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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 5, 2009

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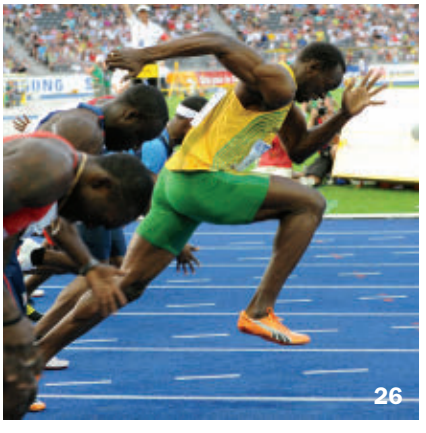
DECEMBER 5, 2009 • VOL. 176 • NO. 12



ScienceNews

In The News

Features

Departments

COVER Scientists and policy makers will meet in Copenhagen this month to take steps toward an international agreement on curbing climate change. *Photo: Randall Fung/Corbis Illustration: B. Rakouskas*

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FROM THE EDITOR

For athletes, journalists, success can earn awards

Unlike sports, science isn't usually about setting and breaking records. It's about understanding the physical and biological world. Mostly scientific research is undertaken for its own sake, or perhaps to provide various benefits for humankind, not winning races.

Sometimes scientific understanding does enhance efforts to break athletic records, though, as freelance writer Laura Beil reports in this issue (Page 26). The confluence of physical and biological science in sports plays out in the mix of technology and physiological knowledge that makes today's athletes race faster than those in the past—whether on foot, in the water or on bicycles or ice skates. Many athletes owe their records and gold medals to scientific research and the technology that flows from it. In turn, sports provide science with interesting material to study in the quest to understand how human muscles make feats of athletic prowess possible.

Scientists don't participate in precisely the same sort of competitions that athletes do, but science does have its rewards and honors. So does science journalism. And if you'll forgive the use of this space for a brief commercial message, *Science News* has fared well in some recent journalistic competitions. In October, environment and chemistry writer Rachel Ehrenberg received the Acoustical Society of America's 2008 Science Writing Award for Journalists, for her report on sonar's effects on whales (*SN: 7/19/08, p. 22*). In January, earth sciences writer Sid Perkins will receive the Award for Distinguished Science Journalism in the Atmospheric and Related Sciences given by the American Meteorological Society, for his feature on the global impacts of a Peruvian volcanic explosion in 1600 (*SN: 8/30/08, p. 16*). And in November, Douglas Fox, a freelancer writing for the Science News for Kids website, was named the winner in the Children's Science News category of the 2009 AAAS Kavli Science Journalism Awards from the American Association for the Advancement of Science, for his feature on the underground rivers and lakes of Antarctica (see www.sciencenewsforkids.org/antarctica).

Our purpose, of course, is not to win such prizes, but to provide our readers with the best coverage of science news available anywhere for a general audience. But we do hope that these prizes are a reflection of some degree of success in that endeavor. —*Tom Siegfried, Editor in Chief*

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"I think what drives me as a mathematician are those things which are not seen, the things that we haven't discovered, and it's all those unanswered questions that make mathematics a living subject. I always come back to this quote in the Japanese *Essays in Idleness*: 'In everything … uniformity is undesirable. Leaving something incomplete makes it interesting and gives one the feeling that there is room for growth.'"

—UNIVERSITY OF OXFORD MATHEMATICIAN MARCUS DU SAUTOY IN A PUBLIC LECTURE POSTED ONLINE IN OCTOBER AT TED.COM

Science Past | FROM THE ISSUE OF DECEMBER 5, 1959

INSECTS WINNING RESISTANCE BATTLE — Insects appear to be winning the costly battle — $500,000 is spent each year on control — to keep them in check. Resistance

to insecticides is now virtually nationwide according to results of an extensive study.... Resistance can take many forms, research has shown. Some of these are: slow rate of absorption which prevents the insect's getting a lethal dose of insecticide ... or, avoidance of the insecticide such as is seen by some insects changing their normal habitat. The chemical industry, which produced some 575,000,000 pounds of pesticides in 1958, is constantly attempting to develop effective new insecticides and devise stronger formulations.

Science Future

December 14–18
The American Geophysical Union meets in San Francisco. See www.agu.org/meetings

January 10–14
Researchers convene in Washington, D.C. to discuss threats posed by invasive species. Go to www.nisaw.org for agenda

February 16
Deadline to submit videos about the personal impacts of neurological illnesses to the 2010 Neuro Film Festival. See www.neurofilmfestival.com

SN Online

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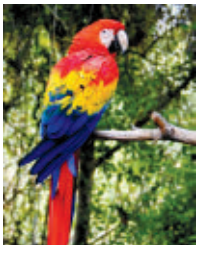
SCIENCE & THE PUBLIC
The Copenhagen climate summit has the potential to affect global policy, but challenges remain, experts say. See blog titled "Guarded optimism on Copenhagen climate talks."

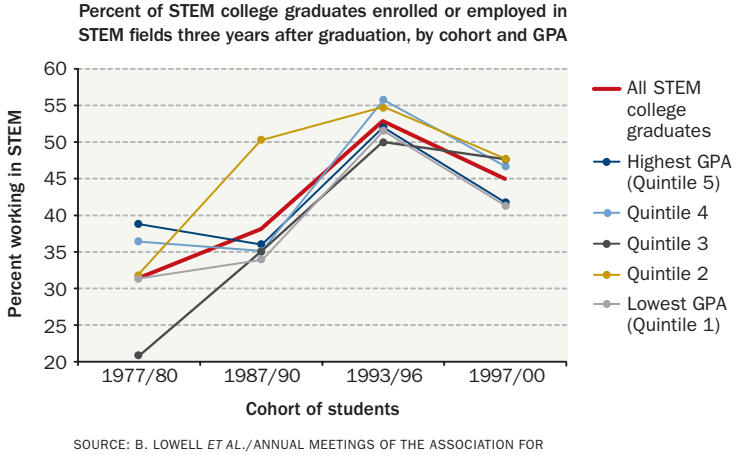
HUMANS
The ancient inhabitants of northwestern Mexico kept exotic pets. Read "Macaws bred far from tropics during pre-Columbian times."



ATOM & COSMOS
Looking for atmospheric lithium can help researchers spot stars likely to have planets, a new study shows. See "Chemical fingerprint found for planet hunting."

Science Stats | POST-COLLEGE LEAKS IN THE PIPELINE

After a surge in the mid-1990s, fewer graduates with degrees in science, technology, engineering and math (STEM) have been taking jobs in those industries.



SOURCE: B. LOWELL *ET AL.*/ANNUAL MEETINGS OF THE ASSOCIATION FOR PUBLIC POLICY, ANALYSIS AND MANAGEMENT, 2009

The (-est)

The existence of the farthest known galaxy group has been confirmed, researchers reported in October. Galaxy cluster JKCS041 lies about 10.2 billion light-years away, beating the previous record holder by nearly a billion light-years. This cluster (X-ray emissions from cluster's galaxies shown in blue) was first spotted in 2006

during an infrared deep-sky survey and was subsequently confirmed using optical and X-ray data. A detailed description of the galaxy cluster is set to appear in an upcoming *Astronomy & Astrophysics*.

CLOCKWISE FROM TOP LEFT: RICHARD MARSHALL; MARY C. SOMERVILLE; NASA/CXC/INAF/S.ANDREON *ET AL.*

“We actually see this massive structure in the distant universe. Not theory… This is the real universe.” —MASAYUKI TANAKA, PAGE 9

In the News

SCIENCE/AAAS

The Thoroughbred mare Twilight donated DNA for the genome sequencing project.

STORY ONE

Whoa, Nellie! Horse genome is revealed

Equine genetics help answer a core chromosome question

By Tina Hesman Saey

Scientists around the world are reading an entirely new type of Twilight saga — not a fictional account of vampires, but the real-life evolutionary story of horses that’s encoded in the DNA of a gray mare. And the tale has plenty of plot twists researchers didn’t see coming.

A mare named Twilight, who lives at Cornell University, gave her DNA to the Horse Genome Project, an international collaboration. The complete picture of the Thoroughbred’s 2.5 billion to 2.7 billion DNA bases — the chemical building blocks that encode her genetic information — reveals that horses and humans share large blocks of DNA where genes are lined up in the same order, researchers involved in the sequencing effort report in the Nov. 6 *Science*.

Horses have about 90 inherited conditions — such as inflammatory diseases, infertility and muscle disorders — that also affect humans. Because the human and horse genomes are similar, knowing where disease genes are in the horse genome might make it easier to pinpoint the genes in people, says Kerstin Lindblad-Toh, a geneticist at Uppsala University in Sweden and the Broad Institute of MIT and Harvard University. Lindblad-Toh and Claire Wade, a geneticist and computational biologist at the University of Sydney, led the horse genome project.

Horses tend to have older versions of genes — closer to the form seen in the common ancestor of vertebrates — than those in humans or mice, so the horse genome “may be more indicative of where we came from,” says David Haussler, a geneticist and computational biologist at the University of California, Santa Cruz.

Haussler and his colleagues have proposed sequencing more than 10,000 vertebrate genomes to put together a more detailed map of genetic changes that led to the modern forms of animals. The researchers detail their proposal online November 6 in the *Journal of Heredity*.

Already the horse genome has helped to answer at least one fundamental question in biology: What is needed for proper centromere function? Centromeres are stretches of DNA, often located near the centers of chromosomes, that are instrumental in the proper segregation of chromosomes during cell division. The centromere usually contains a core element surrounded by repetitive DNA sequences. Scientists know that the repetitive DNA helps stabilize the interaction of cellular machinery with the centromeres but haven’t known the exact steps needed to build a centromere. Specifically, it has been unclear whether a core element could work without the surrounding repetitive sequences and vice versa.

On chromosome 11, horses have an evolutionarily young centromere, one that developed within the last few million years or so, the researchers report. The centromere is functional, but it isn’t wrapped in a blanket of repetitive DNA, suggesting the repetitive elements aren’t necessary for a centromere to function. “It’s really solved the chicken-or-egg problem,” says Lindblad-Toh.

Which doesn’t mean the repetitive DNA isn’t useful, says Wade. “It’s like moving house,” she says. “When you live somewhere for a long time, you accumulate a lot of stuff around you that makes

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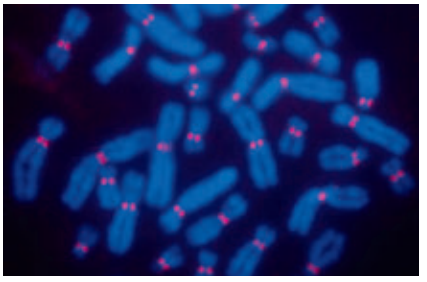
SN Today at **www.sciencenews.org**

you feel secure, but when you move, you clean house. This centromere has just moved." In time, the centromere on horse chromosome 11 will acquire repetitive sequences around it, making it more stable and settled, she says.

Analyses of the horse genome are also helping scientists trace the animal's evolutionary and domestic history and pin down the horse's relationship to other equines. About 3 million years ago, the genus *Equus* split into eight or nine different species, including horses (*Equus caballus*), zebras (*Equus zebra*) and donkeys (*Equus africanus*).

Horse Genome Project researchers mapped about 1 million locations in the horse genome with single letter variations in the DNA. Comparing the pattern of those spelling variations — known as SNPs — the scientists could reconstruct a family tree for horse breeds. Modern domestic horses are thought to have evolved from wild horses such as Przewalski's horse, a short, dun-colored equine with a stiff Mohawk-style mane. Because the wild horse has an extra pair of chromosomes compared with modern domestic horses, the team was surprised to find that Przewalski's horse had no SNPs of its own. All of the spelling differences detected in Przewalski's were also found in domestic horse breeds, Wade says.



Centromeres (pink dots) sit at chromosome centers (human shown). The centromere on horse chromosome 11 evolved relatively recently.

Either ancestral horses had extra chromosomes, as Przewalski's horse does, which later fused to form a single chromosome in the domestic horse, or ancestral horses had a big, domestic-looking chromosome that later broke to make the Przewalski's extra chromosomes, Wade says.

Donkeys, on the other hand, have unique variations that place *Equus africanus* in a clearly different group from horses. The result could mean that domestic horses and Przewalski's horses interbred after their subspecies split or that Przewalski's horses actually derived from domestic horses.

Also recorded in the horse DNA is the history of horse domestication. Analysis of the genome confirms previous genetic (*SN: 2/10/01, p. 95*) and archaeological evidence that there was not a single domestication event with a small number of horses that served as a founding group.

Instead, "it's quite easy to imagine that we [humans] may have taken all the horses from the wild to use for our own purposes," Wade says. Many different groups of humans may have collected horses from the wild. For example, archaeological data published earlier this year suggest people were milking horses 5,000 years ago (*SN: 3/28/09, p. 15*). "Basically, they were useful so we took them all," she says.

