SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SEPTEMBER 27, 2003 PAGES 193-208 VOL. 164, NO. 13

coming soon: video on paper

whaling pressures sea lions

post-columbia fallout

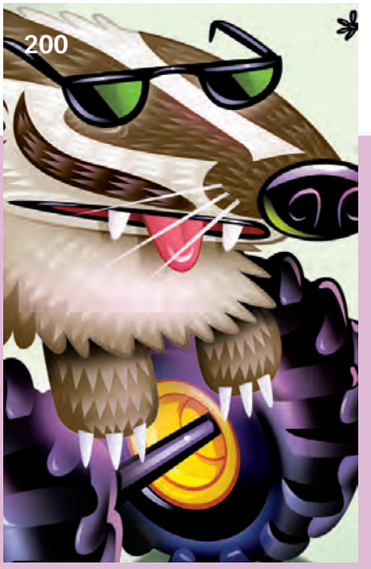
rotavirus on the ropes

www.sciencenews.org

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SCIENCE NEWS

SEPTEMBER 27, 2003 VOL. 164, NO. 13



Features

This Week

Meetings

Departments

Cover The snake is too narrow to stay in a collar; the respirator helmet doesn't fit the iguana; the bird pecks off its identification band. What's an experimentalist to do? Animal-behavior research demands creativity. (Dean MacAdam) Page 200

THIS WEEK ONLINE
www.sciencenews.org

Sweet risks Long-term trends confirm that sugary drinks are fostering cavities in children's teeth. See Janet Raloff's Food for Thought.

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.

Science News is published by Science Service, a nonprofit corporation founded in 1921. The mission of Science Service is to advance the understanding and appreciation of science through publications and educational programs. Visit Science Service on the Web at www.sciserv.org.

The Daily Flicks

Morphing ink may bring video to newspapers

Imagine opening the newspaper and seeing a full-color, video clip of a battle or sports match. That's the sort of vision that drives developers of electronic paper. Even though a black-and-white version that can display static images remains in development, two new approaches offer the prospects of video and bright color.

Electronic paper is a display technology akin to conventional paper but in which the words and images can be changed at will (*SN: 6/20/98, p. 396*). Until now, most developers have rolled out prototypes that rewrite images too slowly for video.

Among many e-paper schemes is that of E-Ink of Cambridge, Mass. The company encloses white and black particles inside an array of liquid-filled microspheres. Electrically controlled spheres collectively serve as a pixel in an image. A voltage across a microsphere induces the particles to migrate in opposite directions so that one face of the sphere becomes black and the other white. Reversing the voltage flips the pixel to the opposite configuration.

In the Sept. 25 *Nature*, Robert A. Hayes and B. Johan Feenstra of Philips Research in Eindhoven, the Netherlands, describe a new type of e-paper pixel. It looks dark when covered by a thin film of colored oil. But when a voltage sweeps the oil into a corner, a bright white surface appears. Pixels one-quarter millimeter on a side can switch between dark and light in less than 15 milliseconds—fast enough for standard video signals.

By building a more complicated pixel structure that includes filters and multiple oil layers, the researchers have made elements of e-paper that can generate a wide range of colors with exceptional brightness.

Although the display depends on liquid spreading over surfaces, it's stable against tipping or jarring, notes Hayes. That's because the fluids are held in place by capillary forces that overpower gravity and other mechanical forces.

Claiming to have already tested the same technology, physicist Joseph M. Jacobson of the Massachusetts Institute of Technology and a cofounder of E-Ink, remarks that the Philips technology harbors a serious flaw: The pixels require continuous power to maintain an image because the oil recoats the pixel surface as soon as the electricity is shut off. Consequently, batteries might run down quickly.

The power issue is a real one, Hayes acknowledges, but it's most problematic for static images, which last for seconds or longer. He says, "We're focusing on video-speed applications, where we have to [repeatedly and rapidly] refresh the screen, anyway."

By next spring, Jacobson says, E-Ink will probably unveil its own full-color e-paper that can change fast enough for video. Unlike the approach that the Philips' team is taking, the E-Ink technology consumes no power when the image is static, Jacobson says.

Last week at the International Display Research Conference in Phoenix, a Canadian research team reported yet another potential way to achieve color video on e-paper. This one relies on particles that move through a liquid. The distance the particles need to migrate is only a small percentage of the distance required in E-Ink's microsphere technology. Shorter distances translate into faster switching, a key to creating moving images, says team leader Lorne A. Whitehead of the University of British Columbia in Vancouver.

The video e-paper race is on. Paul S. Drzaic, former director of technology at E-Ink and now with Alien Technology in Morgan Hill, Calif., says that which players come out on top will depend on "how well they solve the problems that always pop up." —P. WEISS

Killer Consequences

Has whaling driven orcas to a diet of sea lions?

From the 1970s to the 1990s, populations of sea otters and some pinnipeds, including Steller sea lions and fur seals, took a mysterious nosedive in the northern Pacific. A new study floats a surprising explanation: These creatures became choice entrées for killer whales after industrial whaling wiped out the great whales that killer whales had been eating.

A leading explanation for the disappearing pinnipeds had been that global warming or overfishing caused food shortages, says Alan M. Springer of the University of Alaska in Fairbanks. But several recent reviews of sea lions and their habitats indicate that these animals are not wanting for food. That observation spurred Springer and his colleagues to investigate whether the problem lies with pinnipeds themselves becoming food. The scientists present their hypothesis in an upcoming *Proceedings of the National Academy of Sciences*.

Killer whales eat a wide range of ocean critters, from salmon to sperm whales. Although marine biologists debate about how often great whales end up on an orca's platter, they agree that killer whales are the most significant natural predators of these massive cetaceans.

Except, of course, for people.

Using data collected by the International Whaling Commission, Springer's team sur-

B. CHRISTMAN/NOAA

SNACK FOOD The decline of the Steller sea lion may have resulted from killer whale appetites.

mised that by 1969, whalers essentially wiped out the fin, sei, and sperm whales within 370 kilometers of the Aleutian Islands and the Gulf of Alaska coast.

Then, the numbers of smaller marine mammals began declining, Springer says. The harbor seal population crashed in the late 1970s. In the following years, fur seals and Steller sea lions disappeared in droves. In the 1990s, sea otter numbers plummeted.

Those trends point to killer whales, says Springer. He proposes that these spry predators would first hunt the fat, docile harbor seals. Once those prey dwindled, orcas would settle for the smaller fur seals and aggressive sea lions. Finally, killer whales would snack on otters. In what may be a further iteration of this ecological cascade, sea urchins—a favorite food for otters—have thrived (*SN: 10/17/98, p. 245*).

"Monkeying around with the system could lead to things you would have never predicted would happen," Springer says.

By estimating the number of otter and pinniped deaths during the declines and determining how many of these creatures would be required to feed a killer whale, Springer and his colleagues calculated that the population crashes could have occurred even if the orca population had shifted its diet less than 1 percent.

"I think it's the best hypothesis out there" for these declines, says Jeremy B.C. Jackson of the Scripps Institution of Oceanography in La Jolla, Calif.

Andrew W. Trites of the University of British Columbia in Vancouver questions whether great whales ever constituted major portions of orcas' diets. He adds that in computer models of marine ecosystems, removing great whales had no significant effect on pinnipeds.

Springer acknowledges that the mystery of these declines may be hard to solve with confidence, since much of the relevant data disappeared with the missing animals. —K. RAMSAYER

Galileo's Demise

A planetary plunge, by Jove

GRAND FINALE Depiction of Galileo plowing into Jupiter near the planet's equator.

JPL/NASA

The Galileo spacecraft ended an 8-year tour of Jupiter and its moons on Sept. 21, when it dove into the planet's atmosphere, as scientists had planned. Minutes after the craft disintegrated, Earth received Galileo's swan song, a radio signal suggesting that rocky debris lies along the orbit of the small Jovian moon Almalthea.

