SN
SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC
APRIL 19, 2014

Whooping Cough's Return

Cuckoo Goo Helps Hosts

One Nose, A Trillion Scents

Sonic Tractor Beam

A MOMENT'S NOTICE

Earthquake alerts could arrive precious seconds before shaking starts

How to Tell Time Like a Man

Our digital-analog hybrid has two sides... tough and tougher. Get it now for an unbelievable $59!

Your watch shouldn't cost more than your car. It should look and feel like a power tool and not a piece of bling. Wearing it shouldn't make you think twice about swinging a hammer or changing a tire. A real man's timepiece needs to be ready for anything. But that's just my opinion. If you agree, maybe you're ready for the ***Stauer Centurion Hybrid***. Use your **Exclusive Insider Promotional Code** below and I'll send it to you today for ***ONLY $59.***

This watch doesn't do dainty. And neither do I. Call me old-fashioned, but I want my boots to be leather, my tires to be deep-tread monsters, and my steak thick and rare. Inspiration for a man's watch should come from things like fast cars, firefighters and power tools. And if you want to talk beauty, then let's discuss a 428 cubic inch V8.

Did I mention the $59 price tag? This is a LOT of machine for not a lot of money. The ***Stauer Centurion Hybrid*** sports a heavy-duty alloy body, chromed and detailed with a rotating bezel that allows you to track direction. The luminous hour and minute hands mean you can keep working into the night. And the dual digital displays give this watch a hybrid ability. The LCD windows displays the time, day and date, includes a stopwatch function, and features a bright green electro-luminescent backlight. We previously offered the ***Centurion*** for $199, but with the exclusive promotional code it's yours for **ONLY $59**!

No matter what, this watch can keep up. Thanks to the Stauer 30-day Money Back Guarantee, you've got time to prove it. If you're not totally satisfied, return it for a full refund of the purchase price. You also get a 2-year replacement guarantee on both movements. But I have a feeling the only problem you'll have is deciding whether to keep the Stauer ***Centurion*** on your dresser or tucked inside your toolbox.

★★★★★

"I work in the surveying and construction industry... This is my work horse watch and I am proud to wear it."

— C.S. from Fort Worth, TX

TAKE 70% OFF INSTANTLY!
When you use your Promotional Code

Stauer Centurion Hybrid Watch— ~~$199~~

Promotional Code Price Only $59

or two payments of $29.50 + S&P

Order now to take advantage of this fantastic low price.

1-800-333-2057

Your Insider Promotional Code: CNW235-03
Please use this code when you order to receive your discount.

ACCREDITED BUSINESS
BBB Rating of A+

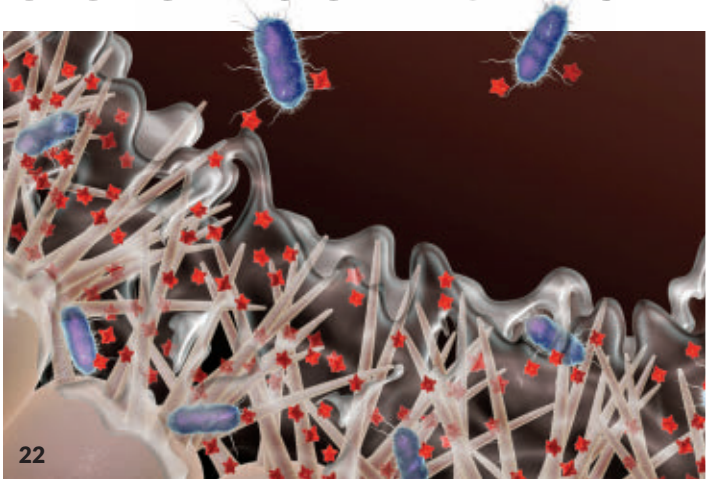
Stauer®
14101 Southcross Drive W., Dept. CNW235-03
Burnsville, Minnesota 55337 **www.stauer.com**

Digital-Analog Hybrid • Dual digital displays • Heavy-duty chromed body • 3 ATM Water Resistant
LCD windows for time, date and day • Luminous hands • Contrast Stitch Band fits a 7 1/4"–9 1/4" wrist

Smart Luxuries—Surprising Prices™

VOL. 185 | NO. 8

ScienceNews


22

Features

News


10


28

Departments

COVER A warning system could have given San Francisco seconds to prepare for seismic waves from the 1989 Loma Prieta earthquake. *Russell Curtis/Photo Researchers/Getty Images*

CLOCKWISE FROM TOP LEFT: NICOLLE RAGER FULLER; IMSS; PRILL/SHUTTERSTOCK

Science can save lives, but only if society lets it

Society faces lots of problems that science can't yet fix, from the troubling rise in asthma to the lack of a cheap energy source that doesn't harm the environment. But there are also plenty of cases in which scientists know enough to avert tragedy. Whether society acts on that knowledge is a separate issue.

The resurgence of whooping cough offers one example. A new type of pertussis vaccine was introduced in the 1990s that avoided many of the worrisome, but ultimately harmless, side effects of its predecessor. As biomedical writer Nathan Seppa reports on Page 22, it is now clear that the new vaccine is much weaker than the old one. And a disease that was all but eradicated in the United States 40 years ago is causing outbreaks with tens of thousands of cases, a handful of them lethal. But the obvious solution — return to the old vaccine — is considered a nonstarter in this age of vaccine paranoia.

In the case of the recent landslide in Oso, Wash., that took more than two dozen lives, it seems that other societal forces trumped scientific information. According to news reports, geologists had long ago identified the area as highly unstable, and had recorded a series of historical landslides, including one in 2006. Yet that was not enough to prevent new homes from being built in harm's way (see Science Visualized on Page 32).

Lives might be saved if authorities on the West Coast capitalize on the efforts of seismologists who are developing an earthquake early warning system. On Page 16, contributing correspondent Alexandra Witze writes that the system, already in testing, can deliver alerts seconds to tens of seconds ahead of the most damaging seismic waves emanating from an earthquake's epicenter. When a magnitude 5.1 quake hit the Southern California town of La Habra on March 28, the prototype gave seismologists in nearby Pasadena a four-second warning that shaking was imminent. That's enough time for schoolchildren to dive under desks or for automated systems to shut down heavy equipment. But funding to fully implement the system hasn't yet materialized. Imagine the frustration of the system's designers if a deadly quake arrives before the money does. — *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 SCHAEFFER

Actual Size
30.61 mm
90% Pure Silver

Before they were carved in stone, they were struck in SILVER.

JUST RELEASED: One of America's FIRST Civil War Silver Half Dollars.

As we commemorate the 150th anniversary of the Civil War, collectors are scrambling to add Civil War artifacts to their collections. No collection can be complete without one of the FIRST-EVER Civil War commemorative coins struck by the U.S. Mint: The 1925 Stone Mountain Silver Half Dollar.

The coin features Generals Robert E. Lee and Stonewall Jackson on horseback, exactly as they appear on the Stone Mountain Memorial near Atlanta, Georgia. The memorial was designed by famed sculptor Gutzon Borglum, whose next masterpiece would be the magnificent Mount Rushmore.

Etched in History, Carved in Stone, Struck in Silver!
These 90% silver half dollars were minted in 1925 to raise money for the memorial. Over the years since they were minted, many were spent during the Great Depression, or melted to obtain their precious silver. Today, they can be difficult to find.

Thanks to a remarkable recent discovery, GovMint.com has obtained a limited supply of these desirable Stone Mountain Silver Half Dollars. The detail and relief on these stunning coins make each coin a work of art. It's no wonder they're in such high demand!

Historic Public Release
We are now releasing our entire supply of these historic and valuable coins to the public. Each is in lightly circulated condition and comes with an informative story card and a certificate of authenticity.

Order Now Risk Free!
Genuine Civil War items like this don't appear every day. We expect our small supply of these historic silver coins to disappear quickly. We urge you to call immediately to avoid disappointment.

1925 Stone Mountain Silver Half Dollar: $69.95 *(plus s/h)*

You must be 100% satisfied with your genuine 1925 Stone Mountain Silver Half Dollar or return it within 30 days of receipt for a prompt refund *(less all s/h)*

Call toll-free 24 hours a day

1-800-517-6468

Offer Code SMS199-01
Please mention this code when you call.

GovMint.com®
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive West, Burnsville, MN 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 December 2013. ©2014 GovMint.com.

Excerpt from the April 18, 1964, issue of *Science News Letter*

50 YEARS AGO

Millions of Working Mamas

Millions of mamas — and even grandmamas — go to work every day in the United States. One-third to one-half of the working women are mothers and grandmothers. About nine million mothers with children under 18 years of age this year will work.... About six times as many mothers will work this year as worked two decades ago. Almost five million more mothers will work in 1964 than worked in 1950, if the present trend continues.... Women working full-time earn only about three-fifths as much as men.... "There must be equal pay for equal work for both sexes as well as among the races. Pay should be based on the job done — not on who does the job," declares Mrs. [Assistant Secretary of Labor Esther] Peterson.

UPDATE: It has been a long time since millions of American women working outside the home was big sociological news. Women are now 47 percent of the U.S. workforce. But some things have not changed as much as was hoped in 1964. In 2012, U.S. women made 77 cents for every dollar earned by men.

IT'S ALIVE

See-through shrimp

Much of the body of a Pederson's transparent shrimp looks like watery nothing, but it's a superhero sort of nothing. The shrimp is transparent enough to read through, but it's not some frail, filmy thing. It's packed with invisible muscle.

Searching for *Ancylomenes pedersoni* shrimp has a touch of the summer-camp prank about it, being a hunt for something that's mostly invisible. On a research trip to reefs in Belize, "everyone else would give up," says Laura Bagge of Duke University. But she'd find an anemone, where the transparent shrimp hide among stinging tentacles, and then float in the water watching for the twitch of a tiny visible part, such as an antenna or claw. "It's like a 'Where's Waldo' thing, because you can't see it at first and then all of a sudden it becomes visible."

The clear shrimp look so delicate that Bagge was startled at how power-

HOW BIZARRE

Soft robots go swimming

A new robotic fish can wiggle and writhe like the real thing. With a squishy silicone body and a bellyful of electronics, the little swimmer flips and turns nearly as fast as living fish do. To make the robot so nimble, MIT engineers sandwiched a firm plastic sheet between hollow channels embedded in each side of the tail. Spurts of gas inflate the channels on one side, which push against the plastic sheet to bend the tail. Using a small canister of compressed carbon dioxide tucked in the fish's guts, researchers can make the bot swim forward, or contort its body to quickly change direction. They can also control the angle and speed of the fish's twists, Daniela Rus and colleagues report in the March *Soft Robotics*. Such an agile gizmo could sneak into fish schools and collect behavior data, the researchers suggest. Building bots based on living and extinct animals could also help to study fish evolution (*SN: 6/2/12, p. 30*). — *Meghan Rosen*

IT'S ALIVE: L. BAGGE; HOW BIZARRE: M. SCOTT BRAUER

Watch a video of robotic fish swimming at **bit.ly/SNrobofish**

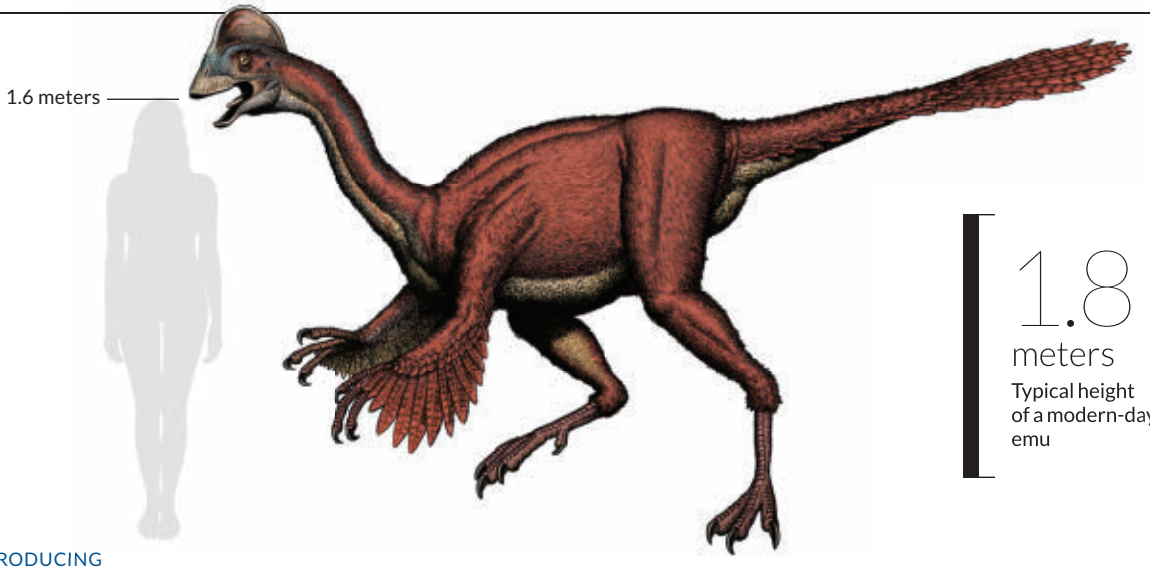
fully they can jet backward to escape. She practiced using a turkey baster as a squirt gun to maneuver shrimp into "escaping" into a glass jar. The shrimp voluntarily make little forays from their anemone homes to work as cleaners, darting into the mouths of fish and nipping up parasites and debris. To attract clients for these hygiene services, though, the shrimp have to violate their own superb camouflage. They sway and "do this little rocking dance" that gives away their location, Bagge says.

They're fun to watch in the lab, too, she says. The brown or red food pellets that a shrimp eats show up as dots as they move into the stomach. "You can tell when they're hungry," she says: As the stomach clears, the dotted line disappears.

The digestive organs and most other visible structures are bunched toward the front of the body. Females, however, carry their clutch of yellowish eggs attached to the clear abdomen, somewhat ruining the camouflage.

Becoming transparent is more than a matter of not containing pigment. "The bigger issue is scattering," Bagge says. Light shifts direction when it passes through one material and hits another with different refractive properties. "Think of a snowman," Bagge says. It's just water, but snow's particles scatter so much light that it's opaque. Now Bagge is looking at the muscles under extreme magnification to see if some quality of the fibers suppresses scattering. Whatever the trick turns out to be, it breaks down when the shrimp dies. A dead shrimp soon turns visible. *—Susan Milius*

A Pederson's transparent shrimp, disguised as nothing much (left), is clear enough to read through. Despite its delicate looks, the shrimp (also shown above) is packed with muscle.



1.8
meters
Typical height of a modern-day emu

ROBERT WALTERS/SMITHSONIAN, KOR7EZ/ISTOCKPHOTO

INTRODUCING

The dinosaur 'chicken from hell'

A supersized chickenlike reptile with large, sharp claws and a toothless beak is the latest creature to earn the distinction of being called a dinosaur. The animal is named *Anzu wyliei*, its genus recalling a birdlike demon in Mesopotamian mythology, and the researchers describing the dinosaur jokingly refer to it as a "chicken from hell." It is the second-largest birdlike, feathered dinosaur behind *Gigantoraptor* and the largest found in North America. The species roamed what are now the Dakotas 66 million to 68 million years ago with *Tyrannosaurus rex* and *Triceratops*. *A. wyliei* was identified from three fossil finds that, when combined, make a nearly complete skeleton. Based on calculations from the skeleton, the birdlike reptile, measuring 3.5 meters long and weighing 200 to 300 kilograms, would have been bigger than the biggest ostrich, scientists report March 19 in *PLOS ONE*. *—Ashley Yeager*

BODY & BRAIN

Human noses can sniff 1 trillion odors

Smell may have played an underappreciated role in evolution

BY BRUCE BOWER

Respect the nose. Humans use it to tell apart an average of more than 1 trillion odors, a new study finds.

That estimate of smell's reach vastly exceeds the roughly several million colors and 340,000 sounds a typical person can distinguish, reports a team led by geneticist Leslie Vosshall of Rockefeller University in New York City. A decades-old claim that humans discriminate only about 10,000 odors had not been systematically tested until now, the scientists say in the March 21 *Science*.

Most odor researchers already thought that people could whiff far more than 10,000 scents. Previous investigations found that humans have 400 genes that code for odor-sensing molecules. That's a sign that smell discrimination played a significant role in human evolution, says Rockefeller geneticist and study coauthor Andreas Keller.

Although sight and hearing outweigh smell as senses necessary for finding food, evading dangers and other daily necessities, the need to discriminate between similar odors is nothing to sniff at, Keller asserts. Consider the advantages of being able to detect the faintest hint of spoiled food, he says.

"We're visual animals, but this new report highlights humans' superb sense of smell," says neuroscientist Noam Sobel of the Weizmann Institute of Science in Rehovot, Israel. The ability to distinguish among vast numbers of odors proves especially important in social situations, Sobel suspects. His team has shown that women's emotional tears contain substances that influence men's behavior via smell (*SN: 1/29/11, p. 10*).

Vosshall and colleagues tested the ability of 26 men and women to distinguish scents concocted from 128 odor molecules, such as banana-scented isoamyl acetate. Participants were unfamiliar with most of the resulting smells, which were randomly presented in mixtures of 10, 20 or 30 odor molecules.

