SN
SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC
SEPTEMBER 6, 2014

Carbon Capture Woes

Neutrons in Wonderland

Heart Disease, Mummified

Shape-Shifting Robot Swarm

MISUNDERSTOOD CREATURES

Why the oceans need jellyfish

YOUR FREE PEARLS ARE HERE

EXPERIENCE THE LUXURY OF MITSUKO ORGANIC CULTURED PEARLS REGULARLY $299, GET THEM TODAY FOR FREE*

We owe you an apology. This exclusive deal is guaranteed to ruin every jewelry purchase you make from now on. Once you realize that it's possible to own a genuine cultured pearl necklace for **FREE**, other luxury brands are bound to disappoint. They can't handle **FREE** jewelry. They can't even afford to try. But you can. And that's all that matters to us.

We're offering our ***Mitsuko Organic Cultured Pearl Necklace*** online for $299. But if you'd like it for near **NOTHING** (you pay only the $19.95 shipping & processing–*see details below*) all you need to do is call 1-800-859-1542.

It's okay to be skeptical. You have every right to be. Why would any company give away a pearl necklace? Good question. We believe that once you try us, you'll be back for more. But maybe a better question is why other luxury jewelers don't think twice about offering cultured pearls for hundreds—even thousands—more. I'm sure they have their reasons. But you don't have to fall for them. Not anymore. Call today for your **FREE *Mitsuko Organic Cultured Pearl Necklace*** and you'll realize that luxury doesn't have to cost a fortune.

By implanting a nucleus inside the oyster, farmers stimulate the natural creation of a pearl. Each Mitsuko cultured pearl is harvested, polished and strung by hand.

Mitsuko Organic Cultured Pearls—Exclusively from Stauer. Every necklace is the product of generations of expertise. From natural genesis to final selection, imported Mitsuko organic cultured pearls are held to the highest standard. This continous, 26" strand showcases a collection of 6½-7mm white cultured pearls. Each necklace is hand-strung and double-knotted to keep every precious pearl secure.

This exclusive FREE offer can't last forever. Unfortunately, we are only able to make a limited number of these necklaces available to the public for free. Don't let this incredible opportunity pass you by! To ensure that you receive your ***FREE Mitsuko Organic Cultured Pearl Necklace***, please call today. Your idea of luxury will never be the same!

Mitsuko Cultured Pearl Necklace
Regularly ~~$299~~†

Yours FREE*

***Pay only $19.95 shipping & processing**

Stauer®

ACCREDITED BUSINESS BBB Rating of A+

14101 Southcross Drive W.,
Dept. MFP280-02
Burnsville, Minnesota 55337 www.stauer.com

† Free is for Call-In Customers only versus the original Stauer.com price.

You must use the offer code below to receive these special free pearls.

1-800-859-1542

Promotional Code MFP280-02
Please mention this code when you call.

Smart Luxuries—Surprising Prices™

* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV, OR, SC, VA and ID. These state residents will be charged one cent ($.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address.

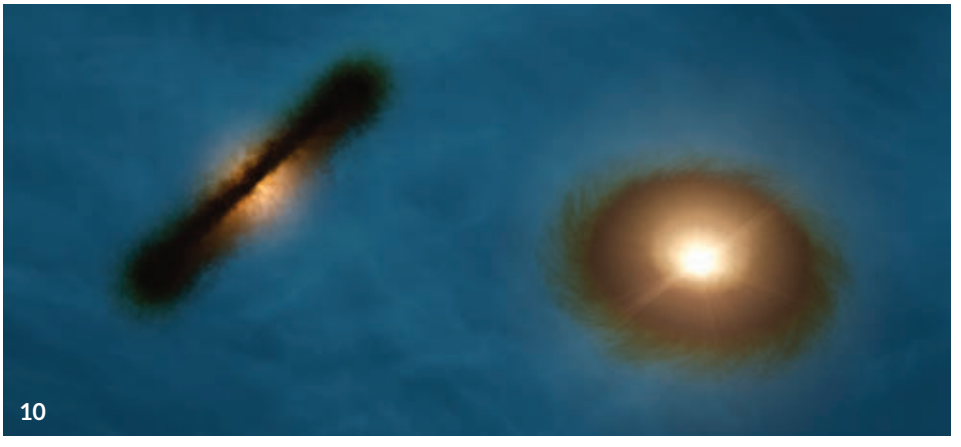
VOL. 186 | NO. 5

ScienceNews


22

Features

News


10


4

Departments

COVER Beyond the sting of a jellyfish (*Cyanea capillata* shown) is a complex creature important in its ecosystem. *Alexander Semenov/Cultura Science/Getty Images*

CLOCKWISE FROM TOP LEFT: NICOLLE RAGER FULLER; NICOLASVOISIN44/SHUTTERSTOCK; R. HURT, IPAC/JPL-CALTECH/NASA

Sometimes value lies deep below the surface

People tend to notice jellyfish only when they are a bother (stinging beach-goers or showing up in massive blooms) or a beauty (tamed in an aquarium case). Surprisingly little has been known about their wild lives, as Susan Milius describes on Page 16, largely because they are difficult to study.

Now research is revealing aspects of their lives that are seldom appreciated. Some jellies are sophisticated hunters of the open ocean. Others harbor an array of hangers-on, serving as mobile mini-ecosystems. Leatherback sea turtles fatten up on jellyfish. These and other surprises about jellyfish serve as a reminder of all that people don't know about ocean ecosystems, and of how shortsighted notions to intervene — a la jellyfish-killing robots — may turn out to be.

Shortsightedness could also be at play in the issue of controlling carbon emissions, particularly for coal-burning power plants, which generate almost half of global carbon dioxide emissions. Carbon capture and storage technologies that would dramatically reduce power plant emissions already exist. But, as Beth Mole describes on Page 22, convincing power plants to add the technologies has been a tough sell.

As currently formulated, the technologies siphon off a good chunk of a plant's energy output. And they are expensive to install and run. Still, a few utilities are trying. By implementing the techniques, one of which has been around for 80-plus years, utilities may be able to improve the methods and pave the way for more widespread use. And that surely would have a large impact on global carbon levels, and thus on future climate.

Also in this issue, read on Page 6 about signs of heart disease in the blood vessels of mummies, illustrating just how old this age-old problem is. And on Page 7, learn what scientists have discovered about the transmissibility of the Ebola virus.

We tend to pay the most attention to things, be it jellies, carbon, heart disease or Ebola, once they are a problem. But when we do, what's learned is often amazing and useful, and may just help keep people and this planet healthy.

— Eva Emerson, Editor in Chief

EDITORIAL, ADVERTISING AND BUSINESS OFFICES

Audit Bureau of Circulations

1719 N Street NW, Washington, DC 20036
Phone: (202) 785-2255
Customer service: member@societyforscience.org
Editorial/letters: editors@sciencenews.org
Sponsor content: snsales@sciencenews.org

Science News (ISSN 0036-8423) is published biweekly by Society for Science & the Public, 1719 N Street, NW, Washington, DC 20036.

Online and iPad access: Activate your subscribing member account, including digital access and the ability to opt out of print, at sciencenews.org/activate

Subscribe:
Web Visit sciencenews.org/join to become a subscribing member or renew at sciencenews.org/renew
Phone Call (800) 552-4412 in the U.S. or (570) 567-1191 outside of the U.S.
E-mail member@societyforscience.org
Mail *Science News*, PO Box 1205, Williamsport, PA 17703-1205

Subscribing memberships include 26 issues of *Science News* and are available for $50 for one year (international rate of $68 includes extra shipping charge). Single copies are $3.99 (plus $1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

SANDY SCHAFFER

Australia Gives America the Bird!

Perth Mint sends Wedge-Tailed Eagle to U.S. in first-ever silver dollar release

Actual size is 40.6 mm

No worries, mate...Australia and the United States are on great terms. So great, in fact, that they've teamed up on this Australian legal tender 99.9% pure silver, historic first ever silver dollar coin release.

The 2014 Australian Eagle Silver Dollar is a hefty full ounce of 99.9% pure silver bearing tons of numismatic pedigree. Minted by Australia's award-winning Perth Mint in gleaming Brilliant Uncirculated condition, this silver dollar is an exclusive **WORLD's FIRST**. For the first time ever a renowned former U.S. Mint Chief Engraver has designed a coin struck by another country.

FIRST TIME EVER
Chief Engraver John Mercanti created the timeless American Silver Eagle design in 1986. Now, for the FIRST TIME EVER, Mr. Mercanti has sculpted a bold new Australian Eagle Silver Dollar featuring a Wedge-Tailed Eagle just about to land.

PERSONALLY AUTOGRAPHED
Each 2014 Australian Eagle Silver Dollar has been certified to be in Gem Brilliant Uncirculated condition by Professional Coin Grading Service (PCGS). Each archival holder also bears the hand-signed autograph of Chief Engraver, John Mercanti.

FIRST RELEASE / WORLDWIDE EXCLUSIVE
GovMint.com is the exclusive worldwide distributor for this exciting new Silver Dollar. You can secure yours now at our special release price by calling today or visiting www.GovMint.com. Your satisfaction is assured with our no hassle 30-day guarantee.

BUY MORE and SAVE MORE!
You can lock in your FIRST EVER Australian Eagle Silver Dollar for the low price of just $29.95 each (*plus s/h*).

Better yet, if you buy more, you can **SAVE MORE!**

One 2014 Australian Silver Eagle for $29.95 each (*plus s/h*)
Twenty 2014 Australian Silver Eagle for $28.95 each (*plus s/h*)

For fastest service, call today toll-free

1-888-254-9607

Offer Code AUE184-03
Please mention this code when you call.

GovMint.com ▪ 14101 Southcross Dr. W. Dept. AUE184-03 ▪ Burnsville, Minnesota 55337

Prices and availability subject to change without notice. Past performance is not a predictor of future performance. NOTE: GovMint.com® is a private distributor of worldwide government coin and currency issues and privately issued licensed collectibles and is not affiliated with the United States government. Facts and figures deemed accurate as of July 2014. ©2014 GovMint.com.

GOVMINT.COM®

THE BEST SOURCE FOR COINS WORLDWIDE™

ADVERTISEMENT

Excerpt from the September 12, 1964, issue of *Science News Letter*

50 YEARS AGO

Odd-ball quasars may be closer than they seem

The odd-ball heavenly objects called quasars may be much closer to the earth's own Milky Way galaxy than astronomers have thought. ... They have been regarded as the brightest and most distant objects known. However, they may not be so distant after all. Dr. James Terrell ... believes quasars could be within two billion billion miles of earth.... This would place them between the Milky Way galaxy and the Andromeda Nebula.

UPDATE: In the 1970s and '80s, astronomers figured out that quasars are luminous disks of gas powered by supermassive black holes, most of which are located more than halfway across the universe. The most powerful quasar known, discovered in 2012, blasts out about 100 times as much energy as all the stars in the Milky Way galaxy combined. As the light from a quasar traverses the cosmos, it picks up the chemical fingerprint of gas clouds, which allows researchers to probe conditions in the early universe.

Distinctive patterns on the foreheads of bumphead parrot fish let researchers identify individuals.

NICOLASVOISIN44/SHUTTERSTOCK

IT'S ALIVE

When big bumpheads break stuff

The sound of the world's largest parrot fish swimming toward him, says Douglas McCauley, is not some watery swish, swish. It's crunch, crunch. "You can hear a school of them before you see it," he says.

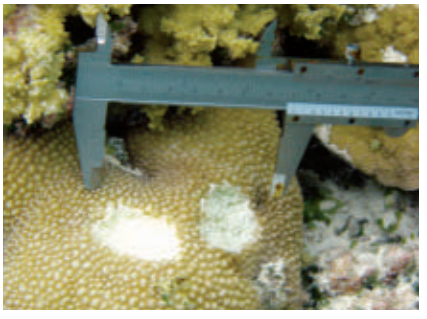
Bumphead parrot fish (*Bolbometopon muricatum*) grow to "about the size of a junior high school kid" as McCauley puts it. And feeding is a noisy business because they eat — and loudly digest — what's essentially rock.

The fish gouge out hunks of reef and snap thumb-sized coral branches. But what McCauley finds even more impressive are the noises of the parrot fish's down-deep throat teeth, which can grow wider than half dollars, milling the coral chunks.

Crushing coral uncovers what the fish really want: fleshy polyps and other tiny organisms hiding inside. Bumpheads excrete the broken-up coral as gravel and a plume of white sand that "just hovers," McCauley says, "as if you had opened a carton of milk underwater."

So prodigious a grinder of coral is the bumphead that more than four tons of coral sediment land on the reef in a year from the excretions of a single parrot fish.

Calculating that number required 130 days underwater from McCauley, now at the University of California, Santa Barbara, and a series of helpers carrying syringes the size of turkey basters for collecting excreted coral. On two atolls in the Northern Line Islands in the Pacific, McCauley eased as close as he could to one bumphead at a time and recorded what it ate and pooped as long as he could keep it in sight. On his best day, that was 5.3 hours. If he took



Douglas McCauley (top) has recorded close-up details of nearly 6,000 bumphead bites, mostly from corals. Beaklike mouthparts can gouge substantial divots (bottom) as bumpheads swallow coral to get at the tasty organisms hidden within.

his eyes off a fish for just 30 seconds, he could lose it. "I kept a PowerBar in my sleeve," he says.

His hard-earned data reveal a dilemma for people who love coral reefs. Bumpheads can help corals (for example, by mowing down smothering algae) but in crowds over decades they may reduce the diversity of coral species, McCauley and his colleagues suggest July 26 in *Conservation Biology*. And the charismatic fish themselves rank as vulnerable to extinction, a conservation conundrum with a terrestrial parallel. The big, loud, wonderful, alarming bumpheads, McCauley says, are "underwater elephants."
— Susan Milius

FROM TOP: LAUREN PALUMBI; D. MCCAULEY; © 2007 MBARI

INTRODUCING

Gut-dwelling virus is surprisingly common

A newly discovered virus may already be living in your intestines. As many as three-quarters of people carry this virus, yet it has gone unnoticed until now.

"We haven't been able to capture the little bugger on a plate and take a picture of it," says computational biologist Robert Edwards of San Diego State University, who led the study. Instead, the researchers found the new virus by looking at DNA from people's feces.

The virus went unrecognized for so long because many of its genes don't resemble those of other known viruses, researchers report July 24 in *Nature Communications*.

73 percent
Fraction of human fecal samples containing the crAssphage virus

Dubbed crAssphage after the computer program used to discover it, the new virus is a bacteriophage that infects and kills bacteria. It attacks *Bacteroides*, one of the most common types of friendly bacteria found in people's intestines. Previous studies have shown that a gut microbe mix containing fewer *Bacteroides* and more members of another bacteria group, *Firmicutes*, may promote obesity. It's not yet clear whether people who carry crAssphage are more prone to obesity because of the virus's assault on *Bacteroides* bacteria.
— Tina Hesman Saey

This deep-sea octopus brooded the same clutch of eggs for nearly four and a half years.

THE -EST

'Octomom' sets egg-brooding record

The deep ocean has spawned a new record: the longest egg-brooding period. In April 2007, Bruce Robison of the Monterey Bay Aquarium Research Institute in Moss Landing, Calif., and colleagues sent a remote-operated vehicle down 1,397 meters into the Monterey Submarine Canyon. There they saw a deep-sea octopus (*Graneledone boreopacifica*) making its way toward a stony outcrop. One month later, the scientists spotted the same octopus, which they dubbed "Octomom," on the rock with a clutch of 155 to 165 eggs. The researchers returned to the site 18 times in total. Each time, she was there with her developing eggs.

In general, female octopuses lay only one clutch of eggs, staying with the eggs constantly and slowly starving to death while protecting them from predators and keeping them clean. When the eggs hatch, the female dies.

The scientists report July 30 in *PLOS ONE* that the octopus was observed on her eggs for 53 months, until September 2011, the longest brooding period of any known animal. *— Bethany Brookshire*

Watch a video about the Octomom's long vigil at **bit.ly/SN_Octomom**

HUMANS & SOCIETY

Mummies reveal hardened arteries

Pharaohs, ancient Peruvians, many others had heart disease

CT scans of mummies from around the world reveal that hardening of the arteries has been a problem for more than 5,000 years.

BY TINA HESMAN SAEY

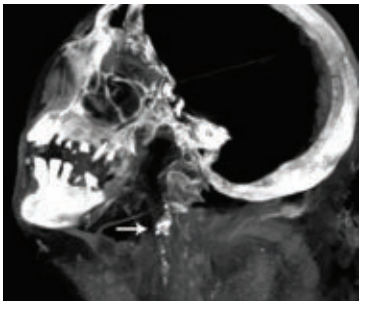
Atherosclerosis, or hardening of the arteries, is usually considered a modern disease brought on by fatty diets, smoking and lack of exercise. But new studies of mummies from around the world show that the disease is an ancient affliction with a plethora of possible triggers.

In the June *Global Heart*, researchers present evidence of heart disease from a diverse array of mummies including the famous 5,300-year-old Tyrolean Iceman, ancient Egyptians, native Peruvians dating from the third to 16th centuries, Pueblo Indians who lived in Utah about 1,000 years ago, a Renaissance king, a 15th century nomad from the Gobi Desert and 19th century hunter-gatherers from the Aleutian Islands. CT scans or autopsies revealed calcium deposits in artery walls of many of the mummies, a sign of vessel hardening.

Atherosclerosis results when plaque composed of cholesterol and other substances builds up on the interior walls of arteries. That plaque can nucleate a blood clot or break away in bits to clog arteries and cause heart attacks or strokes. Cardiovascular disease is the leading cause of death in the United States, killing about 600,000 people each year.

