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SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

black hole magnetism
the nature of nurture
condom confirmation
finicky, fastidious fish

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whacky mole rats

MORE SOCIAL THAN PEOPLE

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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JUNE 24, 2006 VOL. 169, NO. 25

Features

This Week

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Of Note

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Cover Damaraland mole rats have taken mammal sociality to the next level. Groups live communal lives like termites, as do their more famous cousins, the naked mole rats.
(T. Jackson) Page 394

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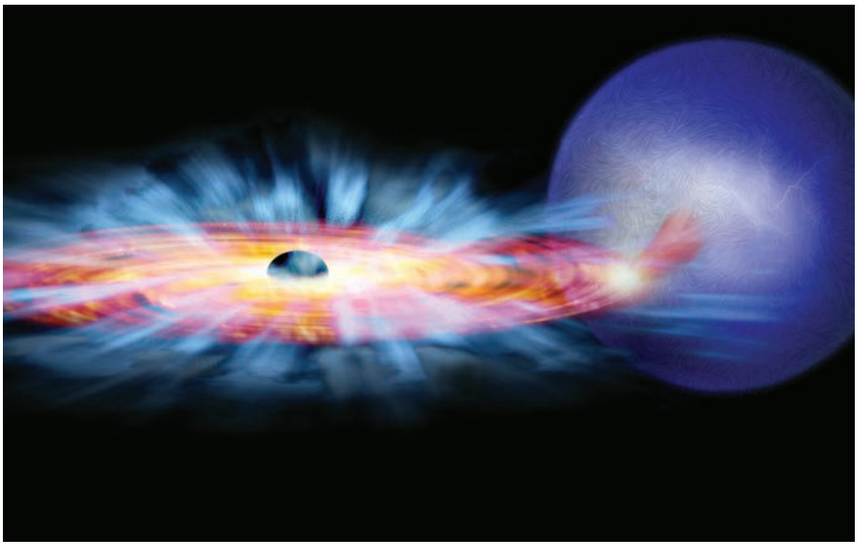
Magnetic Thrust

Fields force matter into black holes



DISK DISCONNECT Gas from a star (right) circles a black hole, in this artist's representation. A new study confirms that magnetic fields disrupt the disk's orbit and cause some of the matter to fall into the black hole.

NASA/CXC/M. WEISS

Like a child scared to dive into a pool, cosmic matter needs one last push to plunge into a black hole. New observations confirm that magnetic fields provide this final galactic shove.

The observations come from a system in the Milky Way called GRO J1655-40, which consists of a black hole and a normal star. Gas from the star is pulled toward the black hole, where it forms what's called an accretion disk. Angular momentum—the same property that keeps Earth from diving into the sun—keeps the disk revolving around the black hole instead of falling into it.

Unless something knocked them off course, the gases in the disk would continue to circle the black hole forever. "To get matter in toward the black hole, we have to change the orbits in the disk," says study leader Jon Miller of the University of Michigan in Ann Arbor. Until now, scientists weren't sure whether magnetic fields, radiation pressure, or heat alter the orbit and trigger that fall.

Using NASA's Chandra satellite observatory, Miller's team collected data on X rays emitted from the J1655 system. They found that the X rays came from a wind blowing from the disk, so some force must propel the wind past the black hole's gravitational pull. After simulating the wind on a computer, the researchers conclude that only magnetic fields could create such a force, they report in the June 22 *Nature*.

The team had ruled out a wind fueled by heat from the core of the disk or by pressure from radiation blasting out of the disk. A heat-driven wind would have been hotter than the one that the researchers observed, and radiation pressure is too weak to drive that wind.

"Magnetic pressure really was the only viable means remaining," Miller says.

Such pressure could upset the gas disk's orbit in two ways. The magnetic fields could push the wind outward like a spring, or the force of the spinning disk could fling the wind away from the disk's center. Either disruption of the disk's orbit would cause some matter to spiral downward.

Miller's team appears to prefer the first scenario, says Roger Blandford of Stanford University. Blandford prefers the second, which he describes as an organized magnetic slingshot. "I suspect there are different answers in different types of systems," he says. "But on the face of it, this looks like a big advance observationally."

Though most astrophysicists expected magnetic fields to play a role in black holes, the finding is "very important evidence that what we thought before makes sense," says Avi Loeb of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. "It's the first time there's clear evidence for wind coming off an accretion disk."

The finding could help astrophysicists understand the "complex give-and-take between galaxies and black holes," Miller says. —E. JAFFE

Proof of Protection

Condoms limit infection by cervical cancer virus

Using a condom during sexual intercourse significantly reduces a woman's risk of being infected with the human papillomavirus (HPV) and lessens her chance of developing precancerous growths on the cervix, a new study finds.

While condoms have been shown to limit the spread of AIDS and other sexually transmitted diseases, their effectiveness has been less clear against HPV, a common, sexually transmitted pathogen that infects roughly three-fourths of U.S. adults at some point in their lives.

To assess condom effectiveness, Seattle researchers focused on 82 female college students who had their first sexual intercourse during the study or within 2 weeks before it started. Each participant maintained an electronic diary, documenting whenever she had intercourse and whether she and her partner used a condom. Every 4 months, the women were tested for HPV and underwent a Pap smear to check for precancerous cell growth, says Rachel L. Winer, an epidemiologist at the University of Washington.

The women, who averaged 19 years old at the start of the study, updated their diaries for about 34 months. During that time, 37 became infected with at least one strain of HPV—some with two or more—after having intercourse.

Women who reported condom use less than 5 percent of the time in the previous 8 months were three times as likely to get HPV infection as were women who used condoms every time they had sex, the researchers report in the June 22 *New England Journal of Medicine*.

No precancerous lesions turned up in regular clinical checkups of women who had always used condoms during sex during the preceding 8 months, whereas 15 such cases occurred in women who used condoms less often in that period.

"This is certainly the most rigorous study to date looking at condom effectiveness in HPV," says epidemiologist Markus J. Steiner of Family Health International, a nonprofit research group in Durham, N.C. Previous studies of HPV infection and con-

dom use typically relied on participants' memories of their sexual practices over several months, he says.

Winer says that previous research had suggested that because the electronic diary guards the participants' privacy, it elicits more-truthful responses on sensitive subjects than do face-to-face interviews.

The Food and Drug Administration recently approved a vaccine (*SN: 10/15/05, p. 243*) against four common strains of HPV, two of which cause nearly three-fourths of all cervical cancers. But Winer says that since there are more than 100 HPV strains, even after vaccination, "a condom is still a good idea." —N. SEPPA

CUSTOMER SATISFACTION As small cleaner fish feed on the skin parasites of a bigger fish, they may be building their reputations as good workers.

Fishy Reputations

Undersea watchers choose helpers that do good jobs

Coral reef fish do consumer research in a way that keeps a service-providing species honest, says a new study.

When parasites build up on the skin of a reef fish, it can get relief by swimming over to a small, so-called cleaner fish that nibbles off the encrustations. Now, lab tests show that potential clients choose cleaners that they've seen working attentively, says Redouan Bshary of the University of Neuchâtel in Switzerland.

Other lab evidence suggests that the cleaners are on their best behavior when there's an audience of potential clients, Bshary and Alexandra S. Grutter of the University of Queensland in St. Lucia, Australia report in the June 22 *Nature*. In the team's previous observations, fish in the wild were less likely to bite one client when potential clients lingered nearby.

"It's much more complicated than simple reciprocity," says behavioral ecologist Lee Alan Dugatkin of the University of Louisville in Kentucky, who has studied altruism. The cleaner-client system appears to be a case of indirect reciprocity, where a fish works attentively and holds back on taking a tasty nibble of the client's protective mucus coating, which would incite a jolt and perhaps a chase. By so doing, it wins an opportunity to clean a future client—the fish that watched.

The idea that animals show generous behavior and reap benefits from those that observe it "has been floating around," says Dugatkin. "This is the strongest evidence so far that it's really happening in nature."

Bshary and Grutter put a possible client, the brindled monocle bream *Scolopsis bilineatus*, in the middle compartment of an aquarium, where it could watch two cleaner fish, *Labroides dimidiatus*, in the end compartments. The researchers provided clients to each of the cleaners.

One cleaner, which got a client smeared with delectable prawns, worked diligently picking off the treats. The other cleaner, given a familiar, already clean client, largely ignored the visitor. In 28 tests, the observer fish in the center compartment tended to hover nearer the compartment of the harder-working cleaner.

In that experiment, the cleaners couldn't see the observer. To see what might happen when the cleaners had an audience, Bshary and Grutter used pairs of food plates as stand-ins for client fish.

