SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

JANUARY 28, 2006 PAGES 49-64 VOL. 169, NO. 4

winged duets

orangutans' drastic drop

risk in eating venison?

transplanting better kidneys

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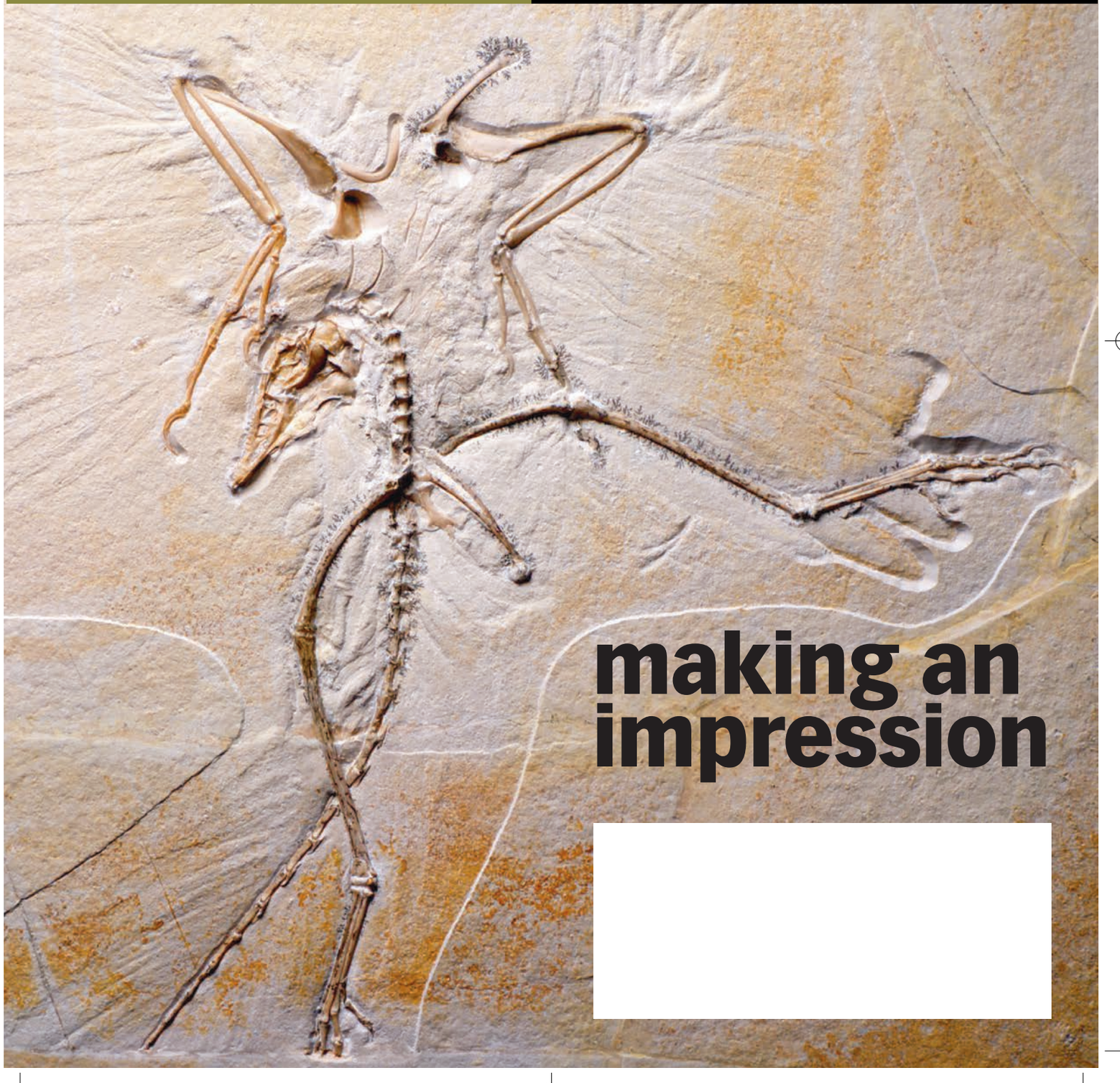

making an impression

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Cover Fossils of *Archaeopteryx*, which presumably formed in sediments on a lake bottom, are beautifully preserved. Carcasses of modern birds, however, don't typically sink intact. New studies suggest factors that contributed to the formation of *Archaeopteryx* fossils, such as this one, and to other fossils. (G. Mayr/Senckenberg Research Institute)
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Red Alert for Red Apes

DNA shows big losses for Borneo orangutans

Because they hang out in nests high up in trees and lead relatively solitary lives, orangutans have challenged scientists trying to study them. Now, orangutans face their own challenge, and it's urgent.

Increasingly steep population declines over the past century or two have imperiled orangutans' survival in northeastern Borneo, according to a new DNA analysis. In just the past few decades, the population has dropped from more than 20,000 to about 5,000 orangutans, report geneticist Benoit Goossens of Cardiff University in England and his colleagues. This trend coincides with extensive forest clearance that began in the 1890s and accelerated during the past 50 years, the scientists note.

"This is the first time that a recent and alarming decline of a great ape population, brought about by [people], has been demonstrated, dated, and quantified using genetic information," Goossens says.

DNA evidence of dwindling orangutan numbers emphasizes the need for intensive conservation efforts, the scientists conclude in the February *PLoS Biology*.

During a 2001 survey of the still-forested parts of a Borneo wildlife sanctuary, Goossens and his coworkers collected orangutan feces found under nests or near orangutans that they encountered. The team also collected hair from tree nests. A total of 200 individuals were identified by chemically tagging DNA segments known as microsatellites. Studies in people indicate that individual genetic differences evolve relatively quickly in microsatellites.

The researchers used computer programs to analyze the distribution of genetic variants that had evolved within the sample and to estimate changes in population size that would have produced that distribution.

The results indicate that orangutan populations in northeastern Borneo decreased by more than 95 percent over the past 100 to 200 years. The decline was most rapid in the past few decades, the researchers report. Their new findings are consistent with a controversial 1987 report in which another investigator estimated a population of more than 20,000 after counting orangutan nests observed from a helicopter.

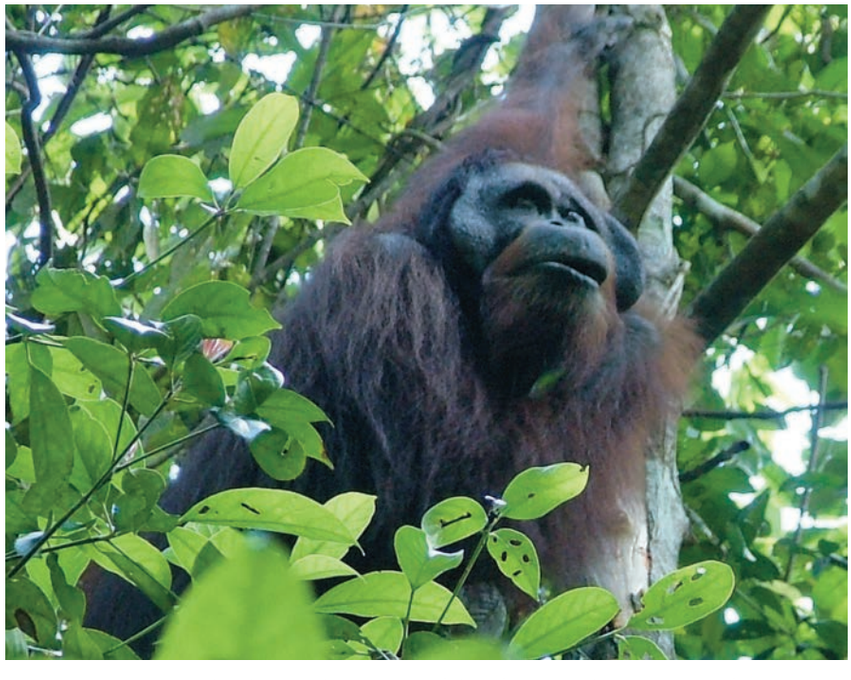
East Borneo orangutans, including the groups that Goossens' team studied, face a high risk of extinction within the next few decades, the researchers conclude. Major survival threats come from forest destruction to develop oil palm–tree plantations and from illegal hunting.

The arrival of the first farmers in Borneo about 5,000 years ago apparently had little impact on the numbers of resident orangutans, Goossens' team says.

The new investigation supports the findings of the 2004 Orangutan Population and Habitat Viability Assessment. After surveying orangutans on Borneo and Sumatra, researchers concluded that habitat loss and other factors would wipe out the animals on both islands within about 50 years.

Neither the new genetic study nor the 2004 project appears likely to spark conservation efforts, remarks anthropologist Roberto A. Delgado Jr. of Hunter College, City University of New York. "There are larger socioeconomic and political forces at play in Southeast Asia," he says.

A proposal to expand timber harvesting is now being considered by the government of Borneo, Delgado notes. Orangutans also suffer from the illegal trade in exotic animals. —B. BOWER



J. SINYOR/KOCP

UP A TREE New genetic study portrays a bleak future for orangutans in Borneo if conservation efforts are not initiated. DNA changes indicate a rapid drop in population.

Mother-of-Pearl on Ice

New ceramics might serve in bones and machines

Beneath the shimmer of an oyster's mother-of-pearl, an intricate microstructure bestows both strength and toughness on the natural ceramic. Now, scientists have come up with a way to replicate that structure in human-made substances.

The process exploits one of the most common transformations in nature—the freezing of water—so it's remarkably simple and potentially inexpensive and environmentally friendly, its developers say.