The mummy studies present compelling evidence that people developed atherosclerosis "even in an environment where exercise was abundant and fast food was nonexistent," says Matthew Budoff, a cardiologist at UCLA who was not involved in the work.

The project was born in 2008 when cardiologists Gregory Thomas of the University of California, Irvine and Adel Allam of Al-Azhar University in Cairo visited Cairo's Egyptian Museum. A sign by the mummy of the pharaoh Menephtah said that the ruler had died in his 60s of atherosclerosis. Thomas and Allam decided to test the claim. The disease was easy to find in scans of 2,000- to 3,500-year-old Egyptian elites, the researchers and their team reported in 2009 (*SN: 12/19/09, p. 14*).



Ancient Egyptians suffered from atherosclerosis. In this CT scan of a mummy at least 3,200 years old, the arrow points to calcium deposits in an artery.

The team has now compared the cardiovascular systems of 76 Egyptian mummies with the blood vessels of 178 modern Egyptian cancer patients. Hardened arteries appeared in about 38 percent of the mummies and more than 60 percent of the present-day people. When the researchers accounted for the ancient people's shorter life spans — the mummified people had died on average at age 36, while the modern Egyptians had an average age of 52 — ancient and modern people's diseases were nearly indistinguishable, Allam says. The arteries that were hardened in modern people were the same ones with plaque buildup in mummies.

The researchers also found calcified plaques in the arteries of 37 percent of mummies from Peru, the American Southwest and the Aleutian Islands.

"Their findings are provocative," says cardiologist Nathan Wong of the University of California, Irvine. Because some of the mummies were not well preserved, he thinks that atherosclerosis may have been even more prevalent in the ancient people than the studies indicate.

Egyptian pharaohs and the obese 15th century King Ferdinand I of Naples ate meaty diets and had sedentary lifestyles that could foster the disease, just as they do in modern people. But the other mummified people didn't have rich diets and got plenty of exercise. None of them smoked tobacco. Their atherosclerosis must have sprung from other sources, researchers say.

Increasingly, scientists think of atherosclerosis as a product of genetics and aging, Thomas says. "We haven't been able to find a culture that doesn't get blockages of their arteries." That commonality suggests atherosclerosis stems from errors "baked into human genes," he says. Or the genetic underpinnings of heart disease may provide some hidden benefit early in development or may have helped humans evolve better defenses against infectious diseases, he says.

At least one of the mummies, the Tyrolean Iceman known as Ötzi, had genetic variants that, in modern people,

BOTH: R.C. THOMPSON *ET AL/GLOBAL HEART* 2014

have been linked to heart disease, report researchers led by Albert Zink, a paleopathologist who directs the Institute for Mummies and the Iceman in Bolzano, Italy. The combination of variants in Ötzi's genome would have doubled his chance of getting heart disease.

At the time of his death in his 40s, due to an arrow wound in the back, the Iceman had atherosclerosis. "It's possible that if he wasn't killed by this arrow, he could have died of a heart attack or stroke 10 years later," Zink says.

But bad genes are no guarantee that someone will get heart disease, says David Hunt, a physical anthropologist at the Smithsonian Institution in Washington, D.C., who was not involved in the work. Environmental factors such as diet, exercise, smoking and exposure to pollution bring on the disease, he says: "Genetics loads the bullets in the gun, but environment pulls the trigger."

Exactly what the ancient trigger pullers were is still a matter of debate. One possible cause is inhaling smoke from indoor cooking fires. Autopsies of two Aleutian Islanders revealed soot in their lungs, and CT scans showed that three of five examined had atherosclerosis.

Inflammation caused by chronic infections may also have brought on the disease, the researchers say. Many of the mummies carried parasites and evidence of other infections.

And don't forget about stress, says coauthor Randall Thompson, a cardiologist at Saint Luke's Mid America Heart Institute in Kansas City, Mo. Disease, bad weather, food shortages, cultural conflict and other difficulties of the ancient world could have produced stress to rival anything in modern society.

As for Menephtah, his wrappings were unwound in 1907 and an autopsy uncovered "large bonelike patches" in the walls of his aorta. Allam's team was unaware there had been an autopsy when it began its work. CT scans confirmed the diagnosis, Allam says.

While the researchers can't say for certain that Menephtah died of heart disease, Allam says, "We would have put him as a high-risk patient." ■

BODY & BRAIN

Airborne transmission of Ebola unlikely, monkey study shows

Captive macaques did not transmit deadly virus

BY TINA HESMAN SAEY

Monkeys do not pass Ebola to each other through the air, researchers report. The result confirms observations of human outbreaks of the deadly virus: Infection requires contact with bodily fluids.

The study follows a 2012 report that raised concerns that Ebola might be able to spread by air (*SN: 12/15/12, p. 12*). That study, led by infectious disease researcher Gary Kobinger of the Public Health Agency of Canada, found that macaques contracted Ebola when housed in cages near piglets infected with Ebola. The animals never touched. The researchers said the virus probably floated to the monkeys' cages as a fine airborne spray of particles shed by the pigs.

Pigs seem to give off more aerosolized viral particles than other species, says Derek Gatherer, a viral evolutionary biologist at Lancaster University in England. "If it's going to spread by aerosols, then pigs are the species to do it."

But he doesn't think the researchers definitively demonstrated airborne transmission. Virus-laden water droplets could have splashed from the pig pen to the macaque cages when the researchers washed the pig enclosure, he says.

Pigs probably aren't a source of human Ebola outbreaks. No African pigs are known to be infected with *Zaire ebolavirus*, the cause of the current epidemic.

Even if pigs can transmit the virus by air, they may be unique in the ability. The new study, published July 25 in *Scientific Reports* by Kobinger and a different group of collaborators, found no evidence that sick macaques could give the virus to healthy monkeys through airborne particles.

The researchers placed two rhesus macaques infected with *Zaire ebolavirus* in cages near two uninfected cynomolgus macaques. The animals couldn't touch, but no shielding protected the uninfected monkeys. The infected monkeys were euthanized after six days. Meanwhile, the cynomolgus macaques remained free of Ebola for the 28 days of the experiment, well beyond the six to 16 days it takes for symptoms to appear.

Since December 2013, this largest ever outbreak of Ebola has killed at least 1,145 people — more than half of the 2,127 people infected — in the West African nations of Guinea, Liberia, Sierra Leone and Nigeria. Those infected include two American health care workers, who have been transferred to Atlanta for treatment in an isolation facility at Emory University Hospital.

Fabian Leendertz, an epidemiologist and disease ecologist at the Robert Koch Institute in Berlin, says that the outbreak is spreading by human-to-human contact. The people who are dying are mostly women who care for the sick, their children and people who touch dead bodies during funeral rituals, he says. Health care workers are also at risk.

But Ebola is not nearly as easily transmitted as many people assume, he says. Even if an infected person were to hop on a plane and fly to the United States, Europe, or elsewhere, Leendertz says, tight health care measures would ensure that Ebola "will never get far." ■

Rhesus macaques infected with Ebola in a laboratory experiment did not pass the virus through the air to other monkeys.

ATOM & COSMOS

Single black hole may be masquerading as a pair

New observations cast doubt on recent discovery of binary system at galaxy's center

BY CHRISTOPHER CROCKETT

Astronomers may have been seeing double when they recently announced the discovery of a pair of supermassive black holes at the heart of a galaxy collision (*SN: 7/26/14, p. 10*). New observations of the galaxy suggest that what seemed to be a duo may instead be one lonely black hole blasting the surrounding space with two jets of charged particles.

At the center of the controversy are two blobs about 450 light-years apart that emit radio waves — radiation at the low-frequency end of the spectrum. Roger Deane, an astrophysicist at the University of Cape Town in South Africa, and colleagues reported that the radio waves came from two supermassive black holes locked in a gravitational embrace.

Another team of astronomers, led by Joan Wrobel of the National Radio Astronomy Observatory in Socorro, N.M., took a closer look with the Very Long Baseline Array, a network of 10 radio telescopes stretching from Hawaii to the Virgin Islands. What they found was not in Deane's observations: faint tails of radio waves connected to the two bright spots, each pointing to a spot between them. The new images, the researchers report July 28 at arXiv.org, show the subtle signature of two fountains of charged particles driven by a single black hole and slamming into dense clouds of interstellar gas.

> "This is not the final nail in the coffin."
>
> **HAI FU**

Deane agrees but with reservations. Jets from black holes should pump out more energy at lower radio frequencies, he says. But these spots parcel energy out equally across a range of frequencies.

The dual black hole hypothesis doesn't fare much better, says study coauthor Hai Fu, an astrophysicist at the University of Iowa in Iowa City. The alignment of the faint tails, he says, means a black hole pair would have to be shooting directly at each other. "That's too much coincidence," he adds.

Still, he cautions, "this is not the final nail in the coffin. Science is not like that. We constantly go back and forth."

Now the two teams have joined forces. They propose using the Very Long Baseline Array in concert with other radio observatories to tease out faint structures that any single telescope wouldn't see.

Either outcome is intriguing. Binary black holes should be sources of gravitational waves, theoretical ripples in the fabric of space that no one has directly detected. But jets might unravel the curious link between the mass of a galaxy and the black hole at its core. Galaxies are hundreds of thousands of light-years across, and the gravitational reach of a black hole is relatively puny. Astronomers suspect that jets may be the key to understanding how a tiny speck can control the fate of an entire galaxy. ■

ATOM & COSMOS

Rosetta spacecraft confabs with a comet

After a 10-year chase, the Rosetta spacecraft has caught up with the comet 67P/Churyumov–Gerasimenko (shown). On August 6, the European Space Agency released images and data showing that the probe had come within 100 kilometers of the space rock and is ready to enter into orbit around it. The meeting marks the closest a spacecraft has come to a comet without slamming into it and could reveal whether such space rocks ferried water and other ingredients for life to Earth billions of years ago.

The Rosetta team plans to harpoon a lander onto the comet's surface. Together the orbiter and lander will give astronomers a ringside seat as the comet gets close to the sun. "We have this crazy, bonkers, gold-medal-winning comet to play with for the next year and a half," says ESA scientist Mark McCaughrean. Researchers are particularly interested in watching what happens to the comet's water during the rock's journey. Doing so may divulge whether comets could have brought water to the inner solar system.

The mission may even help astronomers determine whether relatively small, rocky worlds with as much water as Earth are the norm or flukes in the creation of planets around stars, says Edward Young, a geochemist at the University of California, Los Angeles who is not involved with Rosetta. — *Ashley Yeager*

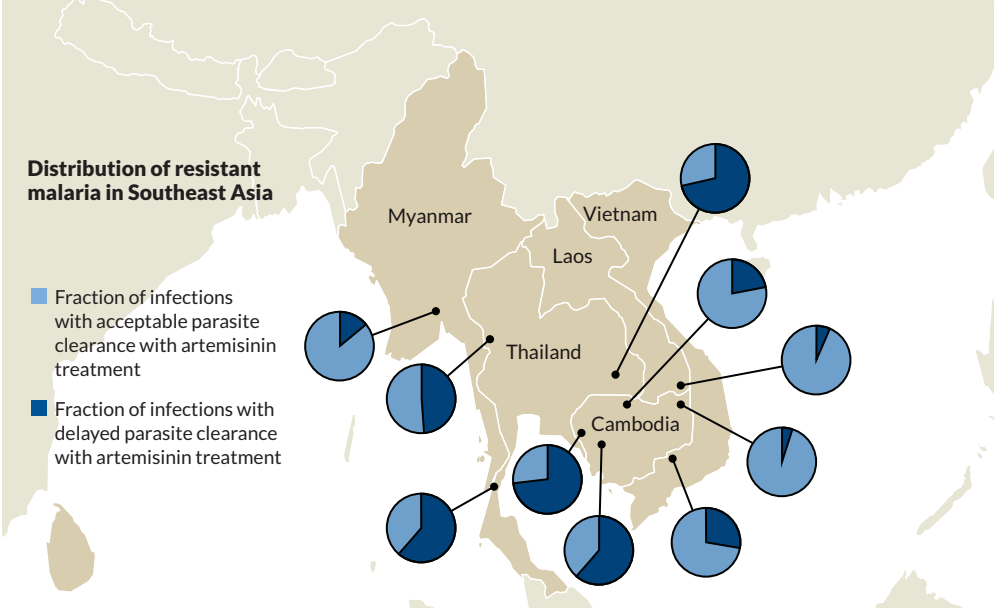
OSIRIS/MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA/ROSETTA/ESA

BODY & BRAIN

Resistance to key malaria drug spreads

Hard-to-treat parasites now affect several Asian countries

BY NATHAN SEPPA



Fighting back Substantial percentages of people in Southeast Asia given artemisinin have malaria parasites that are resistant to the drug (dark blue). A case is considered resistant if half of the parasites remain in the blood more than five hours after taking one dose of artemisinin.

Resistance to the top malaria drug has fanned out from its origins in Cambodia to other parts of Southeast Asia. A report in the July 31 *New England Journal of Medicine* establishes that the scourge has found a way to skirt the effects of artemisinin and its chemical derivatives, the best available antimalarial drugs. Scientists suspect that a genetic mutation underpins the resistance.

"I'm concerned," says Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases, or NIAID, in Bethesda, Md. "Artemisinin derivatives used in combination with other drugs have been game changers."

There were 207 million cases of malaria worldwide in 2012, the World Health Organization estimates, killing 627,000 people, most of them children under age 5. There is no approved vaccine against the malaria parasite, which is spread by mosquitoes and causes fever, chills, convulsions and more severe symptoms.

Artemisinin and its derivatives have been especially good at hammering *Plasmodium falciparum*, the protozoan that causes the most severe malaria infections. The drug is based on an ancient plant remedy that was rediscovered in the 1970s and developed into a pill. Along with mosquito nets, artemisinin-derived drugs used in tandem with other antimalarials have helped ease the global malaria burden in recent years. WHO recommends use of artemisinin derivatives only in combination with other drugs, to limit the survival of parasites that could develop resistance.

But the history of malaria treatment is peppered with drugs to which the parasite has become resistant, and artemisinin might be next. A decade ago, Cambodia emerged as the epicenter for artemisinin-resistant malaria (*SN: 11/22/08, p. 9*). Hints that resistance there had spread to neighboring countries showed up five years ago (*SN: 12/19/09, p. 15*). In the new study, researchers provide hard evidence of this proliferation, finding that many patients in Thailand, Vietnam, Laos and Myanmar are now taking longer to clear the parasite from their bodies after artemisinin treatment. Delayed clearance means parasites are surviving the drug's effects longer — that the drug is losing its punch.

To assess the trend, researchers identified 965 malaria patients across Southeast Asia and treated them with three days of artemisinin alone followed by three days of artemisinin plus another drug. Used experimentally, treating with artemisinin alone can reveal whether the parasite dodges the drug's usually prompt effects.

Scientists consider a case resistant to artemisinin if half of the malaria parasites are still alive in the blood more than five hours into treatment. Depending on location, it took a median time of 6.9 to 9.6 hours after the first artemisinin dose for patients' parasite loads to be reduced by half.

The study solidifies a link, found in earlier research, between delayed parasite clearance and mutations in a *P. falciparum* gene called *kelch13*. The presence of these mutations might aid in tracking drug resistance, says study coauthor Nicholas White, a tropical medicine physician at Mahidol University in Bangkok. How the mutation helps the parasite remains unknown, he says.

There is no way of predicting whether these findings signal the beginning of the end for artemisinin as a frontline drug. "The efficacy of artemisinin is definitely taking a hit right now in Southeast Asia," says study coauthor Rick Fairhurst, a physician and malaria researcher at NIAID. He expects more malaria parasites across the region to acquire mutations in *kelch13*.

Patients with artemisinin-resistant parasites will need longer treatment, many will fail on current drug combinations and some may die, White says. But for now, a six-day treatment — rather than the standard three — of artemisinin plus another antimalarial seems able to clear resistant infections, the study shows.

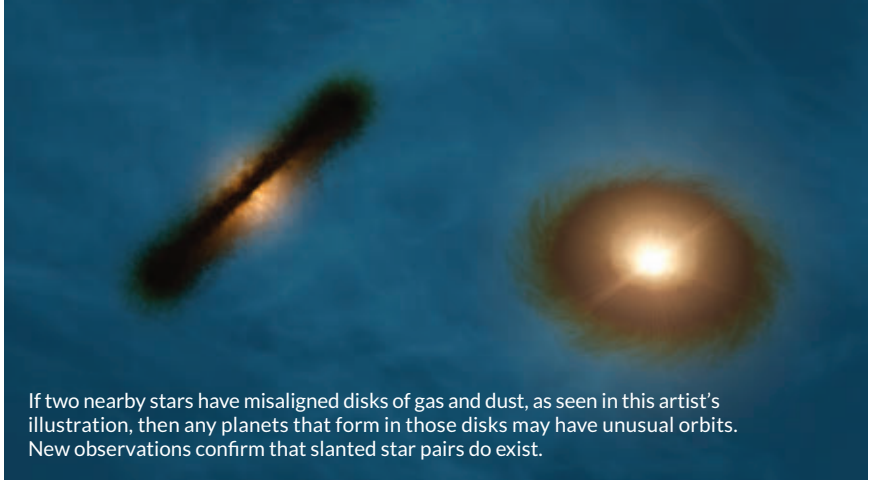
Fauci calls that solution temporary. He notes that six days of pills costs more than three and requires more diligence, increasing the risk that patients won't take full prescriptions. "If you start feeling better and have 75 percent of your parasites cleared and your fever is gone, you may get to day four and say, 'I've had enough,'" he says. Such partial treatment contributes to resistance. ■

E.A. ASHLEY *ET AL*/*NEJM* 2014, ADAPTED BY E. OTWELL

ATOM & COSMOS

Stars' tilted disks clarify odd orbits

Mismatched planet nurseries may shape trajectories



If two nearby stars have misaligned disks of gas and dust, as seen in this artist's illustration, then any planets that form in those disks may have unusual orbits. New observations confirm that slanted star pairs do exist.

