SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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dino-dining cannibals

belching black holes

smallpox vaccine debate

can coots count?

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after the shuttle

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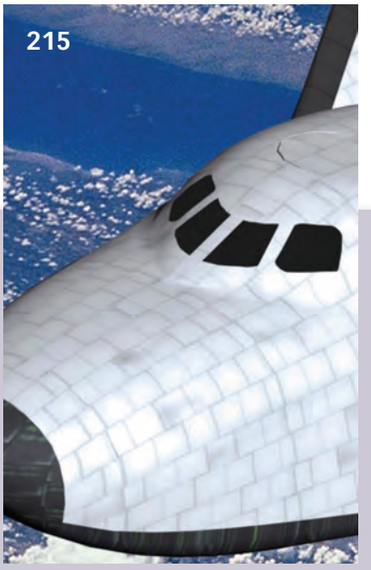

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Of Note

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Cover Possible design of the Orbital Space Plane—a smaller, lighter version of the shuttle—that in the next decade could carry crew to and from the International Space Station. Scientists are also testing new materials and engines for next-generation space vehicles. (NASA) Page 215

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Fractal prints Making mathematical art out of fractured granite slabs. See Ivars Peterson's MathTrek.

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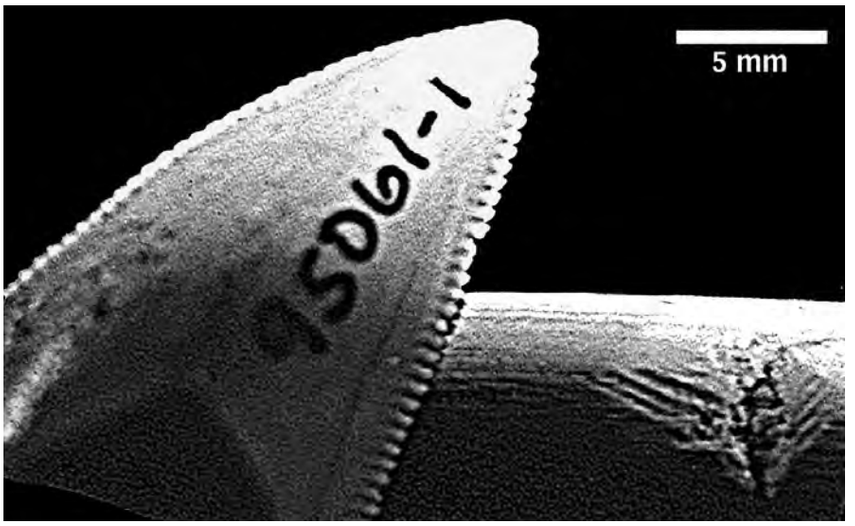
SCIENCE NEWS
This Week

Family Meal

Cannibal dinosaur known by its bones



R. ROGERS, MACALESTER COLLEGE

GROOVY BONES The size and spacing of denticles on the teeth of *Majungatholus atopus* match the grooves on bones of another member of the dinosaur species.

Some carnivorous dinosaurs routinely fed on their own species, according to an analysis of scarred fossils. Paleontologists contend the ancient gnaw marks are among the strongest evidence yet that some dinosaurs indeed were cannibals.

Majungatholus atopus was a 9-meter-long theropod that strolled the plains of Madagascar, the large island off southeastern Africa, about 70 million years ago. The dinosaur's size and its meat-shearing teeth mark the species as a top predator, says Raymond R. Rogers, a paleontologist at Macalester College in St. Paul, Minn.

The edges of *Majungatholus*' bladelike teeth, like those of many carnivores, sport denticles. These tiny, chisel-like features provide a serrated edge that can leave minuscule grooves on gnawed bones. At Madagascan fossil sites containing *Majungatholus* remains, many bones bear such grooves. And in more than 20 cases, says Rogers, it's the bones of *M. atopus* that are so scarred.

The denticle grooves on several *Majungatholus* bones were, on average, spaced about 0.48 millimeter apart. Rogers and his colleagues, who present their analysis in the April 3 *Nature*, found that the denticles on 10 randomly selected *Majungatholus* teeth had a spacing of 0.5 mm. Also, parallel tooth marks left by one bite indicate that the chewer had teeth spaced between 10 and 17 mm apart, a measurement also emblematic of *Majungatholus*.

No other carnivore known in the ancient ecosystem could have left these marks, says Rogers. The only other theropod dinosaur found to inhabit Madagascar at the time was the 1.8-m-long *Masiakasaurus knopfleri* (*SN: 1/27/01, p. 52*), whose teeth and bite were too small to make these traces. The teeth of the two large crocodile species known to live then were too blunt and too irregularly spaced to have produced the narrow grooves found on the *Majungatholus* bones.

"If the [denticle] marks weren't made by *Majungatholus*, they were made by an unknown animal with teeth just like theirs," says Thomas R. Holtz Jr., a vertebrate paleontologist at the University of Maryland in College Park.

Scientists often gain insight into the behavior of extinct animals through analyses of so-called trace fossils, such as tooth marks or footprints (*SN: 6/9/01, p. 362*). Although the fossil evidence suggests that *Majungatholus* ate its kin, it's unclear whether the creature preyed on its relatives or scavenged their remains.

Evidence for true cannibalism among dinosaurs is equivocal, says Rogers. Other analyses of chewed bones suggest that tyrannosaurs often ate tyrannosaurs, but the teeth marks aren't distinctive enough to determine whether victim and predator were members of the same species. Also, Rogers notes, some paleontologists are questioning earlier claims of cannibalism among *Coelophysis bauri*, a theropod species for which dismembered remains of juveniles turned up seemingly within the rib cages of adults.

Cannibalism in dinosaurs wouldn't be surprising, says Hans-Dieter Sues, a paleontologist at the Carnegie Museum of Natural History in Pittsburgh. Many reptiles today, including crocodilians and Komodo dragons, regularly prey on their own species, he notes. —S. PERKINS

Progress Against Dementia

Drug slows Alzheimer's in severely ill patients

A drug already sold in Europe hampers the relentless assault of late-stage Alzheimer's disease, a new study reveals. The finding suggests that the drug, called memantine, could help patients previously considered untreatable.

"This is really the first drug that seems to have had salutary effects in the more advanced cases of Alzheimer's disease," says Neil S. Buckholtz, a neuroscientist who heads the Dementia and Aging Branch of the National Institute on Aging in Bethesda, Md.

Although the drug has been used in Germany against dementias since the 1980s, its effectiveness had never been definitively demonstrated in a study of Alzheimer's patients. The first evidence that memantine might slow late-stage Alzheimer's disease came in 1999 from a preliminary report by scientists in Latvia, says Barry Reisberg of New York University School of Medicine.

To corroborate that finding, Reisberg and his colleagues identified 181 people with advanced Alzheimer's disease who lived at home with a caregiver and who retained some capacity to speak, dress themselves, and handle other daily chores. The researchers then gave memantine pills to 97 of the patients and an inert substance to 84 others.

After 28 weeks, the scientists found that the group getting the drug was faring significantly better than the other patients according to four of seven standard measurements of mental function. The tests gauge a person's ability to dress, bathe, use the toilet, and participate in other common activities. The findings appear in the April 3 *New England Journal of Medicine*.

Information supplied by caregivers indicated that the drug-treated patients also required, on average, 46 hours less assistance per month than the other patients did.

Memantine is made by Merz Pharmaceuticals in Frankfurt, Germany. The company is now testing the drug in people showing early signs of Alzheimer's disease, Reisberg says. If memantine proves effective against mild dementia, doctors might

prescribe it with other drugs that are now given in early phases of the disease.

Like memantine, none of these other drugs reverses Alzheimer's symptoms. But they slow mental deterioration by blocking the breakdown of the brain chemical acetylcholine. Memantine should be "complimentary or even synergistic" with these drugs, Reisberg says. That's because memantine, rather than affecting acetylcholine, inhibits the action of glutamate, a brain chemical that runs amok in Alzheimer's patients.

Normally, glutamate binds to docking sites on neurons to initiate a signal. Overstimulation of the binding sites in Alzheimer's patients kills neurons. This cell death contributes to the memory lapses and confusion seen in the patients. By occupying docking sites on the neurons, memantine prevents glutamate from binding and overstimulating the cells.