During its sojourn, Galileo overcame several obstacles, notably the failure of a main communications antenna. The craft took the first close-up portraits of Jupiter's four largest moons: Io, Ganymede, Europa, and Callisto. In 1995, a Galileo probe parachuted into Jupiter. Data from several flybys of Europa suggested that the icy moon hides a vast ocean.

That finding ultimately dictated how Galileo would die. To make sure that the aging craft wouldn't crash into a body that might harbor life, scientists 2 years ago put Galileo on a collision course with the planet it had explored so intimately. —R. COWEN

Faulty Memory

Long-term immunity isn't always beneficial

Come down with a case of chicken pox and, after you recover, your body seems to wear an invisible suit of armor that protects you from getting the disease again. Catch a cold, on the other hand, and the protective armor seems to fall away quickly.

Common sense indicates that the longer your immune memory lasts, the healthier you will be. Now, a mathematical model indicates that there may be a good reason that you quickly lose your protection against the sniffles. The endless succession of colds that results may protect you from far nastier bugs.

When a person becomes infected by most pathogens, the immune system instantly goes on the attack. After the infection is vanquished, the immune response subsides, but not all the way down to its original level. Long-lived sentries called memory cells remain ready to pounce if the bug reappears.

Dominik Wodarz of the Fred Hutchinson Cancer Research Center in Seattle has considered a scenario in which two different pathogens—call them A and B—threaten a host population. He assumed that pathogen A is far more deadly to its host than pathogen B is. Pathogen B, he also assumed, is fitter than pathogen A, meaning that if the two pathogens in the host have to compete for resources on an even playing field, pathogen B will win out.

If an individual becomes infected with pathogen B, the immune system will create memory cells against B, but that will tilt the playing field in A's favor. This makes the host vulnerable to the more virulent A. Thus, long-lasting memory of pathogen B can actually work against the health of the host.

Wodarz carried out calculations showing that, in this scenario, the host population will indeed evolve toward a short immunological memory of pathogen B infections. He reports his findings in the Sept. 16 *Current Biology*.

"Wodarz' paper suggests that the naive assumption—that the longer memory lasts, the better—may be wrong," says Charles Bangham, an immunologist at Imperial College in London.

Over the long term, Wodarz says, a host population would probably cycle between long and short immune memory. In the above scenario, for instance, once the host population evolved to have a short memory of pathogen B, pathogen A might become extinct. That would eliminate the competition and permit the host's memory of pathogen B to gradually lengthen. Eventually, the door would open for another pathogen like A to spring up, and the cycle would begin again.

The findings could have important pub-

lic health implications, Wodarz says, since vaccines are essentially humanmade immune-memory boosters against diseases. "If you vaccinate a population, it may backfire and allow the invasion of pathogens that are more virulent," he says.

However, he notes, it would be hard to test this hypothesis in people, since epidemiological studies of immune memory are difficult and slow. "It is hard even to measure the duration of memory in a controlled way," Wodarz says. "You have to identify when a person is infected, then draw blood every year."

For now, mathematical modeling may be the best way to gain insight into the duration of immune memory, says Derek Smith, a computational biologist at the University of Cambridge in England. For instance, he says, it would be interesting to figure out time scales on which a population would cycle between short and long memory.

The current study is a good start, Smith says. "It's a very sound and well-worked-out analysis." —E. KLARREICH

Letting the Dog Genome Out

Poodle DNA compared with that of mice, people

Chihuahuas, Irish wolfhounds, pit bulls, beagles, greyhounds, and more. Man's best friend comes in a range of sizes, shapes, and temperaments unmatched by any other mammalian species. Biologists have now taken a step toward understanding that diversity by conducting a limited, but relatively quick and inexpensive, scan of one dog's full DNA sequence, or genome.

The data from this scan should ultimately help researchers study the more-than-300 human diseases, such as cancer and epilepsy, that also afflict dogs. The new work has already enabled scientists to compare the mouse, dog, and human genomes.

"The sequence of our genome is more similar to the dog's, despite the fact that the dog lineage split off first from the common ancestor" of all three mammals, says Ewen F. Kirkness of The Institute for Genomic Research (TIGR) in Rockville, Md., who led the dog-genome project. The rodent's unusually high mutation rate has made its DNA diverge more from people's than the dog's DNA has, he explains.

In the strategy pursued by Kirkness' team, biologists isolate copies of an animal's genome and break the strands of DNA into millions of short fragments. After determining the sequence of nucleotides making up each such piece of DNA, biologists use a computer to match overlapping sequences and piece together as much of the animal's full DNA sequence as possible. The more DNA analyzed, the better the chance that the final genome sequence will be accurate and have few gaps. For the human and mouse genomes, geneticists sequenced fragments equaling 6 to 10 times the DNA in the actual genome of each.

The National Institutes of Health in Bethesda, Md., is sponsoring a similarly thorough dog-genome project, but Kirkness and his colleagues wondered whether they could glean important information from a substantially smaller amount of DNA. If so, researchers might then consider sequencing the genomes of one animal from each of the 18 orders of mammals.

In the Sept. 26 *Science*, Kirkness and his colleagues describe their survey of the dog genome. They ultimately sequenced DNA equal to only 1.5 times the genome. From that work, they determined 77 percent of the dog genome and found canine DNA fragments corresponding to 18,473 of the 24,567 previously documented human genes. "We got more than we expected," says Kirkness.

The newly available dog genome is "just a wonderful resource," says Gustavo D. Aguirre of Cornell University.

The canine DNA analyzed came from a male standard poodle belonging to two of the coauthors on the new report, TIGR's Claire M. Fraiser and J. Craig Venter of The Center for Advancement of Genomics, also in Rockville. That selection isn't surprising given that Venter used his own DNA when his former company, Celera, performed its commercial sequencing of the human genome (*SN: 5/23/98, p. 334*). NIH's dog-genome project, scheduled to finish next year, uses DNA from a boxer. —J. TRAVIS

A Soft Touch

Imaging technique reveals hidden atoms

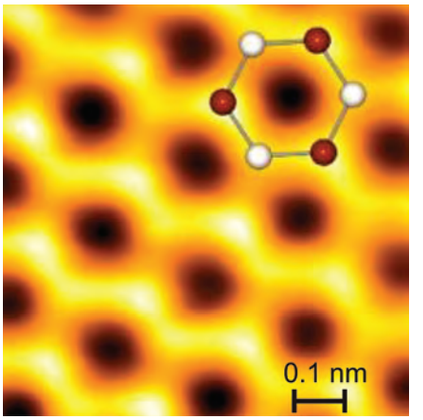
One of today's celebrity scientific instruments, the atomic force microscope (AFM), is valued despite some quirks. Famous for rendering atoms visible, it can also be blind.

That shortfall has been particularly glaring when it comes to graphite. AFM images reveal only three of the six carbon atoms in each of the material's basic hexagonal units. In an upcoming *Proceedings of the National Academy of Sciences*, a team of German physicists describes how it solved that problem. The advance may lead to techniques to image biological materials, the physicists say.

In graphite, the hexagonal units fuse into sheets resembling miniaturized chicken wire. Loose connections between these sheets make graphite soft; it's these sheets that a pencil leaves behind on paper. When intact, the sheets stack such that every other carbon in each ring rests directly above a carbon in the sheet below. These are known as alpha atoms. The other carbons, called beta atoms, have nothing directly underneath.

When the AFM's cantilever tip passes over the graphite, it gently tugs on each carbon atom but can detect the attractive forces only between the tip and the beta atoms. That's because electrons in the alpha atoms overlap with those of the atoms below, restricting interactions between the electrons and the AFM tip. In contrast, the less-fettered electrons of the beta atoms show up in AFM images.

Jochen Mannhart and his colleagues



HIDE-AND-SEEK **New technique shows all six atoms of graphite's basic structural unit.**

S. HEMBACHER ET AL.

at the University of Augsburg in Germany modified their AFM to measure repulsive forces instead of attractive ones. The tip pushes down on each atom "like an atomic braille system," explains Yip-Wah Chung at Northwestern University in Evanston, Ill.