R. HURT, IPAC/JPL-CALTECH/NASA

BY CHRISTOPHER CROCKETT

Exoplanet orbits come in all shapes and sizes, and a pair of nearby stars is helping astronomers figure out why. Cockeyed disks of gas and dust that give rise to planets circle the two stars, new observations show. The disks' misalignment might nudge future planets into off-kilter orbits. Researchers hope that the discovery is the first step toward understanding the origin of the galaxy's diverse planetary arrangements.

Compared with some planetary systems, the solar system is pretty dull. Earth and its siblings travel along nearly circular orbits in almost the same plane. A handful of planets around other stars are a bit more free-spirited. Some orbit at angles that are highly inclined relative to their star's equator; some plunge in close to their sun before flying out to the backwaters of their system; still others carry the mass of Jupiter yet whip around their stars in mere days.

One leading explanation of the odd orbits lays the blame on a second, nearby star. This hypothesis works only if the orbit of the second star is tilted relative to the disk in which planets form. Until now astronomers weren't certain if this arrangement was possible.

But the disks around the stars in a binary system located 525 light-years away in the constellation Taurus are misaligned, Eric Jensen of Swarthmore College in Pennsylvania and Rachel Akeson of Caltech report in the July 31 *Nature*.

The researchers used the Atacama Large Millimeter/submillimeter Array in Chile, or ALMA, to measure light emitted from carbon monoxide gas and microscopic dust grains, which revealed the orientations of the two rotating disks. The discovery implies that disks can form at odd angles relative to a stellar duo, creating conditions that are perfect for shaping the strange orbits of some planets.

Imagine a planet orbiting one of the stars in a pair, Akeson says. That planet senses the gravity of its own star, but it will also feel a nudge from the second star. If the companion star lies above or below the plane of the planet's orbit, gravity will

MATH & TECHNOLOGY

Computer chip mimics the brain

Parallel-processing device could improve pattern recognition

BY ANDREW GRANT

Human brainpower has produced a computer chip reminiscent of the human brain.

The chip, reported in the Aug. 8 *Science*, scraps the design that forms the basis of traditional computers in favor of an architecture resembling a bundle of a million neurons. Such technology could pinch-hit to perform tasks that conventional computers struggle with, such as identifying objects in photos and videos.

"It's an impressive piece of silicon," says Stephen Furber, a computer engineer at the University of Manchester in England. "A million neurons on a single chip is a big number."

Computers' basic architecture hasn't changed much since the 1940s (*SN: 10/19/13, p. 28*). A central processor, following a sequence of instructions, takes data from memory, manipulates it and then returns it. The need to shuttle so many 1s and 0s back and forth limits the speed of computers and bloats their energy usage.

The human brain can't do things like multiplication and division nearly as fast as a computer, but it works far more efficiently at other tasks. The brain's roughly 85 billion neurons transport signals across junctions called synapses, and some of those connections result in the storage of memories. This work is done in parallel, allowing the brain to perform complex tasks while consuming about 20 watts of power on average, just a fraction of what's used by energy-hogging chips in most computers.

Mimicking the neuron-synapse architecture, a team led by Dharmendra Modha at the IBM Almaden Research Center in San Jose, Calif., introduced brain-inspired circuits called neurosynaptic cores in 2011. Instead of containing centralized blocks of processing and memory, each silicon core carried a network of decentralized components to transport, process and store data, much the way a bundle of neurons does.

Now the researchers have shrunk those cores and merged 4,096 of them into a chip called TrueNorth, which is the size of a keyboard key and contains the equivalent of 1 million neurons. Each neuron can communicate with 256 others, creating 256 million synapses. The neurons relay electrical signals across synapses in parallel.

Still, IBM's chip doesn't rival the brains even of organisms with far fewer

finesse the planet into a path that more closely aligns with the two stars. The planet's orbit will also stretch. If the orbit becomes highly stretched, the host star can drag the planet into a much smaller orbit, which could explain the origin of Jupiter-mass planets with tiny orbits.

The observations demonstrate that the binary-nudging mechanism can work, "but this can't be the whole story," Jensen says. There are many planets with eccentric, inclined orbits and many may have unseen binary companions — but probably not all of them. Interactions between planets might also scatter orbits.

Previously, researchers could get only limited information about disk orientation, which prevented them from testing ideas about the formation of both planets and binary stars, notes astronomer Andrew Skemer of the University of Arizona in Tucson. Obtaining the orientation of both disks is "completely new," he says. It was possible because ALMA is a sensitive telescope that can probe long wavelengths of light in which the disks appear much brighter. ■

than 1 million neurons. Real neurons can connect to thousands upon thousands of others and can adjust those connections; each of TrueNorth's neurons is locked in to a predetermined set of 256 others. "We have not built a brain, but we have come closest to approaching its structure in silicon," Modha says.

Yet reverse engineering even an oversimplified brain has the potential to improve computing, he says. His team used TrueNorth to scan the pixels of a video in parallel to identify people and vehicles. While it's hard to directly compare TrueNorth with a conventional chip, the latter would have to sequentially run tests on each pixel and would consume a thousand or more times the energy each second to complete the task.

Future iterations of brain-inspired chips could enable driverless cars to identify obstacles on the road, Furber says, or allow computers to find patterns in huge amounts of data. ■

EARTH & ENVIRONMENT

Dead zone shrank as winds declined

Warming may not enlarge North Pacific low-oxygen region

BY THOMAS SUMNER

Waning winds could give the world's largest oxygen-starved ocean region a breath of fresh air as the planet warms, researchers report in the Aug. 8 *Science*.

Curtis Deutsch of the University of Washington in Seattle and colleagues show that the North Pacific dead zone shrank during much of the 20th century despite rising temperatures. "Our results totally go against the paradigm that a warming climate causes low-oxygen regions to expand," Deutsch says.

Dead zones naturally form at depths of about 200 to 1,000 meters, where sinking organic matter from the surface nourishes oxygen-gobbling bacteria. Warm water holds less dissolved oxygen than cold water, so researchers thought that dead zones would grow as the climate warmed.

The North Pacific dead zone stretches westward from North and Central America, encompassing an area larger than Canada. Most marine life cannot survive there and either vacates or suffocates.

The zone is driven by the Pacific trade winds, which draw up nutrients from the deep sea that fertilize plankton near the surface. As the plankton die, dead organic matter descends, feeding bacteria that consume what little oxygen remains in the water. The microbes deposit large amounts of a heavy form of nitrogen onto the seafloor.

To reconstruct the zone's past, Deutsch's colleagues collected sediment cores at three sites under the North Pacific dead zone. Each millimeter-thick layer of accrued sediment corresponds roughly to a year in time. By precisely measuring the amount of heavy nitrogen in each layer, the researchers tracked oxygen increases and thereby inferred decreases in the zone's size over the last 150 years.

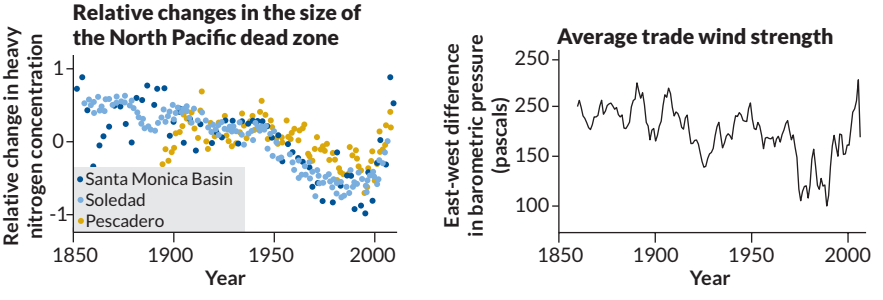
The shrinking coincided with rising temperatures and weakening Pacific trade winds. The finding shows that wind, not temperature, is the biggest driver of the dead zone, Deutsch says. As the wind wanes, fewer nutrients are drawn up, slowing the cycle of oxygen depletion, he proposes.

Over the last two decades, the Pacific trade winds have intensified, causing the dead zone to rebound. But, Deutsch says, many climate simulations predict that in the long run, the trade winds will weaken again in response to rising temperatures.

Changing winds may also shrink other low-oxygen regions caused by upwelling, but Deutsch warns that the dangers of ocean oxygen loss elsewhere remain.

Still, Eric Galbraith of McGill University in Montreal says the results come as a relief. "There has been a huge amount of concern that these oxygen minimum zones were growing extremely rapidly," he says. "This research puts some water on that fire by suggesting that this expansion will turn around once the trade winds calm down." ■

In decline A shrinking North Pacific dead zone, as measured by drops in nitrogen deposited by oxygen-eating bacteria at three sites (left), coincides with weaker winds (right). Stronger winds caused the dead zone to rebound recently, but models predict the winds will wane in the future.



C. DEUTSCH ET AL/SCIENCE 2014

MATTER & ENERGY

Quantum Cheshire Cat detected

Experiment appears to split neutrons from their properties

BY ANDREW GRANT

Quantum mechanics has reached *Alice in Wonderland* levels of weirdness.

An experiment tracking subatomic particles maneuvering past a fork in the road seems to reveal that the particles went one way while one of their intrinsic properties, their spin, went in the other. Although the result conflicts with intuition, it agrees with a decade-old prediction. The phenomenon is called the quantum Cheshire Cat, after the *Alice* feline whose mischievous grin inexplicably remains after its body has disappeared.

"You can separate basically any property of a particle from the particle itself," says Jeff Tollaksen, a quantum physicist at Chapman University in Orange, Calif., and coauthor of the new study, which appears July 29 in *Nature Communications*.

> "You can separate basically any property of a particle from the particle itself."
>
> JEFF TOLLAKSEN

While the result defies explanation for now, he says, it could lead to better understanding of the quantum world as well as improvements in measuring particles' most subtle properties.

Any physicist trying to decode quantum mechanics has to deal with superposition. It's a phenomenon in which a neutron or other particle takes multiple paths simultaneously, with a probability of existing along each path at a given time. Physicists can use instruments to locate a neutron, but the act of measuring it destroys the superposition — the neutron is now definitely in one path and there is no way to know where it would have gone if left undisturbed.

In 1988, Yakir Aharonov, a physicist now at Chapman and Tel Aviv University in Israel, and colleagues put forward a way to peek behind the superposition curtain. They proposed firing particles toward a detector but placing another instrument along the particles' path. That instrument would make what's called a weak measurement — a rough estimate of properties that barely disturbs a particle.

Such a weak measurement could be made by an instrument that exposed the particles to subtle effects, such as a weak magnetic field. An individual weak measurement of a single particle is useless because it is imprecise. But by repeating the measurement on thousands or millions of particles, physicists would learn something about how the particles on average behaved en route.

That's the technique that Yuji Hasegawa, a quantum physicist at Vienna University of Technology, and his colleagues used to search for the quantum Cheshire Cat, the decoupling of a particle and its properties hypothesized by Aharonov and Tollaksen in 2001.

The researchers steered a beam of neutrons emitted by a nuclear reactor at the Institut Laue-Langevin in Grenoble, France, into a crystal, which divided the beam in two. The team manipulated the beams so that all the neutrons in the upper beam had a particular spin (for instance, $+1/2$) and all the neutrons in the lower beam had the opposite spin ($-1/2$). The beams eventually recombined, and a detector at the end of the crystal counted only neutrons with $+1/2$ spin. Intuition suggests that the detected neutrons should all have traveled via the upper beam, and that tinkering with the lower beam would have no effect on the detector's measurement.

To determine whether intuition is wrong, the researchers performed two different weak measurements before the particles reached the detector. First the researchers placed a neutron-absorbing metal plate into the paths of each beam, one at a time. As expected, when the plate was in the lower path, it had no effect on particle count at the detector. The plate reduced the neutron count when placed in the upper path.

Then the researchers exposed each of the beams to a magnetic field just powerful enough to alter the particles' spins. One would expect that, as with the plate, the field would mess up the detector's reading only when cast upon the upper beam, where all the detected neutrons (and presumably their spins) were traveling. Yet the opposite happened: The field had an impact only when exposed to the lower beam, suggesting that neutrons — or at least their spins — were using that thoroughfare.

The researchers concluded that the detected neutrons passed through only the upper path, but their spins traversed only the lower path. In *Alice* terms, the cat took the upper path and its grin took the lower.

"It's a very beautiful demonstration," says Aephraim Steinberg, a quantum physicist at the University of Toronto who was not involved in the research. However, he notes that the study does not prove that any single neutron took a different path than its spin; it shows only that the measured neutrons behaved this way on average. Steinberg is optimistic that this experiment and others using weak measurements will provide insights into quantum behavior of particles — he just isn't sure what those insights are yet.

Regardless of when physicists make sense of the results, the Cheshire Cat technique could become a useful tool. The researchers suggest that scientists can home in on a hard-to-measure property of a particle by removing the influence of another property. For example, some scientists are probing gravity at microscopic scales, where it is dwarfed by other forces such as electromagnetism (*SN Online: 2/26/10*). The gravity measurement would become a lot easier, Steinberg suggests, if researchers could isolate particles from their electric charge. ■

GENES & CELLS

Grizzlies master healthy obesity

Tuned insulin signals may keep animals free of diabetes

BY MEGHAN ROSEN

Feasting in the fall helps grizzlies pack on pounds for winter. The animals manage to stay healthy while obese by adjusting insulin signals.

Grizzly bears have figured out how to be fat and fit. Though the animals beef up before hibernating, they may avoid diabetes by tweaking signals in fat cells, researchers report in the Aug. 5 *Cell Metabolism*.

Whether scientists will be able to manipulate the signals to develop drugs for humans is uncertain, says molecular biologist Sandy Martin of the University of Colorado Denver. "But it's certainly worth pursuing," she says. "There's a huge amount we can learn from bears. They actually manage obesity and use it to their advantage."

Grizzlies can double their body fat every fall. If humans did that, says study coauthor Heiko Jansen, they'd show signs of type 2 diabetes, such as high blood sugar and chronic insulin resistance. Grizzlies don't seem to suffer the same consequences. But no one had measured insulin sensitivity in the animals, says Jansen, a neuroendocrinologist at Washington State University in Pullman. By injecting insulin into captive bears, the researchers found that the animals' response to the hormone varied depending on the season. Normally, insulin tells cells to remove sugar from the blood and to start storing fat.

Even at their fattest in the fall, the animals managed to stay sensitive to insulin's call — a feat uncommon in obese humans with diabetes. But during hibernation, grizzlies ignored the message and became insulin resistant. In the spring, the bears' bodies bounced back and responded to insulin again.

The researchers wondered how the bears' bodies orchestrate this back-and-forth switch. So Jansen and colleagues looked at many of the molecules that direct insulin's message to cells. In fat cells, one protein, PTEN, stood out: Bears' bodies shut it down in the fall and the spring but not in the winter. The protein acts as a kind of roadblock, stopping insulin's message from getting to cells. By toggling the protein on and off, bears might control when insulin delivers its message, and when cells store and burn fat.

Still, the idea of "healthy obesity" might be best left to the bears, says Maren Laughlin, a program director at the National Institute of Diabetes and Digestive and Kidney Diseases in Bethesda, Md. "The thing to remember is these bears don't stay obese for very long." Bears' metabolic adaptations to a cycle of feasting and fasting might be what keeps the grizzlies healthy. ■

BODY & BRAIN

Hippocampus helps pigeon roaming

Birds without the brain structures take fewer detours

BY LAURA SANDERS

A brain structure enables exploratory jaunts during homing pigeons' prodigious flights to their lofts, a study suggests. The results, published July 16 in the *European Journal of Neuroscience*, bring scientists closer to understanding how animals find their way in the world.

Sights, smells and Earth's magnetic field may help a pigeon navigate. Along with other brain areas important for homing, the hippocampus acts as a navigator, pointing out landmarks near home.

But the brain structure has another job earlier in the flight, animal behavior scientist Anna Gagliardo of the University of Pisa in Italy and her team found. The researchers loaded homing pigeons with GPS data loggers and released the birds from an unfamiliar place 19 to 30 kilometers away from home. The birds often made detours early in their journey, perhaps to familiarize themselves with the new area. As they approached home, the birds flew straighter.

Then the researchers surgically removed the pigeons' hippocampi and released the birds in another new area. As expected, 18 pigeons without a hippocampus had trouble finding their loft when they got within about six kilometers. But their behavior early in flight was a surprise: The homing pigeons without hippocampi flew toward home as if on autopilot, Gagliardo says. The detours that normal birds take when flying over a new area were rare.