The new data, some of which were reported at a meeting last year, convinced the European Union to add late-stage Alzheimer's disease to memantine's approved uses. Merz has since asked the U.S. Food and Drug Administration for similar approval. —N. SEPPA

Careful Coots

Do birds count their eggs before they hatch?

A coot may tally the eggs in her nest, a rare example of an animal counting in the wild, suggests a new study.

American coots (*Fulica americana*) wage covert egg wars among themselves, sneaking into a neighboring nest to deposit an egg for the other family to raise, explains Bruce E. Lyon of the University of California, Santa Cruz. He's made an unusually detailed study that shows that coots do fight back. They often count up the rightful ones and move or destroy the suspect eggs, Lyon contends in the April 3 *Nature*.

Biologists have found dozens of bird species that catch interloper eggs from different species, but only a few—some ostriches, weaverbirds, moorhens, and now coots—with defenses against sneaks of their own species.

Lyon and his energetic field assistants monitored coot nests in a marsh in British Columbia every day for four breeding seasons. Stealth egg layers hit 41 percent of the more than 400 nests. A parasitic chick posed a threat because half of all chicks starved, and an intruder among the early hatchlings snagged food that might have kept a later-emerging, rightful resident alive.

Coots remove an egg by rolling it out of their nests or burying it in the nest's reedy mass. In these ways, the birds ditched only 2 percent of eggs they'd laid themselves—mostly those with cracks—but a third of the eggs from cheating neighbors. "They do recognize parasitic eggs," Lyon concludes.

Also, he found the first evidence that phony eggs are disproportionately pushed to the undesirable outer rim of the nest, which slows hatching.

The background colors of rejected eggs differed more from rightful eggs than did the shades of eggs that tricked foster parents. The cue therefore is probably visual, Lyon says.

To see if coots can count, Lyon compared the records of birds that eventually accepted parasitic eggs with those of birds that rejected them. Accepting coots tended to lay fewer eggs, roughly one less per interloper egg. At the critical time when the birds' bodies determined whether to stop producing eggs, both groups of birds faced the same number of parasitic eggs in their nests. Lyon argues that both groups were counting how many eggs they perceived as their own and that the accepting birds were fooled by the counterfeits.

Parasitic-bird specialist Stephen Rothstein of the University of California, Santa Barbara says he'd like to see tests that manipulate the birds' perceptions, rather than this study's hands-off observations, before he accepts that coots count.

Another researcher who studies egg sneaks, Malte Andersson of the University of Göteborg in Sweden, is more open to the current findings. He says that many lab experiments have suggested counting ability in captive animals, and the new study provides one of the first examples of animals' counting in nature. —S. MILIUS

Autism Advance

Mutated genes disrupt nerve cell proteins

A French research team has identified two mutated genes that appear to cause the neurological disorder known as autism. The little-studied genes both normally yield proteins that nerve cells use to form communication channels.

"These are the first genes convincingly linked to autism," says team member Thomas Bourgeron of the Pasteur Institute in Paris.

Other researchers find the evidence compelling, if not quite conclusive. "These are really good candidates" for autism genes, says Edwin Cook of the University of Chicago.

Autism is a puzzling disorder in which individuals have trouble interacting with other people or the environment. If the new findings lead to an understanding of what goes awry in autism, researchers might find a new way to treat the disorder and gain insight into the normal function of the human brain, says Bourgeron.

The newly implicated genes encode proteins called neuroligins, which appear on nerve cells at the specialized junctions known as synapses. It's at a synapse that one nerve cell releases chemicals to signal an adjoining nerve cell. Researchers have found that neuroligins help create a synapse by physically connecting two nerve cells at that location.

In an upcoming *Nature Genetics*, Bourgeron and his colleagues report finding mutations in the two known neuroligin genes on the X chromosome. The researchers studied two Swedish families, each having two

COOTS EGGED An American coot can often tell that something's wrong when neighbors of the same species sneak eggs (here, the two darker ones) into its nest. LYON

boys affected by autism or Asperger syndrome, a disorder that shares some features with autism. In one family, the mutation disrupts a neuroligin gene so severely that the protein produced is truncated. In the other family, the mutation is subtler, altering a single amino acid on a neuroligin protein.

The mutations in both cases appear to have originated in the mother and then been passed on to sons. Since women have two X chromosomes, the mothers had a backup copy of a normal neuroligin gene that presumably protected them from developing autism. Their impaired sons, however, inherited the single X chromosome with the mutated gene. The Y chromosome each boy inherits from his father carries a neuroligin gene, but it doesn't appear to compensate for a defective neuroligin gene on the X.

Autism appears in four times as many men as women, so scientists have long suspected that the X chromosome contains relevant genes. It's not clear, however, whether the new findings account for this sex bias. "So far as we can tell, these mutations are rare events and thus whilst explaining why some vulnerable males have autism, they are not contributing to the general liability to autism," says David Skuse of University College London.

Few scientists have investigated neuroligins, says Thomas Sudhoff of the University of Texas Southwestern Medical Center in Dallas, who was part of the group that in 1995 identified the first neuroligin gene. The newfound connection to autism is "the first time that a protein associated with synaptic cell adhesion is implicated in a disease," he says.

Some scientists suspect that the other three known neuroligin genes may also be involved in autism. Last year, a study of Finnish families with autism implicated the chromosome 3 region where a neuroligin gene dwells. Leena Peltonen of the National Public Health Institute in Finland and the University of California, Los Angeles, a coauthor on that study, tells *Science News* that her group is examining those families' copies of the chromosome 3 neuroligin gene. The new report "is a highly encouraging finding and will definitely focus the interest of autism researchers on this gene family," she says. —J. TRAVIS

A New Cool

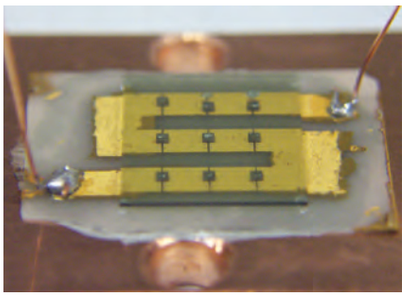
Prototype chills fast and electrifies, too

Researchers last week rolled out a prototype semiconductor-based device that stands a good chance of transforming some refrigeration and power technologies. Made of thousands of alternating atoms-thick layers of two semiconductor materials, the so-called thermoelectric structure can pump heat when powered by electricity or, conversely, turn a temperature difference into electric current.

For 40 years, scientists have envisioned thermoelectric materials as quiet, reliable, and energy-efficient components for cooling devices such as refrigerators, says Rama Venkatasubramanian of the Research Triangle Institute (RTI) in Research Triangle Park, N.C. In reality, thermoelectrics have been too inefficient and expensive to do much more than cool beverages in picnic baskets or power deep-space probes that need especially reliable components (*SN: 9/6/97, p. 152*).

Then, 18 months ago, Venkatasubramanian and his colleagues reported a new thermoelectric material that greatly surpassed the efficiency of previous materials (*SN: 11/3/2001, p. 280*). Last fall, another research group reported yet another thermoelectric material that also passed that milestone.

At a meeting of the American Chemical Society in New Orleans on March 27, Venkatasubramanian reported that he and his RTI colleagues have incorporated their material into a prototype device that performs as well as conventional thermoelectric-based coolers, yet is far smaller and quicker to chill. The team has used the device as a power source to run four small fans. To show its chilling abilities, they cooled a small block of steel 15°F in 2 minutes.



M. MANTINI/RTI INTERNATIONAL

COOL GADGET A prototype, the size of a postage stamp, relies on thin layers of semiconductors to power small fans and cool steel.

Venkatasubramanian and his colleagues must have solved some challenging engineering problems to make the prototype, says mechanical engineer Gang Chen of the Massachusetts Institute of Technology, who hasn't yet seen the device. The work is "very encouraging," he says.

With another 6 months of development, Venkatasubramanian expects the device's efficiency to double. Initial applications would be high-end ones, such as spot cooling of lasers in communications networks, he says. Eventually, thermoelectric components might power cell phones by taking advantage of a person's body heat. In other designs, Venkatasubramanian suggests, the materials might quickly cool cans of soda in a vending machine shortly before they're dispensed instead of relying on energy-consuming, perpetual refrigeration.