The researchers stocked two plates with both ho-hum fish-food flakes and delectable bits of prawn. In one scenario, as long as the cleaner nibbled the flakes, the researchers left the second mixed plate as if it were a waiting client. If the cleaner fish gulped a prawn, though, the researchers snatched away the second plate.

That setup mimics real life, says Bshary, because a cleaner has to forgo nibbling on a client's mucus coating if it's going to avoid scaring away its next meal.

When researchers trained the cleaner fish with plate-snatching rules, the fish ate more of the uninspiring flakes when the second plate was nearby than when there was only one plate. When the two plates were available, the trained fish also ate more flakes than a fish that hadn't been taught the rules.

"What makes this unique is that this study brings together audience effects and image-scoring in one system," says Dugatkin. —S. MILIUS

A Chronicle of Coasts

Study charts historical changes in seas, estuaries

Human exploitation of marine species and destruction of habitat have been spoiling coastal ecosystems since the birth of the Roman republic. By comparing historical changes in 12 bodies of water worldwide, a new study highlights the extent to which civilization's advance has led to ecological degradation.

"Estuaries, because of their proximity to human settlements, are sort of ground zero for human impacts," says marine ecologist Larry B. Crowder of Duke University. The bounties of coastal seas and estuaries began attracting people before the start of recorded history.

This makes it difficult for scientists to study the evolution of a coastal ecosystem from its unsullied state to its current condition, says fisheries and restoration ecologist Hunter S. Lenihan of the University of California, Santa Barbara. "For the most part, we've used reference points that are far down the time line of historical degradation," he says. A broader perspective might reveal potential interventions.

Lenihan and his colleagues reviewed hundreds of documents, including scientific studies, written historical accounts, and artwork, to identify past shifts in coastal species diversity, abundance, and size.

I. BURKHARDT

Their information included 8,000-year-old sediment data that predate civilization along the northern Adriatic and western Baltic seas. For various North American and Australian waters, the researchers assessed data including paleontological and archaeological remains and water-quality information. The researchers, led by Heike K. Lotze of Dalhousie University in Halifax, Nova Scotia, report their findings in the June 23 *Science*.

Most ecological damage in the New World occurred after European settlement, they find. But the breakdown began earlier around San Francisco Bay, where natives fished and hunted heavily during pre-colonial times.

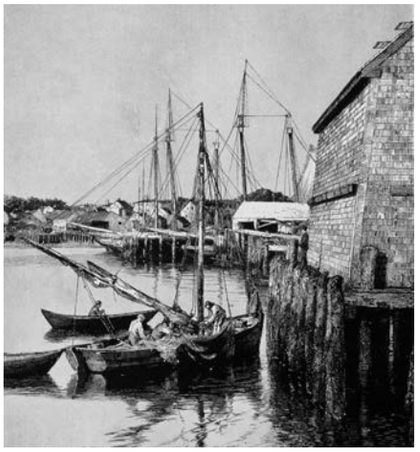
"Degradation started sooner in some systems than others, but ... the sequence of degradation was similar," Lenihan says.

Colonialism brought to the New World large-scale deforestation and destruction of wetlands, and soil erosion dumped sediment and excess nutrients into the seas. But, says Lenihan, "it wasn't until [people] began to overharvest biofiltration organisms"—such as oysters—"that we saw massive changes in water quality." With neither these living water filters nor wetlands, "systems can no longer withstand the inputs of nutrients and sediment," he says.

Restoration of oyster habitat in North Carolina's Pamlico Sound, the most degraded New World site in the study, "would have a profound effect on biodiversity, the production of economically valuable species, and filtration," Lenihan says.

While fishing has played a primary role, the new study highlights that "declines are not due [exclusively] to any one human activity," Crowder says.

A few ecological "success stories" have occurred in waters where society has taken multiple steps to repair nature, Crowder says. "Where we've failed to do that, things continue to degrade." —B. HARDER



NOAA, WILLIAMS

COASTING DOWNWARD Fishing and other human activities have a long history of degrading near-shore ecosystems.

Older but Mellower

Aging brain shifts gears to emotional advantage

Given all the bad news that science has delivered about brain cells withering and memory waning as the years mount, older people have a right to be cranky. But, instead, the over-50 crowd handles life's rotten realities and finds life's bright side more effectively than whippersnappers do. In no small part, that's because the aging brain makes critical emotional adjustments, a new study indicates.

Advancing age heralds a growth in emotional stability accompanied by a neural transition to increased control over negative emotions and greater accessibility of positive emotions, according to a team led by neuroscientist Leanne M. Williams of Westmead (Australia) Hospital. A brain area needed for conscious thought, the medial prefrontal cortex, primarily influences these emotional reactions in older adults, Williams and her colleagues say.

In contrast, people under age 50 experience negative emotions more easily than they do positive ones. These younger adults' emotion-related activity centers on the amygdala, a brain structure previously implicated in automatic fear responses.

This gradual reorganization of the brain's emotion system may result from older folk responding to accumulating personal experiences by increasingly looking for meaning in life, the researchers propose in the June 14 *Journal of Neuroscience*.

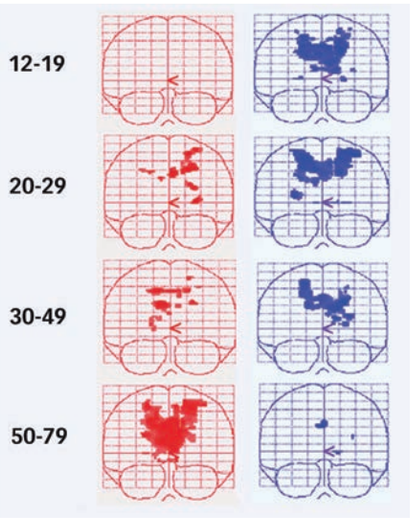
Evidence that emotional functions improve in older brains "indicates that our ability to register the significance of information is preserved, and even enhanced, as we age," Williams says. Older people may benefit from associating information they need to remember with personally significant matters, such as a favorite tune, he adds.

Ironically, older individuals' reliance on the medial prefrontal cortex to regulate emotions comes as aging kills cells in this area. The surviving neurons somehow pick up the slack, the investigators note.

The researchers studied 122 males and 120 females, ages 12 to 79, who had no current or past mental illnesses and good physical health.

Scores on a questionnaire that assesses emotional stability rose steadily from adolescence into the senior years.

Brain testing occurred as volunteers viewed images of various facial expressions. They had been told to identify the emotion in each expression and to rank its intensity. Researchers measured neural response using functional magnetic resonance imaging, which tracked blood-flow changes, and an electrode-studded cap that monitored brain cells' electrical responses.



NEURAL FEEL As people age, from 12 to 79 years old, they respond to fear with greater and greater boosts in medial prefrontal activity (left) and to happiness with smaller and smaller boosts (right).

In older adults, mushrooming medial prefrontal cortex activity triggered by negative facial expressions occurred in conjunction with neural responses that have been linked to conscious thought. This pattern appeared even in older adults who displayed especially low numbers of prefrontal neurons.

In contrast, young people showed far more medial prefrontal activity, and thus conscious thought, in response to positive facial expressions than older people did.

The new results provide a neural framework for growing evidence that, unlike young people, older adults focus on positive information and downplay negative events, remarks psychologist Mara Mather of the University of California, Santa Cruz. The amygdala showed little volume decline with age in the new study, so it's unlikely that age-related shrinkage of that structure causes the psychological shift, she adds.

"Older adults apparently use cognitive-control processes supported by prefrontal brain regions to help them avoid experiencing negative information and focus instead on positive information," Mather says. —B. BOWER

Toxic Leftovers

Microbes convert flame retardant

Bacteria can break down a common flame retardant into more-toxic forms, researchers report. Besides finding more degradation products than earlier work had, the new

study is the first to identify specific bacterial strains capable of the feat, the team says.

Polybrominated diphenyl ethers (PBDEs) are a family of flame-retardant chemicals found in products such as electronics, automobiles, and furniture. The chemicals have 1 to 10 bromine atoms and come in 209 versions. Manufacturers use deca-BDE, which has 10 bromine atoms, or mixtures dominated by penta-BDEs, with their 5 bromines, or octa-BDEs, with 8 bromines.

The chemicals' effects go beyond fire resistance (*SN: 10/25/03, p. 266*). Studies in rats and mice have found that penta- and octa-BDEs disrupt development. Deca-BDE is considered less harmful, although the Environmental Protection Agency has listed it as a possible human carcinogen.

The toxins are ubiquitous in the environment, turning up in soil, water, and even human-breast milk.