A pit atop the skull of the 28-million-year-old *Cotylocara macei* indicates that this early toothed whale used echolocation.

JAMES CAREW AND MITCHELL COLGAN

LIFE & EVOLUTION

Fossilized skull hints at evolution of echolocation in toothed whales

Underwater sonar may have originated 34 million years ago

BY ASHLEY YEAGER

The skull of a newly identified species of extinct toothed whale may help scientists piece together when echolocation evolved underwater.

Recovered from a drainage ditch near Charleston, S.C., the 28-million-year-old fossil has a deep pit in the top of its head that divides the right and left sides of the skull. "It's a highly unusual feature," says Jonathan Geisler, an anatomist at the New York Institute of Technology in Old Westbury. No other known whale, dolphin or porpoise has such a pit, he says. "It's really bizarre."

Geisler and his colleagues named the species *Cotylocara macei* (the genus name means "cavity head" in Greek). The pit and other skull features suggest that the ancient toothed whale sent calls out into the water to echolocate objects. The age of the skull and the animal's relationship to other extinct whales imply that the basic anatomy for echolocation developed shortly after toothed whales split from filter-feeding whales 35 million years ago, Geisler and colleagues argue March 12 in *Nature*. (Filter-feeding whales are not known to use echolocation.)

Today's toothed whales emit sonar by moving air between spaces in the head. Species such as orcas and sperm whales use the sounds that echo back to navigate and search for prey. Scientists look for evidence of echolocation in ancient whales in the density of fossil bone, location of pits in the skull and upper jaw shape. Previously, the earliest known toothed whale that may have used sonar to hunt was 32 million years old, but the evidence wasn't definitive.

On each of 264 trials, volunteers sniffed three vials. Two vials contained the same odor; the task was to pick the scent that differed. Paired odor mixtures shared varying fractions of molecules in different trials.

Participants had little difficulty telling the difference between mixtures that shared as much as 51 percent of their odor molecules. The number of volunteers able to tell scents apart declined steadily as pairs of odor mixes increasingly shared components. No one could discriminate between mixtures that chemically overlapped by more than 90 percent.

10 thousand
Odors once thought distinguishable by humans

1 trillion
Minimum number of odors that humans can smell

Based on individuals' accuracy rates, the number of possible odor mixtures (on the order of 10^{29}) and the amount of overlap among those mixtures, the researchers calculated that the average participant could discriminate a minimum of more than 1 trillion smells containing 30 odor molecules.

There were big differences among participants. The best-performing volunteers could have distinguished many more mixtures than 1 trillion, while the least accurate sniffer could have identified almost 80 million distinct scents, the researchers say.

Humans undoubtedly distinguish more than 1 trillion smells, Keller says. Many more odor molecules and scent mixtures exist than were tested.

The findings suggest that humans can put broad odor discrimination to good use, says smell scientist Avery Gilbert, president of Synesthetics, Inc., a research consulting firm in Montclair, N.J. "People revel in perfumes and flavors because we can appreciate the nuances that smell provides." In contrast, nonhuman animals often focus on a relatively narrow range of species-specific scent signals that they discern with exquisite sensitivity, Gilbert says. Limited scent learning is possible, as in dogs trained to recognize the smell of hidden cocaine or explosives.

Many other animals may also discriminate a trillion or more odors, Sobel contends. For instance, mice possess about 1,000 genes that code for odor-sensing molecules, and flies have about 50 such genes. Smell-discrimination studies comparable to the new one have yet to be conducted on nonhuman animals. ■

The skull of *C. macei*, dated to 28 million years ago based on the age of the sediment layer it was found in, is 55 centimeters long and 27 centimeters wide. That makes the head comparable in size to a bottlenose dolphin's but with a slightly longer snout. The whale had features typically found in modern toothed whale species that echolocate, including thickening of the bone bordering the nasal opening, cavities in the back of the snout and a broad upper jaw. The similarities imply that *C. macei* probably used these traits to make sound, says Philip Gingerich, a paleontologist at the University of Michigan in Ann Arbor. "It would be difficult to interpret these observations any other way."

Unfortunately, not all of *C. macei*'s ear bones were recovered, says John Gatesy, an evolutionary biologist at the University of California, Riverside. "The structures preserved in the specimen examined here mostly have to do with sound generation and not hearing the echoed sounds that come back to the whale."

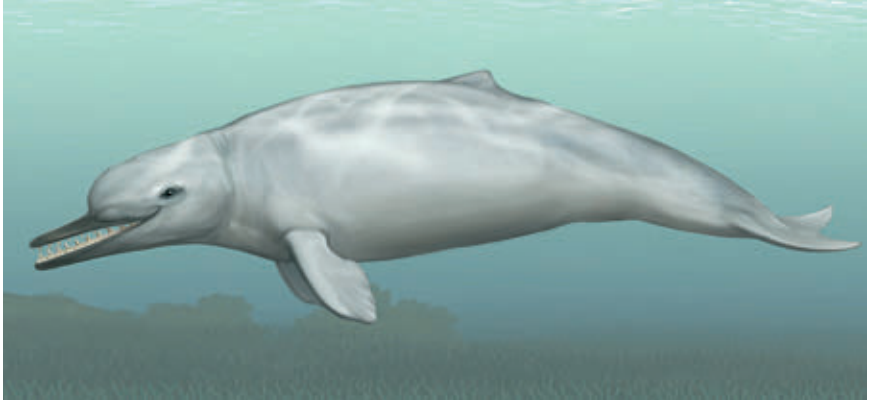
Geisler hopes to analyze other species closely related to *C. macei* to provide a more complete view of the evolution of echolocation. "The layers of sediment around the Charleston area are very rich in whale fossils, and there are a lot more we need to describe," he adds.

The researchers analyzed characteristics of *C. macei* and other extinct whales to construct a whale family tree and assess when echolocation might have evolved. The team estimates that underwater sonar may date back as far as 30 million to 34 million years ago. This period is also when *C. macei*'s ancestors, part of a now-extinct lineage, split from the ancestors of living toothed whales, dolphins and porpoises.

Geisler adds that whale fossils could even provide information about anatomical changes that may have allowed echolocation to evolve in other species. Bats that release sonar through their noses have a downturned snout similar to toothed whales'.

"The fossil record doesn't have all the answers," he says, "but it's starting to show how complex features such as echolocation evolved bit by bit over time." ■

Cotylocara macei, shown in this artist's representation, lived in an ocean that covered what is now South Carolina 28 million years ago and belonged to a now-extinct lineage of whales.



CARL BUELL

LIFE & EVOLUTION

Elephants pick out worrisome voices

Herds react to speech that they may recognize as dangerous

BY SUSAN MILIUS

Elephants may pick up on differences between the voices of men and women, and even between the speech sounds of two African ethnic groups.

Recordings of men's voices, or of Maasai voices versus those of another ethnic group, were likely to prompt a bit of defensive behavior among elephants in Kenya's Amboseli National Park. Animals edged closer together and changed their travel direction, report Karen McComb of the University of Sussex in England and colleagues.

Playing recorded voices to elephants "was a way of getting at whether they could pick up very subtle vocal cues to pick out which were the most dangerous situations, when faced with a really versatile predator," she says.

That versatile threat is of course humans. "Apart from lions, they're the main predator elephants have to worry about," McComb says. She and colleagues have shown that experienced elephant matriarchs differentiate between recorded roars of female and male lions, the latter of which pose the greater danger (*SN: 4/9/11, p. 10*).

Elephants' responses to human voices broadcast from a speaker suggest that the animals can tell a lot from how a person talks.

Elephants encounter many people in the park. But for a long time, the ones most likely to kill them have been Maasai men, whose voices were the most likely to trigger defensive behavior, the researchers report March 10 in the *Proceedings of the National Academy of Sciences*.

Maasai herd livestock and bring their animals into the park. Until recently, Maasai men hunted elephants that killed people or their livestock. In contrast, the Kamba people, whose voices didn't stir as much of a reaction, clash infrequently with elephants.

For the recordings, researchers asked 35 Maasai and Kamba volunteers to say in their own language, "Look, look over there. A group of elephants is coming." In overall sound, the two languages differ about as much as English and Spanish do, says coauthor Graeme Shannon, now at Colorado State University.

It took two field seasons to play the recordings for 47 elephant groups. The team then scored the intensity of the huddling reaction using a four-point scale. The more disturbing voices (male or Maasai) averaged above 1 on the scale (subtle reduction in diameter of the group) but did not reach 2 (interruption of activity and formation of a coordinated bunch within three minutes). The less threatening voices (female, boy or Kamba) ranked below 1.

Distinguishing male from female voices might seem trivial — just pick the deeper voice. But elephants are probably using other cues such as breathiness, McComb says. Digitally raising the pitch of recorded male voices and lowering the female ones did not fool the elephants.

That elephants with long experience of human contact would distinguish the voices most likely to be dangerous sounds perfectly plausible to Anne Clark of Binghamton University in New York. She studies urban crows, which learn a lot about signs of danger from people. ■

MATTER & ENERGY

Tractor beam tugs on objects with sound

Ultrasound machine pulls on a target visible to the naked eye

BY ANDREW GRANT

Tractor beams have hit the big time. A newly constructed device generates a beam of concentrated sound that, for the first time, exerts a continuous, perceptible tug on objects large enough to see. The researchers didn't actually reel in an object, but they demonstrated that an ultrasound tractor beam could do the job.

Using a tractor beam to haul a damaged spaceship may look simple on *Star Trek*, but nature makes it very difficult to pull objects from a distance. Waves of light or sound fired at an object tend to bounce off its surface like raindrops falling on an umbrella, collectively exerting a subtle nudge called radiation pressure that pushes the object away.

Christine Démoré, a physicist at the University of Dundee in Scotland, and colleagues set out to reverse the direction of that radiation pressure, so that an object would get pulled rather than pushed. The goal was to sculpt a beam of

BODY & BRAIN

Trial supplement is no elixir of life

Compound lets mice live healthier but not longer lives

BY TINA HESMAN SAEY

An experimental compound helps mice stay healthy longer, but it doesn't extend their lives.

The substance, known as SRT1720, is intended to mimic caloric restriction. Calorie restriction can stretch life span in a variety of organisms, including dogs, mice, rats, fruit flies, worms and yeast. Proteins known as sirtuins are necessary

COURTESY OF G. SHANNON

Watch a video of elephants reacting to human voices at **bit.ly/SN_voices**

sound waves to bounce off the target and then scatter in the direction opposite from the source of the beam. As a result, the object would get shoved backward, toward the beam's source.

Démoré and her team started with an ultrasound machine typically used in noninvasive surgery to destroy cancerous tumors. It consists of a 7.6-centimeter-long array of about 1,000 small pillars that move up and down 550,000 times a second. The team placed the machine in a tank of water and suspended a target a few centimeters above it with thread. Their target was a hollow, elongated prism-shaped shell of metal and rubber, 10 centimeters long and resembling a Toblerone chocolate bar.

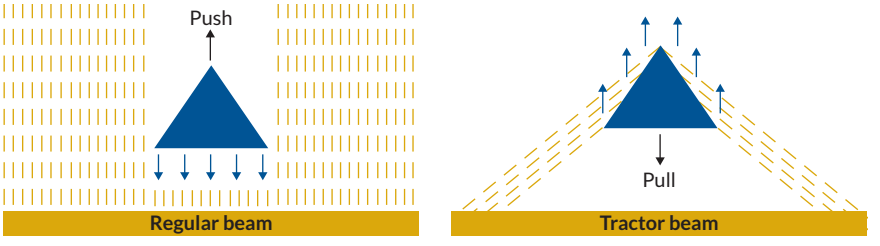
When they turned on the machine, the pillars' rapid motion generated waves of pressure that combined to form a beam of sound (beyond the range of human hearing). The pillar array sent out sound waves from each end. That enabled the two segments of the beam to converge on the target from the sides, and not from the bottom. The sound rebounded off the sides and scattered upward. Although the suspended target couldn't go far, it visibly inched downward and tugged on the thread. A scale measured that pull and confirmed that the net force acting on the target was directed straight down, toward the ultrasound machine. A paper detailing the tractor beam will appear in *Physical Review Letters*.

"It's a big step forward," says New York University physicist David Grier. However, he would have liked to see a demonstration of moving an object all the way to the tractor beam's source. "We haven't fully done the *Star Trek* thing where we bring something in to the ship," Démoré says. Her group hasn't run that experiment yet because it requires constructing a target that won't float or sink on its own, she says.

In 2010 Grier built the first tractor beam, a light-based version that yanked microscopic objects about the size of a bacterium backward nearly 10 micrometers (*SN Online: 3/10/11*). Unlike that device and subsequent iterations, the new tractor beam can tow objects visible to the naked eye because sound applies much more force than light. Sound also exerts an uninterrupted force as the object approaches the beam's source. "This is more like the tractor beams in sci-fi movies," says coauthor Patrick Dahl, who is now an engineer at Sonoscan outside Chicago. "It continuously pulls things in."

Sound can't travel through a vacuum, so this tractor beam will never round up space junk or aid space walking astronauts. But acoustic tractor beams could be useful in environmental sampling, Grier says, allowing scientists to analyze a chemical or geologic sample without risk of contaminating it by touching it. Dahl hopes the technology could also help with noninvasive surgery, allowing doctors to steer concentrated sound waves around ribs to destroy tumors. "The potential is there to do some pretty great things," he says. ■

Waves (yellow dashed lines) from a regular beam of light or sound (left) tend to bounce off an object (blue arrows) and deliver a subtle push. Waves from a new tractor beam (right) bounce off the sides of an object and rebound upward. As a result, the object gets pulled toward the source of the beam.



to achieve this life span extension, with sirtuin 1, or SIRT1, often regarded as the most important.

Scientists have been very interested in finding ways to imitate the benefits of caloric restriction in pill form. Researchers have used a chemical found in red wine to turn on SIRT1's antiaging activity. But that chemical, resveratrol, probably does lots of other things in the body too .

SRT1720 activates SIRT1 apparently without affecting other proteins.

In a study published in the March 13 *Cell Reports*, researchers found that the substance reduced inflammation, slowed down cataracts and improved cholesterol and other measures of a healthy metabolism in mice. What it didn't do was lengthen the rodents' maximum possible life spans. The mice tended to live no longer than 160 weeks — about three years — whether or not they ate the compound as part of a standard diet, report Rafael de Cabo of the National Institute on Aging in Baltimore and colleagues.

The researchers also tested whether the supplement could reverse the effects of an unhealthy diet. Mice were fed a high-fat diet starting at about 6 months old. Some of those mice also got SRT1720.

Mice on a high-fat diet died on average at about 80 weeks. None lived longer than 140 weeks, months less than their counterparts on a standard diet. The fat-fed mice that got the supplement were healthier, weighed less and had a longer average life span — about 110 weeks — than those that didn't eat the compound. But even with SRT1720's help, the longest-lived fat-fed mice could not make it past 140 weeks. "The compound delays the effect of the high-fat diet tremendously," de Cabo says, but eventually the animals pay for the unhealthy diet with a shortened maximum life span.

Geneticist Tomas Prolla of the University of Wisconsin–Madison says the results mean that "the root causes of aging have not been affected" by the drug. Compounds such as resveratrol (*SN: 8/2/08, p. 14*) and SRT1720 may improve quality of life, but researchers still haven't figured out how to lengthen it without restricting calories. ■

M. ATAROD

EARTH & ENVIRONMENT

Kangaroo gut microbes make eco-friendly gas

Marsupials' low methane could help researchers lower livestock emissions

Unlike ruminants, kangaroos produce low-methane effluvia, and researchers are discovering how they do it.

BY BETH MOLE

When kangaroos pass gas, the result is offensive to the nose but easy on the planet.

Marsupial flatulence and belches contain little or no methane, a potent greenhouse gas. The low emissions are thanks to the distinct mix of microbes in the kangaroo gut, according to a study that appears March 13 in the *ISME Journal*, a microbial ecology journal. By sniffing out the microbes responsible for the "green" gas, Australian researchers hope to glean ways of curtailing methane from other grazing animals.

Emissions from farm ruminants such as cows and goats account for up to 25 percent of methane released per year due to human-related activities.

To get to the bottom of kangaroos' low-methane emissions, microbiologist Scott Godwin of the Queensland Department of Agriculture, Fisheries and Forestry in Brisbane, Australia, and colleagues collected the foregut microbes of three wild eastern gray kangaroos that had been hunted for food.

The researchers fermented the harvested microbes in bottles alongside bottles of cow gut microbes, and then added a dash of molecules that produce carbon dioxide containing carbon-13, a heavy form of the element. "The idea is to trace where the carbon goes," says Godwin.

In the foregut, a kangaroo's meal of greenery is broken down by fermentation, with carbon dioxide and hydrogen left over. That's similar to what happens in cows and other ruminants, where microbes called methanogens gobble up those leftovers and transform them into methane. But in the kangaroos' guts, the team found something different.

