

# World Science News in Review

## [Archaeology]

### Fossils Found in China Could Be Earliest in East Asia

In 1958, in the county of Liujiang in southern China, farm workers discovered several human bones, including a skull, while digging in a cave. Because it resembles to-date fossils in Japan, scientists estimate this *Homo sapiens* skull to be from 20,000 to 30,000



years old. However, according to an article in the December 2002 *Journal of Human Evolution*, the fossils might be much older than that.

The fossils probably came from sediment dating to 110,000 to 139,000 years ago, estimates a team led by geologist Guanjun Shen of Nanjing (China) Normal University. He also said the fossil discoveries probably came from either the cave deposit dating from 68,000 years ago or one dating to more than 153,000 years ago.

The team concluded that if any of the estimates are true, “the Liujiang [specimen] is revealed as one of the earliest modern humans in East Asia.” This would roughly coincide with the earliest known fossil dates in Africa and the Middle East.

Yet evidence of the skull may complicate the human-origins debate, creating problems for the out-of-Africa theory of human evolution—that modern humanity started in Africa between 100,000 and 200,000 years ago and then spread elsewhere. If the fossils found in Liujiang are dated accurately, supporters of the out-of-Africa theory will have to find even older African *Homo sapiens* fossils. Another possibility for the adherents would be showing that modern humans migrated very quickly from Africa to Eastern Asia.

The scientific accounts from 1959 and 1965 of the fossil discoveries led to the new determination of the likely burial site of the fossils. Shen and his coworkers mapped various soil deposits in the cave and used uranium decay methods to work out the age of the crystallized limestone. According to Shen, other sites’ uranium samples have been analyzed and support the idea of ancient human origin in southern China. Teeth that were discovered in two other caves have been estimated to be at least 94,000 years old, said Shen.

On the other hand, some anthropologists doubt the estimated age of the Liujiang skull. It’s still uncertain how the skull got in the cave and where it was originally buried, remarked Christopher B. Stringer of the Natural History Museum in London.

Milford H. Wolpoff of the University of Michigan in Ann Arbor agreed. “I’d love for the Liujiang skull to be as old as Shen proposes, but we’ll never know for sure without directly dating the specimen.”

Shen said he hopes he can get an agreement with the Chinese officials to date the specimen directly. —M. Kwan

## [Biological Sciences]

### Nervous System Drug Shows Promise for Male “Pill”

Researchers have discovered a new oral drug, known as *N*-butyldeoxynojirimycin or NB-DNJ, that prevents sperm cells from developing normally in mice. Until now, the only FDA-approved male birth control methods have been condom use and vasectomy, though a practical birth control pill for men has long been sought after.

Researchers at the University of Oxford in England stumbled upon NB-DNJ’s potential birth control abilities while exploring its use in treating diseases of the nervous system, during which male mice exposed to the drug



became temporarily infertile. "So, we started a study to look at what this drug was doing to male-mouse fertility," said Frances M. Platt.

She and her colleagues at Oxford spiked the mouse feed with varying doses of NB-DNJ and found that the females coupled with the control males produced normal litters, but the treated males, even those who were given low doses of the drug, could not impregnate the females.

After further investigation, the researchers found that NB-DNJ damages the sperm mitochondria and nuclei, thus impairing the sperm's swimming ability. The drug also prevents the formation of a cap, called the acrosome, on the sperm's head, which normally enables the cell to penetrate an egg.

The effects of the drug are reversible: Sperm of the mice treated with any dose of the drug for up to six months (which is a significant portion of the average two-year lifespan of a mouse) were able to regain fertility by three weeks after researchers stopped administering the drug.

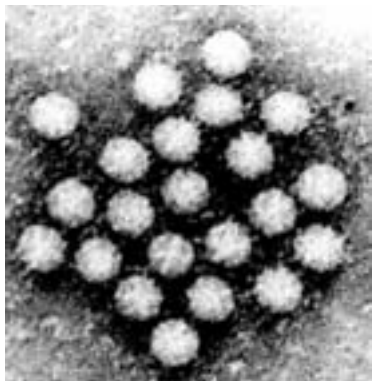
Though a version of NB-DNJ has been approved by the European Union for the treatment of Gaucher's disease, the drug's use as a male birth control pill will require further scrutiny of its known toxic effects, such as those affecting sperm internal parts.

NB-DNJ appears to be less risky than some other drugs being studied for their male birth control potential, stated Ronald Swerdloff of the Harbor-UCLA Research and Education Institute in Torrance, Cal. He added that NB-DNJ "is a long way from a final, tested product, but it seems to be an exciting lead."