The European Union and California have banned penta- and octa-BDEs, and the sole U.S. manufacturer has volunteered to stop making these forms (*SN: 11/01/03, p. 275*). Deca-BDE remains in production and in wide use.

Lisa Alvarez-Cohen of the University of California, Berkeley and her colleagues were looking for a way to use bioremediation to eliminate the chemicals. They reasoned that various strains of anaerobic bacteria that can remove chlorine atoms from chemicals might also lop off bromines to detoxify the PBDEs.

The group tested whether several different bacterial cultures could break down either deca-BDE or an octa-BDE mixture in the laboratory. The researchers found that the bacteria converted the chemicals into more-toxic forms.

"We were quite surprised to see the production of all these very toxic intermediates," says Alvarez-Cohen.

For example, *Sulfurospirillum multivorans* converted deca-BDE into eight- and seven-bromine forms but could not break down the octa-BDE mixture. *Dehalococcoides ethenogenes* transformed the octa-BDE mixture into five-, six-, and seven-bromine forms but did not alter deca-BDE. When other microbes were added to *D. ethenogenes*, the mixture also produced two- and four-bromine PBDEs. Among the breakdown products were several especially toxic forms.

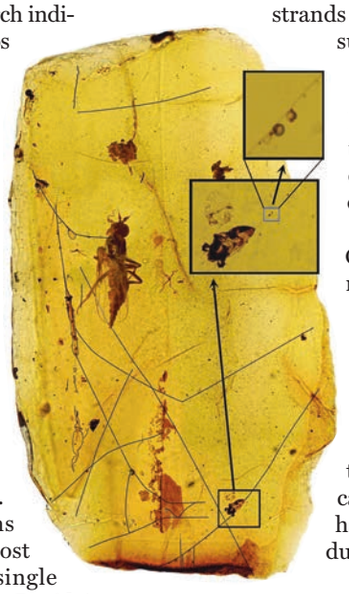
While other researchers have reported the microbial debromination of deca-BDE in anaerobic sewage sludge to nine- and eight-bromine forms, "this is the first time anything beyond octa has been shown," says Alvarez-Cohen. Her group's work appears in an upcoming *Environmental Science & Technology*.

"Lots of folks weren't that concerned about deca-BDE because it was portrayed as being stable," notes Robert C. Hale of the Virginia Institute of Marine Science in Gloucester Point. But the new research, coupled with other published examples of fish and sunlight converting deca-BDEs to less-brominated forms, is "a real reason for concern," he says. "We haven't seen massive amounts of debrominated products out there yet, but it may be a question of time." —A. CUNNINGHAM

Sticky Subjects

Insights into ancient spider diet, kinship

Remnants of a spider web embedded in ancient amber suggest that some spiders' diets haven't changed much in millions of years. Separate research indicates that some groups of modern spiders that spin webs in the same pattern didn't stumble upon that design independently, as scientists had suspected, but evolved from a common ancestor. Both studies provide glimpses of spiders' evolutionary history.



WICKED WEB Strands of silk, which are too small to be seen in this photo, are indicated by dark lines superimposed on the amber. Also entombed in the amber are a fly (left center) and a mite (lower inset). The upper inset shows glue droplets used to capture prey.

Spider silk is made of proteins, so it degrades quickly and rarely fossilizes. When old specimens are found, they're most often preserved as single strands in amber, says David A. Grimaldi, an entomologist at the American Museum of Natural History in New York City. But in a piece of 110-million-year-old Spanish amber, he and his colleagues discovered a collection of silk strands. They describe this oldest known example of a multi-strand web, which still contained several insects, in the June 23 *Science*.

Grimaldi, his museum colleague Enrique Peñalver, and Xavier Delclòs from the University of Barcelona found pieces of at least 26 strands of silk preserved in the amber fragment, which measured about 18 millimeters in length. The longest strand of silk is about 5.7 mm long, and the strands generally measure between 0.6 and 1.9 micrometers in diameter.

Most of the silk strands are straight or slightly curved, and some are connected in a pattern similar to that seen in webs spun by modern orb-web spiders. In such webs, long strands of silk connect at the center, like spokes of a wheel, and the sticky threads that capture prey spiral out from that center.

Small droplets, presumably of spider-produced glue used to make the web sticky, adorn two of the strands preserved in amber, another sign that the ancient web maker probably was an orb weaver, says Grimaldi.

Regardless of its lineage, that spider apparently was successful—it had snagged a wasp, a fly, and a mite in its web. Those insects represent the three insect groups most commonly captured by today's orb-web spiders, Grimaldi notes.

There are two groups of modern-day orb-web spiders, says Jessica E. Garb, an evolutionary biologist at the University of California, Riverside. Their webs are remarkably similar in shape, but they differ by one telling detail. The araneoids snare prey by embellishing their webs with droplets of glue, as in the web found in amber. The deinopoids spin silk strands that they then comb until the surface is covered with sticky fibers—"like tubular Velcro," says Garb. Most scientists have presumed that the distinctive shapes of these spiders' webs arose independently in the two groups.

However, new research by Garb and her colleagues, also reported in the June 23 *Science*, makes the opposite case. The researchers analyzed genetic material in the silk-making glands of two species of deinopoid spiders. Along with 12 new kinds of silk proteins, they identified proteins called MaSp2 and Flag, which had been known to be produced only by araneoid spiders. MaSp2 appears in the spider glands that generate silk for the orb web's radial threads, and Flag protein is found in the glands that spin the sticky threads, says Garb.

Garb's findings are strong evidence that the orb-web design evolved only once, says Samuel Zschokke, a zoologist at the University of Basel in Switzerland. "Evolution is a big puzzle, and this is another piece that fits into it," he notes. —S. PERKINS

SCIENCE

150,000 Years Ago Humans Started Talking

And language has been changing ever since. Explore *The Story of Human Language* in a 36-lecture course taught by one of America's leading linguists

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Dr. John McWhorter (Ph.D., Stanford University) is Senior Fellow at the Manhattan Institute. An accomplished scholar, he is also a skilled popularizer, whose book *The Power of Babel* was called "startling, provocative, and remarkably entertaining" by the *San Diego Union-Tribune*. The London *Times* calls him "a born teacher."

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NURTURE TAKES THE SPOTLIGHT

Decoding the environment's role in development and disease

BY CHRISTEN BROWNLEE

Identical twin sisters Elizabeth and Eleanor (not their real names) say that when they entered the world on November 19, 1939—Elizabeth first, then Eleanor 8 minutes later—their mother was rather shocked. She'd been expecting just one baby, not two. But that day, she made a vow: The girls would always be treated the same, so that there would be no competition between them.

Their mother was true to her word. As children, Elizabeth and Eleanor wore the same outfits in the same colors, shared school classes, and had the same group of friends. "We were treated like a unit—more like one person instead of two separate individuals," says Elizabeth.

Although they moved to different locales more than 43 years ago, the women still resemble each other and have similar interests. However, 7 years ago, a critical difference emerged. A lump in Eleanor's breast turned out to be cancer, but Elizabeth remains cancerfree.

When Eleanor thinks about why she, and not her sister, was the unlucky one, she doesn't focus on genetics. Like all identical twins, she and Elizabeth inherited the same genes. "Genetics has a big influence on who a child is—there's no mistake about that. But you can't rule out nurture, the contribution of the environment," she says.

Mounting scientific evidence suggests that Eleanor's view is on target. Six years after researchers from around the world finished a first read of the human genome, it's becoming increasingly clear that genes don't tell the whole story of a person's looks, personality, and health.

New studies suggest that what a person eats, what chemicals he or she is exposed to, and other features of a person's environment put in place chemical modifications to the chromosomes, thereby changing how genes are ultimately expressed. This emerging area of study, known as epigenetics, is examining how such modifications affect development and play a role in diseases ranging from cancer to schizophrenia.

MOUSE OF A DIFFERENT COLOR As early as the 1940s, researchers who couldn't explain some of an organism's attributes by straightforward Mendelian genetics started calling these aberrant traits epigenetic, says Randy Jirtle, a researcher who studies gene control at Duke University in Durham, N.C. "'Epigenetics' literally means 'above the genome,'" he explains.

Scientists eventually learned how apt the name was. Inspecting the double helix turned up hundreds of thousands of what scientists colloquially call "marks"—places where DNA is tagged with carbon and hydrogen bundles known as methyl groups. Enzymes attach methyl groups only at points on the genome where two DNA components—cytosine and guanine—meet. These components often cluster near the beginning of a gene, where proteins attach to turn on genes. If a methyl group blocks a protein from binding, the gene typically stays switched off.