The researchers needed to make sure the AFM tip wasn't pushing down on the graphite surface too forcefully. "Otherwise, the carbon [atom] will disappear inside the material," says Mannhart.

As the tip approaches a carbon atom, the electron clouds and the tip repel each other, changing the cantilever's vibration frequency. In this mode, both alpha and beta atoms become visible.

The procedure is slow. To prevent subtle motions in the sample and instrument that would blur the images, the measurements must be carried out at just a few degrees above absolute zero.

Other types of microscopes can image hard, electrically conducting materials with atomic resolution, but soft, nonconducting materials such as graphite and biological molecules have been difficult to image.

To probe DNA and proteins, says Northwestern's Mark Hersam, the German tech-

nique needs to be modified so that it works at much warmer temperatures that preserve the samples' biologically relevant structures. —A. GOHO

Origins of Smelting

Lake yields core of pre-Inca silver making

According to 16th-century Spanish accounts, an Incan ruler who reigned nearly 600 years ago discovered Cerro Rico, a major silver deposit in southern Bolivia's Andes Mountains. More recently, archaeological discoveries have documented the Incas' extensive efforts to mine silver ore and extract the precious metal in smelting operations.

It now appears, however, that the Incas were latecomers to silver production. A thriving silver industry existed in southern Bolivia about 1,000 years ago, according to a new study. Four centuries before comparable Incan operations, Bolivia's Tiwanaku culture probably launched silver mining at Cerro Rico and the large-scale smelting of silver ore, say Mark B. Abbott of the University of Pittsburgh and Alexander P. Wolfe of the University of Alberta in Edmonton.

The two geologists extracted a sediment core from a lake near Cerro Rico and measured concentrations of five metals associated with smelting. "Our data imply that several thousand tons of silver were produced in pre-Incan times," Abbott says.

He attributes the scarcity of silver artifacts in Bolivia dating back a millennium to a combination of looting at archaeological sites, transport of silver elsewhere in the Americas as a trade item before the Spanish conquest, and export of silver overseas by the Spanish after conquest.

The ratio of metals such as silver, lead, and antimony in the lake core indicates whether smelting occurred, and radiocarbon analyses provided age estimates for soil layers in the core. Cerro Rico ores were smelted from A.D. 1000 to A.D. 1200, a period ending close to the time that Tiwanaku society collapsed, the researchers conclude in the Sept. 26 *Science*.

Silver smelting declined markedly for the next 2 centuries, they say. From A.D. 1400 to A.D. 1650, the practice again flourished, first among the Incas and then their Spanish conquerors.

The new findings on early silver production support the view that Tiwanaku society grew considerably around 1,000 years ago, shortly before severe drought contributed to its breakup, remarks archaeologist Alan L. Kolata of the University of Chicago. Kolata directs an ongoing excavation of the Tiwanaku capital on Bolivia's western border.

That project has unearthed many silver artifacts, including ceremonial masks, rings, and tubes packed with pigment. Kolata finds it "somewhat surprising but plausible" that Tiwanaku society produced thousands of tons of silver, as Abbott and Wolfe contend.

"The [new] estimate of the tonnage of silver produced prior to Inca involvement . . . is remarkable," comments archaeologist Heather Lechtman of the Massachusetts Institute of Technology. However, the latest archaeological evidence indicates that Tiwanaku society collapsed between A.D. 900 and A.D. 950, before the proposed start of silver production, she says.

Archaeological investigations under way in central and southern Bolivia need to identify other early cultures that may have initiated silver mining and smelting, Lechtman holds.

Analyses of metal concentrations in other Bolivian lakes will also prove crucial in disentangling the origins of silver production, Abbott says. —B. BOWER

Breathless

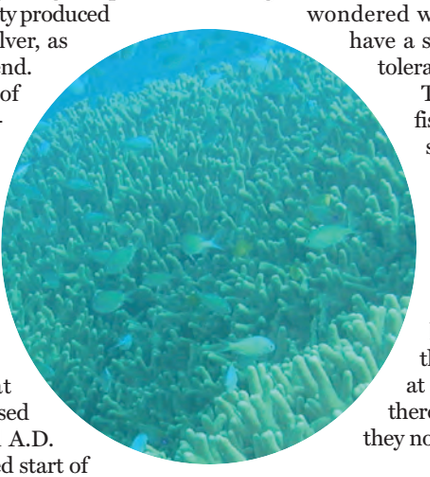
Reef fish cope with low oxygen

Despite their seemingly idyllic surroundings, coral reef fish show unexpected toughness, according to a new analysis of fish respiration.

In the first tests of low-oxygen tolerance among reef fish, all 31 species captured off the coast of Australia did surprisingly well, says Göran E. Nilsson of the University of Oslo. The reef fish matched the performance of the epaulette shark, famed for surviving oxygen drops in tide pools cut off from the surf, Nilsson and Sara Östlund-Nilsson report in an upcoming *Proceedings of the Royal Society of London B*.

When respiration physiologists look for adaptation to low oxygen, they poke around in still waters, such as swamps and tide pools, says Nilsson. But coral reefs? "It's not something that most people have bothered about," he says. Plenty of churning there should mix the seawater well enough to avoid oxygen drops.

Nilsson didn't think to look for low-oxygen tolerance at reefs until he began to observe mouth brooding in cardinalfish around Lizard Island on Australia's Great Barrier Reef. A male of these small reef fish takes a female's egg mass, sometimes a quarter of his body weight, into his mouth for a week or two, until the eggs hatch. Since the egg mass might inhibit water flow through the mouth to the gills, Nilsson wondered whether these fish have a special capacity to tolerate low oxygen.



REEF REFUGE **It may look like paradise, but have the fish hiding among these coral spikes adapted to an oxygen shortage?**

NILSSON

To test the cardinalfish, the researchers sealed them temporarily in containers with seawater and a sensor for oxygen concentration. Many organisms keep consuming the available oxygen at a steady rate until there's so little left that they no longer metabolize normally. The cardinalfish surprised Nilsson by breathing steadily until the oxygen concentration had dropped to 20 percent of its normal concentration.

At first, Nilsson says, he thought he'd found especially low oxygen tolerance in cardinalfish. For comparison, he decided to test reef fish that don't carry broods in their mouths. Surprisingly, he says, all the species he caught showed low-oxygen tolerance.

Data by other researchers show that some freshwater fish such as trout proved only half as tolerant of low oxygen as the reef fish did. The most tolerant of swamp fish require only a little less oxygen than the most tolerant of the reef fish do. Nilsson notes that no one has made comparable measurements on ocean fish away from reefs.

Perhaps reef fish hide in low-oxygen culde-sacs of coral, Nilsson speculates. In lab measurements, he found that those pockets can have oxygen concentrations below 20 percent of saturation.

Physiologist Jeff Graham of the Scripps Institution of Oceanography in La Jolla, Calif., says that plenty of questions remain. He'd like to see comparisons between fish that hide in reef nooks and those that don't. —S. MILIUS

LEASHING THE RATTLESNAKE

A behind-the-scenes look at experimental design

BY SUSAN MILIUS

Depending on how you look at them, snakes have no neck or nothing but neck, and either way, Ron Swaisgood had a problem. To finish his Ph.D. at the University of California, Davis he had to figure out how to put a rattlesnake on a leash. Obviously, dropping a slipknot around the snake's neck wouldn't do. Swaisgood's research project required that the snake comfortably slither, coil, and strike but still be tethered tightly enough that there was no chance it could escape.

Swaisgood eventually developed a great snake leash, finished his degree, and proceeded to his current job at the San Diego Zoo. The scientific paper based on the research just says he tethered the snake and then goes on to describe the ways that ground squirrels assess snakes as threats (*SN: 10/9/99, p. 237*). The leash joined thousands of other little unsung triumphs of creativity in experimental design that don't usually show up in scientific articles—or reports in *Science News*. Ask for the details, though, and another side of research appears. Here, many biologists say, is a lot of the fun.