Genetic data suggest that a few stallions and many mares have contributed their DNA to the modern domestic horse lineage. Thus it appears that humans preserved the herd structure horses follow in the wild — a stallion with a harem of mares — so horses didn't balk at domestication, Wade speculates. "It really wasn't a big impact on their social structure so they didn't mind too much." ■

Back Story | WHOLE GENOMES: ABOUT 5,000 DOWN, 10,000-PLUS TO GO

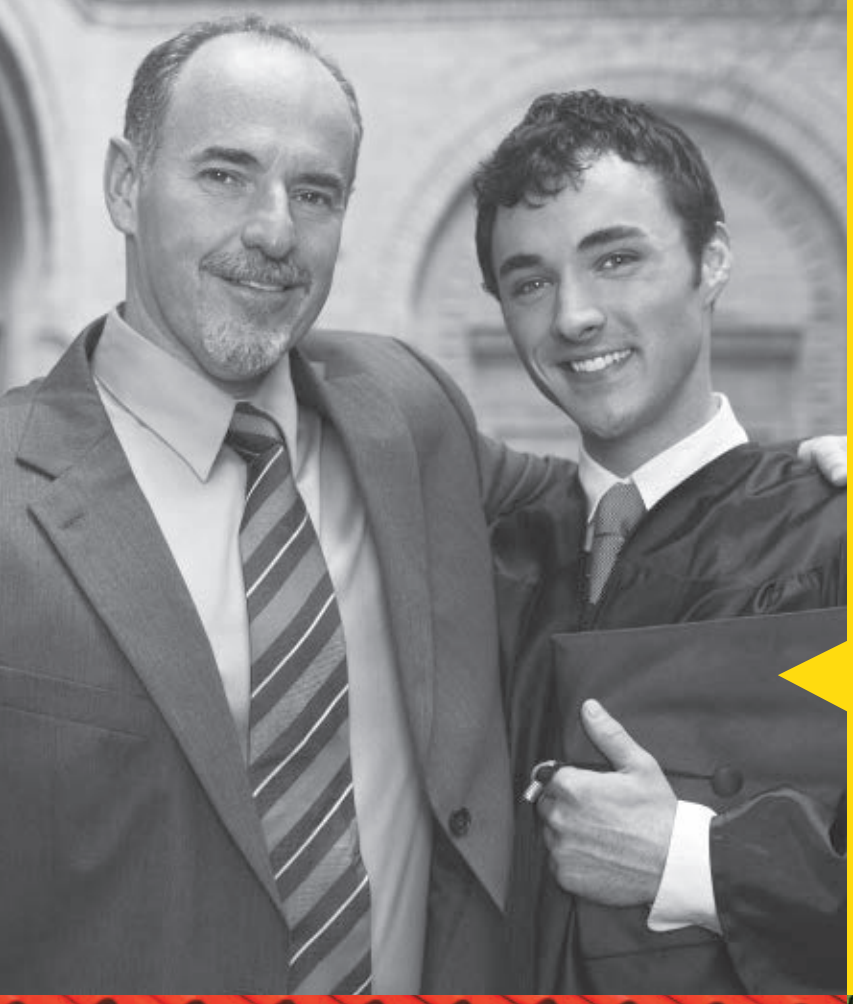
The genomes of 5,000 organisms, mostly bacteria and viruses, are complete, according to the National Center for Biotechnology Information. Assemblies for about 300 higher organisms (plants and animals) are in progress and some, such as the human genome, are complete. More are joining the list (below). Researchers plan to sequence all the DNA of 10,000 vertebrate species.

Cucumber — announced Nov. 1 The Chinese long cucumber genome reveals that 10 chromosomes from the melon's ancestor fused to form five of the seven modern cucumber chromosomes. The genome also provides information about traits of cukes, such as their "fresh green" scent, researchers reported in *Nature Genetics*.

Pig — announced Nov. 2 A Duroc pig named T.J. Tabasco (her clones are shown) donated DNA for decoding the pig genome, now about 98 percent complete. The full genome could help reveal which genes are important for meat production and tell more about genes involved in diseases that affect people.

Cassava — announced Nov. 9 Cassava is a starchy root and a dietary staple in Africa. Its draft genome, about 95 percent complete, has already served up leads on three genes that may help the plants resist diseases, such as the cassava brown streak virus that's now decimating crops in the Lake Victoria region.

CLOCKWISE FROM TOP: INSTITUTE FOR GENOME SCIENCES AND POLICY/DUKE UNIV.; DONALD DANFORTH PLANT SCIENCE CENTER IN ST. LOUIS; DON HAMERMAN; COURTESY OF ZHONGHUA ZHANG OF THE CHINESE ACADEMY OF AGRICULTURAL SCIENCES IN BEIJING



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Observations of starburst galaxies provide clue to cosmic ray origins

Detection of gamma rays solidifies supernova explanation

By Ron Cowen

WASHINGTON — Astronomers have for the first time traced gamma rays, the most energetic form of light, to galaxies undergoing a frenzy of star birth. The finding, which has revealed a new class of galactic gamma-ray sources, is not unexpected. But it provides new hints about the origin of many cosmic rays, the high-speed protons and other charged particles of extraordinarily high energies that bombard Earth.

Telescopes including the Fermi Gamma-ray Space Telescope, launched in 2008, and VERITAS, an array of four 12-meter telescopes atop Mount Hopkins in Arizona, have detected gamma rays from three galaxies undergoing intense waves of star birth. The finding helps to confirm a suspected connection between cosmic rays and supernovas.

After hearing the news, "I didn't fall out of my chair but I got a big smile on my face," says theorist Brian Fields of the University of Illinois at Urbana-Champaign, not a member of either team. Had Fermi and VERITAS not found gamma-ray emissions from starburst galaxies, he notes, "it would have been back to the drawing board" for understanding the origin of cosmic rays.

Prevailing theory suggests that cosmic rays are accelerated to energies of billions to trillions of electron volts by the expanding shock waves generated when massive stars explode. (Cosmic rays with even higher energies are thought to be powered by supermassive black holes at the centers of galaxies.) Kinks in a galaxy's magnetic field keep cosmic ray particles bouncing back and forth like pingpong balls between the advancing shock wave and the region just in front of it, revving up the particles to these high energies, theory suggests.

Massive stars live for only a few million years before exploding — an eyeblink in astronomical terms. Galaxies that produce lots of newborn massive stars therefore have lots of dying stars that explode as supernovas and ought to have an abundance of cosmic rays.

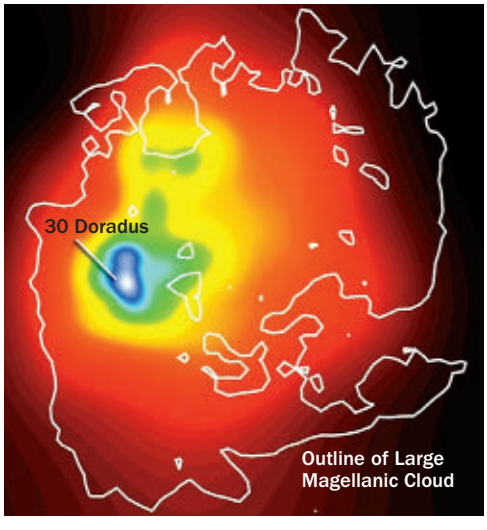
Testing that theory isn't easy, though, because galactic magnetic fields bend the paths of charged particles, preventing astronomers from tracing any but the highest-energy cosmic rays (which can escape the magnetic fields) back to their home galaxies. But cosmic rays collide with other atomic nuclei in surrounding gas or dust to produce gamma rays, which aren't bent by magnetic fields.

In studies reported November 2 at the 2009 Fermi Symposium, VERITAS observed gamma rays ranging from 700 billion to several trillion electronvolts from the galaxy M82, about 12 million light-years from Earth. M82 is a starburst galaxy; within a small, central region it makes stars at a rate 10 times higher than that of the entire Milky Way.

"It took us two years of all-out observations of M82 to acquire all the necessary data," said VERITAS researcher Wystan Benbow of the Smithsonian Astrophysical Observatory in Cambridge, Mass.

Finding gamma rays in a starburst galaxy "had been long predicted, but nobody had ever done it before this year," noted Benbow, whose team also reported the discovery in a paper published online November 1 in *Nature*.

The Fermi telescope also found gammas from M82 and from another starburst galaxy, NGC 253, Keith Bechtol of the SLAC National Accelerator Laboratory in Menlo Park, Calif., reported at the Fermi Symposium. Fermi also recorded a diffuse gamma-ray glow from a region of intense star formation in the Large Magellanic Cloud, a satellite galaxy of the Milky Way. Jürgen Knödlseder of the Center for the Study of Space Radiation in Toulouse, France, and colleagues found that the gamma rays emanated from a region with highly ionized gas, where massive stars should be common. The finding "implies that massive star-forming regions are the main source of cosmic rays in the Large Magellanic Cloud," Knödlseder said.



Gamma rays from 30 Doradus, a star-forming region in the Large Magellanic Cloud, support models linking supernovas to cosmic rays.

NASA, DOE, FERMI LAT COLLABORATION

Although the discoveries "bolster our confidence that cosmic rays are accelerated by supernova remnants," they do not clinch the case, said gamma-ray theorist Charles Dermer of the Naval Research Laboratory in Washington, D.C., who is a member of the Fermi collaboration.

The clincher may come if Fermi finds that gamma-ray emissions from starburst galaxies peak at the energy generated when a subatomic particle called a neutral pion decays into two gamma rays. Galactic pions can be generated only by cosmic-ray collisions, so this peak would offer compelling proof, Dermer said.

10 million | Span, in light-years, of Local Group galaxy cluster

110 million | Span, in light-years, of Virgo supercluster

160 million | Span, in light-years, of new supercluster

Galaxy graveyard growing bigger

Cluster of clusters confirms scope of cosmic structure

By Lisa Grossman

A gigantic galactic graveyard lurks in the distant universe, and the death toll is growing.

New observations establish a supercluster centered on the cluster CL0016+16 as the most prominent galactic congregation ever found, astronomers report online October 7 in *Astronomy & Astrophysics*. The supercluster extends even farther than previously thought, and it's drawing in more and more galaxies.

CL0016+16 lies about 6.7 billion light-years from Earth. That cluster was first observed in 1981, and later observations hinted that it might be just one of a cluster of clusters. Observations by David Koo of the University of California, Santa Cruz in 1996 pointed to a large structure extending from the main cluster.

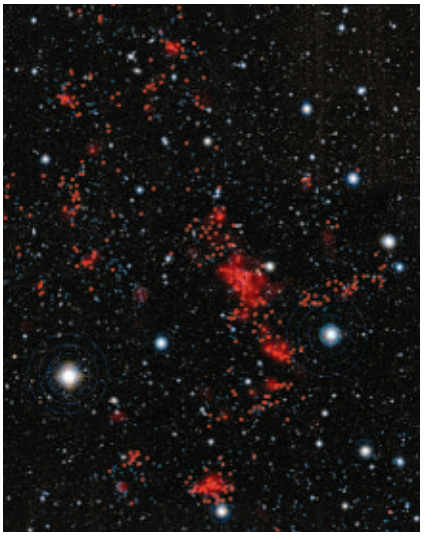
"There are many predictions for large-scale structure in the universe, but nobody has really confirmed that this large-scale cluster exists in the distant universe," says study coauthor Masayuki Tanaka of the European Southern Observatory. "We actually see this massive structure in the distant universe. Not theory, not prediction — this is the real universe."

Tanaka and colleagues observed the region between August 2007 and December 2008 using the Subaru Telescope in Hawaii and the Very Large Telescope in Chile. They found that the supercluster extends at least 60 million light-years in one direction beyond the 100 million light-years already known, and it could reach even farther.

"It must be gigantic," Koo says. "This thing is not only big, it's big in the opposite direction from what we saw. It's probably twice as big as we thought."

When galaxies group together, they tend to switch off each others' star formation, "bringing a flourishing galaxy into a dead one," says study coauthor Alexis Finoguenov of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany.

Galaxies are known to clump together along dark matter filaments that extend for millions of light-years in an enormous cosmic web, providing a framework for the universe's large-scale structure.



The most prominent group of galaxy clusters, shown in red, is bigger than had been thought, new observations show.

Tanaka's team identified tens of clumps of galaxies surrounding CL0016+16, some of which are up to a thousand times more massive than the Milky Way. Most of those galaxies are either dead or dying, meaning they're not making new stars. The tremendous gravitational pull of the central cluster is drawing in other galaxies, which will eventually cease star formation in the growing galactic graveyard.

Sign of antimatter seen in lightning

Gamma-ray flash energies indicate presence of positrons

By Ron Cowen

WASHINGTON — Designed to scan the heavens thousands to billions of light-years beyond the solar system for gamma rays, the Fermi Gamma-ray Space Telescope has also picked up a shocking vibe from Earth. During its first 14 months of operation, the flying observatory has detected 17 gamma-ray flashes associated with terrestrial storms — some containing a surprising sign of antimatter.

During two recent lightning storms, Fermi recorded gamma-ray emissions with an energy that could have been produced only by energetic positrons, the antimatter equivalent of electrons. The positron observations are the first of their kind for lightning storms. Michael Briggs of the University of Alabama in Huntsville announced the findings November 5 at the 2009 Fermi Symposium.

The 17 flashes Fermi detected occurred just before, during and immediately after lightning strikes, as tracked by the World Wide Lightning Location Network.

During lightning storms previously observed by other spacecraft, energetic electrons moving toward the craft slowed down and produced gamma rays. The unusual positron signature seen by Fermi suggests that the normal orientation for an electric field associated with a lightning storm is somehow reversed, Briggs said. Scientists are now working to figure out how the field reversal could have occurred. But for now, he said, the answer is up in the air.

Recording terrestrial gamma-ray flashes isn't new. The first were found by NASA's Compton Gamma-ray Observatory in the early 1990s. NASA's RHESSI satellite, which primarily looks at X-ray and gamma-ray emissions from the sun, has found some 800 terrestrial gamma-ray flashes, Briggs noted. ■

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Body & Brain

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Neuroblastoma, a childhood nerve cancer, proves sensitive to drug

Compound allows body's own tumor suppressor to do its job

By Nathan Seppa

A compound that unleashes one of the body's best tumor suppressors may someday come to the aid of cancer's smallest victims — children with neuroblastoma. In mice, the compound, called nutlin-3, limited the growth of the nervous system tumors, scientists report in the Nov. 18 *Journal of the National Cancer Institute*.

Nutlin-3 also slowed the growth of chemotherapy-resistant neuroblastoma cells and limited the spread of the cancer in the animals. The compound works by freeing up the cancer-fighting protein p53, which gets bogged down in patients with neuroblastoma and other cancers.

The first human trials of nutlin compounds are just getting under way, with Hoffmann-La Roche recruiting adults with recurring leukemia or bone cancer.

Neuroblastoma, the most common non-brain solid cancer in children, accounts for some 10 percent of pediatric cancers and 10 percent of childhood cancer deaths.

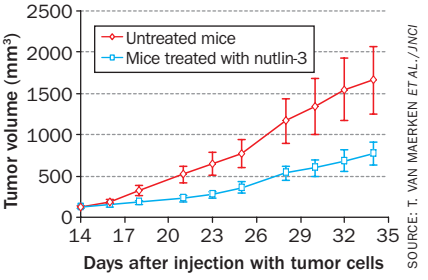
In the new study, Tom Van Maerken of Ghent University Hospital in Belgium and his colleagues used nutlin-3 to neutralize MDM2, a protein that binds to the p53 protein. Earlier studies have shown that nutlin-3 can prevent MDM2 from blocking p53, thereby restoring p53's ability to trigger programmed cell death in malignant cells.

Researchers injected mice with a particularly lethal form of neuroblastoma, using tumor cells obtained from human patients who had relapsed and then selecting out tumor cells resistant to the chemotherapy drug doxorubicin.