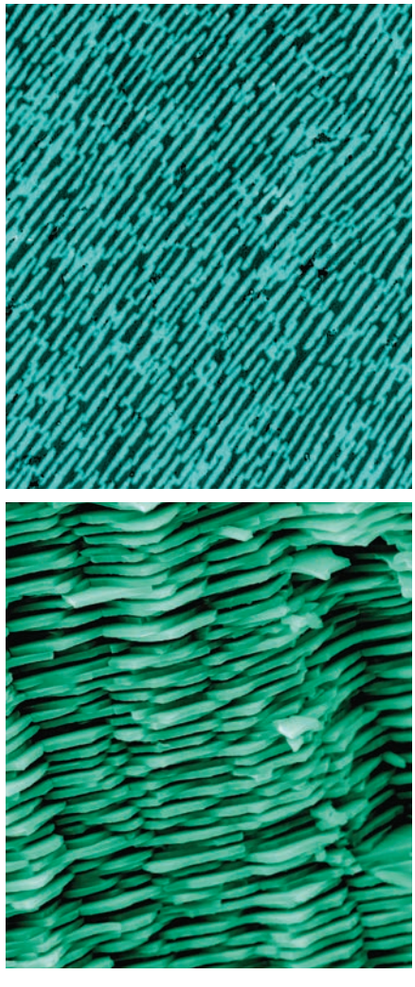
These researchers, at the Lawrence Berkeley (Calif.) National Laboratory, have used their new approach to create an exceptionally rugged substance that may serve as a scaffold for new bone growth. The method also works well with nonbiological materials, report Sylvain Deville and his colleagues in the Jan. 27 *Science*. Using it, the team has fabricated novel metal-ceramic composites that benefit from a seashell-like internal architecture.

Mollusks such as abalone and oysters create their iridescent armor, known as nacre, from brittle calcium carbonate microcrystals and pliant proteins arranged like bricks and mortar, respectively (*SN: 5/16/92, p. 328*). Materials specialists have long envied the composite's resilience, which is superior to that of human-made ceramics.

Past efforts to artificially replicate the shells' architecture have typically stalled after a few microlayers or generated cruder lam-

inations than those in the real stuff, says team member Eduardo Saiz (*SN: 6/21/03, p. 397*). Using the new method, he, Deville, and Antoni P. Tomsia of the Lawrence Berkeley lab and Ravi K. Nalla, now at Intel Corp. in Chandler, Ariz., fabricated centimeters-thick chunks of ceramic with internal layering almost as thin as that of natural nacre.

"This is an exciting paper," comments Manfred Rühle of the Max Planck Institute for Metals Research in Stuttgart, Germany. The new approach "represents a breakthrough in processing advanced materials," he adds.



BRICK-A-STACK Novel materials made from microplates of ceramic such as alumina (top) joined by metal mortar replicate the microstructure and properties of natural mother-of-pearl of an abalone shell (bottom). The two micrographs are at different scales; the artificial plates are actually about 10 times as thick as those in the mother-of-pearl.

To make a microstructured ceramic, Deville and his colleagues mixed water with finely ground ceramic powder and polymer binders. They then poured the blend into a chamber a few centimeters across. By carefully controlling subfreezing temperatures at the chamber's bottom and top, the researchers produced a temperature gradient that generated an ice structure sometimes observed in frozen seawater.

In that structure, sheets of microscopic hexagonal ice crystals formed vertically in the chamber. As those crystals grew, they forced the powder and binders to congregate between the pure-ice sheets. Freeze-drying removed the ice, and high-temperature sintering then solidified each ceramic-binder layer into a solid plate. Finally, the researchers selected a substance to play the role of nacre's protein and introduced it into the spaces between the ceramic plates.

To create bonelike composites, the researchers employed epoxy as the mortar between plates of hydroxyapatite, which is the predominant ceramic in bone and teeth. For nonbiological materials, they bound alumina plates with a mortar containing an alloy of aluminum and silicon and, in some cases, titanium. Such composites may prove useful to many industries, including electronics, machining, and aerospace manufacturing. —P. WEISS

Charting the Past

Surveys map two lost harbors of Phoenicia

By analyzing long tubes of sediment drilled from locations in and around the Mediterranean ports of Tyre and Sidon, scientists have discovered the locations of the harbors from which legions of ancient Phoenician mariners set sail.

Tyre and Sidon, located in what is now Lebanon, were the two most important city-states of Phoenicia, a trading empire founded more than 3,000 years ago. Although archaeologists knew much about the two cities and Phoenician civilization, they have long debated the sizes and locations of the ancient harbors, says Christophe Morhange, a geoarchaeologist at the National Center for Scientific Research in Aix-en-Provence, France. Now, Morhange and his colleagues present strong evidence to settle the dispute.

The researchers drilled 25 holes within the modern city of Sidon and 30 within Tyre, recovering a sediment core at least 10 meters long from each site. From the contents of those samples, representing the past 8,000 years, the team determined the locations and extents of the ancient harbors. And by carbon-dating the plants, wood, and shells in the harbor samples, the researchers pegged the period when the ports were active. Morhange and his colleagues report their findings in the January *Geology*.

Both harbors started out as natural bays before the cities were built, says Morhange. The shells and remains of marine organisms found in the oldest sediments are characteristic of sheltered waters. While large ships could have anchored in the bays when the cities were young, their cargo would probably have been ferried to shore in small boats.

About 1200 B.C., the Phoenicians began building artificial harbors to shelter their fleets and to accommodate their expanding trade network, Morhange proposes. Protective structures calmed the waters, and fine-grained sediments accumulated.

Although Tyre and Sidon gained their fame and splendor during the Phoenician era, the ports were most active in the Greco-Roman and Byzantine periods, from about 330 B.C. until A.D. 1000. The large amounts of fine sands and mud deposited during this interval hint that the harbors were almost fully enclosed, says Morhange. The Romans dredged some areas to maintain sufficient depth for ships.

With the demise of the ports during medieval times, a more open marine environment returned. Then, over time, the harbors became clogged with silt. Later, the city centers of modern Tyre and Sidon were built upon material that accumulated after the cities' fortunes waned.

Although the ancient cities were considered important, archaeologists had few other details, says Dorit Sivan, a coastal geologist at the University of Haifa in Israel. The sediment record is sometimes better than the archaeological one because cities often are destroyed and then rebuilt, she notes.

The team's findings "solve a centuries-old mystery of where these harbors actually were," says David E. Fastovsky, a geoscientist at the University of Rhode Island in Kingston. —S. PERKINS

Hunter Beware

Infectious proteins found in deer muscle

Infectious agents called prions that cause a mad cow–like disease in deer and elk are present in the infected animals' muscles, according to a new study. Prions had been shown to congregate primarily in the brains and spinal cords of infected animals, so the finding could increase concern among people who eat deer meat.

Researchers have found that prions are responsible for similar diseases in several species: for example, Creutzfeldt-Jakob

DEVILLE ET AL./SCIENCE

disease in people; bovine spongiform encephalopathy, also known as mad cow disease, in cows; and chronic wasting disease (CWD) in deer and elk. These diseases start when a normal protein present in all mammals, called the prion protein, becomes misfolded. When normal prion proteins interact with the misfolded ones, they also become misfolded and propagate the disease.

Since transmission of these diseases relies partly on the similarity between the infectious prions and the normal proteins, each disease typically passes only among members of the same species. However, some prion diseases can pass between species—bovine spongiform encephalopathy has killed people, for example.

Earlier studies in cows had suggested that muscle and other tissues from infected animals are free of prions. Thus, hunters handling or eating muscle from deer with CWD hadn't previously been considered at risk for prion exposure (*SN: 11/30/02, p. 346*). However, some researchers suspected that muscles of infected deer carry prions, says Glenn Telling, a microbiologist at the University of Kentucky in Lexington.

Telling and his colleagues took samples from the brains and muscles from deer infected with CWD and from deer that didn't have the disease. The researchers injected these samples into the brains of mice that were genetically engineered to carry the deer form of the normal prion protein, making them susceptible to CWD.

PHOTODISC

MUSCLE TROUBLE **Muscles from deer infected with chronic wasting disease carry infectious proteins. Researchers don't yet know whether the proteins can infect people who eat deer meat.**

As expected, mice injected with bits of CWD-infected deer brain readily came down with CWD, showing telltale neurological symptoms within 9 months. Mice injected with tissue from uninfected deer never showed signs of the disease. However, Telling's group found that mice injected with infected deer muscle also developed CWD, although symptoms took about 5 months longer on average to arise than they did in mice receiving infected brain matter.

The researchers report these results in an upcoming *Science*.

Telling notes that the findings don't necessarily mean that people who eat meat from infected deer will come down with CWD. "Whether or not humans will be susceptible to CWD is a gray area right now," he says.

However, says neurologist Patrick Bosque of Denver Health Medical Center, the new results "clearly support [the possibility] that humans who eat CWD-infected deer are exposed to prions. If humans can avoid consuming meat from these deer, they probably should." —C. BROWNLEE

QUOTE

"It's another cool example of an insect-microbe interaction."
CAMERON CURRIE, University of Wisconsin–Madison

Eggs Scramble

Fungi trick termites into babysitting

In a novel case of egg mimicry, a fungus is taking advantage of hard-working termite nursemaids, a researcher says.

A fungus in the genus *Fibularhizoctonia* forms compact balls of tissue that, under the right conditions, can start a new colony of the fungus, explains Kenji Matsuura of Okayama University in Japan. Termites in both Japanese and American species pick up these balls and tuck them into a nest's egg piles.

At first, Matsuura and other entomologists had speculated that fungi and termites both benefit from their relationship. Now, the fungi look as if they're just parasites, Matsuura says in an upcoming *Proceedings of the Royal Society B*.

The most famous egg parasites are birds. Cuckoos and cowbirds, for example, sneak their eggs into the nests of other species. The victims often accept an interloper egg and raise the chick.

The fungus balls are brownish spheres that don't look like the white, sausage-shaped termite eggs. However, it's dark in a termite nest. Mimicry doesn't have to be visual, says Matsuura.