Experimental science demands creativity in solving problems great and small, and the study of animal behavior makes a dramatic showcase for the process. Animals clearly have minds of their own, and to elucidate such foreign perspectives, researchers have to design cleverly, from the basic strategy of the experiment to dozens of lesser details. The traditions of animal behavior celebrate do-it-yourself flair, and experiments mix the sublimely high tech with the ridiculously simple. Consider the snake leash.

Swaisgood reminisces that the first Northern Pacific rattlesnake he'd caught for his experiment "was kind of a phlegmatic snake." The university veterinary surgeons who frequently prepare animals for experiments gave the rattler an implant of a little plastic loop. Swaisgood then just clipped a line to the loop and staked the snake in place.

The next snake, however, had a completely different personality and moved vigorously. A loop implant didn't look like a good idea. "We were concerned he might hurt himself," Swaisgood says. "We started going through our tackle box of research gear looking for something else." He finally leashed his rattlesnake by attaching fishing line to it with—bonus points to readers who saw this coming—that icon of invention: duct tape.

WHAT THE ...? — A cat may be more bemused than frightened, but a souped-up badger taxidermy mount proves just the thing to provoke calls of alarm from marmots in the wild.

FOOLING MOTHER NATURE The core of an experiment in behavioral science depends on changing one thing about an animal's world but leaving everything else the same. This challenge sometimes demands a mix of scientific sophistication and parlor tricks.

Ken Kardong couldn't use a silk handkerchief as a blindfold since the eyes he needed to cover belonged to a rattlesnake. After Kardong's lab at Washington State University in Pullman had documented the biomechanical marvels of the snake's strike, he began thinking that the snake's sensory systems needed to be equally marvelous to take advantage of that natural engineering. He decided to study how the snake's senses contributed to strike targeting, so he wanted to block, and then restore, each of its senses.

Snakes' eyes carry a clear, protective layer that lacks the nerve endings that make human eyeballs so tender. "It's like they're wearing glasses," says Kardong. So, with a conventional snake-handling stick, he held a rattler down on a counter, got a firm grip at the back of its head, and placed a patch of black electrical tape over each eye.

Kardong next had to invent another kind of blindfold, this one for the infrared-sensing pits on the snake's face. Depending on the size of the snake, the pair of pockets varies from depressions the size of a pinhead to pits that could hold a BB.

Again, Kardong thought of electrical tape, but he wanted extra insulation to block heat. At first, he considered rolling up little balls of paper. Then, a brainstorm came from a Styrofoam coffee cup. He sliced it into strips and rolled bits between his thumb and forefinger until he had the right size for each snake.

Kardong says, "My definition of cleverness includes 'simple.'"

Blindfolding either the eyes or the pits, by the way, made no difference in the accuracy of a rattlesnake's strike. Sight or heat sensing was sufficient on its own.

Other scientists have also needed to jam and unjam a sensory organ. For instance, Alejandro Purgue invented earmuffs for bullfrogs.

Now at Cornell University's Laboratory of Ornithology in Ithaca, Purgue had been studying the acoustics of North American bullfrogs. He began to suspect that the power of the male's commanding "ribit" came not from the throat but from vibrations in ear membranes. Purgue needed to damp and then release the membranes to document any differences in calls.

He tried smearing globs of standard laboratory silicon grease on the membranes to prevent them from vibrating. However, cleaning grease off the frogs' ears to reverse the effect turned out to be a nuisance. So, Purgue cut little ear pads out of the shock-absorbing foam used for inserts in running shoes. (He bought the foam at a supply company; no shoes were harmed in this experiment.)

BLUMSTEIN

To link the pads, Purgue wound a tiny, tight coil of piano wire into a spring that would go over the frog's head.

This proved the sticking point of the design. "The angle between their ears was so shallow," says Purgue. "If your head was like that, you'd have trouble keeping your earmuffs on, too." He got a prototype to cover a bullfrog's head just long enough for him to admire the effect. "It just looked adorable," he says.

For the actual experiments, Purgue came up with a better solution: tidy devices that stay in place—the researcher's fingertips.

Purgue's hypothesis indeed proved correct. When he covered the frog's ears, the sound lost its power in midcroak (*SN: 1/3/98, p. 12*).

THREAT ON WHEELS Scientific trickery often demands a faux animal, and researchers turn puppeteers. One of the more famous of these stand-ins goes by the name RoboBadger. Its creator, Dan Blumstein of the University of California, Los Angeles, studied alarm calls of marmots and needed something harmless that the rodents would find alarming. Old taxidermy mounts have a long and distinguished history in the study of animal behavior, but the tricky part comes in revealing the stuffed menace to the creatures under study. It's not going to jog into place by itself, so researchers have an equally long and distinguished history of rigging drop cloths on strings to raise the curtain on the pretend threat.

Blumstein saw a way to render the arrival of his menace, a stuffed badger, a little more realistic. He dismantled a remote control model called Monster Truck and mounted the badger on the wheels and motor. RoboBadger now whirs into view on his own, though Blumstein has to select experimental sites near suitable trails that make good motorized-badger highways.

For a fake aerial predator, Blumstein developed Eagle Knievel, a customized, remote control model glider. "Marmots live in rocky places, and there's never a good place to land a model plane," he sighs. "I've spent days by now gluing him back together."

Lizard specialists like Diana K. Hews take a simpler approach. Based at Indiana State University in Terre Haute, she relies on one animal to provoke specific behaviors from its companions. She attaches a looped string to a fishing pole, lassos a real lizard, and then sets it down where she needs territorial conduct or flirtation. As she stands patiently nearby holding the end of the fishing pole, "they'll display, they'll even mate," Hews says.

Some experimenters fool their subjects with a fake environment rather than a phony or scientist-controlled animal. Paul Switzer of Eastern Illinois University in Charleston was investigating whether male dragonflies were more likely to switch to a new territory after a string of mating setbacks. He had to jinx a dragonfly's love life without changing its style.

"I was working at my aunt and uncle's farm, and they had plenty of sticks and wire," Switzer says. So, he set out sticks good for egg laying in dragonfly territories along a pond edge and attached them to a handle.

Switzer lurked nearby until a male started to impress a female prospect with a tour of a stick. Then Switzer dunked the stick out of sight. The male dragonflies seemed to search for it, but in the confusion, the females typically flew away. And yes, sexual discouragement did incline a male to seek new ground.

ADOLPH

JOGGER MASK — Desert iguanas wouldn't wear the helmets designed for monitoring other lizards' oxygen consumption. So, Stephen Adolph of Harvey Mudd College in Claremont, Calif., and Todd Gleeson of the University of Colorado at Boulder, turned to laboratory cousins of eyedropper bulbs. With scissors, they tailored them to fit a desert iguana snout and fastened them on with strips of athletic tape. "They look like clown noses," Adolph recalls, but the iguanas don't seem to mind.

DETAILS, DETAILS Even after the research designer has worked out the central stage magic for an experiment, dozens of other challenges may loom ahead.

Aaron Krochmal, who grew up in New York City without a lot of personal wildlife experience, recalls that his surprises started when he received the first shipment of his test animals. For his dissertation, he'd devoted months to perfecting a protocol to test rattlesnakes' perception of environmental hiding spots, but he'd never had to manage a live rattler.

Disturbingly, his first shipment didn't arrive as he expected, with snakes in a bag, but with each coiled in a 2-pound deli container. Krochmal says, "My first thought was, 'How did they get them in there?' Which was followed rapidly by, 'How am I going to get them out?'"

He'd practiced basic handling routines on nonvenomous snakes, but not extraction methods from deli containers.

To anyone else who should suddenly confront this dilemma, Krochmal, now at Whitman College in Walla Walla, Wash., passes along his solution: Put the snakes in the fridge to chill them to sluggishness. Then, weigh down the top of a container—a length of rebar does nicely—while working loose the seal. With very long–handled clamps, move the container to the snake's new home, turn the container sideways, and gently squeeze.

Just keeping animals of unfamiliar species healthy in the laboratory can bring its own puzzles, says Hews. She recalls one husbandry crisis when she began rearing lots of little lizards in isolation containers. She fed them mutant fruit flies that can't fly, the cuisine that lizards usually enjoyed in her lab. In the solitary containers, though, many of the fruit flies evaded capture by roosting out of reach on the upper walls or outright escaping.