When the researchers sucked out gas from the kangaroo bottles, which smelled like manure with a hint of vinegar and parmesan cheese, they found little methane, as expected. In the milieu, they discovered a spike in acetate made by bacteria called acetogens. These microbes compete with methanogens to use the carbon dioxide and hydrogen.

To pinpoint the acetogens in the kangaroo mix, Godwin harvested all of the microbial RNA from one batch of kangaroo gut microbes. Any organisms using the carbon-13 labeled molecules would

BODY & BRAIN

Better aging through brain chemistry

Serotonin and dopamine accompany worms' life span extension

BY LAURA SANDERS

It's no eternal youth, but worms on a very low-calorie diet produce high levels of certain neural chemicals even as they age. These chemicals may be key to longer, healthy lives, a new study suggests.

Unlike their normal counterparts, worms with a genetic mutation that makes them eat less maintain high levels of serotonin and dopamine as they get older, scientists report in the March 12 *Journal of Neuroscience*. But calorie restriction wasn't necessary to get some benefits: Extra serotonin on its own seemed to provide behavioral improvements and a modest life span boost.

It's too early to say whether the results hold true for other animals, but there are hints that some aspects of the brain's serotonin and dopamine machinery go awry in people as the years advance.

The worm results may help clarify which physiological changes can actually influence the aging process and which are just along for the ride, says geneticist Michael Petrascheck of the Scripps Research Institute in La Jolla, Calif. "The question is, 'Which ones really do matter?'" The new study suggests that in some cases, these brain chemicals may be important, he says.

Researchers led by Shi-Qing Cai of the Chinese Academy of Sciences in Shanghai noticed that in the roundworm *Caenorhabditis elegans*, old age came with diminished levels of serotonin and dopamine. These neurotransmitters help neurons send signals, some of which involve mood, pleasure, movement and eating. But a similar decline wasn't present in the worms that carried a mutation making them inefficient eaters. (The mutation, in the *eat-2* gene, extended worm life span by about 50 percent in previous experiments.)

Worms didn't have to eat less to get some benefits. Worms genetically altered to produce more serotonin throughout their lives showed improved feeding and mating behavior and a slightly longer life span than usual, Cai and colleagues found. On average, these worms lived 24 days, while normal worms lived 22 days. Worms that ate and absorbed serotonin late in life also showed behavioral improvements and lived slightly longer lives than normal, the team found. Extra dopamine didn't extend life span.

Human studies suggest that serotonin and dopamine signaling start to deteriorate beginning in middle age, Cai says. These changes may contribute both to

PRILL/SHUTTERSTOCK

incorporate some of it into their RNA, he reasoned.

After sequencing the RNA labeled with carbon-13, the researchers identified known acetogens, methanogens and some unclassified microbes. Godwin says he's not sure what all of the microbes do, but he was heartened to find the acetogen *Blautia coccoides*. The bacteria live in cows as well as in kangaroos, he says, so if researchers could find a way to boost the species in cattle, it could be a route to environmentally friendlier flatulence and belches.

In cows, methanogens usually outcompete acetogens because producing methane is more energy efficient than making acetate, explains rumen microbiologist Peter Janssen of the New Zealand Agricultural Greenhouse Gas Research Centre in Palmerston North.

Questions remain about how the kangaroo's methanogens are subdued, Janssen says. The marsupial's gut may be inhospitable to methanogens, he suggests. "It's an important first study," he says, but it's not the full story. "It's the clue where to look." ■

SINCLAIR STAMMERS/SCIENCE SOURCE

Calorie-restricted *C. elegans* maintain high levels of the brain chemicals serotonin and dopamine, unlike normal worms, a new study finds.

movement problems that come with age, such as difficulty walking and rigidity, and to more complex brain problems such as memory trouble, he says.

Most studies on aging focus on life span alone, Cai says, but "being healthy and living longer are equally important for elderly people." The new results in worms may provide a clue in the quest for healthier, longer lives, he says.

Petrascheck cautions that while the results are interesting, much of how the body and brain age remains mysterious, particularly in people. "I wouldn't say we're even close to understanding what drives aging," he says. "There is still a lot to be learned." ■

ATOM & COSMOS

Exoplanet oxygen may not signal life

Water and ultraviolet light could create the gas

BY CHRISTOPHER CROCKETT

The first sign of extraterrestrial life probably won't be a spaceship landing in a cornfield or a radio transmission from deep space. Most likely, the announcement will be encoded in the chemistry of a distant planet's atmosphere. On Earth, oxygen betrays life's presence. But oxygen in an exoplanet's atmosphere wouldn't necessarily indicate alien shrubbery. Two researchers argue that an ocean-bearing planet zapped by its sun's ultraviolet light could masquerade as a living world.

Photosynthesis produces Earth's oxygen. But Robin Wordsworth and Raymond Pierrehumbert, geophysicists at the University of Chicago, wondered whether there is another way for a rocky planet to have an abundance of the gas. The pair considered a deceptively simple scenario: a planet devoid of certain other gases, such as nitrogen. One of nitrogen's roles on Earth is to help form a low-temperature layer in the atmosphere that water can't get past, called a cold trap. On a planet without nitrogen gas, Wordsworth says, water would drift to a height where the planet's atmosphere would no longer shield it from UV radiation from the planet's sun. UV light would break water molecules into hydrogen, which would escape to space, and oxygen, which would stay behind.

Wordsworth and Pierrehumbert argue, in a paper posted March 11 at arXiv.org and in press at *Astrophysical Journal Letters,* that eventually enough oxygen could build up to create a different kind of cold trap that would stabilize and hold on to an oxygen atmosphere for billions of years. Without the trap, the oxygen would eventually either follow the hydrogen into space or be absorbed by rocks.

"What they have done is clever," says Jonathan Lunine, an astronomer at Cornell University. Astrobiologists have until now thought water was a potential oxygen source only on planets such as Venus, where a runaway greenhouse effect drove temperatures to spiral higher and higher, eventually boiling away the oceans. On Venus, hot temperatures broke down the planet's cold trap long ago, causing the planet to lose its water and hydrogen to space. Hypothetical alien astronomers, if they had pointed telescopes our way several billion years ago, would have briefly detected oxygen in Venus' atmosphere, but it wouldn't have been a sign of life. "It actually would have been the signature of a dying planet," Lunine says.

Wordsworth's work extends previous ideas about water destruction on Venus-like worlds to any rocky planet within a star's habitable zone, the region around a star where a planet could comfortably sustain liquid water.

Lisa Kaltenegger, an astronomer at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., says that most scientists don't think oxygen alone would be enough to claim the presence of life. Astrobiologists, she says, look at the big picture: the planet's orbit, its composition and the presence of oxygen in conjunction with other gases produced by life such as methane.

One issue with Wordsworth and Pierrehumbert's scenario, Lunine adds, is how a planet without nitrogen would come to exist. While the origin of Earth's nitrogen is a mystery, he says, it was probably delivered by asteroids and comets. Scientists expect other solar systems to be similar. "Still," he says, "the universe surprises us all the time."

Current telescopes aren't up to the task of testing these ideas. Getting a chemical reading from an exoplanet atmosphere is possible only for Jupiter-like giants orbiting nearby stars. But upcoming telescopes, including the Transiting Exoplanet Survey Satellite due to launch in 2017 and the James Webb Space Telescope in 2018, could let astronomers knock on the door of a sister Earth and see if anyone's home. ■

LIFE & EVOLUTION

A parasitic cuckoo can be a lifesaver

Intruder chick releases putrid goop that may foil predators

BY SUSAN MILIUS

A parasitic cuckoo chick foisted upon other birds can be luck in disguise, saving the nest with a disgusting defense.

Defense by cuckoo chicks of carrion crow nests at high risk of predator attack could be the first example of a parasitic bird's benefit to its host, says Daniela Canestrari, an ecologist at the University of Oviedo in Mieres, Spain.

About 1 percent of bird species, including cuckoos, outsource childcare by leaving eggs in other birds' nests. The intruder chick often kills or outcompetes the rightful offspring.

Chicks of the great spotted cuckoo (*Clamator glandarius*) don't directly kill chicks of the carrion crows (*Corvus corone corone*), so the crow parents have a chance of producing their own offspring. When lots of predators lurk, the cuckoo chick's strong defense mechanism — releasing a caustic, stinking slime from its rear — may explain why parasitized nests are more likely to fledge a crow chick than unparasitized ones. In the right circumstances, even cuckoo parasitism can turn into a mutually beneficial relationship, Canestrari and her colleagues argue in the March 21 *Science*.

A great spotted cuckoo chick (front) doesn't directly kill the carrion crow nestlings it grows up with and, in a crisis, it may benefit the entire nest.

An example of a benefit of brood parasitism is "exceedingly unusual and cool," says Claire Spottiswoode, an evolutionary biologist at the University of Cambridge.

A previous suggestion of a brood parasite's benefit, reported nearly 50 years ago from giant cowbirds parasitizing oropendola nests in Panama, hasn't stood up to later research, says cuckoo researcher Juan Soler of the Arid Zones Experimental Station in Spain.

Supposedly the cowbird chicks would pick parasitic botflies off the rightful nestlings. Later researchers dismissed the idea, questioning whether the young cowbirds could even grasp and yank off the parasites.

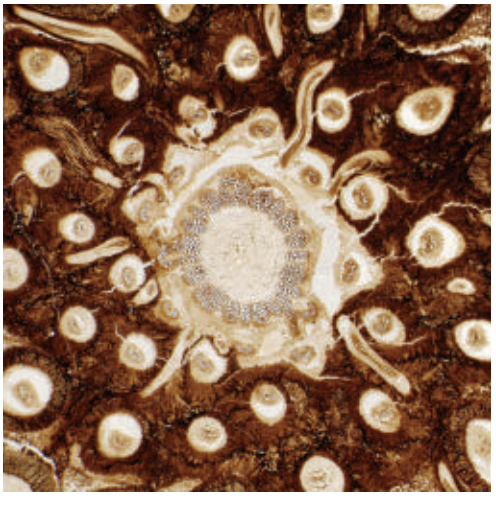
In the new study, researchers analyzed 741 carrion crow nests at a site in Spain over 16 years. Nests with at least one cuckoo chick in them were more likely (76 percent versus 54 percent) to fledge at least one crow nestling than were nests with no cuckoo chicks. There was a cost, though: Among the nests that survived, those with cuckoo chicks fledged on average only 2.1 crows, fewer than the 2.6 fledglings in nests without an intruder.

To see if the benefit seen was due to cuckoos simply targeting the most robust crow nests, the team added and removed cuckoo chicks. Nests with cuckoos were still more likely to fledge at least one crow.

When disturbed by intrusions such as a researcher grabbing a nestling, spotted cuckoo chicks defend themselves — and everything else within splattering distance — by releasing dark, sticky glop that's stinkier than their usual poop. "It's terrible," says Canestrari. "The worst part is that the smell doesn't go away when you wash, but lingers for a long time."

A chemical analysis revealed what she calls "an acid bomb." The goo contains substances known to repel animals, and tests with predators such as falcons confirmed the slime's power to disgust. Only one of 12 feral cats tried even a bite of meat coated in cuckoo excretions.

"I don't think that the results are broadly applicable to brood parasites in general," says Stephen Rothstein of the University of California, Santa Barbara. Nearly all other species of parasitic cuckoos and parasitic honeyguides kill all the host young. Even with parasitic cowbirds, "which are sometimes mistakenly cited as examples of parasites that are not very harmful," he says, hosts nearly always lose all of their young because cowbirds outcompete the host chicks. ■



LIFE & EVOLUTION

Fossil fern preserves chromosomes

After 180 million years buried in volcanic rock in the southern tip of Sweden, a recently discovered fern fossil looks almost as good as new.

Viewed under a microscope, thin slices (one shown) of the matchbox-sized fossil reveal cells jam-packed in the stem, like water balloons stuffed in a barrel. Inside the cells, within tiny dots of nuclei, chromosomes appear.

Such exquisite detail was probably preserved when minerals dissolved in hot, salty water rapidly solidified within the entombed, living plant, paleobotanist Benjamin Bomfleur of the Swedish Museum of Natural History in Stockholm and colleagues report in the March 21 *Science*.

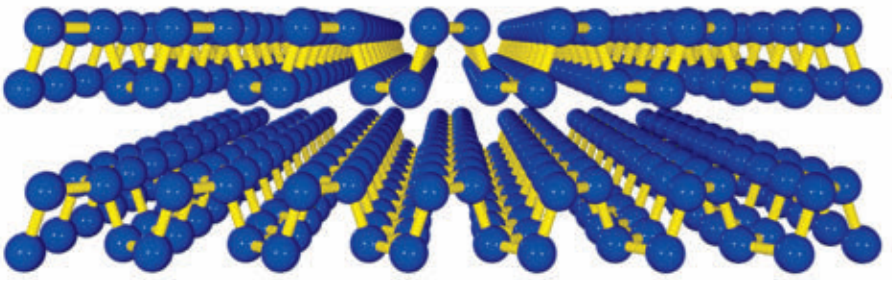
Because the fossil's nuclei closely resemble those of the modern cinnamon fern, *Osmundastrum cinnamomeum*, the researchers suggest that the plants' genomes probably haven't changed much since Early Jurassic dinosaurs prowled the planet. — *Meghan Rosen*

FROM TOP: COURTESY OF VITTORIO BAGLIONE; COURTESY OF B. BOMFLEUR

MATTER & ENERGY

Graphene alternative introduced

Phosphorene may lead to faster semiconductor electronics



P. YE

Sheets of phosphorus just one atom thick have a ridged structure, as shown in this illustration of two sheets. Graphene sheets, which are carbon atoms arranged in a honeycomb lattice, are flat.

BY ANDREW GRANT

Phosphorus has become the second element after carbon to be separated into sheets each a single atom thick, researchers announced March 7. The ultrathin material, dubbed phosphorene, could prove superior to its carbon counterpart for use in next-generation electronics.

Graphene, which consists of a flat honeycomb lattice of carbon atoms, has been the darling of materials scientists since 2004. Andre Geim and Kostya Novoselov peeled off sheets of graphite with Scotch tape, a simple step that produced graphene and was rewarded with the 2010 Nobel Prize in physics (*SN: 10/23/10, p. 16*). Among graphene's remarkable properties is that it can shuttle electrons rapidly while hardly heating up, which led some scientists to predict that it could replace silicon in computers and other electronics.

> "Graphene is beautiful, interesting and useless."
> DAVID TOMÁNEK

But graphene has one major and perhaps fatal flaw: Turning off the electron flow through the material is difficult. Silicon is a semiconductor, allowing transistors in computer chips to switch electric current on and off; graphene is a conductor. Some physicists say it's time to look for other thin materials that share the attractive properties of graphene but are semiconductors. "Graphene is beautiful, interesting and useless," says David Tománek, a physicist at Michigan State University.

While some scientists have moved on to compounds such as molybdenum disulfide, Tománek's colleague Peide Ye, a physicist at Purdue University, decided to explore black phosphorus, a stable variety of the element that forms under high temperature and pressure. He began by purchasing a chunk on eBay.

Ye, Tománek and their team measured the sample's properties and plugged the results into equations to predict how thin layers of the material would behave. The analysis suggested that phosphorene would transport charge better than silicon (though not as well as graphene); most importantly, it would be a semiconductor.

Then the researchers moved from theory to experiment. Borrowing the Scotch tape method from graphene manufacturing, the team isolated phosphorus layers just a few atoms thick and made transistors. In December, Ye exfoliated sheets just one atom thick, with phosphorus atoms arrayed in hexagonal ridges.

Researchers seem intrigued but skeptical about the new material. "Nothing really comes close to graphene" in a variety of properties, said MIT chemical engineer Michael Strano, emphasizing phosphorene's inferior charge transport speeds. But, he added, any new material with a unique combination of properties is exciting. Phosphorene could be layered like a Lego block in a stack with graphene or other thin materials to achieve distinct electronic properties. ■

MEETING NOTES

Temperature tunes magnetism

A small change in temperature can alter a new material's magnetic properties. The feature holds promise for building more dependable hard drives. Ivan Schuller of the University of California, San Diego described the material March 3. His creation consists of nickel layered atop vanadium oxide. The oxide is an insulator at low temperatures and a conductor at higher ones. By adding nickel, the hybrid material's magnetism became linked to temperature. Schuller and his team manipulated the material's coercivity, a measure of how difficult it is to switch the magnetic state, by adjusting temperature over a 20-degree-Celsius range. Schuller sees the material as the foundation of hard drives that would apply small magnetic fields to write data, and then when not in use, would raise the requisite magnetic field strength to prevent accidental overwriting. —*Andrew Grant*

Shifting grains help clarify earthquake lightning

Beads could help explain a rare phenomenon: lightning before or during big quakes. Results presented March 6 demonstrate that shifting granular materials, which simulate movement at a fault line, can induce high voltages. Troy Shinbrot of Rutgers University previously made a simple setup to see whether earth under stress could create conditions favorable for lightning. When he tipped a container of flour, a sensor registered a signal of about 100 volts (*SN: 7/14/12, p. 13*). Now he has put tanks of beads under pressure until one section slipped relative to another, like slabs of earth at a fault. The voltage surged during slips. The effect resembles static electricity, but that shouldn't build up in a single material. "It seems to us to be new physics," said Shinbrot. —*Andrew Grant*

HUMANS & SOCIETY

Roman gladiator school digitally rebuilt

Imaging tools revive ancient training facility with no excavation

BY BRUCE BOWER

Without breaking ground, researchers have uncovered the largely complete remains of a nearly 1,900-year-old Roman school for gladiators in what's now eastern Austria.

