn't have formed recently, Duncan notes. The density of objects in the belt today is too low for collisions to happen often, and the relative velocity of objects is too high for fragments of colliding objects to stick together and form a moon.

The orbits of Kuiper belt objects also indicate a violent past. Many of them travel in highly elliptical paths inclined at large angles to the plane of the solar system. The only way theorists can account for these wayward trajectories is by assuming that direct collisions combined with close gravitational encounters between objects.



NEPTUNES GALORE — In a newly proposed theory, the fledgling solar system contained five Neptunes (green circles), crammed into a region that begins 20 times as far from the sun as Earth's orbit and extends to twice that distance. The interaction of these embryonic planets with Kuiper belt objects (yellow circles) helped to sculpt the outer solar system.

Several researchers argue that the Kuiper belt didn't form at its present location. In one scenario (*SN: 5/28/05, p. 340*), proposed early this year by Hal Levison of the Southwest Research Institute of Boulder, Colo., and his colleagues, the new-formed planets huddled in a space only half as large as the region that they occupy today. Just beyond this crowd resided a slowly orbiting band of ice, gas, and dust. The forerunner of the Kuiper belt contained 100 to 1,000 times as many inhabitants as the belt does today. As particles from this band leaked out both toward and away from the sun, their gravity influenced the orbits of the young planets. Jupiter moved inward, while Saturn, Uranus, and Neptune moved outward.

The migration proceeded slowly and steadily until Saturn had drifted into an orbit exactly twice as wide as Jupiter's. With the planets in this relationship, their mutual gravity caused Saturn's circular orbit to suddenly elongate. This pushed the orbits of Uranus and Neptune so far outward that they barreled into the band of gas, dust, and ice.

Debris in the band dispersed. Some of it slammed into the inner solar system, while a small percentage—perhaps one-hundredth of the original population—was flung out further, becoming today's sparsely populated but energetic Kuiper belt.

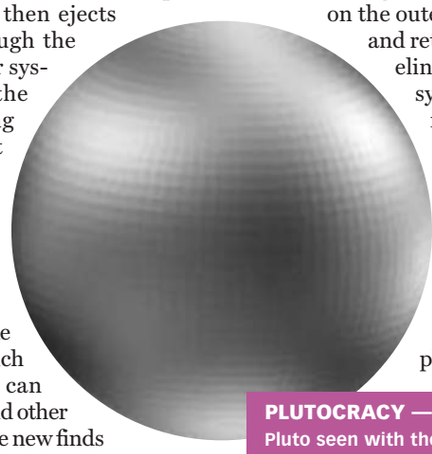
In an alternative model recently proposed by Eugene Chiang of the University of California, Berkeley and his colleagues, the newborn planets occupied about the same region of space as they do today. However, there were five Neptune-size planets instead of just one. That's the maximum number of Neptunes that could have coalesced from the amount of ice, dust, and gas particles that then inhabited the solar system's outskirts, notes Chiang.

CHIANG ET AL.

In this model, gravitational interaction among the five Neptunes stirs up their orbits, transforming them from circular to highly elliptical. In several million years, the paths become so elongated that they intersect the orbits of Saturn and Jupiter. The gravity of those two giant planets then ejects four of the Neptunes, which pass through the Kuiper belt on their way out of the solar system. Their passage wreaks havoc on the belt, depleting it of material and throwing into disarray the circular orbits of belt residents.

It's not yet clear how future observations could distinguish between Levison's and Chiang's scenarios. Both theories can account for nearly all the tilted, elliptical orbits of the Kuiper belt today.

However, Xena and Buffy stick out like sore thumbs. No theory, even one in which planets plow through the Kuiper belt, can explain such high tilts, notes Levison. He and other theorists are struggling to incorporate these new finds into their models.



PLUTOCRACY — Surface of Pluto seen with the Hubble Space Telescope. Pluto is no longer an oddball at the solar system's fringe. Several newly discovered objects have about the same size, mass, and orbit as it does.