It's difficult to minimize heat and electricity losses when creating a working device, says Cronin B. Vining, president of the thermoelectric consulting company ZT Services in Auburn, Ala. If in just a year and a half, the researchers have made a prototype that performs in the ballpark of commercial devices, says Vining, "that's serious progress." —J. GORMAN

Wrong Number

Plastic ingredient spurs chromosomal defects

The primary chemical in some plastics causes female mice to produce eggs with abnormal numbers of chromosomes, according to a new study. In people, the condition—called aneuploidy—is the leading cause of miscarriages and several forms of mental retardation including Down's syndrome.

The new finding could shed light on the causes of aneuploidy, but it also raises questions about the safety of bisphenol A (BPA), the prime ingredient of the polycarbonate plastics that make up products ranging from baby bottles (*http://www.sciencenews.org/sn_arc99/9_4_99/food.htm*) to tooth-protecting sealants (*SN: 11/22/97, p. 324*).

Earlier this year, scientists conducting a survey of environmental chemicals in blood and urine revealed BPA in some healthy adults who had no known exposure to the chemical (*SN: 2/22/03, p. 120*). So far, there is little direct evidence linking BPA exposure to health risks in people. However, several studies in animals have found that the chemical, which mimics the hormone estrogen, may affect reproduction by, for example, altering the size of the prostate gland and shifting the onset of sexual maturity.

When reproductive biologist Patricia A. Hunt of Case Western Reserve University in Cleveland and her colleagues discovered that BPA can affect mouse eggs, they were studying what they call a "big mystery" of human reproduction: Up to 25 percent of fertilized human eggs have an abnormal number of chromosomes. The only factor clearly tied to human aneuploidy is a mother's age. The older the woman, the more likely she is to give birth to a child with Down's syndrome. Hunt suspected that hormonal fluctuations might be responsible.

When she and her colleagues began testing that idea in the laboratory, they observed wildly fluctuating aneuploidy rates in animals not receiving any special

treatment. Within this group, 2 percent produced aneuploid eggs one week, and 40 percent did the next. The team had expected the rate to stay the same throughout the experiment. "It was a big disaster," Hunt says.

It was also a clue. The scientists traced the apparent anomalies to the mouse cages. Built of polycarbonate, they had been washed with a harsh detergent. The researchers soon learned that polycarbonate is made with BPA, which can leach from damaged plastic.

To clinch the case against BPA, the team recreated the accidental exposure by housing some mice in newly damaged polycarbonate cages and others in BPA-free cages. Aneuploidy rates skyrocketed in mice exposed to the BPA-laden plastic compared with those of the control mice, the team reports in the April 1 *Current Biology*. In another experiment, the group provided mice with BPA-laced drinking water at concentrations matching those of the accidental BPA exposures. The more BPA the animals ingested, the higher the aneuploidy incidence.

Earlier studies had failed to link environmental factors, including smoking and alcohol, to chromosomal defects in egg cells, notes cytogeneticist Dorothy Warburton at Columbia University. The new work, she notes, "shows that there are things in the environment that can affect aneuploidy."

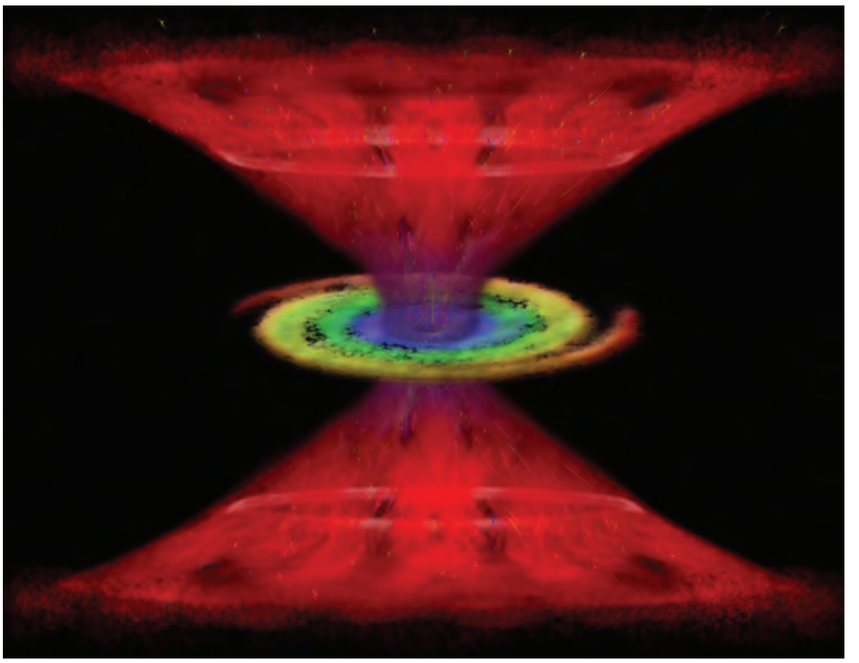
"It's an utterly incredible result," marvels geneticist R. Scott Hawley of the Stowers Institute in Kansas City, Mo. If an estrogen mimic can induce aneuploidy, then hormonal changes might well underlie the increased rate of chromosomal abnormalities in the eggs of older women, he says.

Whatever the implications of the new finding, BPA pervades the environment at the concentrations that spurred aneuploidy in mice, Hunt says. "It's kind of scary, " she adds. —K. MORGAN

Cosmic Blowout

Black holes spew as much as they consume

Notorious for gorging on matter, the super-massive black holes at the cores of galaxies may blow out as much material as they swallow. A study reported last week suggests that during the roughly 10 billion years that these black holes power the brilliant light beacons known as quasars, they also generate high-speed winds that eject an amount of gas equivalent to billions of suns. These winds, which contain oxygen, carbon, and iron, may seed the black hole's host galaxy—and possibly intergalactic space—with the elements necessary for life.



WIND MACHINE Illustration of a massive black hole flanked by swirling gas (green). The disk's intense heat propels some of the gas in the top and bottom layers to lift off. X rays generated near the disk's inner edge then force this gas into cone-shaped winds (red) and accelerate it.

The winds travel at 20 to 40 percent of the speed of light and demonstrate that black holes, though they comprise only one-thousandth of a galaxy's mass, "can exert a profound influence on galaxy evolution," comments theorist Mitchell C. Begelman of the University of Colorado in Boulder.

In the study, George Chartas of Pennsylvania State University in State College and his colleagues examined the X-ray spectra of two quasars. Each quasar's light emanates from a rotating black hole. For gas to spiral into a spinning black hole and fuel a quasar, it must first form a rotating disk that permits material to move inward while radiating energy. The hotter, inner part of the disk radiates mostly X rays, while the cooler, outer portion radiates less-energetic, ultraviolet light.

Researchers had already observed that ions in the outer part of disks absorb some of the ultraviolet light. This process accelerates the ions outward in a wind that ejects annually as much material from a black hole as the sun contains. Astronomers had inferred the existence of a more energetic wind generated by inner-disk ions that absorb X rays but had no direct evidence for it.

In the new observations, reported at a meeting of the American Astronomical Society in Mont Tremblant, Quebec, Chartas' group took advantage of a type of gravitational mirage.

A cluster of galaxies lying between each quasar and Earth creates the mirage. Each cluster acts as a magnifying lens, greatly brightening a quasar's light. Studying the amplified light of quasar APM 08279+525 with NASA's Chandra X-ray Observatory and quasar PG1115+080 with the European Space Agency's XMM-Newton satellite, Chartas' team detected a wind of inner-disk ions. The observations mark the first time that astronomers have found a wind from a black hole's inner disk transporting oxygen, carbon, and iron ions into space. These elements are among the building blocks of future star generations and of life.

Begelman suspects that such winds could be widespread among black holes, not just those with quasars. He suggests that when hard-to-detect black holes, like the one at the Milky Way's center, gorge on gas, they convert most of their radiation into superfast winds instead of producing fireworks.