In recent years, scientists have learned that methylation isn't the only mark that changes whether genes are expressed. Various chemical groups clip on to histones, the spools around which DNA wraps when it condenses into chromosomes. These groups can affect how tightly DNA is packed. Although histone modification is not as well studied as methylation, researchers have shown that genes on loosely packed DNA are more likely to be expressed than are those on DNA that's tightly wound.

Most of these epigenetic marks are set by cells long before an animal's birth, says Jirtle. Each type of cell, from liver to skin to muscle, carries a distinct pattern of methylation and histone modifications that, for the long term, switch genes on or off in the pattern necessary for the cell to do its job.

However, Jirtle adds, not all of these marks are set in stone. Outside factors during development can change which DNA segments are epigenetically modified, setting the stage for traits that linger into adulthood.

> "We believe these different epigenetic patterns in twins depend many times on the environment."
>
> — MANEL ESTELLER, SPANISH NATIONAL CANCER CENTER

Three years ago, Jirtle and his Duke colleague Robert Waterland illustrated how easily epigenetically controlled traits can be changed. The researchers were working with a strain of mice that carry a gene called *agouti*. Mice with this gene have brindled fur that ranges in color from yellow to brown. When the researchers supplemented pregnant animals' food with vitamin B_{12}, folic acid, choline, and betaine—a nutrient from sugar beets—the offspring typically grow brown coats. Those mothers that hadn't received the supplements gave birth to babies that grew yellow fur.

Jirtle and his colleagues recently repeated the experiment using supplements of genistein, a nutrient derived from soybeans. The team used amounts, scaled down for the mouse's size, in a typical human diet in Asia.

The researchers report in the April *Environmental Health Perspectives* that giving pregnant mouse mothers genistein not only shifted their offsprings' coat colors toward brown but also decreased the babies' chances of developing various diseases, such as obesity, diabetes, and cancer.

Jirtle says that these profound effects occur because the nutrients influence methylation, often by directly contributing methyl groups that can migrate onto DNA and shut off genes. Although the DNA sequence within the *agouti* gene was the same in all the offspring, methylation in the animals that grew brown coats had shut off that gene as well as a cascade of others important for diseases.

Some scientists are showing that factors other than foods, drugs,

and environmental chemicals can also change a developing organism's gene expression. For example, the attention that a young animal receives from its mother can have long-lasting effects on genes that affect its behavior in adulthood, says Moshe Szyf of McGill University in Montreal.

Researchers had long known that rat pups that don't receive as much licking and grooming—perhaps a rat mother's brand of affection—grow up to have more-exaggerated stress behavior than better-cared-for pups do. In 2004, Szyf and his colleagues showed that rats that aren't adequately licked and groomed as babies end up with a methyl group on a gene that makes the glucocorticoid receptor, a brain cell–surface protein essential for the stress response. Less-well-tended rats methylate that gene, says Szyf.

He and his colleagues published a paper in the Feb. 28 *Proceedings of the National Academy of Sciences* showing that the effects of maternal care, good or bad, needn't be permanent. Administering drugs that put on or knock off methyl groups changed the glucocorticoid- receptor gene's methylation status in adulthood and, therefore, how much stress the animals experienced.

Szyf and his colleagues are now attempting to determine whether a human mother's care for her baby has a similar effect. However, he points out that the study in rats illustrates one potential benefit of epigenetic modifications. During evolution, a pivotal gene typically changes only slowly, but the environment around an organism can change quickly, Szyf explains.

Thus, if a mother has cause to be stressed and is too preoccupied to groom her pups, her offspring had better prepare themselves for stressful lives. "Epigenetics gears us toward the world we'll be finding ourselves in," Szyf says.

POSTER CHILDREN — Illustrating how epigenetics can control physical traits, the slimmer and browner of these mice, carrying a gene called *agouti*, were born to mothers that ate more DNA-methylating foods.

MAKING A MARK These epigenetic adjustments don't stop during youth—marks in the genome can shift throughout adulthood and into old age. For example, Manel Esteller of the Spanish National Cancer Center in Madrid and his colleagues reported in the July 26, 2005 *Proceedings of the National Academy of Sciences* that identical twins who start out with near-identical methylation patterns grow apart epigenetically as they age (*SN: 7/9/05, p. 19*). The researchers found that these differences were magnified in twins that spent the majority of their lives apart.

"We believe these different epigenetic patterns in twins depend many times on the environment," says Esteller, "whether it's exposure to different chemical agents, diets, smoke, or whether people live in a big city or the countryside."

Researchers are still trying to figure out whether an organism has control over the placement of these epigenetic marks.

Although many of these marks could have a positive effect or no effect at all, explains Esteller, numerous studies have suggested that some epigenetic changes have negative effects that increase the likelihood of diseases, including cancer. For example, several studies of cells sampled from cancer patients' tumors have found that tumor-suppressor genes that normally protect a cell from developing cancer are often silenced by epigenetic modifications.

Studying epigenetic modifications and the environmental effects that lead to them could provide information on why people get cancer in the first place, says Andrew Feinberg of Johns Hopkins University in Baltimore. He and his colleagues study a phenomenon called imprinting, in which gene copies take on epigenetic marks that keep them on or off, depending on which parent each copy was inherited from. One copy of a particular imprinted gene, which makes a protein called insulinlike growth factor 2 (IGF2), is normally turned off when inherited from an animal's mother. The copy inherited from an animal's father generally stays on.

In the March 25, 2005 *Science*, Feinberg's team showed that mice that lose epigenetic control over the maternally inherited copy of the *IGF2* gene, and so turn it on, have more than double the risk of getting colon cancer when they later get a cancer-causing genetic mutation. "It looks like it's important for this cancer to have a double dose of IGF2 expression," says Feinberg.

Loss of imprinting and other epigenetic changes could play a role in numerous other diseases, including those that affect mental health. For example, Arturas Petronis of the University of Toronto and his colleagues are analyzing methylation patterns in postmortem brain tissue from autopsies of people who had schizophrenia or bipolar disorder and from people who had good mental health. His team is hoping to spot some critical differences in gene regulation.

Petronis admits that separating the tangled web of cause and effect in mental diseases is a difficult task. Methylation patterns might have contributed to a person's disease, but they might also have been influenced by the numerous psychotropic medications that psychiatric patients often take. Nevertheless, Petronis says, the work is gradually racking up data that could point out genes misregulated in these diseases.

NURTURING PATIENTS One vital feature of epigenetic modifications is that they're faithfully passed down as a cell divides. For example, each cancer cell in a spreading tumor inherits the same epigenetic mishaps as did the cell that originally spurred the disease. However, these marks need not spell out a patient's death sentence. Several pharmaceutical companies are now focusing on creating new drugs that attack the enzymes that chemically modify chromosomes.

A handful of these drugs is already on the market, but it's not clear how they work, says cancer researcher Jean-Pierre Issa of the M.D. Anderson Cancer Center in Houston. However, he notes, researchers suspect that shutting down these enzymes leaves dividing cells without the resources to pass on their epigenetic marks. Therefore, more cells in each new generation are missing the marks that propagated their parent cell's disease.

Regardless of the mechanism, the important thing is that the drugs do seem to fight disease, notes Issa. "The epigenetic approach is working," he says.

In the April 15 *Cancer*, Issa and his colleagues published the results of a trial of a demethylating drug called decitabine. In 170 patients with a type of blood cancer, about 9 percent of the group was in complete remission after 6 weeks of treatment with the drug, compared with none of the patients who received typical supportive care. About a third of the drug-treated patients had significant improvements in their disease symptoms and progression.

Issa notes that decitabine and other drugs that target gene methylation might work even better when administered with some traditional chemotherapy medications. His team plans on

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JIRTLE/ENVIRONMENTAL HEALTH PERSPECTIVES

NAKED AND NOT

Two species of mole rats run complex societies underground

BY SUSAN MILIUS

On his first trip into Namibia, Chris Faulkes woke up in his tent with a peculiar kink in his back. The ground beneath him had been flat enough when he went to sleep. Yet the next morning, "there was a whopping great lump," he says. A mound of dirt had arisen under Faulkes. He'd inadvertently found—or been found by—Damaraland mole rats, the very creatures he'd come to study. With one of the oddest social systems yet found in mammals, these sub-Saharan rodents spend their lives in networks of underground tunnels that they continually excavate.

These mole rats and a better-known species called naked mole rats survive in land that goes months without rain. When rain finally comes, the animals go into a frenzy of digging to expand their tunnels before the ground bakes again.

With the mole rats' extreme social system, individuals labor for the sake of the colony. Since the early 1980s, mole rats have been used as models of social organization.