Two weeks later, some of the mice were fed nutlin-3 and others received an inert solution. After three weeks of treatment, tumors in the nutlin-3–treated animals were less than half the size of those in the mice getting no drugs. Neuroblastoma can metastasize, or spread, to other organs, so scientists also looked at the liver, lungs and blood. The team found that the treated mice had substantially fewer signs of nascent cancer in these areas than did untreated mice.

"This is a very aggressive cancer," says Jason Shohet of Baylor College of Medicine in Houston. "The fact that you can knock it back by up-regulating p53 is really kind of exciting."

Tumor growth in treated and untreated mice



SOURCE: T. VAN MAERKEN *ET AL./JNCI*

Meanwhile, the nutlins could have uses beyond neuroblastoma, leukemia or bone cancer, Shohet says. The machinery for manufacturing p53 remains intact in many cancers, he says, which suggests that suppressing MDM2 with a nutlin drug could help treat these diseases.

New brain cells aid memory recall

Neurogenesis in hippocampus affects rodents' learning ability

By Tina Hesman Saey

Old memories may get the boot from brand-new brain cells.

A rodent study shows that newborn neurons destabilize established connections among existing brain cells in the hippocampus, a part of the brain involved in learning and memory. Clearing old memories from the hippocampus makes way for new learning, researchers from Japan suggest in the Nov. 13 *Cell*.

Others had proposed the idea that neurogenesis, the birth of new neurons, may disrupt old memory circuits, but this is the first evidence to support the idea, says Paul Frankland of the Hospital for Sick Children in Toronto.

Memories form in the hippocampus and eventually are transferred to long-term storage in other parts of the brain. For some time, a memory resides both in the hippocampus and elsewhere. What's not known is how the memory is gradually cleared from the hippocampus. Researchers also debate the role of neurogenesis in learning and memory. The hippocampus is one of only two places in the adult brain where new neurons are known to form.

Previous studies suggest that new neurons are needed to form new memories. Kaoru Inokuchi of the University of Toyama in Japan and his colleagues show something different: Newborn neurons weaken or disrupt connections encoding old memories in the hippocampus.

Scientists trained mice to fear a mild electric shock when placed in a particular cage. Using radiation to block neurogenesis and some genetic tricks to uncover the role of the hippocampus, the team compared how well the animals remembered the fear 28 days after training. Animals with normal neurogenesis froze in the cage, showing they were able to retrieve the scary memory directly from long-term storage. Those with no neurogenesis didn't freeze as much, indicating that recall still depends on the hippocampus if new neurons aren't being supplied.

New neurons may help form new memories by keeping the hippocampus from filling up with old ones, Inokuchi says.

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Earth

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Kilimanjaro snow may soon vanish

Thinning rate suggests ice caps may disappear by 2022

By Sid Perkins

The famed snows of Kilimanjaro may soon appear only in old tourist photos and a short story by Ernest Hemingway if current rates of melting persist, a new study suggests.

Warming in recent decades has caused high-altitude glaciers worldwide, especially in tropical areas, to shrink substantially (*SN: 10/4/03, p. 215*). Recent studies atop Tanzania's Mount Kilimanjaro show ice loss to be proceeding apace on the African peak: More than a quarter of the ice cover in the year 2000 had disappeared by late 2007, says Lonnie Thompson, a glaciologist at Ohio State University in Columbus.

At current melting rates, permanent ice fields could disappear from Kilimanjaro by 2022, he and his colleagues report online November 2 in the *Proceedings of the National Academy of Sciences*. Data from aerial surveys supplement the team's field studies, which show that Kilimanjaro's melting has dramatically accelerated in recent decades. From 1912 to 1953, ice coverage declined by 1.1 percent per year. Between 1953 and 1989, the annual rate of ice loss jumped to 1.4 percent. From 1989 to the most recent survey in 2007, the ice-covered area dropped, on average, a whopping 2.4 percent per year, the researchers report.

Like tropical ice cover elsewhere, glaciers and ice masses atop Mount Kilimanjaro in Tanzania are shrinking.

Not only are the ice masses of Kilimanjaro receding farther up the peak, they're thinning considerably — a trend detectable only by improved ground observations made in recent years. The thickest part of the peak's 50-meter-thick Northern Ice Field thinned by 1.9 meters between 2000 and 2007, Thompson says. Kilimanjaro's Southern Ice Field — which was about 21 meters thick in 2000 — lost about 5.1 meters by 2007. It's unclear whether the ice loss stems from melting due to global warming or from increased sublimation because of a climate shift that starved the peak of precipitation.

As Kilimanjaro's glaciers retreat and break into smaller pieces, the dark rocks surrounding the remaining ice will absorb more sunlight and heat up, accelerating the melting, says Thompson.

Lessons learned from the Kilimanjaro studies could help scientists better predict when glaciers elsewhere in the tropics — many of which people depend on for water — will eventually disappear, says Tad Pfeffer, a glaciologist at the University of Colorado in Boulder.

Small quakes may not be predictors

Midplate temblors possibly aftershocks of ancient big ones

By Sid Perkins

Using the locations of moderate-sized quakes to estimate where "The Big One" will eventually strike may not work for all regions, a new study reveals.

Many moderate-sized temblors far from the edges of tectonic plates could be merely the aftershocks of larger quakes that occurred along the same faults decades or even centuries ago, geophysicist Mian Liu of the University of Missouri in Columbia and Seth Stein of Northwestern University in Evanston, Ill., report in the Nov. 5 *Nature*. Many researchers have assumed that small-scale quakes reveal where stress is building up that can cause larger quakes in the future.

Most large earthquakes occur along the edges of tectonic plates, where stress accumulates as large masses of fractured crust scrape past each other. But major temblors can also strike fault zones in continental interiors thousands of kilometers from plate edges. Such quakes are less frequent and therefore much less predictable. "Intraplate quakes don't follow a single pattern," Liu says.

Analyzing worldwide earthquake data, Stein and Liu found that aftershocks died off a decade or so after major quakes where the sides of a fault moved past each other at an average of more than 10 millimeters per year. For faults where the sides scraped past each other at just a few millimeters per year, aftershocks lasted about 100 years. The longest series of aftershocks, some lasting several centuries, were triggered by quakes in continental interiors along slow-moving faults.

"Aftershocks don't help you predict where the next big shock can occur," says Tom Parsons, a geophysicist with the U.S. Geological Survey in Menlo Park, Calif. In midplate regions where repetitive cycles of earthquakes can take millennia to unfold, forecasting when and where the next big quake will occur is akin to predicting a full year's weather based on conditions during one week in January, he notes in a commentary in the same issue of *Nature*.

THOMPSON *ET AL.*/*PNAS*

Life

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Hormones give sharks a glow

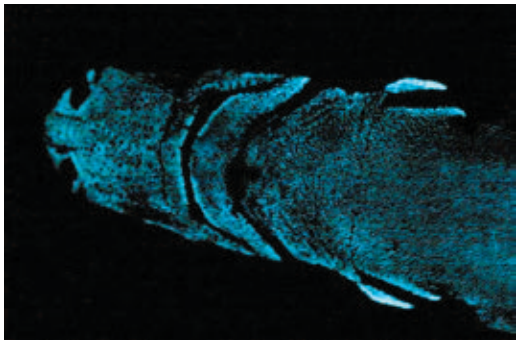
Team discovers a new path to bioluminescence in fish

By Rachel Ehrenberg

The safe answer to how a lantern shark turns its luminescence on and off is: "Any way it wants." Now researchers have looked into the belly of the beast and found that three hormones act as on-off switches for these glow-in-the-dark sharks. It is the first discovery of hormones controlling bioluminescence in fish, the scientists report in the Nov. 15 *Journal of Experimental Biology*.

Melatonin, prolactin and alpha-MSH, hormones known to control sharks' skin coloration, are key in regulating glow.

Researchers have known that nerve activity and symbiotic bacteria can impart luminescence in animals. Finding a parallel pathway to bioluminescence, one controlled by hormones rather than by nerves, strongly supports the notion that light-emitting powers have evolved multiple times in animals, comments marine scientist Jim Gelsleichter of the University of North Florida in Jacksonville, who was not involved in the research.



Glowing patterns on the underside of a lantern shark are controlled by hormones rather than by nerve signals, new research finds.

Light-emitting cells in some sharks aren't connected to prominent nerve cells, and the slow onset of these sharks' glows hinted at control by something other than nerves. Exposing patches of skin from lantern sharks to hormones and to nerve-signaling molecules confirmed that hormones set the sharks aglow.

Melatonin, an important hormone for sleep regulation in humans, slowly induced a glow that lasted hours in the skin patches of velvet belly lantern sharks, *Etmopterus spinax*. This light probably serves to camouflage the sharks, counter-illuminating them from below as they descend to darker depths of the sea, says Julien Claes, coauthor of the study with Jérôme Mallefet of the Catholic University of Louvain in Belgium.

Prolactin spurred a quicker shine that lasted up to an hour. The prolactin-induced glow might be a means of communication with other sharks and potential mates, the scientists speculate. A third hormone, alpha-MSH, turns the shark's lights off. Several common nerve-signaling molecules had no effect.

A possible preflower-era pollinator

Scorpionflies may have carried pollen among ancient plants

By Sid Perkins

An obscure group of scorpionflies with specialized mouthparts may have pollinated ancient plants millions of years before flowers evolved.

Wind was the main pollinator of seed-bearing plants before flowers evolved about 130 million years ago. Yet pollen grains of some preflowering plants were too big to be wind-dispersed, says Conrad Labandeira of the Smithsonian National Museum of Natural History in Washington, D.C. And windborne pollen wouldn't have reached pollen receptors deep within some of those plants.

Now, in the Nov. 6 *Science*, Labandeira and colleagues propose that an ancient group of scorpionflies might be among the missing pollinators of such plants.

The study analyzed 21 fossil specimens of scorpionflies from 11 long-extinct species, with body lengths ranging from 3 to 28 millimeters. Most of these insects were preserved in rocks laid down as fine-grained sediments, but one had been preserved in amber, says Labandeira.

The fossil record suggests that these creatures were rare but present in Eurasia throughout a 62-million-year interval that began around 164 million years ago, well before flowers evolved.

The long proboscises of some now-extinct scorpionflies suggest that they pollinated plants long before flowers evolved.

All the scorpionfly specimens have long, siphonlike mouthparts capable of sucking liquids. Because pollen grains could be too large to fit through the slim siphons, the researchers suggest that the pollen stuck to ridges or hairlike structures on the insects' mouthparts or faces as they fed on fluids from the plants. Then, as they foraged, the insects may have carried the pollen between plants.

Labandeira and colleagues didn't find any pollen on or around the fossil insects they analyzed. Grains of pollen preserved with such specimens would be the missing piece of evidence to definitively link these scorpionflies to the pollination of ancient plants, says Jeff Ollerton, an evolutionary ecologist at the University of Northampton in England.

FROM TOP: J. MALLEFET; MARY PARRISH/NATIONAL MUSEUM OF NATURAL HISTORY

Impatiens prove to be ideal siblings: willing to share and not too leafy

Jewelweeds hold back on competition when roots sense kin

By Susan Milius

Jewelweeds make nice with their leaves when their roots share roots. In lab experiments, seedlings of *Impatiens* wildflowers react mildly when planted in pots with other offspring from the same mother plant, says ecologist Guillermo P. Murphy of McMaster University in Hamilton, Canada.

Seedlings planted among non-siblings of the same species shift extra resources into growing leaves, a plant version of elbowing out the competition to capture light. Sibling neighbors, however, grow with a few more branches than solitary seedlings but don't engage in outright leaf warfare, report Murphy and Susan Dudley, also of McMaster, in the November *American Journal of Botany*.

That sibling-stranger difference showed up only when the plants' roots shared soil, the researchers say.

"This is the first paper that shows that plants are responding aboveground to sibling roots," Murphy says. That's a contrast to another plant the Dudley lab has tested for kin recognition, the Great Lakes sea rocket, *Cakile edentula*. Only the roots of that plant grew differently with siblings. Seedlings apparently tolerated the presence of kin but strangers inspired a shift of resources to roots, as if battling to snatch water and nutrients from rivals, the team reported in 2007.

Yellow jewelweeds can recognize their siblings — as long as roots share soil.

That the two species react differently makes ecological sense, Murphy says. Sea rockets sprout on beaches. Grabbing enough light there should be easy, but roots struggle for water and nutrients. Jewelweeds thrive along shady watersides, where moisture abounds but light is scarce. Easing competition among siblings takes the form most appropriate for the habitat, he says.

In both plants, though, it's the roots that seem to tell kin from strangers, Murphy says.

The new study and others suggest that "the phenomenon is quite common," says Hans de Kroon of Radboud University Nijmegen in the Netherlands. He notes, though, that kin recognition's evolutionary importance in plants is unclear.

Dudley and her colleagues have also reported that *Arabidopsis* seedlings grow differently in response to root secretions from their siblings versus those from strangers.

What's still uncertain is whether sharing with kin gives plants any reproductive advantage, says Rubén Milla of Universidad Rey Juan Carlos in Madrid. The power to recognize sibs could be just a by-product of an ability to recognize self from nonself in plants, he says.

FROM TOP: PELLAEA/FLICKR; R. BRECHBÜHL

Spider hider catches no extra

Long touted as an example of cryptic coloring, the female crab spider (shown) switches her body color over the course of days to match the flower where she lurks. Contrary to the textbook scenario, though, a white spider on a white flower doesn't catch more prey than a white spider on a yellow flower, researchers report online November 4 in *Proceedings of the Royal Society B*. Rolf Brechbühl of the University of Fribourg in Switzerland and his colleagues videotaped some 2,000 insect landings on flowers that held a spider. Spiders caught only 3.6 percent of insect visitors, and color-coordination didn't make a difference, perhaps because insects could see spiders using ultraviolet vision. Matching also didn't seem to help spiders hide from predators. Brechbühl frequently moved spiders to flowers of the wrong color, but he recorded only one predator (a bird) nabbing a spider. Color changing may be, or may have been, beneficial for spiders, but it's not clear how, says Marie Herberstein of Macquarie University in Sydney. "I suspect that textbooks may now need to be rewritten." —*Susan Milius*

Humans

To hear the different cries of newborn German and French babies, visit **www.sciencenews.org/babyaccents**

Size doesn't matter for Hadza mates

Western stereotypes don't apply to forager group in Tanzania

By Bruce Bower

Unlike most Western guys and gals looking for love, Africa's Hadza foragers pair up without regard to each other's size and strength, a new study finds. And that stature-may-care approach underscores the often unappreciated variety of human mating strategies, the researchers say.