Advanced imaging techniques led to the discovery of a training center for these warrior-entertainers at Carnuntum, a Roman city excavated on and off since the late 19th century. The ancient facility lies beneath a field near the remains of an amphitheater that could have held about 13,000 spectators.

Wolfgang Neubauer of the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in Vienna and colleagues describe the discovery in the March *Antiquity*.

"This find for the first time gives an impression of how gladiatorial games were organized outside of Rome," Neubauer says.

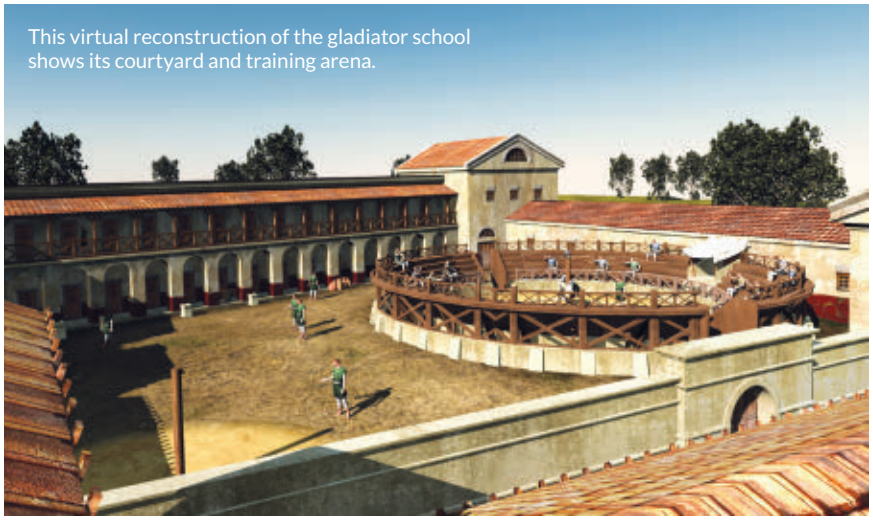
The only other gladiator school ever found has been partially excavated behind the Coliseum in Rome. Work at Pompeii has revealed gladiator housing located far from the city's amphitheater. Written accounts indicate that most gladiators were prisoners of war, slaves or criminals. Amphitheater confrontations featured gladiators battling other gladiators, wild animals and criminals condemned to death.

Data from noninvasive imaging enabled Neubauer's team to generate 3-D virtual reconstructions of the gladiator school.

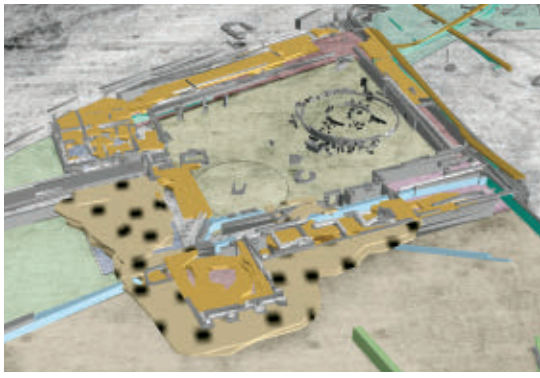
Research flights in the 1990s identified a field with soil and vegetation disturbances suggesting that structures lay beneath the surface. In 2000, a magnetic survey and ground-penetrating radar provided the first evidence of buildings buried in the field.

A 2011 investigation, aided by aerial and 3-D ground-based imaging techniques, revealed a rectangular building complex that covered about 1,700 square meters.

In the new reconstruction, an access path leads to an entranceway to the facility. Nearby buildings include an administrative center and living quarters for the school's owner and the owner's family. Previous archaeological finds in Rome and written accounts support that interpretation, the researchers say. Past the entranceway is a courtyard with a circular training arena. A hole in the arena's center may have held a wooden pole that gladiators practiced striking with swords and body slamming with shields.



This virtual reconstruction of the gladiator school shows its courtyard and training arena.



Ground-penetrating radar was used to produce a 3-D map of a gladiator school at the Roman site of Carnuntum in Austria. A path on the left leads to the facility and its inner courtyard, which featured a training arena.

Another part of the complex consists of a row of small cells that probably housed approximately 75 gladiators. One wing of the complex served as a Roman bath, where gladiators could recover from harsh training. A room in the bath area contains a circular depression in the floor that the researchers suspect was for a fountain or a well.

In a prominent rectangular building, used either as a training area or an assembly hall, the floor has partly collapsed, apparently into built-in hollow spaces. The spaces may be signs that the building was heated: In a previously known Roman technique, heat and smoke from a wood-burning furnace was funneled through floor and wall spaces and then out roof openings.

Neubauer's team was unable to locate a kitchen, dining hall, bathrooms or medical treatment room in the ancient center. Poorly preserved parts of the complex may have housed those essential facilities for resident gladiators-in-training, Neubauer says.

The work at Carnuntum offers a promising but preliminary view of the training facility, remarks archaeologist Ian Haynes of Newcastle University in England.

Without thorough excavations, he cautions, "visualizations can appear to suggest we know more about the structures in question than we necessarily do." Actual digging at the gladiator school site has yet to begin. ■

FROM TOP: LBI ARCHPRO; M. KLEIN/7REASONS

See more pictures of the gladiator school at **bit.ly/SN_gladiator**

MING SUN/UAH, SERGE MEUNIER, NASA, ESA

ATOM & COSMOS

Galaxy drags trail of stars behind it

It's raining stars in the Norma galaxy cluster. ESO 137-001, a galaxy 200 million light-years away in the constellation Triangulum Australe, drags along filaments of gas and stars as it plows through the cluster. The star streams are 260,000 light-years long — more than twice the length of the Milky Way. The streams form when ESO 137 slams into hot gas. Wind from the gas sweeps away debris from the galaxy, like confetti blowing off a parade float. The released gas clouds collapse and ignite new stars. The Hubble Space Telescope snapped pictures of the star streams (above right, blue), which blaze with the intense ultraviolet radiation of star birth. — *Christopher Crockett*

MATTER & ENERGY

Protein found in milk may be a nontoxic flame retardant

Milk: It may do a body good and protect fabrics as well. Italian researchers dunked cotton, polyester and a polyester-cotton blend into a liquid formula of powdered milk proteins called caseins, which are key to making cheese. The researchers found that the phosphate-rich proteins extinguished fires set on the fabrics, slowing the spread of blazes by 40 to 70 percent. Upon burning, caseins may release acids, such as phosphoric acid, that form a molecular firewall and keep the flames from fanning out, the researchers report in the March 12 *Industrial & Engineering Chemistry Research*. A casein-based flame retardant could be a safe alternative to fireproofing chemicals that give off toxic fumes. The milky fire extinguisher may have a delayed debut while the team works on a version that doesn't easily wash out or smell rancid. — *Beth Mole*

GENES & CELLS

Now-extinct moa thrived before people reached New Zealand

Humans probably caused the extinction of giant wingless birds called moas in New Zealand, DNA evidence suggests. Scientists have debated why nine species of moa went extinct about 100 years after Polynesians settled New Zealand around 1300. Various evidence suggests that people's hunting, setting fires and bringing competing species to the islands caused the big birds' demise. But recent genetic evidence hinted that moa were declining before people ever arrived. It was suggested that the birds may have been victims of disease and volcanic eruptions that reduced their numbers. An international team has now analyzed fuller DNA records from fossils of four moa species. The fossils range in age from around 600 to 13,000 years. The researchers saw no evidence of decline in genetic diversity over the last 4,000 years of the birds' existence. In fact, the population of one species, *Dinornis robustus*, increased, the team reports March 17 in the *Proceedings of the National Academy of Sciences*. — *Tina Hesman Saey*

BODY & BRAIN

MS milder when patients begin with higher vitamin D levels

Multiple sclerosis patients who harbor low levels of vitamin D early in their disease fare worse than patients with higher levels. MS is marked by damage to the myelin sheaths coating the brain's nerve fibers. The result can be an off-and-on series of symptoms including loss of muscle control, numbness and problems thinking. Vitamin D has shown promise in fighting a variety of diseases and may limit this MS onslaught (*SN: 7/16/11, p. 22*). In 2002, researchers studying the effect of the drug beta-interferon-1b against MS set aside blood samples from 465 patients. When researchers recently analyzed those samples, they found that patients who had had blood levels of vitamin D exceeding 20 nanograms per milliliter at six and 12 months after the onset of MS had fewer symptom flare-ups during the rest of the five-year study than those with lower readings did. Some scientists think 20 nanograms per milliliter is a healthy level; others see 30 as a healthier minimum. MRI scans revealed that, after five years, those who started out with low vitamin D levels had four times as much myelin damage as those with higher levels. The results appear in the March *JAMA Neurology*. — *Nathan Seppa*

Pianists learn better by playing

Instead of simply hearing a melody, learning to play a ditty makes people more familiar with it. The finding, published March 12 in *Cerebral Cortex*, provides evidence for the brain's enhanced ability to learn by doing. Researchers from McGill University in Montreal and INSERM, the National Institute of Health and Medical Research in France, asked 20 skilled pianists to each learn 12 simple melodies by listening to them or by playing them. In later tests, the pianists were better at spotting a single errant note in a recording of a piece they had played than at spotting a wrong note in a piece they had only heard. Electrodes monitoring the pianists' brain activity revealed that hearing a wrong note in a previously played song activated parts of the brain that handle movement. Physically doing a task sears its memory into the brain in a special way, the authors suggest. — *Laura Sanders*

Buying time

West Coast warning system could offer crucial seconds when earthquakes hit

By Alexandra Witze

At 2:46 p.m. on March 11, 2011, an earthquake-detection station on Japan's northeast coast began rocking back and forth, rattled by a powerful seismic wave racing from deep offshore. Just 5.4 seconds later, the Japan Meteorological Agency issued a notice that a magnitude 4.3 quake had begun.

As the seconds ticked by, however, and more stations picked up the rippling wave, the tremor started looking bigger. Three seconds after the first notice came an official warning: A quake of at least magnitude 7.2 was on its way. That's a big tremor, even for earthquake-prone Japan. The city of Sendai needed to act quickly.

Televisions, radios and cellphones blared alerts. Trains screeched to a halt. Assembly-line robots froze in place and schoolchildren dived under desks. Fifteen seconds later, the biggest earthquake in Japanese history rocked Sendai — a monstrous magnitude 9.0 accompanied by a tsunami that disastrously flooded two nuclear power plants in nearby Fukushima.

Earthquakes are impossible to predict. But in the last few years, officials in various countries have started alerting the public once a quake is under way. Seismic sensors and communications networks have improved to the point that electronic alerts can race ahead of seismic waves. Such notifications give a few crucial seconds during which emergency managers can secure natural gas lines, factory workers can shut down hazardous equipment and surgeons can withdraw their scalpels from patients. In Sendai, those 15 seconds of advance notice may have saved

Students at Twin Lakes Elementary School in Federal Way, Wash., take shelter under tables in a 2012 earthquake drill. Millions of people took part in the "Great ShakeOut" to prepare for the possibility of real quakes in the future.

TED S. WARREN/ASSOCIATED PRESS

many lives, making the catastrophic Tohoku earthquake at least a little less devastating.

Many other countries have seismic early warning systems. Japan's nationwide system has been in place since 2007. Mexico City gets public alerts when a big quake begins. Even Romania uses a small network of seismometers to alert nuclear reactor workers when the ground is about to shake.

The United States has no public warning system for incoming quakes — yet. Officials are seriously talking about launching a full-fledged early warning system for the quake-prone West Coast. In September, California Gov. Jerry Brown signed legislation that requires the state to figure out how to fund an earthquake early warning system by 2016. Lawmakers have yet to pony up the money, but even so "we are the closest we've ever been," says Richard Allen, a seismologist at the University of California, Berkeley.

California is close to taking action, in part, because of innovations that are improving the accuracy of warnings. In the last few years, earthquake specialists have begun incorporating real-time data from global positioning system stations, which measure how the ground moves. Traditional earthquake-monitoring systems rely on seismo meters, which measure the energy of seismic waves passing through the ground, but do not do a good job measuring big shifts from big quakes. Adding the GPS data produces a better estimate of exactly how a big earthquake propagates across hundreds of kilometers, and therefore what kind of hazard it may pose to people. During the Tohoku quake, for instance, the Japanese early warning system relied mostly on seismometer data, and thus underestimated the strength of shaking very far from where the quake began. The system didn't accurately warn people in Tokyo, 300 kilometers from Sendai, of their vulnerability.

New discoveries have essentially solved that problem. "We have the technology, we have the science, we have networks that can communicate quickly enough to provide warning," says Allen, who directs the Berkeley Seismological Laboratory. "It doesn't make any sense to wait for the next big earthquake. We should go ahead and do it."

Call to action

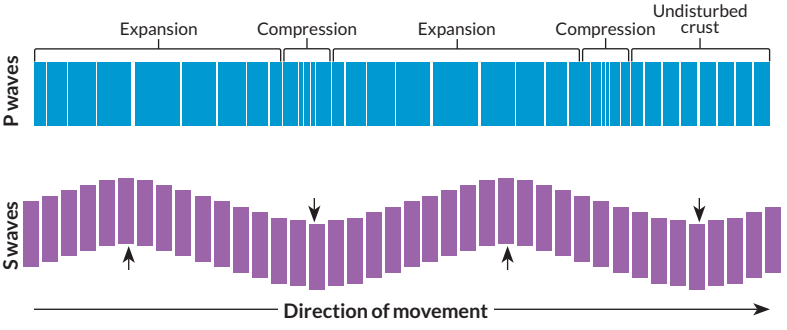
The idea of earthquake early warning is far from new. In 1868, a San Francisco physician proposed setting up an alarm bell in the city, strung by telegraph wires to some sort of faraway mechanical device that would generate an electric current if the ground started shaking. "This bell should be very large, of peculiar sound, and known to everybody as the earthquake bell," J.D. Cooper wrote in the *San Francisco Daily Bulletin*.

Turning the earthquake bell into reality took more than a century. After the 1989 Loma Prieta earthquake rocked the San Francisco Bay Area, the U.S. Geological Survey rigged a warning system to help protect workers who were trying to restore collapsed portions of an interstate in Oakland. USGS researchers peppered the area around the quake's epicenter with seismometers. When an aftershock hit, the stations automatically radioed a warning to the workers in Oakland, about 80 kilometers away. "It was a temporary system, but it worked," says Allen. In one case, it provided workers a warning as long as 20 seconds.

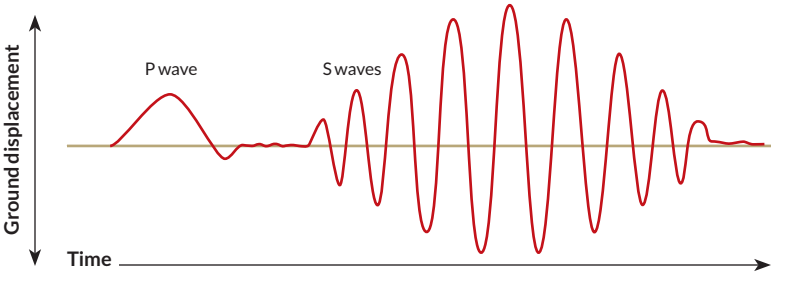
It took more than two decades for the next big advance. In 2011, the USGS and university partners debuted ShakeAlert, a prototype warning system that uses data from about 400 seismic monitoring stations across California. When an earthquake starts, the computer screen of a ShakeAlert user flashes a bright blue-and-yellow warning box. Numbers begin counting down to when ground shaking will begin at the user's location and how strong it will be. A blaring

Follow the wave Earthquake early warning systems rely on the fact that quakes produce several types of seismic waves. The first to arrive are P, or primary, waves and after that come S, or secondary, waves.

P waves travel as a series of contractions and expansions through Earth's crust, while S waves travel by shearing material at right angles to their direction of movement.



P waves travel roughly twice as fast as S waves, so they appear first on a seismograph. They serve as the initial warning to brace for the larger ground shaking that will arrive with the S waves.



E. OTWELL

alarm ensures that nobody misses the message.

Like other countries' early warning systems, ShakeAlert relies on the fact that earthquakes generate different types of seismic waves. P waves, or primary waves, shake the ground back and forth in the direction of travel. They move faster — at about 6 kilometers per second — and thus arrive first. P waves are noticeable but not particularly damaging. After the P waves come the S or secondary waves, which shake the ground up and down. S waves generate most of the ground movement during a quake and cause most damage to buildings and risk to people.

By triggering when a P wave arrives, an earthquake warning system can provide seconds to tens of seconds of warning before the S waves show up. The farther you are from the quake, the more warning you get.