—F. Merali

## Noroviruses Cause Many Shipboard Outbreaks

According to recent reports from the Centers for Disease Control and Prevention (CDC) in Atlanta, cruise ships' sanitation practices do not reliably wipe out viruses that cause diarrhea outbreaks. Although cruises are cleaner today than in past years, stopping the viral scourge on ships will require even more rigorous measures, including completely scrubbing down affected vessels.



The viruses, called Noroviruses, pervade easily through casual contact and can last for many days in the open air. The viruses often set off epidemics of diarrhea and extreme vomiting in cramped spaces on ships, military camps, and overcrowded

areas. They also cause approximately 23 million illnesses in the United States every year.

In 2002, at least 23 outbreaks occurred on cruise ships, in which more than 2,000 people were sick on five ships operated by four different companies.

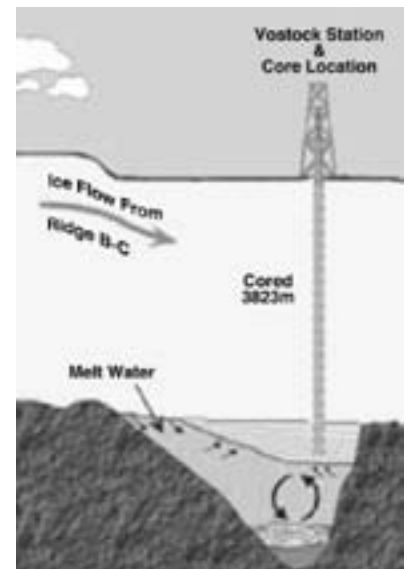
On three of the five ships, these outbreaks affected several consecutive voyages because the virus probably survived onboard between scheduled cruises. The preventative measures used on the voyages ranged from scrubbing public areas to sanitizing poker chips. In one particular case, the virus struck Holland America's *Amsterdam* on four different voyages. The outbreak started to subside only when the ship was docked for ten days and underwent intense cleaning.

In 2002, the wave of viral outbreaks contrasted from an overall downward trend in stomach infections on the ship. In the 1990s, inspectors reported improper handling of water on 55 percent of inspections and food on 62 percent. They also reported a 95 percent equipment maintenance and dishwashing violation rate. Despite these scores, half of all cruise lines received passing scores.

—M. Kwan

## Life under Thick Ice in Antarctica Lake

In 1996, the collaboration of Russian and British glaciologists helped discover Lake Vostok, one of the largest and deepest lakes, below 4,000 meters of ice in Antarctica. Three years later, the scientists were able to map out the dimensions of the territory with advanced technology. The biggest mystery that has bewildered all scientists is whether life



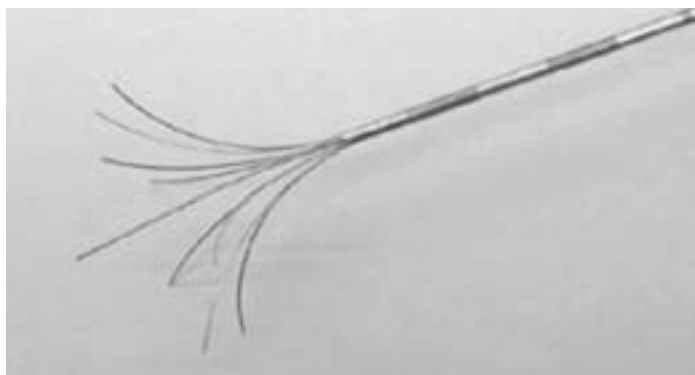
exists in the lake. In 1999, curiosity drove the National Science Foundation to initiate an airborne survey of the lake and later an actual expedition to the lake at the Vostok Station. It is highly suspected that ancient microbes or life forms do dwell in the lake. Cylindrical ice samples have been pulled from the lake for examination, but the research was stopped in 1998 for fear of contamination. Yet from what has already been extracted, scientists have found a variety of living organisms—from bacteria to algae—three-fourths of the way down the lake, and current researchers are working to find viable microbes even deeper into the

lake. Although the physical conditions at this level make the chances of finding organisms slim, scientists expect to find microbe existence. The study of Lake Vostok and its possible inhabitants has also attracted NASA, which planned to use the lake as a practice site for an expedition to Europa.