It's possible that birds without hippocampi perceive their environment but have trouble recognizing that places are new and responding appropriately, says neuroscientist Loren Frank of the University of California, San Francisco. Work from Frank's lab and from studies in humans has suggested that nerve cells in the hippocampus respond strongly to new things, he says. ■

ANDREANITA/SHUTTERSTOCK

LIFE & EVOLUTION

Nematode sperm may go rogue

When worms crossbreed, male sex cells can kill partners

BY SUSAN MILIUS

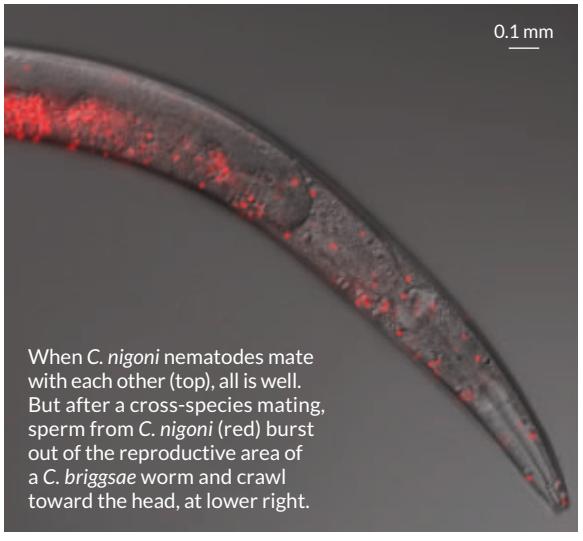
When nematodes have sex with the wrong species, sperm can turn into rampaging killers.

In the worst mixed-up couplings between tiny, eyeless worms of the genus *Caenorhabditis*, the sperm of males from more sexually competitive species can be so aggressive that they reduce the fertility of, or even kill, the receiving partner. The marauding sperm push beyond normal receptacles for sperm and storm into ovaries and the rest of the partner's reproductive tract, says Eric Haag of the University of Maryland in College Park.

That premature contact with sperm can ruin eggs that have not developed enough for fertilization. Then aggressive sperm can "bust out of the ovary and start crawling around the body cavity," Haag says. He's even found sperm barging around in a partner's head.

While gruesome, such mating mayhem gives clues to which worm species have long-standing conflicts between the sexes that would be hard to detect otherwise, Haag and colleagues report July 29 in *PLOS Biology*. The cross-species mating result "is a kind of gross, weird thing," Haag says, but it sheds light on same-species mating too. "What it's telling us is that within a species the world is much rougher than it looks."

The perils involved in mixed mating "surprised a lot of us when we first saw the preliminary data," says Diane Shakes of the College of William & Mary in Williamsburg, Va. She learned of the sperm violence last year at an international meeting of specialists studying *C. elegans*. The worm is a familiar workhorse in labs worldwide, but the way it gets trashed by the sperm of other species with livelier sex lives was startling.



When *C. nigoni* nematodes mate with each other (top), all is well. But after a cross-species mating, sperm from *C. nigoni* (red) burst out of the reproductive area of a *C. briggsae* worm and crawl toward the head, at lower right.

The contrasts between the nematode species' mating habits lie at the heart of the experiment. In *C. elegans* and two related species, male worms turn up now and then, but most individuals are self-fertilizing hermaphrodites. Nematode gonads don't differ hugely between males and females, so it's not a big deal for individuals to start out life producing and storing sperm and later to switch to making eggs for the stored sperm to fertilize.

These minimalist hermaphrodites don't have the right anatomy to deliver sperm to another worm but they can receive sperm from the occasional males of their species. Using their own stored sperm, "they go generations without mating at all," Haag says. Over evolutionary time the sperm of these species have become weak competitors.

In contrast, species of *Caenorhabditis* with full-time males and females often mate with multiple partners. In such a promiscuous arena, evolution favors barnstorming aggression that lets sperm reach an egg first. For females of these species, "their body is the battleground upon which these males are fighting," Haag says. Evolution also favors females that "make sure these pushy, aggressive sperm that are good at fertilizing eggs don't get too pushy and harm them," he adds. As long the sexes' countermeasures balance, this escalating conflict between the sexes causes little visible harm and can be difficult to detect.

Signs of the hidden evolutionary arms races reveal themselves when worm species mix. The ferocious aggression showed up when researchers paired males from various competitive species with partners from any of three self-fertilizing hermaphrodite species, including *C. elegans*. The competitive species' alien sperm not only goes on rampages but can actually push aside the smaller sperm from males of the mostly hermaphroditic species. (Nematode sperm can't swim but are powerful, amoeba-like crawlers.)

In one set of doomed pairings, a population of mild-mannered *C. briggsae* hermaphrodites started dying after only one encounter with males of *C. nigoni*. These pairings also yielded only about 25 young on average instead of the 225 or more from hermaphrodites left to fertilize themselves.

These nematodes, so useful for other research, may become revealing organisms for studying how battles of the sexes play out over evolutionary time, says molecular biologist Ronald Ellis of Rowan University School of Osteopathic Medicine in Stratford, N.J. Other animals routinely injure their partners during sex. These nematodes, Ellis points out, inflict harm after mating; partners have already gone their separate ways when the sperm left behind break bad. ■

FROM TOP: COURTESY OF JANICE TING; GAVIN WOODRUFF

ATOM & COSMOS

Geysers on Saturn moon draw up water from subsurface ocean

The seas of Saturn's moon Enceladus are blasting into space. Saltwater-spewing geysers on Enceladus' icy surface appear to connect to the moon's warm subsurface ocean, scientists report July 28 in the *Astronomical Journal*. The presence of a deep underground ocean (*SN: 5/3/14, p. 11*) and ice erupting from the moon's south pole (*SN: 8/27/05, p. 141*) have made Enceladus a tantalizing spot for finding alien life. Researchers have wondered whether the geysers' spray originates in that ocean or at the icy surface, where friction along cracks could create warm spots that melt the ice. The new findings, based on over six years of data from NASA's Cassini spacecraft, reveal that warm spots around each geyser are too small to fuel the jets. Instead, the researchers suggest, Saturn's gravity opens fractures in the ice, causing water from the ocean to get drawn up into the vacuum of space. — *Christopher Crockett*

GENES & CELLS

Gene methylation can lead to cancer

Changing a gene's activity can cause cancer, even if the DNA itself hasn't mutated, a study shows. The work is some of the first direct evidence that epigenetic changes can cause cancer. Lanlan Shen of Baylor College of Medicine in Houston and colleagues studied whether cancer could result from changing a chemical tag called a methyl group to the DNA building block cytosine. Such a tag can shut down a nearby gene without changing the gene's information. The team genetically engineered mice to carry a bit of DNA that acts as a methylation magnet and placed it in front of the gene *p16*, which is involved in tumor suppression. As the mice carrying the methylation magnet aged, their *p16* genes carried more and more methyl groups, and the genes' activity plummeted. More than a quarter of middle aged and elderly mice that had the methylation attractor developed tumors, the team reports July 25 in the *Journal of Clinical Investigation*. None of the normal mice got cancer during the study. — *Tina Hesman Saey*

BODY & BRAIN

Study claiming narcolepsy is an autoimmune disease retracted

Scientists have retracted a December 2013 study suggesting that narcolepsy is caused by an immune attack on one's own tissues (*SN: 1/25/14, p. 12*). The study, led by Stanford researchers, found that people with narcolepsy had cadres of immune T cells that target neurons making the peptide orexin (also called hypocretin), a neurotransmitter crucial for staying awake. Earlier research had shown that people with narcolepsy lack such orexin-making neurons. But in subsequent experiments, the scientists could not replicate their main result: a stronger autoimmune reaction in T cells from people with narcolepsy than in those from people without it. The retraction appears in the July 30 *Science Translational Medicine*. — *Nathan Seppa*

MATH & TECHNOLOGY

Robotic fingers lend a helping hand

Robo-fingers could help humans get a grip. A new type of wearable robot pairs two tonglike digits with a wrist brace to give a person the dexterity of a seven-fingered hand. After slipping on the contraption, users can palm a basketball, single-handedly twist off a bottle cap or hold a tablet computer and type on it using the same hand, Faye Wu and Harry Asada of MIT reported July 15 at the Robotics: Science and Systems conference in Berkeley, Calif. Wu and Asada's robotic digits, thick tubes that jut from the wrist, use a simple computer program to coordinate movements with the wearer's finger motions. To teach the program where to direct the digits, Wu held different objects while wearing a prototype with glove-mounted fiber-optic sensors, and then she moved the robo-fingers into place. The sensors recorded the position of her real fingers so that the researchers could automatically match the robot's movements with hers. The gadget could one day help healthy or disabled users lift large or heavy objects, or hold extremely hot or cold items. — *Meghan Rosen*

ESER KARADAĞ/WIKIMEDIA COMMONS (CC BY 2.0)

HUMANS & SOCIETY

Goalkeepers deceive themselves

Soccer goalies routinely dive the wrong way because their minds presume trends that don't exist, scientists report in the Aug. 18 *Current Biology*. During penalty kick shoot-outs, each team has five chances to score from 12 yards away with only the goalie protecting the net. Professional penalty kicks travel up to 80 miles per hour, giving goalies less than half a second to react. Many goalies begin diving before the ball is hit, says Erman Misirlisoy of University College London. Misirlisoy and a colleague watched videos of 361 penalty kicks from the last 36 years of the World Cup and the European Cup. When multiple kickers in a row shot toward the same side, goalies often dove in the opposite direction on the next kick. The kickers' behavior, meanwhile, lacked any predictable pattern. People often link independent events, Misirlisoy says. "This can lead to the gambler's fallacy," a tendency to doubt a random trend in one direction will continue, even if the odds of each direction are 50-50. — *Nsikan Akpan*

SEEING PAST THE JELLYFISH STING

Jellies are home and more to a slew of creatures

By Susan Milius

Robots that hunt down and exterminate jellyfish: Good or bad idea? Discuss.

A 2013 video from robotics designers at the Korea Advanced Institute of Science and Technology shows three jelly-killer prototypes gliding as a metallic fleet over gently rippling water. An underwater video demonstrates the cunning plan. Pale jellyfish bells drift into view, and a blenderlike slicer whirs into action. Jellies explode in beige puffs as they are sucked into the spinning blades.

"This invention is fantastic," commented Veronica Bingham on the *IEEE Spectrum* news website. "Jellyfish are a plague," added commenter Soulshock.

People don't see that jellyfish are doing some good for the ocean, says marine biologist Thomas K. Doyle of National University of Ireland, Galway. He doesn't deny that they sting. But snakes and spiders bite, and they get more regard, acknowledged as useful in controlling pests. When talk turns to jellyfish, however, people just want them gone, he says.

The clear bell of a gelatinous hydrozoan is a floating home for a jelly-rider called a hyperiid amphipod (top).

ALEXANDER SEMENOV/CULTURA SCIENCE/GETTY IMAGES

The widespread negative attitude toward jellyfish drove Doyle and his colleagues to contribute a cautionary chapter to the 2014 book *Jellyfish Blooms*. They compiled 22 pages summarizing research on what jellyfish do for the neighborhood.

Though jellies are not easy to study, researchers have learned enough to say they are important to the fates of plenty of ocean

creatures. In spite of their stings, jellyfish are fuel for other animals, nourishing some charismatic species that people would never feed to a robot. They offer shelter, creating floating refuges for tinier sea animals. As predators, jellyfish help regulate food webs, hunting with surprising sophistication for flimsy beings with no centralized brain.

There's a peculiar contrast between our views of the much-maligned jellyfish and much-loved corals. They are cousins in the same phylum, Cnidaria, named for specialized stinging cells. An individual coral is just a brainless tube with stingers and one opening that doubles as mouth and anus. But corals get public love and conservation dollars when they come together as architects of reefs that host a rainbow of darting, drifting, lurking, dazzling life. Anyone old enough to leave nose-smudges against aquarium tanks can witness how corals matter in a community. The unfolding story of what good jellyfish do, however, is not getting through.

An experimental robot for hunting down and slicing up jellyfish can float in small jelly-terminator packs.

What's a jelly

The meaning of the word "jellyfish" can drift depending on the currents of the conversation.

"There's sometimes quite a lot of ..." — Cathy Lucas pauses to choose her words carefully — "discussion and disagreement about what exactly a jellyfish is." As one of the editors of the new *Jellyfish Blooms* volume, Lucas points out that the sea has many filmy, gelatinous organisms, some not closely related at all (see "Jelly genealogy," Page 19).

In the more traditional sense, Lucas says, the term "jellyfish" applies just to the watery species in the stinging cnidarians, and she sometimes narrows even further to a subgroup called scyphozoans. A fine example is the moon jelly (*Aurelia aurita*) which stars in much of Lucas' research at the University of Southampton in England. Bobbing in oceans like pale, wavering reflections of the moon, the broad, shallow bells of the adult moon jelly pulse gently along, with tentacles trailing and the circular, sometimes pinkish gonads hazily visible as four moonlets.

Just what jellyfish in the broadest sense do in their watery ecosystems has become a topic of urgent interest in recent decades. Biologists are debating whether jellyfish blooms, great sudden aggregations of sexually reproducing adults, are increasing, and whether gelatinous species are on their way to overrunning the oceans. More blooms could mean more beach closings, more clogged fishing nets or intake pipes (jellies have temporarily shut down at least one power plant) and, some argue, fewer fish. That long-running, ongoing discussion has prompted new insights into what jelly animals mean for the rest of sea life.

That's a huge question, and researchers are going to creative lengths to track and measure jellies' impact. They have learned that jellyfish may move so much that they help mix ocean water, spreading nutrients around. Jellies might be big players in transferring carbon from the upper ocean into deep storage way below, preventing it from wafting into the atmosphere as greenhouse gases. For example, the gelatinous salps, noncnidarians that look like plastic party garlands, do an efficient job of sending their carbon-rich fecal pellets down deep, fast: up to 2,700 meters a day versus the otherwise impressive krill deposit rate of 862 meters per day.

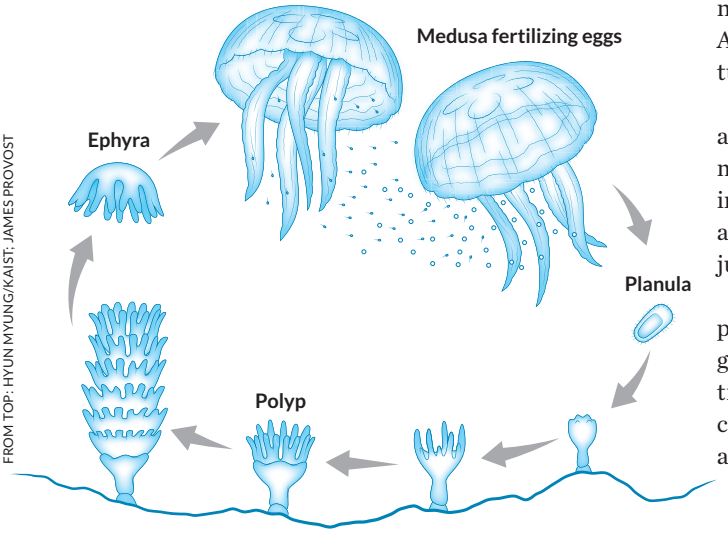
Roughly speaking, filmy jelly animals consist of more than 95 percent water, with very little carbon. Yet even that can be worth eating.

A tally of stomach studies indicates at least 69 species of fish eat jellies as more than a random snack. The best example of a jellyvore may be the most improbable: the leatherback sea turtle, the largest turtle on Earth. Leatherbacks breeding in the Caribbean average some 400 kilograms and swim several thousand kilometers from their tropical breeding waters to northern latitudes for summer feasts on abundant jellyfish. After several months of chewing on stinging, watery prey, turtles actually gain weight.

People often ask sea turtle biologist Mike James of Fisheries and Oceans Canada in Dartmouth, Nova Scotia, how any animal endures mouthful after mouthful of jellyfish. That's thinking like a human, he tells them. "We see turtles with tentacles all over them, on their heads, over their eyes." To turtles, it's just lunch.

The messy but traditional way of understanding diet involves poking into half-digested glop in stomachs. Jellies turn into glop just about at first gulp and slip speedily through a digestive tract, making them hard to identify and easy to undercount. So James has been working since 2006 with engineers and leatherback-savvy fishermen to customize cameras to

Variety show For many jellies, the floating bells are the adult, sexual forms of a varied life cycle. A young planula settles down as a sedentary polyp, which can sprout more polyps, sometimes for several years. Triggered by temperature shifts or other cues, it can also grow tiny discs that float off to make more of the bell-shaped medusae.



FROM TOP: HYUN MYUNG/KAIST; JAMES PROVOST

see how a diet of jellies sustains these colossal creatures. The team managed to sneak up on jelly-distracted turtles, lean off a boat platform and attach cameras with suction cups to the oily, leathery skin covering the shells of 19 turtles.

Hours of dinner-cam footage showed jelly after jelly bobbing in the distance, nearing and finally disappearing as turtle head motions indicated chewing. Watching video from more than 600 jelly grabs was actually "soothing," says collaborator Susan Heaslip of Dalhousie University in Halifax, Nova Scotia.

Turtles gain weight because they eat 73 percent of their massive weight in jellyfish a day, mostly lion's mane jellies (*Cyanea capillata*). That's an average of 261 daily jellies, about 330 kilograms, Heaslip, James and their colleagues reported in 2012.

The researchers went further, coaxing turtles to swallow capsules containing tiny temperature monitors. They revealed stomach temperatures rising at night after a daytime dip. That temperature boost from digesting a day's jellies helps the tropical turtles cope with chilly northern seas, James and his colleagues report in the July 1 *Journal of Experimental Biology*.

A leatherback sea turtle, swimming toward a colonial mass of gelatinous pyrosomes, can actually gain weight when it binges on flimsy jellies.

Floating world

Jellies can shelter as well as feed, but biologists needed to change their collecting strategies to appreciate just how much of a refuge they can be.

A mix of animals caught in the same net does little to reveal relationships, and jellies too easily slip through. With so little to go on, says Larry Madin of the Woods Hole Oceanographic Institution in Massachusetts, "it was easy to relegate the gelatinous things more to the category of curiosities than to really central components in the oceanic community."