The real science of ShakeAlert is in how it converts seismic signals into a warning. It uses three different algorithms, or sets of calculations, to analyze the seismic data. Each algorithm has its strengths and weaknesses; together they are meant to add up to the best possible prediction of how much the ground will shake.

The first algorithm, called Onsite, issues an alert once one seismic station has experienced three seconds of P wave shaking, followed by a second station detection. Onsite generally spits out alerts faster than the other two algorithms. Its drawback is that it also sends out a lot of false alarms, particularly when the research team simulates large earthquakes.

The second algorithm, ElarmS, offers a nice balance of speed and accuracy, says Allen. It kicks into gear on just 0.5 seconds of P wave data. But it won't send out an alarm until at least three other stations also sense the P waves. The idea is to cut down on the rate of false alarms by verifying motion at more than one station, and it seems to work, says Allen.

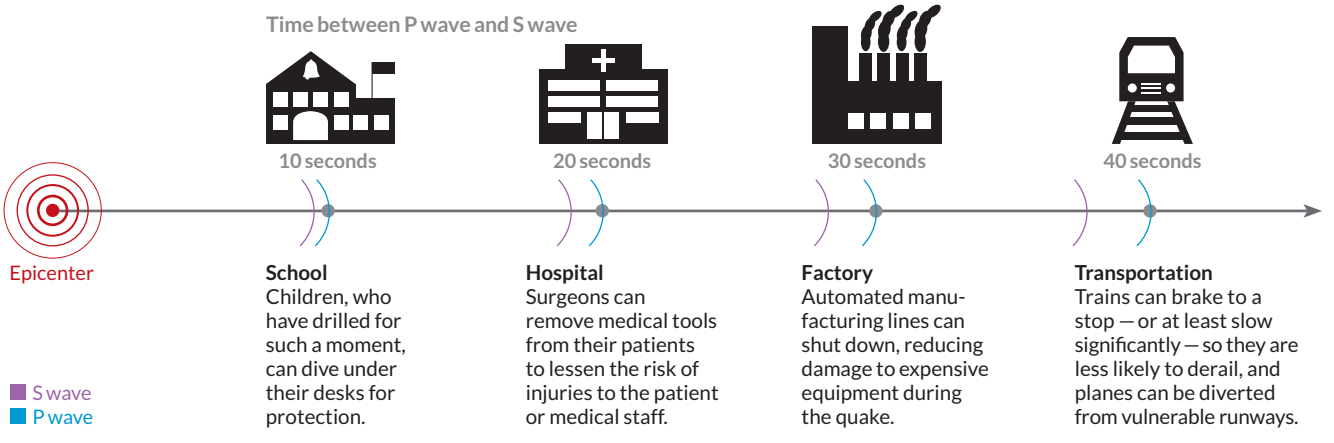
The third algorithm, with the less catchy name of Virtual Seismologist, triggers on three seconds of P waves, like Onsite. It's the slowest of the three because it runs through a series of complex analyses (taking into account factors such as the region's known fault hazards and the health of each station) before it issues any warning.

ShakeAlert combines all three algorithms to generate an estimate of how large a quake is and where its energy is radiating. The system's organizers tweak it regularly, sometimes giving more weight to ElarmS while dialing back on the Virtual Seismologist. Then they test it by seeing how well each combination performs on the small quakes that frequently rattle the California coast.

So far, the only groups who receive ShakeAlert alarms are carefully screened organizations that want to use the information in emergency planning and are willing to tolerate a few false alarms to help improve the system. They include the biotech company Amgen in Thousand Oaks, the Disneyland Resort in Anaheim, Los Angeles County's emergency managers and the BART rail system in the San Francisco Bay Area.

Earthquake early warning is particularly important for high-speed transportation, says John McPartland, a director of BART. On any given workday there could be 45 BART trains speeding along at up to 112 kilometers per hour. Those trains automatically start to decelerate if they receive a ShakeAlert alarm. "Within 24 seconds we can get the train to a complete stop," McPartland said at a meeting of the American Geophysical Union in San

This is not a drill An earthquake alert system works by detecting P waves with a network of seismic sensors. The system combines the signals to figure out the quake's epicenter, then sends an alert racing ahead of more damaging S waves so people have time to prepare. Some examples:



Francisco in December. "That's a huge advantage."

Simulations show that if the Loma Prieta quake were to happen again and an early warning system were in place, the cities where BART runs would get about 20 seconds warning. That's enough time to halt most trains, saving them from derailing.

Up the coast

California is the capital of U.S. earthquake early warning because it is the state with the highest seismic activity (after sparsely populated Alaska) and it already has the densest network of seismometers. The Pacific Northwest, however, faces the prospect of an earthquake that could dwarf even a Big One in California.

Here, the greatest seismic risk is the subduction zone known as Cascadia, where the Juan de Fuca crustal plate dives under the North American continent. The zone has been essentially locked in place since its last great quake, in the year 1700, when it ruptured in an estimated magnitude 9.0.

A similar quake today could devastate coastal communities as well as the major cities of Seattle, Portland and Vancouver. On the bright side, the fault is at least 75 kilometers offshore, far enough that an earthquake early warning system could give those cities up to 30 seconds of warning before the shaking hit.

Quakes in Oregon and Washington are monitored by a University of Washington–led group called the Pacific Northwest Seismic Network. The group joined ShakeAlert in 2012.

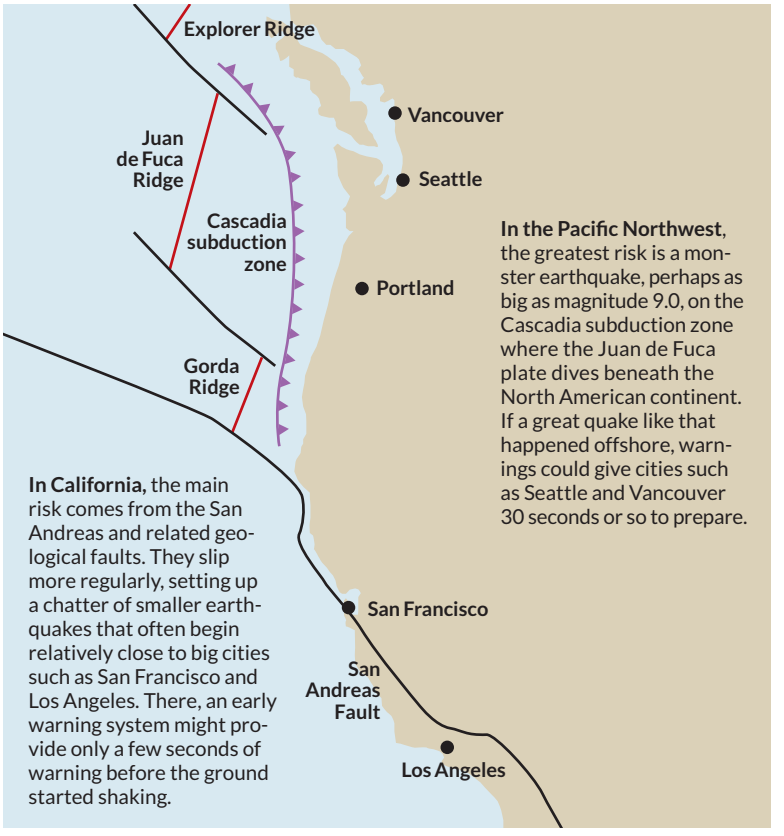
Because a Cascadia quake would be so enormous, any early warning system would have to accurately assess its magnitude from the start. And that's the problem with the early generation of ShakeAlert algorithms. Essentially, they treat an earthquake as occurring at a single point rather than recognizing that very large earthquakes can rupture for long distances, unzipping faults along the way. The Japanese system didn't warn Tokyo appropriately of the Tohoku quake because it failed to account for the quake's sheer physical size. It takes an entirely different set of calculations to account for seismic energy radiating from a fault plane rather than from a single point.

"We had known this was a limitation, but we were just focusing on getting the point-source algorithms working," says Allen. The Tohoku quake "was a push for us to solve the problem." In the last few years, seismologists have radically improved their algorithms to accurately capture these large quakes.

One new algorithm, called FinDer, maps a rupture in real time by comparing ground shaking measured by a seismic network with a set of precalculated values, says Maren Böse, a seismologist at Caltech who helped develop the system. Böse tests FinDer by simulating how it would have performed in hypothetical or past quakes. It does a good job, she says, at figuring out the real-time rupturing during a magnitude 7.8 test scenario on southern California's San Andreas fault.

The system could do even better by incorporating measurements from GPS stations. Whereas seismic stations measure waves of seismic energy passing through the ground, GPS measures the large physical displacement caused by the ground moving. Such measurements provide a direct look at how far and how fast a fault is ripping apart.

In California, data from dozens of GPS stations near San Francisco and Los Angeles flow into ShakeAlert along with the traditional seismic information. Combining the two makes for more accurate warnings, says Allen; ShakeAlert is testing several algorithms, including a version of ElarmS that incorporates GPS data. Once these are fine-tuned to catch earthquakes as best as possible, they will likely become a permanent part of ShakeAlert.



Here or there

Building an earthquake early warning system for the entire U.S. West Coast is challenging because of the very different seismic hazards across the region.

SOURCE: U.S. GEOLOGICAL SURVEY

E. OTWELL

The blind zone

The team is also working to reduce the blind zone, or the area so close to a quake that there is essentially no time to provide a warning. In California, the distance between seismic stations varies dramatically; in cities they can be less than 5 kilometers apart, whereas in the sparsely populated northern counties, 70 kilometers may separate them. The farther apart the stations, the sparser the information flow in the case of an earthquake.

Allen and his colleague H. Serdar Kuyuk, also of UC Berkeley, recently studied how much they could shrink the blind zone if stations were closer together. Their calculations showed that a typical California earthquake, occurring 8 kilometers deep, would mean a blind zone about 32 kilometers across no matter how closely spaced the stations. Within that circle, there's simply no time to disseminate an alert based on P waves before the more damaging S waves strike. Still, to give as many people as possible the best warning, stations should be placed less than 10 kilometers apart in urban areas on known faults, the team wrote last year in *Seismological Research Letters*.

All such suggestions remain purely theoretical unless the state of California decides to fund the next step for ShakeAlert. To become truly operational, the state will need to build hundreds more seismic and GPS stations across the state, as well as roll out a huge public education effort to tell people what to do once they get an earthquake alert. "An early warning that you don't know what to do with is not an early warning," says Peggy Hellweg, operations manager at the Berkeley Seismological Laboratory.

The cost to build and operate a California-wide system for five years would be $80 million; a Pacific Northwest system would require another $40 million. After the initial five years, operating costs would run $16 million annually for the entire West Coast. That's about twice what the region currently spends on earthquake monitoring.

California's Office of Emergency Services has been tasked with finding money for the state's contribution; it is due to report back with options for what a system might look like by the end of June. If money isn't found by January 2016, the law requiring an earthquake early warning system expires.

Yet between the legislative push and the new technological developments, scientists hope to have an early warning system in place to buy crucial time for West Coast inhabitants before the next big quake. "It's amazing to see such rampant progress both in terms of developing new ideas and in turning those ideas into things that are actually working," says Thomas Heaton, a seismologist at Caltech. "It's been a very exciting time for us." ■

Explore more

- California Integrated Seismic Network: www.cisn.org
- Earthquake early warning research at Caltech: www.eew.caltech.edu
- Pacific Northwest Seismic Network: http://pnsn.org

Personal quake detectors

Chances are, you've got an earthquake detector in your pocket.

Earthquake specialists are hunting for new, nontraditional sources of seismic data to flesh out traditional seismic monitoring. Any device that can measure shaking and is hooked into a network that tracks its location has the potential to become a quake-catcher. In California, there are about 16 million smartphones fitting that description.

At the University of California, Berkeley, Richard Allen and his colleagues are developing a smartphone app, called MyShake, that uses a phone's built-in accelerometer to sense shaking from earthquakes.

"This is never going to replace our traditional seismic networks," says Allen. "It's just an additional source of data." Accelerometers inside today's phones can detect a magnitude 5.0 earthquake that strikes within 10 kilometers, and soon should be able to detect a magnitude 3.0 within 100 kilometers, he says. Because an earthquake ripples over such a large area, the scientists can distinguish the distributed pings of seismic shaking from an individual iPhone lurching around in a backpack.

People without smartphones can become part of the Quake-Catcher Network, which uses small accelerometers bolted to the floors of houses and offices and wired to Internet-connected computers. Quake-Catcher software monitors signals from its 2,000-plus sensors, and by combining them can rule out sources like trucks rumbling by or doors slamming. Because geology can vary on the scale of city blocks, the shaking measured by neighborhood Quake-Catchers can reveal which addresses are particularly vulnerable in a given earthquake. "It just makes a lot of sense," says seismologist Elizabeth Cochran of the USGS Pasadena office.

Crowdsourcing earthquake sensors is one approach; another is to monitor the flow of quake chatter online. Seismologist Rémy Bossu watches traffic on the website of the European-Mediterranean Seismological Centre, in Strasbourg, France, to see who might have just felt an earthquake and runs to the Internet to check it out. And Paul Earle of the USGS in Golden, Colo., uses Twitter to confirm ground shaking by searching for the keyword "earthquake" in tweets.

— Alexandra Witze

PHONE: HOCUS-FOCUS/ISTOCKPHOTO; SCREEN: MYQUAKE UC BERKELEY EARTHQUAKE APP

“To you, it’s the perfect lift chair. To me, it’s the best sleep chair I’ve ever had.”

— J. Fitzgerald, VA

Remote Controls for Heat, Massage, Recline and Lift

We’ve all had nights when we just can’t lie down in bed and sleep, whether it’s from heartburn, cardiac problems, hip or back aches – could be a variety of reasons. Those are the nights we’d give anything for a comfortable chair to sleep in, one that reclines to exactly the right degree, raises feet and legs to precisely the desired level, supports the head and shoulders properly, operates easily even in the dead of night, and sends a hopeful sleeper right off to dreamland.

Our Perfect Sleep Chair is just the chair to do it all. It’s a chair, true – the finest of lift chairs – but this chair is so much more! It’s designed to provide total comfort and relaxation not found in other chairs. It can’t be beat for comfortable, long-term sitting, TV viewing, relaxed reclining and – yes! – peaceful sleep. Our chair’s recline technology allows you to pause the chair in an infinite number of positions, including the Trendelenburg position and the zero gravity position where your body experiences a minimum of internal and external stresses. You’ll love the other benefits, too: It helps with correct spinal alignment, promotes back pressure relief, and encourages better posture to prevent back and muscle pain.

And there’s more! The overstuffed, oversized biscuit style back and unique seat design will cradle you in comfort. Generously filled, wide armrests provide enhanced arm support when sitting or reclining. The high and low heat settings along with the dozens of massage settings, can provide a soothing relaxation you might get at a spa – just imagine getting all that in a lift chair! Weight capacity 375 lbs. Shipping charge includes white glove delivery. Professionals will deliver the chair to the exact spot in your home where you want it, unpack it, inspect it, test it, position it, and even carry the packaging away! Includes one year service warranty and your choice of fabrics and colors – ships in approximately three business days.

The Perfect Sleep Chair

Call now toll free for our lowest price.

Please mention code 47889 when ordering.

1-877-670-8854

46357

Long Lasting DuraLux Leather

Tan | Brown | Burgundy

DuraLux2 Microfiber

Burgundy | Cashmere | Fern | Chocolate | Indigo

Whooping Cough Bounces BACK

Replacement vaccine is not so great at protecting kids

By Nathan Seppa

Whooping cough has turned up in North America after decades of near absence, and we have only ourselves to blame.

In the last several years, the highly contagious microbe that causes whooping cough has spawned a string of outbreaks, adeptly piercing the shield of vaccination that once afforded solid protection against it. The last time whooping cough was this pervasive in the United States, Dwight Eisenhower was president and newscasters were smoking cigarettes on TV.

Caused by the *Bordetella pertussis* bacterium, whooping cough is emerging from the shadows in response to a fateful switch of vaccines embraced in the 1990s, just when it seemed the disease was licked. The vaccine used today has proved less potent than its predecessor. Meanwhile, curious changes are appearing in the pertussis bacterium itself, possibly in response to the weaker vaccine, and they may further undermine its effect. To top it off, a phobia against vaccines has induced some parents to skip or delay their kids' shots, contributing to the disease's spread (see Page 26).

"The newer vaccine's protection wanes over time, the pathogen is morphing and more patients aren't getting vaccinated on time," says Jason Glanz, an epidemiologist at the University of Colorado Denver and the Kaiser Permanente Institute for Health Research Colorado. "Put them together and you get greatly increased risk."