—W. Lee

## Medical Procedure Eases Pain in Bone Cancer Patients

For most cancer patients, experiencing physical pain is perhaps one of the most difficult consequences of the disease. However, scientists at a recent meeting of the Radiological Society of North America (RSNA) announced a new pain-reducing treatment for bone cancer patients: radiofrequency ablation (RFA).



RF ablation electrode with full deployment.

Utilizing computer tomography (CT) and ultrasound guidance, RFA transmits high-frequency electrical currents through a needle to the targeted tissue, thus heating and destroying a large part of the tumor. Since the process successfully eliminates a large portion of the lesion, RFA substantially reduces the pain in patients. According to Dr. Matthew Callstrom of the Mayo Clinic in Rochester, Minnesota, RFA has been previously used to treat other cancers such as those in the lung and kidney tissue. The ablation procedure has recently been used to treat patients with metastatic bone cancer. Metastatic bone cancer results from the spreading of a malignant tumor via the bloodstream to one or more bones near the body's center, such as the hip or spine.

Callstrom, who works for one of the nine research centers in the United States and Europe participating in the study, confirmed that RFA has successfully eliminated pain in patients with metastatic bone disease. Approximately 81 percent of the patients attained "a high degree of pain relief," and nearly half experienced "complete elimination of pain" six months following treatment. Furthermore, the patients reported a decrease in physical pain from 7 to 2 on the standardized Brief Pain Inventory (BPI), a 10-point scale with 10 being the highest level of pain. Taking these

results into account, Callstrom optimistically expressed that RFA offers a safe and effective treatment option to reduce severe pain so as to "improve the quality of the patients' lives."

However, what RFA can't do is successfully eliminate pain in patients whose cancer has spread throughout their entire skeletons—it can only help lesions. Despite this drawback, the outlook for this new treatment is optimistic: The U.S. Food and Drug Administration (FDA) officially approved the use of RFA for treatment in December 2002.

—L. Peng

## [Chemistry]

### Findings of Acrylamide in Food May Lead to Health Risks

Those who love to eat French fries may be shocked to hear that what they are eating does not only contain high fat content, but also contains acrylamide, an agent that causes cancer in rats. According to the U.S. Food and Drug Administration (FDA) and Germany's Bavarian Ministry of Health, scientists have reported findings of acrylamide in foods like French fries and gingerbread.

Acrylamide, a chemical substance used in the production of plastics, is created by high-temperature cooking methods, especially in starches. The FDA has already initiated testing of acrylamide levels in starchy foods such as French fries and potato chips. The researchers first tested for acrylamide concentration in French fries by baking numerous batches of different types of fries, from various chain restaurants to various home-cooked (store-bought) types (see table). For restaurant-cooked fries, the acrylamide concentration ranged from 117 ppb (parts per billion) at KFC to 1030 ppb at Popeye's. For home-cooked fries, Ore Ida brand registered at 616 ppb and Lamb Weston Island Valley peaked at 1325 ppb.



Acrylamide Concentrations (ppb) in French fries at different locations of chain restaurants (FDA preliminary data)\*

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6	Batch 7
Burger King	197	220	369				
Checkers	257	407					
Fuddruckers	346	452					
KFC	117	162	270	313			
McDonald's	155	193	245	270	328	356	497
Popeye's	301	484	610	1030			
Wendy's	157	169	254	260	302		

Other foods that tested positive for acrylamide concentrations were fish fillets (30 ppb), Pepperidge Farm Cheddar Goldfish crackers (57 ppb), unbrewed Starbucks Coffee Columbia Ground (175 ppb), Hershey's Cocoa (909 ppb), and Lipton Soup & Dip Mix (1184 ppb).

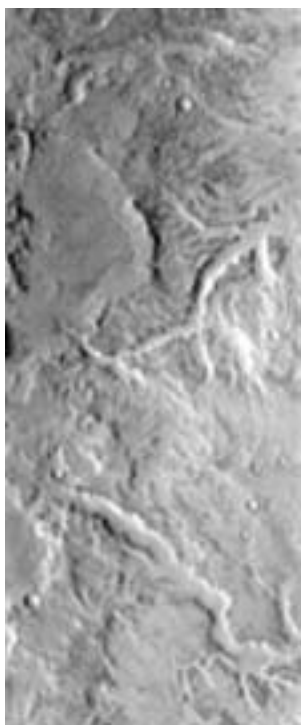
What should one make of all these numbers? Even though these foods contain acrylamide, these results are only preliminary and do not currently pose a major health risk to Americans, according to the FDA. More research is needed to form a better conclusion about the potential health risks that acrylamide might pose. —L. Peng

Source: *Science News*, "Acrylamide—from Spuds to Gingerbread."