Madin and his graduate adviser, William Hamner of the University of California, Los Angeles, started changing that view in the 1970s with glass jars and a frightening notion for ocean research at the time: blue-water diving.

After much persuasion of nervous captains on research vessels, Madin, Hamner and their colleagues took glass sample jars far from ship interference, tethered themselves to a small inflatable boat that would be swept along with them in the current and dove in the featureless water of the open ocean.

"Everything is just blue all around you," Madin says. Of the people who tried it, "some of them loved it and some of them found it very, very disorienting."

But what a difference it made to see the gelatinous animals alive and whole, and to bring back jars of unscathed samples. Among the many surprises: "Almost all the jellyfish and all the other gelatinous jelly animals were hosts to a collection of ... hitchhikers," Madin says.

Before this, biologists had speculated that certain crustaceans might specialize in clinging to jellyfish. But Madin and his colleagues found hangers-on everywhere: larval fish, a juvenile octopus, polychaete worms, sea anemone larvae. Jellies may not be teeming like a coral reef, but they are "floating habitats," he says.

Most members of a category of crustaceans called hyperiid amphipods are evolutionarily specialized for jellyfish riding. A genetic analysis in 2013 recognized 23 families, some with huge eyes — useful when living on jellies that float up to water levels where light penetrates. "Females live on a jelly host and use it as a nursery for the babies," Madin says.

Tropical jellyfish often take in tinier partners, strains of yellow-brown algae. As the algae photosynthesize, the carbohydrates and oxygen they produce give a nutritional boost to the jelly.

Some of the most entertaining of these species are upside-down jellyfish in the genus *Cassiopea*. Lucas' students surveyed them on a field trip to Bermuda this summer, in a mangrove-rimmed saltwater pond. Algae colonize the ruffled surfaces of the jellyfish's branched feeding structures called oral arms. The jellies flip on their backs, and the algae bask in sunlight and photosynthesize. The algae-tinged jellies look "like a creamy-brown version of a broccoli or a cauliflower," Lucas says.

Carb-loading is a nice perk from the algae, but most jellies are active hunters. Like any predator, they influence the balance of prey in a food web. Humans lament some of the jellies' prey, like larvae of herring or other commercial fish, but for the most part, jellies feed on copepods and other jellies.

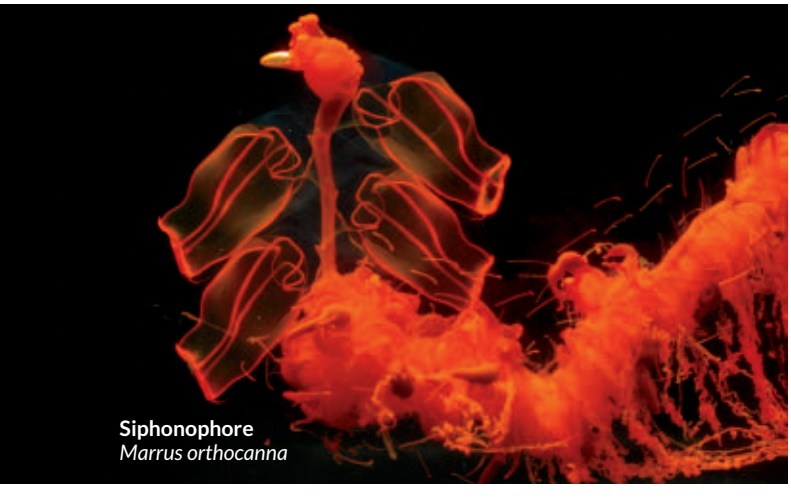
Gone hunting

To figure out how jellyfish, most of which have no eyes and not much muscle, can hunt takes some clever tinkering. To try to follow their motions when they forage, Doyle and his colleagues decided to tag them. Never mind that they are watery and slippery. Australian researchers Matthew Gordon and Jamie Seymour of James Cook University in Cairns had tagged some box jellies by taking them out of the water, partly drying them and affixing a tag with surgical glue. Instead, Doyle and his colleagues found they could fasten a cable tie collar with a tiny depth recorder around the closest thing a barrel jellyfish (*Rhizostoma octopus*) has to a neck. Called the peduncle, the tubelike structure descends underneath the bell and branches out into more elaborate tubes for feeding.

Data recovered from 25 barrel jellyfish showed they were doing more than mildly wafting at one depth. They rose and sank an average 619 meters per day; that's more than 60 times the depth of water where they were tagged, Doyle and his colleagues reported in February 2012 in *Proceedings of the Royal Society B*. Regardless of how intentional or accidental parts of their journeys were, the movements at times approximate a pattern good for searching out scarce prey. They don't see and

Siphonophore
Physophora hydrostatica, hula skirt siphonophore

Comb jelly
Beroe abyssicola



Siphonophore
Marrus orthocanna

Scyphozoan
Cyanea capillata, lion's mane jellyfish

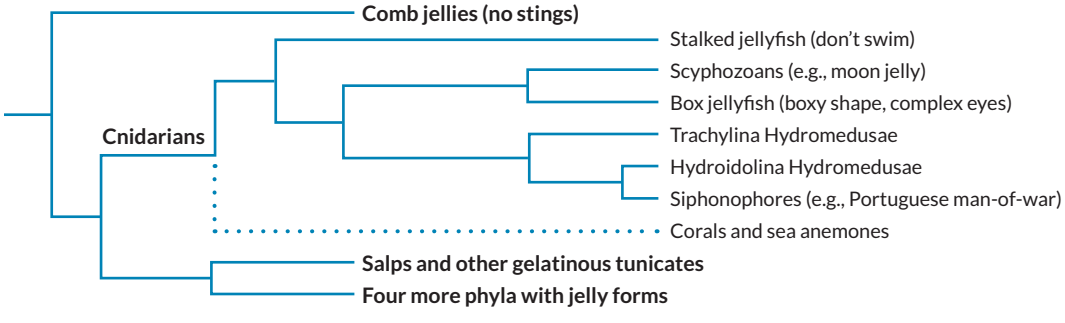
Scyphozoan
Atolla wyvillei

Salp chain
Pegea

Jelly relatives

Watery, filmy bodies make up substantial parts of at least seven phylum branches of the tree of animal life. "Jellyfish" often refers to the gelatinous cousins of corals in Cnidaria. They vary from scyphozoan tentacle-trailing bells to hitched-together garland colonies of siphonophores.

Jelly genealogy



Upside-down jelly As a *Cassiopea* jellyfish contracts its upside-down bell, water swirls in, carrying any tidbits to the jellyfish's frilly feeding structures, as shown in simplified sketches below. As the bell relaxes, water keeps flowing upward, prevented by frills from sloshing back down. The next contraction brings in a new swirl of water to glean for food. SOURCE: A. SANTHANAKRISHNAN *ET AL/J EXP BIOLOGY* 2012

chase after prey the way fish do, but with their up and down motion, Doyle points out, jellyfish cover territory and can compete with foraging fish for food in open water.

To see if such behavior is common in the jelly world, Doyle and his colleagues need to tag other species. They've already tried to monitor lion's mane jelly, which is quite a challenge. Its peduncle lies amid folds upon folds of fragile tissue above more than a thousand tentacles 3 to 4 meters long that make it the most venomous jelly in Irish waters. Hauling the jelly out of the water to try to glue on a tag is out of the question because air bubbles get trapped in its complex structures and ruin its buoyancy. Applying surgical glue underwater was a bust. "We actually got a needle and thread and tried to stitch a tag on," he says. "We just put holes in the jellyfish."

In the end, someone wearing as much protective gear as possible has to swim over to grope for the peduncle in hopes of attaching a cable tie collar without ripping the jelly or getting stung. "The only thing is, your lips protrude with the snorkel," Doyle says. "The solution: layers of Vaseline."

> "It's like watching a screen saver."
> JENNIE JANSSEN

What and how much food jellies catch while hunting depends on how and how much they move. For decades researchers assumed that jelly contractions sent them forward by jet propulsion. Not always so, it turns out.

Small bullet-shaped jellies do jet, says Sean Colin at Roger Williams University in Bristol, R.I. Their thin muscles have enough power to clench the bells and shoot quickly forward. This helps them flee danger but it's not a tool for hunting. "They're like spiders," Colin says. They hang motionless to hunt, with their tentacles out like the strands of a web, waiting for what food blunders in, such as small, zipping fish.

In contrast, big, flattish jellies with wide bell openings aren't great at jet propulsion (*SN: 2/23/08, p. 122*). They don't have the muscle. Instead they flex the margins of their bells inward and then relax, in a rowing motion. This propels them, though not particularly fast. But importantly, the motion swooshes water — along with any tiny floating edibles — toward their tentacles.

Even those bottom dwelling jellies known as *Cassiopea* pulse while sunning their live-in algae. That pulsing intrigues researchers studying fluid motions, because these jellies are contracting their bells but not swimming. They may be using their minimal movements as a couch-potato way of hunting.

Upside-down jellies often sunbathe on sand or other sediments with lots of tiny cracks and channels filled with a feast of tiny edibles for any organism that can extract it. Bell pulsing can suck goodies out of the sand, reported Carin Jantzen of the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, and colleagues in 2010. Her team buried red-dyed sediment under an undyed layer. An upside-down jelly was settled on top, pulsing away. When the researchers lifted the jellyfish, a red circle marked where it had been. The jelly's motions had drawn up the colored sediment.

The upside-down jellies may be such good pulsers that they serve as local ecosystem engineers, according to Arvind Santhanakrishnan of Oklahoma State University in Stillwater. Bells don't just draw up potential food treasures from directly underneath, according to recordings he made with colleagues. The researchers analyzed green dye plumes and clouds of brine shrimp eggs (a jelly-safe alternative to plastic beads) as they swirled and sloshed in the surrounding water while the jellies pulsed in place. The lip of a bell flaps during a contraction and creates a strong swirl that pulls water toward it from across the sandy bottom, the researchers reported in July 2012 in the *Journal of Experimental Biology*.

"We were expecting more of a back and forth," says coauthor Christina Hamlet, now at Tulane University in New Orleans. But the current goes forth and forth. As the bell relaxes, the complicated, frilly broccoli-arms prevent backwash, and the water pulled inward streams upward. In the fairly stagnant water where these jellyfish settle, the flow might provide a valuable bit of mixing, Santhanakrishnan speculates.

Ecosystem engineers or not, *Cassiopea* illustrate one thing jellies have going for them: They're gorgeous. Jellyfish displays in public aquariums mesmerize visitors. "It's like watching a screen saver," says Jennie Janssen, who cares for the jellies at the National Aquarium in Baltimore. Does she find visitors anxious for gelatinous eradication, wondering what in the world jellyfish are good for?

"No" she says. "I get that about mosquitoes." ■

Explore more

■ Kylie A. Pitt and Cathy H. Lucas (editors). *Jellyfish Blooms*. Springer, 2014.

ILLUSTRATIONS: JAMES PROVOST; IMAGE: STEPHEN M. SCHELB

See video of upside-down jellyfish pulsing at **bit.ly/SN_jellyfish**

NEW

No Contract

Finally, a cell phone that's… a phone

FREE Car Charger

Better Sound and Longer Battery Life

Introducing the all-new Jitterbug5®.

We've made it even better… without making it harder to use.

All my friends have new cell phones. They carry them around with them all day, like mini computers, with little tiny keyboards and hundreds of programs which are supposed to make their life easier. Trouble is… my friends can't use them. The keypads are too small, the displays are hard to see and the phones are so complicated that my friends end up borrowing my Jitterbug when they need to make a call. I don't mind… I just got a new phone too… **the new Jitterbug5. Now I have all the things I loved about my Jitterbug phone along with some great new features that make it even better!**

GreatCall® created the Jitterbug with one thing in mind – to offer people a cell phone that's easy to see and hear, simple to use and affordable. Now, they've made the cell phone experience even better with the Jitterbug5. It features a lightweight, comfortable design with a backlit keypad and big, legible numbers. There is even a dial tone so you know the phone is ready to use. You can also increase the volume with one touch and the speaker's been improved so you get great audio quality and can hear every word. The battery has been improved too—it's one of the longest-lasting on the market—so you won't have to charge it as often. The phone comes to you with your account already set up and is easy to activate.

The rate plans are simple too. Why pay for minutes you'll never use? There are a variety of affordable plans. Plus, you don't have to worry about finding yourself stuck with no minutes– that's the problem with prepaid phones.

	Basic 14	Basic 19
Monthly Minutes	50	was ~~100~~ NOW 200
Monthly Rate	$14.99	$19.99
Operator Assistance	24/7	24/7
911 Access	FREE	FREE
Long Distance Calls	No add'l charge	No add'l charge
Voice Dial	FREE	FREE
Nationwide Coverage	YES	YES
Friendly Return Policy[1]	30 days	30 days

More minute plans available. Ask your Jitterbug expert for details.

Since there is no contract to sign, you are not locked in for years at a time and won't be subject to early termination fees. The U.S.-based customer service is knowledgeable and helpful and the phone gets service virtually anywhere in the continental U.S. Above all, you'll get one-touch access to a friendly, and helpful GreatCall operator. They can look up numbers, and even dial them for you! They are always there to help you when you need them.

Call now and get a FREE Car Charger – a $24.99 value. Try the Jitterbug5 for yourself for 30 days and if you don't love it, just return it for a refund[1] of the product purchase price. Call now– helpful Jitterbug experts are ready to answer your questions.

Available in Blue, Red (shown) and White.

Order now and receive a **FREE Car Charger** for your Jitterbug – a $24.99 value. Call now!

jitterbug5

firstSTREET for Boomers and Beyond®
1998 Ruffin Mill Road
Colonial Heights, VA 23834

100% U.S. Based Customer Service

NEW Jitterbug5 Cell Phone

Call toll free today to get your own Jitterbug5.

Please mention promotional code 48335.

1-888-790-6378

www.jitterbugdirect.com

We proudly accept the following credit cards.

47622

IMPORTANT CONSUMER INFORMATION: Jitterbug is owned by GreatCall, Inc. Your invoices will come from GreatCall. All rate plans and services require the purchase of a Jitterbug phone and a one-time set up fee of $35. Coverage and service is not available everywhere. Other charges and restrictions may apply. Screen images simulated. There are no additional fees to call Jitterbug's 24-hour U.S. Based Customer Service. However, for calls to an Operator in which a service is completed, minutes will be deducted from your monthly balance equal to the length of the call and any call connected by the Operator, plus an additional 5 minutes. Monthly minutes carry over and are available for 60 days. If you exceed the minute balance on your account, you will be billed at 35¢ for each minute used over the balance. Monthly rate plans do not include government taxes or assessment surcharges. Prices and fees subject to change. [1]We will refund the full price of the GreatCall phone and the activation fee (or set-up fee) if it is returned within 30 days of purchase in like-new condition. We will also refund your first monthly service charge if you have less than 30 minutes of usage. If you have more than 30 minutes of usage, a per minute charge of 35 cents will be deducted from your refund for each minute over 30 minutes. You will be charged a $10 restocking fee. The shipping charges are not refundable. Jitterbug and GreatCall are registered trademarks of GreatCall, Inc. Samsung is a registered trademark of Samsung Electronics Co., Ltd.

Carbon Quagmire

Technology to capture CO_2 from power plants approaches its long-delayed debut. But hurdles and doubts linger

By Beth Mole

Like every other project, Jänschwalde failed.