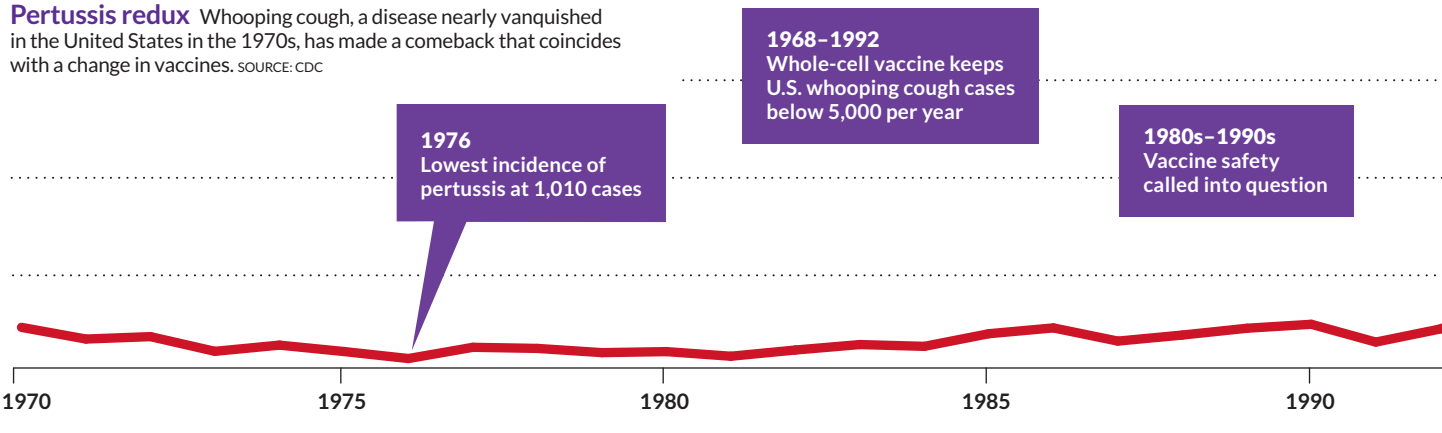
A worrisome trend

Whooping cough, also called pertussis, is easy to catch and hard to shake. The trademark symptom is three weeks of a wrenching, can't-catch-your-breath cough, but it can last longer. The disease is treatable with antibiotics early on. But by the time the coughing starts, the bacteria targeted by these drugs have left behind toxins that infiltrate cells lining the airways of the body (see diagram, Page 25). Whooping cough can be fatal in infants, often by leading to pneumonia.

In its prevaccination heyday in the 1930s, whooping cough was a major problem, sickening between 100,000 and 265,000 people a year in the United States. But after scientists developed a vaccine and put it to use (combined with vaccines for diphtheria and tetanus) in the 1940s, cases dropped steadily to a low of 1,010 in 1976. From then until the 1990s, many doctors rarely saw a case.

U.S. cases stayed well below 5,000 per year until 1993. But during the 1990s, the newer vaccine (also with diphtheria and tetanus vaccines) replaced the old one and rates began to rise. California's 2010 outbreak reached epidemic proportions, with 9,120 people sickened and 10 infants dead. In 2012, the state of Washington reported 4,916 cases, Minnesota 4,142 and Wisconsin 6,880. The Centers for Disease Control and Prevention tallied more than 48,000 cases nationwide that year,

Pertussis redux Whooping cough, a disease nearly vanquished in the United States in the 1970s, has made a comeback that coincides with a change in vaccines. SOURCE: CDC



including 20 deaths. The 2012 toll was the highest since 1955. Canada, Australia and Europe have also had recent bouts with pertussis after adopting the newer vaccine.

Yet many poor countries have dodged the problem, maintaining low infection rates by sticking with the older vaccine.

The West appears loath to go back to the older, tougher vaccine out of fear that its dramatic but harmless side effects might further put off parents already dubious about vaccinating their children. So health officials are exploring ways to improve the newer vaccine. Devising, testing and getting approval for a more potent version, however, could take up to a decade.

Side effects backlash

People in the United States who are in their late teens or older probably received one of several old pertussis vaccines. That inactivated, whole-cell vaccine offers up the full pertussis bacterium, bristling with scores of proteins that our bodies recognize as foreign and build an immune response against. The resulting all-hands-on-deck response engenders immune memory that will awaken when faced with a live pertussis bacterium, even years later.

But the whole-cell vaccine's rampant immune reaction carries a downside. Babies commonly run fevers, get agitated and feel pain at the injection site. "Those babies are really unhappy," says James Cherry, a semiretired infectious disease physician at the UCLA School of Medicine.

Harsher reactions can occur, too. Among more than 15,000 babies included in a 1981 analysis by Cherry and his colleagues, nine developed seizures shortly after an injection and nine others had an episode of listlessness. None of the babies showed long-term effects from these episodes, but such events are alarming for parents, Cherry says.

On top of that, the whole-cell pertussis vaccine was dogged by allegations that it might cause encephalopathy, which carries the risk of brain damage. Starting in 1946, anecdotal cases dribbled in that seemed to link encephalopathy in babies with the whole-cell vaccine. But a 1983 analysis of 33 cases found no connection.

Nevertheless, by then the specter of side effects had attached to the whole-cell vaccine like a burr. It didn't help that the shots made many babies miserable, so a search began for an alternative vaccine that didn't use a whole cell. Public health officials endorsed the goal, and pharmaceutical companies developed acellular — meaning no cell — vaccines that contain up to five of the antigens found on the pertussis bacterium. Fewer antigens would still trigger immunity, scientists figured, with fewer side effects.

"What drove acellular vaccine development was misinformation about encephalopathy," Cherry says. Although five studies in the 1990s showed the whole-cell vaccines still worked better, the push for acellular shots gained momentum.

The acellular vaccines tested well enough. Some even outperformed a whole-cell pertussis vaccine in Italian and Swedish trials published in 1996 in the *New England Journal of Medicine*.

But Stanley Plotkin, a pediatrician formerly at the University of Pennsylvania and inventor of the widely used rubella vaccine, recalls that the whole-cell vaccine used for these comparisons was an oddly ineffective version made by Connaught Laboratories that protected only about one-third of recipients. Another whole-cell pertussis shot, CDC reported a year later, protected recipients at rates of 83 to 94 percent. Comparing the new acellular versions with a weak whole-cell vaccine "made the acellular vaccines look good," says Plotkin, who currently advises vaccine maker Sanofi Pasteur.

Those two European trials were also brief, following children less than three years on average. Other trials were shorter. In

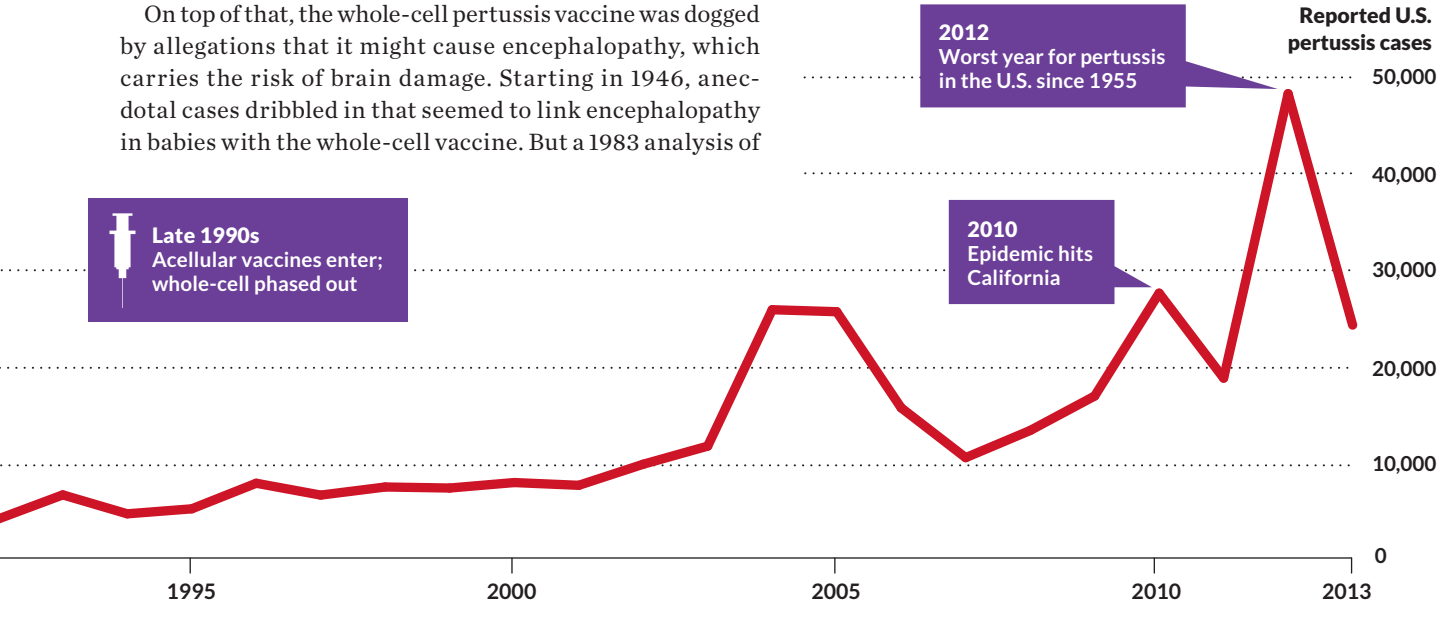
Pertussis rebound

U.S. whooping cough cases at peak before vaccines (top), with whole-cell vaccines (middle) and with acellular vaccines

1934
265,269

1976
1,010

2012
48,277

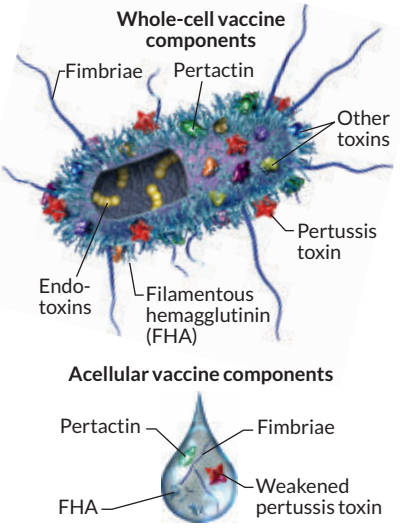


each, the acellular vaccine seemed to impart protection and had few side effects. "People wanted this to work," Cherry recalls.

Whooping cough was on the ropes at the time. Whole-cell vaccines had established a semblance of "herd immunity," says Stacey Martin, a CDC epidemiologist. With so many people protected, the pathogen had trouble getting a foothold in the population. This respite allowed people to focus on other matters, such as vaccine side effects.

Just as the first acellular pertussis shots were getting approved during the 1990s, vaccines of all stripes came under fire. A paper linking the measles-mumps-rubella vaccine to autism appeared in *Lancet*. Although retracted years later, it damaged vaccines in the public eye. Other false claims arose on front pages only to be refuted later with less fanfare. Vaccine safety had become an issue, and the whole-cell pertussis vaccine — with its history of squalling babies — was an easy target.

Tale of two vaccines Whole-cell pertussis vaccines are inactivated bacteria with many antigens, including endotoxins, which trigger broad immunity. The acellular vaccines use only a few antigens, including a weakened pertussis toxin, to limit side effects.



Public health agencies in many developed countries began to recommend the acellular vaccine in the late 1990s. "The switch was made because of parental concern about these side effects," says Douglas Opel, a pediatrician and researcher at the University of Washington in Seattle. "Unfortunately, what we got was something that doesn't work as well. And because of that, we've got more pertussis."

Protection fades

Soon after whooping cough outbreaks in 2010 to 2012 sent tens of thousands of people to doctors, the hammer of science dropped squarely on the acellular vaccine. Physicians Nicola Klein and Roger Baxter and their team at the Kaiser Permanente Vaccine Study Center in Oakland, Calif., tapped into the massive Kaiser patient database to identify people who had gotten a course of acellular shots in early life. During 2006 and 2011, they found, the acellular vaccine protected only 53 to 64 percent of kids who got it.

It occurred to the researchers that U.S. teenagers — who were babies in the 1990s — represented a mixed group of vaccine recipients. Some had gotten the old whole-cell pertussis shots as infants and others received acellular shots. When the Kaiser researchers assessed more than 1,000 teens for signs of the pertussis microbe, they found it in only 3.4 percent of children who had received whole-cell shots but in 18.3 percent of the acellular vaccine recipients. Kids who got the newer vaccine had failed to fully fight off the bacteria when exposed to it.

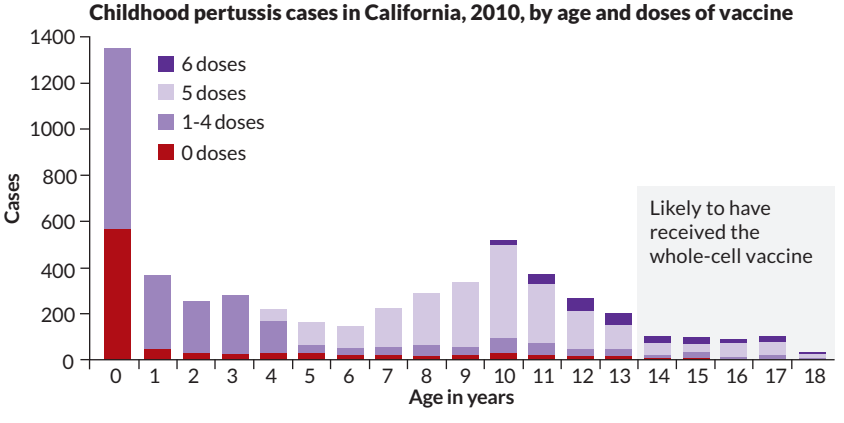
The researchers also looked at how children ages 4 to 12 fared during the outbreak. These kids typically got five doses of the acellular vaccine spread out from age 2 months to 7 years. Their protection seemed short-lived, even after five doses. Their odds of getting pertussis rose by 42 percent per year after the final shot. That report appeared in 2012 in the *New England Journal of Medicine*.

Plotkin says these long-term problems didn't show up in the earlier trials that led to approval and adoption of acellular vaccines. In retrospect, he says, researchers "did not understand that the immunology of acellular would lead to faster waning of immunity." Exactly why protection fades is still being sorted out.

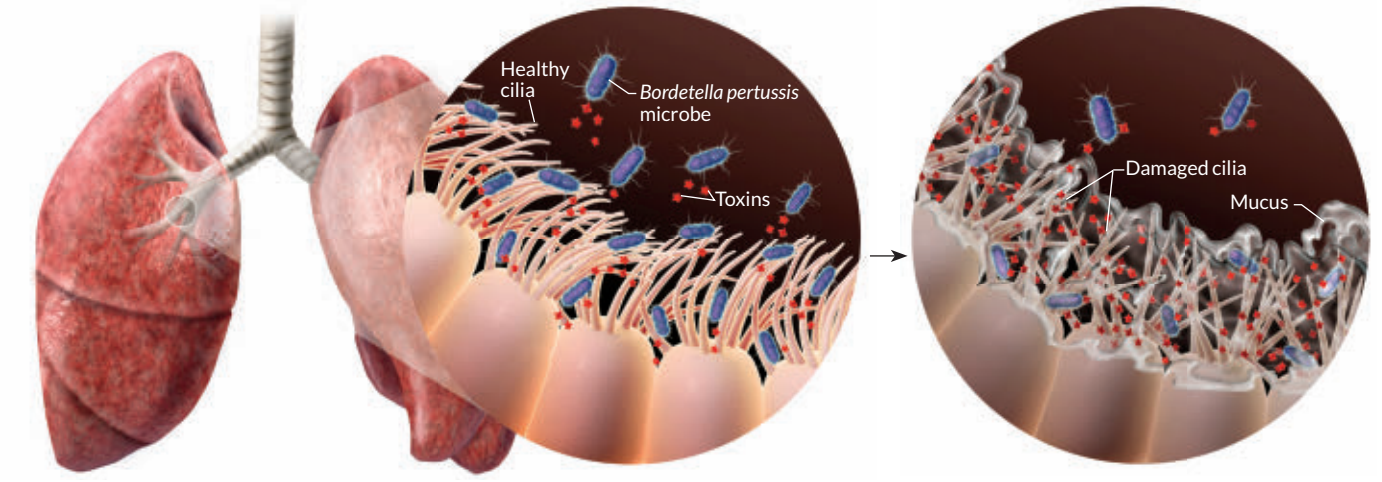
The same incomplete protection showed up in a 2013 study that involved baboons (*SN Online: 11/25/13*). Researchers vaccinated infant baboons with three shots of either an acellular vaccine, a whole-cell vaccine or gave no vaccine. When scientists exposed them to live pertussis at age 7 months, the unvaccinated baboons predictably got sick. Neither of the other groups showed any severe symptoms, but those that received the acellular vaccine retained live pertussis microbes in their nasal cavities, meaning they could still transmit the disease, and they did in fact give it to other healthy baboons. The animals that got the whole-cell vaccine demolished the invading microbes, a U.S. Food and

Babies bear the brunt In children with a traceable vaccination history who had whooping cough in California in 2010, newborns fared the worst. The first three vaccinations for pertussis are recommended at 2, 4 and 6 months, with a fourth dose between months 15 and 18 and a final shot around kindergarten. This chart shows strong protection around the time of the fifth dose, but it fades by the preteen years. Children born in the mid-1990s or earlier exhibited long-lasting protection from whole-cell shots they received as babies.