Hews therefore made her containers roost proof by dipping their upper sections in a nonstick coating that comes as a liquid.

Will Mackin of the University of North Carolina at Chapel Hill found a sweet way to measure how deep a bird called a shearwater dives. After finding the serious electronic wizardry that's available to be far too expensive, he came across journal articles describing equipment that costs about a dime. Mackin subsequently updated the technique. In his experiment, he sucked up confectioners' sugar to dust the insides of thin plastic tubes and then used a cigarette lighter to close one end. He attached the tube to a shearwater, and when the bird dove to forage, the increasing pressure drove water into the tube.

When Mackin recovered the tubes, he checked the ring marking the lowest point that water had dissolved the sugar and from that he could calculate the lowest point of the dive. He learned that the birds routinely dive about 7 meters.

Andrew Mason also figured out a modern version of old equipment as he monitored an *Ormia* fly's tracking the direction of a sound. Decades ago, German researchers who wanted to monitor the movement of an insect used a globe made for a streetlight. An optical sensor detected when an insect on top of the globe moved off center, and gearing underneath shifted the globe to keep the insect scrabbling on top. That system inspired Mason to paint irregular dots on a Ping-Pong ball and rest it in

a modified cradle from an optical computer mouse. When he tethered the fly on top, the optical sensors picked up shifting dots and sent the information directly to a computer.

MASON

FLY BALL — A Ping-Pong ball painted with dots provides a monitor of how a tethered *Ormia* fly tracks sounds. Optical sensors picked up the shifting of the dots and sent the information to a computer.

WHO'S WHO?

A basic question in studying social behavior is how to distinguish among the research animals. Even time-tested marking systems, such as colored bands for birds, can turn unexpectedly tricky. The commercial bands don't work on birds such as red-winged blackbirds, says Ken Yasukawa of Beloit College in Wisconsin. The birds fidget with the bands, squeezing them in their beaks until the bands eventually break off.

An idea from a colleague who custom-made bands for smaller birds, sent Yasukawa off to a craft store. He made his birds ankle bracelets, literally, from the plastic beads that melt together into colorful jewelry when pressed with an iron. He cuts a slit in the ring and pries it open just enough to slip it onto a bird's leg.

Yasukawa says a lot of his scientific equipment has come from Kmart, Ace Hardware, and craft stores, and that a good grasp of their offerings enhances creativity in scientific design. "Sometimes, I go just to look around," he says.

Other experimental behaviorists give close consideration to beauty products. Jill Mateo of the University of Chicago says that she's happy with the blue-black Lady Clairol for dyeing individual marks on the Belding's ground squirrels she studies.

Blumstein, however, has switched to a cattle dye for marking wild marmots. It's great, he says—easy to apply and long-lasting. Unfortunately, it dyes researchers' hands, too, a drawback when his field crews go into town for some sociability.

But that's not the most embarrassing social situation an innovative researcher has faced. Consider a string of experiments designed to see whether nonhuman primates have a sense of self. The researchers dyed a few pink streaks on an animal's ear or eyebrow and gave it a mirror. Apes appeared to notice something amiss, but experiments had not found similar reactions in monkeys. Marc Hauser of Harvard University wondered whether somehow changing the dye protocol, using more or different colors, might lead to different results.

He asked a student in his lab, whose hair on that day was orange, to recommend a nontoxic dye with lots of colors. "Manic Panic," she told him. The best local source turned out to be Hubba-Hubba, a store that advertises itself as "a boudoir of sin."

When Hauser bought four colors of dye, the clerk asked what he was going to do. He told her that they were for animals but immediately regretted the remark.

Back at the lab, Hauser found that he needed even more colors. When he arrived at Hubba-Hubba the next day, the clerk remembered him. "You were just in here yesterday," she said. "Now, what do you really want?"

To prepare budding young scientists for such eventualities, Steve Nowicki of Duke University in Durham, N.C. starts raising the theme of experimental ingenuity in introductory biology courses. Plenty of concepts abound for great experiments, he tells his students, but they can lie around for decades stalled by some obstacle.

"The idea was there—what you had to do was make it work," he says. ■

AFTER THE TRAGEDY

Columbia accident puts NASA in the hot seat

BY RON COWEN

"We get it." Those are the words that NASA Administrator Sean O'Keefe recited over and over again at congressional hearings earlier this month, as if they were the can-do agency's new mantra. O'Keefe was responding to scathing criticism in the late-August report of the Columbia Accident Investigation Board. But several space historians and scientists, including former NASA employees, say that neither O'Keefe nor his agency is truly getting it.

Although the board concluded that loose insulation foam caused the demise of the Columbia shuttle and its seven-member crew last February, the panel also pointed a finger at what it regarded as NASA's culture of complacency. An admission of guilt and a solemn promise to follow the board's recommendations aren't enough to keep the agency from repeating past mistakes, the critics say. NASA's initial "return-to-flight" plan, with a stated goal of making needed repairs and organizational changes so that the remaining three shuttles can begin flying again as early as next March, was really a rush to return to business as usual, says historian Alex Roland of Duke University in Durham, N.C.

Last week, NASA announced it might not be ready to test-fly the shuttle until next summer because it didn't know when it could meet one of the board's key recommendations—having an in-flight repair kit to patch large holes in the shuttle surface.

The accident report was "excellent" at describing what led to the Columbia disaster, says Roland. But the report doesn't address, and NASA officials still aren't confronting, whether human space flight should continue and, if it does, what its destinations should be, he adds.

The United States has lost 17 astronauts in space accidents, including two shuttle disasters 17 years apart.

Historian Robert Smith of the University of Alberta in Edmonton notes that one of NASA's dilemmas is that the shuttle is the only vehicle the agency has to continue ferrying crew members and materials to the multibillion-dollar International Space Station.

Given the number of international partners who have invested in the space station, ditching it is no longer an option, says Wesley T. Huntress of the Carnegie Institution of Washington (D.C.), who was associate administrator for the agency's space science program from 1992 to 1998. "It's not our space station, it's the world's, and we have an obligation to complete it," he asserts.

Delays in shuttle flights during the 1990s pushed back the projected completion of the space station to 2007 and increased costs just as NASA's budget was being cut. Those setbacks led to a NASA mentality that almost no flaw encountered could stop or cut short a shuttle flight, notes historian Howard E. McCurdy of American University in Washington, D.C. McCurdy speculates that that outlook led NASA managers to accept the contractors' assessment that the chunk of foam hitting Columbia's left wing on takeoff—which engineers spotted on film the next day—was of little consequence.

SHUTTLE REDUX? — NASA says it's uncertain when the next shuttle will fly.

TOWARD THE FUTURE Since the 1980s, NASA and its contractors have proposed a multitude of vehicles to replace the shuttle, but all the designs have been scrapped (*SN: 4/5/03, p. 215*). Before any shuttle is flown again, McCurdy says, NASA must begin building an alterative; otherwise, "it never will."

Huntress says that a space capsule like the capsules flown during the Apollo missions and still flown by the Russian-Soyuz cosmonauts could safely and simply ferry crews to and from the space station. Despite the capsule's excellent safety record, he says, enthusiasm for a high-tech, winged vehicle—underpinning what Huntress calls NASA's "joystick culture"—has buoyed support for the shuttle.

The agency should commit to retiring the entire fleet after a limited number of new flights, says McCurdy. "It ought to be inscribed on the front of the [agency's] building that the last shuttle will be flown by date XX," he asserts.

Another factor besides NASA's culture may have played a role in Columbia's demise, McCurdy says. The agency no longer has the in-house technological resources to check and recheck the many tests used to certify flights and to troubleshoot. To lower its costs, the agency farmed out many of those functions to the same contractors that built the equipment.

Roland, who worked at NASA headquarters from 1973 to 1981, says he's heartened that the accident board plans to reconvene in a year to see whether NASA has followed through on its safety promises. Less encouraging, he says, is that the panel appointed by NASA to oversee the agency's progress consists largely of current and past agency employees.