Black hole winds may be linked to another type of galactic wind. Last year, researchers reported that many galaxies in the early universe generated winds that blew material from one galaxy to another (*SN: 4/20/02, p. 244*). Slower than the black hole winds but covering a wider area, these winds were probably driven by a string of supernovas, the explosions of massive stars. Tom Abel of Penn State, not a member of Chartas' group, speculates that supernova-driven winds were so efficient because winds from a supermassive black hole had already cleared a path through the galaxy. —R. COWEN

CHANDRA/M. WEISS

BUILDING A BETTER SHUTTLE

NASA turns to new designs and materials

BY RON COWEN

By now, the space shuttles can be considered the dinosaurs of the space age, as obsolete as a 386 computer. But they're still flying, and when and if NASA lifts the moratorium it imposed after the shuttle Columbia broke apart on Feb. 1, the shuttles may fly for the rest of the decade. When the space agency originally built a fleet of four shuttles, no one expected that the very same vehicles would still be on the launch pad more than 20 years later. Had NASA adhered to the once-a-month launch schedule that it once envisioned, the 100-flight proposed lifetime of each vehicle would have expired years ago.

But the $3 billion annual cost of the shuttle program and the labor-intensive efforts required to maintain the vehicles after each bruising space flight has led to a much slower schedule. On average, there are only five shuttle flights per year. Even Discovery, the most flown shuttle, has taken only 30 trips.

In one respect, that's fortunate because NASA has yet to choose a successor to the space shuttle. In the 1990s, the agency failed in two costly attempts to design and begin building next-generation, reusable spacecraft. On the other hand, the continued use of the shuttles is only a stopgap on the way toward truly 21st-century space vehicles.

HOT TILE — Example of a new type of heat-resistant tile, composed of layers of titanium and other metals, which might eventually replace tiles now on the space shuttles.

NASA

VARIATION ON A THEME Although the Columbia tragedy may force NASA to speed up development of the next-generation spacecraft, the agency is currently addressing the future of space flight with a conservative, two-pronged approach—one evolutionary and one more revolutionary.

The evolutionary approach, announced last November, calls for the construction of a spacecraft that would serve initially as an emergency escape vehicle for the crew of the International Space Station. NASA hopes that the first of these rescue vehicles, dubbed the Orbital Space Plane, will attach to the space station by 2010. But if the craft proves durable, a modified version would begin ferrying space-station crew to and from Earth by 2012.

The space plane isn't intended to replace the space shuttle, notes former astronaut Vance D. Brand, now deputy director of Aerospace Projects at NASA's Dryden Flight Research Center in Edwards, Calif. The space plane would be roomier than the Russian Soyuz module that currently serves as the space station's lifeboat. But, unlike the shuttle, it wouldn't have the space to serve as a cargo container or host a science laboratory.

Moreover, the plane would be launched piggyback atop a disposable rocket. That's in contrast to the shuttle, where the rocket boosters are often recovered and refurbished, at great cost, for reuse.

BEYOND THE SHUTTLE In addition to pursuing the Orbital Space Plane, engineers are starting from scratch with more radical designs. It's likely that any shuttle successor will resemble a streamlined airplane, perhaps a fighter jet, predicts Daniel Rasky of NASA's Ames Research Center in Mountain View, Calif.

That's in stark contrast to the blunt features of the space shuttle, whose broad, flat underbelly—designed to distribute the heat of reentry over a large area—is anything but sleek.

And like jets, the next generation of space vehicles might take off from a runway rather than a launch pad. Getting these vehicles into space would probably require a combination of engines to accelerate the craft up to 25 times the speed of sound. After an initial ascent by a conventional rocket or turbo jet engine, the plane would zoom horizontally, scooping up oxygen from the air at high pressure and mixing it with a tank of liquid fuel.

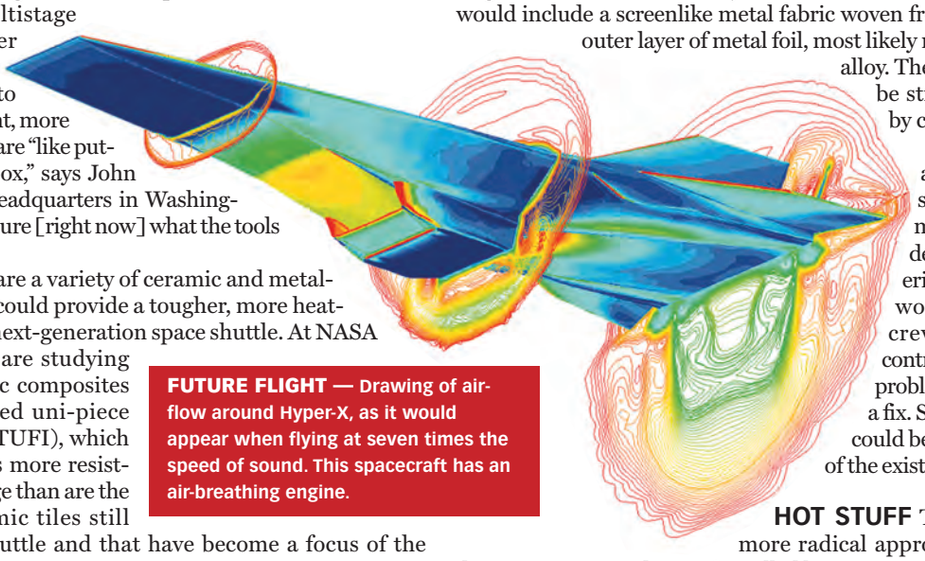
Because the oxygen comes from the atmosphere, the craft doesn't have to carry huge amounts of it to propel the vehicle. In contrast, each space shuttle carries more than a half-million kilograms of liquid oxygen. Scientists are working on alternative fuels that would consist of solid wax (*SN: 3/22/03, p. 187*).

High speed, air-breathing engines are known as ramjets or scramjets because they ram oxygen into the front of the engines. Aerospace engineers first began thinking about such engines several decades ago in a project that became known as the National Aerospace Plane. But at the time, says Brand, the technologies required weren't mature enough to make the concept work. After sinking more than $1 billion into the project, NASA abandoned it in 1994.

Rasky says that it's inevitable that the ramjet concept will be incorporated into any shuttle successor, but the vehicle probably won't be ready until 2020 or so.

In 2001, NASA scrapped a $912 million venture aimed at developing a reusable, single-stage-to-orbit spaceliner. The streamlined, wedge-shaped craft known as X-33 proved problematic. It was too heavy, and its liquid-hydrogen fuel tank didn't work properly. The failure of the X-33 shuttle-replacement venture has prompted NASA to focus on multistage engines for the next generation of spaceliners.

With several multistage designs now under consideration, technical advances to make a lighter-weight, more durable space plane are "like putting tools in a toolbox," says John Rogacki of NASA headquarters in Washington, D.C. "We're not sure [right now] what the tools will be used for."



FUTURE FLIGHT — Drawing of airflow around Hyper-X, as it would appear when flying at seven times the speed of sound. This spacecraft has an air-breathing engine.

Among the tools are a variety of ceramic and metallic composites that could provide a tougher, more heat-resistant skin for a next-generation space shuttle. At NASA Ames, researchers are studying low-density ceramic composites known as toughened uni-piece fibrous insulation (TUFI), which are 20 to 100 times more resistant to impact damage than are the glass-coated ceramic tiles still standard on the shuttle and that have become a focus of the Columbia investigation.

The coating on the heat-resistant tiles now in use is so fragile that technicians servicing the shuttle must remove jewelry lest they scratch the surface, notes Rasky. The problem, according to NASA scientists, is that the coating gets little support from the porous structure of the underlying tile. As result, when the tile surface gets hit, whether by a micrometeoroid or shuttle debris, it cracks or chips.

Although TUFI tiles have the same silica-fiber interior as the standard tiles do, they have a more durable surface coating. The coating permeates the pores near the surface of the tile, creating a strong, crack-resistant outer surface. In contrast, when a standard shuttle tile is hit, a crack spreads from the point of impact as it does when window glass is struck.

TUFI tiles are already being used on the shuttle's base heat shield, which covers the main engines and some other areas that are prone to damage in space but aren't subject to extremely high heat during reentry.