The wrinkled, hairless rodent known as the naked mole rat has achieved celebrity status even outside science. In Faulkes' office at Queen Mary College of the University of London stands a cardboard cutout of the Disney-cartoon character of the naked mole rat Rufus. Even the Wall Street Journal has run a page-one story on naked mole rat charms. The subhead read: "What Is Whiskered and Ugly and Has Little Squinty Eyes?—No, Not Your Former Spouse...."

The Damaraland mole rat that woke Faulkes doesn't have a popular following, but it offers a valuable comparison with the naked mole rats' social behavior. Although the Damaraland's basic biology resembles the naked mole rat's, its social structure has some twists. What's more, recent research has revealed a cast that includes couch potatoes.

Says Nigel Bennett, one of Faulkes' colleagues on the Namibia expedition, "I hope people will realize the haired mole rats are just as interesting as the naked ones, if not more so."

MEGA BITE — A Damaraland mole rat, like its naked cousin, digs its tunnels by biting away the soil with front teeth that arise outside its mouth. The excavator can thus keep its mouth closed and dirtfree.

FAULKES

GOOD OLD DAYS No scientist knew much about the biology of mole rats in the 1960s, when Jennifer Jarvis of the University of Cape Town in South Africa began studying the evasive, underground rodents. The family she studied contains several dozen species in sub-Saharan Africa that are neither moles nor rats, but are more closely related to guinea pigs and porcupines.

To find mole rats, a researcher looks for hills of dirt and guesses where to dig to strike a tunnel. When the shovel slices through a passageway, researchers fit it with a tube trap rigged so that a door will snap down and capture any mole rat that ventures inside.

Many times, the mole rats detect the breach, says Jarvis. In those instances, instead of trotting into the trap, the mole rats wall off the violated tunnel. That means even more digging for the scientists, often in 40°C heat and full sun.

Jarvis collects captured mole rats aboveground in tubs until she's retrieved a whole colony. To protect the captives from temperature swings, Jarvis shades the tubs during the day and tucks the animals in at night with carpet backing and hot-water bottles.

When Jarvis first brought a colony of naked mole rats back to her lab, she struggled to find suitable burrows. First, she filled a glass-sided box with soil. "They dug a marvelous burrow system," she says. "The next day, they dug again—and it collapsed." Now, she knows that soil soft enough for easy digging is a rare stimulus for mole rats to embark on urban renewal. "The colony goes crazy," she says.

So, she made her lab colony a plaster of paris home riddled with tunnels that wouldn't collapse. Soon though, the mole rats "looked like tiny white ghosts with beady eyes," she says. Finally, she settled on mole rat runs custom-built from plastic tubing.

Bringing the animals into the lab provided other challenges, which Jarvis would later recognize as clues for one of her major research contributions. She remembers lamenting that she wasn't catching any reproductive females. Also, "I was very distressed to find [the captives] fighting all the time," she says.

"Finally, the penny dropped," says Jarvis. Corresponding with Richard D. Alexander of the University of Michigan in Ann Arbor, she realized that a naked mole rat colony has only one reproductive female at a time. And as befits a queen, she's almost always the last one to get caught in the trap.

If a group of mole rats lacks a queen, the subordinate females struggle to win her place. "There were sometimes vicious fights for over a year," Jarvis says. Contenders often kill each other, until one female manages to dominate the rest. "Then peace reigns," she adds.

In 1981, Jarvis compared such goings-on to the communal behavior of ants, bees, termites, and the like. Naked mole rats, she

said, were the first mammals shown like those insects, to, live in groups that include several generations of workers sharing the tasks of the colony but to have only a single or very few dominant females bearing young. Among the mole rats, both male and female workers dig burrows and collect food.

Borrowing a word from entomologists, Jarvis argued that naked mole rats are eusocial. They've outstripped the rest of mammals and taken their social organization to another level.

In 1982, she finally found queens in the wild. Just how a naked mole rat queen dominates her subjects is still not entirely clear. The queen spends more time than the other adults do patrolling the tunnels. When she meets a mole rat coming toward her, she typically climbs over it, while other colony members pass each other side by side. The queen also rams certain colony members, nose to nose, as if to assert her authority more strongly. "She seems to know who needs shoving," says Jarvis.

Whatever its mechanism, her domineering behavior works. Among naked mole rats, only the queen and the several males she chooses as mates reproduce. "The colony's very aware of her," says Jarvis. "When she's pregnant, both males and females develop teats." Only the queen nurses, but the other colony members undergo hormonal changes and tend the pups.

NOTES FROM UNDERGROUND Bennett says that he got interested in Damaraland mole rats when he came to South Africa in the early 1980s to do graduate work with Jarvis. The two researchers set up the first major field study of the species and brought a colony into his lab.

"I actually thought the animals looked quite handsome," remembers Bennett, who is now at the University of Pretoria in South Africa. They're huskier than the naked mole rats, and their brown or black fur sets off a white blaze on their heads. Also, he says, "they have a very strong smell that is slightly fruity."

Damaraland mole rats turned out to resemble naked mole rats in many ways. Both block off the ends of their tunnels with dirt and survive without regular fresh-air exchange.

Both species dig with their oversize, paired front teeth. They actually bite their way through the ground. The upper and lower incisors emerge through skin above and below their mouths. Mole rats can close their mouths behind the teeth, keeping dirt out of their mouths during excavation.

The teeth continue growing throughout a mole rat's lifetime, and the animals sharpen them by grinding the top and bottom pairs against each other, often as they're dropping off to sleep.

Such equipment permits prodigious digging. From the size of molehills in the wild, Bennett and Jarvis calculated that within the 2 months after a rain, a colony of 16 mole rats had chewed 700 meters of new tunnels and pushed 2.6 metric tons of soil out of their burrows.

The animals tunnel as a way of looking for food without leaving the burrow. Mole rats eat the tubers and roots where aridland plants store moisture and nutrients. Damaraland mole rats bring chunks back to store in chambers in the burrow system.

Mole rats are also adapted to underground dining. Without regular sun exposure or abundant vitamin D, they use physiological tricks to manage their calcium balance efficiently. Their diet presents the mole rats with a lot of fibrous material that's not easy to digest. Cows cope via an extra stomach where microbes break down the slurry of plant material before it works its way onward in digestion. Mole rats rely on microbial assistance, too, but their microbial richness lies beyond the stomach in a section of their gut called the cecum.

That organ is less efficient than the stomach at absorbing nutrients. Mole rats get around this difficulty by putting their food through their digestive systems more than once.

A defecating mole rat often bends down to fill its mouth, and weaning naked mole rat pups beg adults for a share. When the queen is too pregnant to bend over well, she, too, demands donations from the rest of the colony.

"It sounds strange to us, but it obviously sounds delectable to them," says Jarvis.

The burrow systems also have bathroom chambers, which get walled off after long service.

OEDIPUS RAT Despite the similarities between the naked and Damaraland mole rats, there are differences. For example, naked mole rats give some 18 vocalizations, variations of "squeaking and grunting and twittering," Jarvis says. The Damaraland variety does make "birdlike chirps" but isn't very vocal, says Bennett.

The two species "exhibit totally different reproductive strategies," says Bennett. This may reflect the seemingly independent origin of the extreme colony structure within the two species.

Several family trees based on DNA suggest that the naked mole rat lineage arises from an ancient branch at the base of the family tree. The Damaraland mole rat lineage sprouts higher in the tree, Faulkes says. On the intermediate branches, there are a variety of solitary species and ones that are social but not eusocial.

NAKED NURSERY — In a naked mole rat colony, only the queen (with large belly) bears pups. Colony members help care for youngsters and share a sleeping chamber.

T. JACKSON

Naked mole rats breed readily enough with close kin. Although their preference is to outbreed, Faulkes says, "a daughter might kill her mother and mate with her father and take over the colony."

In contrast, observations plus genetic work indicate that Damaraland mole rats don't often mate with close kin. When a Damaraland mole rat queen dies, a daughter does not step into her paw prints, and the colony breaks up.

Even in an operating colony, a Damaraland mole rat now and then tunnels off in search of a new living situation. It may meet up with a like-minded mole rat of the opposite sex for possible colony formation or move into another established colony.

Genetic studies support the scientists' view of such underground hookups. Naked mole rat colonies, without an incest taboo, may end up highly related. When Cornell University researchers Kern Reeve and Paul Sherman checked relatedness of naked mole rats in wild colonies, they found that members had the same version of some 80 percent of their genes. However, Damaraland mole rats in a natural colony match only about half of their genes. That's about normal in a mammal family, Faulkes says.