Hadza marriages don't tend to consist of individuals with similar heights, weights, body mass indexes, body-fat percentages or grip strengths, say behavioral ecologist Rebecca Sear of the London School of Economics and anthropologist Frank Marlowe of Florida State University in Tallahassee. Neither do Hadza couples feature a disproportionate percentage of husbands taller than their wives, as has been documented in some Western nations, the researchers report in the Oct. 23 *Biology Letters*.

Almost no Hadza individuals mention height or size when asked to explain what makes for an attractive mate, Sear and Marlowe add.

People everywhere seek healthy, fertile marriage partners, Sear proposes. "But I suspect there may not be a preference for one particular signal of health in mates across every population," she says.

Hadza men and women don't consider height, weight or strength in determining whom to marry, a new study finds.

Among the roughly 1,000 Hadza scraping out a living in rural Tanzania, knowledge of a potential mate's health history may render that person's height and weight irrelevant, the researchers suggest. Also, any health benefits of being big may get nullified by the difficulty of maintaining a large body during periodic food shortages endured by the Hadza.

Sear and Marlowe criticize evolutionary psychologists who have argued that physical size influences mating decisions in all societies. That argument rests largely on self-reports of Western college students and analyses of personal advertisements in U.S. newspapers for dating partners, they say.

Other researchers suspect that cultural evolution over the past 50,000 years, not genetic evolution during the Stone Age, has helped lead human mating strategies to become increasingly diverse (*SN: 5/23/09, p. 5*).

"Cross-cultural data are hard to come by, and this is a valuable contribution," comments psychologist Robert Kurzban of the University of Pennsylvania in Philadelphia. But he argues that the Hadza findings do fit with evolutionary psychologists' proposal that genetically ingrained, universal mating strategies get triggered in different ways depending on social and ecological conditions.

In large societies, where people know little about one another's health history and food is plentiful, height and weight may be reasonable initial indicators of a healthy mate, he suggests.

Newborns cry in mom's language

French, German infants wail with melody of native tongue

By Bruce Bower

Only days after birth, babies have a bawl with language. Newborn babies cry in melodic patterns that they have heard in adults' conversations before birth, say medical anthropologist Kathleen Wermke of the University of Würzburg in Germany and her colleagues.

By 2 to 5 days of age, infants' cries bear the tuneful signature of their parents' native tongue, a sign that language learning has already commenced, the researchers report online November 5 in *Current Biology*.

During the last few months of fetal life, babies can hear what their mothers or other nearby adults are saying, providing exposure to melodies peculiar to a specific language, Wermke says. Newborns then re-create those familiar patterns in at least some of their cries, she proposes.

"Our data support the idea that human infants' crying is important for seeding language development," Wermke says.

In the days after birth, babies show signs of discriminating the sound of their native language from others. Wermke's team suggests that newborns adapt their cries to melodic patterns characteristic of whatever language they have heard spoken in the final months of gestation.

She and colleagues studied 30 newborns in French-speaking families and 30 in German-speaking families. German newborns' cries tended to start high-pitched and gravitate to increasingly lower pitches. French newborns' cries started low-pitched and then moved higher. Comparable intonation patterns characterize words and phrases used by fluent speakers of German and French.

More work remains to be done to confirm that parental talk affects how babies cry, remarks psycholinguist D. Kimbrough Oller of the University of Memphis in Tennessee.

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Climate might be right for a deal

Copenhagen negotiations will take steps toward a climate-stabilizing treaty

By Janet Raloff

On December 7, negotiators from some 190 nations will convene in Copenhagen to build the framework for a new climate treaty. Twelve years ago, a similar conclave in Japan — also meeting under the aegis of the United Nations — set out with much the same aim. But that accord, known as the Kyoto Protocol, largely failed to deliver on its primary goal: reducing greenhouse gas emissions by the world's industrial powers.

This time around, hopes are high — if cautious — that the negotiations will make progress toward a more politically viable treaty.

One measure of growing political support for such a treaty appears in a joint declaration issued this past July by leaders of the biggest greenhouse gas emitting nations. They vowed to respond vigorously to climate change with measures aimed at keeping global average temperatures from rising more than 2 degrees Celsius above the average just before the industrial revolution.

The Kyoto Protocol had sought to keep the planet cool with mandated reductions by 2012 in emissions of carbon dioxide and other greenhouse gases by all industrialized countries — cutbacks that were to average about 5 percent below those nations' 1990 emission levels (*SN: 12/20/97, p. 388*). Collectively, emissions from industrial nations dropped by 2007 to about 4 percent below 1990 levels.

But 18 of the 40 industrial nations now spew more greenhouse gases than they did in 1990 — some of them substantially more, according to a U.N. report released October 21. The United States, for instance, releases about 17 percent

JEWEL SAMAD/AFP/GETTY IMAGES

Young environmental activists from around the world plead for a new agreement to reduce global greenhouse gas emissions during the 2007 U.N. Climate Change Conference in Bali, Indonesia.

more now than it did in 1990. Percentage increases for emissions by Spain, Australia, Canada and several others are higher still. And China, classified as a developing country and thus exempted by the treaty from having to make emissions reductions, recently surpassed the United States as the leading emitter of greenhouse gases.

Meanwhile, climate scientists have been steadily fine-tuning assessments of Earth's elevating global fever — and what will happen if stronger anti-inflammatory policies are not enacted soon.

A treaty won't emerge from the Copenhagen talks, President Obama and other leaders acknowledged on November 15 while attending an Asian-Pacific summit in Singapore. Still, they pledged to "work towards an ambitious outcome in Copenhagen" — one that delivers the building blocks of a new treaty.

Indeed, there's optimism that "we'll get an interim agreement that establishes the basic architecture of a post-2012 treaty," says Elliot Diringer of the Pew Center on Global Climate Change in Arlington, Va.

What's needed is acknowledgment that the climate problem is not going to fix itself — and that ecosystems are already imperiled by the trajectory of warming that awaits if business-as-usual reliance on fossil fuels continues, says Achim Steiner, executive director of the U.N. Environment Program, based in Nairobi, Kenya. Climate studies don't guarantee doom, he says. Rather, "the science is a wake-up call to say that we must think about different policy trajectories" to avoid catastrophic scenarios.

Stanford University climate scientist Stephen Schneider echoes the views of many when he says reaching an accord at Copenhagen or soon thereafter will rely on leadership that convinces people that for the health of their families — and the planet — procrastination on strong greenhouse gas limits must not be tolerated.

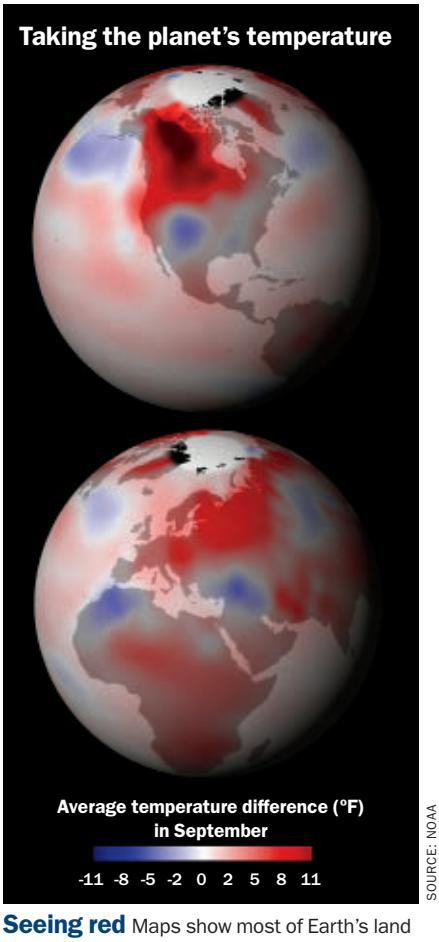
Kyoto postmortem

In diagnosing why the Kyoto Protocol fell short of its primary aim — catalyzing serious emissions reductions by all major industrial powers — most analysts point to the United States. The treaty, which went into force on February 16, 2005, has been ratified, accepted or agreed to by 189 countries. The lone holdout among nations that negotiated this accord: the United States.

A refusal by the United States, and initially Australia, to ratify the treaty "in some sense diluted the whole sanctity of that agreement and the seriousness with which the world took it," contends R.K. Pachauri, director of the U.N. Intergovernmental Panel on Climate Change and director general of TERI, an energy and resources center based in New Delhi.

U.S. negotiators are free to agree to an international accord on behalf of the White House. But unlike in some nations, where heads of state or their representatives are empowered to accept subsequent treaties, no treaty can become U.S. law without the Senate's blessing. And six months before the Kyoto meeting, Sen. Robert Byrd, D-W. Va., and Sen. Chuck Hagel, R-Neb., warned the White House in their "sense of the Senate" declaration that a global climate treaty would not win Senate ratification if abiding by that treaty "would result in serious harm to the economy of the United States," or if the treaty exempted developing nations from having to commit to greenhouse gas reductions.

In what proved to be the real deal breaker, the Kyoto Protocol set up a two-tiered regulatory system. Developed



SOURCE: NOAA

Seeing red Maps show most of Earth's land surface was warmer in September 2009 — by up to 8° F — than the 100-year September average. That made this the second warmest September on land since records began in 1880.

countries were directed to ratchet down greenhouse gas releases. Developing countries — representing most of the world, but not most greenhouse gas emissions — had to make no cuts.

The rationale for this dichotomy: Developed nations had powered their industrial revolutions over the past century by burning cheap, dirty fossil fuels. Cleaner, greener alternatives tend to require a more technologically advanced infrastructure. They also tend to be more expensive (at least if no accounting is made for fossil fuels' effects on climate and health). Industrial nations, presumably, could afford to switch to low- or no-carbon fuels, but the world's poorest nations could not. So negotiators had decided even before the Kyoto meeting to give developing countries extra time to find a less carbon-intensive path to industrialization — with help and financing from already industrialized nations.

President Bill Clinton's negotiators played a pivotal role in drafting the strategy that asked developed nations to shoulder the big cuts in greenhouse gases, notes Diringer. "But the Clinton administration — and I was part of the Clinton administration — did not develop a domestic program that then would have delivered on that target," he observes. So there "was this fundamental disconnect in the framing [of the treaty] between the international view and the congressional view."

Clearly, Diringer says, the Kyoto Protocol "went ahead without the United States. It's just that we've limited its effectiveness — its reach." Moreover, he suspects, "the countries that took on [emissions-reduction] targets under Kyoto, they're not going to do it again without us."

Says Diringer, "the view of Congress then — and I'd say now — is that if the United States is asked to take on a binding commitment, we need some measure of commitment from China, India and the other major developing countries."

Science strengthens

The IPCC's Pachauri also notes that during the late 1990s and into the new millennium, the world wasn't totally convinced it needed immediate action on climate because of lingering doubts about the strength of the science.

Since then, the science linking climate change to human activity has strengthened demonstrably, he notes. And the Fourth Assessment Report of that science by the IPCC, in 2007, "created an enormous awareness worldwide" of the risks of continuing business as usual when it comes to emitting greenhouse gases, Pachauri says. That report declared that the world could face global catastrophe if temperatures warm by much more than an average of 2 degrees C, something that the IPCC predicted would occur if atmospheric CO_2 concentrations exceed 450 to 500 parts per million (*SN: 2/10/07, p.83*).

With CO_2 concentrations now around 385 ppm, "Leadership in most countries of the world is totally committed to taking action," Pachauri says.

At a September 30 briefing on Capitol Hill, Robert Corell, a principal consultant to the Washington, D.C.-based Global Environment and Technology Foundation, noted that current atmospheric CO_2 concentrations are about 40 percent higher than in preindustrial times, and climbing about 2.3 ppm per year — almost double the rate of increase in the 1970s. At this accelerating pace, he said, atmospheric CO_2 will hit 500 ppm by mid-century.

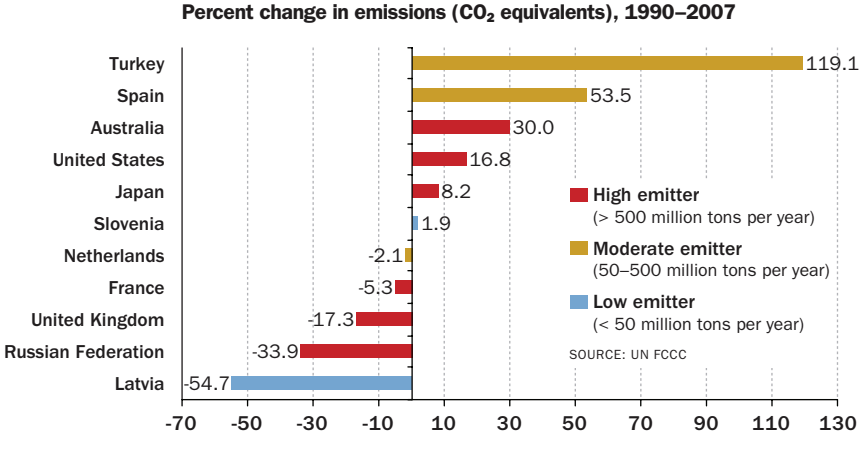
Indeed, Schneider says, if trends don't change, "We're eventually headed to 900 ppm, a very dangerous overshoot" of that 450 to 500 ppm target.

Once CO_2 is released into the atmosphere, about a quarter of it can stay there for millennia. A climate science report issued September 24 by the U.N. Environment Program, or UNEP, noted that global warming caused by the CO_2 already in the atmosphere has only partially been realized. It could take another half-century for the rest to take effect. Even holding atmospheric CO_2 at current levels won't change that trend.

With CO_2 concentrations still climbing, Corell worries that "we're headed to a 4 degree C world" — one where global temperatures will dangerously exceed the preindustrial average. "We don't want to go there."

Glaciers melting, vanishing Arctic sea

Losers and gainers Greenhouse gas emissions for developed nations shrunk overall by about 4 percent from 1990 to 2007, though much of the loss came through economic changes and not targeted action. Emissions below do not include those from deforestation.