That panel's cochair, former astronaut Richard O. Covey, recently announced that his committee couldn't yet determine when shuttles would be ready to fly again. He notes that the agency has yet to devise a detailed plan for an independent safety and engineering organization within NASA.

"Maintaining vigilance over the long term won't be easy," says Roland. With NASA's every move now under scrutiny, "it won't be the first flight after Columbia that will have the problem—it might be the one 5 years from now," he predicts. ■

CHECKMATE FOR A CHILD-KILLER?

Vaccine researchers close in on rotavirus

BY BEN HARDER

For medical professionals battling one of the world's deadliest childhood infections, 1998 offered soaring hope. That fall, the first vaccine against human rotavirus—a highly contagious if somewhat obscure diarrhea-causing pathogen—went into pediatric use throughout the United States. The following year brought a shattering disappointment: Reports of a rare but serious side effect caused the manufacturer to suspend the vaccine's production.

In the aftermath of that setback, researchers redoubled their efforts to find a safe way to check the spread of rotavirus. Advanced trials of competing vaccine candidates are now under way, and early results suggest that the medical pieces needed to checkmate rotavirus may soon be in place.

Rotavirus may not be a household term, but it's a universal germ. "All humans are infected by the time they're 5 years old," says virologist H. Fred Clark of the Children's Hospital of Philadelphia. "Everybody gets [infected], regardless of economic status. Ordinary hygienic measures do not prevent the spread of rotavirus."

Infection typically confers lifelong immunity, so the disease almost always appears in young children rather than in adults.

Diagnosis of short-term rotavirus infections is rare. But each year in the United States, rotavirus makes 50,000 or more kids sick enough to require hospitalization, causes 20 to 40 deaths, and racks up costs of about $1 billion.

In poorer countries, rotavirus takes an even greater toll. A worldwide body count of at least 450,000 and up to 800,000 each year puts rotavirus sixth among infectious killers. Among children, only pneumococcus, malaria, and measles are more deadly than rotavirus.

BAD BREAK The unveiling 5 years ago of a vaccine designed by scientists at the National Institutes of Health (NIH) in Bethesda, Md., and produced by Wyeth Laboratories of Marietta, Pa., appeared to be a major breakthrough for global health.

Albert Z. Kapikian and his NIH colleagues fashioned their vaccine from a strain of rotavirus that naturally infects rhesus monkeys. To make the rhesus strain recognizable to the human immune system, the scientists added genes from the four most common human rotavirus strains.

Wyeth-funded studies revealed that giving infants three oral doses of the live, hybrid virus prevented many cases of rotavirus infection and reduced the severity of infections that did occur (*SN: 10/25/97, p. 263*). The U.S. government approved the vaccine, which Wyeth named RotaShield. Pediatricians in the U.S. administered more than 1 million doses of the Wyeth vaccine between October 1998 and July 1999.

A study of more than 1,000 children in New Orleans who received the vaccine from their pediatricians found that three doses completely prevented rotavirus infections requiring hospitalization, and that one or two doses reduced the risk of hospitalization by more than 60 percent. Rodolfo E. Bégue of Louisiana State University in New Orleans and his colleagues reported the findings in the December 2002 *American Journal of Epidemiology*.

"It was a very exciting time," Kapikian recalls. He and other researchers expected that foreign countries would follow the U.S. lead and that the vaccine might ultimately save more than 1,000 lives per day.

An unforeseen problem, however, soon froze the vaccine's use. Data from a national system for monitoring vaccines' performance suggested that in the 2 weeks after children received the Wyeth vaccine, they had an elevated risk of developing a potentially fatal intestinal blockage called intussusception.

"We were surprised," says Kapikian. "It was very, very disappointing." The finding led the national vaccine committee to withdraw its recommendation.

Rotavirus ranks sixth among top global infectious killers

After the United States rejected the vaccine, no other country took it up—although rotavirus currently kills 1 in every 300 infants in the developing world. Wyeth voluntarily ceased to produce the vaccine and is now working on other approaches against rotavirus.

SEARCHING FOR SAFETY The demise of the Wyeth vaccine opened the field to other vaccines in development, including one created by Philadelphia's Clark with funding from the pharmaceutical giant Merck & Co. in Whitehouse Station, N.J. If the results of current safety trials allay concerns about possible side effects, Merck's candidate vaccine could be on the market within 3 years.

It's been a long time coming: In the early 1980s, Clark hypothesized that a bovine rotavirus might prime people to fight off the human form of the pathogen. In an approach similar to Kapikian's, Clark and his colleagues mixed a bovine rotavirus with rotavirus strains they'd isolated from sick infants in Philadelphia. The strains then swapped genes. Out of the mix, the researchers selected viruses that were genetically less than 10 percent human rotavirus but that displayed a protein on their surfaces to which the human immune system responds.

Clark's team eventually created five hybrid viruses—each designed to confer immunity against a different strain of human rotavirus—and mixed them into an oral-vaccine cocktail that Merck calls RotaTeq.

When the Wyeth vaccine stumbled, RotaTeq became a leading candidate.

"While a naive reaction might be that bad news for your competitor is good news for you, it ain't true," says Clark. Wyeth's expe-

rience, he says, has placed a burden on all vaccine makers to test whether their rotavirus formulation causes rare adverse events such as intussusception. That requires safety trials that are 5 to 10 times as large as they would otherwise need to be, he says.

"That's set back [Merck's rotavirus-vaccine] program years and untold millions of dollars," Clark says.

To test the product, Penny Heaton of Merck and her colleagues have enrolled more than 55,000 infants in 11 countries and currently plan to add at least 5,000 more babies to the study. Half of the babies get the vaccine and half get an inert solution with a similar salty-sweet taste.

Because the study's design doesn't permit the researchers to know which children get the vaccine and which the placebo, Heaton won't be able to thoroughly analyze the data until at least next year. She nevertheless finds reasons to be optimistic.

There have been only a handful of intussusception cases among the 55,000 kids, and none has arisen within 2 weeks of a child receiving either the vaccine or placebo, Heaton told *Science News*. If the Merck vaccine caused or accelerated abdominal blockage soon after a vaccination, it would be apparent by now, she says.

Another encouraging sign, Heaton says, is that few children who receive the Merck vaccine excrete detectable quantities of its virus in their stool, whereas virus was detectable in the stools of about half the recipients of the Wyeth vaccine. The Merck vaccine's viruses may replicate less readily in the body and therefore put less stress on the small intestine than the Wyeth vaccine did.

Data from a Merck-funded trial in Finland suggest that the new vaccine is working. Timo Vesikari of the University of Tampere and his colleagues report that, among 1,946 infants, RotaTeq conferred immunity against 59 to 77 percent of rotavirus infections, depending on the dose of the vaccine given.

BIG KILLER — Reflecting an annual estimated mortality of 800,000 from rotavirus, this map marks with a dot the location of each 1,000 deaths.

CROWDED FIELD Merck isn't the only company testing a possible rotavirus vaccine. The London-based pharmaceutical company GlaxoSmithKline has a candidate vaccine called Rotarix, which is also in advanced safety trials.

The GlaxoSmithKline vaccine differs from both the Wyeth and Merck vaccines in that it's fashioned strictly from a human form of rotavirus, says its inventor Richard L. Ward of Cincinnati Children's Hospital Medical Center.

Ward and his colleagues made their vaccine from an entirely human pathogen. They began with the most common human rotavirus strain, known as serotype G1, and forced the virus to adapt to laboratory conditions. The process, called attenuation, reduces a pathogen's viability in the body.

Some scientists, including Clark, worry that an attenuated rotavirus could reverse its changes once it's reintroduced into people. Kapikian notes that since the attenuated virus is derived from just one strain, it might not confer immunity against all human rotaviruses.