A. STERN/SWRI, M. BUIE/LOWELL, NASA, ESA

FAR OUT Among the new finds, it's Sedna that Brown places "scientifically head and shoulders above everything else out there, as important a discovery as Pluto was in 1930."

Consider its orbit. The Kuiper belt ends at 70 AU, but Sedna gets no closer than 76 AU. "It's not part of the Kuiper belt and never comes back into the belt," says Brown.

To place Sedna where it is today, "there had to be something different about the solar system in the past," he notes. Sedna's presence suggests that that the sun, like many stars, was not born alone but in a dense cluster, says Duncan. Soon after this stellar nursery emerged, the sun and the other stars went their separate ways. By now, they would have moved so far apart that no hint of their common origin would remain.

Early on, however, during the first million-or-so years, the nearest sibling to the infant sun could have exerted a sizable tug on the outer solar system. That tug would have slowed and retained Sedna and perhaps other objects traveling rapidly outward at the fringes of the solar system, says Duncan. Without the pull of a neighboring star, these objects, flung outward by the gravity of the planets, would probably have sailed out of the solar system altogether.

That mechanism, some theorists argue, would have sculpted the entire Oort cloud. In this scenario, material originally residing between the orbits of Jupiter and Saturn was kicked outward by the gravity of these giant planets but remained within the outer reaches of the solar system, where the tug of passing stars and the mass of the Milky Way galaxy puffed the debris into a spherical cloud. Sedna may therefore belong to the inner part of the proposed Oort cloud, suggests Brown.

Moreover, by studying Sedna and hunting for other objects that may lurk beyond the Kuiper belt, astronomers may reconstruct the environment in which the sun flamed into existence.

Sedna provides "a fossil record of what happened at the birth of the solar system 4.5 billion years ago," says Brown.

Levison says that the distant object "provides the first clue about what kind of star cluster we were formed in." ■

(continued from page 24)

In the mid-1990s, the radar crew joined the Rothamsted Research team in Harpenden to conduct test flights.

In the early trials, people mimicked flying insects by bicycling in beelines and loops around a military base while carrying transponders mounted on poles. The radar tracked the cyclists and later picked up traces from real bumblebees carrying transponders. Smith and his colleagues announced the success of radar tracking for flying insects in 1996, and the group has since been taking a look at "flight patterns that we could never see before," says Rothamsted-team researcher Juliet Osborne.

For example, the group recently managed to track butterflies for the first time with the true-radar transponders. In the April 22, 2005 *Proceedings of the Royal Society B*, they reported two distinct flight patterns: great, loopy paths that an insect might use to get oriented and relatively linear flights that look more like beelines than the popular stereotype of butterfly meanderings.

With the same method, the researchers have also found that bumblebees are anything but bumbling. They can compensate for strong crosswinds without being blown off course, and they can fly an average of 7 meters per second, "much faster than anyone really expected," says Osborne.

Since Menzel began studying the tracks captured by radar, he's had to rethink some of his opinions about bees' mental powers. In 1986, when Princeton University's James Gould proposed that honeybees have a cognitive map and can figure out shortcuts from it, Menzel says, "I was one of those who rejected it."

However, he's now coming around to a similar idea of a maplike spatial memory in the insects. He tracked three groups of honeybees, all of which had flown from a hive to perform meandering survey missions over a flat, grassy field. Once the bees had this chance to learn about their turf, the researchers put bees from each group into dark boxes and moved them to a new area of the field. The team then used radar to track bees' flight paths.

TRAVEL LIGHT — Researchers have now managed to outfit even butterflies with small, sturdy, metal-tag devices for true radar.

ROTHAMSTED RESEARCH

At first, the insects searched around in different ways, but eventually they all set off on relatively straight routes either to their home or to a feeder, Menzel's group reported in the Feb. 22, 2005 *Proceedings of the National Academy of Sciences*. The bees were working out where they and their destinations were, by using a maplike memory of the locale, Menzel proposes.