He reports that some *Reticulitermes*-termite nursemaids adopt fungus balls that match the diameter of eggs. The fungus balls of this species are smaller than those of other species. In experiments with glass beads, he found that an object had to also have the right egg scent to appeal to the termites. Moreover, microscopy showed that fungus balls in this species have smoother surfaces, more like those of termite eggs, than do similar structures of closely related fungus species.

Matsuura also examined whether termites benefit from the relationship. His original research, conducted with two colleagues, suggested that more termite eggs survive if they commingle with fungal balls. But that study was conducted in a lab setup without natural nesting material.

Now, Matsuura has tested termite-egg survival in nurseries furnished with a chunk of wood plastered with termite droppings, which carry natural antibiotics. In this setup, Matsuura saw no jump in survival for eggs sharing a nursery with fungal balls.

He suggests that in the wild, termites waste energy on faux eggs made of a fungus that the insects don't eat. He points out that workers often groom more than 10,000 eggs and fungus balls per day.

Benefits in a mutual relationship, as well as costs, can take a while to tease out, notes microbial ecologist Cameron Currie of the University of Wisconsin–Madison. A benefit might show up only under certain conditions, so he says that he's looking forward to more research before declaring this fungus-termite relationship straightforward parasitism.

In any case, Currie says, "it's another cool example of an insect-microbe interaction." —S. MILIUS

Double Dose

Two ways to boost kidney-transplant viability

By testing the blood-purifying capacity of kidneys obtained for transplant from people 60 years or older—then culling the worn-out kidneys—scientists have identified organs likely to last in their new hosts. To bolster a recipient's odds, researchers transplanted the older kidneys in pairs.

The measures could expand the number of kidneys available to patients, says study coauthor Giuseppe Remuzzi, a nephrologist at Mario Negri Institute for Pharmacological Research in Bergamo, Italy.

There's a shortage of good kidneys for transplant. In the United States, about 65,000 people with severe kidney disease are candidates for a transplant. Yet only about 16,000 of them will find a matching donor this year. Nearly all will get a single kidney. More than half of the transplants

come from brain-dead donors or cadavers; the others come from a living relative or an unrelated donor.

Within 10 years, nearly two-thirds of kidneys transplanted from brain-dead donors or cadavers fail, defined as a decline in blood-filtering capacity to a point at which the person needs dialysis. Many of these people go back on the waiting list for a new kidney.

In the new study, doctors gave transplant candidates two options for receiving kidneys from brain dead-donors: get on a waiting list for a single kidney from a person of unknown age or receive one or two kidneys from a person age 60 or older.

For the latter group, doctors went beyond standard practice by taking biopsies of potential transplant kidneys before they were removed. The team evaluated an organ's supply of healthy nephrons—the kidneys' blood-filtering cell clusters. Kidneys lose nephrons over the years, and in this experiment, only organs with a good supply of nephrons were removed and transplanted.

Of the 62 patients electing to get the screened kidneys from an older person, almost all received a pair. The standard-transplant group was made up of 248 patients. Each patient received one unscreened kidney; half came from a donor under age 60 and half from someone 60 or over. The physicians matched donors and recipients for immune compatibility.

During 2 years of follow-up, the researchers found that of patients receiving a pair of older kidneys that were tissue tested before transplant, about 6 percent had kidney failure. That same percentage failed among untested kidneys obtained from donors under age 60. However, 23 percent of untested kidneys from donors age 60 and over failed, the researchers report in the Jan. 26 *New England Journal of Medicine*.

STATS

65 thousand

People in the United States waiting for a kidney transplant

The study supports the view of nephrologist Barry M. Brenner of Harvard Medical School and Brigham and Women's Hospital in Boston, who maintains that the future well-being of a transplanted kidney is in large part governed by its number of functional nephrons. Since the 1990s, Brenner has argued that nephrons are the overlooked players in kidney transplants. He notes that small kidneys transplanted into large people have a high failure rate, probably because the nephrons become overworked.

When tests show that their nephron numbers are marginal, Brenner advocates transplanting kidneys from brain-dead donors in pairs, and hence delivering more nephrons. While transplanting two kidneys into a single recipient might limit the number of organs available to other people in the short term, the kidneys would last longer and reduce the number of transplant recipients returning to the waiting list, he says. —N. SEPPA

Young Scientists Get Results

Science, math, and engineering competition selects 40 talented finalists

Forty high school students—the top 2.6 percent of 1,558 competitors—have each earned a spot as a finalist in the 65th annual Intel Science Talent Search. With some half-a-million dollars in scholarships hanging in the balance, the students' diverse science, math, and engineering projects will compete head-to-head in Washington, D.C., in March.

As in past years, New York produced more finalists than any other state did. A student from Idaho and another from Utah are the first finalists to represent their respective states in more than a decade.

Women make up 42.5 percent of the overall group.

"While as a nation we continue to struggle to improve science and math education, these students give us hope for our future," says Craig Barrett, chairman of Intel Corp. of Santa Clara, Calif.

Intel sponsored the event, which is administered by Science Service, the publisher of *Science News*. Both organizations announced the finalists' names on Jan. 25.

Past finalists have gone on to win Nobel prizes and other illustrious awards in scientific fields.

The 2006 finalists are:

Alabama: Jennifer Ann Taylor, Florence H.S., Florence.

California: Genevieve Williams, Redondo Union H.S., Redondo Beach; Michael Anthony Viscardi, Josan Academy, San Diego; Yi Sun, The Harker School, San Jose.

Colorado: Adam Daniel Sidman, William J. Palmer H.S., Colorado Springs.

Connecticut: Kiran Reddy Pendri, Choate Rosemary Hall, Wallingford; Jonathan Blake Sellon, Staples H.S., Westport.

Florida: Shoshana Sophie Rothman Tell, Pine Crest School, Fort Lauderdale.

Idaho: Lucas Edward Moller, Moscow H.S., Moscow.

Illinois: Xin Wang and Letian Zhang, Illinois Mathematics & Science Academy, Aurora; Sukrit Ranjan, Glenbrook North H.S., Northbrook.

Louisiana: Kate Elizabeth Lowry, Louisiana School for Math, Science & the Arts, Natchitoches.

Maryland: Myers Abraham Davis, Baltimore Polytechnic Institute, Baltimore; Jeffrey Chunlong Xing, River Hill H.S., Clarksville; Minh-Phuong Huynh-Le and Yuan Zhang, Montgomery Blair H.S., Silver Spring.

Massachusetts: Kimberly Megan Scott, Wellesley H.S., Wellesley Hills.

Michigan: John Cong Zhou, Detroit Country Day School, Beverly Hills.

New York: Allison Mae Gardner and Joseph Daniel Vellone, Byram Hills H.S., Armonk; Adam Ross Solomon, John F. Kennedy H.S., Bellmore; Irina Vladimirovna Zaitseva, Centereach H.S., Centereach; Jerrold Alexander Lieblich and Harley Huiyu Zhang, Ward Melville H.S., East Setauket; David Bruce Kelley, Highland H.S., Highland; Brittany Nicole Russo, Sanford H. Calhoun H.S., Merrick; Eric Allan Meyerowitz, Northport H.S., Northport; Carmiel Effron Schickler, Paul D. Schreiber H.S., Port Washington; Sarah Kate Rapoport, Horace Mann School, Riverdale; Sheela Krishnan, Suffern H.S., Suffern; Diane Jeehea Choi, Syosset H.S., Syosset.

Ohio: John Pease Moore, Dayton Christian H.S., Dayton.

Oregon: Elyse Autumn Hope and Sergio-Francis Mellejor Zenisek, Oregon Episcopal School, Portland.

Texas: Evan Scott Gawlik, Texas Academy of Mathematics & Science, Denton.

Utah: Shannon Lisa Babb, American Fork H.S., American Fork.

Virginia: Justin Moore Solomon, Thomas Jefferson H.S. for Science & Technology, Alexandria.

Washington: Anna Jolene Mork, Shorewood H.S., Seattle.

Wisconsin: Nicholas Michael Wage, Appleton H.S. East, Appleton. —B. HARDER

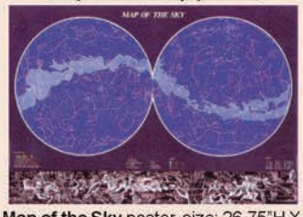
Science Mall shopping

sciencemall-usa.com

Rocks, Minerals and Gemstones

Rocks, Minerals and Gemstones of the U.S. 100 piece set, size: 20"L X 12"W X 1"D, Oak casing. Great for classrooms, collectors or young scientists. Suitable for wall hanging. Order #JPT-1888, Cost: $85.00 *Meteorite included!*

Map of the Sky poster



Map of the Sky poster, size: 26.75"H X 38.5"L and shows the constellations in the heavens and much more! Order #JPT-skymap, Cost: $15.95

The Planets *poster*

The Planets poster, NEW! - Very colorful. Laminated, size 24" H X 36" W, one of the best posters seen on this subject. Order #JPT-planets14, Cost:$15.95

Saturn *poster*

Saturn poster, NEW! - Very colorful. Laminated, size 24" H X 36" W, with all kinds of interesting facts about Saturn. Order #JPT-planets14, Cost:$15.95

Deluxe Dinosaur Panorama Poster

The Deluxe Dinosaur Panorama poster - A colossal wall poster that embodies the elegance and power of dinosaurs. Painted by Haruo Takino. Size: 64.375"L X 22.75"H and comes laminated. Order #JPT-dinopan cost: $38.00

Dino Panorama Floor Puzzle - 70 piece - NEW! Puzzle size: 39"W X 14" H #JPT-dinofloor, Cost: $16.95

Dino Panorama Puzzle - 1,000 piece - Puzzle size: 37"W X 13"H #JPT-1000 Cost $19.95,

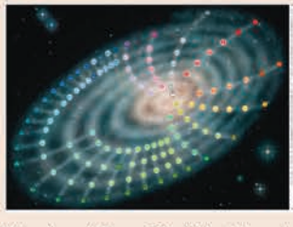
Both puzzles are based on the deluxe poster shown above.