SOURCE: K. WINTER *ET AL*/*JOURNAL OF PEDIATRICS* 2012



FROM TOP: NICOLLE RAGER FULLER; M. ATAROD



Settling in Pertussis bacteria attack cells lining the airways in the body. The ropelike structures shown are cilia, extensions of cells lining these airways. Cilia are housekeepers that sweep away dirt and other inhaled foreign objects that have been caught in the protective mucus produced by cells. In a whooping cough infection, the pertussis microbes use adhesive proteins to glom onto the lining while releasing toxins that damage the cells, impair cilia, trigger inflammation and increase mucus production. The body resorts to coughing.
SOURCE: M.C. SOANE *ET AL/RESPIRATORY MEDICINE* 2000 AND J. CHERRY/UCLA

Drug Administration team reported in the *Proceedings of the National Academy of Sciences*.

The FDA study offered "the first hard data" in support of lingering transmissibility even after acellular vaccination, Martin says. "One of the things we rely on is herd immunity. If you're not effectively eliminating transmission, herd immunity may not be achievable." That could spell trouble for children who don't get vaccinated, since their only protection comes from being part of the "herd."

A moving target

B. pertussis does its dirty work with a slew of key compounds. Some are toxins that irritate cells lining the windpipe and airways of the lungs and send people into severe coughing jags. Others are dubbed adhesins because they help the microbe stick to these tissues. The microbe's genetic instructions for building these adhesins has changed, according to recent evidence. That's bad news for an already weak vaccine.

Since 2000, tests of pertussis samples in Japan have shown a loss of one of its key adhesins — pertactin — which is often a component of the acellular vaccine.

CDC biologist Lucia Pawloski and her colleagues screened 1,300 pertussis microbe samples collected from patients from 1935 to 2012 and found that 306 seemed unable to make pertactin. All but one of those dated to 2010 or later, suggesting that the pathogen morphed recently. The researchers described their findings in *Clinical and Vaccine Immunology* in 2013. They've also identified at least 10 mutations in the gene that encodes pertactin.

European researchers, writing in the October 2012 *Clinical and Vaccine Immunology*, called pertactin loss "alarming." If the immune system is primed by the vaccine to recognize pertactin, but the bacteria has evolved to no longer carry it, the immune system may be less likely to "see" and go after the invader. While this hasn't been established, Plotkin says, "it's disturbing because it means the pertactin portion of the vaccine may no longer have an effect."

B. pertussis apparently is also undergoing genetic changes that increase production of the pertussis toxin, researchers in the Netherlands reported in 2009 in *Emerging Infectious Diseases*. They suggested that use of the relatively weak acellular vaccine encouraged these changes in the microbe.

No going back

Some of the resurgence in pertussis may result from better detection of the disease in clinics, says Cherry. But he and others agree that the acellular vaccine is underperforming and that a better shot is needed. "If you put in 10 new antigens, that might be good," Cherry says, "but you need to get the balance right."

Maybe dosing can be tweaked to add boosters. The current vaccine regimen stops at five shots for most people; some scientists believe that's not enough. Booster shots given later might rekindle some immunity, and acellular vaccine boosters have proved safe to give to the elderly.

But the thinking on boosters is in flux. The Advisory Committee on Immunization Practices, which advises CDC on vaccination schedules, decided against calling for boosters in 2013. Even though acellular vaccine protection fades over time, the panel reasoned that boosters would add only modest protection and would be expensive. Cherry, a former member of ACIP, says money never used to be part of the equation. "We never discussed the cost of anything when I was on it. It's just scientifically sound" to vaccinate, he says. "This to me is very appalling."

ACIP Chair Jonathan Temte, a family physician at the University of Wisconsin–Madison, says the panel is instead making a priority of vaccinating pregnant women in the third trimester.

"Current policy is aimed at trying to protect individuals who

NICOLLE RAGER FULLER

are the most vulnerable, infants in their first six months of life," Temte says. Late-pregnancy vaccination triggers immunity that carries over to the newborn, and is part of a larger strategy endorsed by ACIP that scientists call "cocooning," in which a newborn in the house is surrounded by family members and caregivers who have been freshly immunized.

But none of the suggestions — improving the acellular vaccine, pregnancy vaccination or boosters — seize upon an obvious alternative: Switch back to a whole-cell pertussis vaccine.

The whole-cell vaccine is still used in more than half the world, including India, Indonesia, South America, most of Africa and Pakistan, with good results. In Thailand, for example, where about 90 percent of pertussis shots given are whole-cell, whooping cough has steadily declined and there is "a substantial rise in herd immunity," scientists reported in the June 4, 2013 *Proceedings of the National Academy of Sciences*.

But no one interviewed for this story expects the United States to embrace whole-cell again.

"I certainly would be happy to go back to the whole-cell vaccine," Kaiser Permanente's Klein says. "It seemed to provide longer-lasting immunity. But I think the climate on refusal and hesitancy is such that it's a completely different world. I don't know that most parents would accept [it] at this point." ■

Explore more

- Nicola P. Klein *et al*. "Comparative effectiveness of acellular versus whole-cell pertussis vaccines in teenagers." *Pediatrics*. June 1, 2013.

Refusals and delays

U.S. schools typically require vaccination for pertussis and other infectious diseases before kindergarten. States allow exemptions, however, for medical, religious or philosophical beliefs. States with easy-to-get exemptions had roughly 50 percent more pertussis cases than states that made it harder to skip shots, according to a 2006 report in *JAMA* by Saad Omer of Emory University and his colleagues.

After the 2010 pertussis outbreak in California, Omer and colleagues identified 39 population clusters with high rates of nonmedical exemptions from vaccination and found pertussis cases were 20 percent more likely to pop up in those areas than elsewhere in the state.

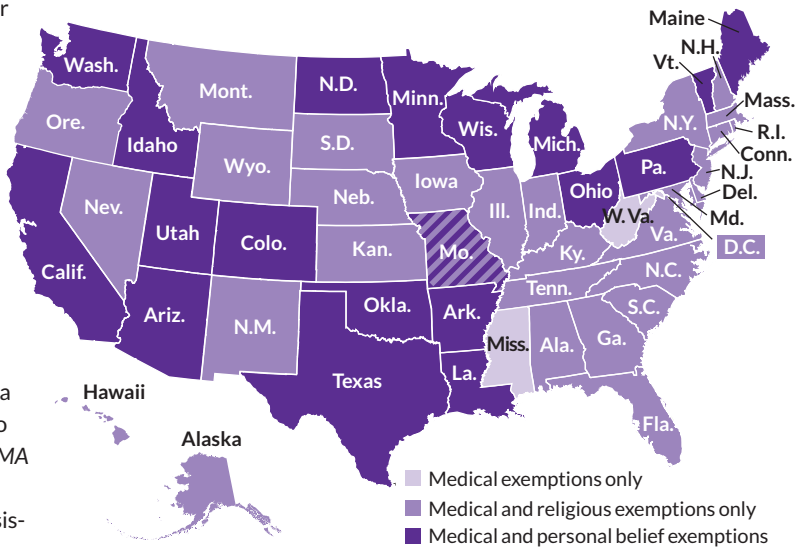
Even with recent outbreaks, whooping cough remains a vague and distant threat to many people. "It's not like polio in the 1950s," says Jason Glanz of the Kaiser Permanente Institute for Health Research Colorado. Up to 15 percent of children nowadays don't get shots on time, he says.

The current vaccine is weaker than hoped, but it's better than nothing, and missing shots means less protection, says CDC epidemiologist Stacey Martin. She and colleagues checked the histories of 682 children who had whooping cough and 2,016 others who didn't get sick during the California epidemic. The sick kids were one-ninth as likely to have completed a five-dose regimen of shots as were kids who never got sick, the scientists reported in *JAMA* in 2012.

Pediatricians can counter vaccination resistance with the right approach, says Douglas Opel, a pediatrician at the University of Washington in Seattle. Opel's team videotaped 111 doctor-parent conversations on vaccines, with permission. In *Pediatrics* in 2013, the scientists reported that most doctors started the vaccine chat with a declaration such as, "We have to do some shots today." Three-fourths of parents addressed that way promptly agreed to vaccination.

When the doctor was equivocal — "What do you want to do about shots today?" — only one of 24 parents promptly accepted. Three offered their own plan for their child, such as one shot per visit. The other 20 resisted, and fewer of their children ultimately got vaccinations on time.

"We live in a more consumerist society than we did 30 years ago," Opel says. "The doctor-parent relationship has become less authoritarian. I think that's a good thing. The flip side of that is everything becomes a discussion," he says, which can delay vaccination. — *Nathan Seppa*



State laws mixed Every state allows students to attend school without getting standard vaccinations if they have a medical reason. But some also exempt kids for religious reasons or their parents' personal beliefs. Missouri's personal belief exemption is limited to day care facilities and preschools.

SOURCE: D. DIEKEMA/*ANN. REV. OF PUBLIC HEALTH* 2014

VECTORAPZ, ADAPTED BY M. ATAROD

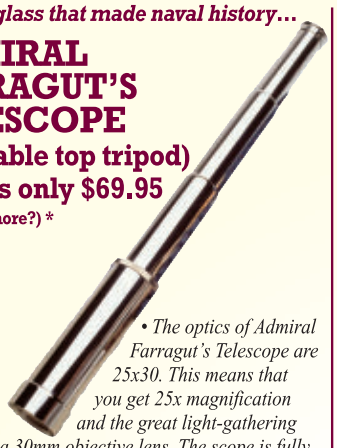
Three outstanding optical instruments from Jomira. Our exclusive imports, our exclusive prices*

***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

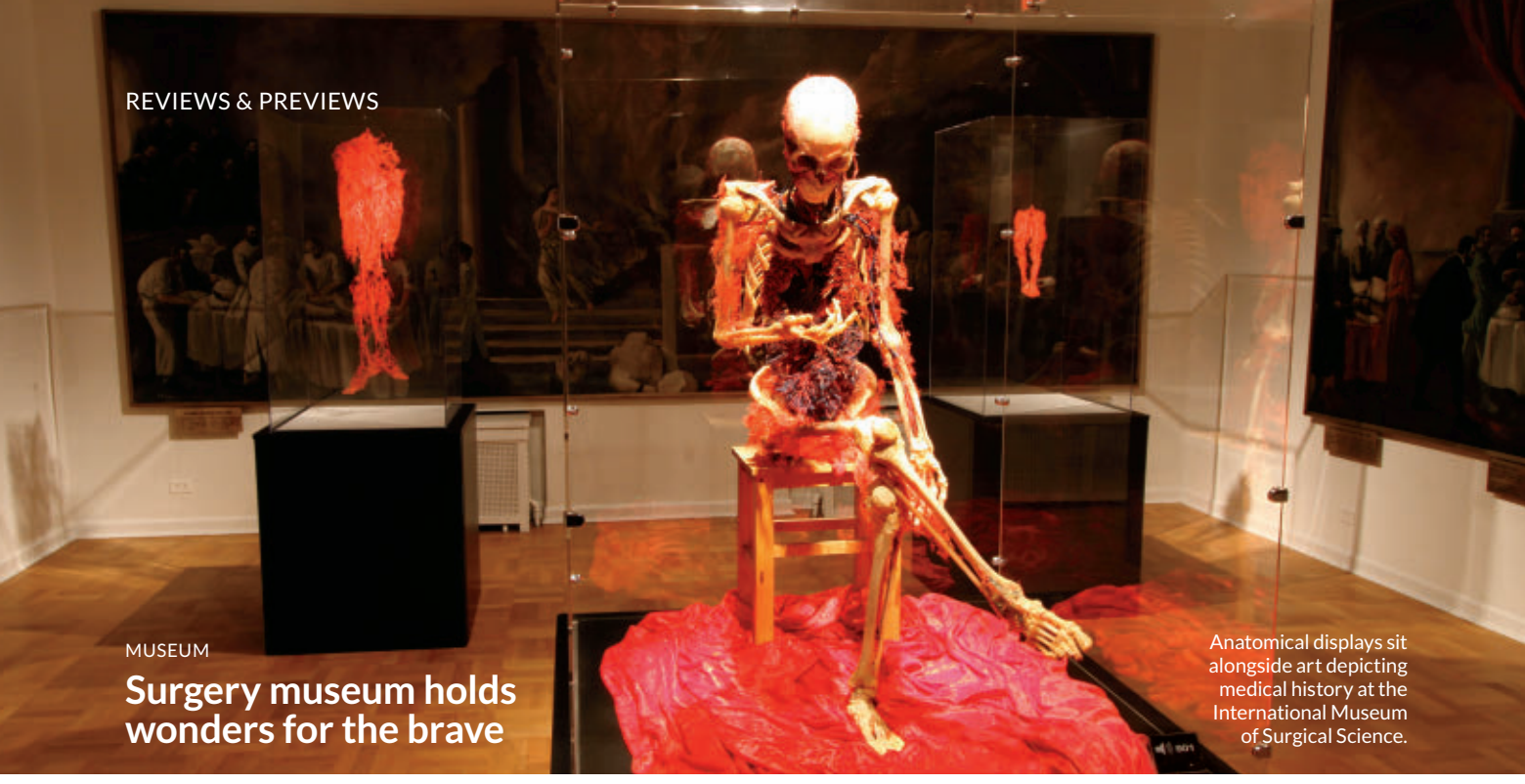
470 3rd St., #211, San Francisco, CA 94107

*** 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



MUSEUM

Surgery museum holds wonders for the brave

Anatomical displays sit alongside art depicting medical history at the International Museum of Surgical Science.

You would expect a place called the International Museum of Surgical Science to display a lot of sharp-edged instruments — and does it ever. From ancient blades used to cut holes in a patient's skull (a still-mysterious procedure called trepanation) to the modern devices used to remove blockages from blood vessels, this Chicago museum provides a fascinating historical tour of surgical technology.

In many cases the old gadgets on display would be thoroughly familiar to today's physicians. Surgical tools unearthed from the Roman city of Pompeii, smothered by volcanic ash in the year 79, are barely different from their modern analogs. These and other relics will appeal especially to those who are medically inclined or have an interest in history.

Yet the museum doesn't just dwell on past glories. Visitors can see how prosthetics have advanced from the days of peg legs and hooks to high-tech devices made with advanced alloys, and how anesthesia has evolved from a stiff gulp of booze to sophisticated mixtures of pain-killing gases and drugs. A display of artificial heart valves shows how surprisingly delicate the devices are and drives home the intricacy of repairing the human body.

Gazing toward the future, the exhibit *Surgicogenomics: Genes and Stem Cells in Surgery* offers the promise that a patient's detailed genetic information could someday be used to fine-tune treatment. Doctors could prescribe medicines and dosages based on how a particular patient, not just the population at large, might respond to a drug. Knowledge of a patient's genome may one day help doctors identify which patients might benefit from a procedure and which wouldn't, says Tobias Raabe, a geneticist at the University of Pennsylvania in Philadelphia and one of the exhibit's scientific advisers.

The museum resides in a four-story mansion about 2 kilometers north of downtown Chicago. Built in 1917 in the style of a French chateau, the mansion — converted into the museum in the early 1950s — is one of few historic mansions still standing along the lakefront, and the only one open to the public. Its rooms offer intimate spaces in which to view a variety of surgery-themed art alongside science exhibits.

A permanent collection of portraits and murals depicts significant people and events in surgical history, and shows contemporary works inspired by medicine or anatomy, says curator Lindsey Theiman.

Bucking the trend of new hands-on, experiential science museums, these are exhibits mainly for looking, not touching. Many of the artifacts are encased in glass. Large items, such as an apparatus once used by shoe salesmen to X-ray the feet of potential customers, are similarly "hands off."

Though little about the museum is interactive, one refreshing exception is the current artist-in-residence, Vesna Jovanovic, who spends half-days in her workspace at the museum at least twice each week and is happy to chat at length about her art, techniques and inspirations. Her latest work (shown, center) was inspired by French surgeon Alexis Carrel, who won the Nobel Prize in 1912 for developing ways to seamlessly stitch together major blood vessels. Its title, *Sadi Carnot*, is an homage to a popular French president assassinated in 1894. Carnot couldn't be saved because at the time surgeons couldn't repair his mortal stab wounds — a deficiency that Carrel corrected, to great acclaim. — *Sid Perkins*

FROM TOP: IMSS; VESNA JOVANOVIC

For museum hours and admission, visit **www.imss.org**

BOOKSHELF

The Thing With Feathers

The Surprising Lives of Birds and What They Reveal About Being Human

Noah Strycker

Bird nerds get an unfair rap as socially awkward. But in his second book, the affable author all but lassos readers with his binocular strap to bring people nose to beak with the plumed creatures he knows so well.

An ornithologist and editor at *Birding* magazine, Strycker has a knack for describing random avian encounters: "The first time I walked through the Adélie penguin colony at Cape Crozier, Antarctica, I quickly learned to step carefully." He makes tracking his feathered friends seem anything but tedious, whether he's haplessly (and happily) frozen in place as penguins untie his shoelaces, stopping two hummingbirds from killing each other in a Costa Rican jungle or stumbling upon a bowerbird's "artwork" in the Australian outback.