While doing their experiments on bees flying to and from feeders, Menzel and his colleagues tested the communication power of the waggle dance, one of the most famous bits of honeybee science. Austrian biologist Karl von Frisch won a Nobel prize in 1973 for showing that a forager buzzes back into her hive and, through a dance, communicates the location of the food she's found.

Menzel and his colleagues let some bees discover a feeder and then return to dance the news to the rest of the hive. When newly informed bees started leaving the hive, the researchers captured them, affixed transponders, moved the recruits to a novel spot, and let them fly off. The bees flew the right distance in the right direction to where the feeder would have been had they started from the hive where they observed the original forager's dance, the researchers reported in the May 12, 2005 *Nature*.

"It was the first time one could directly see how [bees] used information," says Menzel.

Insect tracking has come a long way since his students used to bumble about on bee chases. ■

OF NOTE

ZOOLOGY

First maternal care filmed in squid

Cameras deep in the Pacific Ocean have unexpectedly recorded caring behavior by squid moms.

The remotely operated vehicle Tiburon has encountered five *Gonatus onyx* squids, each dragging along thousands of developing eggs, says Brad A. Seibel of the University of Rhode Island in Kingston.

Parental care was unknown among squids. In the most-studied species, mothers often lay eggs on the ocean bottom and leave the clutch to its fate. Getting details of deep-water squid family life has been tricky.

EGG BASKET Abundant eggs in a sack dangle from the arms of a female squid deep off the coast of California.

Tiburon found the offspring-caring mother squids at depths between 1,500 and 2,500 meters in Monterey Canyon off California's coast. Each *G. onyx* mother, which has a body length of about 14 centimeters, pulled 2,000 to 3,000 eggs behind her in a membrane sack almost as long as her body (*for video, see www.sciencenews.org/articles/20060114/squidmom.mpeg*). The eggs are sandwiched between the sack's inner and outer membranes, and the outer membrane attaches to hooks on the mother's arms. The females typically flare their arms once or twice a minute, as if flushing water over the egg mass to provide oxygen, says Seibel.

The females probably have to carry the eggs for months, which would encumber their swimming and raise the risk of getting caught by a whale or seal. The researchers show off their squid pictures in the Dec. 15, 2005 *Nature*. —S.M.

BIOLOGY

Sexual selection: Darwin does Jamaica

A study of Jamaicans dancing finds that some of Darwin's ideas about the evolution of animal courtship apply to people. Darwin himself suggested that dance has been shaped by sexual selection, an evolutionary process that favors showy traits, such as peacock tails, that attract mates. The trait doesn't have to boost survival and may even be detrimental to long life, but it has to say "sexy."

For dance to serve as an example of sexual selection, the performance has to reveal something about the innate physical quality of the dancer. To test for such hints, scientists turned to people in Southfield, Jamaica, who had been tested for physical symmetry in a long-term study by Robert Trivers of Rutgers University in New Brunswick, N.J. A controversial theory has argued that asymmetries, say in ear size, indicate developmental shortcomings that make the individual get sick more easily and reproduce less successfully than a symmetrical person.

William Brown and Lee Cronk of Rutgers and their colleagues used cameras to track laser reflectors fastened on people and then made 40 animations of young Jamaicans dancing to the same pop song (*see video at http://grail.cs.washington.edu/projects/dance-symmetry/index.html*). The animations didn't reveal the dancer. The researchers then asked 155 other young Jamaican men and women to rate how well the animated characters danced.

Observers ranked the dances most highly when the person behind the animations belonged to the high-symmetry group, Brown and his colleagues, including Trivers, report in the Dec. 22/29, 2005 *Nature*. So, a head-turning dance style may be a good way to choose a partner. —S.M.