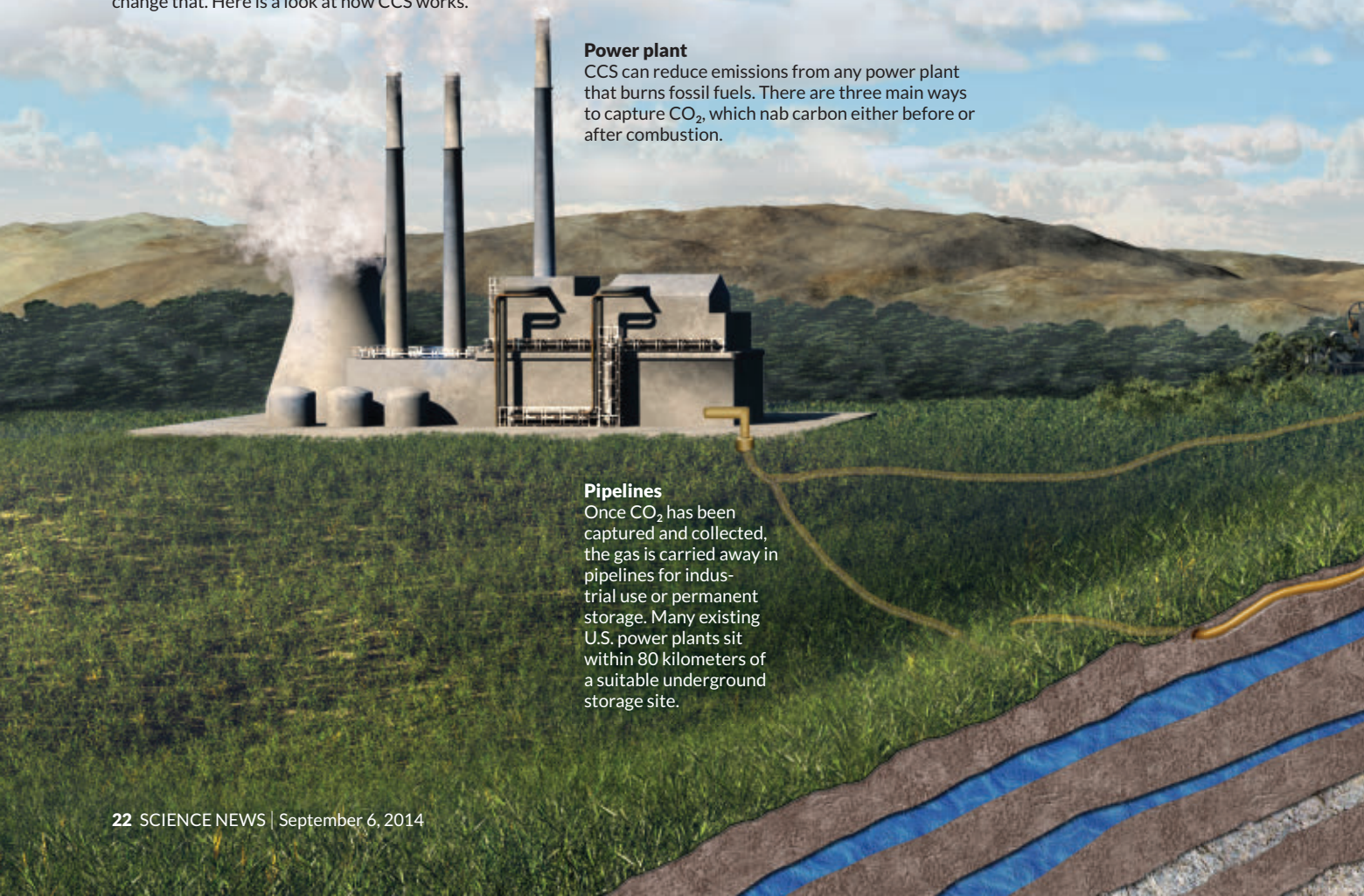
In 2008, it was set to become the world's largest demonstration of just how cleanly coal could be burned to generate electricity. The revamping of an aging power plant in Germany, Jänschwalde was to become a paragon of a technology that can slash up to 90 percent of the carbon dioxide emitted by fossil fuel–burning power plants — the single largest global source of greenhouse gas emissions. The technology, called carbon capture and storage, or CCS, collects planet-warming carbon pollution produced by power plants and permanently removes it from circulation. As the world steadily increases its use of fossil fuels, and greenhouse gas emissions continue to soar, CCS holds massive potential to help avert the dire climate scenarios predicted for the next century.

Yet, like more than a dozen similar projects, Jänschwalde was abandoned. CCS, with all its potential, returned to a state of limbo. For years now — starting well before Jänschwalde folded — scant funding and hostile politics have held CCS back. Despite successful trials and pilot projects, the promising technology still has no large-scale demonstration, no foothold in mainstream power production.

"This is a bit of a sad story," says Wolfgang Rolland of Vattenfall, the Swedish state-run power company that ran the Jänschwalde project. "We've lost four or five years," says

NICOLLE RAGER FULLER

Pocketing pollution Carbon capture and storage can cut up to 90 percent of carbon dioxide emissions from power plants. With more than a dozen false starts, the technology has yet to be demonstrated on a commercial scale. Two projects nearing completion could soon change that. Here is a look at how CCS works.



Rolland, head of business communication for Vattenfall's mining and generation unit. "On the other hand, none of the problems we have are solved. We still have climate, we still have the world increasing the use of coal."

This year, the story of CCS could change. In North America, two commercial-scale power plants are on the cusp of firing up CCS technology for the first time. Both are entering the final stages of construction. The projects, one in Mississippi and the other in Canada, already have made it further than any other carbon capture demonstration project to date. If the two projects come online, they could clear a path for other CCS-equipped plants around the world, lower emissions and help to combat climate change. If the new plants go the way of Jänschwalde, it would mean more years in limbo for the technology.

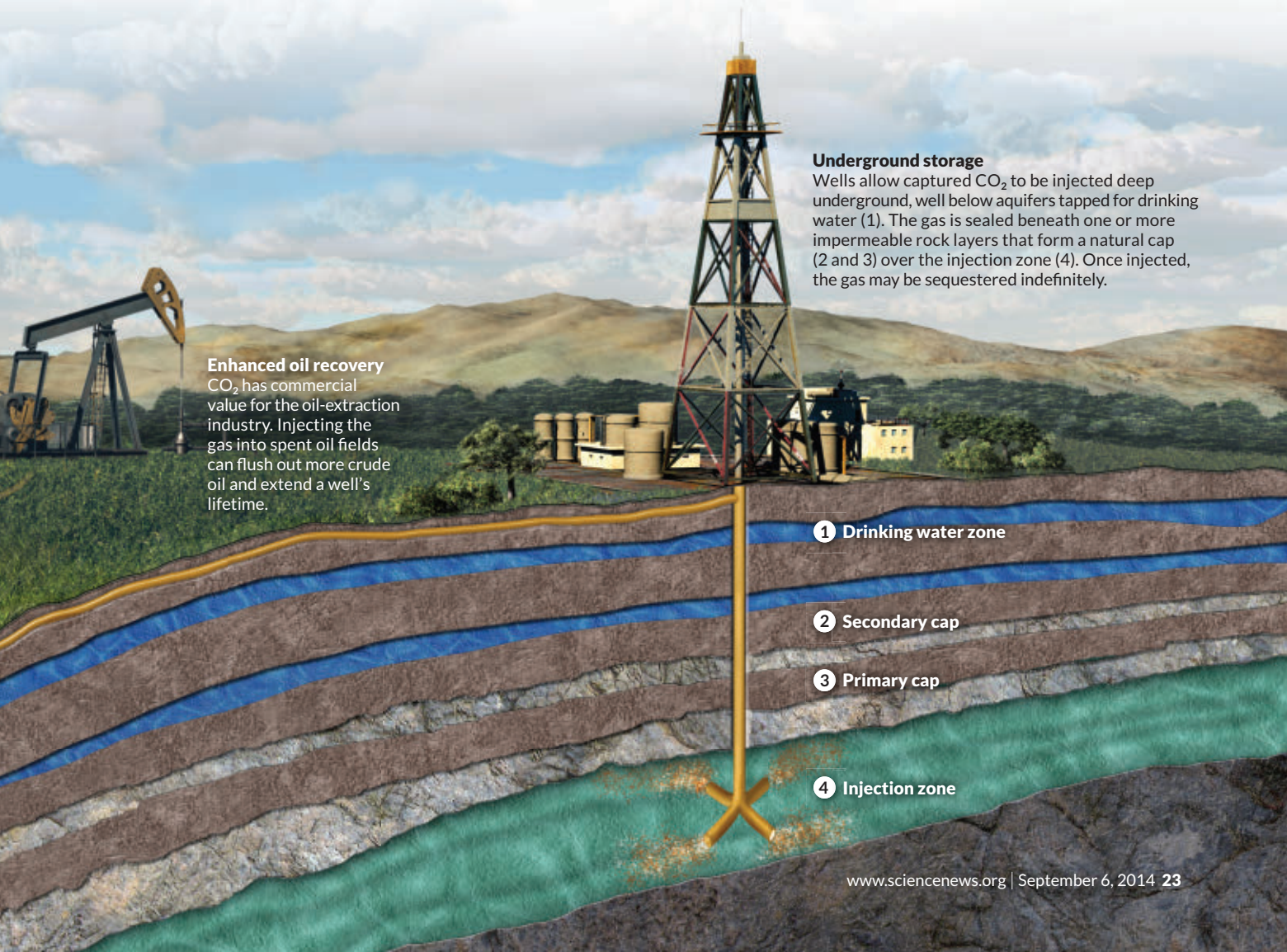
Worries about these projects are percolating within the CCS community. The specific technologies that each plant has chosen may be hard to replicate elsewhere. And both projects have faced financial struggles and delays, perhaps setting a troubling precedent for future plants.

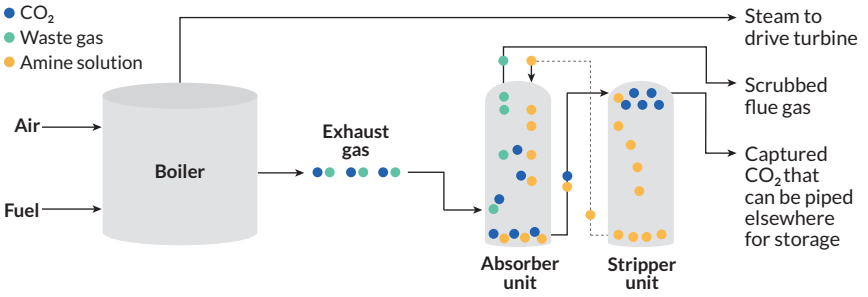
The field is wary, says Howard Herzog, a senior research engineer at MIT and an expert on CCS technology. "People are more in a wait-and-see attitude," Herzog says. "In 2008, there was a lot of optimism. Now, there are not a lot of new projects coming into the pipeline."

Shaky starts

Despite uncertainty over its implementation, the technology behind CCS works. In some cases, it has worked for decades. Even without a commercial rollout, CCS scientists and engineers have crept toward cheaper, more efficient methods. Bits and pieces of the technology have cropped up in environmental monitoring systems and in the food processing and beverage industries, which can use CO_2 collected from power plants. More than a dozen small trials worldwide have proven that CCS can cut emissions from power plants and safely store the captured gas in rock formations deep underground.

So far, scientists have developed three ways to capture carbon from power plants and other emission sources: oxyfuel combustion, precombustion and postcombustion. The oxyfuel method burns fuel not in air but in pure oxygen, resulting in exhaust that is mostly CO_2 and water vapor, which are easy to separate. In precombustion, fuel is converted to a gassy mixture of CO_2 and hydrogen. The two gases are then





Basic scrub Canada's Boundary Dam project will rely on amines to scrub CO_2 from the power plant's flue gases. The acid-base reaction uses an alkaline liquid to grab acidic CO_2. But boiling off the gas for later capture can be energy-intensive. SOURCE: J.D. FIGUEROA *ET AL/INT. J. GREENH. GAS CONTROL* 2008

separated, and the CO_2 is collected while the hydrogen moves to a turbine. In postcombustion, the most established capture method, the exhaust created by burning fuel moves through large silos that chemically scrub it of CO_2. After capture, the CO_2 is piped down to storage.

"The individual technological pieces that fit together for CCS are all established," says CCS expert Casie Davidson of the Pacific Northwest National Laboratory in Richland, Wash. The only missing step, she says, "is to demonstrate how the technologies work together as a whole."

Jänschwalde was meant to be that demonstration. The 1.5 billion euro (around $2 billion) project would have spruced up an old, air-polluting coal plant in Germany with both oxyfuel and postcombustion technologies, giving its operators the ability to lock away about 1.7 million metric tons of CO_2 each year. But in 2011, amid public fears and drawn-out policy battles, Vattenfall ditched Jänschwalde before the project ever broke ground. This May, Vattenfall announced its defeat, abandoning all efforts on CCS.

Vattenfall found the technology trapped in a catch-22: Without a demonstration of CCS on the scale of Jänschwalde, critics say the technology isn't ready for prime time or worthy of government incentives and public backing. And without that backing, building a large demonstration is difficult, given the financial and regulatory obstacles. The dilemma played out in the United States last September, when the Environmental Protection Agency proposed that new fossil fuel plants come equipped with CCS technology. Power companies balked, claiming that requiring the expensive, "unproven" technology would drive coal plants out of business. In June, the EPA released regulations to cut carbon pollution from existing power plants but made no requirements for CCS.

Rolling out new technology isn't easy, says Ken Humphreys, chief executive officer of FutureGen Industrial Alliance, which is planning one of the few full-scale CCS projects still in the pipeline. "It's not particularly surprising that around the world, for every 10 projects you see announced, only one or a couple go to construction," he says. FutureGen, based in Jacksonville, Ill., is planning to retrofit a coal plant in Illinois with oxyfuel combustion and have it running by 2017.

The potential for CCS to help fight climate change makes the struggle worthwhile, says Humphreys. The scientific community agrees. In a report released in April, the United Nations Intergovernmental Panel on Climate Change included CCS in a small set of clean-energy solutions that it says are needed to avoid a 2-degree-Celsius rise in global temperatures above preindustrial levels. Without tripling or quadrupling the use of these greener energies globally, climate change will continue to imperil communities worldwide, the IPCC concluded. The risks include flooding, extreme weather, threats to farm yields and fishery production and the spread of disease-carrying organisms.

Meanwhile, greenhouse gas emissions continue to increase. Global CO_2 emissions linked to fossil fuel combustion reached roughly 31 gigatons in 2011. Of that, 42 percent, or about 13 gigatons, came from the generation of electricity and heat, according to the International Energy Agency, an intergovernmental organization. Since 1990, CO_2 emissions from this sector have nearly doubled. While CCS potentially could cut carbon emissions from burning any fossil fuel, coal is an obvious first target. Releasing more CO_2 during burning than any other fossil fuel, coal is the world's leading source of energy-related CO_2 emissions, accounting for about 44 percent. Its share of total energy sector emissions is expected to grow over the next two decades.

"The IPCC report is saying there's going to be dire consequences," says Herzog. Yet "the result is business as usual."

Carpe carbon

According to Vattenfall's Rolland, the best hope for anything other than business as usual is wrapped up in the fate of the two North American CCS projects: Mississippi's Kemper County energy facility and the Boundary Dam power station in Estevan, Canada.

Even so, North American scientists don't feel like frontrunners. "If anything, we've gone downhill from 2009," says chemical engineer Gary Rochelle of the University of Texas at Austin. Rochelle specializes in postcombustion capture, the technology slated for the Boundary Dam plant. Given the long string of failed CCS projects, Rochelle worries that the science behind CCS has stalled, and others worry that the field has lost engineering talent. The basic method for postcombustion capture was patented in the 1930s.

The Boundary Dam technology boils down to a simple acid-base reaction, using a method called amine scrubbing. In some modern versions, the gas produced in burning coal — usually a mix of oxygen, water vapor, nitrogen, CO_2, and other trace pollutants such as sulfur dioxide — is blasted through a 15-meter-tall, 30-meter-wide cylinder packed with layers of eggcrate-shaped material. The gas blows in at the bottom, while an amine solution — an alkaline liquid — pours down from the top. The solution trickles over the large surface area created by

E. OTWELL

the grooves and ridges in the material packing the cylinder. As the amine drips down, it grabs the acidic CO_2 moving up. The exhaust, now scrubbed of any CO_2, vents out the top. Meanwhile, the CO_2-bearing solution pools at the cylinder's bottom before being sucked into another giant tower. There, the mixture is boiled, releasing a stream of pure CO_2 for capture.

Over the last 80 years, researchers have made incremental improvements — picking the best amine and tweaking designs to use less energy. Even so, the process can require about a quarter of a plant's power output, particularly to boil off the CO_2 in the stripping step. "We continue to make advances," Rochelle says, "5 percent here, 5 percent there — evolutionary improvements." Without a full-scale demonstration to tweak and perfect, these gains are academic.

Though Rochelle isn't involved in the Boundary Dam project, he's watching it closely. In addition to perhaps becoming one of the first large-scale demonstrations of CCS, the project could provide a model of how to equip existing power plants with postcombustion scrubbing. The $1.35 billion project, run by the Saskatchewan-based electric utility SaskPower, involves retrofitting part of an old coal-fueled plant with the technology. The company says the plant will capture about 90 percent of its CO_2 emissions, or 1 million metric tons of CO_2 each year, about the same annual reduction as taking 250,000 cars off the road.

2
gigatons
CO_2 emitted from U.S. electricity generation in 2012

90
percent
Fraction of a power plant's emissions that can be cut by CCS

The project has hit snags. It was initially expected to open this past April. Last October, SaskPower announced a delay and added $115 million to the project's budget. The aging plant needed unforeseen upgrades, including steel reinforcements and lead paint removal. Work also slowed that month as the power company paused to remove 800 federally protected frogs from the area around the construction site. With more than 90 percent of the construction complete, SaskPower now plans to open the plant later this year.

The setbacks seem trifling when compared with those faced by Mississippi's Kemper project, run by Southern Company. The $5.5 billion project was originally slated to open in early 2014. Its opening has been bumped to the first half of 2015, and its budget overruns are more than $1.5 billion. Delays and cost overruns aren't the only problems facing the project.

Incendiary capture

The Kemper project will use precombustion capture that requires first turning unburned coal into a gas. The coal is pulverized, mixed with oxygen and steam and then heated in an apparatus called a gasifier. The process transforms the coal into a gaseous mixture containing hydrogen and CO_2. To collect the carbon, the gases move into a pressurized silo where the CO_2 meets a liquid solvent. Instead of a chemical reaction, as in amine scrubbing, the solvent physically absorbs the CO_2 under high pressure, sort of like carbonating a beverage. And just as an uncapped bottle of soda eventually becomes flat, the CO_2 can be released by dropping the pressure, which happens in an adjoining silo. That's where the CO_2 is collected.