Theoretical limitations notwithstanding, Ward's approach seems to have worked. In the November 2002 *Journal of Infectious Diseases*, Ward and his colleagues reported that among 184 healthy U.S. infants followed for 2 years after vaccination, the GlaxoSmithKline vaccine reduced by more than 75 percent the risk of any rotaviral illness. None of the vaccinated children suffered an infection severe enough to require medical care. That makes the new vaccine at least as effective as Wyeth's was, Ward says.

GlaxoSmithKline recently initiated a trial comparable in size to Merck's current rotavirus-vaccine study. Preliminary data on 1,986 Latin American children suggest that the attenuated-virus vaccine was 77 percent effective at preventing severe infections caused by either serotype G1 or other strains, GlaxoSmithKline researchers reported last November at the Infectious Diseases Society meeting in Santiago, Chile. Data on tens of thousands of subjects will be required to evaluate the potential for rare side effects.

While competing Western drug companies move forward with safety trials, a Chinese company already has a vaccine on the market. Authorities there maintain that the product is safe and effective, but U.S. scientists say that no credible data support the claim. Nevertheless, millions of doses of the vaccine have already been given to infants in parts of China.

In India, the country with the largest death toll from rotavirus, a candidate vaccine based on an attenuated human strain of rotavirus is under development with help from Centers for Disease Control and Prevention (CDC). "Those studies are just in their infancy," says CDC's Roger I. Glass, but if the vaccine can eventually obtain government approval there, it could have an immediate, dramatic effect on infant mortality.

Meanwhile, Ruth Bishop and Graeme Barnes of the University of Melbourne in Australia are conducting experiments with a human strain of rotavirus that, although never attenuated in the lab, doesn't cause illness in people. Early studies suggest that only some children inoculated with the virus mount an immune response, but if they do so, they gain protection from disease-causing strains of rotavirus.

Other researchers are taking approaches that don't use live viruses. For example, Mary K. Estes at Baylor College of Medicine in Houston and her colleagues have designed organic particles that resemble rotaviruses. In rodents, these viruslike particles trigger immune responses similar to those produced by rotavirus infection.

READY FOR ANYTHING Regardless of which vaccines emerge successful from testing, public health organizations are preparing for a global assault on rotavirus. They want to ease the regulatory and distribution hurdles that often make global availability of a childhood vaccine lag a decade or more behind its introduction in the West.

In February, the Seattle-based Program for Appropriate Technologies in Health (PATH) received a 3-year, $30-million grant intended to speed widespread use in poor countries of rotavirus vaccines, once they're licensed. The funding came from the Global Alliance for Vaccines and Immunizations—a partnership of vaccine manufacturers, governments, the World Health Organization, the World Bank, and philanthropic foundations—and its subsidiary, the Vaccine Fund.

A first step for PATH's project, says its director, John Wecker, is to test vaccine efficacy in Asia and Africa. PATH will fund these trials, run in conjunction with the vaccine manufacturers. Governments of poor countries often hesitate to fund public health campaigns when data have been collected only in well-nourished populations served by modern medical facilities. PATH expects its studies to encourage pharmaceutical companies to market a product in the developing world, Wecker says.

Prospective buyers and sellers of the vaccine will also need subsidies to bridge the gap between the vaccine's cost and many countries' limited resources for vaccine procurement, Wecker says. The Vaccine Fund already supports distribution of several childhood vaccines. When a safe, effective rotavirus vaccine is ready for prime time, it will be a natural addition to that list. ■

M. MILLER, NIH

CLIMATE CHANGE

Mapping carbon dioxide from space

NASA is gearing up to make the first measurements of atmospheric carbon dioxide from space. Researchers at the agency's Jet Propulsion Laboratory in Pasadena, Calif., are developing a spacecraft dubbed the Orbiting Carbon Observatory that will collect information on the greenhouse gas for 2 years.

This wealth of new data will not only generate the most detailed map ever of atmospheric carbon dioxide, but it will also enable researchers to dramatically improve their predictions of future climate changes. Scheduled to launch in the summer of 2007, the observatory will cover Earth every 16 days and collect 25 million CO_2 measurements during each of these periods, says Charles Miller, the project's deputy principal investigator.

The measurements are based on sunlight reflecting from Earth back to space. As the sunlight is reflected, molecules of CO_2 absorb specific wavelengths of the light, creating a unique optical signature. A spectrometer on the spacecraft will detect that signature and beam the optical data back to Earth. Computers at the Jet Propulsion Laboratory will convert the data into values for the concentration of CO_2 in various parts of the atmosphere.

About half the CO_2 produced by industry and vehicles remains in the atmosphere, but just where the rest goes has long puzzled scientists. A global map showing variations in CO_2 concentrations should identify which forests and oceans sequester huge amounts of the gas. —A.G.

MATERIALS SCIENCE

Soft spheres yield photonic structures

A novel method for creating light-manipulating patterns inside photonic crystals—materials that transmit and reflect specific wavelengths of light—could hasten the arrival of a new generation of faster, all-optical telecommunications technologies.

Instead of building photonic crystals out of hard materials such as silica, Andrew Lyon and his colleagues at Georgia Institute of Technology in Atlanta used hydrogel nanoparticles—water-saturated polymer spheres that swell and contract in response to temperature. Roughly the size of large viruses, the spheres measure, on average, 224 nanometers in diameter. The researchers mixed the spheres with even smaller, gold nanoparticles. A heating-and-cooling treatment prompted the spheres to self-assemble into crystal structures with the gold particles between them.

To create light-guiding conduits in the structures, the researchers zap specific portions of the nanoassemblies with a laser. At those places, the gold nanoparticles absorb light and heat up. If this process raises the temperature of the surrounding hydrogel spheres above 31°C, the spheres expel water and contract. A rapid cooling traps the spheres in the laser-zapped regions into disordered and optically transparent states.

With this technique, researchers could use a laser to draw patterns in the crystal, creating channels that guide light through the material, perhaps even around sharp corners. What's more, Lyon says, the process is reversible until a chemical step locks in a final structure. This means that the researchers can overwrite one light-guiding pathway with a new one. —A.G.

BIOMEDICINE

Charging cartilage

Borrowing a few tricks from the field of electronics, biomedical researchers have developed a new material for growing tissue in the lab. The team, led by Frank Ko of Drexel University in Philadelphia, mixed polymer nanofibers with carbon nanotubes to produce a scaffold for growing cartilage.

For tissue engineering, researchers typically seed a biodegradable polymer scaffold with cells. As the cells proliferate and form new tissue, the scaffold dissolves. However, existing polymers don't have the mechanical properties to support the growth of stiff tissues, such as bone and cartilage, says Ko.

"Cells need to feel at home," he says. "They need the right mechanical stimuli." So, Ko decided to strengthen the polymer scaffold with carbon nanotubes and give it the look and feel of natural collagen, the structural protein in cartilage.

The researchers blended the two materials and fed the mix through a nanofiber-spinning machine. The machine churned out fibers 20 to 500 nanometers in diameter—approximately the same width as natural collagen fibrils. While only 3 to 5 percent of the resulting material was made up of carbon nanotubes, that was enough to increase the material's resistance to deformation by two orders of magnitude. The composite fiber behaved more like real cartilage than existing polymers do.

Adding carbon nanotubes to the biodegradable polymer also made the scaffolding slightly conductive, says Ko. Scientists have shown that passing a small electrical current through tissue scaffolding can stimulate cell proliferation and encourage connections between cartilage and bone tissue in, say, knee joints.

Cartilage cells added to the nanofiber scaffolds multiplied and produced new collagen. The team plans to test the performance of its scaffolding in animals within a year or so. —A.G.

PHARMACEUTICALS

Mollusks point way toward better drugs

Although a drug's set chemical structure determines its mechanism of action, its larger crystal structure can change in ways that determine how well the drug dissolves in the gut and how long it will last on the shelf. Adam Matzger of the University of Michigan in Ann Arbor has developed an efficient way to create various crystal structures, known as polymorphs.

When growing polymorphs in the lab, researchers either vary the amount of solvent in a solution of the drug that is undergoing crystallization or tweak the solution's temperature. But how the crystals form different shapes is a mystery, and repeating a crystallization process doesn't always produce the same polymorph.