TECHNOLOGY

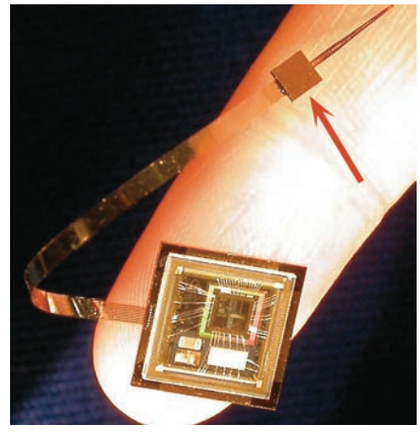
Hearing implant knows where it goes

Engineers out to improve the performance of cochlear implants have developed a version with sensors that may aid a surgeon in installing the device optimally.

Cochlear implants can restore hearing to people with deafness caused by damage to vibration-sensing cells (*SN: 12/10/05, p. 371*). The devices translate sounds into electric signals that travel to a narrow probe covered with electrodes. That probe, inserted into the coiled inner ear tube known as the cochlea, directly stimulates auditory nerve fibers.

When installing any cochlear implant, a surgeon threads its electrode-studded probe into the cochlea's inward-spiraling interior. The farther in that the electrodes go, the wider the range of frequencies that the listener can detect—and the better he or she will hear, says Kensall D. Wise of the University of Michigan in Ann Arbor. However, surgeons typically insert the probes so cautiously that the electrodes don't reach optimal depths.

A prototype implant developed by Wise and his Michigan colleagues Mayurachat Gulari and Jianbai Wang includes piezoelectric sensors in the probe. These sensors generate electrical signals in response to mechanical forces. The unusual microfabricated implant is also exceptionally slim and packs more electrodes onto its surface than conventional implants do.



SOUND SYSTEM Signals from sensors at one end of a new type of cochlear implant may help surgeons insert the probe (arrow) more deeply into the inner ear, producing improved hearing.

A sensor at the tip of the probe responds when it bumps the cochlear wall, so surgeons can make adjustments during insertion, Wise says. Signals from sensors along the probe indicate how coiled it has become and so reveal how far into the cochlea it has penetrated, he adds. A surgeon could therefore guide a probe deep into the cochlea while minimizing destructive contact with the channel's walls, says Wise.

Wang discussed the new implants, which are currently being tested in animals, at the IEEE International Electron Devices meeting last month in Washington, D.C. —P.W.

ARCHAEOLOGY

Stone Age Britons pay surprise visit

Scientists excavating ancient river sediment along England's southeastern coast have unearthed stone tools from roughly

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE; WANG ET AL./ IEDM

OF NOTE

700,000 years ago, the earliest evidence of human ancestors in northern Europe.

A team led by Simon A. Parfitt of University College London found 32 pieces of worked flint, including a cutting implement with a sharpened edge and a fist-size rock from which smaller, tool-size pieces had been hammered. These unexpected discoveries occurred near the village of Pakefield, Suffolk, and near the base of an eroding cliff that has been combed by fossil hunters for the past 200 years.

IN LIKE FLINT A 700,000-year-old flint tool found in southeastern England features a sharpened edge.

Fossils of extinct animals found near the artifacts, as well as measurements of Earth's magnetic field within the sediment, guided the scientists' age estimate. Remnants of cold-averse animals, insects, and plants in the tool-bearing deposit further indicate that a warm, Mediterranean climate prevailed there 700,000 years ago, the researchers report in the Dec. 15, 2005 *Nature*. At that time, a land bridge connected England to northwestern Europe.

The Pakefield finds show that human ancestors reached northern and southern parts of Europe at around the same time, remarks John McNabb of the University of Southampton in England. Other researchers previously uncovered remains of *Homo* species that inhabited Mediterranean areas, such as Spain and Italy, by at least 800,000 years ago. Until now, the earliest evidence of human ancestors in England dated to about 500,000 years ago.