The Sun *poster*

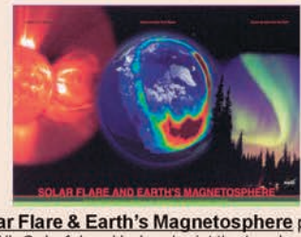
The Sun poster, NEW! - Very interesting and informative. Size: 24"W X 36"L, laminated NEW! Order #JPT-sun, Cost $15.95

Oviraptor in Egg Replica Authentic, hand-painted replica of the first carnivorous dinosaur embryo ever found. It was discovered in 1994, in Mongolia. The replica is the actual size and is constructed of durable polyvinyl. NEW! Comes with educational tag. Size: 5"L X 3" H, Order #JPT-ovegg, Cost $12.95

Chemical Galaxy: *A New Vision of the Periodic Table of the Elements*



Chemical Galaxy poster is a new creation in the world of periodic table charts. Developed by Philip Stewart, Oxford University, this table was created in a spiral design. It uses a starry pathway to link the elements and to express the astronomical reach of chemistry. Copyright 2006, Size: 26"H X 38"W Laminated, info sheet provided. Order#JPT-2221, Cost $28.95



Solar Flare & Earth's Magnetosphere poster, NEW! -Colorful and helps depict the true beauty of nature. Size: 24"W X 36"H, laminated, Order #JPT-1211, Cost $15.95

Red Eye Frogs poster

Red Eye Frogs poster Size: 24"W X 36"H, laminated, Order #JPT-stars, Cost $15.95 *They are just adorable!*

This elegant **Paua Shell Necklace** is unique to New Zealand. A commoner name for it is the "abalone" shell. The Paua shell is easily among the most colorful shell in the world and its shimmering rainbow of colors and iridescence make it among the most sought-after for "elegant wear" jewelry. Comes with a 20"gold braided chain. 14K gold wire wrapped pendant is hand sculpted in a cosmic spiral design. Size: 2 1/8" X 1 1/8"W Order # JPT-1033, Cost: $85, including display box. For Paua shell earrings and matching pendant order #JPT-1040 - $165, which includes elegant, crushed black velvet display case.

Authentic Titanic Coal Pendant - classy and attractively wrapped in 14K pendant style -w- 20" gold-braided chain. Coal- the only thing sellable to the general public from that famous shipwreck. Order #JPT-1637, Cost $145; #JPT-1552, Cost $165 (garnet or aquamarine accent added)

Famous Allende Meteorite Pendant

Why is this meteorite famous? It is one of the most studied meteorites in the world! Allende is a Type CV3 carbonaceous chondrite. The white clumps in this meteorite are called CAI's (calcium-aluminum inclusions) and are believed to represent the first silicate minerals to have condensed out of the solar nebula 5 billion years ago. Carbonaceous chondrites are thought to be the oldest form of matter in the universe and have a composition very close to that of the sun. Meteorites are older than the oldest rocks on Earth, making them, in our brief lifetimes, seemingly "eternal." 14K Gold Rope Style Pendant, with a 20" gold chain, info and authenticity. Very Limited Quantity. Order #JPT-Allende, cost $285

Other meteorite pendants available: Meteorite set in sterling silver pendant in the style pictured above, meteorite NWA 869, discovered near Tindouf, Africa. Size: 1" X 1" with 20" braided sterling silver chain, Order #JPT-1064 - $75.00, In gold style as above, meteorite NWA 869, Order #JPT-1165, Cost $185.00, 20" gold braided chain displayed in a crushed black velvet jewelry box with information and authenticity.

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FIRST STEPS

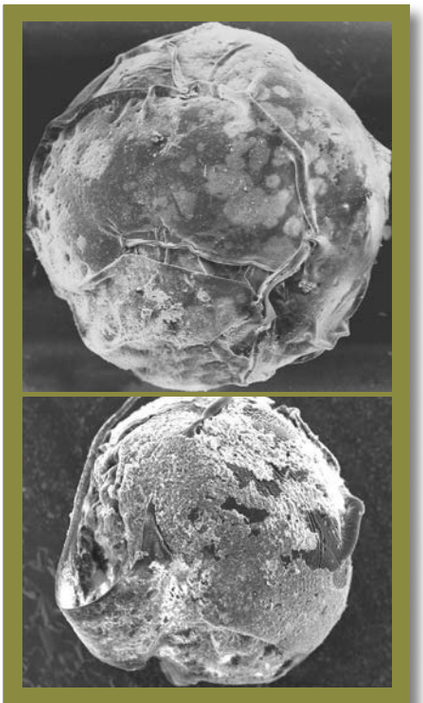
Modern science investigates the initial stages of how fossils form

BY SID PERKINS

Imagine that during a tour of the paleontology wing of a museum, a group stops to gaze upon a 150-million-year-old fossil of *Archaeopteryx*, the world's first bird. "Only 10 of these have been discovered since the species was first described in 1861," says the guide. "Amazing," a tourist marvels. "I wonder why there are so few." Simultaneously, a paleontologist standing nearby is thinking, "I wonder why there are any at all."

Archaeopteryx fossils may be rare, but those that scientists have collected preserve the ancient creature intact, or nearly so. The creature's delicate skeleton and feathers show up clearly. They're encased in limestone presumably derived from the layered, fine-grained sediments that accumulated on the bottom of an ancient lake. But modern birds don't usually end up in peaceful repose on lake bottoms. If the birds die over water, their light carcasses typically float until they rot. Now, researchers who've conducted field experiments with a couple-dozen dead birds and a little mud say that they've come up with a scenario that may explain how such fossils get their start.

Mystery underlies the fossilization not just of birds but of most animals. Some teams of scientists are now using lab and field tests to investigate how postmortem processes affect animal tissues of various types and sizes, from crustacean embryos to elderly rhinos. In doing so, they're gaining insights into the fossilization process. That information may lead to more-accurate interpretations of the fossil record and reveal new views of ancient creatures and their environments.



GETTING HARDER — The surface of a European lobster egg (top) becomes almost completely mineralized (bottom) after a month-long bath in phosphate-rich seawater.

STICK IN THE MUD Most organisms live, die, and disappear without leaving any hints that they ever existed. Some creatures, however, leave behind trace fossils, such as their burrows or their footprints (*SN: 6/9/01, p. 362; 1/7/06, p. 3*). In rare cases, biological remains survive scavengers and decomposition, become buried, and evade geological processes such as erosion. These are the remains that become fossils—either by making an impression in rock or by themselves turning into rock.

Most carcasses that harden into fossils, including those of birds, were deposited in a body of water and then buried by sediment, says David A. Krauss, a paleobiologist at City University of New York. However, the irksome fact that dead birds float conflicts with this observation. In fact, bird carcasses float for quite a while, according to the results of experiments conducted by Krauss and his colleagues. The researchers reported their findings last October at a meeting of the Society of Vertebrate Paleontology in Mesa, Ariz.

In their tests, conducted outdoors during the summer, Krauss and his colleagues placed carcasses of doves, swallows, and blackbirds in tanks filled with water. Every one of the dozen birds floated. By the end of the third day, a thick film of bacteria had formed on the carcasses. Soon thereafter, the birds' remains became infested with bugs and maggots. Over the next 3 to 4 weeks, the carcasses decayed, lost some feathers, and began to fall apart—but they still floated.

Only after decomposition breached the birds' internal air sacs and permitted water to flow into those cavities did the body parts finally sink, says Krauss. At that point, the remains certainly wouldn't have made informative fossils.

After some experimentation, the researchers found a way to overcome a dead bird's buoyancy. When a carcass was dropped onto moist sediments that contained clay, the material soaked into the bird's feathers and bound the body to the mud in just a few minutes. Later, when water was added to the tank, the stuck-in-the-mud carcass remained submerged.

Taking their work even further, Krauss and his team added enough sediment to the tanks to bury the submerged carcasses. Then, they placed weights on the mud to increase the pressure, as a naturally buried body would experience if accumulating lake sediments gradually covered it. The team left the bodies in place for 3 years.

When the researchers unearthed their samples, they found that the patterns and extent of preservation of the faux-fossil birds were remarkably similar to those seen in actual fossils millions of years old. This resemblance suggests that the remains of ancient birds might have begun their process of fossilization in just such a way, Krauss notes. The team's findings may enable scientists to better interpret fossils and deduce the environments in which they formed, he adds.

TOUGH EGGS Some body parts, such as bones and teeth, have a good head start on fossilization because they contain significant amounts of long-lasting minerals. Soft body parts, by contrast, typically succumb to decomposition. However, even the flimsiest of tissues can become fossils if environmental conditions are right.

BRIGGS

In 1998, for example, scientists reported finding fossils of two- and four-cell embryos. These fossils, less than a millimeter across, turned up in rocks derived from marine sediments deposited about 570 million years ago (*SN: 2/7/98, p. 153*).

Ancient arthropods or their predecessors were probably the source of the embryonic remains, says Derek E.G. Briggs, a paleontologist at Yale University. He and his colleagues conducted lab experiments to see whether they could replicate the fossilization of these gelatinous tissues.

The researchers took eggs of several modern-day aquatic crustaceans and placed them in glass vials that contained a fluid resembling seawater. To some of the vials they added extra phosphate because the rocks that had yielded the ancient embryos were rich in that mineral. To simulate the burial of eggs by the creature that laid them, the researchers added to many of the vials sediment taken from an estuary. All the vials were crimped shut and then stored at 15°C.

Bacteria naturally present in all the samples fed on available nutrients, including the eggs. In less than a day, that activity robbed the water of its oxygen and the bacteria died, so no further decomposition occurred.

The release of hydrogen sulfide, carbon dioxide, and small amounts of fatty acids during the brief period of decomposition caused the water to become more acidic, says Briggs. That, in turn, set up conditions in which dissolved carbonate and phosphate minerals could more easily precipitate from the solution and accumulate on what remained of the eggs and on other surfaces.