## [Earth, Atmosphere, and Planetary Sciences]

### Collisions Heat Up Mars Climate and Erosion Debate

A group of physics-driven planetary scientists propose that the mysterious erosion markings on Mars can be explained by giant asteroid collisions. The source of water for the massive amounts of erosion has remained a mystery for about thirty years. Climate models cannot explain why the frozen planet was warmer in its early years. However, a new physics-based approach is generating very convincing ideas and numbers. The group calculates that a relatively small



asteroid measuring 100 kilometers delivered about  $4 \times 1,026$  joules of energy to the planet.

The energy of the impact, combined with the deep layer of hot rock debris that covered the planet afterward, brought global surface temperatures to about 800 K. As a result, the frozen planet thawed on its surface, at its polar ice caps, and in its subsurface. A small 100-kilometer object impact would result in 5 meters of water covering the planet for at least one year. A single 250-kilometer asteroid might have melted 50 meters of water for at least a century. At least ten such objects collided with Mars, punctuating the planet's cold, dry climate with episodes of rain and erosion. According to the new research, the cumulative effect of the impacts can account for the massive erosion.

Geologists point out that this new theory may explain the earlier stages of erosion, but it cannot account for the later valley formations and flooding of craters. The amount of erosion seems to have required kilometers of water, much more than the 50 meters produced by an impact. To attract more supporters, the physics-driven planetary scientists need to develop a better model of the cumulative effects of impacts over time. —S. Kan

## [Materials Science]

### Size Doesn't Matter: Nanotubes Play Big Role in Strengthening Ceramics

University of California-Davis researchers, led by Joshua D. Kuntz and Amiya K. Mukherjee, have managed to triple the fracture resistance of ceramics. The scientists accomplished the feat by introducing small amounts of carbon nanotubes into the mix of alumina crystals to make a superstrong material.

Many researchers have tried to introduce carbon nanotubes as the agent to eliminate the infamous brittleness of ceramics. The UC-Davis researchers strayed from traditional approaches in two ways: the type of nanotubes used and the technique in hardening the ceramics. Previously, other researchers had relied on multi-walled rather than single-walled nanotubes. In addition to using



the different type carbon nanotubes, the UC-Davis scientists also employed a low-temperature heating technique to harden the ceramic. They suspected that the previous sintering technique that operated at a higher temperature damaged many of the nanotubes.

The two changes caused a two-and-a-half-fold increase in fracture resistance compared to the old method. (The previous best had only decreased the brittleness of the alumina crystal ceramics by 24 percent.)

With this significant increase in shatter resistance, the future for the new ceramic material is boundless; it could be used for gears, industrial parts, and the like. But until researchers can find a way to lower the price of the expensive carbon nanotubes, the material will probably be used only in heavy industries, where production cost is not the main concern.

—T. He

## [Mathematics]

### Mathematical Forays into Musical Compositions

In Swedish composer Daniel Cummerow's musical works, each musical fragment is determined by a mathematical recipe through the use of a formula that links numerical digits with musical notes. For example, the mathematical constant  $\pi$ , has an intricate, vaguely medieval correlate, whereas the decimal digits of the constant  $e$ , progress at a relentless, suspenseful pace.

A variety of different strategies are used by algorithmic music composers to get such interesting results. One method involves converting prime numbers directly into their corresponding MIDI notes, at least up to 127, to get a curiously rising scale. The MIDI specification assigns a number to each note on a keyboard (e.g., middle C is 60, C-sharp is 62, and so on, for a total of 128 tones) and is used in computer programs to represent musical notes. However, since there are an infinite number of primes, one could continue by dividing each prime by a certain number, then use just the remainder to assign the musical value—an elegant use of modular arithmetic.

In some of his pi compositions, instead of mapping digits directly to their respective MIDI numbers, Cummerow constructs the piece by assigning each digit from 1 to 8 to a note in a specific scale; 0 signals a pause; and 9 means either a pause or the repetition of the previous tone.

In yet another experiment, Cummerow uses a unique musical alphabet invented by French composer Olivier Messiaen, which extended the German names of the notes A to H by giving each letter of the alphabet its own pitch, octave, and note value. Cummerow paired the first 255



digits of pi and applied the above formula to those that fell below twenty-six. For the rest, he followed a different recipe.

Other techniques have yielded fascinating musical pieces featuring the Fibonacci sequence, Pascal's triangle, and intriguing structures that have been associated with chaotic dynamics, such as the Sierpinski triangle and Lorenz's butterfly.