Faced with a climate that fluctuated dramatically every few thousand years, our evolutionary forerunners probably spread northward during warm times and retreated south during cold phases, says University College's Anthony J. Stuart, a coauthor of the new study. —B.B.

SCIENCE & SOCIETY

Fattening fears

The more concerned parents are about neighborhood safety, the more likely their youngsters will be overweight, a new study finds.

When pediatrician Julie C. Lumeng was working at an inner-city clinic in Boston, parents of overweight children often told her, "I can't send my kids out to play because it's not safe. There's too much crime," she recalls. The new study "grew out of that experience," explains Lumeng, now at the University of Michigan in Ann Arbor.

Her team randomly selected families of 768 first graders from 10 locations around the country who were part of a long-running federal study on child health. The children were divided into four groups on the basis of their parents' ratings of safety-related issues such as neighborhood crime, police presence, and drug-related activity.

Of the children whose parents had ranked their neighborhoods least safe, 17 percent were overweight, compared with just 4 percent of youngsters whose parents had the fewest reservations about local safety, the researchers report in the January *Archives of Pediatrics & Adolescent Medicine*. This trend held for all demographic groups, including children from upper-income families.

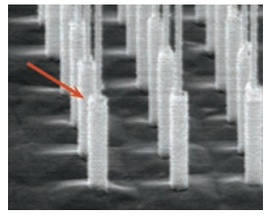
The supposition, she says, is that parents' safety concerns lead to kids being cooped up indoors where the opportunity for exercise is limited and food is easily accessible. —J.R.

TECHNOLOGY

Transistors sprout inner forests

Nanotechnologies for electronics come along all the time, but they're typically far from ready for the factory floor. Now, independent teams of researchers in Sweden and in Korea have combined a promising nanotechnology with conventional microelectronics to create novel transistors that perform better than most and that are expected to be easy to manufacture.

At Lund University in Sweden, Lars-Erik Wernersson and his colleagues have made transistors in which a solid layer of material is replaced by an airy forest of nanowires (*SN: 5/22/04, p. 325*). Sheathing the lower third of each nanowire with a control electrode yielded transistors that waste less power than conventional designs do, says Lund team leader Lars Samuelson.



WIRY ALLY Arrays of nanowires can boost transistor performance. Sheathlike control electrodes (arrow) enclose the lower portions of these indium arsenide nanowires.

The nanowire forests can be made of high-performance semiconductors, such as indium arsenide. Incorporating that material boosts transistor speeds above what's possible with ordinary semiconductors such as silicon.

Advances in methods for growing nanowires promise to make the transistors easy to manufacture, Samuelson adds.

Wernersson described the new nanowire transistors last month at the IEEE International Electron Devices Meeting in Washington, D.C.

At that same meeting, researchers from Samsung Electronics in Yongin City, Korea, unveiled a prototype transistor based on just two silicon nanowires. The engineers claim that the new transistor is "highly manufacturable." —P.W.

BIOMEDICINE

Musical therapy for sounder sleeping

Among the most distinctive sounds of Australian aboriginal music are the low drones of didgeridoos—long instruments made from termite-hollowed tree limbs. Alex Suarez, a Swiss didgeridoo instructor, noticed that since taking up the instrument, he and his students experienced less daytime sleepiness and nighttime snoring. A study by Suarez and Swiss sleep scientists now concludes that playing such wind instruments may be therapeutic to individuals plagued by sleep problems.

In people with obstructive sleep apnea, breathing repeatedly stops for 10 or more seconds throughout the night. This can foster snoring, reduce sleep quality, and double the risk of stroke or premature death (*SN: 11/26/05, p. 349*).

A group of adults with a long history of loud snoring and mild apnea was given didgeridoo lessons. During the 4-month trial, the 14 volunteers practiced 25 minutes per day, 6 days a week, on acrylic instruments. Another 11 volunteers served as controls.