Only in one set of environmental conditions—that in which many European lobster eggs were buried in sediment—did eggs acquire a complete coating of minerals. However, some tests with apparently identical environmental conditions failed to produce mineralized eggs, Briggs notes. Even within a single vial, effects sometimes weren't consistent: Some eggs had patches of minerals on their exteriors, while others ended up with none. Briggs and his colleagues report their findings in the December 2005 *Palaios*.

Although the details about what triggered the mineralization of eggs remain elusive, the tests show the important role that oxygen depletion and low pH play in the process, says Briggs.

In some cases, the coating was visible after just 2 weeks. Most tests lasted no more than a couple of months, but several ran for 10 months or more. Even after that period, mineralization showed only on the eggs' outer surfaces, not within them.

Mineralization of an egg's contents must take longer than the experiments had run, says Briggs. However, the team's findings suggest that eggs can remain intact in sediments at least a year, if not longer. In essence, fossilization is a race between the processes of mineralization and decay, he notes.

BIG MUMMY In 1983, in a remote site on the campus of the University of Wisconsin–Madison, a small group of people buried the headless carcass of a white rhino. Neither a fraternity prank nor part of a voodoo ritual, the interment was the first step in an experiment to study the decay and decomposition of a large animal.

The rhino, which had been donated to one of the university's museums after it died in a nearby zoo, was buried on its side in sandy soil at a depth of about 2 meters, says paleontologist Joe Skulan. Soil temperature at that depth was a nearly constant 7.3°C. The soil was well drained, so oxygen could reach the carcass, but it was also perpetually moist. This combination of conditions maximized the rhino's rate of decay but minimized damage to its carcass from freeze-thaw cycles and the growth of plant roots, says Skulan.

When the scientists unearthed the carcass in the early 1990s, they found that its hind limbs were detached from its body. After taking a few tissue samples, they reburied the rhino. Then, when the scientists dug up the rhino in the spring of 2002, they found that much of the flesh from the creature's rear legs and lower front legs had disappeared. However, muscles from the creature's forelimbs and shoulder had not only escaped degradation, but were moist, pliable, and bright red—"like [they] came out of a butcher's shop," says Skulan.

Fragments of the leathery toe pads from the creature's front feet were still present, but most of the rhino's skin was missing. The rhino's internal organs had dehydrated and shrunk within its body cavity, which hadn't collapsed despite the weight of the overlying soil. That body cavity was surrounded by a thick layer of adipocere, a hard, grainy substance commonly known as grave wax. Adipocere often forms in cool, moist environments when chemical reactions crosslink fat molecules in a body, which makes them into a soap.

Among preserved remains of ancient humans, so-called soap mummies are much more common than the desiccated mummies that people typically think of, says Skulan. This kind of preservation may also explain the formation of fossils known as mummified dinosaurs, which preserve considerable volumes of soft tissue such as muscle and cartilage as well as bones, he notes.

In the spaces between vertebrae and other bones of the buried rhino, the researchers found crystals of a mineral called struvite, a hydrated version of ammonium calcium phosphate. The ammonium ion in the compound comes from the decomposition of nitrogen-rich organic material, says Skulan. As such, the presence of struvite—or minerals that derive from it—near fossilized bones may be a sign that remnants of soft tissue have also been transformed into struvite and thus preserved.

"There's a lot of bad information out there about fossilization," says Skulan. "If you look at the modern descriptions of fossilization, they're the same as the ones included in the 1795 *Encyclopedia Britannica*." Only in the past decade or so have people begun to study in detail what happens to organisms after death, he adds.

Because plants and animals produce such a variety of tissues, Skulan says that there's no single route that scientists can identify as fossilization. In a sense, fossilization is as much a process of elimination as an active means of preservation.

"We need to look not at how tissues are preserved but at how they're destroyed," Skulan notes. "Because bones are already highly mineralized, they're already mostly rock. Unless something happens to destroy [that bone], it's gonna persist. ... If a buried bone lasts 10 years, most of the things that can happen to it have already happened." ■

I FOUND THE SOAP — A researcher unearthing the carcass of a rhino buried 20 years (top) discovered large deposits of adipocere (white in bottom photo), a soapy substance formed when chemical reactions cross-link fat molecules.

SKULAN

JUST DUET

Biologists puzzle over birds' ensemble vocalizations

BY SUSAN MILIUS

As the morning mists rose on the slopes of Ecuador's Pasochoa volcano, the burbling of plain-tailed wrens came through the bamboo thickets. Two researchers started their standard procedure of catching wrens, banding them, and letting them go. Soon, however, they were startled when a small cluster of wrens settled into a bush and began singing together. It turned out to be "one of the most complex singing performances yet described in a nonhuman animal," says Nigel Mann.

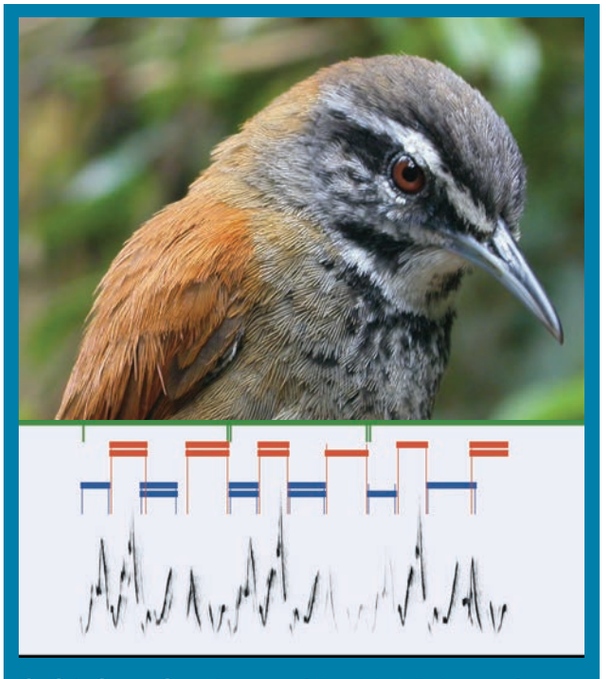
Mann, of the State University of New York at Oneonta, and a colleague had gone to Pasochoa in the summer of 2002 as part of a team that was surveying of the 28-or-so species of the bird genus *Thryothorus*. That genus is famous for musical duets, in which a male and a female alternate phrases, sometimes so rapidly that it sounds like one song. Ecuador's plain-tailed wrens (*Thryothorus euophrys*), relatives of North America's Carolina wren, make a rhythmic, bubbling song together.

Most other wrens in this genus pair off and fiercely defend a territory. "If [four wrens] actually got within a few feet of each other, they'd be fighting," says Mann. That's why he and Kimberly A. Dingess of Indiana University at Bloomington were so surprised to find several plain-tailed wrens sharing a bush. "It took a few hours of wandering around for us to realize we had a group-living species," Mann says.

This social oddity has musical consequences. Often, three or more birds sing—males, then females, then males, and so on—to produce what sounds like a single melody.

"It's quite difficult to work out what's Charlie's contribution, what's Mary's," Mann says.

Yet the scientists did work out the score. At rare moments in the several weeks of observation, Mann or Dingess picked up clues to which bird was singing when one singer perched closer to the microphone than the rest of the chorus did.



CHORUS LINES — The song of the plain-tailed wren of Ecuador sounds like one continuous bubbling tone. However, it comes from two birds and often more. In the jagged sonogram trace (bottom), males sing two kinds of sections (under blue bars) and females fill in gaps with two kinds of phrases (under red bars). Double bars represent two same-sex singers.

From these hard-won moments, the researchers realized that songs typically repeat four phrases: ABCDABCD.... Only males sing the As and Cs, and only females sing Bs and Ds. Each singer knows 25-to-30 variations on each of its two possible parts, and for each variation of A, a particular variation of B usually follows, as do particular Ds after Cs.

When more than two birds strike up a tune, they double up on the parts so precisely that if one bird stops singing, the tune keeps going. The males sing the same variation of A with precise timing, followed by the females chorusing the same version of B, then back to the males for the same C, and so on. The parts shift back and forth at least twice a second. For sounds files, see *www.sciencenews.org/20060128/duets.asp*.

It's the first four-part, synchronized chorus with alternating parts recorded outside human music, Mann, Dingess, and Peter J.B. Slater of the University of St. Andrews in Scotland report in an upcoming *Biology Letters*. And when one considers the split-second alternation, the birds' singing surpasses human vocal virtuosity.

That's the latest, most extreme example of duetting birds, a phenomenon that has fascinated birders for decades and inspired its own chorus of theorizing about what might drive such displays. Warning off rivals? Foiling flirtations? Checking musical passwords? In the past few years, field biologists have applied modern ideas about evolution to begin new tests of why duetters do it.

SINGING DOUBLE Honks, squeaks, and melodic syllables can all be scored into avian duets. In at least 222 bird species worldwide, or about 3 percent of those known, two or more individuals routinely coordinate their vocalizations.

Duetting shows up in a range of bird families and takes many forms, says Michelle Hall of the Australian National University in Canberra. Although members of a mated pair typically alternate as they sing their parts, duos within some species sing in unison. In a few cases, two males vocalize together, or several birds form an ensemble, as among the plain-tailed wrens.

An ornithological sorrow of life in northern temperate zones is

MANN/ BIOLOGY LETTERS

the scarcity of duetting birds. The few nontropical birds that perform together generally do simple numbers.

Ornithologists have described male and female Canada geese alternating honks. And Lauryn Benedict of the University of California, Berkeley is studying a duet of California towhees where male and females produce simultaneous, near-identical, squeal-like vocalizations that are used only in duets and never alone.

Most birds that duet—and the most interesting vocal interactions—come from somewhere other than northern temperate zones.