These tiles aren't being used on the belly of the shuttle and other areas that are most stressed during reentry, because TUFI isn't as good an insulator as the original shuttle tiles are. But researchers are studying a new version of TUFI that consists of silica fibers interspersed with a layer of aerogel. Sometimes referred to as solid smoke, this super-lightweight gel fills the tile's air spaces. Because the filling has such small pores, it traps air and other gases and prevents them from transporting heat through the material.

If these aerogel-filled tiles prove to be as good an insulator as the standard shuttle tiles, says Rasky, "then TUFI could easily be [applied] all over the shuttle—to the belly and other regions—as damaged tiles are replaced."

NASA scientists are also studying thermal blankets, which would provide further insulation during reentry. Rolled out like carpet, the blankets feature a main insulating layer of a ceramic-fiber batting sandwiched between layers of ceramic fabric. Other layers would include a screenlike metal fabric woven from wire and an outer layer of metal foil, most likely made of a nickel alloy. These layers would be stitched together by ceramic thread.

Researchers are also testing smart structures, materials embedded with computerized sensors that would alert the crew and ground controllers to sudden problems and suggest a fix. Smart structures could be affixed to parts of the existing shuttle fleet.

HOT STUFF There's an even more radical approach that some designers are considering. So-called hot structures would replace thermal tiles, heat blankets, and other thermal-protection devices external to the craft's skin. Instead of relying on the continuous shunting of heat away to prevent structural materials from melting, engineers are developing metallic alloys or ceramics that don't melt—or even lose strength—at any temperature they might encounter during space flight. Among the materials now under study are titanium- or nickel-based alloys and silicon carbide ceramic reinforced with carbon fibers.

LIFEBOAT — Artist's depiction of the Orbital Space Plane.

Internal insulation, akin to the fiberglass insulation inside houses, would be applied wherever a hot structure might otherwise come into contact with the crew.

Such a change in strategy would have important several advantages. Not only are tiles difficult to repair, but the absence of any material covering up the skin of a space vehicle would make it easier for engineers to spot faults, such as underlying cracks or metal fatigue.

Rogacki notes that NASA spacecraft have had little margin for error as they've carried crews and cargo into space. For example, there's no procedure for repairing tiles while a shuttle is in orbit. Any new design for human space flight must include a greater tolerance for problems that may be encountered during launch, when reaching orbit, or during reentry, he says.

Of course, the direction that NASA will pursue most actively in the development of a shuttle alternative will depend, in part, on critical factors not yet evident, including the conclusions reached by the committee investigating the Columbia tragedy and how soon the shuttle fleet will be back in business. ■

DRYDEN FLIGHT RESEARCH CENTER/NASA; NASA

THE VACCINIA DILEMMA

Smallpox shot poses modest danger, uncertain benefit

BY BEN HARDER

Consider two troubling scenarios. First, imagine that the government's current smallpox vaccination campaign peters out before even a million people are vaccinated. Then, a month or perhaps a decade from now, terrorists cause simultaneous smallpox outbreaks in several cities. Within days, cases of the once-eradicated disease pop up across the country and around the world. The epidemic burns for months and leaves many thousands dead before it's extinguished.

Here's a second possibility: Government workers vaccinate some 10 million healthcare workers, emergency responders, and citizens. A dozen of those vaccinated die of side effects, and hundreds more suffer serious life-threatening complications. Moreover, even without receiving the shot, scores of people at high risk for the vaccine's side effects become fatally infected with its live virus accidentally imparted by vaccinated friends or family members. A decade later, no smallpox epidemic has appeared, but the country is peppered with memorials to these victims of a terrorism event that never occurred.

Someday, with the luxury of hindsight, the current wrenching debate over smallpox vaccination may appear to have had an unambiguous answer. But for policy makers, health-care professionals, and other individuals who must make decisions today, the fog of alternative scenarios lies thick.

At the heart of the controversy is the uncertain likelihood that smallpox, which vanished a quarter-century ago, will reappear. "The key factor is the one factor that no one knows," says infectious-disease physician Kent A. Sepkowitz of Memorial Sloan-Kettering Cancer Center in New York.

The risk of a smallpox strike isn't the only important unknown. Others include how much mortality and illness will come with widespread public vaccination and whether, in the event of an outbreak, the protection afforded by vaccination will save more lives that the campaign itself destroys.

In spite of those uncertainties, a phalanx of researchers is developing scientifically informed recommendations on who should and shouldn't be vaccinated and when immunization should take place. The scientists' tools include hard-won knowledge from combating smallpox in the 1960s and 1970s, data from current vaccination campaigns, and mathematical models. Different approaches are yielding conflicting results. With so much potentially at stake, this politically charged issue is fanning a fiercely emotional debate.

POPULATION AT RISK British surgeon Edward Jenner launched the practice of vaccination in 1796 by using live, transmissible vaccinia or cowpox virus to protect his patients from closely related smallpox. Immunization has since become one of the safest public-health strategies. Yet because it uses a live virus, the smallpox shot is among the vaccines with the most severe side effects.

When vaccinia was widely used in the past, it caused 1 or 2 deaths and several dozen serious side effects per 1 million recipients. Those risks pale in comparison to the 20 to 40 percent of victims that smallpox infections killed.

The few deaths from the vaccine weren't evenly spread throughout the population. Vaccine-related deaths in healthy adults were "virtually unheard of," says William J. Bicknell of Boston University, a former Massachusetts state health commissioner.

However, large segments of today's population may be highly vulnerable to the worst effects vaccinia can dish out. Individuals at elevated risk include those with certain skin conditions, such as eczema, and those with suppressed immune systems, which today include people with HIV and recipients of cancer therapies or transplanted organs. People in these risk categories were few in the 1960s and 1970s during the last major smallpox vaccination campaigns. Because vaccinia can spread from one person to the next, even unvaccinated people face a small risk of infection and side effects.

> "The certainty of harm [from preemptive mass vaccination] outweighs the small chance of a net benefit."
>
> —SAMUEL A. BOZZETTE

To understand how dangerous vaccinia might be in today's population, J. Michael Lane, formerly of the Centers for Disease Control and Prevention (CDC) in Atlanta, Ga., reviewed studies of post-vaccination transmission of vaccinia before 1970. In the October 16, 2002 *Journal of the American Medical Association*, he, John M. Neff of Children's Hospital and Regional Medical Center in Seattle, and their colleagues report that 20 to 60 cases of accidental infection occurred in the United States for every million people vaccinated. However, they predict today that the frequency would be higher, primarily because of HIV and increased incidence of eczema.

At least 125 deaths would result from vaccinating everyone in the United States, Lane and his colleague Joel Goldstein of the Children's Clinic in Morrow, Ga., estimate in the March 18 *Annals of Internal Medicine*.

Current experiences with the vaccine are consistent with a low incidence of side effects and accidental infection. The Bush administration in late January launched an effort to vaccinate initially 500,000 and as many as 10 million people. So far, the U.S. government has given vaccinia inoculations to more than 200,000 members of the armed forces and some 25,000 civilian health care workers. Ongoing monitoring indicates only a few dozen serious reactions among vaccinees and a handful of cases of secondary vaccinia infections among nonvaccinees. However, some vaccine recipients appear to have developed heart disease as a result of the shot, raising the possibility of previously unknown side effects.

Secondary transmission of vaccinia—and its health consequences—could be a considerably more serious problem in hospitals than in the general population, says Sepkowitz, who has

reviewed past reports of vaccinia's spread in medical centers. In 12 outbreaks in which a total of 85 cases occurred, secondary vaccinia proved fatal in 9 instances, Sepkowitz reports in the Jan. 30 *New England Journal of Medicine*.

Lane attributes the success of the vaccination campaign so far to careful pre-vaccination screening to identify and exclude people at risk for complications. He also credits the education of vaccine recipients about how they can reduce the likelihood of transmitting vaccinia, a condition referred to as contact vaccinia. If the campaign accelerates or if it broadens to include volunteers from the general public, however, that assiduous screening and education might lapse, he suggests.

"If you vaccinate many more people faster, . . . you're going to have more contact vaccinia," predicts Neff. "The more measured pace that we're taking now is highly appropriate."