The didgeridoo players experienced a drop in sleep apnea, daytime sleepiness scores, and other measures of disordered sleep, says Otto Brändli of the Zürcher Höhenklinik Wald in Faltigberg-Wald, Switzerland. Benefits compared favorably with those of conventional treatment using machines called CPAP, which deliver, via plastic masks, continuous positive airway pressure to sleepers. Brändli and his colleagues report their finding in an upcoming *British Medical Journal*.

Didgeridoo playing appears to work by strengthening muscles in the upper airway, from the back of the mouth through the larynx, Brändli says. A periodic collapse of this airway underlies sleep apnea. —J.R.

NATURAL HISTORY MUSEUM; WERNERSSON ET AL./IEDM

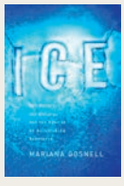
Books

A selection of new and notable books of scientific interest

ICE: The Nature, the History, and the Usage of an Astonishing Substance

MARIANA GOSNELL

As a material, ice is a study in contradictions. It is at once as fragile as glass and stronger than steel, both solid and liquid, easily melted yet persistent in glaciers and ice flows that cover 7 percent of Earth. Gosnell, a former reporter, explores the many faceted nature of the frozen form of Earth's most valuable substance. She explains the formation of ice in our atmosphere, from a single, perfect snow crystal to a large, destructive hailstone. She reveals what extracted ice cores can tell scientists about ancient atmospheric conditions. And she examines the nature of icebergs, including the most famous one of all, the killer that doomed the *Titanic*. Gosnell finds a remarkable variety of ways to look at frozen water, from detailing dangerous breakups of frozen rivers to explaining how seals and emperor penguins make their homes on solid ice. The author offers a poetic picture of this strange material. ***Knopf, 2005, 576 p., hardcover, b&w plates, $30.00.***



MOUNTAINS FROM SPACE: Peaks and Ranges of the Seven Continents

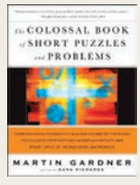
STEFAN DECH, REINHOLD MESSNER, RÜDIGER GLASER, AND RALF-PETER MÄRTIN

The lofty peaks of Earth's most majestic mountain ranges have traditionally been accessible only to the most daring and capable of climbers. But modern remote-sensing technology and digital imaging enable readers of *Mountains from Space* to take a virtual journey to the tops of such giants as Kilimanjaro, the Alps, Mount Everest, and K2. The book features breathtaking, full-color images of each continent's most famous mountain ranges captured from as far as 500 miles to as close as 15 miles, offering a unique, unobstructed perspective of Earth's surface. Accompanying these images is in-depth commentary by scientists who study these ranges and their glaciers. They consider what mountains can tell us about Earth's geologic past and future. Also included are essays by such notable mountaineers as Reinhold Messner and Sir Edmund Hillary, who have firsthand experience with being on top of the world and whose reverence for these mountains, through these magnificent images, can be understood. ***Abrams, 2005, 244 p., color photos, hardcover, $50.00.***

THE COLOSSAL BOOK OF SHORT PUZZLES AND PROBLEMS

MARTIN GARDNER

Gardner's "Mathematical Games" column for *Scientific American* has challenged and befuddled legions of readers for more than 25 years. Gardner has deftly and entertainingly explained concepts such as probability, combinatorics, physics, and geometry through his recreational mathematics. Collected here for the first time are 340 puzzles that highlight the best of Gardner's column. Arranged by subject and prefaced by short introductory notes, the puzzles range from algebraic problems such as "Was Fermat Wrong?" a puzzle challenging Fermat's last theorem, to "Inverting a Triangle," which asks the reader to calculate the minimum number of coins that must be shifted to invert a triangle of 10 pennies. These and many other puzzles, ordered from simplest to most difficult, include detailed solutions. This guide will appeal to both the amateur and professional mathematician. ***Norton, 2005, 704 p., b&w illus., hardcover, $35.00.***



SECRET WEAPONS: Defenses of Insects, Spiders, Scorpions, and Other Many-Legged Creatures