Among magpie-larks, which Hall studied during the 1990s, males and females sing solo as well as together. Common in Australian suburbs, the long-legged, black-and-white birds "can sound a little raucous," says Hall. Either sex can initiate a duet, typically starting to repeat one of nine musical motifs, such as "peewee," with a gap of a third to a half second between repetitions. On occasion, the mate inserts another motif in the gaps to make, for example, a "peewee o-wit peewee o-wit peewee" duet.

Male eastern whipbirds in Australia start a duet with a whistle and a sound like that of a cracking whip, and females chime in with several notes. Up and down Australia's east coast, males sounded remarkably similar, but females had regional variations, report Amy Rogers of the University of Melbourne and Daniel Mennill of the University of Windsor in Ontario in the January *Journal of Avian Biology*.

In one of the rare male-male duets, two long-tailed manakins advertise the location of a courtship perch by simultaneously singing "Toledo."

Male-manakin duos with the tightest coordination get the most visitors, report Jill Trainer of the University of Northern Iowa and her colleagues. However, only the dominant male of a singing pair does any mating. The second manakin can spend up to 10 years with no apparent reward but his increasing skill in singing along.

TROPICAL TUNES — Males and females of many tropical *Thryothorus* wren species, such as the buff-breasted wren, trade parts back and forth so fast that they sound like one song. Sonogram traces 3.5 seconds of a wren duet, with the male's part in purple.

GILL

WHY, OH WHY? Over several decades, scientists have offered at least a dozen explanations for the purpose of avian duets. The theories have focused on the forest, the pair, or conflicts of interest between individual birds.

The abundance of duetting in the tropics inspired some of the early explanations. Scientists in the 1970s noted that dense tropical vegetation would make sound especially important for mates identifying each other or keeping in contact. Recently, theorists have suggested that tropical birds duet to stay in sync reproductively, despite limited seasonal cues such as changes in day length.

Other scientists have stressed the partnership. For example, in the 1980s, the "coyness hypothesis" proposed that birds that consummated their pairing only after the arduous job of learning to duet would have a stronger bond that would discourage extra-pair adventuring.

Yet other theorists have suggested that duetting enables a bird to judge its mate's commitment to the partnership. Discouraging interlopers has been a popular theme, both in duetting to defend a territory and duetting to drive away a potential mate stealer.

Several current duet researchers trace their interest in the field to 1996 papers by Rachel Levin, now of Pomona College in Claremont, Calif. Her work challenged the idea that achieving coordinated singing is a difficult task.

Levin studied Panama's bay wrens, which duet with rapid-fire, his-her alternation. When she kidnapped the mates of 10 bay wrens, the left-behind bird found a new mate and managed immediately to duet almost as well with the new partner as it had with the old.

Too often, these earlier theories treated a duet as a single, cooperative behavior performed for mutual advantage, Levin suggested. Because evolutionary forces act on individuals, Levin urged her colleagues to scrutinize the interests of individuals instead of happy pairs.

Levin's work "reignited the excitement about duets," says Mennill, who was inspired to take up the study of duetting in another tropical wren.

SHE'S/HE'S MINE The current generation of duetting studies often compares his-and-her agendas. One possible agenda is the male's clear interest in fathering the female's chicks. He may be chiming in to the female's song as a musical claim to paternity. If so, Hall says, then a male should duet more when his partner is fertile than when she's not.

That idea didn't hold up in magpie-larks. Hall found that a female tends to sing less when fertile and that a male is less likely to join in when his singing partner is fertile than when she's not.

Buff-breasted wrens (*Thryothorus leucotis*) in Panama do something similar, says Sharon A. Gill, now at Princeton University. Males go "wop," and at times, females smoothly interpose "weooh."

Gill calculated females' fertile periods by keeping track of when they laid eggs. The mates started duets less frequently during these times than when the females weren't fertile, Gill reported in the April 2005 *Behavioral Ecology and Sociobiology*.

Males didn't seem that concerned about paternity in general, Gill says. She didn't find them sticking extra close to mates during fertile times. Nevertheless, only one of the 31 broods that she analyzed showed evidence of mixed parentage.

Even if duetting doesn't guard paternity, either partner might have an agenda "to defend their partnership," as Gill puts it. For example, consider the warbling antbirds in the Amazon (*Hypocnemis cantator*). Males sing solos, and, at times, females add girls-only song elements, report Nathalie Seddon and Joseph Tobias, both of the University of Oxford in England.

When the researchers played songs recorded from other warbling antbirds, both males and females were more likely to approach the speaker and to sing in response to same-sex solos than to male-female duets. When antbird couples hear recorded solos of a female, the resident male usually begins to sing. But then the resident female typically jumps in to duet sooner and more often than she does after recorded duets or male solos. That female is duetting to discourage same-sex interlopers, the researchers suggest in the January/February *Behavioral Ecology*.

African birds called tropical boubous (*Laniarius aethiopicus*) also show signs of mate guarding, but with a twist, Ulmar Grafe and Johannes Bitz of the University of Würzburg in Germany reported in 2004. When they played recorded male solos to pairs

of birds, the female joined in to sing along. Then, in half of the six pairs studied, the female's mate started overlapping the notes in the recorded male solo. Grafe and Bitz interpreted this as a male jamming the signal from a too-enticing male intruder.

MY LAND Territory, as well as mates, might be worth duetting for. As many of the tropical duetters do, rufous-and-white wrens (*Thryothorus rufalbus*) defend their turf year-round. Their duets are "fluty, haunting-sounding," says Mennill, in contrast to the more-staccato bursts of other tropical wrens. In 70 percent of the rufous-and-white wrens' duets, the females join a male song, rather than the male picking up on a female's vocalization, Mennill reported in the January 2005 *Auk*.

The researcher moved around a pair of speakers, one broadcasting a male part in a duet and the other featuring the female, in an action mimicking that of a pair of wrens trespassing on various territories. The rightful territory owners approached the speakers with extra bursts of their own solo and duet songs. They wagged their tails and chattered harshly at the speakers, as they do when chasing off real invaders, Mennill reports in the January *Animal Behaviour*.

Other studies in different species have pointed out that duetting birds often sing loudly from easy-to-see perches, just as solo territorial songsters do. Soloists and duetters both match bits of their songs with those of potential intruders, a one-upmanship contest (*SN: 12/18/04, p. 397*).

Grafe and Bitz have even proposed that boubous sing a particular kind of duet to advertise to the neighborhood that they've trounced a rival. The scientists have broadcast songs to simulate an invading pair of boubous and then compared the duets of resident birds that fled from the invasion with duets of birds that held their ground. After the confrontation, the steadfast pairs used a particular configuration of male-and-female notes in a duet that fleeing birds didn't use, the researchers reported in 2004.

The fury of territory defense led two researchers in 2004 to propose another function of duetting: distinguishing a fellow defender from an enemy. Black-bellied wrens (*Thryothorus fasciatoventris*) fuss and sing when researchers broadcast songs to mimic intruders, says David Logue of the University of Lethbridge in Alberta. He's researching what he calls duet codes, rules saying that a male's musical motif X goes with a female's motif Y. Females "always blast out the right answer," says Logue.

> The wrens need an especially strong password system to tell friend from foe.
>
> — DAVID LOGUE, UNIVERSITY OF LETHBRIDGE

He and David Gammon of St. Edward's University in Austin, Texas, suggested in 2004 that duetting offers a way for black-bellied wren females to make sure that their mates don't attack them by mistake. The dense forests where these birds live distort sounds such as the "here I am" calls that other species use, says Logue. The wrens need an especially strong password system to tell friend from foe, he says.

Hall recounts anecdotes of attacks on intruders by cooperating birds. Purple-crowned fairy wrens, for example, spend much of their time near each other. "If one hops half-a-meter away, the other hops too," she says. And when they hear recorded songs in stereo, they both fly to chasten one speaker and then move together to the second. Hall says that she hopes someone will explore how widespread such defensive coordination might be among duetters.

All the ideas about the function of duets need more testing, she adds.

As bird duets start to make sense, maybe they'll shed light on other duetting species. Birds duet. Bugs duet. Even some primates do it. ■

OF NOTE

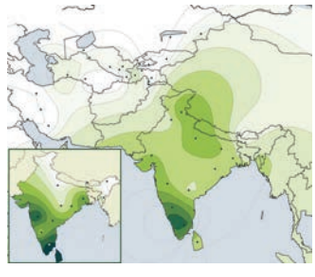
GENETICS

India cultivated homegrown farmers

Approximately 10,000 years ago, hunter-gatherers living in what's now India adapted agricultural practices for their own purposes rather than giving way to an influx of foreign farmers, a new genetic study suggests.

Comparisons of men's Y chromosomes show that nearly all Indian men today, regardless of their tribe or caste, are descendants of populations that inhabited South Asia before agriculture's introduction to the region, concludes a team led by Vijendra K. Kashyap of the National Institute of Biologicals in Noida, India.

The scientists analyzed Y chromosome differences among 936 Indian men representing 77 different populations, including castes. Participants spoke languages from the country's four major linguistic groups.



Y SPREAD Maps of India and surrounding regions denote where a Y chromosome marker occurs more frequently (dark green) and less frequently (light green) in caste populations (larger map) and tribal groups (inset).

KASHYAP/PNAS

Indian men from the various groups displayed substantial genetic similarities and few signs of DNA influences from western Asia, where other researchers had already probed patterns in male chromosomes. A gradually declining frequency of common Y chromosome markers from southern to northern India and into central Asia indicates that India's ancient inhabitants migrated northward, Kashyap's team concludes in an upcoming *Proceedings of the National Academy of Sciences*.

Because modern caste populations in India often cultivate crops and speak Indo-European languages, researchers have long hypothesized that these people derived from western or central Asian farmers who migrated southward. Native South Asians more likely borrowed agriculture techniques and developed them on their own, assert Kashyap and his coworkers.

Previous studies of mitochondrial DNA, which is inherited through the mother, suggest that Africans settled South Asia between 70,000 and 40,000 years ago.