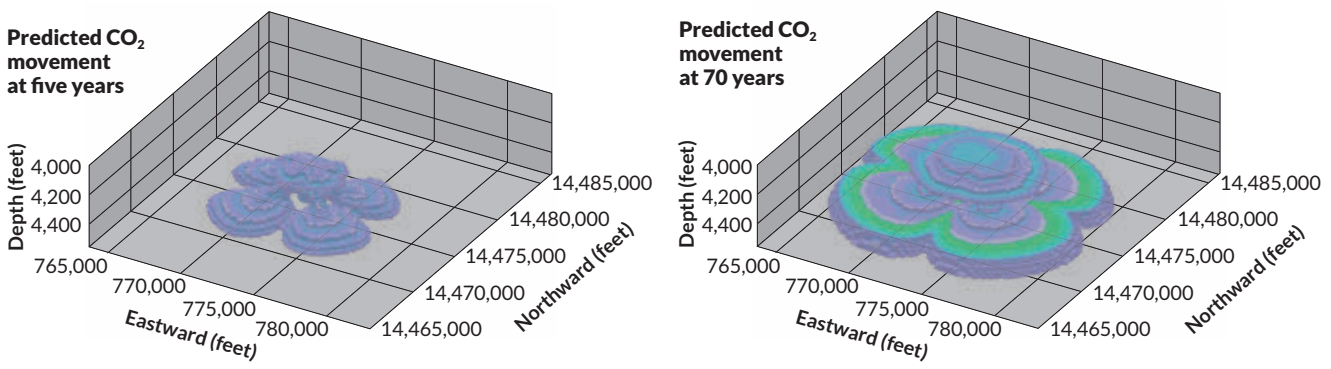
At Kemper, the precombustion method is expected to capture about 65 percent of the plant's CO_2 emissions. "The environmental footprint is about the same as a natural gas plant," says engineer Randall Rush, who manages the gasification technology group at Southern Company.

Although Kemper will be a lot cleaner than other coal-fired plants, Southern Company's main goal isn't to showcase CCS. Instead, it's to demonstrate a newfangled, proprietary gasifier. In fact, the federal support Kemper has received, in the form of a $270 million grant from the Department of Energy, wasn't part of the more than $3 billion the department has spent to support CCS; it came from a $2 billion federal fund to demonstrate coal technology that reduces nitrogen, mercury and sulfur pollution. Kemper's gasifier makes efficient use of lignite, a low-quality coal. The moist, young coal packs less energy and is dirtier to burn relative to higher-quality coal. It's also plentiful: Kemper sits near a minable reserve of more than 3.5 billion metric tons of lignite.

Although Kemper is close to its debut, the project doesn't thrill CCS experts. "Kemper is a very bad example," says chemical engineer Stanley Santos, who works with the greenhouse gas research and development group of the International Energy Agency. Kemper's massive budget overrun, delays and a plan to capture less carbon than other proposed projects make it a poor example of how to go about CCS, he says. And Southern Company seems to agree with Santos. In a February public hearing on the EPA's proposed rules to reduce carbon pollution from existing power plants, the energy company's environmental director testified that Kemper should not be used as a model for CCS because the technology may not be suitable for all coal-fired plants.

Mississippi's Kemper County CCS facility should open in 2015. The plant will use precombustion capture, turning pulverized lignite into a gaseous mixture, to capture 65 percent of its CO_2 emissions.

XTUV0010/WIKIMEDIA COMMONS (CC BY-SA 3.0)



Keep track CO_2 captured at FutureGen's project will be stored in a saline aquifer deep underground. Simulations of gas injections, shown here at five- and 70-year intervals, reveal the predicted movement of the CO_2 plume as it fans out through pores and cracks that permeate the aquifer.

Perfect cache

As a model for other CCS projects, the problems don't end with Kemper's precombustion technology. Its storage plans also don't offer much of an example. The same applies to Boundary Dam's. Ideally, captured carbon would be compressed, sucked into a pipeline and sent to an injection well. There, it would be shoved hundreds of meters belowground, beneath an impermeable cap of rock where the gas could be sequestered indefinitely.

Both Kemper and Boundary Dam plan to take a different approach: Captured CO_2 will be sold to oil companies. These companies will use the gas to flush out extra oil from a field, extending a well's productive life by pushing out extra drops of petroleum in a process called enhanced oil recovery. Although selling CO_2 can help offset the costs of CCS, it may not be a long-term solution. Oil companies tend to recycle their CO_2, sending it into oil wells over and over again. Such reuse could limit how much captured CO_2 they buy.

Still, enhanced oil recovery definitely represents an advantage for North American companies, says Vattenfall's Rolland. Places outside North America don't have the same market for the practice. And long-term geological storage can be a sticking point, particularly in Germany. Part of the reason Jänschwalde never got off the ground was because of public fears that CO_2 injections would carbonate water wells and trigger earthquakes.

While those concerns are real, carbon storage has advanced to a point where it can avoid those problems, says earth scientist Sally Benson of Stanford University, who's been working on geological carbon storage since the 1990s. "We've basically just learned a tremendous amount that will allow us to select sites for maintaining the CO_2 essentially permanently," she says.

Experimental CO_2 injections are now under way in a variety of places to help scientists observe and predict how the gas behaves underground and interacts with the surrounding rock. First, researchers make detailed maps of geological formations deep underground and forecast long into the future how injected CO_2 will move within subterranean layers over time. Most of the injection trials and lab models have focused on saline aquifers, stores of salty water, in layers of sedimentary rock such as sandstone. But some researchers are studying CO_2 injected into porous layers of basalt, a volcanic rock. Basalt has a unique chemistry that allows it to react with CO_2, forming solid carbonate minerals that trap carbon indefinitely.

Once the CO_2 is actually injected through deep-reaching wells, the gas pushes into the rock layer, where it can fan out through tiny pores and cracks. Engineers try to find injection sites that are far from geological faults and well below the depth of aquifers tapped for drinking water. They also look for areas that have a layer of solid rock above the aquifer that can act as a natural cap to keep CO_2 from bubbling back up. As the CO_2 plume moves through a rock layer, scientists can collect data and continually update their models to refine predictions, Benson says.

So far, CO_2 storage in the United States has been tried only on an experimental basis. In March, the EPA issued its first-ever draft permit for the type of well needed for long-term CO_2 storage. The so-called class VI permit went to FutureGen, the group planning the CCS project in Illinois that is slated to open in 2017. The plan is to store the carbon in a saline aquifer 48 kilometers from the power plant and more than 1,200 meters belowground. FutureGen worked closely with the EPA to lay out careful plans to inject, seal and monitor the 1.1 million metric tons of CO_2 it plans to sequester each year. "Our objective is to prove that there are off-the-shelf technologies," says FutureGen's lead geologist Tyler Gilmore, who hopes the project will be a model for CCS.

Like so many CCS projects before it, FutureGen's $1.65 billion effort is off to a good start. The FutureGen Industrial Alliance, a nonprofit made up of mining and coal companies, has worked to avoid delays and manage cost, signing labor contracts and completing detailed construction plans. Humphreys, the CEO, is certain the work is worth it. As long as power plants burn fossil fuels, carbon pollution will be a problem, he says. "I'm extremely confident that the technology is absolutely essential."

CCS is well out of the gate. Now, Humphreys says, it just needs to cross the finish line. ■

Explore more

- EPA carbon capture and sequestration website: www.epa.gov/climatechange/ccs/

FUTUREGEN INDUSTRIAL ALLIANCE

Are you in love with your home... but afraid of your stairs?

Easy Climber® is the safe, dependable and affordable way for millions to stay safe, stay independent and stay in their home.

Surveys have shown that more and more people want to live as long as possible in the home where they've raised their children. The key to this new American Dream is to maintain independence and to live safely and securely. For millions of these people, there is a barrier to the life they love… the staircase. As people age, they become less able to climb stairs safely. Going up stairs is a strain on the heart and joints and going down can be even more dangerous. Many of them are forced to spend the day in their bedroom or their night on the couch. Either way, half of their home is off limits.

Whether you're concerned about a dangerous fall from the stairs or simply need a little extra help getting up and down, Easy Climber® gives you access to your entire home again... safely and affordably. It's made by a company that's been making lifts for over 100 years, so they've thought of everything.

The Easy Climber Advantage
Safety and Security
Soft-touch anti-slip armrest padding
Higher weight capacity
Quality and Simplicity
Power Swivel Seat and Footrest
Limited Lifetime Warranty
Flexibility
Adjustable seat-height range
Lower Profile on staircase

Don't wait for a fall to call. Your home is most likely your largest investment. Get the most out of it with Easy Climber. Call now, knowledgeable product experts are standing by to answer any questions you have.

EASY CLIMBER®

Call now toll free to find out how you can get your own Easy Climber.

Please mention promotional code 48334.

For fastest service, call 24 hours a day.

1-844-493-4841

55777

BOOKSHELF

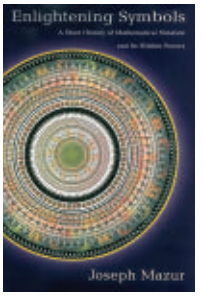
Enlightening Symbols

Joseph Mazur

As the semanticist S.I. Hayakawa stressed in his classic book *Language in Thought and Action*, words are not the things they represent. Words are symbols. It's the manipulation of those symbols that makes communication possible.

In very much the same way, it's the manipulation of symbols of a different type that makes mathematics practical. You can describe mathematical operations using just words — in fact, in ancient times, that was the norm. But such a cumbersome approach is not conducive to anything very complicated. In large part, the advance of mathematics from simple arithmetic to the complexities of algebra and calculus was made possible by the development of effective symbols.

Mazur relates the stories behind those symbols engagingly, if a bit unevenly. He offers a wealth of historical depth in several chapters devoted to Arabic numerals. He traces in detail the evolution of symbols in algebraic equations and the various attempts to find convenient representations of roots and powers.



But he only briefly treats common symbols such as those for division, multiplication, equality and infinity. And the closing chapters veer off into the philosophy of symbols and the neuroscience behind how the brain reacts to them. Still, *Enlightening Symbols* is basically an intriguing if quirky history of mathematics itself, as told through the story of the symbols invented to facilitate it.

It's an interesting and informative book, especially valuable for its attention to recent scholarship that revises some traditional historical beliefs. It suffers, though, from poor editing. We learn that Thomas Hobbes called the use of symbols "a double labor of the mind" in a passage on page 164, then again in a largely duplicated passage on pages 180–181. We learn that Nicole Oresme anticipated Descartes' idea of coordinate systems on page 152, then again on page 154. More attention to such repetitions would have made a good book much better.

— Tom Siegfried

Princeton Univ., $29.95

Buy Books Reviews on the *Science News* website include Amazon.com links that generate funds for Society for Science & the Public programs.

This infant, featured in "Calling the Shots," might have avoided whooping cough if vaccination rates in the surrounding population had been higher.

TELEVISION

'NOVA' sets facts straight on vaccine science

In some quarters, vaccines have become victims of their own success. Having suppressed the diseases they target, vaccines have left room for people to worry more about the shot than the illness. In response, the TV series *NOVA* offers an engrossing, evenhanded documentary, one that would never have been made 55 years ago, when people were happily lining up around the block to get polio shots.

Distrust of vaccines means that California today has an epidemic of whooping cough and Britain and France have faced bouts with measles. Some parents delay or skip vaccines mistakenly thinking they're protecting their kids from autism or other problems. "Vaccines — Calling the Shots" dispels this nonsense.

"Vaccines — Calling the Shots"
PREMIERES SEPTEMBER 10
PBS | *NOVA*

Building the science from the bottom up, the filmmakers use nifty animation to show how a shot whips the immune system into action, putting memory cells on layaway in case the real disease shows up. Other dazzling graphics track a measles outbreak among unvaccinated people in Brooklyn.

The documentary then turns to the doctor's office. Viewers watch from a discreet angle as an Oklahoma City pediatrician asks a mother and teen daughter about vaccinating the girl against sexually transmitted human papillomavirus, which can cause cancers of the cervix and throat. The mother demurs, voicing concerns about teen sexuality and stressing abstinence. They skip the shot.

In the next scene, a woman across town breaks down describing how her 37-year-old daughter died of cervical cancer, having grown up before the HPV shot was available. She would give anything to have vaccinated her girl.

NOVA doesn't hide the fact that all medicines, including vaccines, carry risks. About 1 child out of every 1 million vaccinated will have a serious reaction. It's a question of risk versus benefit, one scientist says, and it's not even close.

Perhaps the program will get through to people who still doubt vaccines. Published science hasn't fully done the trick, and pediatricians are left to tussle with resistant parents. A better approach might be to focus on the next generation: Show this first-rate documentary to middle school kids. *— Nathan Seppa*

COURTESY OF GENEPOOL PRODUCTIONS

Three outstanding optical instruments from Jomira. Our exclusive imports, our exclusive prices*

***But be sure to read this entire ad for our "Special Deal!"**

The spy glass that made naval history…

ADMIRAL FARRAGUT'S TELESCOPE

(with table top tripod) from us only $69.95 (Why pay more?) *

• The optics of Admiral Farragut's Telescope are 25x30. This means that you get 25x magnification and the great light-gathering capacity of a 30mm objective lens. The scope is fully chromed (over brass) for extra beauty, protection and durability. Admiral Farragut's Telescope comes with a vinyl belt-looped carry case and a table-top tripod for extended observations.

When Admiral Farragut ("Damn the torpedoes; full speed ahead!") fought his legendary naval battles he used a telescope just like this to monitor the movements of the enemies' fleets. This beautiful optical instrument, a faithful replica of the famous original (except that Admiral Farragut's was made of brass – ours is fully chromed over its pure brass body), is about 5" long in its collapsed position and 13" when extended to full operating length.

Enlargement is 25x, which means that it brings everything 25-times closer, and in needle-sharp focus, than if viewed with the unaided eye. Compare that to binoculars, which usually give you not more than 6x or perhaps 8x magnification. ADMIRAL FARRAGUT'S TELESCOPE comes with a belt-loop vinyl carrying case. There is also a table-top tripod for extended observations. This beautiful instrument is something you always wanted but thought you couldn't afford. It is a small luxury that you will really enjoy and that will give you wonderful service for many years. It is now available from us at a most affordable price.

The only universal optical instrument…

PANSCOPE

(the complete optical system) from us only $59.95 (Why pay more?) *

• PANSCOPE is beautifully gift-boxed, comes with its neatly fitted leather case and with a plastic "tripod" for extended observations at 15x and 30x.

This is a little optical marvel. PANSCOPE (only 2" long) contains a complete optical system in its tiny body. You may use it as a 3x telescope or as a unique 3x telescope-loupe. In its magnifying mode, it delivers magnifiers and loupes at 5x, 10x, and 15x enlargement. And to top it all, it also functions as a 30x microscope of laboratory quality.

A special stand for long-term observation for 15x and 30x microscope is included

This marvelous little instrument, developed in Wetzlar (Germany), home of famous Leica cameras, is the product of one of Asia's finest makers. Its coated optics are of superb quality, delivering the image with brilliant luminosity, in needle-sharp focus, with absolute clarity and with full chromatic correction. PANSCOPE is the indispensable first choice of scientists and professionals and of just about everybody who wants and needs to see the infinite detail in life that is not readily available to the unaided eye.

Hold the whole world in your hand with…

Jomirascope

8 x 20 monocular from us only $59.95 (Why pay more?) *

• The optics of jomirascope are 8x20 – 8x magnification with 20 mm objective lens. it comes in a neat zippered carrying case. The objective lens can be used as an 8x magnifier. A 25x microscope attachment ($29.95, 3 for $59.90) is also available.

Jomirascope is so small that it fits unobtrusively in a man's coat pocket or a lady's purse. Yet it packs a tremendous wallop in its tiny body. Its 8 x 20 fully prismatic and hard-coated optics give you 8x magnification, with a remarkable field of 366 ft. at 1,000 yds. Its 20 mm objective lens affords unusual light gathering even at dusk or dawn. What was that rustling in the bushes? With jomirascope you'll discover that it was an ivory-billed woodpecker. Do you wish to explore every feature on the moon, or (with some luck) discern the rings of Saturn? jomirascope will be your instrument of choice. Much smaller than even "pocket" binoculars and with greater magnification than most, jomirascope should be your constant companion, for enjoyment and exploration. You can use the objective lens of the jomirascope as an excellent 8x magnifier. And do consider the 25x microscope attachment of laboratory quality, which makes jomirascope a complete optical system.

jomira

division of jomira/advance

470 3rd St., #211, San Francisco, CA 94107

*** And here is our "special deal": You may buy any three of these outstanding optical instruments (mixed or matched) for the price of two, only $119.90 — even the somewhat more expensive Telescope. (Note: Three Telescopes are $139.90)**

You may order by toll-free phone, by mail, or by fax and pay by check or AMEX/Visa/MasterCard. Please give order code shown. Add $6.95 for ship./ins. for one and $9.90 for three instruments - except one Adm. Farragut's Telescope is $9.90 and any three instruments containing Adm. Farragut's Telescope $12.95 - and sales tax for CA delivery. You have 30-day refund and one-year warranty. We do not refund postage. For customer service or wholesale information, please call (415) 356-7801.

We ship the same day we receive your order. Please give order code Z378!

Order by toll-free phone: 1-800/600-2777, or (fastest!) by fax: 1-415/356-7804. Visit our website at www.jomira.com

JULY 26, 2014

SOCIAL MEDIA

Suiting up

In "A suit fit for Mars" (*SN: 7/12/14, p. 32*), **Andrew Grant** unveiled new gear designed to outfit astronauts bound for the Red Planet. The technology may be cool, but readers on Twitter weren't too impressed by NASA's fashion sense.