Inspired by the way mollusks use proteins—one of nature's most versatile types of polymers—to deposit calcium carbonate in their shells, Matzger decided to grow crystals on various synthetic polymers and see what polymorphs emerged. He found that a polymer film determines a polymorph's ultimate crystal structure by the time the first 10 to 100 drug molecules aggregated on the film. Moreover, different polymers, including familiar ones such as nylon and polyvinyl chloride, yielded different polymorphs.

When Matzger and his colleagues grew acetaminophen crystals using the polymers, the technique produced both of the drug's known polymorphs, depending on the polymer substrate. The researchers also grew crystals of the epilepsy drug carbamazepine on various polymers and generated four different polymorphs, one of which had never been seen before.

Matzger's technique could be a boon for drug companies. A drug's crystal structure can have a huge role in the compound's behavior in the body. —A.G.

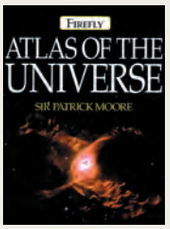
Books

A selection of new and notable books of scientific interest

ATLAS OF THE UNIVERSE

PATRICK MOORE

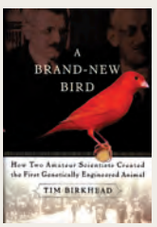
For more than 40 years, Moore has been spreading the word of astronomy to the masses. He's the host of the BBC's longest-running television series, *The Sky at Night*. In this oversize volume, he shares his expertise where he brings together hundreds of the best images from ground-based and satellite telescopes, including the prolific Hubble Space Telescope. Various facets of the universe are dissected in seven sections that include the solar system, the sun, the stars, the universe, and star maps. Two other chapters detail the history of astronomy and provide advice on selecting a telescope and other equipment. Moore is particularly adept at presenting the latest advances with clarity, as illustrated in his synopses of various space probes, how Earth relates to its moon and sun, and the nature of black holes and supernovas. Easily read star maps are accompanied by detailed explanations. Novice and more-advanced amateur astronomers will come away intrigued by and better informed about the night sky. ***Firefly, 2003, 288 p., color photos/illus, hardcover, $45.00.***



A BRAND-NEW BIRD: How Two Amateur Scientists Created the First Genetically Engineered Animal

TIM BIRKHEAD

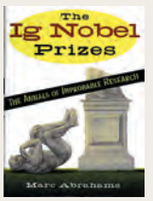
As he walked through town one late-summer morning in 1921, Hans Duncker heard something peculiar—a nightingale singing. This was odd because nightingales don't sing in August and certainly not in the middle of town. Duncker discovered that the bird belonged to a bird keeper named Karl Reich and that it was not a nightingale but a canary that Reich had carefully bred to sound like a nightingale. The two Germans began to work together and blended Duncker's expertise in genetics with Reich's knowledge of birds to try to create another odd bird: a red canary. The pair ultimately created a reddish-copper bird by interbreeding a canary with a red siskin and repeatedly crossbreeding subsequent generations. Birkhead calls the product the first genetically engineered organism and yet describes the many ways in which Duncker and Reich failed to reach their goal. Their major shortcoming was Duncker's overriding belief in the power of genetics and his refusal to believe that color could be determined by anything other than genes. Birkhead states, "Without an environment to operate in, genes are all but meaningless." The author uses this lesson in the history of biology to illustrate the intricate dialogue between nature and nurture. ***Basic, 2003, 268 p., b&w illus., hardcover, $26.00.***



THE IG NOBEL PRIZES: The Annals of Improbable Research

MARC ABRAHAMS

At the Ig Nobel ceremonies, held every year at Harvard University, individuals whose "achievements cannot or should not be reproduced" are honored. Actual Nobel laureates award the prizes to researchers whose work seems so absurd that it must not be true. Each accomplishment however, is in fact real and is deemed worthy by the editors of *The Annals of Improbable Research*, where Abrahams is editor in chief. In this enjoyable book, some of the more notable winners are documented, including the creators of a birthing machine that spins expectant mothers at a high speed, authors of a book explaining why people don't need to eat food, church leaders who devised a mathematical formula for determining the number of Alabama residents destined for hell, and scientists who deemed romantic love indistinguishable from obsessive-compulsive disorder. ***Dutton, 2003, 240 p., b&w photos, hardcover, $18.95.***



THE NEW BRAIN: How the Modern Age Is Rewiring Your Mind

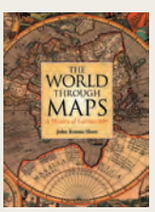
RICHARD RESTAK

With the advent of imaging techniques such as CAT, PET, and MRI scanning, brain science has been revolutionized. Neuroscientists no longer have to open a skull to examine a brain and its workings. Restak, a neuroscientist and well-known science popularizer, explains how these technologies are aiding him and his colleagues in understanding how the normal brain functions and how to treat its ailments. He considers how some stimuli, such as stress and the perception of violent images, adversely affect the brain. Then, he postulates that the demands of modern life are causing a surge in cases of attention deficit disorder. ***Rodale, 2003, 228 p., hardcover, $23.95.***

THE WORLD THROUGH MAPS: A History of Cartography

JOHN RENNIE SHORT

In theory, mapmaking is a no-nonsense profession. However, as Short tells it, political, economic, religious, and geographic biases of cartographers have influenced maps for millennia. In 1979, McArthur's Universal Corrective Map of the World put Australia on the top half. This may seem wacky, but Short points out that the Southern Hemisphere doesn't necessarily belong on the bottom. Nor is there a cosmic mandate that the prime meridian pass through Greenwich, England. Short charts not only the advance of mapmaking but also the events in civilization so deeply intertwined with cartography. Profiles of Gerardus Mercator and Claudius Ptolemy illustrate the science of mapping and explain the increasingly sophisticated tools of 40,000 years of cartography. Short puts the many maps printed on these pages in the context of history. ***Firefly, 2003, 224 p., color photos/illus., hardcover, $40.00.***



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

LETTERS

Something fishy?

Get real. When you were 4 years old, you understood it better ("Catch Zero: What can be done as marine ecosystems face a deepening crisis?" *SN: 7/26/03, p. 59*). It goes like this: You dump the inkwell (toxic discharge from industry and sewage systems) into the goldfish bowl (ocean) and the fish all turn belly up and the bowl is without fish. The moneyed polluting industries, of course, would rather not get caught, so there are other (poorer) fall guys (the fishing industry, for example) to take the heat for dumping the ink into the goldfish bowl. While the rich guys pay for studies (grants) of specific attractive topics to support their point of view, the ocean is still dying.

PENNIE MUMM, NEWPORT, ORE.

I wonder about the boxed section "Sea-Friendly Eating" within "Catch Zero." I don't trust that list of fish that are environmentally good and bad for people to eat. For instance, the indictable offense of farmed salmon is that they will genetically degrade the species through escapes. But if all right-thinking fish eaters would eat only wild salmon, those fish would be terrifically overfished. So, the argument is strong that eating farmed salmon is better and wild Alaskan salmon should be saved for the occasional treat.

LINDA G. JOHNSON, LONGMONT, COLO.

Small worries

The serious harm caused by microscopic dust ("Air Sickness," *SN: 8/2/03, p. 72*) really made me wonder about diesel. You noted that the submicron-scale spheres in the lungs of a nonsmoking resident of Mexico City appeared to be diesel-exhaust particles. While Europeans worry about what will happen in 100 years from global warming, could they be killing themselves now with their huge jump in diesel use in recent years?

ERNEST LIEBERMAN, NEW YORK, N.Y.

Your article, "Air Sickness," discusses the hazards of particles under 2.5 microns in size. For people living in highly polluted areas, are there any filters for windows, air conditioners, or air purifiers that will trap particles of that size?

MEREDITH WARSHAW, NEWTON, MASS.

Probably not, since these particles are so tiny. —J. RALOFF

SEND COMMUNICATIONS TO:
Editor, Science News
1719 N Street, N.W., Washington, D.C. 20036
or editors@sciencenews.org
All letters subject to editing.