That pace isn't slow entirely by design. Hospital workers have expressed concerns that they could transmit vaccinia to patients, many of whom have risk factors for complications from the virus. Some health providers also worry about diverting resources from fighting active public health threats, such as influenza. For those and other reasons, many health care workers have refused President Bush's request that they get vaccinated, and the administration is still far short of achieving its initial goal of vaccinating 500,000 such health-care providers.

THIS COULD HURT — Hundreds of thousands of military personnel have already been vaccinated against smallpox.

WHAT IF? In lieu of data from actual smallpox attacks, several recently devised mathematical models simulate how vaccination and other public health measures could shape the course of hypothetical epidemics. A model by Martin I. Meltzer and his colleagues at CDC suggests that isolating people diagnosed with smallpox and vaccinating family members and others who had had extended contact with them—a tactic called contact tracing—would be sufficient to control an outbreak.

A related but more aggressive tactic, known as ring vaccination, calls for vaccination of everyone who might have had contact with an individual during his or her infectious period. For example, an entire town might be vaccinated in response to a single case.

A combination of isolation, contract tracing, and ring vaccination is widely credited with halting the spread of smallpox worldwide by 1977. In many parts of the world, universal vaccination was never implemented.

According to Meltzer's model, a future outbreak would grind to a halt if infectious people were promptly isolated, even if no vaccine was used.

Epidemiologist Edward H. Kaplan of Yale University and his colleagues present a more alarming scenario. They hold that without vaccination, a smallpox outbreak would expand indefinitely. Even selective vaccination would prove insufficient, they argued in the Aug. 6, 2002 *Proceedings of the National Academy of Sciences (SN: 7/13/02, p. 21)*. In one instance, they calculate that after an initial attack that infects 1,000 people, launching mass vaccination as soon as smallpox is identified would save at least 4,000 lives as compared with contact tracing for the first month.

If an attack does come, Kaplan says, everyone in the affected city and its vicinity should be vaccinated. Also, because any attack indicates significant possibility of attacks elsewhere, a single case in New York City might well merit complete preemptive vaccination throughout the country, Kaplan reasons.

In any case, public clamor for inoculations might require a liberal vaccination program after an outbreak.

"Smallpox vaccine is a precious commodity," Neff says. The U.S. stockpile of smallpox vaccine should be used conservatively in case it's needed to help control a global outbreak.

INTERRUPTING TRANSMISSION Many of the contradictions among outbreak scenarios stem from conflicting perceptions of how smallpox spreads. Transmission occurs mostly via airborne droplets of saliva or other bodily fluids. Before a person shows symptoms or becomes contagious, the smallpox virus incubates within an infected individual for 1 to 2 weeks. At that point, the person develops a high fever that lasts 2 to 4 days, then the fever drops and the patient may feel somewhat better. In the throat, however, virus-filled pustules develop. A characteristic rash soon appears over the face, extremities, and trunk and keeps the patient bedridden for the 2-to-3-week balance of the illness.

Scientists disagree about whether an infected person is likely to pass on the virus before the external rash appears. Kaplan's model assumes that transmission occurs in this brief period between the infection's first nonspecific symptoms and the onset of the disease's distinctive rash.

Linking infectivity with this period of relative relief is a fiction, other researchers claim. They see the most infectious period as coming after the rash develops. At this time, the bedridden patients release many viral particles and are likely to infect their caretakers. "Almost all smallpox is contracted at the bedside," says Thomas Mack of University of Southern California in Los Angeles.

Another discrepancy among the models is how easily smallpox jumps from one person to the next and, therefore, how explosive an outbreak could be. With no immunity in the population and no control measures, a typical smallpox victim spreads the disease to between 1 and 6 new victims. In Kaplan's outbreak model, a transmission rate of 5 new cases per victim results in many deaths, unless large-scale vaccination is implemented promptly. In other models, a similar transmission rate leads to less disastrous outbreaks.

However, some individuals transmit the virus on a much larger scale through casual or indirect contact, and the various models weigh that factor differently. Kaplan argues that officials should plan for the worst possible scenarios. In 1902, a single victim reportedly infected more than 100 people on a train car. In 1972, a Yugoslavian man hospitalized with undiagnosed smallpox spread the disease to 38 people, most of them hospital staff and other patients.

The 1972 Yugoslav outbreak, despite its "smallpox-spreading champion", was halted rapidly after the disease was recognized and patients were quarantined, notes Lane. The effectiveness of quarantine means a smallpox attack "would be more like a grenade than a dirty bomb," says Mack. It would have an immediate, localized effect, not one that ripples out insidiously. Thus, control measures less drastic than massive, nationwide vaccination would be enough even if an outbreak occurred, Mack, Lane, and others argue.

PLANNING AHEAD Differences of opinion over the proper response to a smallpox outbreak have led to disagreements over what needs to be done to prepare for that possibility.

The top priority, Kaplan says, is to create a pool of first-responders who could administer vaccine to others in the event of an outbreak. He envisions preemptively vaccinating between 1.25 and 2.5 million potential first-responders in the United States. Next, he says, clinics should be prepared to rapidly roll out a full-scale campaign that could vaccinate everyone in the country within 10 days. In an outbreak, "everyone should know where they report," he says.

Bicknell advocates immediately vaccinating more people—8 to 10 million emergency workers, hospital workers, and others who could administer vaccine in the case of an outbreak. "When that's done, we're well protected," he says. He also favors encouraging widespread voluntary vaccination among the entire civilian population, a step that makes his recommendations even more aggressive than the Bush administration's current goals.

Other researchers suggest that only thousands of health workers need to be vaccinated to set the stage for immunizing the 300 or so million U.S. residents, if that was deemed necessary, in response to an outbreak. Epidemiologist Samuel A. Bozzette of RAND Health Care in Santa Monica, Calif., says that he has considered several bioterrorism scenarios using both pessimistic and optimistic assumptions about the course a smallpox outbreak would take.

In all cases, vaccination of health care workers and first-responders is justified, he says. Unless an attack is imminent, however, general vaccination shouldn't occur "because the certainty of harm outweighs the small chance of a net benefit," Bozzette and his colleagues conclude in the Jan. 30 *New England Journal of Medicine*.

BOTTLED UP — Smallpox vaccine contains vaccinia, a related virus that causes cowpox, a less-dangerous disease.

OLD LESSONS, NEW WORLD Until and unless the threat of smallpox permanently subsides, any vaccination campaign would need to continue indefinitely, says CDC's Meltzer. "You can't just vaccinate everybody, step back, and dust your hands," he says. Staff turnover at hospitals would necessitate ongoing vaccination. Also, as immunity of past vaccines wanes over decades, revaccinations would be needed. Therefore, the cumulative health toll of staying on guard against smallpox would steadily climb. Even if safer forms of smallpox vaccine were developed, the financial cost would mount.

In some ways, the world may be lucky that the threat of smallpox has resurfaced now, rather than several decades hence. Many leaders in public health who participated in the disease's eradication are still alive. "All 70 years old and sharp as a tack" is how Sepkowitz describes his senior colleagues.

They remember aspects of disease control that weren't well documented. For example, they report anecdotal evidence that vaccination soon after exposure to the disease can prevent infection.

Still, there may be danger in relying too heavily upon past lessons. A genetically engineered smallpox virus, for example, could cast out the most basic of assumptions. And "if it turned out that the vaccine didn't work, we'd all be in trouble," says Kaplan.

More optimistically, immunizing a population might stave off an attack by reducing the virus' strategic value for terrorists, he posits.

With fundamental aspects about the contemporary threat of smallpox unknown, the hard question about whether and how to vaccinate remains just that—a question. ■

CDC

OF NOTE

EARTH SCIENCE

Ssshhh! South Pole has a new seismic station

New seismometers near the South Pole reveal that the area is the quietest spot on the planet for eavesdropping on earthquakes. Scientists hope the remote instruments, first turned on in mid-January, will pick up quake signs that are drowned out by the cacophony of civilization in other parts of the world.

Researchers have operated seismic instruments at the South Pole since 1957, says Scott Borg, a geologist at the National Science Foundation in Arlington, Va. The previous observatory was located about a football-field-length away from the other Antarctic scientific facilities and 6 meters underground. That site wasn't ideal because the instruments picked up vibrations from the throbbing generators of a small power plant, as well as from construction and other activities. Also, the shuddering of windblown antennas and buildings at the research base sent tremors through the surrounding terrain.