AUSTIN POST, NAT'L SNOW & ICE DATA CENTER

The McCall glacier in Alaska's Arctic National Wildlife Refuge has undergone accelerating ice loss in recent decades.

ice, ocean acidification — such symptoms of global warming have been occurring at higher-than-predicted and accelerating rates. Says Corell, "That's the kind of thing that we're seeing in this [new UNEP] report that the IPCC early on in 2007 couldn't see" — because research papers detailing those changes had not yet been formally published.

"The problem we have right now is that the public policy arena has been slow in catching up with the science," says UNEP's Steiner.

So on September 24, his agency's climate-science website unveiled a new Climate Change Science Compendium. It has been developed to update the latest IPCC report, now two years old, by presenting more recent peer-reviewed data — findings that UNEP hopes will inform negotiations at Copenhagen and in the months afterward.

Copenhagen's prospects

Since the Kyoto negotiations, much has changed that buoys optimism about the Copenhagen talks. For instance, "Having learned — maybe even overlearned — the lesson from the Clinton era and Kyoto, the U.S. administration this time around is really waiting to take all of its cues from Congress," notes Rob Bradley, of the World Resources Institute's International Climate Policy Initiative in Washington, D.C.

And unlike in 1997, he says, "There is at least a reasonable prospect of getting an ambitious climate bill out of Congress in the next six to nine months."

Moreover, Bradley says, since publication of the IPCC's Third Assessment Report eight years ago, "We've seen a real shift among a number of major developing countries, perhaps starting with China, in accepting the science." One reason: He observes that unlike American climate policy makers, who are usually lawyers, most of those in China were trained as engineers or scientists.

Three years ago, China committed itself to reducing its energy intensity, or energy use per unit of gross domestic product, 20 percent below 2005 levels — by 2010, Bradley notes. Compared with the United States, he adds, China also has considerably more ambitious renewable-energy goals and fuel-efficiency standards for its vehicles. And China has also mandated major emissions improvements by its 1,000 largest industrial operations, he says. Together, these enterprises account for one-third of China's primary energy use.

Concludes Bradley, "If the U.S. said: 'We'll match what China's going to do,' I'd be fairly happy with that."

At a September 22 meeting at the United Nations in New York, Japanese Prime Minister Yukio Hatoyama announced that his country was committed to long-term reductions in greenhouse gases. For a midterm goal, Japan would aim (but not commit) to cut its emissions 25 percent below 1990 levels — by 2020. Earlier, the European Union pledged to work toward at least a 20 percent reduction during the same time period, and a phasing in of renewable-energy sources to account for 20 percent of energy consumption.

Taken together, Pachauri says, such pledges mark "a big step forward. Now the world is waiting to see what the United States comes up with." Most countries are looking for clues in the climate legislation now slowly wending its way through Congress.

Numbers game

At Kyoto, there was much debate about how big mandated emissions reductions should be and against what baselines they should be computed. The same issues threaten to prove a stumbling block at Copenhagen.

The United States and a number of other countries have recommended that emissions should fall by perhaps 80 percent between now and 2050. "And that's a nice aspirational goal," Diringer says. "But we're not going to get there unless we set some credible midterm goals."

Several such midterm numbers are being floated. Many scientists, for instance, would like to see commitments

China, which recently surpassed the United States in total (not per capita) greenhouse gas emissions, is trying to improve energy efficiency. Workers install a solar roof for Shanghai's 2010 World Expo (left) and a man charges an electric car at the Shenzhen campus of the BYD Company, whose founder is China's richest person.

CLOCKWISE FROM TOP LEFT: MATT NOLAN, NSIDC; KEVIN LEE/BLOOMBERG/GETTY IMAGES; AP

to cut emissions 25 to 40 percent below 1990 levels within a decade. The Obama administration, Diringer points out, has proposed instead just returning U.S. emissions to 1990 levels.

Disputes also arise over whether to use 1990 as the baseline year against which to measure cutbacks. Some, for example, are championing 2005. It is anything but an academic issue.

The European Union's current target for 20 percent cuts below 1990 levels corresponds to only 14 percent below 2005 levels, Diringer points out. And he notes that President Obama's target ends up in the same ballpark as the EU's — if measured against 2005 emissions. "And that's because since 1990 our emissions have continued to grow significantly," Diringer explains, "while the EU emissions have been relatively flat."

But Schneider claims that when it comes to midterm goals, "there's way too much numerology here. I do not want Copenhagen to degenerate into a shouting match over whether emissions are to drop 10, 15 or 20 percent below even 2005 emissions." And the reason: "There's no way they'll be achieved, because it takes a couple decades to make major replacements in our existing energy systems." The goal, he argues, should be to replace old and dirty power plants, cars or engines as quickly as possible with hyper-green alternatives.

Which is precisely what many developing and industrialized countries are already pledging to do, Bradley says. Rather than setting explicit domestic CO_2-emissions standards, many nations are developing strict energy-efficiency standards for new products and buildings. Some are looking to clean their air of conventional pollutants, which could encourage some companies to switch to low- or no-carbon alternatives. And many are investigating the idea of putting a tax on carbon and letting the marketplace figure out how most efficiently to minimize tax bills.

Shame game

But however Copenhagen negotiators structure plans to cut emissions, there's still the issue of enforcement, Schneider says. A defining weakness of the Kyoto accord was that its mandates for emissions reductions "had no teeth," he charges. Pachauri agrees.

The problem is akin to developing speed limits and erecting traffic lights with no cops to arrest scofflaws and no judges to impose fines or other penalties on convicted violators. Schneider now worries that without such teeth, any post-Copenhagen accord might prove too feeble to protect the planet.

But Bradley counters that "you can't think of an international agreement in the way that we think about a domestic law, because there's no police force there." In fact, he argues, "the range of tools that you've got at your disposal to force a country to do something is really pretty limited. Unless you're prepared to either invade or slap trade sanctions on them."

Oh, there is one more option, Bradley notes: Publicly naming and shaming scofflaws. "And it's perhaps a lot stronger than it sounds."

Encourage countries to put climate-friendly proposals on the table. Register these proposals with the United Nations. Then make countries report their progress every few years and get countries to take competitive pride in their progress. "I think this can prove a fairly significant, persuasive force," he says. ■

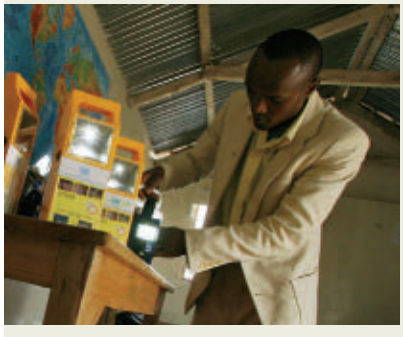
Explore more

- The UN's Climate Change Science Compendium: http://bit.ly/wwUhm

Some nations go it alone

International negotiators will try to pound out a new climate treaty in Copenhagen that shares the burden of cutting emissions. But some nations and other government bodies (such as some U.S. states) have decided that the threat of climate change is too pressing to wait for negotiators to agree. Some have offered to take unilateral actions, creating energy-efficiency goals, carbon sequestration programs (such as planting trees) and more.

On October 26, the Frankfurt-based Deutsche Bank announced that its new Global Climate Change Policy Tracker program had identified and rated the potential effectiveness of 270 of these unilateral climate policies as part of the bank's efforts to identify promising climate change-related investment opportunities around the world.



A vendor in Kenya charges phones and lanterns using electricity from renewable energy. Several African nations have clean-energy goals.

Such projects can make a difference, the bank reports. As of 2007, world greenhouse gas emissions totaled roughly 47 gigatons in CO_2 equivalents, and under business-as-usual conditions, Deutsche Bank projects those emissions could climb 25 percent by 2020. But if the unilateral programs the bank identified reach full potential, 2020 greenhouse gas emissions might rise by only 8.8 percent, the bank estimates.

The bad news: Global emissions need to peak and then fall below the 2007 number by 2020, just to be on track to stabilize greenhouse gases around 450 parts per million of CO_2 equivalents by 2100. That target is intended to limit global warming to 2 degrees Celsius above the planet's preindustrial average. So even though the 270 programs could make a sizable dent in emissions, such efforts still leave "a significant gap," says Mark Fulton, who leads Deutsche Bank's climate change research division. *—Janet Raloff*

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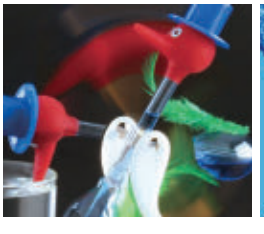

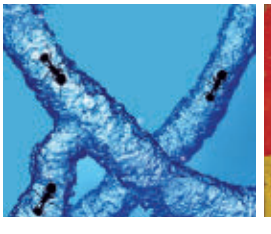

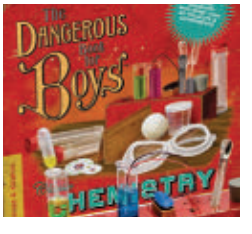

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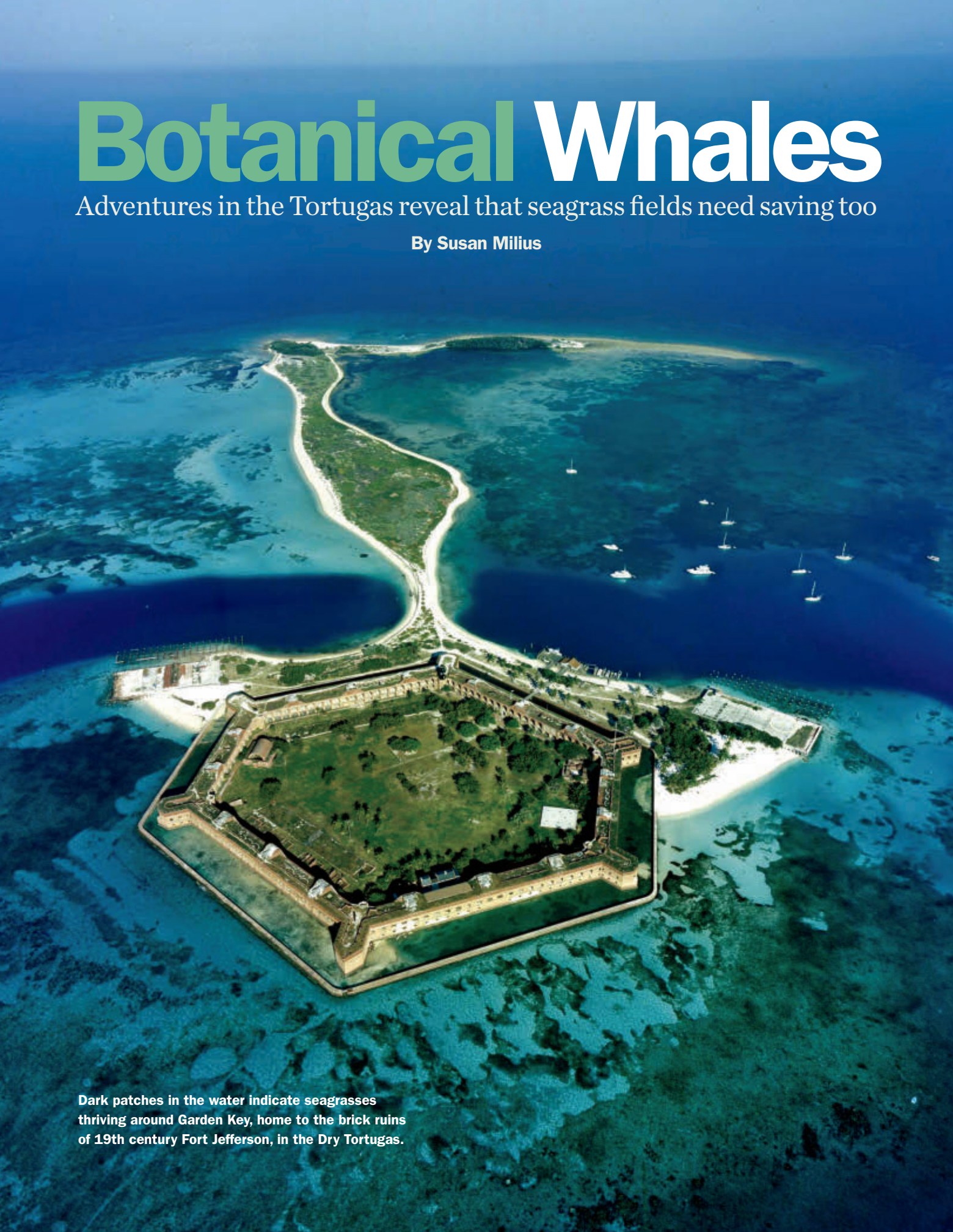
Botanical Whales

Adventures in the Tortugas reveal that seagrass fields need saving too

By Susan Milius



Dark patches in the water indicate seagrasses thriving around Garden Key, home to the brick ruins of 19th century Fort Jefferson, in the Dry Tortugas.

OK, OK, a plant can't really look a person in the eye and share its thoughts. But after a strange couple of days, I'm almost ready to commune with vegetable matter. A string of wet, pinkie-tip–sized green leaves sits on a paper plate in front of me, and I begin to think that this little sprig and I are both wondering, "You? What in the world are you doing here?"

I'm a terrestrial vertebrate rocking slightly from side to side on a research ship more than 100 kilometers west of the tip of Florida, near the Tortugas Ecological Reserve. I'm tagging along with marine biologists on the National Oceanic and Atmospheric Administration's research vessel the *Nancy Foster*. Though my first three days with nothing but water in all directions have been thrilling, I haven't shaken some bone-deep sense that I don't belong here and that air-breathing land creatures visit the seas on sufferance.

In one sense the little sprig does belong to this world. Diver Abigail K. Poray of California State University, Northridge plucked this sample of *Halophila decipiens* seagrass from the pale sediment on the seafloor where the species thrives.

But in another sense, seagrasses are interlopers too. These aren't marine algae like kelp. Seagrasses are true flowering plants, and the world's 50 or so species come from marsh and freshwater plant families. Seagrasses' ancestors lived on land, where seeds and flowers first evolved, but more than 100 million years ago some went off the deep end into the oceans. And today's species still grow flowers, release pollen and form seeds, all underneath meters of saltwater.

Bizarre as this venture to the sea seems, other famous lineages have taken the same path, going oceanic but never quite losing all traces of landlubber biology. I'm communing with a botanical whale.