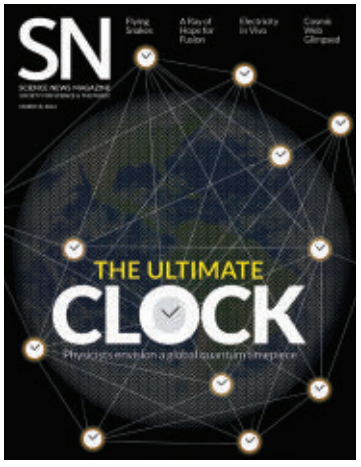
These adventures animate most of the chapters as he homes in on the striking attributes of various species, 13 in all. You could draw whole flocks of listeners by reciting his weird-but-true bird quirks and factoids. (Did you know that vultures' stomachs can neutralize anthrax spores?)

Strycker then links these findings to human behavior. In several cases, he pulls this off with aplomb, as when he deftly draws on social science, physics, video games, social media and Serena Williams to explain how murmurations (starling flocks) can fly in formation without careening into each other and how this applies to humans performing collective movements.

Sometimes his attempts to demonstrate how the bird world applies to people's lives result in anthropomorphic flights of fancy. A chapter on the phenomenon of snowy owl irruptions (excursions outside the birds' usual range) starts off strong, but peters out with the almost rhetorical "Do snowy owls have a wanderlust gene?" a question that neither he nor other scientists can truly answer. The writing becomes wobbly, peppered with qualifiers — "might," "seem," "probably" — making the reader wish Strycker had stayed in his comfort zone of observing fairy wrens and buzzard's nostrils as in the rest of this otherwise edifying and entertaining book. — *Laura Fisher Kaiser*

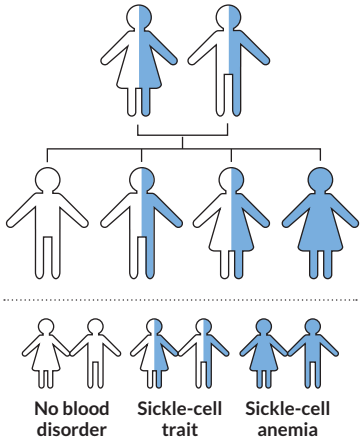
Penguin, $27.95

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



MARCH 8, 2014

Bad genes, good genes



A genetic mutation (indicated in blue) causes sickle-cell anemia. But people who inherit only one copy of the mutated gene receive some protection against malaria. Similar unexpected benefits may be the reason some other genetic disorders stick around in the population. SOURCE: CDC

Join the conversation

E-MAIL editors@sciencenews.org

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

Connect with us

Ancient genes persist

*Stone Age interbreeding with Neandertals appears to have left its mark in humans' genes. In "Neandertal hot spots highlighted in modern humans' DNA" (*SN: 3/8/14, p. 12*), **Bruce Bower** reported that variants in genes relating to skin and hair traits, as well as some autoimmune disorders, come courtesy of these ancient hominids.*

"I found your article fascinating, especially following my recent reading of Svante Pääbo's book on the topic (*Neanderthal Man: In Search of Lost Genomes*, reviewed in the same issue)," reader **Sala Horowitz** wrote in an e-mail. "I can surmise why a skin genome legacy from our cousins might have proved useful in human evolution, perhaps to more efficiently synthesize vitamin D from sunlight, but why would a genetic inheritance for autoimmune diseases not have been selected against?"

It's a good question, says **Bower**, and one that scientists haven't answered definitively. "Perhaps genes involved in lupus and a few other autoimmune conditions were also involved in other, beneficial processes. This appears to be the case with sickle-cell anemia (see left): The mutation that causes the disorder warps the shape of oxygen-carrying proteins in red blood cells, but it also produces compounds that protect against malaria in individuals who carry just one mutated copy of the gene and don't have the disease. Whether genetic variants associated with autoimmune disorders offer advantages of their own is, as the scientists like to say, a matter for further research."

Reactions to a fusion milestone

*In "Step taken toward ignition" (*SN: 3/8/14, p. 6*), physics writer **Andrew Grant** announced that the National Ignition Facility recently achieved fusion reactions that briefly sustained themselves. The results represent progress in the quest to achieve ignition, a crucial first step in producing usable energy from fusion reactions.*

Some readers responded optimistically to the news. "I visited the Princeton stellarator while I was in high school in 1960 or 1961," commented **Tom** on the *Science News* website. "Surprise, I'm still a believer. It is one of the main energy sources of the universe and it's the civilized power source. I'd like to see it happen in my lifetime, but I'd accept waiting until my grandchildren could enjoy it when they're my age."

Others, though, were more reserved with their enthusiasm. "It seems fusion is always 20 years away from scientists handing it off to engineers," **Jan Steinman** said. Commenter **VietVetBob** agreed: "I've been watching this science for 40-plus years now, and as Jan said, it always seems 20 years away. I've been waiting a long time for that free energy bill."

Bacteria for better energy

*In "Spore power" (*SN: 3/8/14, p. 4*), chemistry writer **Beth Mole** described the science behind a new generator that harnesses mechanical energy from swelling and shrinking* Bacillus *spores to produce an electric current.*

"In a practical arrangement, wouldn't the spores either quickly rot or become contaminated? They must need some other nutrients to stay alive," wrote **Mark S.** in the online comments. "Would the surface need to be constantly recoated with new spores?"

The spores are actually incredibly hardy, says **Mole**, because they're metabolically dormant. "They're not processing nutrients, so they don't need any rations. They can survive harsh conditions, such as extreme temperatures and dryness, and they have little risk of rotting. Though the researchers aren't sure exactly how long the spores could last, they have the potential to be stable on the power-generating device for long periods of time — possibly years."

As for contamination, **Mole** notes, "the researchers say the spore-covered device is no more likely to become polluted than any other type of machinery. They intend to test this in the long run and expect that, if needed, common chemical treatments could help keep the spores spotless."

E. OTWELL

Perfect Choice HD™ is simple to use, hard to see and easy to afford…

The invention of the year is great news for your ears.

NEW

Now with more power and clarity!

Affordable and Simple to use.

Virtually impossible to see.

Over the years, technology has made the way we live easier, safer and more convenient. In many cases, it's even made many products more affordable …(remember how much the first VCR used to cost?). Now, if you need some help, especially with soft or distant sounds, a new solution has been invented… it's called Perfect Choice HD™.

Perfect Choice HD is a PSAP (Personal Sound Amplification Product)... a new type of device intended to amplify sound for non-hearing impaired consumers. PSAPs are specifically designed to help with situations like listening to lectures with a distant speaker or listening to soft sounds that would be difficult for normal hearing individuals to hear. We believe Perfect Choice HD is the best PSAP on the market today. It was invented by a world renowned doctor who leads a hearing institute here in the U.S. Perfect Choice HD utilizes the latest, simplest, digital technology so it delivers outstanding performance. And because we've developed an efficient production process, we can make a great product at an affordable price. The unit has been designed to have an easily accessible battery, and is small and lightweight enough to hide behind your ear… only you'll know you have it on. It's comfortable and won't make you feel like you have something stuck in your ear.

Perfect Choice HD is NOT a hearing aid and is not intended for people with a hearing impairment or hearing disease. Hearing aids can only be sold by an audiologist or a licensed hearing instrument specialist with hearing tests and fitting appointments. Once they have you tested and fitted, you could pay more than $5000 for a pair of hearing aids.

Try it for yourself with our exclusive home trial. We want you to be happy with Perfect Choice HD, so we are offering to let you try it for yourself. If you are not totally satisfied with this product, simply return it within 60 days for a refund of the full product purchase price. Don't wait…

Perfect Choice HD™

Call toll free now for the lowest price ever.

Please mention promotional code 47890.

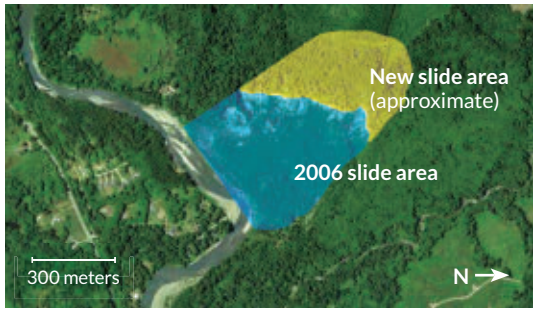
1-877-646-0430

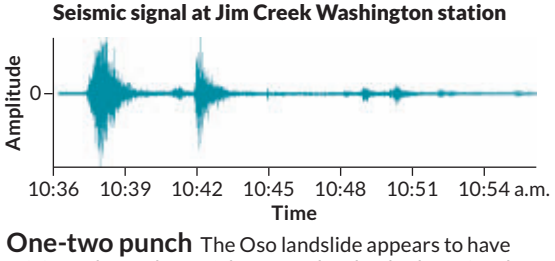
Perfect Choice HD is not a hearing aid.
If you believe you need a hearing aid,
please consult a physician.

81008

Seismic signals chronicle deadly landslide

At 10:37 a.m. local time on March 22, as much as 5 million cubic meters of sediment slid down a hillside outside Oso, Wash., killing dozens and damming a stretch of the North Fork of the Stillaguamish River. The debris scraping and bouncing downhill generated seismic waves like those unleashed during an earthquake. The pattern of these ground vibrations, recorded at regional seismic stations, allowed geologists to decipher the landslide's sequence of events. The stations first detected a roughly two-minute rumble, probably from a part of the hill that had experienced a landslide in 2006, says Kate Allstadt of the Pacific Northwest Seismic Network. The Stillaguamish River, she says, has been cutting into the toe of that landslide's debris pile and destabilizing it. Recent heavy rains may have further weakened the hillside, contributing to its collapse. About five minutes after the onset of the initial event, seismic stations picked up a second, less energetic two-minute slide, probably consisting of material upslope of the 2006 slide area. Smaller falls continued over the next few hours like aftershocks. The area has a history of notable landslides. Tracking landslides with seismic signals may one day allow the monitoring of these disasters in real time and in remote regions (*SN: 4/20/13, p. 11*). — *Erin Wayman*

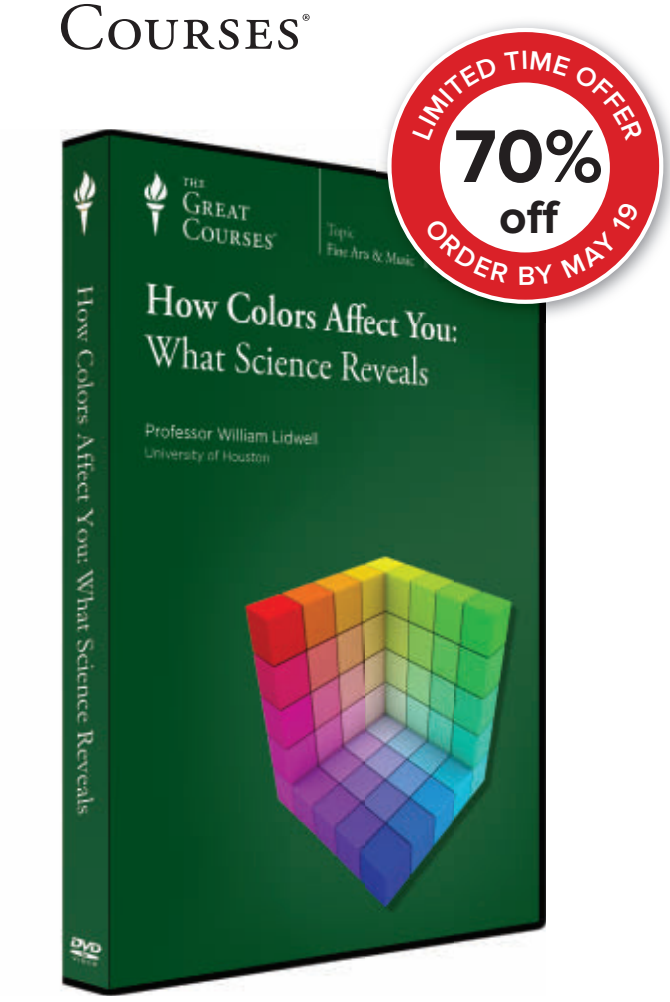




One-two punch The Oso landslide appears to have originated on a slope of the Cascades that had previously collapsed in 2006 (top). A seismic station 11 kilometers away recorded the initial slide, starting at 10:37 a.m. (bottom). At 10:42, the station detected a second big slip farther uphill.

FROM TOP: TED S. WARREN/ASSOCIATED PRESS; ©2014 GOOGLE, CNES, SPOT IMAGE, DIGITAL GLOBE, USGS, USDA; PNSN

THE GREAT COURSES®



See Color in a Whole New Way

There's an actual science behind how colors work on your eyes and your brain. And the secrets that scientists are uncovering offer astounding revelations on how colors influence the way you think, feel, and behave. Now you can learn how to tap into the power of color to create environments and achieve a range of visual goals in the six lectures of **How Colors Affect You: What Science Reveals**, taught by design expert and professor William Lidwell of the University of Houston.

A must-have course for corporate leaders, design professionals, marketers, and anyone who communicates visually, **How Colors Affect You** tells you everything you need to know about the science of color and its impact on all aspects of human experience.

Offer expires 05/19/14

1-800-832-2412

WWW.THEGREATCOURSES.COM/4SN

How Colors Affect You: What Science Reveals

Taught by Professor William Lidwell
UNIVERSITY OF HOUSTON

LECTURE TITLES

1. The Meanings of Color
2. The Black and White Lecture
3. The Red Lecture
4. The Yellow Lecture
5. The Green Lecture
6. The Blue Lecture

ABOUT YOUR PROFESSOR

Professor William Lidwell lectures at the Gerald D. Hines College of Architecture at the University of Houston. He also serves as Director of Innovation and Development at the Stuff Creators Design Studio in Houston, Texas. He earned his B.A. in Psychology from Texas State University and his M.S. in Interaction and Instructional Design from the University of Houston–Clear Lake.

How Colors Affect You: What Science Reveals
Course no. 7022 | 6 lectures (30 minutes/lecture)

SAVE $70

DVD ~~$99.95~~ NOW $29.95
+$5 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 95525

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. Nearly 500 courses available at www.thegreatcourses.com.

Stauer®
Outré Collection

TAKE UP TO 75% OFF INSTANTLY!
When you use your INSIDER'S PROMOTIONAL CODE

"Shockingly Immodest"

Our DiamondAura Outré Collection is inspired by the free-spirits of the Roaring Twenties who stayed up late, sang out loud and lived life as they liked...

The girl had a knack for trouble. Everywhere she went, she raised a ruckus. Her short hair and shorter skirts shocked polite society. Her outrageous behavior was deemed "unacceptable" for 1920s America. But that's just how she liked it. She was a flapper, a new breed of woman—liberated, spirited, unconventional. She danced the Charleston. She drank and smoked. And the only jewelry she wore was something impossible to ignore.

Complete the look with the 2 ctw DiamondAura® Outré Earrings for ONLY ~~$399~~ **$99***

SPECIAL OFFER

Purchase the DiamondAura® Outré Ring & Earrings Set for ONLY ~~$698~~ $179*

Our vintage-inspired, ***DiamondAura® Outré Collection*** is a good-time girl's best friend. The ring explodes with a barrage of brilliant, lab-created Diamond*Aura* stones set in gleaming .925 sterling silver. The earrings dangle like a chandelier laden with glittering stones that bounce back light with a flirtatious twinkle. Both pieces look like a cool million, but can be yours for **ONLY $99!**

Paying retail is for squares. How can we offer such an extravagance for less than $100? The secret is our exclusive lab-created Diamond*Aura*. State-of-the-art technology allows scientists to craft incredibly clear stones that are nearly indistinguishable from the world's most expensive mined diamonds. The result is vintage-inspired jewelry that catches more light and burns with brighter fire... for a fraction of the cost.

Shockingly immodest and gorgeously grand. Art Deco jewelry of the 1920s was designed to capture eyeballs. Flashy cocktail rings were the perfect complement to a hand waving a cigarette, raising a whiskey glass or dangling out the window of a roadster speeding toward the Hamptons. And the swing of drop earrings looked utterly fabulous on the dance floor. Mr. Gatsby may be long gone, but our ***Outré Collection*** keeps the party going!

Your satisfaction is 100% guaranteed. Wear the ***Outré Ring*** and ***Earrings*** for 60 days. If you're not convinced that they're the cat's pajamas or the bee's knees, send them back for a full refund of your purchase price. But once you see them, you may be tempted to stay out later, laugh a little louder, and raise an old-fashioned ruckus of your own!

Diamond*Aura*® Outré Ring — ~~$299~~

Promotional Code Price ***Only*** **$99** **+ S&P** ***SAVE $200!***

**You must use the insider promotional code to get the lowest price.*

1-800-760-8843

Your Promotional Code: OTR186-01
Please use this code when you order to receive your discount.

Stauer® 14101 Southcross Drive W., Dept. OTR186-01, Burnsville, Minnesota 55337 www.stauer.com

ACCREDITED BUSINESS
Rating of A+

Smart Luxuries—Surprising Prices™

Fiery lab-created DiamondAura® • .925 sterling silver setting • Whole ring sizes 5–10