To minimize those sources of seismic noise, scientists placed the new observatory about 8 kilometers from the polar facilities and put the seismic sensors at the bottom of 300-m-deep boreholes. Last week, Borg and his colleagues released analyses of data obtained during the facility's first 2 months of operation.

At the new location, seismometers can discern ground vibrations one-hundredth the size of those that could be distinguished from seismic noise at the old observatory. That's also about one-quarter the size of vibrations detectable anywhere else in the world. In fact, it's so seismically quiet at the new site that on quiet Sundays, instruments can detect ground vibrations from snowmobiles 8 km away. — S.P.

BIOMEDICINE

Prenatal marijuana exposure may pose health risks

Rats that were exposed to a marijuana-related chemical while in the womb show more memory lapses and hyperactivity than unexposed rats do, a study finds. Marijuana-exposure studies in people have been clouded by factors such as a mother's tendency to also smoke tobacco cigarettes or pursue other risky behaviors during pregnancy.

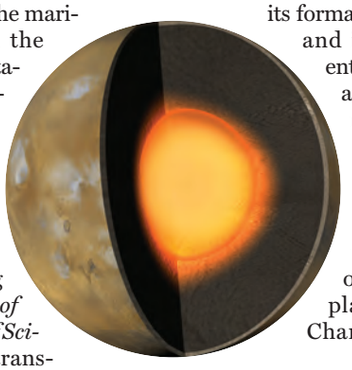
Vincenzo Cuomo of the University La Sapienza in Rome and his colleagues injected several pregnant rats with a drug called WIN55,212-2. In the brain, the drug behaves like tetrahydrocannabinol, the active ingredient in marijuana. Another group of animals received inert injections.

OF NOTE

Compared with the unexposed rats, the pups born to mothers that got the drug showed hyperactivity and reduced memory retention in behavioral tests conducted during the first weeks and months of life.

Also, rats exposed to the marijuana-related drug in the womb produced less glutamate, an essential neurotransmitter in the hippocampus, which is a memory-processing center of the brain, Cuomo says.

The study, which will appear in an upcoming issue of the *Proceedings of the National Academy of Sciences*, doesn't directly translate to people, he cautions. Nevertheless, the findings are in line with some earlier studies pointing to memory problems and hyperactivity among children exposed to marijuana in the womb, the researcher notes. "Our findings suggest that both pregnant and lactating women should avoid using marijuana," Cuomo concludes. —N.S.



JPL/NASA

INSIDE MARS Drawing shows Mars with a liquid core about one-half the radius of that of the planet. The dark layer under the crust is the mantle.

ASTRONOMY

Spacecraft reveal Mars' molten heart

The core of Mars is at least partially liquid, planetary scientists have concluded. The Red Planet hasn't completely cooled since its formation 4.5 billion years ago, and its core is made either entirely of liquid iron or has a solid iron center surrounded by molten iron, researchers report in an upcoming *Science*.

Because the sun exerts a slightly stronger tug on the near side of Mars than on the far side, it causes the planet to bulge slightly. Charles Yoder of NASA's Jet Propulsion Laboratory in Pasadena, Calif., and his colleagues have now measured that bulge. It's just under a centimeter. That, the researchers say, is enough to indicate that Mars must be relatively flexible, which means the planet's core must be at least partially molten.

Yoder's group made the bulge measurements by monitoring the motion of the Mars Global Surveyor spacecraft as it orbited the planet over the past 3 years. A tiny drift in Surveyor's orbit results from the planet's bulge.

The scientists also drew upon data from another spacecraft, Mars Pathfinder, regarding the rate at which the Red Planet's rotation axis slowly wobbles, like that of a top. This rate is proportional to the density of Mars' core. The findings also reveal other details about the core: It's radius is half that of the planet's, as in the case of Earth and Venus. What's more, the core contains a significant fraction of an element lighter than iron, such as sulfur. —R.C.

BIOLOGY

Human RNA genes counted up

A new analysis concludes that 200 to 255 human genes, or nearly 1 percent of all human genes, encode short strands of ribonucleic acid instead of protein as their end product.

Scientists initially discovered several genes encoding these so-called microRNAs in worms and recently unearthed similar

OF NOTE

genes in people and other mammals (*SN: 1/12/02, p. 24*). The RNA strands made by these genes seem to regulate the activity of other genes, particularly ones involved in the embryonic development of animals.

Seeking to identify as many such genes in people as possible, Lee P. Lim of Massachusetts Institute of Technology and his colleagues developed computer software that scans DNA sequences for stretches that can produce RNA strands with features characteristic of previously identified microRNA strands. For people, this approach netted 188 candidate genes.

Given the efficiency of this scanning procedure, the researchers estimate in the March 7 *Science* that no more than 255 microRNA genes exist in total. That makes the microRNA gene family comparable in size to other gene families with a role in regulating gene activity. —J.T.

INFECTIOUS DISEASES

Passive smoking may foster kids' cavities

Young children who grow up in an environment where people smoke face an exaggerated risk of dental decay—but only in their baby teeth, a new study finds.

Earlier studies had demonstrated that environmental exposure to cigarette smoke can weaken the immune system and promote the growth of decay-causing bacteria. Because the enamel on baby teeth is very thin, young children should be especially vulnerable to smoke's effects on teeth, reasoned pediatrician C. Andrew Aligne of Pediathink, a Rochester, N.Y.–based child-health research group.

He and his colleagues investigated that hunch by reviewing dental and health records of nearly 4,000 U.S. children between the ages of 4 and 11. All participated between 1988 and 1994 in the Third National Health and Nutrition Examination Survey.

When surveyed, more than 90 percent of the children still had at least one baby tooth and 76 percent had acquired at least one permanent tooth. Slightly more than half of the children also had residues of a nicotine-breakdown product in their urine, indicating regular exposure to cigarette smoke. These data enabled Aligne's team to compare the youngsters' tooth decay and probable amount of smoke exposure.

Cigarette smoke didn't affect the number of cavities and fillings in a child's permanent teeth. However, after accounting for other known risk factors, the researchers did find evidence that in baby teeth, some 27 percent of unfilled cavities and 13.7 percent of fillings could have been avoided if all of the children had been shielded from exposure to cigarette smoke. The scientists report their findings in the March 12 *Journal of the American Medical Association*. —J.R.

BEHAVIOR

Sleep debt exacts deceptive cost

A modest but constant sleep shortage undermines alertness and other mental faculties in a matter of days, according to a report in the March 15 *Sleep*. Moreover, people who get by on a modest sleep deficit are often not aware of their shrinking thinking capabilities and don't feel particularly drowsy, say Hans P.A. Van Dongen of the University of Pennsylvania School of Medicine in Philadelphia and his colleagues.

The results raise concerns about the effects of such "sleep debts" on military personnel, medical residents, and shift workers, the researchers say.

They studied 48 volunteers, ages 21 to 38, for 2 weeks. Participants were randomly assigned to 8, 6, or 4 hours nightly' sleep, or no sleep at all for one 3-day period. Before the 2-week long-study, volunteers averaged 7 to 8 hours of nightly sleep.

Scores on tests of information monitoring and reaction times dropped for the 6-hour and 4-hour sleepers, but not the 8-hour sleepers. These losses, which were greater for 4-hour sleepers, mounted throughout the study. After 14 days, members of the 4- and 6-hour groups cited little sleepiness or difficulty thinking, but they displayed cognitive declines comparable to those in the entirely sleep deprived group 2 days into their 3-day ordeal. —B.B.

BIOLOGY

Sperm show age

Looks like women aren't the only ones who need to worry about their biological clock when it comes to having a baby. A new study indicates that the quality of men's sperm declines with age.

Women's fertility decreases until menopause, when ovulation ends. In contrast, men produce sperm throughout their lives. However, the sperm of an elderly man don't equal those of a young one, Brenda Eskenazi of University of California, Berkeley and her colleagues report in the February *Human Reproduction*.

The researchers studied sperm samples from 97 volunteers ranging in age from 22 to 80. None of the men had any known fertility problem. Semen volume decreased with age, as did sperm motility, the researchers found. The tendency of sperm to move in a single direction, as opposed to randomly, also dropped as men aged.