Seeing one seagrass sprig makes me want to meet whole plants, whole meadows even. That's not going to be easy for a terrestrial journalist with no dive training who has been plunked into the middle of a high-speed, data-gathering mission with stern safety restrictions that prevent aquatic sightseeing.

Seagrasses will be worth finagling for, though. Among the marvels of the *Foster*'s voyage, these bits of greenery stand out as surprise survivors in an alien world. Recent work is providing clues to how seagrasses have adapted to survive in their saltwater ecosystem. But they're not just survivors. Other studies are showing how some marine icons and even whole coral reef ecosystems wouldn't be what they are today without the energy input and nearby refuges of seagrass meadows.

But like reefs, seagrass expanses are shrinking under the human bootprint. An appreciation of the seagrasses and the perils they face is growing in the research community, but public attention in the form of T-shirt wearing, TV-special viewing and postcard-sending hasn't caught up yet. Meadows of seagrasses "aren't vacation destinations," acknowledges seagrass ecologist Mark Fonseca of the NOAA National Ocean Service's research center in Beaufort, N.C. But without seagrasses, he says, you wouldn't have so many vacation destinations.

Plucked near the Tortugas Ecological Reserve, this wisp of the seagrass *Halophila decipiens* comes from a vast meadow that grows each year from seed in spring and hurriedly blooms, producing a crop of seed before dying off as light dims in the ocean depths each autumn.

Sea world

In a just world, seagrasses would rank as a sought-after tourist spectacle. West of the Florida coast, a low, green *Halophila* carpet sprouts anew from the sediment each spring over some million acres. "Half the size of Yellowstone," Fonseca says.

This spectacle's future, and that of the other seagrass beds in shallow coastal waters around the world, looks iffy. Long-term data on the extent of seagrass meadows aren't great, but combined there's enough to sketch trends along populous coasts, says Jud Kenworthy, also of NOAA's Beaufort research station. Along the coasts of North America, Australia and Europe, nearly a third of the known seagrass landscape has disappeared since the 1870s, an international research team including Kenworthy reports July 28 in the *Proceedings of the National Academy of Sciences*.

Losses look as if they're speeding up along these coasts, the paper warns. Before 1940, records indicate a median

Seagrass dependents Green engines for ocean ecosystems, seagrass meadows provide food and shelter for myriad residents as well as take-out meals for grazers and hunters who drop by from neighboring coral reefs. Some species have particularly close ties with their local seagrass meadows. Such species include (from left to right) the bay scallop, the charismatic West Indian manatee, the seahorse and the green turtle.

FACING PAGE: MICHAEL O'LEARY/US IMAGING INC; THIS PAGE, CLOCKWISE FROM TOP: S. MILIUS; RICH CAREY/ISTOCKPHOTO; CHRIS PICKERELL, WWW.SEAGRASSLI.ORG; ROBERT STEWART/ANIMALS ANIMALS; KIMBERLY PETERSEN MANZO, WWW.SEAGRASSLI.ORG

decline of some 0.9 percent per year. Since 1990, though, total seagrass meadowland has been shrinking about 7 percent a year.

Development along coasts is muddying and polluting offshore waters, and seagrasses falter without clear water allowing light to filter down, Kenworthy and colleagues say. With heavy ship traffic, boats ground in shallow meadows and leave long scars that can take decades to heal. (Fonseca can point out the scrapes and bald spots visible in Google Maps' satellite images.) As for climate change, researchers are just beginning to try to figure out what rising water temperatures and pH changes might do.

At least a billion people live within 50 kilometers of seagrass meadows, Kenworthy and colleagues note. Coastal residents may not give much thought to their green underwater neighbors but could still feel the pinch of seafloor erosion or declining fisheries productivity, among other woes of lost ecosystem services.

Seagrass losses have reached the magnitude of declines seen in celebrity ecosystems such as tropical rain forests and coral reefs. Kenworthy and colleagues say that the new calculations put seagrass meadows among the planet's most threatened ecosystems.

At home or away

Nose-to-node with a *Halophila*, though, what intrigues me is how something with such terrestrial-looking little green leaves could adapt to so much water, and salty at that.

The ocean rocks, in both the good sense and the bad. When I walked up the *Foster*'s gangplank and stepped onto the deck, the ship was as steady as the land I had just left. Not until she was well away from Key West did I notice my computer screen — and chair, and, once I thought about it, everything else — swaying from side to side.

Tippy typing was the least of my problems. I had wondered how long it would take me to master a seaworthy stagger along a swinging deck. What I hadn't realized was how tricky a gentle motion, which was almost but not perfectly predictable, would be for walking. Getting up from a chair and stepping across a floor went as usual for a few steps. Then some outer force redirected my next step, often into a door, wall, table, cabinet or innocent bystander. Fortunately a research ship in the tropics is a long-sleeves, long-pants environment, so I never had to explain the bruises.

Land plants setting up home in the rolling water have their own issues, and seagrasses adjusted much more gracefully than I did.

Fonseca and his colleagues reported a dramatic adaptation in 2007 in the *Journal of Experimental Marine Biology and Ecology*. In places where water flows consistently in one direction, Fonseca and other seagrass specialists had noticed that seagrasses sprout from the sediment in an orderly manner. Straight lines show up in meadows around the world, from San Francisco Bay to Two Peoples Bay in Western Australia. "Straight as rows of corn," he says.

To see what might be driving this spookily farmlike arrangement in the wild, Fonseca and colleagues set out seagrass shoots in a controlled-flow channel at the NOAA laboratory. Researchers planted in both random patterns and rows perpendicular to the direction of the water movement. Plants in the rows experienced less force than did the random shoots overall. And shoots in rows also caught slightly more light filtering through the water than the random plants.

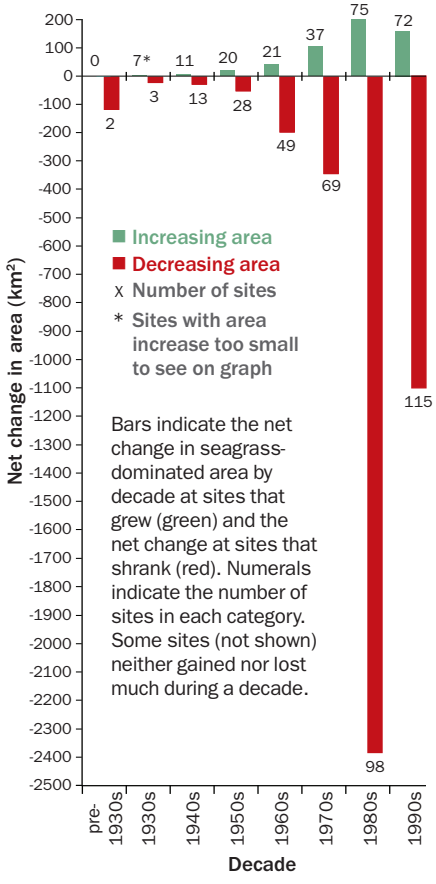
Plants in many families have evolved to get a little bit wet, but only the small seagrass group in the subclass Alismatidae have managed to go all the way to gather their light and pass on their genes completely under saltwater. One of the hardest problems the group cracked was underwater pollination, says Donald Les of the University of Connecticut in Storrs. One genus releases its male flowers to float to the water's surface "like breaking open a bag of pingpong balls," he says. On the surface, the flowers pop open and eventually float like boats keeping their pollen dry for transfer to female flowers on stalks. Other seagrasses have evolved the physiology for reproductive parts to stay viable drowned in saltwater. Their pollen often grows in long filaments, notes Joe Ackerman of the University of Guelph in Canada. His biomechanical analysis shows that approach to work much better than little spheres for tumbling in current flows to snag on female flowers.

Commuter ecosystem

Seagrasses may be newcomers to the ocean but have become what Fonseca calls "the breadbasket of the reef."

Thousands of fish, invertebrate and bird species rely on seagrass habitats, according to the Kenworthy team's analysis. These animals feed there or seek shelter as youngsters before gaining enough size to graduate to the bigger, badder world of coral reefs or open oceans. Charismatic species, including manatees, green turtles and dugongs, need seagrasses. The mead-

Seagrass loss outpacing growth



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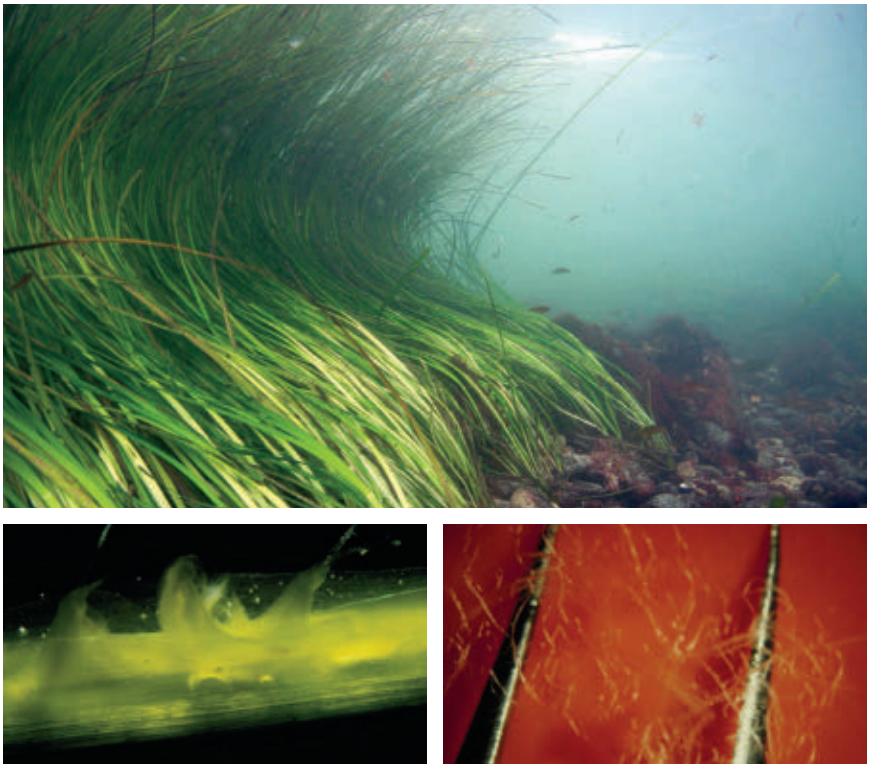


Underwater pollination Seagrasses, such as the *Zostera* shown at top, can grow in dense clumps. The close-up image at bottom left shows two tiny female flowers open on a *Zostera*, with a male flower releasing white pollen in between the other two. In the wild, female flowers mature first, increasing the chances they'll snag pollen from another individual. At bottom right, filaments of pollen in *Zostera marina* float around fine metal forceps. Many seagrass species have evolved long, stringy pollen, which beats spheres at tumbling into small floral targets underwater.

ows account for an estimated $1.9 trillion in nutrient cycling a year.

The *Nancy Foster*'s science team recognizes this connection. The ship's researchers are gathering data on the aftereffects of a much-debated decision to create the ecological reserve in 2001, closing the area to fishing and other human activities. The team of diver scientists is counting fish and other populations at 30 spots both in and out of the no-fishing zone. At the time of establishment, this reserve represented the largest block of no-fishing zones protected by the U.S. government (the vast majority of sanctuaries and parks maintained by the government do allow fishing as well as other marine enterprises). Fish counting has been occurring at these 30 points since a year before the reserve's creation, and the divers swim along transects that include reef as well as soft sediment (which usually means seagrasses).

Reefs have plenty of commuter fish, says NOAA behavioral ecologist John S. Burke, also of Beaufort. Species such as the abundant grunts stay close to the craggy coral during the day, where plenty of crannies can provide shelter from bigger predators. Darkness offers a better chance of evading a predator, and a commuter class of fish gathers at the reef edge. When the crowd gets large enough, Burke says, he and other divers can watch the fish spill out into the seagrass meadow to feed. Grunts poke into the canopy (a grand term for a low fur of *Halophila*) in search of littler things such as shrimp clinging to the blades.

Sated fish swim back to the reef, and the seagrass-captured carbon enters the reef ecosystem. Bigger fish eat the commuters, and bigger things eat them. Commuter excrement enters the nutrient cycle, too. Kenworthy and colleagues have estimated that seagrasses can boost reef productivity, in terms of fish, tenfold.

Fonseca and Carolyn Currin, also of Beaufort, are working on quantifying this migration of nutrients by comparing carbon isotope ratios in the *Halophila* with ratios in various fish. Much of what ecologists know about nutrient cycling comes from studies of upwelling systems rich in tiny floating phytoplankton and not from waters with wide seagrass meadows such as the West Florida shelf.

"What you hear is that phytoplankton drive the oceans," Fonseca says. Working around big seagrass meadows, though, the researchers suspect that the meadows' plant life plays an important role as a primary producer too. Data so far show a contribution from the seagrass itself.

If the idea is right, it will add more evidence to the connection between coral reefs and seagrass meadows. So efforts to save reefs, which certainly do inspire T-shirt wearing and TV-special watching, will need to include a save-the-seagrass component as well.

My own see-the-seagrass mission finally succeeds. At the end of the excursion, some of the divers visit a small island almost entirely occupied by the ruins of the massive brick Fort Jefferson, built in the mid-19th century. It's a national park, and so if I drown in three feet of water or suffer a serious table collision, it's not NOAA's problem.

I take a snorkel into the clear, blood-temperature water off the postcardy sand beach. At last, I can see for myself. In a patch about the size of a picnic table, straps of a seagrass called *Thalassia* cluster in a little depression. Small speckled fish poke around the entrance to a burrow. Around the corner of a wall, I'm suddenly face-to-fin with two stainless steel–colored tarpon, about a meter long. After an initial gasp and subsequent snorkel issue, I realize they're classic browsers in seagrass instead of classic eaters of snorkelers. So I take another look at the green leaves thriving without drowning, and I pass along greetings from seagrass relatives back on land. ■

Explore more

- A.W.D. Larkum, R.J. Orth and C.M. Duarte, eds. *Seagrasses: Biology, Ecology and Conservation*. Springer, 2006.

TOP PHOTO: CHRIS PICKERELL, WWW.SEAGRASSLI.ORG; BOTTOM PHOTOS: J. ACKERMAN

Breaking the Speed Limit

No one has run 100 meters faster than sprinter Usain Bolt, pictured on the track in Berlin in August 2009. But even he has not yet reached the predicted maximum velocity for the human body.