The high relatedness of naked mole rats makes the animals' extreme social structure seem less bizarre, says Bennett. Most of the offspring drudge away their lives raising their mother's latest litter. If those nannies are closely related to the pups, plenty of shared genes get passed along.

Yet for years at a time, a Damaraland mole rat colony functions much like a naked mole rat colony, despite the Damaralands' lower relatedness. "For mammals, you don't have to be super related for eusociality to evolve," Faulkes concludes. The costs of going it alone just have to be super high.

Faulkes, Bennett, and Jarvis hypothesize that a lone mole rat couldn't survive the punishing climate with its erratic rain and patchy food. When rain does come, mole rats have only a short time

to drive their tunnels into new territory and find food or, if necessary, a mate. A solitary animal stands less of a chance of digging a lucky tunnel than does a bunch of animals.

The researchers contend that it's no coincidence that the two mole rat species living in some of the world's toughest habitats have the most extreme social system.

LAZYBONES One of the puzzles of the mole rats' hivelike colonies has been what technical papers politely call "infrequent workers." In conversation, though, Michael Scantlebury, one of Bennett's colleagues at the University of Pretoria, has been known to say "lazy."

Some of the subordinates in a Damaraland colony seem to simply hang around and eat food that other colony members have found. Making up 35 percent of the group, these loafers do only 5 percent of the work. Understandably, they get fat on such easy living.

Infrequent workers had previously been studied in the lab, but only recently have Scantlebury, Bennett, and their colleagues obtained data from the wild.

FORMER MOLE RATS — Embodying the ultimate experiment spoiler, a 3-meter-long mole snake swallowed the whole colony of Damaraland mole rats that a researcher had spent days preparing for a metabolism experiment.

SCANTLEBURY

Again, the researchers collected all the mole rats from each studied colony. Scantlebury then injected these animals with a substance used for monitoring energy expenditure. He released the mole rats back into their home burrows and, a few days later, recaptured them for measurement.

This was not an easy experiment, says Scantlebury. Outdoors, mole rats evaded the traps easily and often. On one bad-data day, he failed to recapture any of the members of a colony. As hours ticked toward the deadline for getting usable data, "I dug the biggest hole of my life," he says.

Finally, a little flick in the sand tipped him off. Poking at the motion, he found a 3-m-long snake that had slid into the borrow, eaten all the experimental subjects, and bulged up so much that it got stuck in the mole rat tunnel.

Still, Scantlebury and his colleagues managed to get metabolic measurements from nearly 40 animals in seven or eight colonies during a dry period and after rain. In the April 6 *Nature*, the team reports that during the dry period, the fattest group of mole rats showed extremely low metabolic activity after its return to the burrow.

But during the wet period, all the mole rats got more active, and the difference was larger in the fat animals than in the others.

The freeloading lifestyle may pay off in the long term for the colony. When rains finally permit digging, says Scantlebury, the animals that are well provisioned with fat reserves could be the ones that strike off digging to find new sources of food and, perhaps, to cross tunnels with a potential mate.

A class of couch potatoes doesn't necessarily make a society less sophisticated. Bennett, with perhaps an undertone of irony, calls the supersocial mole rats "the pinnacle of social evolution in the mammals." Even if the Damaraland mole rats never become Disney stars, they offer scientists a new look at high society. ■

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testing that possibility.

While cancer is the primary target of epigenetic therapies for now, some companies are branching out. For example, Montreal-based MethylGene is working on drugs to treat problems ranging from diabetes to neurodegenerative diseases to fungal infections.

Right now, drugs aimed at altering epigenetic marks hit in a random way. They knock off methyl groups that could have positive effects as well as groups that could have harmful ones. For researchers to target treatments to the specific marks that influence a disease, they'd need a map of marks. That's one reason that many researchers, including Peter Jones of the University of Southern California in Los Angeles, are pushing for a human epigenome project.

Similar to the landmark Human Genome Project, the human epigenome project would scan the chromosomes of volunteers to look for similarities and differences in epigenetic patterns. But, notes Jones, comparing epigenomes will be a far more monumental task than mapping genes.

"There are different epigenomes in every tissue—even in every person," says Jones. Challenging decisions confront researchers designing such a project. How many of the body's tissues will they scan? Will they include people of different ages and ethnicities? How will smoking and other lifestyle factors figure in? And how will they handle the enormous amount of information the project will generate?

Someday, notes Jirtle, scientists may paint a complete picture of how nature and nurture work together. But for now, he agrees with identical twin Eleanor's view. "Both nature and nurture are important, and both are intertwined," he says.

"But what's bigger is epigenetics, in terms of bulk," he adds. "Genomics might be the tip of the iceberg, but I truly believe that epigenetics is the base." ■

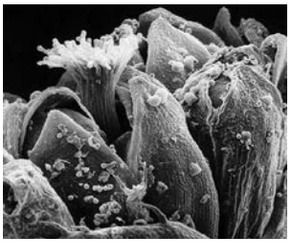
OF NOTE

ENVIRONMENT

Main source of airborne pollen varies by month

People with seasonal allergies know that some months can be tougher than others. An unprecedented 15-year study conducted in the New York City area charts how air concentrations of different types of pollen vary throughout an average year.

Ragweed pollen, the most significant cause of allergy, is airborne mainly during August and September, report researchers at the University of Medicine and Dentistry of New Jersey–New Jersey Medical School in Newark.



PUBLIC ENEMY #1 This common allergen, ragweed pollen, is shown dispersed on a ragweed plant in this scanning electron micrograph.

CDC/J. CARR

By contrast, tree pollen is most abundant during May and is nearly absent from the air after the end of June. Grass-pollen concentrations peak in June and rise again, albeit to a lesser extent, in September.

Contrary to what some people with allergies might think, pollen abundance has decreased—at least in the New York City area—over the past decade.

The new data might help some people avoid unnecessary outdoor exposure at times when their allergies are most likely to be active, Leonard Bielory and his colleagues say in the May *Annals of Allergy, Asthma and Immunology*. They note that seasonal pollen patterns are likely to differ from one region of the country to the next. —B.H.

BOTANY

Herbal therapy for beleaguered lawns

Many people don't like the biting taste of mustard. Neither, it turns out, do sting nematodes—small, parasitic roundworms that siphon food from plant roots. That finding could prove good news for maintaining golf courses, sports fields, and other picture-perfect lawns.

Some weeds and other plants naturally resist sting nematodes (*Belonolaimus longicaudatus* Rau). Suspecting that these plants produce defensive chemicals, Campbell J. Cox and his colleagues at Clemson (S.C.) University applied extracts from several of these plants and a few other candidates to the roundworms in test tubes and greenhouse soils. The group included spotted spurge, tall lettuce, goldenrod, lantana, poinsettia, and a mustard.

Mustard-seed and poinsettia-shoot extracts proved most effective, Cox's team reports in *Agronomy Journal*, published online June 5. In their greenhouse experiments, the poinsettia preparation killed virtually all the sting nematodes in grass, but only if it remained in the root zone for 4 days. Irrigating the grass during that period dramatically diminished the extract's effects.

On the other hand, the mustard killed most of the roundworms within 2 days after an application, even when the researchers watered the grass during that time. Indeed, such irrigation might be essential in applying the mustard extract, Cox notes, since the extract caused leaf damage when it dried on the blades of grass. —J.R.

ENVIRONMENT

Something's fishy about these hormones

To beef up animals quickly, most U.S. cattle ranchers treat their livestock with growth-promoting hormones. Among the more widely used drugs is trenbolone acetate (*SN: 1/5/02, p. 10*), a synthetic anabolic steroid. In April, Environmental Protection Agency scientists reported finding trace concentrations of two breakdown products of this drug in wastes released into a stream by an Ohio cattle feedlot. Now, the scientists show that female fish develop masculine traits when exposed to these testosterone-like breakdown products at the same concentrations seen in those feedlot wastes.

A team led by Gerald T. Ankley of the EPA laboratory in Duluth, Minn., scouted for trenbolone's breakdown products—17-alpha and 17-beta trenbolone—in feedlot wastes. Both occurred at a few parts per trillion (ppt), the group reported in an April supplement to *Environmental Health Perspectives*.

The alpha metabolite was 5 to 10 times as abundant as the beta metabolite, but preliminary test-tube data had suggested that the alpha form was only one-tenth as potent as the beta.

To the team's surprise, the alpha and beta metabolites proved equally potent in their effects on female fathead minnows. In water with 11 ppt of either metabolite, a concentration comparable to that in the Ohio wastewater, egg production fell to half of normal, the Duluth team reports in the May 1 *Environmental Science & Technology*. A concentration of about 110 ppt shut down egg production and produced bumps on the females' heads, a trait normally seen only in males. —J.R.