A related debate concerns whether agriculture spread throughout Europe as a result of the migration of Middle Eastern farmers or of the adoption of cultivation by native Europeans (*SN: 12/3/05, p. 358*). —B.B.

MATERIALS SCIENCE

Engineering membranes from cellular parts

Chemists have for the first time spun fibrous networks out of the molecules that make up cellular membranes. The engineered membranes may eventually be used as biocompatible drug-delivery devices or antimicrobial coatings for fabrics or other surfaces.

Phospholipids are molecules that contain a water-attracting chemical group attached to a water-repelling chemical tail. In a cellular membrane, the water-attracting groups, which are exposed to the aqueous cellular environment, sandwich an inner core of water-repelling tails.

Timothy E. Long of Virginia Polytechnic Institute and State University in Blacksburg and his colleagues investigated whether they could manipulate phospholipids with a laboratory technique called electrospinning, which is typically used to process polymer solutions into nanoscale-diameter fibers. In this technique, says Long, researchers apply a voltage to a polymer-filled syringe and spray the cotton candy–like fibers onto a surface.

The group added lecithin, a natural mixture of phospholipids, to an oily solvent. In such a solution, the phospholipids organize into spheres with their water-repelling tails on the outside and their water-attracting groups at the core. With increasing concentrations of lecithin, the spheres coalesced to form tubular structures.

Using a 45 percent lecithin solution, the team spun the phospholipids into fibers and deposited them onto a metal surface, creating a 7-by-15-centimeter membrane. Under a microscope, the membrane revealed a porous network of fibers that had an average diameter of 3 micrometers. The researchers report their work in the Jan. 20 *Science*. —A.C.

CHEMISTRY

Reactions on the spot

A miniature version of a ubiquitous laboratory instrument could move chemistry experiments out of test tubes and into tiny droplets. Researchers report that they have engineered a pipette that can dispense solutions at volumes of a billionth of a billionth of a liter.

The nanopipette consists of a millimeter-diameter glass tube that contains two chambers. The tube ends at a fine tip with two holes, one per chamber and each roughly 100 nanometers across. Each chamber holds an electrode and a conductive solution of water and salt.

A computer applies a voltage to the chambers, starting a current that flows from one chamber to the other. Voltages from 25 to 100 volts move liquid out of the chambers, forming a single droplet. As the group had shown in previous work, voltages of 1 to 2 V move only molecules, but no liquid, out of the pipette openings.

The researchers, led by David Klenerman of the University of Cambridge in England, performed chemical reactions in their minuscule droplets. In one experiment, the nanopipette dispensed chemicals and the enzyme that catalyzed their reaction in the tiny droplet to form a fluorescent product, the team reports in an upcoming *Nano Letters*.

Klenerman would like to automate the system and build nanopipette arrays that can produce thousands of small droplets at a time. Such work could lead to "highly miniaturized chemistry" in volumes similar to those within individual living cells, he says. —A.C.

BIOLOGY

Enzyme measures RNA using natural ruler

For almost a decade, researchers have taken advantage of a powerful process called RNA interference (RNAi) to turn off certain genes in lab organisms and cell cultures (*SN: 7/2/05, p. 7*). Cells also use RNAi as a natural tool in immunity, development, and gene rearrangements within chromosomes.

The process begins when a cell chews double-stranded RNA into bite-size fragments of about 25 base pairs, the chemical building blocks of RNA.

Scientists knew that an enzyme called dicer carries out this chopping task, but they hadn't figured out how dicer measures lengths of RNA so precisely. A new study of dicer's chemical structure suggests that the enzyme carries a built-in ruler.

Jennifer Doudna of the University of California, Berkeley and her colleagues bombarded dicer with X rays to decipher its structure.

"It was almost immediately clear how the enzyme probably works," says Doudna.

Team members noticed that dicer is shaped much like a hatchet. A broad area at one end of the molecule contains blade-like protein components that cleave RNA. Extending from these components is a handlelike part that attaches to an RNA strand. The distance from the tip of this handle to the edge of the blade is about the length of 25 base pairs, the team reports in the Jan. 13 *Science*.

Doudna adds that understanding how dicer works may give researchers clues to how RNAi evolved. —C.B.

SCIENCE & SOCIETY

New law to limit politicized science

The Labor, Health and Human Services, and Education appropriations bill, signed into law on Dec. 30, 2005, mandates that the federal government clean up its scientific act—at least for a year. The law prohibits the three agencies from knowingly disseminating bad data and bans application of any political litmus test to experts under consideration as outside advisers.

No agency funds shall be used "to disseminate scientific information that is deliberately false or misleading," the statute commands.

"It's somewhat outrageous that this wasn't already illegal," argues Lexi Schultz of the Union of Concerned Scientists in Washington, D.C., an advocacy group.

The law also says that no agency funds "may be used to request that a candidate for appointment to a federal advisory committee disclose [his or her] political affiliation or voting history ... or the position that the candidate holds with respect to political issues not directly related to and necessary for the work of the committee involved."

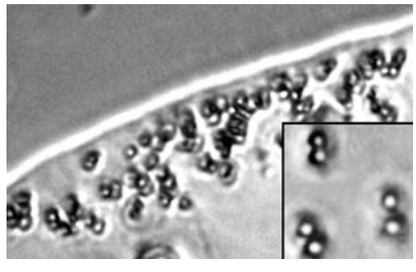
Introduced by Sen. Richard J. Durbin (D–Ill.), the latter provision was triggered by anecdotes of experts passed over for appointments because of their political views. Durbin charged, for instance, that William R. Miller of the University of New Mexico in Albuquerque was denied a position on the National Advisory Council on Drug Abuse in 2002 after the psychologist admitted, under questioning, that he hadn't voted for President Bush.

Unless renewed, the new prohibitions remain in effect only during the current fiscal year. —J.R.

MICROBIOLOGY

Polar-opposite bacteria swim south in the north

Some aquatic bacteria that orient themselves using Earth's magnetic field swim in the opposite direction from what researchers typically expect, calling into question a longstanding theory of what this navigational behavior accomplishes.



DOGMA DASHER This newly discovered bacterial species, nicknamed "barbell" because round individuals tend to link in pairs, swims away from the magnetic pole that researchers have assumed attracts such microbes.

Such magnetotactic bacteria typically live between the high-oxygen surface and low-oxygen floor of ponds or sediments. Researchers have long proposed that the bacteria take advantage of Earth's geomagnetic field to hover in this preferred middle zone. Lab studies seemed to support this idea: In high-oxygen environments, microbes in the northern hemisphere usually swam, in high oxygen conditions, toward geomagnetic north, which took them deeper into a body of water. Those in the southern hemisphere swam toward the geomagnetic south, the down direction in that part of the world.

While researching magnetotactic bacteria's role in the environmental cycling of iron and sulfur, Sheri Simmons of the Woods Hole (Mass.) Oceanographic Institution and her colleagues serendipitously discovered bacteria with opposite navigational behavior. In the lab, the previously unknown species, isolated from salt ponds in Woods Hole, prefers to swim south.

Why these unusual bacteria go against the flow isn't clear. However, Simmons and her colleagues suggest in the Jan. 20 *Science* that the original explanation may be too simple to account for the microbes' behavior. "We need more controlled experiments to see what's really regulating their swimming behavior," she says. —C.B.

BIOMEDICINE

Old idea fights ovarian cancer

Delivering chemotherapy directly into the abdomen improves survival in women with advanced ovarian cancer, a new study shows.

Doctors randomly assigned 415 women with ovarian cancer that was spreading to nearby tissues to receive either standard chemotherapy intravenously or that therapy plus up to six courses, at 3-week intervals, of chemotherapy injected into the abdomen via a catheter. This approach is available for cancer treatment, but few doctors use it. The drugs used in the new study were cisplatin and paclitaxel (Taxol).

The median survival time for the 205 women getting the abdominal infusions was 66 months, the longest ever recorded for a group treated for this stage of ovarian cancer, the researchers report in the Jan. 5 *New England Journal of Medicine*. Median survival time was 50 months for women getting only intravenous chemotherapy.

The longer survival came with a price. Early in the treatment, women getting the abdominal therapy had more gastrointestinal, nerve, and heart problems than the other patients did. Many of the women getting abdominal therapy also had complications and discomfort associated with their catheters. Only 42 percent of them completed all six planned abdominal-chemotherapy treatments, says study coauthor Robert A. Burger, a gynecologic oncologist at the University of California, Irvine.

But after 1 year, surviving patients in both groups reported similar qualities of life.

The National Cancer Institute and several professional societies now recommend that this regimen be offered to women with stage III ovarian cancer. "Since most oncologists have not administered [abdominal] chemotherapy," Burger says. "We need to train people how to do this safely and effectively." —N.S.