HANNIBAL/EPA/CORBIS

Studies examine physiology and technology to better foresee the ultimate edge of human performance

By Laura Beil

Jamaican sprinter Usain Bolt secured his claim as the world's fastest human in August when he ran 100 meters in 9.58 seconds, reaching a top speed of nearly 28 miles per hour. One day, no doubt, someone will sprint faster still. Perhaps by then, scientists may better understand why all speed records made have eventually been broken.

Statisticians have long tried to calculate the upper limits of human speed. One recent estimate, published last year in the *Journal of Experimental Biology*, put the quickest possible time for 100 meters at 9.48 seconds. That prediction was based largely on past performance and the pace at which current records are falling. But while statistical exercises provide fodder for speculation, no one really knows the limit of human speed — both because scientists still can't fully explain the blend of biology and physics that separates athletes like Bolt from the rest of the world, and because unforeseen technologies can push athletic achievement beyond the merely human.

"The more you understand biomechanics, and the more technologically advanced you become, the more you become capable of intervening," says physiologist and biomechanics expert Peter Weyand of Southern Methodist University in Dallas. Those interventions have become both hailed and dreaded, as they often end up casting a shadow over organized sports. This summer, when little-known German swimmer Paul Biedermann beat Olympic champion Michael Phelps in the 200-meter freestyle, Biedermann seemed unsure whether to credit his swimming or his newfangled polyurethane swimwear:

"I hope there will be a time when I can beat Michael Phelps without the suit," Biedermann told sportswriters, some of whom dubbed the new swimsuits "doping by wardrobe."

Technological innovations that confer a competitive edge have paralleled advances in understanding the physiology of human athletic performance, says Rick Neptune, a mechanical engineer at the University of Texas at Austin. "When they intersect, you start to see world records get broken," he says. "We can't say in the future which will matter more, as the rules of competition adjust." In the current issue of *Annual Review of Biomedical Engineering*, Neptune chronicles how improvements in equipment design have a history of pushing racing past its natural boundaries.

"It's not clear where that boundary is until you've crossed it," he says. For example, in 1997 he witnessed one of the first international speed skating competitions with widespread use of klapskates, which reduce friction and maximize muscle force by allowing the boot of the skate to pivot away from the blade. At a single World Cup competition in Calgary, Canada, he watched 14 world records devoured, one heat after another—all owing to the new skates. The International Skating Union ultimately allowed klapskates to remain, saying they had revolutionized the sport and were widely available to any competitor.

Future conflicts might be avoided as scientists better define the basis for human ability. "It's surprising how little we understand when it comes to tying performance to our physiology and anatomy," says evolutionary biologist Thomas Roberts of Brown University in Providence, R.I. "We don't completely understand the basis for top speed."

Certainly, each separate component of movement has been well studied. Scientists know, for example, that muscle fibers produce force by lengthening and contracting. These fibers come in two basic types, fast-twitch and slow-twitch. Fast-twitch muscles are thick and mighty, producing greater power with each contraction, but they sacrifice endurance for strength. Slow-twitch muscles cannot produce as much power, but they are loaded with mitochondria (the energy factories of a cell) and do not easily tire.

"We know a lot about how muscles work," Roberts says. "I can predict the mechanical output for a single muscle." He can even predict the power output for any given weight of muscle. But just as you can identify individual notes and still not read music, you can know the intricacies of each muscle, bone and tendon and not fully comprehend their harmony. For example, Usain Bolt cannot run 28 miles per hour backward, because his ability lies in the mechanics of his whole body, not just the power in his legs.

Born to run

In fact, much about speed defies intuition. In 2000, while at Harvard University, Weyand reported the surprising finding that fast runners don't win by moving their legs more quickly. He and his colleagues conducted a series of experiments with 33 runners, placing the volunteers on treadmills moving at faster and faster speeds. The treadmill could measure leg movement and also the force at which each foot hit the ground. In the *Journal of Applied Physiology*, the researchers reported that faster runners' feet hit the ground harder, and spring up quicker, than slower runners', giving each thrust of the leg more forward motion.

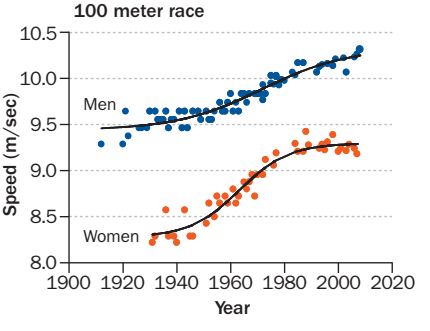
"What separates you from Usain Bolt is that he hits the ground way harder than you do, with regard to how much he weighs," Weyand says. He figures a runner like Bolt slams down with roughly 1,000 pounds of force, and he does so for only 0.05 seconds. What's not known is how Bolt can do that—ask him to lift 1,000 pounds with one leg, and he would surely fail. "We don't have any idea for sprint-running how these guys are able to hit the ground as hard as they do," Weyand says. "There's something about the mechanics of running that amplifies their production of muscular force."

Fast runners may simply be built for speed. For example, a study published in November in the *Journal of Experimental Biology* found that sprinters have shorter Achilles tendons and longer toes than nonrunners of similar height. Their muscles may also set them apart. Most people are born with a middle-of-the-road mixture of fast- and slow-twitch muscle fibers. But an athlete may be drawn to a certain sport based on his or her natural ratio of fast- and slow-twitch fibers: Sprinters, who tend to average about 75 to 80 percent fast-twitch muscles, rarely make good marathon runners, and marathoners hardly sprint. Slow-twitch muscles, but not fast-twitch, work largely aerobically, and have a great hunger for oxygen. They sustain mountain climbers and cyclists. Bolt's sub-10–second, record-breaking bursts are probably an anaerobic feat of fast-twitch muscles.

Sprinters may also use their size to produce the force that pops each foot off the ground in fractions of a second. In 2005, Weyand calculated the body mass index of the world's 45 top runners in various events between 1990 and 2003, and searched for a relationship between their size and the distances they run. (Distance, not speed alone, affects oxygen need.) Writing in the *Journal of Experimental Biology*, he reported that an ideal body size exists for each running distance. Being more massive helps generate the forces needed for greater speed, but only up to a certain point. At some threshold, a big runner's size will work against him.

All of which makes Usain Bolt perplexing to those who study running. At 6'5", he is larger than sprinters are supposed

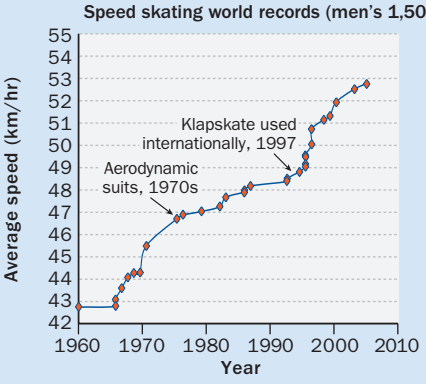
Running records dashed Best times for women in the 100 meters each year have plateaued since the 1980s, suggesting female sprinting may be hovering at the upper limits of speed. But men's times keep getting shorter, and experts predict world records will still fall.



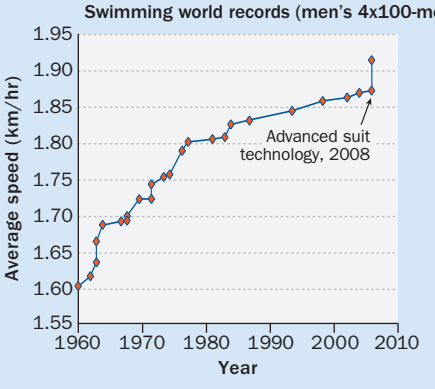
SOURCE: M. DENNY/*JOURNAL OF EXPERIMENTAL BIOLOGY* 2008

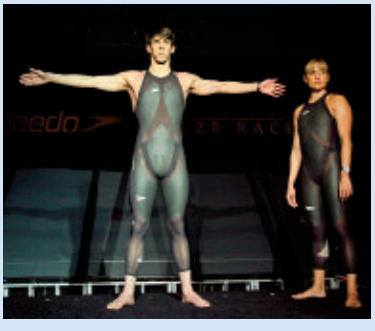
Strife in the fast lane: 50 years of world records

Technology can help athletes push limits of speed, but rarely without controversy

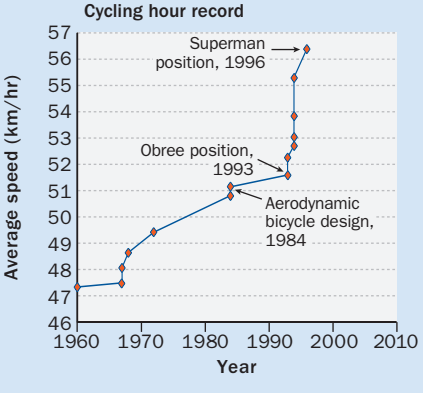


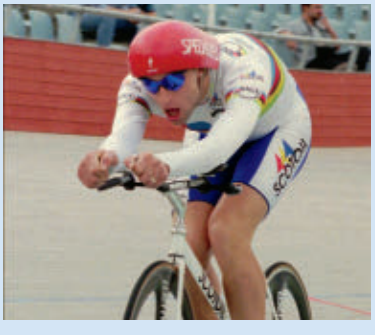
Speed skating Finishing times in the 1,500-meter race were falling even before 1997, when klapskates (pictured, 1998) entered the sport. The skates allow the blade to remain longer on the ice, giving a skater more power with each push. Over the objection of some sports purists, skating authorities allowed the skates to remain in use.





Swimming The use of body-compressing, drag-minimizing LZR swimsuits (modeled in early 2008 by U.S. swimmers Michael Phelps and Natalie Coughlin) set off a world record feeding frenzy. Even faster, all-polyurethane suits dominated the 2009 world championships, where 43 world records fell. Polyurethane suits will be banned from competition in 2010.





Cycling The top speed of cyclists, measured by the hour record, shifted into high gear after changes in bicycle design and position. The banned Obree position, named for Graeme Obree (shown in 1996 in the superman pose, also now banned) involves a deep, aerodynamic tuck. One study largely credits better design for records set from 1967 to 1996.

SOURCE: ALL GRAPHS FROM NEPTUNE *ET AL./ANN. REV. BIOMED. ENG.* 2009

to be. His size should make it harder for him to accelerate. His longer legs should take more time to reposition. Yet somehow, his large frame supports the fast-twitch physique of a sprinter. He may have been, almost literally, born to run.

The degree to which a person can dramatically change the character of muscles — the balance of fast- to slow-twitch — is controversial. (In other words, an elite sprinter can't easily switch to endurance running.) However, in 2004, researchers from the Salk Institute for Biological Studies in La Jolla, Calif., created slow-twitch muscles by genetically engineering mice. The scientists manipulated a certain gene that controls musculoskeletal development in embryos, thus creating sedentary mice built like marathon runners. In *PLoS Biology*, the scientists wrote that the experiment "demonstrates that complex physiologic properties such as fatigue, endurance, and running capacity can be genetically manipulated." Last year, in *Cell*, the Salk team described an experimental drug that may have similar ability to spur the development of slow-twitch muscle in adult mice that never hit the exercise wheel.

Steroids bulk up fast-twitch muscles, which is why their use is banned in sports. But is it cheating, Weyand asks rhetorically, "if you're reprogramming your own DNA?" (*SN: 8/2/08, p. 16*). The Salk scientists themselves recognized the potential for their experiment to be exploited, reporting their findings to the World Anti-Doping Agency. In the future, however, the line between natural and unnatural might not be so clear.

The gear-head advantage

This may be one of the dangers of learning the secret to speed. Potentially, someone is willing to seize each piece of new information for a competitive advantage. This is nothing new; ancient Greek Olympians swung handheld weights to improve their performance in the long jump. But only in modern athletics has insight into body mechanics dovetailed so spectacularly with innovations in engineering. "A lot of what technology does is to improve the interaction with

FROM TOP: JED JACOBSOHN/ALLSPORT/GETTY IMAGES; KATHY WILLENS/AP; ARIS SARIS/AP

the environment so you lose less energy," says Roberts. Klapskates did so famously in the 1990s. While critics at the time chafed, the sport eventually made peace with the new footwear. Today, a competitor is unlikely to win without them.

Controversies don't always reach such a natural end. The cycling hour record — the distance an athlete can pedal in one hour on a flat track — steadily rose in the 1980s and 1990s as riders began to use new high-tech gear and streamlined riding positions to improve their aerodynamics. In 1999, University of Tennessee researchers used a model that accounted for adjustments in bicycle design, riding position and other modifications. Writing in *Medicine and Science in Sports and Exercise*, the team reported that about 60 percent of the world records in the previous two decades of cycling were due to better engineering. In 2000, cycling leaders essentially locked the sport in a time machine, declaring that cycling equipment and position had to be similar to designs used to set the hour cycling record in 1972 — an effort, Neptune wrote this summer, "to prevent the hour record from becoming influenced more by technology than by the athletes." Records set between 1972 and 2000 are still on the books, but in a category called "best hour performance."

Swimming may now be similarly a victim of its own rocket science. After the 2004 Olympics, Speedo teamed with NASA engineers to design a space-age swimsuit. The result was the LZR Racer, which Michael Phelps unveiled in 2008, just before donning one of the new suits into Olympic stardom. In fact, the Beijing Games, which marked the international debut of the suits, saw nearly every world record taken by swimmers in LZR Racers. The ultra-lightweight material — the suit is about half polyurethane — not only reduces drag, but also compresses the body to keep a swimmer in an optimal position during the race.

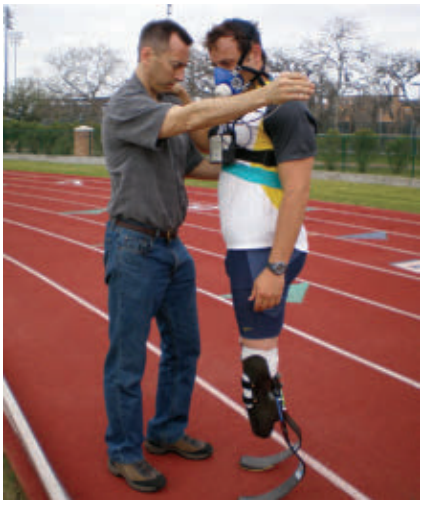
The new suit set off an arms race in swimsuit technology, with even faster designs made possible through better body compression and increased buoyancy (from trapped air). Biedermann beat Phelps wearing a suit that was entirely polyurethane. Swimming's governing body, FINA, has said it plans to ban the suits in 2010, but has not announced what, if anything, will happen to records set during the polyurethane spree.