BIOMEDICINE

Coffee protects against alcoholic cirrhosis

A sobering cup of joe after a night of hard drinking may provide some people an unexpected benefit: protection from cirrhosis, a liver-scarring disease that's common in alcoholics.

More than 5 million people in the United States have cirrhosis, typically from heavy alcohol use. However, only about a quarter of chronic drinkers end up with the disease, leading some researchers to hypothesize that lifestyle factors have a protective effect.

To search for such factors, Arthur L. Klatsky of the Kaiser Permanente Medical Care Program in Oakland, Calif., and his colleagues analyzed data recorded over more than 2 decades from 125,000 patients enrolled in the large health care plan. Between 1978 and 1985, these people had given detailed information on a variety of personal habits, including how much alcohol, coffee, and tea they drank.

The scientists analyzed the habits of people with similar alcohol consumption who had died from cirrhosis and of people who were free of the disease as of 2001. With each cup of coffee a person drank daily, the risk of cirrhosis dropped about 22 percent. Those who drank more than 4 cups per day were only 20 percent as likely to get the disease as people who did not drink coffee were, the team reports in the June 12 *Archives of Internal Medicine*.

Although coffee seems to exert some unknown protective effect, notes Klatsky, the best protection against cirrhosis is to cut down on alcohol consumption. —C.B.

SUPPLEMENTS

Glucosamine isn't at fault

According to a new study the popular dietary supplement glucosamine doesn't cause insulin resistance, the precursor of type 2, or adult onset, diabetes.

Glucosamine, a sugar that's naturally produced by the body, collects in cartilage and other connective tissue. Millions of people take glucosamine supplements to relieve pain caused by osteoarthritis.

Previous animal and human studies had found that "giving glucosamine can impair insulin's action, which can potentially make [people] diabetic or worsen diabetes," says Rajaram J. Karne, now of the Ohio State University Medical Center in Columbus. However, participants in those studies received high doses of glucosamine by injection.

Karne and his colleagues at the National Center for Complementary and Alternative Medicine in Bethesda, Md., tested a commonly used dose of oral glucosamine in 20 normal-weight and 20 obese adults. Each volunteer took a 6-week course of either three 500-milligram pills of glucosamine daily or a placebo. Researchers tested each person's insulin sensitivity at the beginning and end of the study.

"We're glad to say that 6 weeks of glucosamine doesn't make any measurable difference on insulin's action," Karne says. —K.T.

GENETICS

Three gene variants boost diabetes risk

In a large study, researchers have linked small variations in three genes to type 2 diabetes. The information may prove useful in the development of a screening method to determine who is most likely to develop the disease.

Earlier, smaller studies had associated the three gene variants with type 2 diabetes. Valeriya Lyssenko of Lund University in Malmö, Sweden, and her colleagues set out to determine whether detecting common forms, or alleles, of nine diabetes-linked genes could predict who would develop the disease among a large population.

For their study, the researchers randomly selected 7,061 men and women who were participants in the Malmö Preventive Project, a massive, long-term clinical trial that began in the 1970s and followed each person for about 22 years. Lyssenko's team collected each person's medical history and studied analyses of their DNA. Almost 1,500 people in the sample developed type 2 diabetes.

Certain alleles of three genes—*PPARG*, *TCF7L2*, and *KCNJ11*—increased the risk of developing type 2 diabetes. People with all three risky variants were almost three times as likely to show the disease as were people who carried none of the alleles.

The researchers also calculated that these risk alleles strongly influence the numbers of cases. For example, if the variant of *TCF7L2* were eliminated from the population, there'd be 22 percent fewer cases of type 2 diabetes. "These high numbers most likely reflect that these three alleles are common in the population," Lyssenko says.

Because the three alleles appear to be independently associated with increased risk of developing diabetes, each one probably has a unique role in the disease, Lyssenko adds. —K.T.

PHARMACOLOGY

New drugs reduce blood sugar

Two experimental drugs can lower blood sugar significantly in people with type 2 diabetes, research shows. If approved by the Food and Drug Administration, the drugs could represent a new class of diabetes medication.

Both compounds inhibit an enzyme called dipeptidyl peptidase 4 (DPP-4), which usually controls the body's production of a hormone, called GLP1. Cells lining the intestines normally release GLP1 in response to ingested sugars, and the hormone then alerts cells in the pancreas to release insulin for sugar regulation (*SN: 8/16/03, p. 104*).

But GLP1 lasts only minutes in the body because DPP-4 breaks it down. Researchers have hypothesized that suppressing the enzyme would make more GLP1 available to the pancreas cells to stabilize insulin production.

Two groups now report that DPP-4 inhibitors significantly lower blood sugar compared with placebos. The effects showed up when the inhibitors were taken alone or in combination with other diabetes drugs.

One of the new drugs, sitagliptin, is made by Merck Research Laboratories of Rahway, N.J. The other, called vildagliptin, is made by Basel, Switzerland–based Novartis.

Compared with a placebo, neither drug caused more occurrences of a severe drop in blood sugar.

"DPP-4 inhibition is a mechanism by which we can enhance the body's own glucose regulation," says Merck scientist Peter Stein.

The DPP-4 inhibitors show great promise, agrees John B. Buse of the University of North Carolina School of Medicine in Chapel Hill. But even though they appear safe in these studies, the drugs' full impact may not be apparent until they're taken by thousands of people for many years. "There are many [compounds in the body] degraded by DPP-4," he notes, and inhibiting the enzyme could increase those compounds' concentrations, with yet-unknown effects. —N.S.

BIOMEDICINE

Antidepressant drugs show link to diabetes

People taking antidepressant medication might be at increased risk of developing diabetes.

The unexpected association comes from a study of 3,187 people that was designed to find out whether type 2 diabetes could be prevented. All participants were at high risk of developing diabetes because they were overweight, sedentary, or had other risk factors. Some participants were directed to change their lifestyle, and some received diabetes medication or a placebo.

Roughly 6 percent of participants were taking antidepressants at the start of the study. Over the course of the trial, these people were nearly three times as likely to develop diabetes as were people not taking antidepressants, reports Richard R. Rubin of Johns Hopkins Medical Institutions in Baltimore.

However, people taking antidepressants who were also assigned to receive the diabetes medication metformin (brand name Glucophage) weren't any more likely to develop diabetes during the 3-year study than were people not on antidepressants, the researchers found.

It's unclear how antidepressants might contribute to type 2 diabetes or how metformin might offset such risk. "We don't have a clue as to what's going on, [but] the potential public health implications are substantial," Rubin says.

He counsels people not to change their medication based on the new study. "These are dramatic and striking findings that deserve further investigation," he concludes. —N.S.

Books

A selection of new and notable books of scientific interest

THE CLOUDSPOTTER'S GUIDE: The Science, History, and Culture of Clouds

GAVIN PRETOR-PINNEY

Most people don't think about clouds, except to curse them for blocking the sun. Pretor-Pinney, however, celebrates the fluffy white or even dark gray forms. Founder of the Cloud Appreciation Society, Pretor-Pinney provides the tools that every fledgling cloudspotter needs to identify the 10 main cloud varieties. Each chapter is devoted to a particular type of cloud and includes a "How to Spot" chart. Listings include cloud types, Latin names, typical altitudes, places of origin, and chances of producing precipitation that can reach the ground. Divided into sections devoted to low, middle, and high clouds, this field guide to the skies includes such details as the ferocious, storm-producing capabilities of the cumulonimbus, the UFO-like appearance of the altocumulus lenticularis, and the halo-forming tendencies of the cirrostratus. Finally, the author describes his voyage to Australia to view the cloudspotter's ultimate find, a cloud known as the morning glory, which can stretch as far as 600 miles across the sky. ***Penguin, 2006, 320 p., b&w photos and illus., hardcover, $19.95.***

THE CALCULUS WARS: Newton, Leibniz, and the Greatest Mathematical Clash of All Time

JASON SOCRATES BARDI

Historians regard Isaac Newton and Gottfried Wilhelm Leibniz as two of the greatest scientific thinkers in history. Both are revered for their monumental advances in mathematics and physics. Few people know, however, of the bitter dispute between these two men over the intellectual ownership of calculus, the mathematics that describes bodies in motion. Today, Newton and Leibniz get equal credit for inventing the field, but during the late 17th century, neither was willing to give the other any credit for the work. Science writer Bardi tells the tale of the public, private, and lifelong feud. It's clear that Newton created calculus in 1666 but kept his invention secret. Leibniz independently created calculus in 1675 and then published his work in two papers, which catapulted him to fame in Europe. Bardi describes how Newton accused Leibniz of stealing his ideas, to which Leibniz responded with his own attacks. The war lasted many years. ***Thunder's Mouth Press, 2006, 277 p., hardcover, $25.00.***