While female fertility abruptly ends at menopause, male fertility seems to gradually decline without a similar cut-off, Eskenazi and her colleagues conclude. "The present findings have important implications for men who choose to delay fatherhood, since they reduce their chance of success the longer they delay," the scientists say. —J.T.

PALEONTOLOGY

Fossils of early salamanders found

Newly discovered fossilized salamanders push back a milestone in amphibian evolution by more than 100 million years, paleontologists say.

Volcanic ash smothered members of at least five previously unknown species of cryptobranchid salamanders about 160 million years ago in what's now Inner Mongolia. Living relatives include the Asian giant salamander, which can grow as big as a small human adult, and the smaller hellbender of North America, says Neil H. Shubin of the University of Chicago.

VOLCANO VICTIM
This 18-centimeter salamander represents a group that's now considered at least 160 million years old.

M. ELLISON/U. CHICAGO

The fine ash preserved many of the doomed creatures' soft tissues, including eye lenses, external gills, and tadpole-like tails. Even remnants of last meals were preserved, such as the bellyful of shrimp fossilized inside one 8-centimeter-long larval salamander. Juvenile members of one of the ancient species grew to at least 18 cm in length, and the adults presumably grew larger. Shubin and Ke-Qin Gao of Peking University describe the find in the March 27 *Nature*.

Previously, scientists held that the oldest known cryptobranchids lived about 56 million years ago. The newfound fossils suggest a surprisingly early split of this salamander lineage from a closely related salamander group, which still survives, and that cryptobranchids have changed little since that time. —S.P.

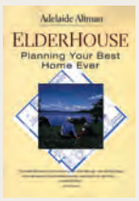
Books

A selection of new and notable books of scientific interest

ELDERHOUSE: Planning Your Best Home Ever

ADELAIDE ALTMAN

A house that served you well when the children were young may not be the best environment as you age, reports Altman. It may be unsafe or simply too much work. Altman helps readers envision homes that serve present and future needs so that they can live out their lives comfortably, easily, and, most importantly, independently. She "walks through" an average house from the front door to the garden to the basement, explaining how to build or retrofit safer walkways, better-lit spaces, wider doors, lower cabinets, and handy grab bars. Along the way, she provides hundreds of tips for reducing risk, from eliminating potential falls over doormats to raising washers and dryers to a more reachable level. Another section of the book tackles downsizing and making the most of a small space when you're used to having lots of room. ***Chelsea Green, 2002, 232 p., b&w illus., paperback, $19.95.***



THE KILLERS WITHIN: The Deadly Rise of Drug-Resistant Bacteria

MICHAEL SHNAYERSON AND MARK J. PLOTKIN

This is a wake-up call that penicillin and its drug relatives can no longer be considered cures for infectious diseases. Shnayerson and Plotkin report that because of the misuse of antibiotics, bacteria are becoming increasingly resistant to traditional drugs. Between the antibiotics that we feed livestock and the drugs needlessly prescribed to people, bacteria are becoming stronger and more deadly. The authors cover this story from all angles, examining how this crisis took hold, which bacteria are the most threatening, and what drugs researchers are working on to curb the problem. Interestingly, some future antibiotics may lie in unusual places, including the saliva of Komodo dragons. Shnayerson and Plotkin also make a plea for people to improve hygiene protocols in hospitals and day care facilities, where bacteria thrive. ***Little, 2002, 328 p., hardcover, $24.95.***

KRAKATOA: The Day the World Exploded: August 27, 1883

SIMON WINCHESTER

More than 40,000 people perished as a result of the eruption of the Krakatoa volcano in Java nearly 125 years ago. Most of these people were killed as a result of the giant tsunamis it triggered. The blast was so intense that people felt it thousands of miles away. Pumice from Krakatoa floated as far as the coast of Africa. The volcano itself exploded into oblivion. Many people in the area believed that the world was coming to an end. However, once the dust settled, scientists began to see Krakatoa as an opportunity for gleaning insight into both the beginnings of life on what was suddenly a barren landscape and the effects of subsurface Earth movements. Just as compelling is the significance of this event as the first global news story. Via new, state-of-the-art underwater telegraph cables, news of the eruption traveled the globe in a matter of hours. Winchester deftly blends all these elements into a stirring account. He examines the event's long-lasting repercussions for both the people and wildlife of Java and reports on his recent visit there to witness a new mountain rising on the volcano's site at a rate of 20 feet in height and 40 feet in width per year. ***HarpC, 2003, 416 p., b&w photos/illus., hardcover, $25.95.***

TOUGH PLANTS: Unkillable Plants for Every Garden

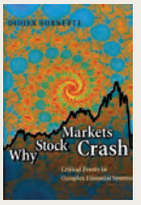
SHARON AMOS

So your thumb's not so green, or you have a patch of land that just doesn't seem to support plant life. This guide to 100 virtually unkillable plants may be for you. Initial chapters provide some basic gardening tips for improving soil, weeding, and selecting the right plants. A directory features easy-to-use profiles and full-color images of these hardy plants—many of which have magnificent blooms—including Scotch broom, trumpet honeysuckle, and anthemias. The profiles detail where to plant each species, how much water and sun it requires, and other plant-care tips. ***Firefly, 2003, 144 p., color photos, paperback, $21.95.***

WHY STOCK MARKETS CRASH: Critical Events in Complex Financial Systems

DIDIER SORNETTE

Here a scientist treads on economists' territory. Sornette applies cutting-edge thinking in the field of complexity and the theory of critical phenomena to the inner workings of the stock market. The objective is a potentially lucrative one: to predict the market's peaks and valleys. As Sornette points out, "Market crashes exemplify in a dramatic way the spontaneous emergence of extreme events in self-organizing systems," meaning that the science he employs should work. Generally, economists believe that stock market crashes are explained by effects that occur in short time scales—hours, days, or weeks at most. Sornette argues to the contrary, that the months and years of accelerating ascent of market prices—commonly known as a bubble—explain a crash. In a bubble, the market has entered an unstable phase and any small disturbance or process triggers its instability, explains Sornette. In much the same way that geologists and social scientists predict earthquakes and demographic changes, physical and statistical modeling techniques can forecast stock prices, the author argues. In postulating how, why, and when stock markets crash, Sornette predicts that the end of the world's economic growth era will occur around 2050. ***Princeton U Pr, 2003, 421 p., b&w illus., hardcover, $29.95.***



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LETTERS

Cheese, if you please

"Dairying Pioneers: Milk ran deep in prehistoric England" (*SN: 2/1/03, p. 67*) says that "lactose, a sugar in milk, commonly elicits allergic reactions." Lactose and many other carbohydrates don't elicit an allergic response.

JONATHAN STAPLEY, WEST LAFAYETTE, IND.

Lactose intolerance is the inability to digest significant amounts of lactose because there's a shortage of an enzyme that breaks down milk sugar. This condition shouldn't have been described as an allergic reaction. —B. BOWER

Prehistoric British dairying pioneers didn't need to wait "several thousand years" to digest the raw milk products they were using. After leaving the udder, milk quickly becomes colonized with lactobacilli that break down lactose.

JOANN S. GROHMAN, DIXFIELD, MAINE

The thesis that milking animals were kept to produce cheese and butter until the early English population could digest the milk intact is, at best, a dicey one. What is plausible is that the nutrient concentration, storability, and portability of cheese and butter were the chief motivators for their production. Or maybe it was the flavor.

ALAN E. KLIGERMAN, PLEASANTVILLE, N.J.

Space available

Years of budgetary constraints and compromises have all but destroyed NASA's ability to deliver on the grand visions of yesteryear ("Columbia Disaster: Why did the space shuttle burn up?" *SN: 2/8/03, p. 83*). Sadly, I think that the best outcome of this tragedy would be to acknowledge that the shuttles are unsafe at any speed. Perhaps the national embarrassment is just what the U.S. government needs to get over this period of willful neglect of the space program.

ROB FOSTER, ONTARIO, CANADA

I wonder why, given the history of ceramic-tile failure, no backup procedures were developed. The orbit didn't allow for a rendezvous with the space station, nor was Columbia equipped to dock there. Once the launch problem was detected, it would have been nice to have had that option.

RUSS AGREEN, DENTON, MD.

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