Many other musicians have also delved into mathematical music, exploring ideas such as the fractal notion of self-similarity in which each component is a miniature replica of the overall structure.

Only rarely do composers enter the seemingly forbidding world of mathematicians and their abstruse concerns, though the recent frenzy of forays into the field may be just the start of a beautiful marriage between mathematics and music.

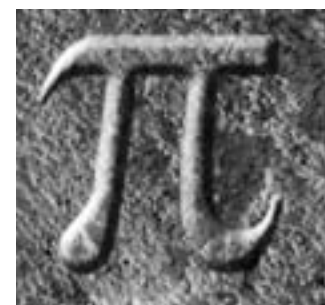
—F. Merali

Intriguing mathematical music compositions of the following artists can be found on the World Wide Web: Cummerow (<http://www.geocities.com/Vienna/9349/>); Chris K. Caldwell (<http://www.utm.edu/research/primes/programs/music/listen/>); and José Oscar Marques (<http://www.midiworld.com/c/jmarques.htm>).

### A Step Closer to Finishing Pi

At the University of Tokyo Information Technology, Yasumasa Kanada and his colleagues have been able to calculate the value of  $\pi$  up to 1,241,100,000,000 digits, the last of which is 5. Thanks to the improvements in the algorithm to calculate  $\pi$  and 602 hours of a Hitachi SR8000 computer's time, the group was able to set this new record, surpassing their previous world record in 1999 of 206,158,430,000 digits. As expected, initial statistical analyses indicate that each of the digits from 0 to 9 appears with the same frequency. Questions about the distribution and apparent randomness of  $\pi$ 's digits still remain: Do all digits appear infinitely often? At some point beyond the range of current computations of  $\pi$ 's value, do its decimal digits revert to a string constrained of only digits of say 1 and 0 (or any other number(s))?

—M. Sircar

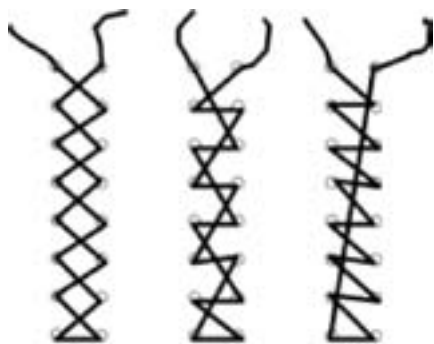


## Survival of the Fittest Shoelaces

Computer scientist John Halton and Australian mathematician Burkard Polster recently investigated a problem to which even a small child can relate: how best to lace one's shoes.

Though there exist more than 50,000 possible lacing methods for a shoe with as few as five eyelets per side, over time, humans have gravitated toward several common lacing patterns. The three most common lacings are criss-cross, also termed "American," European straight, and shoe store straight.

Through mathematical modeling of the shoelace as two parallel lines, each with  $n$  points, Halton and Polster were able to evaluate the strongest and shortest lacing patterns. Halton discovered that the zigzag American pattern required the least amount of lace for a given number of eyelets, with the European straight next, followed by shoe store straight, provided that at least four eyelets are present on each side of the shoe.



Polster investigated less traditional lacings as well, finding that a bow tie lacing in fact uses the least lace of all. When considering which lacing is strongest, however, Polster concluded that a "dense" lacing such as the American style that crosses back and forth between sides of the shoe is best.

—K. Rivoire

## [Physics]

### Antineutrino Transformations Detected on Earth

Recent evidence gathered by an international group using an underground detector known as the Kamioka Liquid Scintillator Antineutrino Detector, or KamLAND, in Toyama, Japan, indicates that



electron antineutrinos morph into muon or tau antineutrinos on Earth, as they do on the sun. The research group determined this by monitoring light flashes caused by electron antineutrinos generated by a few dozen nuclear power reactors in Japan and Korea. KamLAND, set up in a mine one kilometer below ground level, contained thousands of tons of organic liquids that emitted light when struck by these electron antineutrinos. Because only 63 percent of the expected number of electron antineutrinos, and thus light flashes, were detected, physicists concluded that the electron antineutrinos had oscillated into the two other possible forms—muon and tau antineutrinos. These earthly findings closely follow observations of transformations of neutrinos and antineutrinos emitted by the sun. Giorgio Gratta of Stanford, the lead scientist of the study and a KamLAND spokesman, concluded that oscillations are "a property of neutrinos and not that of the sun."

—M. Sircar