"The Martians are going to laugh at us."
@VaughnFry

"It looks like Buzz Lightyear in his later years."
@thisisbossi

"Maybe the shorts should be a contrasting color, for that undies-on-the-outside superhero vibe. Then again, maybe not."
@LoremIpsum00

Join the conversation

E-MAIL editors@sciencenews.org

MAIL Attn: Feedback
1719 N St., NW
Washington, DC 20036

Connect with us

The art of science

Dazzling images of life on a cellular level now greet travelers flying into the U.S. capital, as ***Tina Hesman Saey*** *reported in "Microscapes take off at D.C.'s Dulles airport" (*SN: 7/26/14, p. 28*). The exhibit, called "Life: Magnified," offers viewers a glimpse of cells, microorganisms and other microscopic details at larger-than-life size.*

A few fortunate *Science News* readers have had the chance to check out the exhibit in person. **Julie Sigler** recounted her experience in an e-mail: "As I strolled sleepily through the dull gray Dulles United Airlines terminal, hours early for my plane, a phalanx of colorful photos woke me. 'Just like those I see in *Science News*,' I thought. Back home a few hours later, reading through my copy of the July 26 *SN*, I was delighted to see an article that explained the exhibit I'd just passed!" she wrote. "I wish each photo had been labeled. If any explanation were present, I must have been still asleep as I walked past it."

Reader **ZZTop** liked the exhibit but had a problem with the location. "The exhibition space is in a corridor where you are either rushing to your gate or from it, so you never really feel like you have a chance to study the images. How about putting some art in spaces where people are still, or have a little more time?"

The trouble with triclosan

A ubiquitous bacteria-killing compound can wash into wastewater treatment plants and disrupt helpful microbial communities that digest sewage solids. ***Beth Mole*** *noted in "Triclosan may spoil wastewater treatment" (*SN: 7/26/14, p. 9*) that the chemical may also boost drug resistance in some microbes.*

Anthony Giarratano wondered if researchers could create a sludge-processing microbe with a beefed-up defense against triclosan. "Of course, this would not resolve the issue of harmful microbes also becoming resistant to triclosan, but perhaps it could help resolve part of the problem by allowing the beneficial microbes to continue their work." But that would just escalate an unwinnable war, argued **Anthony Kerwin**. "We get ourselves into these endless loops of 'create drug, bug evolves to develop resistance, create new drug, bug evolves....' A never-ending battle with dire, and unintended, consequences." He added, "Perhaps a triclosan-resistant microbe could help in the short term. I still worry about those unintended consequences."

The most efficient solution is to just ban triclosan, said **conradseitz**."It isn't particularly effective, and multiple negative studies have been piling up lately. Soap by itself washes away the bacteria and archaea anyway."

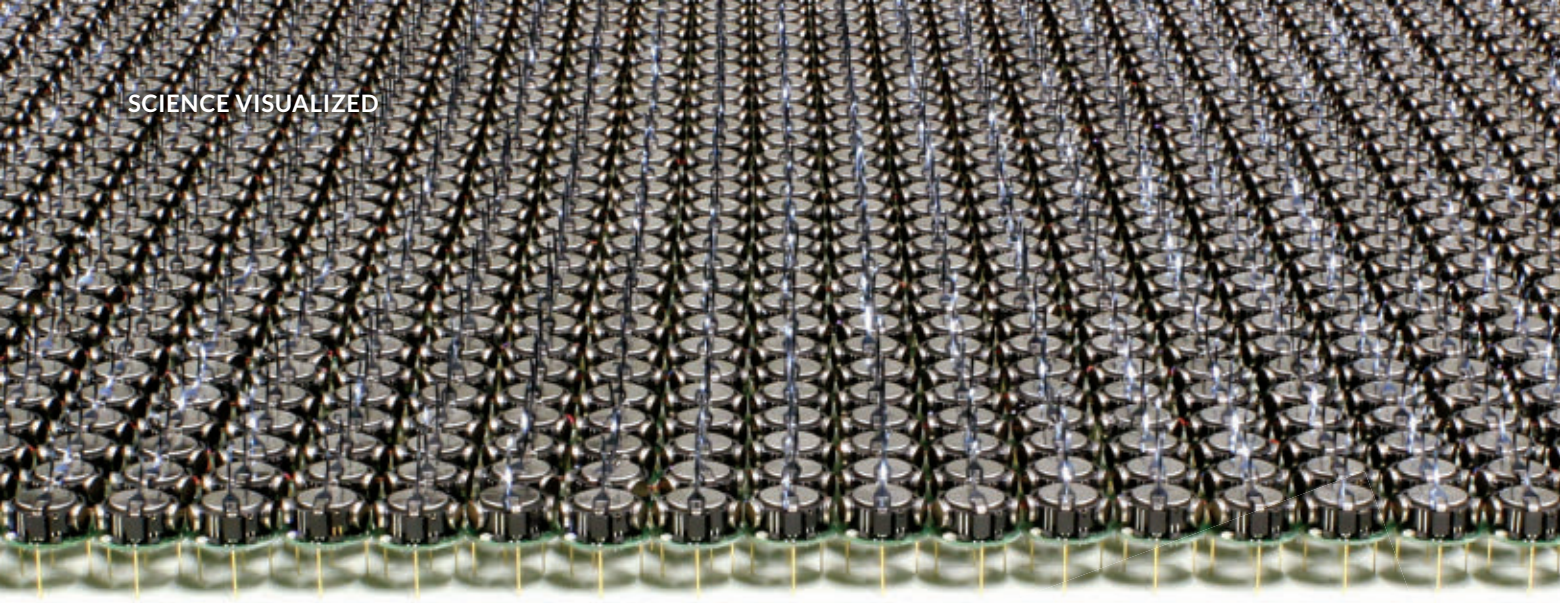
Weighing in on birthweight

Researchers know that babies born too small can suffer health problems later in life, but new studies reveal that being too big at birth has its own risks. ***Nathan Seppa*** *explored the consequences of a high birthweight, which the Centers for Disease Control and Prevention defines as more than 4 kilograms, or 8.8 pounds, in "Big babies" (*SN: 5/31/14, p. 22*).*

In an e-mail, pregnancy researcher **Sally Ann Lederman** of Columbia University noted that high-birthweight babies born of naturally large parents don't face the same added risk that babies born with extra fat do. But, she said, some studies cited in **Seppa's** article didn't make that distinction. She also took issue with the cutoff point of 4 kilograms for a big newborn. "If this idea is accepted, a great disservice will be done to American babies and their mothers," she wrote, arguing that 4.5 kilograms is a better marker. In defense of large babies, she pointed to earlier research showing better neonatal survival, lower chance of high blood pressure and possibly higher IQ in people born big.

While researchers are still sorting out how being born heavy affects future health, **Seppa** notes that many of those earlier studies suggesting benefits of high birthweight were published before the obesity epidemic hit full force. Newer data, as his feature reported, show problems.

NASA

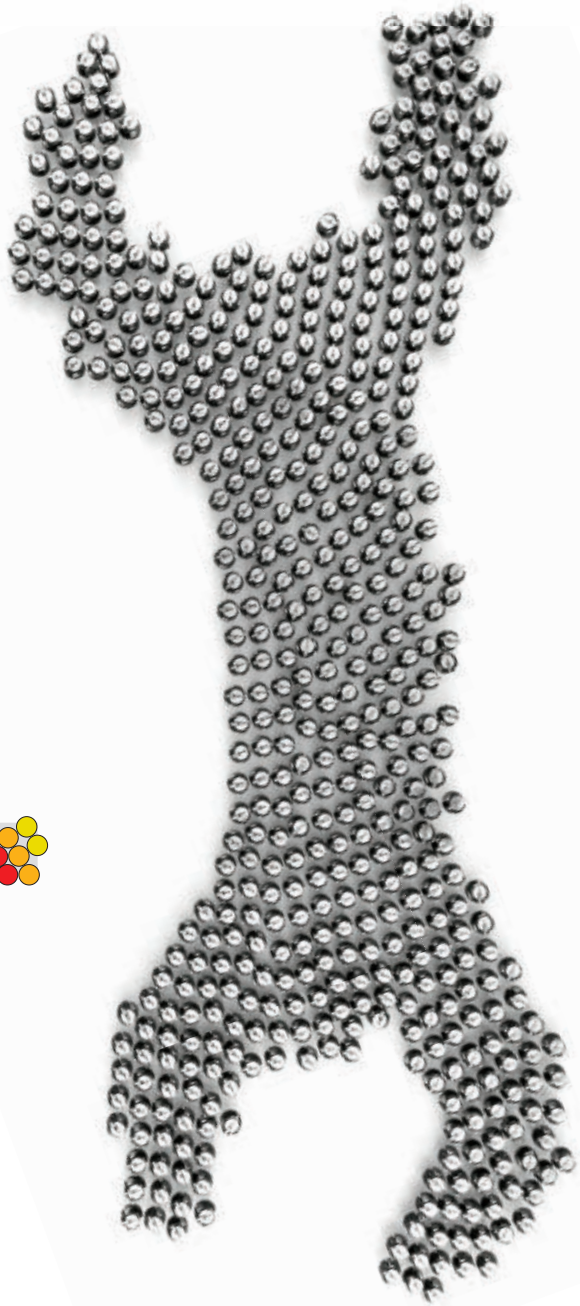


Robot swarm takes many shapes

One Kilobot is not very smart. Each quarter-sized bot scuffles along on three rigid legs and can communicate only with its neighbors. Yet by instructing more than 1,000 Kilobots to follow a few simple rules, computer scientist Radhika Nagpal and her team at Harvard can get the crude bots to assemble into multiple shapes — including a wrench (right), a star and the letter K — without human intervention.

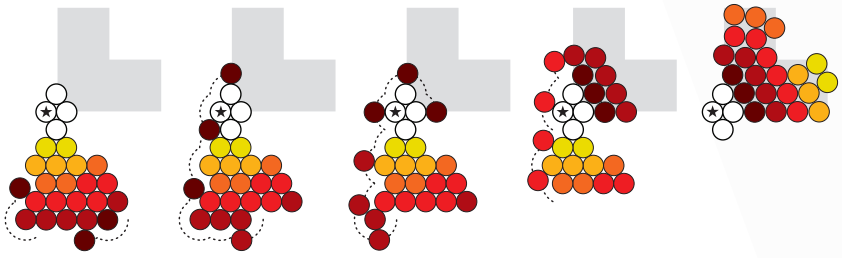
The demonstration, reported in the Aug. 15 *Science*, is the closest scientists have come to mimicking cooperative swarms in nature, such as ants that clump together to form makeshift rafts (*SN Online: 6/17/14*). Previous attempts involved smaller swarms of more expensive and sophisticated robots. But Kilobots, which the Harvard team developed in 2011, cost about $20 apiece; they move using the motors that make cellphones vibrate. The trick was developing a program that made the most of the bots' capabilities, along with patience: The bots need about 12 hours to form each shape.

Eventually researchers hope to develop intelligent swarms of sand-grain-sized robots that autonomously form 3-D structures — say, an actual wrench. — *Andrew Grant*



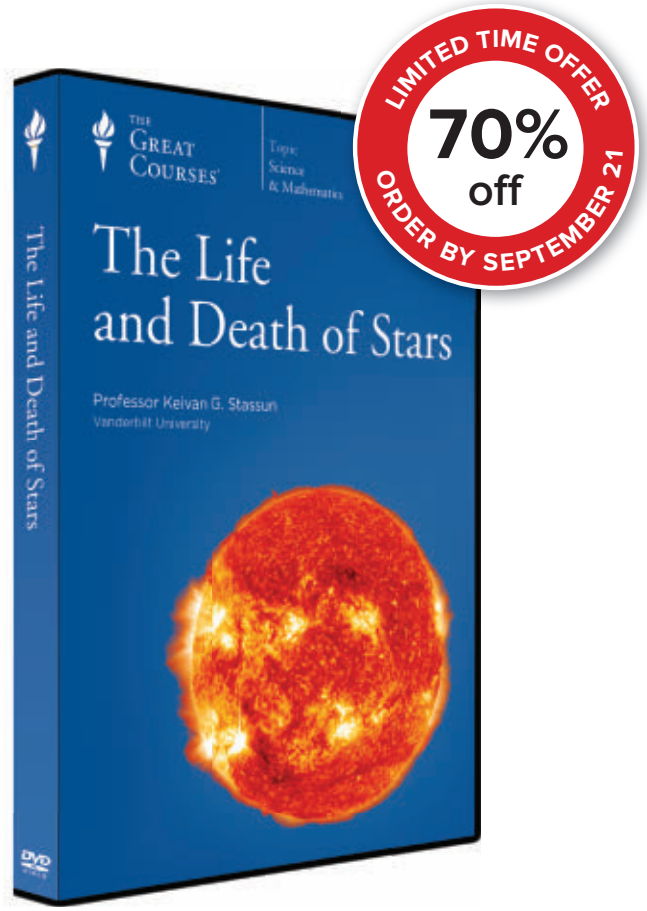
ALL: M. RUBENSTEIN *ET AL*/*SCIENCE* 2014; GRAPHIC ADAPTED BY S. EGTS

How to harness a swarm of dumb, cheap robots



Herding Kilobots To entice robots to form shapes, researchers upload an image of the desired shape (shaded area) to each bot. The four white bots are called seed robots — they mark the position and orientation of the shape and never move. The other bots use information from neighbors to figure out their distance from the starred seed bot; the farthest ones (darkest red) start moving along the edge of the swarm. Upon reaching the seed bots, the moving bots are able to triangulate their exact position. The bots stop when they are within the shaded area and either reach the boundary or touch the bot that has just stopped in front of them. Following these rules, the bots gradually fill in the shape.

THE GREAT COURSES®



Understand Astronomy at a Fundamental Level

No other large-scale object in the universe is as fundamental as a star. Stars are a central topic of astronomy, and because the study of stars encompasses key concepts in nuclear physics, electromagnetism, chemistry, and other disciplines, it is an ideal introduction to how we understand the universe at all scales.

The Life and Death of Stars introduces you to this spectacular story in 24 beautifully illustrated lectures that lead you through the essential ideas of astrophysics—the science of stars. Your guide is Professor Keivan G. Stassun of Vanderbilt University, who provides lively, eloquent, and authoritative explanations at a level suitable for science novices as well as for those who already know their way around the starry sky.

Offer expires 09/21/14

THEGREATCOURSES.COM/8SN

1-800-832-2412

The Life and Death of Stars

Taught by Professor Keivan G. Stassun
VANDERBILT UNIVERSITY

LECTURE TITLES

1. Why the Stellar Life Cycle Matters
2. The Stars' Information Messenger
3. Measuring the Stars with Light
4. Stellar Nurseries
5. Gravitational Collapse and Protostars
6. The Dynamics of Star Formation
7. Solar Systems in the Making
8. Telescopes—Our Eyes on the Stars
9. Mass—The DNA of Stars
10. Eclipses of Stars—Truth in the Shadows
11. Stellar Families
12. A Portrait of Our Star, the Sun
13. $E = mc^2$—Energy for a Star's Life
14. Stars in Middle Age
15. Stellar Death
16. Stellar Corpses—Diamonds in the Sky
17. Dying Breaths—Cepheids and Supernovae
18. Supernova Remnants and Galactic Geysers
19. Stillborn Stars
20. The Dark Mystery of the First Stars
21. Stars as Magnets
22. Solar Storms—The Perils of Life with a Star
23. The Stellar Recipe of Life
24. A Tale of Two Stars

The Life and Death of Stars
Course no. 1872 | 24 lectures (30 minutes/lecture)

SAVE $190

DVD ~~$269.95~~ NOW $79.95
+$10 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 95545

For 24 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free mobile apps for iPad, iPhone, or Android. Over 500 courses available at www.TheGreatCourses.com.

Six Minutes to Save the World

Perfect timing for your next mission... Get the Stauer Valeo Watch for ONLY $29!

According to my watch, I have six minutes to save the world. There are five armored trucks on my tail, three kilometers of open road to the border, and one gorgeous double agent in the back seat. If they catch her, it's game over. That's why I check my watch one more time, floor the gas pedal and drive *through* the roadblock instead of around it. I'll definitely lose the deposit on the rental car, but we'll make it back to Budapest in time for dinner.

Every day is a series of split-second decisions. Not all of them involve the fate of the free world. But you need a watch worthy of the mission. You need precision, performance, and style. You need the ***Stauer Valeo Watch***. And if you act quickly, you can make it yours today for **ONLY $29!**

We take your time seriously. Building a watch that looks this good and works this well for a price this low wasn't easy. You'll find that other luxury brands are happy to charge you thousands for similar looking timepieces without blinking. They bank on celebrity endorsements to boost value. But we prefer to make timepieces for men who do their own stunts.

Your watch, should you choose to accept it. Outside, the ***Valeo*** is a gleaming showpiece with a stainless steel case back, brilliant blue dial and bold luminescent numerals. Inside, the precision movement oscillates at 32,768 times per second to maintain perfect timing during any scenario. The black leather band with white stitching adds a dash of debonair flair, completely ruining this watch's attempts to go unnoticed. Strap it on, buckle up, and get ready for your next adventure!

Your satisfaction is 100% GUARANTEED. If for any reason you are unimpressed with the ***Valeo*** Watch, send it back within 30 days for a full refund of your purchase price. But we're betting that once you spend a few minutes with the ***Valeo***, you'll wonder how you ever survived without it.

Stauer Valeo Watch— ~~$199~~*

***Offer Code Price* $29 + S&P SAVE $170!**

You must use the insider offer code to get our special price.

1-800-721-0387

Your Offer Code: VBW131-01
Please use this code when you order to receive your discount.

Stauer®
14101 Southcross Drive W.,
Dept. VBW131-01
Burnsville, Minnesota 55337
www.stauer.com

BBB ACCREDITED BUSINESS
Rating of A+

** Discount for customers who use the offer code versus the original Stauer.com price.*

Smart Luxuries—Surprising Prices™

Durable stainless steel case back with striking blue dial - Precision quartz movement - Genuine black leather band fits wrists 6¾"–8½" - Water-resistant to 3 ATM