THOMAS EISNER, MARIA EISNER, AND MELODY SIEGLER

Though small, insects and their relatives dominate Earth in sheer number. Over time, insects and other arthropods have employed various means of defense that have allowed for their evolutionary success. This guide focuses on 69 arthropods, mostly from North America, and investigates their defense mechanisms, be they chemical, behavioral, or morphologic. Each chapter is devoted to a different creature, from the aptly named vinegaroon to the stinging honeybee, and includes both the common and scientific names, an in-depth description of their weapons of choice, and color photos of the arthropod in action. The authors, professors at Cornell and Emory Universities, also provide detailed advice on how to study insect defenses. The book is a useful guide for both students and experts. ***Harvard, 2005, 384 p., color photos, hardcover, $29.95.***

WARPED PASSAGES: Unraveling the Mysteries of the Universe's Hidden Dimensions

LISA RANDALL

Extra dimensions, wormholes, and parallel universes may sound like science fiction, but they are concepts being considered by physicists as a way to explain the mysteries of the universe. Randall, a theoretical physicist at Harvard University, explains in clear and accessible language the experiments scientists have done to test the standard model of particle physics, which explains the fundamental particles of matter and the forces between them. Before diving into the more complex ideas behind string theory, the author provides an overview of early 20th-century physics, including the key ideas behind relativity and quantum mechanics. She then tackles the more speculative and exciting theories that scientists began only recently to consider, including the notion of small, curled-up extra dimensions and infinite braneworlds that are undetectable in our three-dimensional universe. Overall, Randall provides an excellent primer to the most elusive and groundbreaking concepts of modern physics. ***HarperCollins, 2005, 499 p., b&w illus., $27.95.***

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LETTERS

Alcohol calculus

"A toast to thin blood" (*SN: 11/12/05, p. 317*) says, "the blood of people who consume 3 to 6 drinks weekly was less likely to clot in a test tube than was the blood from nondrinkers." I wonder if there is a rebound effect that could make the blood of new abstainers even more likely to clot than that of regular nondrinkers. In other words, if one abruptly stops drinking, is that a temporary added risk?

TOM PASKAL, MONTREAL, QUEBEC

This is an interesting idea, but it is not one that the authors of the current study pursued. —C. BROWNLEE

Albedo: Abetted or abated?

"Runaway Heat" (*SN: 11/12/05, p. 312*) makes the point that shrub intrusion into tundra reduces albedo, the percentage of reflected light, but doesn't report actual impact on ground temperature. Albedo itself is not a good indicator of waste heat. Much of the extra absorbed sun energy is used by the shrubs for photosynthesis and the fixing of carbon and thus is unavailable for heating the environment. I hope this detail was addressed in the field experiment with accurate ground and ambient-air temperature measurements. The effect of the albedo alone may not tell the whole story.

BOB PETTIT, CORVALLIS, ORE.

Some experiments suggest that even though the shrubs sequester carbon, the soil beneath loses even more, resulting in a net loss of carbon. —S. PERKINS

Flying spaghetti mastered?

I would venture to suggest the reason that the pasta-fragmentation process stops ("That's the Way the Spaghetti Crumbles: Physicists solve a vexing kitchen puzzle," *SN: 11/12/05, p. 315*). Once the strand breaks, it becomes x number of new strands, each of which is still vibrating at some residual frequency and amplitude. The mass, diameter, and length of each resultant strand might determine the wavelength and amplitude necessary to break it. If a strand has gotten small enough that the amount of energy contained by the frequency and amplitude of the residual vibration are too low to cause enough stress on the strand, it doesn't break. My wife has put me on notice that any further experimentation is strictly off limits in the kitchen, so I will leave the mystery to the experts.

JIM LONGLEY, ALLEN, TEXAS

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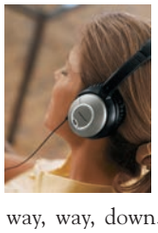

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