Books

A selection of new and notable books of scientific interest

THE MATURE MIND: The Power of the Aging Brain

GENE D. COHEN

As a great proportion of the U.S. population approaches retirement age, increasing attention has been focused on the seemingly inevitable mental decline that comes with getting older. Cohen, acting director of the federal National Institute on Aging, sets out to correct what he sees as misrepresentations of the aging brain and to demonstrate that life after 60 can be a period of continued growth and development. He cites research indicating that that the brain, instead of being unchangeable, can form new neuron-to-neuron connections in response to new experiences. He also dispels the myth of the inevitable midlife crisis and describes what he deems the "inner push" that drives middle-aged and older people to seek out new, enriching life experiences and relationships. This push, writes Cohen, enables mature people to examine their lives with a freedom and wisdom not attainable during youth. The author emphasizes that despite the increasing physical difficulties that accompany aging, this period of life can be marked by vigor and creativity. ***Basic, 2005, 256 p., hardcover, $24.95.***

SATISFACTION: The Science of Finding True Fulfillment

GREGORY BERNS

What drives the ultra-marathoner to run more than 100 miles to the point of exhaustion? For that matter, what drives the multitudes to get out of bed and go to work each day? Motivation is an elusive concept that has been the focus of intellectual inquiry for centuries. However, current brain research has opened new ways for scientists to determine what satisfies a person and why. Berns, a professor of psychiatry at Emory University, sets out to discover how the sense of satisfaction is manifested in the brain. Readers sit in on lab tests measuring the satisfaction people get from everything from money to sex, food, and word puzzles. What Berns reveals is surprising: Instead of being ruled by the so-called pleasure principle, people are driven by challenge, adversity, and novelty. Berns challenges assumptions about what makes us tick and suggests how we can derive more satisfaction from our lives. ***Henry Holt, 2005, 304 p., hardcover, $24.00.***

VEGETABLES, HERBS, & FRUIT: An Illustrated Encyclopedia

MATTHEW BIGGS, JEKKA MCVICAR, AND BOB FLOWERDEW

This comprehensive reference book offers advice and tips for novice gardeners and experts on growing and using more than 70 vegetables, 100 herbs, and 100 fruits. Gardening experts Biggs, McVicar, and Flowerdew cover the cultivation and the culinary and medicinal uses of each plant product and include useful information on the origin and growth habits of each species. The authors sprinkle this large and attractive volume with unusual tidbits, such as the fact that Western populations drank catnip tea before adopting black tea. Complete with full-color photographs and mouth-watering recipes as well as important warnings about poisonous species, this guide is a valuable reference for both gardeners and inquisitive chefs. ***Firefly, 2006, 640 p., color photos, hardcover, $29.95.***

FORTUNE'S FORMULA: The Untold Story of the Scientific Betting System That Beat the Casinos and Wall Street

WILLIAM POUNDSTONE

Claude Shannon, the author of theories that undergird modern computers and the Internet, and Edward Thorp, a mathematics professor, are accomplished academics who nevertheless made their reputations by beating the odds. By applying their minds to both Wall Street and casino gaming tables, they became wealthy men. In Las Vegas, they used a betting system invented by Bell Labs' John Kelly to beat the roulette and blackjack tables. In the stock market, they got a quick-buy-and-sell technique known as arbitrage to yield an extraordinary amount of money with low risk. In this thrilling and entertaining book, Poundstone explains the mechanism behind the controversial Kelly formula, describes the various efforts to discredit it, and shows how it paid off for Shannon and Thorp. The author also examines the seedy underbelly of gambling and organized crime that brainy gamblers sometimes encounter. With a host of colorful characters, from corrupt telegraph operators to billionaire investors, this is the first full-length examination of Shannon and Thorp's ingenious techniques and mathematical legacy. ***Farrar, Straus and Giroux, 2005, 386 p., hardcover, $27.00.***

THE LAST GENTLEMAN ADVENTURER: Coming of Age in the Arctic

EDWARD BEAUCLERK MAURICE

What began as the author's impulsive adolescent decision became his enriching, life-altering journey of self-discovery and cultural awareness. In 1930, Maurice joined the Hudson Bay Company and became an apprentice clerk at the Pangnirtung Post on Baffin Island in the Canadian Arctic. During his 9 years there, his open-minded, non-paternalistic view of the Inuit people led him to be welcomed into their culture. Though the Inuit people initially regarded Maurice as a baby-faced innocent and dubbed him "the Boy," his adaptation to and earnest curiosity about their culture, from their hunting techniques to their language, gained their respect. That respect was mutual, as revealed by Maurice's touching and personal narrative. More than an adventurer, he became a friend to these people and was even their doctor. Maurice died 2 years before his memoir's publication. ***Houghton Mifflin, 2005, 416 p., hardcover, $25.00.***

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LETTERS

Oil-for-food exchange

Several decades ago, I heard of the anecdotal correlation between the rise of hydrogenated oils in our foods and the rise of colon cancer. The Swedish study that correlated high dairy-fat intake with lower risk of colon cancer ("Dairy fats cut colon cancer risk," *SN: 11/19/05, p. 333*) might be reexamined to see if it reveals a correlation between intake of hydrogenated oils and risk of colon cancer. People apt to favor dairy fats might also be apt to avoid heavily processed foods.

MARK RICH, STEVENS POINT, WIS.

Snob stories

First, thanks for a great article, "A Skunk Walks into a Bar …" (*SN: 12/3/05, p. 362*). I did note a few overgeneralizations. The most important, from a beer drinker's perspective, would be this quote from Raymond J. Klimovitz of the Master Brewers Association of the Americas: "The fresher the beer, the better it's going to be." While this is generally true for lighter, mainstream beers, many beers improve with age. In fact, one style of beer, India pale ale, was intended to be aged while it was being shipped from England to India. Another point: Ales are fermented with *Saccharomyces cerevisiae*, but lagers are fermented with *Saccharomyces carlsbergensis*, and some styles employ other organisms to produce complex flavors.

COADY LAPIERRE, TARLETON STATION, TEXAS

Since I began home brewing 2 years ago, I've found that: Fresh, my beer tastes pretty good; a few weeks after fresh, the beer begins to have overly astringent or bitter characteristics; and aged 4 months, the beer is notably better than when fresh and free of excessive bitterness. Many brewers recommend that a beer be aged before drinking. I believe the major beer companies—Bud, Coors, and Miller—do not produce "good beer." They produce plain, inoffensive, cold, refreshing drinks that sell well across the country. Finally, Charlie Bamforth's quotation at the end of the article ["… If I am at a baseball game, I would drink a Bud."] takes away all of his credibility for me, a beer snob.

RYAN KARB, AMHERST, MASS.

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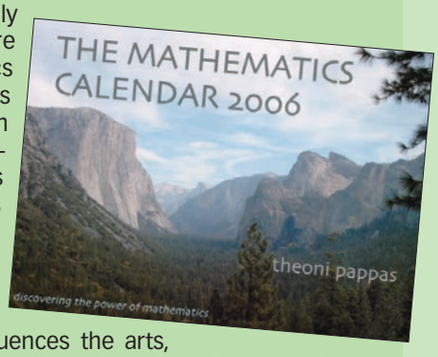
Create Math Fun

with a calendar and books from Theoni Pappas

THE MATHEMATICS CALENDAR 2006

Now in its 27th year, with its exciting topics, graphics and mind-boggling problems, this calendar continues to be a hit with teachers, students, engineers, math buffs and puzzle lovers. It's more than a calendar of stories, illustrating how mathematics influences, touches, and impacts our lives. It is uniquely designed so that each day of every month has a problem whose solution is the date. The brain twister lies in figuring how to arrive at the answer. For each month, the problems range from arithmetic to calculus. THE MATHEMATICS CALENDAR has given thousands of people a new perspective about how math can be fun, fascinating and intriguing. It's no wonder its popularity continues to grow.



The 12 monthly themes feature exciting topics which remind us again and again how mathematics describes nature, impacts the sciences, is essential to architecture, is inseparable from music, influences the arts, exercises and tantalizes the mind with its puzzles and problems, stimulates and creates new technologies, and reveals the multi-dimensions of our world and universe through its ever-evolving ideas and insights.

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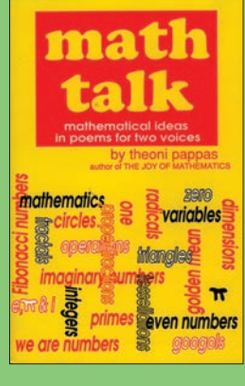
MATH TALK

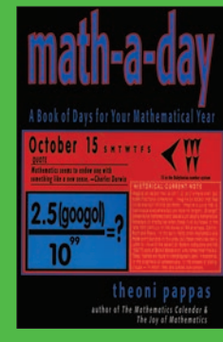
Mathematics and poetry? Why not? Pappas delivers a new way to enjoy and learn some sublimely abstract notions, such as tessellations, fractals, googols, imaginary numbers, and much more. Creative juices were certainly at work when this book of mathematical dialogues was created. It presents a new way to enjoy and learn mathematical ideas via poetic dialogues read by two people. Discover and enjoy a new twist to mathematical themes with this refreshing volume of mathematical poems for two voices.



—Wide World Publishing/Tetra, 5 ½" x 8 ½", 72 pages, paperback $8.95

MATH-A-DAY

Pappas has come up with yet another way to make math part of your life. Not a calendar, not a reference book, but a compendium of mathematical information that will give you your math fix everyday. *Each day -*

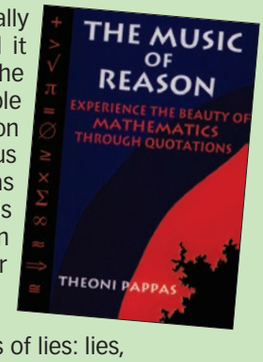


- kick starts your brain with a problem or puzzle (detailed solutions are included)
- has a mathematical quote to inspire the other side of your brain
- features a historical or current math note
- has its date expressed in another number system

—Wide World Publishing, 5 ½" x 8 ½", 250 pages, paperback $12.95

MUSIC OF REASON

The power of mathematics has literally defined the limits of the universe and all it contains. But equally certain is that the science has perplexed its share of people with its unique brand of logic. This collection of quotes—a mixed bag of the humorous and the philosophical from sources as diverse as Alice in Wonderland author Lewis Carroll, Albert Einstein, and Napoleon Bonaparte—is a thought-provoking sampler on the subject.



Some of the musings included are:

- Benjamin Disraeli: "There are three kinds of lies: lies, damned lies, and statistics."
- Henri Poincaré: "The mathematician does not study pure mathematics because it is useful; he studies it because he delights in it and he delights in it because it is beautiful."
- Huckleberry Finn: "I had been to school … and could say the multiplication table up to 6x7=35, and don't reckon I could ever get any further than that if I was to live forever. I don't take stock in mathematics, anyway."

Consists of 15 chapters of quotes organized by themes such as Mathematics & Art or Mathematics & the Imagination, with wonderful graphics sprinkled throughout this gem of a book.

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