GUANXI: (The Art of Relationships) Microsoft, China, and Bill Gates's Plan to Win the Road Ahead

ROBERT BUDERI AND GREGORY T. HUANG

As U.S. companies continue to outsource more and more jobs to countries such as China and India, many people wonder whether the U.S. economy is being undermined by that strategy. However, Redmond, Wash.–based computer-software giant Microsoft has found a way to tap into Chinese talent while remaining on the forefront of information technology. Buderi is a research fellow at the Massachusetts Institute of Technology's Center for International Studies, and Huang is a science editor. They describe Microsoft's Beijing-based lab, founded in 1998, and recount how its wealth of top young Chinese minds in computer science has produced many of Microsoft's latest achievements. Microsoft founder Bill Gates set about recruiting employees for this new lab by offering them the opportunity to work on cutting-edge technology while remaining in their native country. So far, Microsoft has invested $100 million and hired 400 of China's best and brightest computer scientists. ***Simon & Schuster, 2006, 306 p., b&w plates, hardcover, $26.00.***

A WALK AROUND THE POND: Insects in and over the Water

GILBERT WALDBAUER

In North America alone, there are more than 10,000 aquatic and semiaquatic insect species that live parts of their lives in fresh water. How did they evolve to survive both on land and in water? Waldbauer, professor emeritus of entomology at the University of Illinois, attempts to explain the feat while providing a who's who of these remarkable insects, including mayflies, dragonflies, true bugs, beetles, and mosquitoes. He describes how these species have evolved methods to breathe, search for food, reproduce, regulate temperature, see, and prey on other insects in aquatic environments. For instance, the whirligig beetle uses its sensitive antennae to detect water-surface ripples made by struggling insects. Finally, Waldbauer describes the complex relationship between these insects and people: While mosquitoes and black flies are often carriers of disease, other varieties of aquatic and semiaquatic insects are culinary delicacies. ***Harvard, 2006, 286 p., b&w illus., hardcover, $22.95.***

LIFE AFTER STROKE: The Guide to Recovering Your Health and Preventing Another Stroke

JOEL STEIN, JULIE SILVER, AND ELIZABETH PEGG FRATES

Cardiovascular disease is on the rise in both elderly and young people. Professionals commonly refer to strokes as brain attacks because they have origins similar to those of a heart attack. However, the brain is a much more complex organ than the heart and not as readily treated. In this book, the authors—all physicians specializing in rehabilitation medicine—educate people who have had strokes and their caregivers about the causes of this disease as well as the steps to be taken toward rehabilitation. The text describes the various types of strokes, their immediate symptoms, and their effects on physical and mental functioning. The authors also discuss how stroke patients can best interact with doctors and other caregivers during rehabilitation and what medications are available for treatment. ***Johns Hopkins, 2006, 337 p., paperback, b&w illus., $18.95.***

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LETTERS

Timely suggestions

Clock time has long been out of step with the heavens (*"To Leap or Not to Leap," SN: 4/22/06, p. 248*). Since the adoption of time zones in the 19th century, we have accepted disparities of as much as 30 minutes at the edges of the time zones (more in some cases since time zones are set by politics, not geography). And of course, the 20th century brought daylight savings time, under which most Americans accept a 1-hour disparity between April and October. While I don't like the idea of abandoning leap seconds altogether, I don't think it's unreasonable to let the disparity build up to an hour before making a correction.

MICHAEL A. ZACHARY, PHOENIX, ARIZ.

A simple solution might be to keep a running tally of time beginning, say, at midnight on Jan. 1, 2000. Like the Julian calendar that simply counts days from a zero year, a millennial clock could count seconds from the millennial year. This way, a calculation could be made, accounting for any added leap seconds, to get the local time. Since only the algorithm would change from year to year, those who rely on precision atomic time would not be affected by adding leap seconds.

DAVE HEIDEN, STRATFORD, CONN.

The main reason for the nearly annual adjustment we need now is a mismatch between the definition of the second in terms of atomic time and that in terms of the average speed of the Earth's rotation. The period for which the latter calibration was made happened to be an exceptionally fast one. If a more representative mean rotation had been used, we would need no adjustment most years, and there would be as many lost seconds as leap seconds.

FREDERICK FALLON, BOWIE MD.

Although changing the official definition of the length of the second is a possibility, "the current length of the second is embedded in the definition of physical standards and [a change] would have very far-reaching consequences that make this option unattractive," says Dennis D. McCarthy of the U.S. Naval Observatory. He adds that the second would still have to be redefined in the future to keep up with the Earth's deceleration. —R. COWEN

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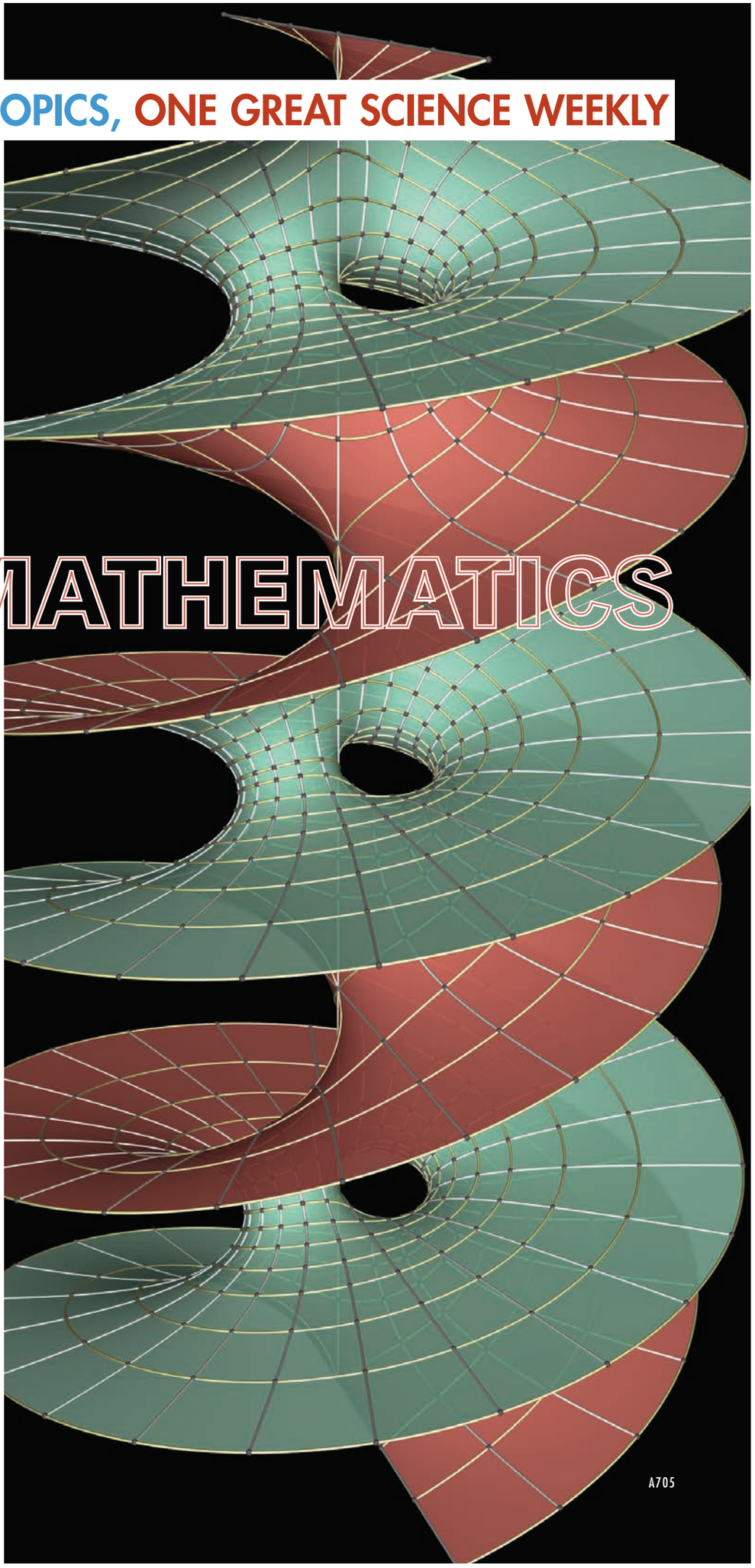

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