Is running due for a similar crisis? Mark Denny, the Stanford University statistician who made the 9.48-second 100-meter prediction, doesn't think so. "Running is about as pure a sport as you can get," he says, pointing out that women's records in the 100 meters have largely hovered around 10.6 seconds since the 1980s. (A faster time is on the books, he says, but evidence suggests it was wind-aided.) Wind aside, running is about the body, the shoes and the ground, and so it has largely remained for almost three decades. Tracks changed in the 1970s, when Harvard researchers designed a surface that reduced foot contact time and increased its spring. By 1980, world records had begun to fall on the redesigned tracks. Since then, the sport has not seen equipment changes capable of dramatically lowering finish times.

Roberts also agrees that running is less receptive to technological intervention because humans evolved doing it. "The closer you get to something we've done naturally, the less able you are to change it with technology," he says.

Prosthetics' edge

That's true, Weyand says, but he is hesitant to say that running isn't open to enhancements in engineering. He recently helped evaluate one of the most profound developments: artificial limbs used by South African runner Oscar Pistorius, who had both legs amputated as a child. The International Association of Athletics Federations had barred Pistorius from competing against able-bodied runners, saying his J-shaped carbon-fiber prosthetics give him an advantage. (He was ultimately allowed to compete last year, following a legal appeal that reversed the ruling.) In September, in the *Journal of Applied Physiology*, Weyand and colleagues published an analysis of Pistorius' running ability, reporting that his mechanics differed from human legs.



Peter Weyand has studied whether sprinter Oscar Pistorius' artificial limbs confer a biomechanical advantage.

Weyand's team reported that Pistorius hits with less force and spends longer with each "foot" on the ground than runners with intact legs. The paper did not directly assess performance advantages.

But in an article in press in the same journal, Weyand and Matthew Bundle of the University of Wyoming release their conclusion: Pistorius has an edge over other runners. He can reposition his lightweight legs more rapidly than any sprinter ever measured, including Usain Bolt. In addition, Pistorius doesn't have to push as hard to produce the same force, much like a bicycle rider can switch to a lower gear and pedal less without losing speed. Other members of the investigation team, however, maintain that Pistorius does not gain an advantage from his artificial limbs. This means, through Pistorius, that scientists are now for the first time faced with the question of defining that which makes running human. In other words, the limit to speed may not lie in the body itself, but in how far we allow technology to take us. ■

Laura Beil is a freelance science writer in Cedar Hill, Texas.

Explore more

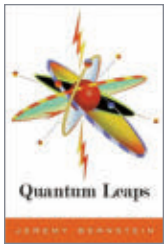
- T. Murray, K. Maschke, A. Wasunna, eds. *Performance-enhancing technologies in sports.* Johns Hopkins Press, 2009.

RICE UNIVERSITY

Quantum Leaps

Jeremy Bernstein

Quantum mechanics is famous for making nature much more complicated than it seems. Within quantum math exist countless possible realities, of which human observers generally perceive only one. Books trying to explain these bizarre multiple existences are about as numerous as the multiple realities themselves.



Adding one more such book to the library already in print may be overkill, but Bernstein's contribution is nevertheless welcome. A physicist-turned-prolific-writer, he is among the most engaging and thoughtful of quantum explainers, and *Quantum Leaps* provides one of the best concise guides available to what the fuss is all about.

In quasiautobiographical fashion, Bernstein describes his own struggle to grasp quantum weirdness, focusing on the work of physicist John Bell. In the 1960s, Bell conceived the insight that allowed quantum weirdness to be truly tested — that is, to distinguish the standard but crazy quantum physics interpretation from Newtonian sanity.

Quantum theory insists that the future is not precisely determined by the present. Naysayers sought to restore determinism with "hidden variables" that secretly did determine the future. Bell showed how to test that idea with experiments on a bizarre long-distance linkage, or entanglement, of certain particle properties. When the tests were ultimately done, weirdness won.

Bernstein recounts how Bell's work brought quantum physics into the mainstream of popular culture, especially in the form of some far-out books and films connecting it to Eastern mysticism and phenomena sounding suspiciously supernatural. Bernstein politely dismisses such works as "amiable nonsense," which they are. Fortunately for those who prefer the real quantum story, Bernstein's book is simply amiable. — *Tom Siegfried*

Harvard Univ. Press, 2009, 213 p., $18.95.

Living Weapons: Biological Warfare and International Security

Gregory D. Koblentz

Biological weapons pose unique threats to international security, beyond those caused by chemical and nuclear weapons, a policy expert argues. *Cornell Univ. Press, 2009, 255 p., $35.*

Reading in the Brain: The Science and Evolution of a Human Invention

Stanislas Dehaene

A cognitive neuroscientist describes how the brain has adapted to reading and what can cause reading problems. *Viking, 2009, 400 p., $27.95.*

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Jovian scars

Page 8 of the August 29, 2009, *Science News* shows a dark impact scar on Jupiter's surface. Similar dark areas appeared when Comet Shoemaker-Levy 9 hit. Why are they dark? Clearly, we are not seeing any "subsurface dirt." Also, the color cannot be due to some dark underlying gas. Could it be an enormous depression in the cloud cover, the bottom of which the light does not reach?

Raul Pettai, Montville, N.J.

Glenn Orton of NASA's Jet Propulsion Laboratory in Pasadena, Calif., responds: Hard as it is to believe when you live on a planet where the dark stuff is almost always below you and where chemical clouds only seem to exist in Pittsburgh, dark stuff is in the atmosphere at impact sites on Jupiter. The particulate debris from Comet Shoemaker-Levy 9 was dark in the visible range of the electromagnetic spectrum ... and consisted of a combination of material from the comet itself, material from the comet and Jupiter's atmosphere mixed together chemically in the shock of the impact, and material pulled up from Jupiter's atmosphere in the rising fireball.... In order [for the scars] to be as black as they are across the entire spectrum, [the material must have been] rich in sulfur and nitrogen. Although we did not see the 2009 July impact itself, the impact "scar" material appears to be spectroscopically indistinguishable from the Shoemaker-Levy 9 debris.

Power over pain

Regarding "'%&*#$!' makes you feel better" (*SN: 8/1/09, p. 9*), pain inevitably brings at least some sense of helplessness, adding to the pain. Anything that restores one's sense of power can help alleviate the pain. Violating community standards by cursing may give one a sense of power. This is probably a reason cursing makes one feel better.

Henry Close, Douglasville, Ga.

Science, politics

Clyde W. Yancy's statement *(SN: 8/29/09, p. 32)*, "We've got to get health care reform through," is an editorial. Yancy is entitled to his views, though his authority as a scientist doesn't extend to politics. *Science News* is entitled to print political opinions, but reading them is not why I subscribe. I subscribe because *Science News* is an excellent way for a nonscientist to learn about science.

George Wiley, Baldwin City, Kan.

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Ken Nealson

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From fringe to electromicrobiological mainstream

Trained as a microbiologist, Ken Nealson pursues many interdisciplinary endeavors. He was a pioneer in the field of geomicrobiology and has worked on astrobiology and microbial fuel cells. He holds posts at the University of Southern California in Los Angeles and the J. Craig Venter Institute in San Diego, where he uses genomics to survey microbial diversity in the oceans. He recently spoke with Science News *managing editor Eva Emerson.*

Tell me about "electromicrobiology."
I think in 20 years, this may well be a major field. What we're learning about is the ability of microbes to transfer electrons to different surfaces. When we first discovered this, it was really thought to be either a mistake or that the organism [we had discovered] was so far out-of-bounds from what other organisms do that the finding almost didn't make any difference.

These were the *Shewanella* bacteria, which you showed could use metals as electron acceptors in respiration.
Yes, we discovered *Shewanella* about the same time Derek Lovley [of the University of Massachusetts Amherst] discovered *Geobacter*.... We found that these microbes were able to reduce solid substrates — iron oxide or manganese. Basically, you take a rock and take away all the oxygen and the bugs would just settle down and respire the rock.... I would say about 90 percent of the microbiological world thought this was some kind of artifact, that it wasn't correct.

Now, 25 years later, everyone's got a bug that does this. So now, I think people are starting to realize this ability of bacteria to interact with the environment in an electrical way. I mean, what are microbial fuel cells? These are just the same bacteria. Instead of giving their electrons to a rock, they give it to the anode of the fuel cell so we can harvest the electricity.

You take advantage of the electromicrobiology in the fuel cell. Are there other potential applications?
The one we really like to think about these days is could you use this to slow down or even totally inhibit corrosion? Corrosion is a many-billion dollar problem. And yet nobody really understands the role of bacteria in corrosion. And what is corrosion? It's electron transfer from metals, it's an energy-yielding reaction. So bacteria are smart: they sit there and they get the energy out of this. And by doing that, they speed it up. That's my own hypothesis. And I'd say that many, many [corrosion] cases have to do with electromicrobiology — it's the flow of electrons. So I wouldn't be surprised if things like tooth decay or bone decay or dissolution of metals and minerals are all connected with this, specifically with what we call extracellular electron transport: the ability of these bugs to communicate electrically with the environment in ways that nobody taught us when we were students.

Now, I think people are starting to realize this ability of bacteria to interact with the environment in an electrical way.

Scientifically, what's most exciting?
It's hard to separate the exciting science from all the applications ... the exciting science are all these things that people didn't believe 10 or 15 years ago — that a bacterium could actually have its enzymes on the outside of the cell and communicate with the environment electrically. To me that in itself is so exciting because it simply wasn't in the textbooks 20 years ago and still is not there in most textbooks.

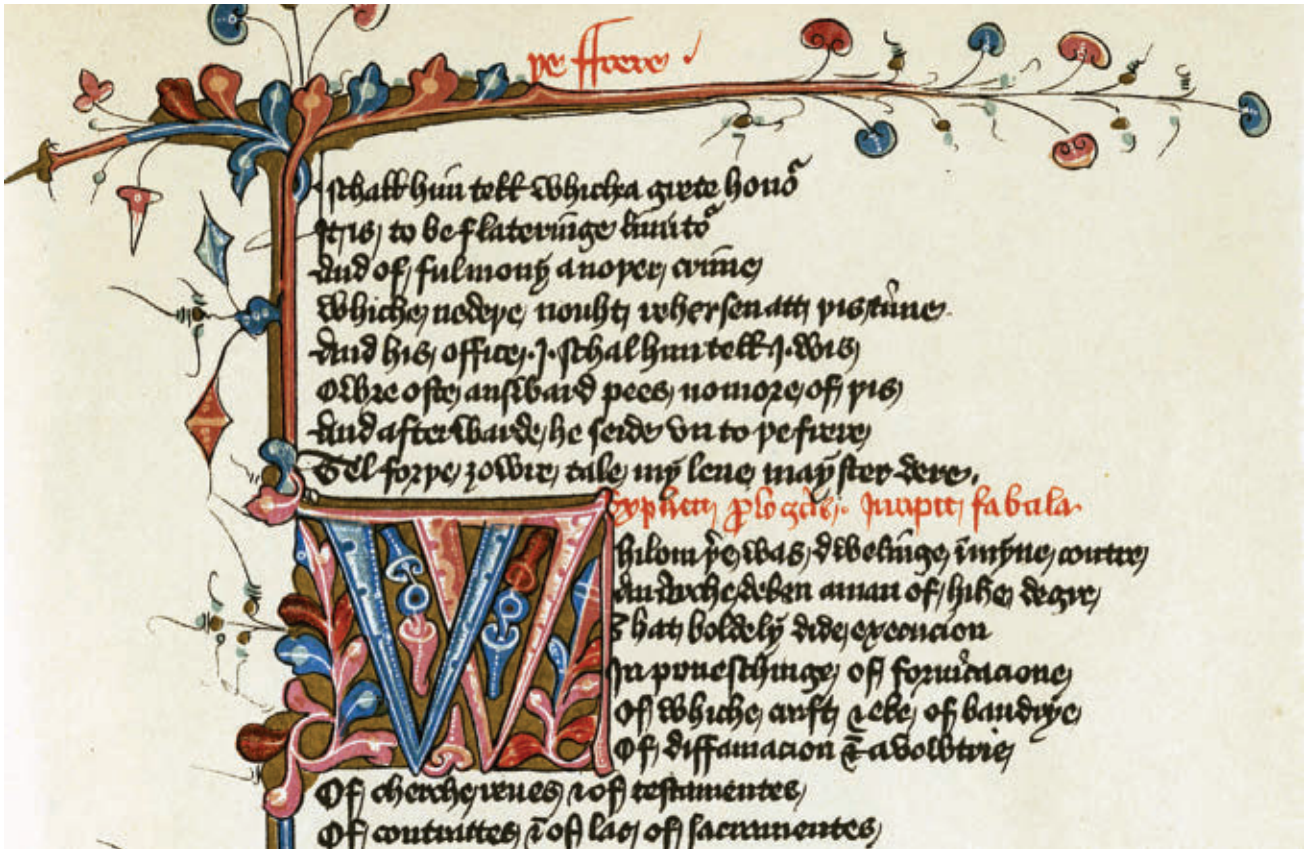
Where do you see electromicrobiology going next?
I think what you'll see is that this ability is far more widespread than anyone thought and that biofilms will be intimately connected with this. Bugs sitting on surfaces, at the surface of the biofilm and 20 layers out, will be doing different things [physiologically] and that they'll all be connected electrically one way or the other. And these electrons are going to flow even between microbial cells — like the things these guys are showing with nanowires [that link cells] (*SN: 3/28/09, p. 16*) — but these bugs don't all need nanowires, because on the outside of the cells there are all of these enzymes. Sitting next to each other, the microbes can do it directly. And this is really an exciting concept: The world isn't ready for it yet, but it's getting close.

I've now given four or five talks, and you can see that people are able to relate what you're saying to something that they've seen....

This is sort of the progression of science. Where it goes from, "That's impossible, this can't be true," over several steps, and the final step is, "Well, I knew it all the time." ... And so everybody and their brother is going to be studying this stuff, so you don't need to do it anymore. And you look for something else, way out on the edge.

Unless I really miss my bet, I think in the next decade or so, this whole electromicrobiology thing will go from a fringe kind of science ... to a major area of the field. So pretty soon, I'm going to have to find something new to do. ■

PHILIP CHANNING/USC COLLEGE



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